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Part 3 Loom weights, 2007

Linda Mårtensson, Eva Andersson, Marie-Louise Nosch, Anne Batzer

Tools and Textiles – Texts and Contexts
Research Programme

The Danish National Research Foundation's
Centre for Textile Research
(CTR)
University of Copenhagen

Contents

Introduction

The experimental research described in the following is a component of the *Tools and Textiles – Texts and Contexts* research program (TTTC) directed by archaeologist Eva B. Andersson, PhD, and historian Marie-Louise Nosch, PhD. The first aim of the experimental research is to investigate the function of textile tools from the eastern Mediterranean area dated to the Bronze Age using experimental archaeology. The second aim is to explore experimental archaeology as a method, including its potentials and risks. Three parts of research focusing on different questions have been performed during 2005 and 2006. Part 1 took place in November-December 2005; Part 2 in March-May 2006 (Mårtensson *et al.* 2006; 2006a; 2006b); and Part 3, presented here, took place in November 2006. The experiments have been conducted by textile technicians Anne Batzer, professional weaver working at Lejre Historical-Archaeological Experimental Centre (HAF) in Denmark, and archaeologist Linda Mårtensson, CTR, trained in prehistoric textile technology.

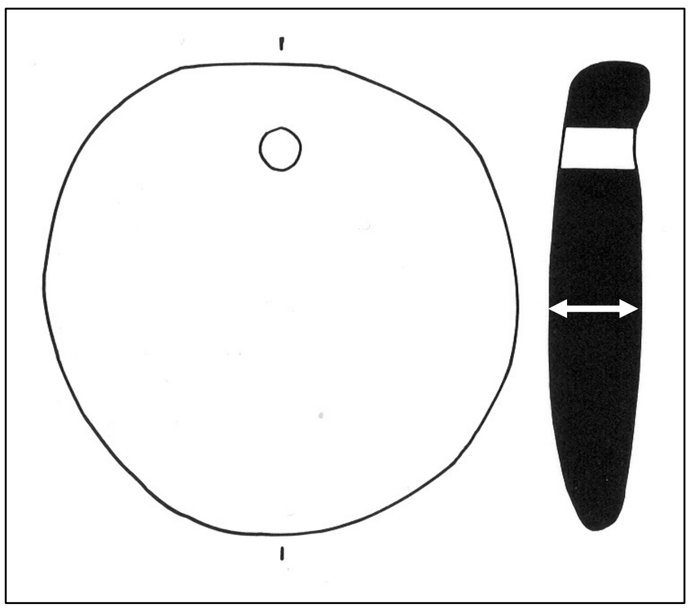

Fig. 1. Example of loom weight demonstrating what we mean by thickness.

Stage 3: Loom weights

There are several shapes and weights represented among the loom weights in the archaeological material from the Bronze Age Mediterranean area. The diversity in shape and weight has been explained in terms of cultural, geographical or chronological factors. In this third part of the experimental research, however we have focused on investigating if the diversity in shapes instead reflects the loom weight function. Such an investigation will further include the important elements in the weaver’s choice of loom weights. Comprehensive knowledge of these elements is of importance when recording and interpreting loom weights as archaeological material.

In previous experiments, different scholars have established that the weight of loom weights influences weaving on a warp weighted loom.[1] In the present study, however, we have focused on different thicknesses of loom weights (fig. 1). We have observed that in order to obtain an arrangement where the loom weights are hanging side by side at the same level and with an optimal tension per thread, loom weight maximum thickness plays an important role. The loom weight thickness defines how close they can hang side by side. The height of the loom weight as well as its diameter partly defines its weight. However, they are of minor importance during weaving since the loom weight is not obstructed in these directions.

This knowledge could perhaps be regarded as common sense. However, the thickness seems not to have been a subject of discussion when interpreting loom weights in the archaeological material. Nor have the influence of the thickness of loom weights on weaving been an object of systematic studies in experimental archaeology. In order to obtain a better understanding of the loom weight function, the experiments described in this report were devoted to investigate this aspect further. Since loom weights rarely have been objects for study in contrast to for example spindle whorls, a further aim in this third part was to develop methods for investigating the function of loom weights. The study could thus be regarded as a kind of "orientational experiment" (Malina 1983:75). The research question was: How does loom weight thickness affect the weaving process and the woven fabric?

Guidelines

The experiment was a pilot project since, to our knowledge, no other tests have previously been carried out to answer this research question. Since this experiment aimed at finding directions of how to design an investigation of the function of loom weight thickness, we did not strictly follow the principles for experimental archaeology, which have been applied in former TTTC experiments. However, three guidelines were still of importance:

- The primary parameter to be investigated is function
- All processes must be performed by at least two skilled craftspeople
- All processes must be documented and described in writing, photographed and some filmed

[1] In general, thin yarn requires less tension and thick yarn needs more tension. By tension we mean the weight per warp thread needed for optimal weaving. Different fibre material in the yarn and variations in the yarn quality might also influence what tension is suitable (e. g. Andersson 2003: 27-29; Gleba Forthcoming, note 11).
For example, regarding the tension of warp threads, in part 1, 2:1 and 2:2 of the *Tools and Textiles* experimental research, it was established that wool yarn spun with the 4 g whorl needed about 13 g/thread, wool yarn spun with the 8 g whorl needed about 19 g/thread and linen yarn spun with the same 8 g whorl needed similar weight per thread as the yarn made of wool, about 19 g/thread (Mårtensson *et al.* 2006; 2006a; 2006b).

Weaving on the warp weighted loom

The warp weighted loom can be operated in several ways, depending on for example what weaving technique is employed such as tabby or twill. Furthermore, the construction of the loom encourages creativity and personal ways of operating. Thus, one can use loom weights of different weight if one calculates the tension and distributes it evenly among the warp threads. Our angle of approach, however, is that weaving was well-planned. By this we mean that planning and preparing of weaving as well as selection of equipment was done with great care. Furthermore, 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.

In order to facilitate an evaluation of different loom setups in present weaving test a list of features needed for optimal weaving on a warp weighted loom was drawn. Obvious features such as good light and comfortable working position were not included. The list will provide criteria for optimal weaving in order to evaluate the results of the weaving in this report.

- Loom in stable position
- Appropriate weight tension per thread
- Even distribution of weight per thread in the whole loom setup
- Loom weights positioned in the same level
- Loom weights positioned side by side
- Loom weights stable, i. e. not whirling or tangling
- Warp threads hanging vertically and evenly distributed
- Warp threads do not tangle
- Warp threads do not break
- Shed easy to change
- Weft is easy to insert evenly
- Identical width of fabric throughout the weaving
- Edges of the weave are straight
- Even and regular feeling when weaving

In present investigation we decided to operate the looms in a uniform way in order to be able to compare and to document the loom weight influence on weaving in the warp weighted loom as well as on the resulting fabric. As such, the test was not a demonstration of individual weaver’s experience but rather was designed as a test of loom weights.

The loom setups

For the weaving tests two warp weighted looms from HAF were used. Batzer and Mårtensson worked side by side on two looms and were alternating between the two looms at regular intervals.

Loom weights

In the weaving tests, we used two different sets of constructed ceramic loom weights made by ceramist Inger Hildebrandt, HAF. They were not reconstructions of specific archaeological loom weights. One set was composed of 22 loom weights of a thickness of 4 cm (fig. 2), and the other set was composed of 22 loom weights of a thickness of 2 cm (fig. 3). All loom weights had identical weight (about 275 g) regardless of their thickness.

The loom weights were positioned side by side, close to each other, at the same level (fig. 2, 3).[2] This position of the loom weights has a practical function. If the loom weights hang in a zigzag line at various levels, the upper loom weights may cause wear damage on the warp threads. If they are not hanging side by side, they might cause a wavy appearance of the warp threads resulting in disturbance while weaving, and they might also tangle and twist the warp threads attached to them. Problems of tangling and jangling loom weights have been experienced and described elsewhere (Carington Smith 1992: 690). Having the loom weights positioned side by side, closely and at the same level, affects the total width of the row of loom weights. The loom weight thickness thus defines the width of the row of loom weights.

Fig. 2. 22 loom weights. 11 in each row.
Thickness: 4 cm
All together: approximately 50 cm.

Fig. 3. 22 loom weights. 11 in each row
Thickness: 2 cm
All together: approximately 28 cm.

Warp

The number of warp threads was chosen in accordance with the number of loom weights we had decided to use in the test. The yarn used was machine spun and made of wool. It was as similar as possible to the wool yarn spun with the 8 g whorl in Part 1: around 1,000 m yarn per 100 g wool (Mårtensson *et al.* 2006). We chose a yarn (worsted-like, Shetland sheep wool, single thread) from *Pulsen Design* ("100% New wool; count: 8.4; Code: 254; Batch: 30916"). This yarn required a warp tension of approximately 20 g per thread, resulting in bunches of 14 threads per loom weight. Identical number of warp threads attached to each loom weight was employed throughout all weaving tests.

Weft

The same yarn was chosen for the weft as for the warp. All samples were made as tabby weaves since this type of weave is documented in the Bronze Age eastern Mediterranean. The weft was put in as a bow, with 2-4 cm space between the weft and the fabric (fig. 4), with the help of a bone pin beater (fig. 5). After this, the shed was changed and the weft thread beaten up with a wooden sword. The aim was to let the loom weights define the result. Therefore, we did not stretch the fabric by pulling it with our hands or with any kind of spreader in order to even out the distribution of the

[2] Loom weights positioned side by side at the same level on a warp weighted loom is seen depictured in Icelandic drawings from the 17th century AD (Hoffmann 1974:116, 117).

weft or the warp threads or to obtain straight edges. We also kept the chain spacing cord with the same width as the row of loom weights throughout the tests. In not manipulating the weaving and loom setup too much, our intention was to focus primarily on the loom weight influence on our weaving. In the two first woven samples, described in the following text, we worked with a balanced fabric in mind.

Fig. 4. Weft thread inserted in the shed.

Fig. 5. Pin beater.

Weaving tests

In total, 4 tests of weaving in different loom setups were made, producing 4 different samples. These will be treated separately in the following text. First weaving sample 1 and 2 will be described since the aim with the two first ones was different from weaving sample 3 and 4.

Loom setups 1 and 2

Aim: to investigate the influence of the loom weight thickness on weaving

Method: to use loom weights of two different thicknesses in two identical setups on two warp weighted looms.

Loom setups 3 and 4

Aim: to demonstrate optimal weaving

Method: on the basis of the conclusions drawn from the work with setups 1 and 2, to adjust two new setups on two warp weighted looms still using different thicknesses of loom weights.

In the following, the number of threads per cm is calculated on the basis of 10 cm. These measurements were taken when the samples were cut down from the loom. In the thread count, ***top*** means measured close to the starting border and ***bottom*** means measured close to the end of the fabric.

Evaluations and measurements were documented after about every 10 cm of weaving. Every sample was measured in the same way during the weaving process and after it was cut down from the loom.

Weaving sample 1 and 2

Two identical warps were set up on two warp weighted looms, with each starting border measuring 34 cm in width (fig. 6). One was attached to the 4 cm loom weights (Sample 1) (fig. 2) and the other to the 2 cm loom weights (Sample 2) (fig. 3). There were 22 loom weights in each loom (11 weights in each layer, front and back).

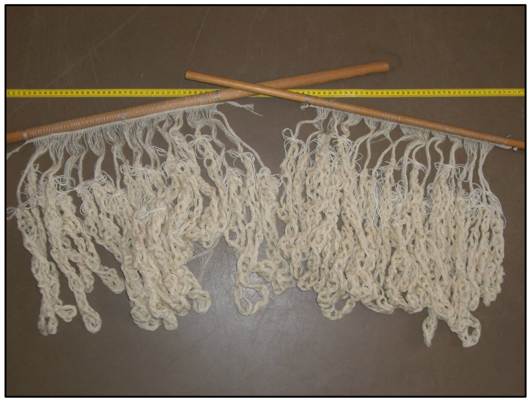

Fig. 6. Two identical starting borders, 34 cm, 308 warp threads in each.

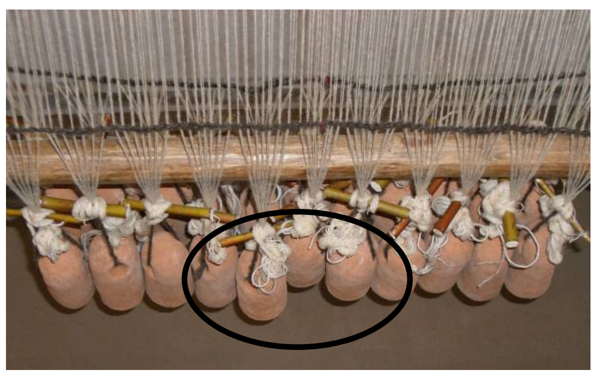

Fig. 7. Example showing loom weights hanging slightly zigzag.

Weaving sample 1

Starting border: 34 cm.

Thickness of loom weights: 4 cm.

Total width of row of loom weights: approximately 50 cm.

The total width of the loom weights (50 cm) exceeded the width of the starting border (34 cm). It was soon noticed that the narrow starting border affected the position of the loom weights. The loom weights in the middle were sometimes hanging zigzag (fig. 7), not side by side, giving a wavy and uneven appearance to the warp threads. This was to some extent caused by the force of gravity. It must be mentioned, however, that the 4 cm thick loom weights had a cylindrical shape which allowed them to hang more clustered. Loom weights with fairly flat sides would have been preferable if the loom weights should keep their position hanging side by side.

Due to the large width of the row of loom weights, the warp threads were hanging outwards (fig. 8). Because of this, the warp threads in the edges were more open than in the middle of the fabric, giving it an uneven appearance. In the middle, the warp threads were rather locked in their tight position. The arrangement of outwards hanging warp threads was thus contributing to an irregular feeling while weaving.

The shed was easy to change since the warp threads were hanging outwards (fig. 8), becoming more open where the heddles were placed than in the starting border.

In spite of the uncomfortable feeling while weaving due to the awry and somewhat wavy hanging warp threads, the fabric became rather even and the edges quite straight (fig. 9). To conclude, the weaving was negatively affected by the arrangement of the loom weights in this setup. The resulting fabric, however, was not markedly influenced.

<u>Warp threads per cm/weft threads per cm</u>

Top: 8.8/7.7
Bottom: 9/6.9

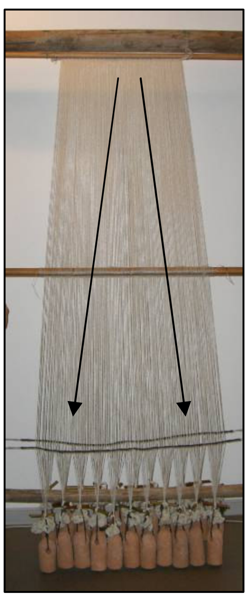

Fig. 8. Loom setup 1, with loom weights of a thickness of 4 cm.
Arrows pointing out, in an exaggerated way, the direction of the warp threads.

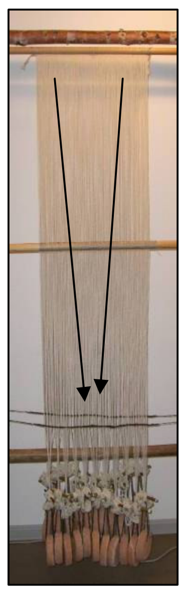

Fig. 10. Loom setup 2, with loom weights of a thickness of 2 cm. Arrows pointing out, in an exaggerated way, the direction of the warp threads.

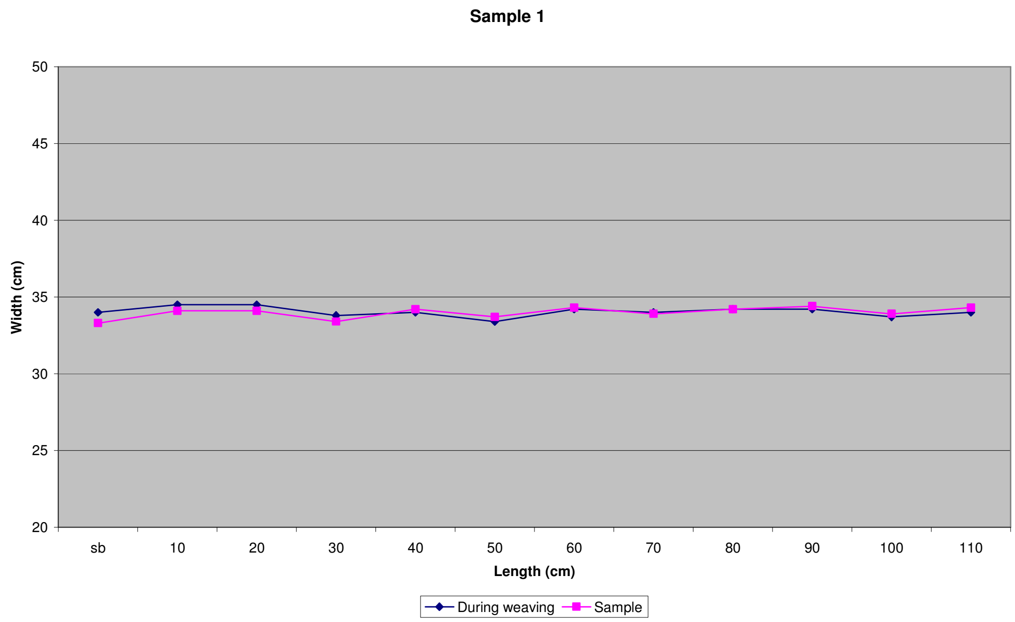

Fig. 9. Graph showing the width of sample 1 every 10 cm of the total length. sb=starting border.

Weaving sample 2

Starting border: 34 cm.
Thickness of loom weights: 2 cm.
Total width of row of loom weights: approximately 28 cm.

The width of the starting border (34 cm) exceeded the total width of the row of loom weights (28 cm). The warp threads were hanging slightly inwards (fig. 10). This affected the weaving and the resulting fabric. Since the warp was getting narrower where the heddles were placed, the heddles caused wear on the warp threads which made them woolly and stick together. For this reason, the shed was difficult to change. The fabric gradually became narrower while weaving. The last 30 cm of weaving, however, was more regular as presented in the diagram (fig. 11). To conclude, the thickness of the loom weights affected both the weaving process and the resulting fabric negatively.

Warp threads per cm/weft threads per cm

Top: 9.7/6.7
Bottom: 11.9/6.9

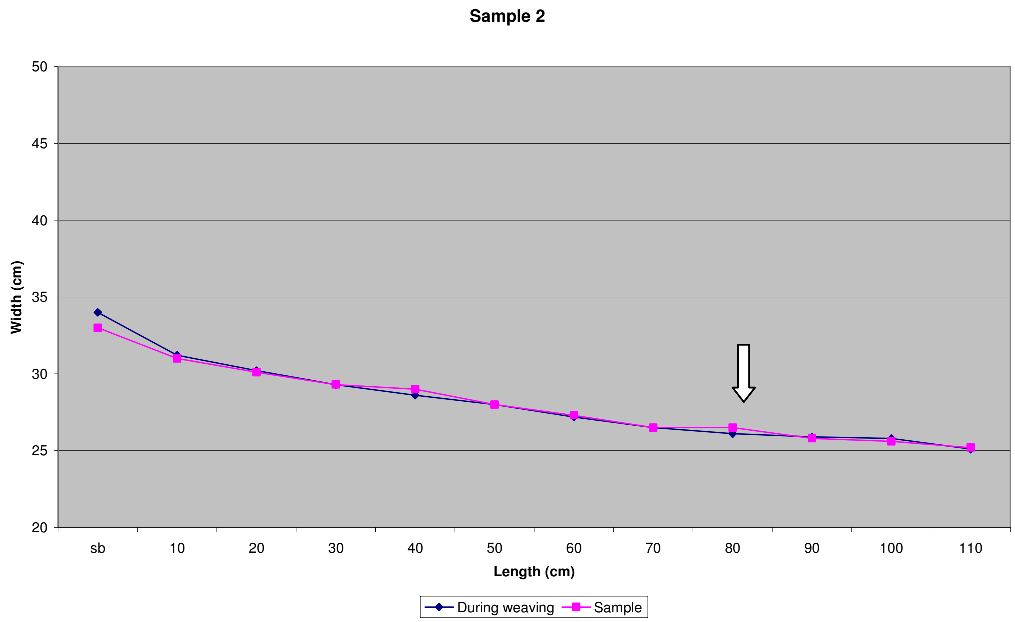

Fig. 11. Graph showing the width of sample 2 every 10 cm of the total length. sb=starting border. The arrow shows from where the weaving was more optimal.

Conclusion, sample 1 and 2

In the two warp weighted looms, with different loom weight thicknesses but otherwise identical setups, the influence of the loom weight thickness was clearly demonstrated. In sample 1, the warp threads were hanging outwards (∧) and in sample 2 they were hanging slightly inwards (∨). In order to clarify how these arrangements influenced the weaving, both of them were compared to the list of features in optimal weaving (fig. 12), which was presented above. Both setups had negative features, some of which were common for both setups. In both setups, the warp threads were not hanging vertically and were not evenly distributed and the weaving was neither even nor regular.

Both setups could thus be regarded as not optimal for weaving. The resulting fabric of setup 1, however, was a quite regular fabric in comparison to sample 2, except for the latter's last 30 cm (compare fig. 9 and 11), which a width of about 26 cm, that is just below the total width of the row of loom weights. Thus, we conclude that it is preferable to use loom weights with a total width which is identical or slightly larger than the width of the fabric to be produced. The principle of having a slightly wider warp than the wanted width of the fabric holds for weaving on a modern horizontal loom as well (personal communication, Batzer 2006). The consequences of these results are of fundamental importance since no one has included these parameters in the interpretation of loom weights from archaeological assemblages. By recording measurements of both weight and maximum thickness and furthermore combining this data with the results of experimental weaving, it is possible to outline the kind of textiles that could have been produced with a given yarn quality.

	Sample 1	Sample 2
Loom in stable position	+	+
Appropriate weight tension per thread	+	+
Even distribution of weight per thread in the whole loom setup	+	+
Loom weights positioned in the same level	+	+
Loom weights positioned side by side	-	+
Loom weights stable, i. e. not whirling or tangling	+	+
Warp threads hanging vertically and evenly distributed	-	-
Warp threads do not tangle	+	+
Warp threads do not break	+	+
Shed easy to change	+	-
Weft is easy to insert evenly	-	+
Identical width of fabric throughout the weaving	+	-
Edges of the fabric are straight	+	-
Even and regular feeling when weaving	-	-

Fig. 12. Sample 1 and 2 compared to features in optimal weaving.
+ corresponds to a positive result
- corresponds to a negative result

Weaving sample 3 and 4

As mentioned above, the aim for loom setups 3 and 4 was to demonstrate optimal weaving based on the conclusions drawn from the work with setups 1 and 2. Since it was confirmed in earlier tests that it is preferable that the total width of the loom weights is identical or slightly larger than the width of the fabric to be produced, we arranged both setups according to this principle. This was done by arranging two warps on the basis of not only the weight of the each loom weight but the thickness as well. Thus the warp threads were distributed evenly according to both weight and thickness.

Sample 2 had already been woven into a width of about 25-26 cm, which fitted well with the total width of the row of the 2 cm loom weights, measuring 28 cm. A small sample was made simply by continuing weaving this sample, in order to form sample 3 (fig. 13). Sample 2 and 3 were separated by a marker and were later cut in two pieces.

Setup 4 required a new loom setup (fig. 14). A starting border was produced measuring 48 cm, which corresponded well with the total width of the 4 cm loom weights, measuring 50 cm.

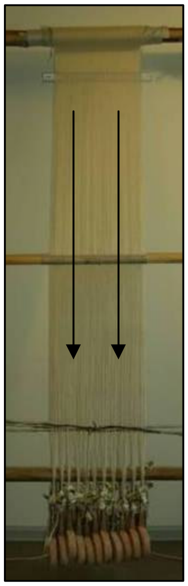

Fig. 13. Loom setup 3. Arrows pointing out the direction of the warp threads.

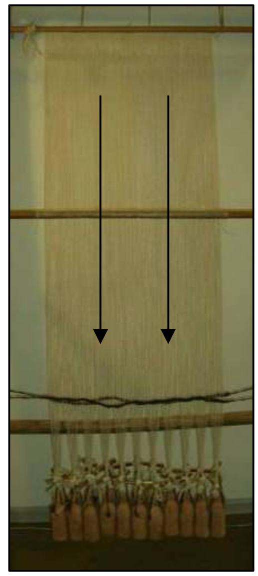

Fig. 14. Loom setup 4. Arrows pointing out the direction of the warp threads.

Weaving sample 3

Starting border: 25 cm.
Thickness of loom weights: 2 cm.
Total width of row of loom weights: approximately 28cm.

Since this setup necessitated a closer warp, it was suitable for producing a warp faced textile, in which the majority of fabric's surface is covered by warp threads. The tightness of the warp made the fabric firm and added to a regular and homogenous feeling while weaving. The weaving was even and regular from the beginning to the end, which is why we only made a small sample measuring 40 cm in length (fig. 15).

Changing the shed was somewhat hard-going. However, since weaving was more regular, the stress on the threads was evenly distributed and the resistant feeling when changing the shed was not a problem to the same extent as in setup 2. A resisting shed must be seen as a natural part of weaving tabby fabrics with a close warp. It should not, however, make too much wear and tear on the warp threads. To conclude, the thickness and weight of the loom weights were regarded as most suitable for this setup.

Warp threads per cm/weft threads per cm

Top: 12.9/6.6
Bottom: 12.9/6.6

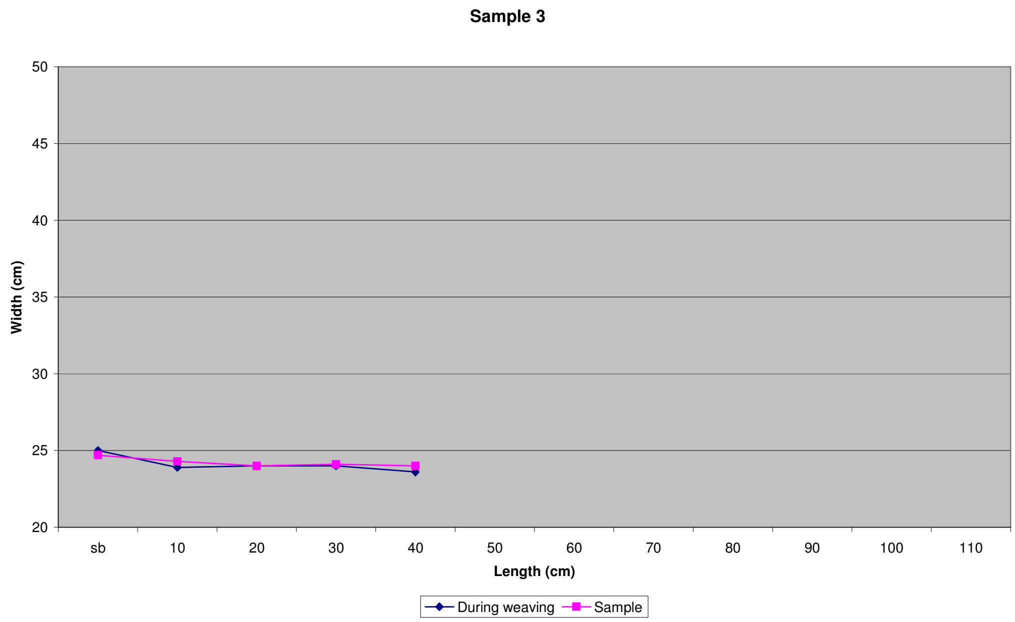

Fig. 15. Graph showing the width of sample 3 every 10 cm of the total length. sb=starting border.

Weaving sample 4

Starting border: 48 cm.
Thickness of loom weights: 4 cm.
Total width of row of loom weights: approximately 50 cm.

Since this setup required an open warp (compare with setup 3), it was suitable for producing an open and balanced tabby or a weft faced tabby, in which the majority of fabric surface is covered by weft threads. The first 70 cm were woven with an open and balanced tabby character in mind.

Without using any kind of warp spreader to keep the very open and movable warp threads in place, irregularities were unavoidable. The fabric was getting narrower (fig. 16), just like in setup 2. It was impossible to estimate to what extent the loom weights actually did influence the weaving in this setup. Such an open and movable tabby would normally have been straightened out with the help of cords attached to the edges of the fabric and the side beams of the loom. An educated guess, however, would be that thinner loom weights of the same weight in this setup would have drawn the warp threads even more together as it was the case in setup 2.

After 70 cm of weaving, we tried to make the fabric denser by pressing the weft threads harder as in a weft faced tabby. The fabric became even narrower. The width of the fabric was stabilised after 10 cm of weaving. The fabric became more firm and homogenous. The finishing width of the fabric, however, did not correspond to the staring width.

To sum up, it could not clearly be estimated how the loom weights influenced the weaving and the fabric. The reason for the fabric becoming narrower, however, should rather be found in the open warp. An open and balanced tabby makes the warp threads movable which is a factor unrelated to the loom weights and needs to be dealt with separately. If thinner loom weights were used, however, they would probably have drawn the warp threads even more together. Thus we conclude that, after all, the chosen loom weights were most suitable for this setup.

<u>Warp threads per cm/weft threads per cm</u>

Top: 6.9/6.6

Bottom: 6.3/8.9

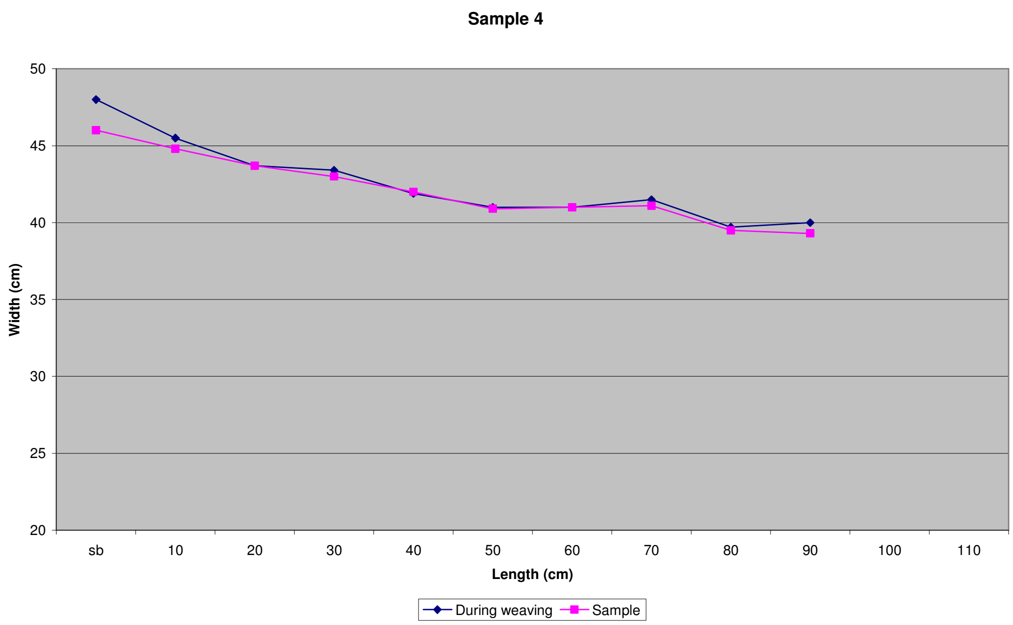

Fig. 16. Graph showing the width of sample 4 every 10 cm of the total length. sb=starting border.

Conclusion, sample 3 and 4

When weaving sample 1 and 2, it was confirmed that it is preferable if the total width of the loom weights is identical or slightly larger than the width of the fabric to be produced. This was the reason why two new warps were set up on two looms on the basis of not only the weight of the loom weights but also the thickness and their total width as well. To begin with, the warps were hanging vertically and were evenly distributed. Both setups were compared to the list of features in optimal weaving (fig 17). Only sample 3 corresponded well to the above list of features for optimal weaving, except for the resistant shed discussed before. Sample 4 was less optimal.

Sample 3 was regular all through the weaving. Both the resulting piece of fabric as well as the weaving was regarded as optimal. Thus the result further confirmed the conclusions drawn from weaving samples 1 and 2: the total width of the loom weights should be the same or slightly more than the fabric to be produced.

Sample 4, on the other hand, was not regarded as optimal weaving. Its very open character made the warp threads movable and the sample irregular. With thinner loom weights, however, the situation would probably have been worse. In this sense, we would still prefer a total width of the loom weights which was the same or slightly more than the fabric to be produced.

	Sample 3	Sample 4
Loom in stable position	+	+
Appropriate weight tension per thread	+	+
Even distribution of weight per thread in the whole loom setup	+	+
Loom weights positioned in the same level	+	+
Loom weights positioned side by side	+	+
Loom weights stable, i. e. not whirling or tangling	+	+
Warp threads hanging vertically and evenly distributed	+	-
Warp threads do not tangle	+	+
Warp threads do not break	+	+
Shed easy to change	-	+
Weft is easy to insert evenly	+	+
Identical width of fabric throughout the weaving	+	-
Edges of the fabric are straight	+	-
Even and regular feeling when weaving	+	-

Fig. 17. Sample 1 and 2 compared to features in optimal weaving.
+ corresponds to a positive result
- corresponds to a negative result

Conclusion

The question asked in present experimental research was how different thicknesses of the loom weights affect the weaving process and the woven fabric. By weaving samples 1 and 2, with different sets of loom weights, it was clearly demonstrated that the thickness does play an important role when weaving and hence the choice of loom weights. If this would not have been the case, the two samples would have appeared more similar, since everything in the two weaving tests was similar, except the thickness of the two sets of loom weights.

We have concluded that in order to obtain a setup on the warp weighted loom that is well suited for weaving, the thickness, as well as the weight, play an important role. It is preferable to use loom weights with a total width, when hanging in a row, which is identical or slightly larger than the width of the fabric to be produced. It is thus vital to record both the weight and maximum thickness of loom weights in archaeological assemblages. Based on this information it is possible to outline what kind of tabby textiles could have been produced with a given yarn quality. Moreover, the shape of the loom weights also proved to be important. If the weights are to hang side by side, we conclude that shapes with flat sides are optimal.

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