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Experimental Archaeology
Part 1, 2005-2006

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Tools and Textiles – Texts and Contexts
Research Programme

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Contents

Introduction

The experimental research programme described in the following is a component of the *Tools and Textiles – Texts and Contexts* (TTTC) project directed by archaeologist Eva B. Andersson, PhD, and historian Marie-Louise Nosch, PhD. The first aim of this programme is to investigate the function of textile tools from the eastern Mediterranean areas that are dated to the Bronze Age using experimental archaeology as a method. The second aim is to explore experimental archaeology as a method, including its potential and risks.

Three experimental projects with different questions were performed during 2005 and 2006. Part one, presented here, took place in November-December 2005; part two took place in March-May 2006; and part three in November 2006. The experiments have been conducted by textile technicians Anne Batzer, a professional weaver working at the Lejre Experimental Centre in Denmark, and Linda Mårtensson, an archaeologist from Sweden and educated in prehistoric textile technology. For the sake of objectivity in the experiments, it is important that the tests be performed by craftspeople with different textile backgrounds.

Why use experimental archaeology? In Scandinavia and in other parts of the world, knowledge of textile techniques used in prehistoric times still exists, such as spinning with a drop spindle and weaving on a warp weighted loom. Several of these techniques are still practiced today and many have been carefully documented by archaeologists, ethnologists and others. By using tools that have been reconstructed from original finds, together with this handicraft knowledge, we can go one step further and discuss if, how and for what purpose the specific tools may have been used.

How can experimental archaeology be used? We often base our interpretations of a tool's function on experiments performed only in our minds. We ask ourselves questions such as what is reasonable and what is not. With experimental archaeology these questions are tested in practice. The results can be used to better our understanding of the archaeological record. However, just as with ethnographical studies of people working with traditional techniques today, we must bear in mind that the results never will explain exactly how something was done in prehistoric times. This is why every step in the experimental process and the results must be interpreted and used with source critical perspectives. To ensure scientific control over the experiments, they have been conducted according to TTTC's principles for utilizing experimental archaeology as a scientific method:

- The primary parameter to be investigated is function
- Raw materials, such as wool and flax, must be selected according to our knowledge of Bronze Age fibres and work processes
- Tools must be reconstructed as precise copies of archaeological artefacts
- All processes must be performed by at least two skilled craftspeople
- Every new test should be preceded by some practice time
- All processes must be documented and described in writing, photographed and some filmed
- All processes must be analysed individually
- All products must be submitted to external experts on textile analysis

Part one

During November and December 2005, the first part of the experimental research programme was carried out. There were two main aims: to test two different types of spindle-whorls and to weave with the spun thread. We also wanted to demonstrate to our collaborators of the *Tools and Textiles – Texts and Contexts* project the results we can obtain by using experimental archaeology as a method.

It is sometimes believed that the quality of the threads is directed by the spinner and can be varied with a whorl of any size. It has also been argued that whorls weighing less than 10g are too light to be used as spindle-whorls (see Carington Smith 1992). These positions have been questioned in experiments conducted on Scandinavian textile tools (Andersson 2003; Andersson & Batzer 1999). Two main questions were asked in the current experiments: how do we, as individual spinners, affect the spun thread and can whorls lighter than 10 g work as spindle-whorls? We decided to use wool fibres, since wool is frequently mentioned in the written sources from the Bronze Age (Ventris & Chadwick 1973: 313-323). The weight mentioned in this report should be understood as approximate, noting that the scales measured with an accuracy of 0.5 g.

Selecting fibre

The wool used in the experiments was selected according to existing knowledge of Bronze Age fibres. We have no information concerning exactly what kind of sheep existed and what kind of wool was used in the period and area. Because this information is not available to date, it was decided that wool with low uniformity in its fleece should be used. According to wool specialist and archaeologist Carol Christianson from the Shetland Islands, this heterogeneous mix of fibres in one fleece is recognised as a characteristic feature of primitive sheep, in contrast to most modern sheep, which have a high uniformity. We decided to use wool from Shetland sheep, which, among other kinds of sheep, have this characteristic feature (personal communication, Christianson 2005).

Wool can be different in many ways, within the same breed and even within one fleece. Out of several fleeces provided by Christiansen for our experiments, we chose a white fleece, weighing 2.7 kg, which had a staple length of 19-22 cm (fig. 1). This choice was made based on information concerning coloured textiles from the Bronze Age (Carington Smith 1992: 691f; Ventris & Chadwick 1973: 313-323). Moreover, white wool has good dyeing possibilities, and in our experience working with different types of wool, white wool usually is of stronger quality. The fleece was quite irregular and asymmetrical. After sorting the 2.7 kg fleece, removing felted parts, dirt and the most irregular parts such as the back and belly, we had 1.1 kg of rather homogeneous wool left to use in the experiments. The wool was mixed by consequently selecting tufts of wool from three different places on the fleece. The three tufts were mixed and then teased by hand, opened up at the bottom and the top and laid parallel. We tried to avoid placing the fibres upside-down on top of each other.

Fig. 1. White fleece from Shetland sheep.

Fig. 2. Wooden wool comb, used in experiments.

Preparing wool

We know from earlier experiments by Andersson and Batzer (1999) that too much underwool in a thin thread will make it open and irregular and the thread will easily break. We also know that the underwool can be reduced by using wool combs. The written sources tell us about "wool-carders" (Ventris & Chadwick 1973: 570), but nobody knows what the tools they used might have looked like or how they might have been used. Since the threads we were about to spin were supposed to work as a warp, weighed down by loom weights, we decided to use a wooden comb, even if to our knowledge none has been found in the Bronze Age Mediterranean. Perhaps they were made of organic materials, which are hard to find in excavations. Two wooden wool combs were made (fig. 2), inspired by the combs made of bone and wood, which have been found in the Caspian Sea area, some of them dated to the Bronze Age (Shishlina, Golikov & Orfinskaya 2000). Before the actual preparation of the wool, we conducted two small tests, one preparing the wool only by hand and one where we combed the whole portion of wool. We could feel a great difference between the two methods. By using only hands, it is difficult and time-consuming to separate even the worst underwool, while the comb makes it easier and gives you a choice of how much underwool you want to discard. We decided to use a method in between the two just described. We prepared the wool foremost by hand with a little help from one wool comb. By using one comb primarily on the ends of the wool fibres, we could better clean the wool of defects such as wrong cuts, felted parts and exceptionally fuzzy and short underwool. In this way, the wool was not truly combed, but rather hackled at the ends[1]. Twenty-two percent of the wool was discarded in this process. Finally, the wool was fastened in the comb and pulled out of the comb with one hand into a band of fibres (fig. 3). In this way, we also removed some of the underwool which remained on the comb. The bands were then formed into balls, ready for spinning. It took about 6 hours for Batzer and Mårtensson to prepare 170 g of wool. It must be kept in mind that 170 g corresponds to only about 6% of this sheep's wool.

Fig. 3. Preparing fibres.

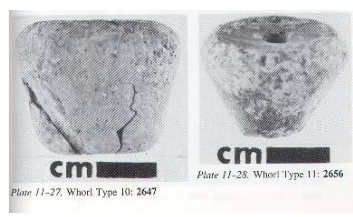

Fig. 4. Whorls from Nichoria.
Left: 18 g whorl. Right: 8 g whorl.
(Source: Carington Smith 1992)

[1] This way of preparing wool with only one wooden comb was inspired by our experience of combing wool with two iron-tooth combs.

Fig. 5. Ceramic whorls made at the Lejre Experimental Centre.

Spinning

One of the aims of the experiments was to test two different weight classes of whorls, one lighter than 10 g, to see if there were any differences or similarities in spinning with these different whorls. The tools that were used in the spinning tests were reconstructed copies of biconical and conical ceramic whorls from Nichoria, one weighing 18 g (whorl type 10: 2647) and the other weighing 8 g (whorl type 11: 2656) (fig. 4) (Carington Smith 1992). The reconstructions were carefully made by ceramist Inger Hildebrandt from the Lejre Experimental Centre. It was of the highest priority to select whorls with the same weight and volume as the originals, according to CTR's principles. Working with ceramics in reconstructions can result in problems with precision and shrinkage in the burning process. Although the whorls were carefully made, we only selected 5 whorls out of dozens (fig. 5) to use in our experiments: three 8 g whorls and two weighing 18 g (fig. 6). Because of the lack of known spindle rods from the period and area of interest, we decided to use rods made of wood that correspond to those used in an earlier experimental project (Andersson & Batzer 1999). The whorls were put on the spindle rods, 2.3-3.6 cm, from the bottom up, until they stuck onto the thicker lower part of the rod as in a low-whorl spindle (fig. 6). For the 8 g whorl we used a rod weighing 2 g and for the 18 g whorl we used a rod weighing 3.5 g. This means that the entire spindles weighed 10 g (8 g whorl) and 21.5 g (18 g whorl). Even though the tools' weight increased by 2-3.5 g when the rod and whorl were put together, we will continue using only the whorls' weight when referring to the two different spindles, since the whorls were the main focus in the reconstruction.

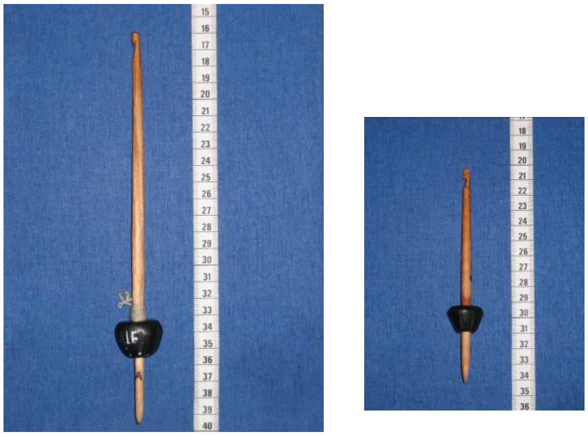

Fig. 6. Two of the reconstructed low-whorl spindles.
Left: 18 g whorl. Right: 8 g whorl.

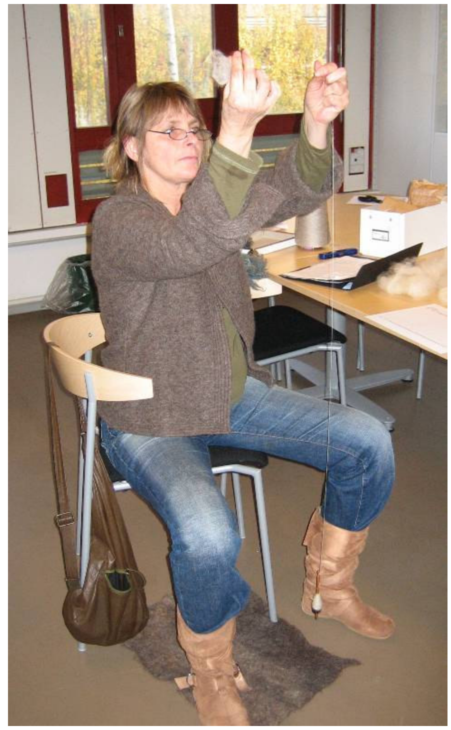

Fig. 7. Working position in the experiment with spinning.
The spindle is hanging freely: a suspended spindle.

Initial test spinning

We did not decide in advance how exactly to spin our thread, as one of our main questions was how two individual spinners affect the spun thread. Some restrictions, however, were made. For example, we decided to sit on chairs when we were spinning and we spun with a suspended spindle (fig. 7). We also decided to spin in a Z direction, because this is considered to be the usual method in the eastern Mediterranean area, with the exception of Egypt (Barber 1991: 66)[2].

We conducted one initial test spinning on the 8 g whorl. We did this because we wanted to get to know the tools and to get a feeling of how to spin with them in a relaxed way. Both spinners were comfortable with giving the spindle a twist by hand three times while the thread was spun, and then two final twists after approximately 1-1.5 m of spun thread. Of course, this varied from time to time depending on for example how easy the wool came out from the hand and how well the hand could manage to twist the spindle. By giving the thread two final twists, both spinners felt that the thread might hold as warp thread, which was the aim. After about 1-1.5 m, the thread was wound up on to the spindle rod. The spinning continued until the spindle was filled (fig. 8), meaning that the weight of the threads affected the rotation of the spindle negatively. We could see some differences in Batzer's and Mårtensson's ways of spinning. For example, in general, Batzer held her fibre very loose above her hand (fig. 7), which gave a smooth feel when the fibres were drawn out. Mårtensson, on the other hand, attached the fibres to her thumb in the beginning, in order to have control of the fibres, and when the ball got smaller, she held it like Batzer. Of course, the physical and mental condition of the spinners also had an influence on the spinning, and on when to stop.

2 See also Susan Möller-Wiering's report *State of research*.

Fig. 8. A filled spindle, 18 g whorl.

Fig. 9. Threads wound on bobbins.

Treating the thread

There is no evidence in archaeological records of tools connected to reeling the thread, as far as we know. For this reason, we chose to work with tools that we are familiar with. These tools and methods can perhaps give a hint of what to look for in the archaeological material. When a spindle was filled, the thread was wound onto a reel and marked with number and date. The two reels we used could bear 140 and 160 cm thread in circumference. The threads were moistened with water and then set to dry on the reel and stretched for approximately two days. Our experience tells us that in this way the twist on the thread will be set, and will not tangle, curl or shrink so much in the woven fabric later on. After this, the different bunches of numbered threads were taken off the reels for weighing and recording. In order to make it easier to handle the threads in the weaving process, the threads were wound onto small bobbins (fig. 9).

Experimental test spinning

To test how two individual spinners affect the spun thread, both Batzer and Mårtensson performed each spinning test, with one filled spindle in each test. Each test was documented in a spinning table (Appendix 1-2). One line and number in the table represents one spindleful. The weight and length of the threads and the time it took to spin a full spindle were measured in each test.

	yarn weight g	yarn length m	spinning time h
Batzer, 15 tests	36.5	402.2	9.8
Mårtensson, 15 tests	40	383.9	9.5
Tot. 30 tests	76.5	786.1	19.3

Fig. 10. Total result, 8 g whorl.

	Yarn weight g	yarn length m	spinning time h
Batzer, 6 tests	26	173	3.8
Mårtensson, 6 tests	30.5	177.6	3.3
Tot. 12 tests	56.5	350.6	7.2

Fig. 11. Total result, 18 g whorl.

As one of our main questions was how whorls lighter than 10 g work as spindle whorls, we chose to devote more time to experimenting with the 8 g whorl than with the 18 g whorl. Thirty tests were conducted with the 8 g whorl (fig. 10). Each spinner conducted 15 tests. All 3 reconstructed whorls were used. Figs. 12-14 illustrate the maximum, minimum and the mean result of all filled spindles spun with the 8 g and 18 g whorl, according to spinning time, yarn length and yarn weight. The maximum and minimum results show that there is significant variety within the individual spinning. The relationship between the productions of two individual spinners becomes clear when comparing the mean results. Recording time, length and weight, the threads from the two spinners' work with the 8 g whorl are rather similar.

Testing the 8 g whorl

While spinning with the 8 g whorl, some important observations were made. We could for example feel that the spinning was greatly affected by whether the spindle-hole was centred or not. The spindle required more force from our hands to rotate properly if the hole was even fractionally unbalanced. We could also sense the effect of not using combs for combing out most of the short underwool. The underwool and the coarse hair emerged quite irregularly and resulted in open, uneven threads with a propensity to break easily. We could feel that there is an obvious relationship between the wool quality, the preparation of wool and the final thread. It required immense concentration to spin with the 8 g whorl. It is doubtful that other duties involving, for example, walking around can be performed while spinning with these whorls.

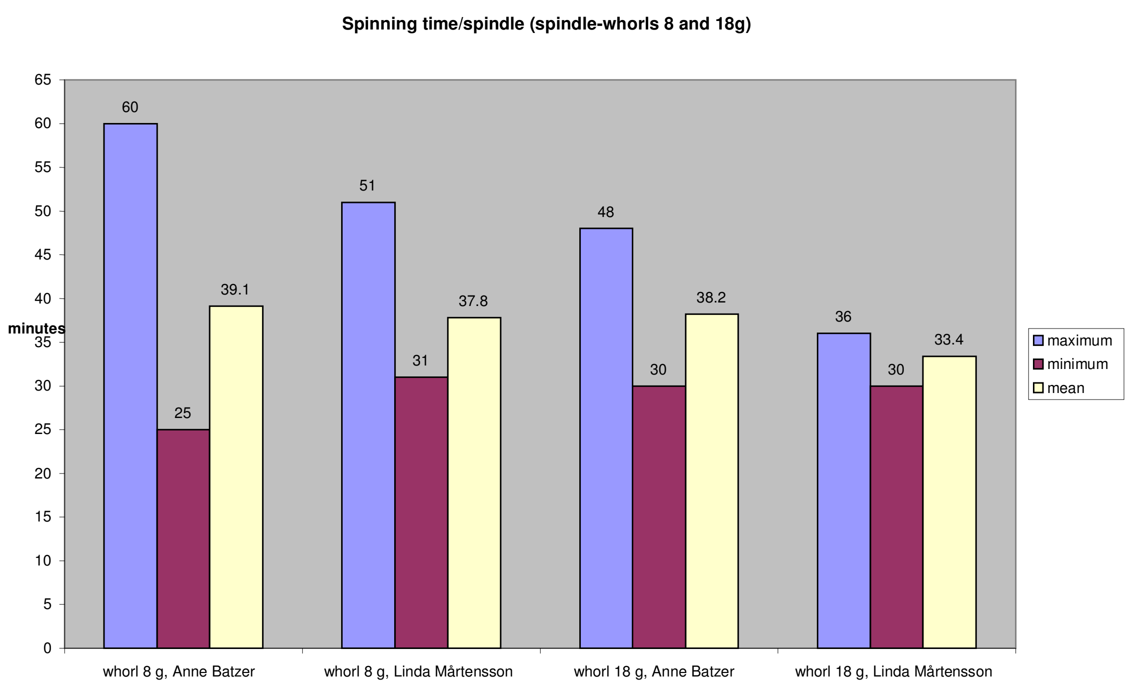

Fig 12. Spinning time for a full spindle, 8 g and 18 g whorl, Batzer & Mårtensson.

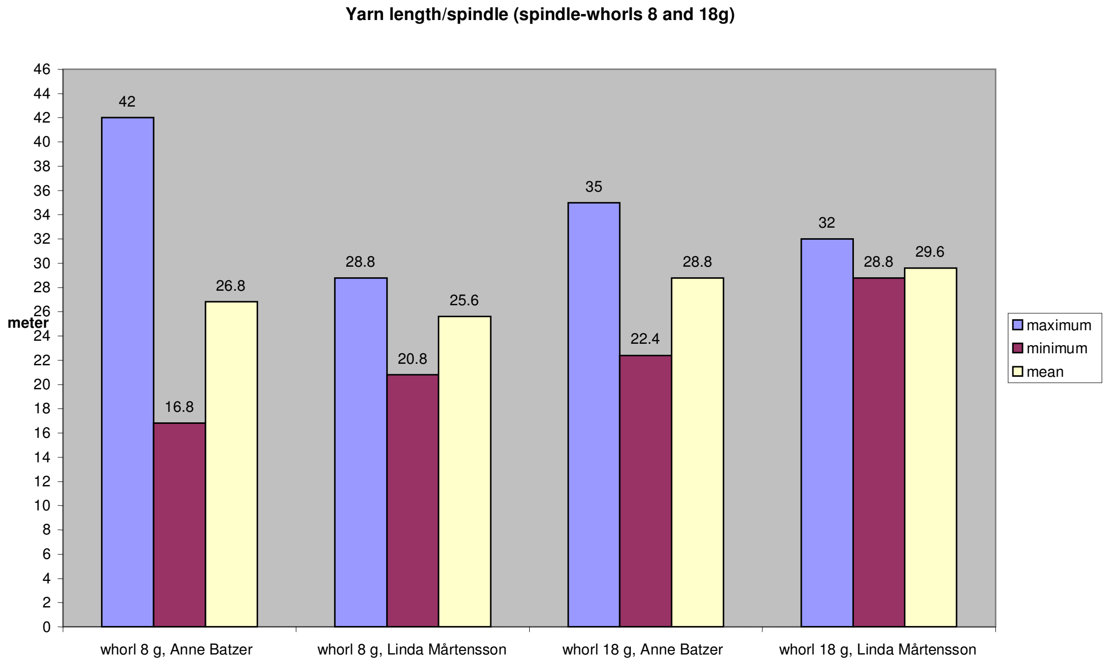

Fig. 13. Yarn length for a full spindle, 8 g and 18 g whorl, Batzer & Mårtensson.

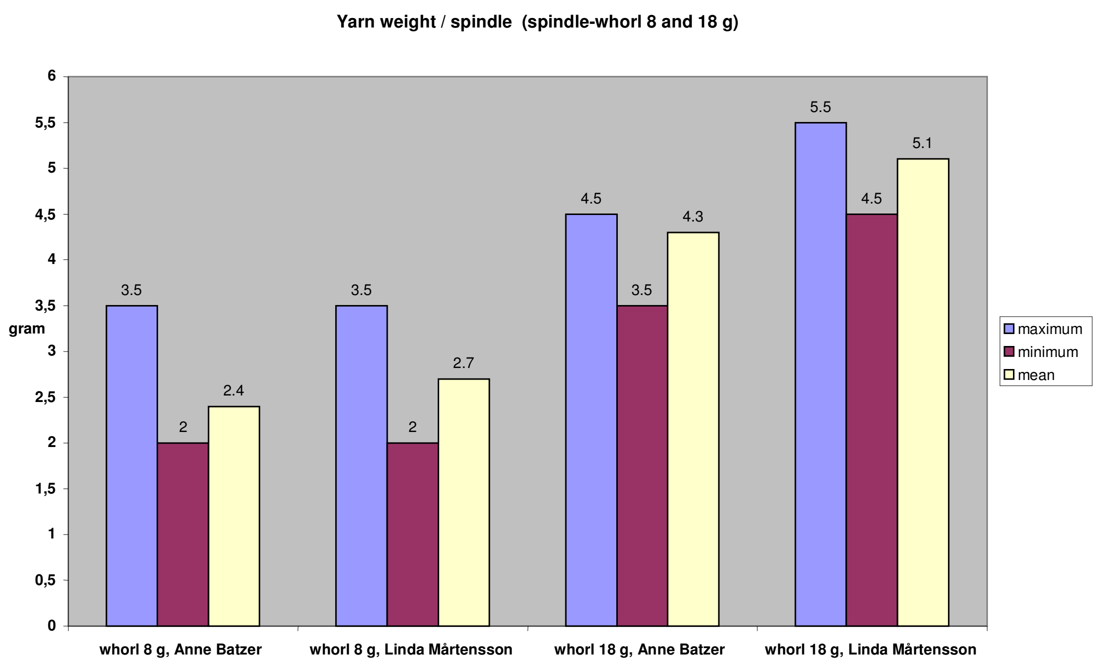

Fig. 14. Yarn weight for a full spindle, 8 g and 18 g whorl, Batzer & Mårtensson.

Testing the 18 g whorl

Twelve tests were conducted with the 18 g whorl, each spinner conducted 6 tests (fig. 11). As with the 8 g whorl, one can see variety within the individual spinning, in terms of the maximum and minimum results of the total spinning (figs. 12-14). According to the mean result, the threads from both spinners are quite similar in length, but not in weight. Mårtensson's threads are 0.8 g heavier according to the mean result (fig. 14).

Wool Consumption

In the first stage, after selecting the fleece to be used, 1.1 kg of wool of the total fleece was sorted out to be used in the experiments. At this stage the wool was unprepared and referred to as *sorted wool*. The sorted wool was then prepared manually and with the help of one wooden comb. Twenty-two percent of the wool was discarded in this preparation process. The 78 % of the wool that remained for spinning is referred to as *prepared wool*. The consumption of prepared wool while spinning was also registered. Some irregularities in the wool were consciously discarded and registered during the spinning.[3] By measuring the wool discarded while spinning from the prepared tufts of wool and comparing the results with the weight of the threads, it is clear that the wool, overall, only lost about 5 g from overlooked spill, dust and dirt while spinning with the 8 g and 18 g whorls. The last stage and the final weight discussed here is the *yarn weight*.

	whorl 8 g, Batzer	whorl 8 g, Mårtensson	whorl 18 g, Batzer	whorl 18 g, Mårtensson
Sorted wool	27	29	35.3	47.4
Yarn weight	16.5	17.5	26	30.5
Discarded wool	10.5	11.5	9.3	16.9
Discarded wool %	***39%***	***40%***	***26%***	***36%***

Fig. 15. Consumption of wool, from sorted wool to spun yarn. Calculations on 8 g whorl are based on spinning tests no. 1-7, to exclude the miscalculated wool weight before spinning no. 8. Calculations on 18 g whorl are based on spinning tests no. 1-6.

In the preparation and spinning processes performed in this experiment, about 26-40% of the wool was discarded (fig. 15). However, all this discarded wool should not be seen as waste material. The discarded wool can be used for spinning threads of other qualities and for felting and as filling material. Some differences in wool consumption were seen between the two individual spinners during the spinning process. Mårtensson discarded 40% of the wool while spinning on the 8 g whorl, and 36% when spinning on the 18 g whorl. Thus, the amount of discarded wool was quite constant, even when using different types of whorls. For Batzer the situation was slightly different. Batzer discarded 39% of the wool while spinning on the 8 g whorl just like Mårtensson, but Batzer discarded only 26% of the wool when spinning on the 18 g whorl. Thus, Batzer discarded a smaller amount of wool when spinning on the 18 g whorl. Her spinning showed a significant difference in the amount of discarded wool for the two types of whorls. Consequently, Batzer discards much less

[3] Before spinning test no. 8 with the 8 g whorl, a new set of prepared wool was picked out, weighed and registered. Later, it was recognised that the registered weight of this tuft of wool was incorrect (Appendix 1-2, marked red). For this reason, spinning tests no. 8-15 are excluded from the discussion and the percentage calculation.

wool while spinning with the 18 g whorl than with the 8 g whorl, and also discards much less in comparison to Mårtensson. In spite of this, Mårtensson's yarn, spun with the 18 g whorl, weighs slightly more than Batzer's yarn (fig. 14), even though the length of the yarn is rather similar (fig. 13). A reasonable explanation for this is that Mårtensson consumes more wool than Batzer with the 18 g whorl, but at the same time Mårtensson tends to discard almost the same amount of wool when spinning with the 8 g whorl.

Thread samples for external analysis

Twelve samples, of more or less 2 m of thread in each sample, were sent for external analysis. Six samples were taken from spinning with the 8 g whorl. Batzer and Mårtensson spun 15 spindlefuls each with the 8 g whorl. Three samples were taken from each spinner. One sample was taken from the first half of the spinning tests, one sample from the middle and one from the second half of the spinning tests, without comparing the threads in advance, i.e., test numbers 4, 8 and 13 (fig. 16), thus obtaining samples from different stages of the spinning process. This selection took place before the results were analysed by Andersson, Batzer and Mårtensson.

Fig. 16. Samples from spinning with 8 g whorl.

Batzer:

No.	Whorl	Spindle	Wool type	Yarn weight g	Yarn length m	Spinning time min
4	**IIa**	**a**	**fleece 3**	**2.5**	**30.8**	**37**
8	**IIb**	**b**	**fleece 3**	**2.5**	**28**	**40**
13	**IId**	**a**	**fleece 3**	**2.5**	**30**	**50**
Mean result of no. 4, 8, 13:				***2.5***	***29.6***	***42***
Mean result of all 15 tests:				***2.4***	***26.8***	***39.1***

Mårtensson:

No.	Whorl	Spindle	Wool type	Yarn weight g	Yarn length m	Spinning time min
4	**IIb**	**b**	**fleece 3**	**2**	**25.6**	**41**
8	**IId**	**a**	**fleece 3**	**2.5**	**24**	**40**
13	**IIb**	**b**	**fleece 3**	**3**	**25.5**	**35**
Mean result of no. 4, 8, 13:				***2.5***	***25***	***38.6***
Mean result of all 15 tests:				***2.7***	***25.6***	***37.8***

Mean result of both Batzer and Mårtensson:	Yarn weight g	Yarn length m	Spinning time min
No. 4, 8, 13:	**2.5**	**27.3**	**40.5**
Mean result of all 30 tests:	**2.55**	**26.2**	**38.45**

Another six samples were taken from spinning with the 18 g whorl. Batzer and Mårtensson spun 6 spindlefuls each with the 18 g whorl. The samples were taken from test numbers 2, 4 and 6 without comparing the threads in advance and the selection took place before the results were analysed by Andersson, Batzer and Mårtensson (fig. 17). In this way we got samples from different stages of the spinning process, just as with the 8 g whorl.

Fig. 17. Samples from spinning with 18 g whorl.

Batzer

No.	Whorl	Spindle	Wool type	Yarn weight g	Yarn length m	Spinning time min
2	**IH**	**C**	**fleece 3**	**4.5**	**26**	**34**
4	**IH**	**C**	**fleece 3**	**4.5**	**32**	**43**
6	**IH**	**C**	**fleece 3**	**3.5**	**22.4**	**30**
Mean result of no. 2, 4, 6:				***4.16***	***26.8***	***35.6***
Mean result of all 6 tests:				***4.3***	***28.8***	***38.2***

Mårtensson

No.	Whorl	Spindle	Wool type	Yarn weight g	Yarn length m	Spinning time min
2	**IE**	**A**	**fleece 3**	**5**	**28.8**	**34**
4	**IE**	**A**	**fleece 3**	**5**	**28.8**	**30**
6	**IE**	**A**	**fleece 3**	**5.5**	**28.8**	**31**
Mean result of no. 2, 4, 6:				***5.16***	***28.8***	***31.6***
Mean result of all 6 tests:				***5.1***	***29.6***	***33.4***

Mean result of both Batzer and Mårtensson	Yarn weight g	Yarn length m	Spinning time min
No. 2, 4, 6:	**4.66**	**27.8**	**33.6**
Mean result of all 12 tests:	**4.7**	**29.2**	**35.79**

Representative or not?

It is important to clarify to what extent the samples that were sent for external analysis were representative for all spinning tests performed by Batzer and Mårtensson. By comparing the mean result of the samples from the tests that were sent with the mean result of all the spinning tests that were performed, one can get a picture of whether the samples were representative or not according to yarn weight, yarn length and spinning time.

The two mean results from spinning with the 8 g whorl show only marginal differences of 2-5%. The mean from spinning with the 18 g whorl also shows a minor difference of 1-6%. In the external analyses, the samples from spinning with both the 8 g and the 18 g whorl therefore are considered to be representative of all spinning tests performed by Batzer and Mårtensson, according to yarn weight, yarn length and spinning time.

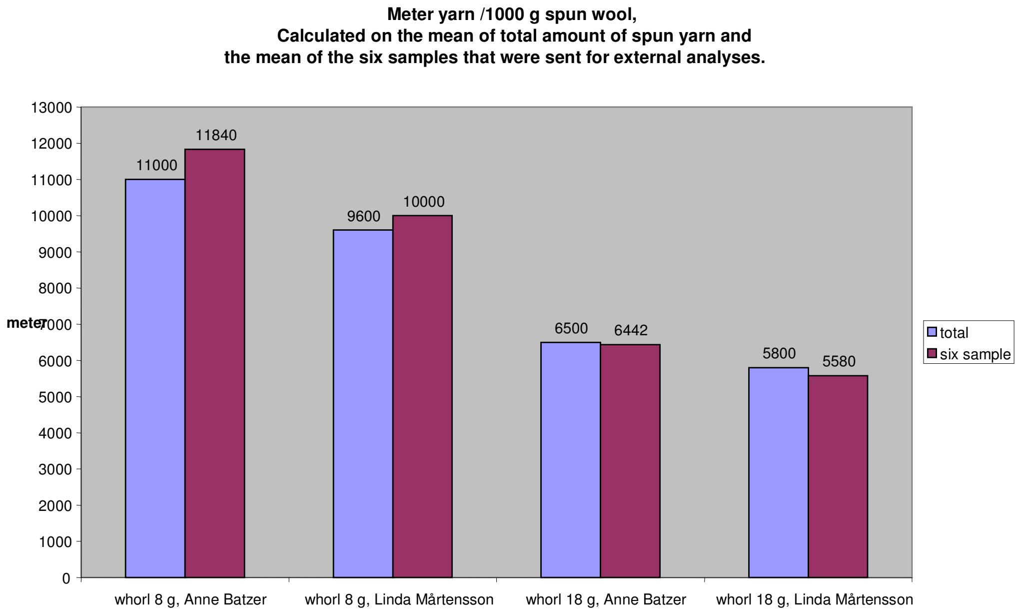

Fig. 18. Calculated meter yarn/1.000 g spun wool.

Conclusion: spinning

A comparison of the results from the spinning tests indicates that the two spinners seem to have spun rather similar threads in respect to length and time taken to spin a spindleful. These similarities were seen even though the spinners had different textile backgrounds and despite the variation between the different methods employed by the spinners and the amount of wool they discarded while spinning. The only clear difference between the spinners is seen in the weight of the threads spun with the 8 g and 18 g whorls. Mårtensson spun threads that consume more wool per metre with these whorls than did Batzer (fig. 18). By comparing the results from the two different weight classes of whorls, clear differences are again seen in the yarn weight. In the mean results of the yarn weight spun on the two different whorls, the threads spun with the 18 g whorl were much heavier (fig. 14; see also fig. 18). These differences between the two whorls can be seen in both Batzer's and Mårtensson's results. In this case, the results indicate that the tools, rather than the two different spinners, influence the amount of wool per metre

A further finding is that a whorl weighing 8 g works well as a spindle whorl, as long as the spindle-hole is centred. It was also confirmed that it would be better to use wool combs or other tools for sorting out the underwool, if light whorls of 8 g or even lighter are used and if the wool is of the same kind as used in this experiment. After working with the 8 g whorl we doubt that it is possible to perform other duties, like tending sheep, while spinning on this type of whorl.

Weaving

To understand a thread, its use and function must be taken into consideration. A thread can be spun for different purposes, for making bands, nets, clothes and so on. The main purpose of this component of the experiment was to examine the function of the thread spun on an 8 g spindle whorl. Since we have no detailed information on different weaving techniques from this period and area it was decided that the threads' function should be tested in an ordinary tabby weave. We started by making a sample with a warp length of approximately 1 m on a warp weighted loom. The warping was made on a wooden warping frame known from northern parts of Scandinavia (fig. 19). We made the warp with the help of a starting border (fig. 20), giving the sample a width of approximately 30 cm with 10-12 threads per cm, one half with only Batzer's warp threads and the other with only Mårtensson's (fig. 21).

Fig. 19. Warping on a warping frame.

Fig. 20. Making the starting border.

Loom weights

The loom weights used were reconstructions from Bronze Age Troy[4]. Two sets were made and tested. One set of flat trapezoidal loom weights weighed 108-112 g (original weight 121.5 g) with a thickness of 2 cm and a diameter of 7 cm (fig. 22). The other set consisted of discoid, rounded loom weights weighing 183-187 g (original weight 266.5 g) with a thickness of 2 cm and a diameter of 10 cm (fig. 23). The reconstructed loom weights lost some weight in the burning process even though some shrinkage was calculated from the beginning.

[4] The loom weights are described in detail in Margarita Gleba's report *Reconstruction of two loom weight sets from Troy*.

Fig. 21. Warp and loom weights on a warp weighted loom.

It has been assumed and experienced that 18-20 g/thread is a functional weight for thin threads like these. However, there has not been a systematic experiment focusing on the loom weights' relation to the quality of the thread yet. The lighter loom weights of 108–112 g gave a tension of 11g/thread. After weaving a piece with these weights, the loom weights were changed. The heavier loom weights of 183-187 g gave a tension of 18.5 g/thread. It was clear that 11 g/thread does not give the tension needed while weaving using these threads. For example, the whole warp, with loom weights, was unsteady and was easily lifted up when beating the weft thread. The phenomenon that the warp threads are moving in more open and tighter parts was also experienced with the lighter weights. The heavier, discoid ones gave the best relation between the weight needed and the width according to this warp. It is important to be aware of the weights' total width in relation to the width of the warp; it should be almost the same and still give the weight tension needed.

Fig 22. Trapezoidal loom weight.

Fig 23. Discoid rounded loom weight.

The weaving process

The threads spun by the two spinners appeared and worked quite similarly while weaving. No clear difference was seen. The threads were strong enough and very suitable to be employed as warp threads, i.e., no threads broke. With a thread count of 10-12 threads/cm, a quite open textile was produced (fig. 24). Since the threads were rather hairy and open, they easily stuck together in the warp while changing the shed, and would thus not be appropriate in a tabby weave with a closer thread count. Perhaps they would work better in a tight twill textile.[5] An important observation was made while weaving. Even though it was a small textile sample of about 30 cm in width, it was noticed that two persons working together could produce more than one person. When working together, about 45 weft threads were passed through the warp in one hour. When working alone, only about 30 wefts were made. After cutting the sample off the loom it measured 28 cm in width and 19 cm in length. The weaving sample was sent for external analysis.

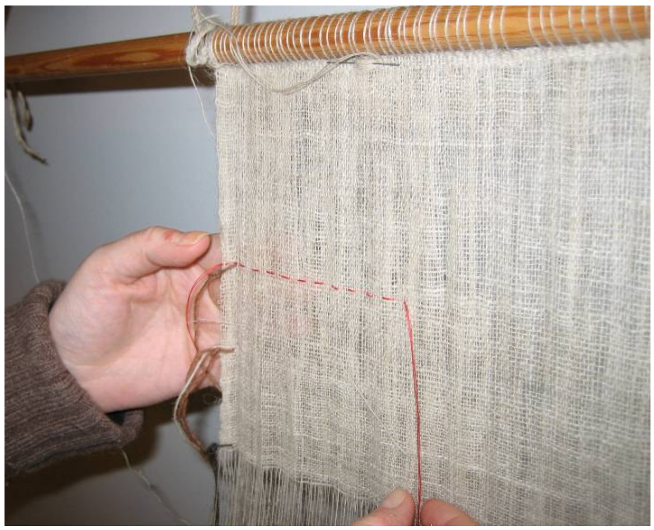

Fig. 24. Weaving sample on loom. The red threads indicate the part of the sample with threads in weft and warp spun only by Mårtensson.

Conclusion, part one

Two different types of spindle whorls were tested, one weighing 8g and one weighing 18 g. The results from the spinning tests indicate that the tools, rather than the spinners, influenced the quality of the threads. This result argues for the importance of detailed descriptions of spindle whorls. It can not be taken for granted that the quality of a thread is directed only by the spinner. The result also proved that a whorl lighter than 10 g works as a spindle whorl. It was also confirmed that threads spun on a whorl weighing 8 g are highly suitable for weaving an open tabby and might also be useful for other weaving techniques. The threads functioned well with a warp tension of 18.5 g/thread.

[5] One attempt to help the threads not stick together was tested by gluing the warp with a paste. The warp glue was made from Batzer's own recipe: 2 spoons wheat flour, 2 spoons beeswax and 1 dl hot water. The glue was smeared on the warp with a brush and left to dry before continuing weaving. No effect on the weaving was noticed from the glue.

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Appendix 1

	Linda Mårtensson									
nr	date	whorl	spindle	wool type	wool before (g)	wool left (g)	discarded wool (g)	yarn weight (g)	yarn length (m)	spinning time (min)
1	10-11-2005	IIb	b	fleece 3	22.5			2.5	28.8	51
2	10-11-2005	IIb	b	fleece 3				2	20.8	33
3	10-11-2005	IIb	b	fleece 3				3	25.6	37
4	11-11-2005	IIb	b	fleece 3				2	25.6	41
5	11-11-2005	IIb	b	fleece 3				2.5	20.8	31
6	11-11-2005	IId	a	fleece 3				2.5	27.2	38
7	11-11-2005	IId	a	fleece 3			4.5	3	27.2	37
8	16-11-2005	IId	a	fleece 3	39			2.5	24	40
9	16-11-2005	IId	a	fleece 3				3.5	28.8	41
10	16-11-2005	IId	a	fleece 3				3.5	28.8	32
11	17-11-2005	IIb	b	fleece 3				2	24	35
12	17-11-2005	IIb	b	fleece 3				2.5	22.4	32
13	17-11-2005	IIb	b	fleece 3				3	25.5	35
14	18-11-2005	IIb	b	fleece 3				2.5	25.6	38
15	18-11-2005	IIb	b	fleece 3		2	3	3	28.8	46
1	09-12-2005	IE	A	fleece 3	40.5			5.5	30.4	34
2	09-12-2005	IE	A	fleece 3				5	28.8	34
3	14-12-2005	IE	A	fleece 3				4.5	32	36
4	14-12-2005	IE	A	fleece 3				5	28.8	30
5	14-12-2005	IE	A	fleece 3				5	28.8	35,5
6	14-12-2005	IE	A	fleece 3		3.5	3.5	5.5	28.8	31

Appendix 2

	Anne Batzer									
nr	date	whorl	spindle	wool type	wool before (g)	wool left (g)	discarded wool (g)	yarn weight (g)	yarn length (m)	spinning time (min)
1	10-11-2005	II a	a	fleece 3	21			2.5	29	46
2	10- 11 2005	IIa	a	fleece 3				2.5	22.4	32
3	10- 11 2005	IIa	a	fleece 3				2.5	19.6	31.3
4	11- 11 2005	IIa	a	fleece 3				2.5	30.8	37
5	11- 11 2005	IIa	a	fleece 3				2	28	41.3
6	11- 11 2005	IIb	b	fleece 3				2.5	28	36
7	11- 11 2005	IIb	b	fleece 3			2.5	2	16.8	25
8	16-11-2005	IIb	b	fleece 3	39			2.5	28	40
9	16-11-2005	IIb	b	fleece 3				3.5	42	60
10	16-11-2005	IIb	b	fleece 3				2	24	35
11	18-11-2005	II d	a	fleece 3				2.5	26.6	36
12	18-11-2005	II d	a	fleece 3				3	29.4	50
13	18-11-2005	II d	a	fleece 3				2.5	30	50
14	22-11-2005	II d	a	fleece 3				2	21	35
15	22-11-2005	II d	a	fleece 3				2	26.6	32
1	09-12-2005	IH	C	fleece 3	41			4.5	26	34
2	09-12-2005	IH	C	fleece 3				4.5	26	34
3	20-12-2005	IH	C	fleece 3				4.5	35	48
4	20-12-2005	IH	C	fleece 3				4.5	32	43
5	20-12-2005	IH	C	fleece 3				4.5	31.6	40
6	20-12-2005	IH	C	fleece 3		13.5	1.5	3.5	22.4	30