With a Little Help from My Friends: Investigating Mycenaean Textiles with Help from Scandinavian Experimental Archaeology

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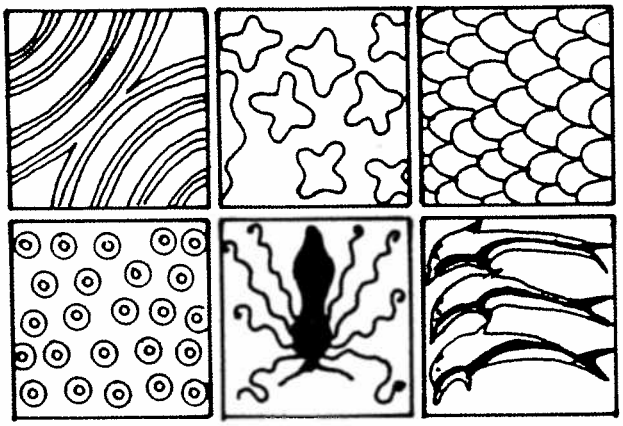

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WITH A LITTLE HELP FROM MY FRIENDS: INVESTIGATING MYCENAEAN TEXTILES WITH HELP FROM SCANDINAVIAN EXPERIMENTAL ARCHAEOLOGY*

In this paper, we wish to investigate some major questions about the Mycenaean textile industry: How are we to explain the very large amounts of wool for cloth in the Linear B records, how much thread do we get from the Linear B quantities of wool, and how time consuming was Mycenaean textile production. This is done with the help of results gained in Scandinavian experimental archaeology. Eva Andersson has specialized in Scandinavian archaeological textiles and textile production[1] and works with the center of experimental archaeology at Lejre in Denmark. At Lejre, textile workers and archaeologists work closely together in order to reconstruct ancient textiles and techniques. Marie-Louise Nosch has focused on the Linear B inscriptions, on workers, wool, textiles and production.[2] Although the societies in the Mycenaean and Late iron age/Viking periods differ greatly, they share many features in textile technology such as the spindle whorl, the warp-weighted loom and the use of wool as a major raw material. We also assume that their spinning skills were similar.

The Scandinavian textile research

Without an actual knowledge of textile crafts, results of textile analyses are difficult to transfer to archaeological contexts. In contrast to textiles, tools such as spindle whorls and loom weights are relatively common finds on excavated settlements. It is also important that many textile techniques have continued in use until the present. Finally, the preserved archaeological textiles in Scandinavia give a clear idea of thread and textile qualities.

Previous studies in Scandinavian textile history in the late Iron Age/Viking period have aimed to achieve a clearer picture of textile production by studying textile tools from excavated settlements in Southern Sweden, Scania. A method of classification of textile tools was proposed in order to analyze the distribution across the site.[3] One of many results was that the spindle whorls which were found in the same house and stratification layer often were of

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1 Further information in English on the Scandinavian textile research and the experimental archaeology can be found in E. ANDERSSON, *The common Thread. Textile Production during the Late Iron Age - Viking Age (University of Lund, Institute of Archaeology, Report Series* no. 67, 1999).

2 M.-L. B. NOSCH, "L'administration de textiles en Crète centrale, hors des séries Lc/Le/Ln," *BCH* 122 (1998) 404-406; EAD., "Acquisition and Distribution: *ta-ra-si-ja* in the Mycenaean Textile Industry," *Trade and Production in Premonetary Greece. Acquisition and Distribution. Proceedings of the 6th International Workshop, Athens 1996* (2000) 43-61; EAD., "Schafe unter Potnia und Hermes in Knossos," *Österreichische Forschungen zur Ägäischen Bronzezeit 1998* (2000) 211-215; EAD., "Kinderarbeit in den mykenischen Palästen," *8. Österreichischer Archäologentag, vom 23. bis 25. April 1999* (2001) 37-43; EAD., "The Textile Industry at Thebes in the Light of the Textile Industries at Pylos and Knossos," in *Festschrift in honour of A. Bartonek* (2001) 177-189; EAD., "Entre collecteurs et travailleurs : les 'responsables' dans l'industrie textile de Knossos," in *Les modalités du contrôle économique dans le monde minoen et mycénien. Journées égéennes 1999, Ktema* 26 (2001) 133-143; M.-L. B. NOSCH & M. PERNA, "Cloth in the Cult," *POTNIA. Deities and Religion in the Aegean Bronze Age. 8th International Aegean Conference, University of Göteborg, (12-15 April 2000) Aegaeum* 22 (2001) 471-477.

3 E. ANDERSSON, *Textilproduktion i arkeologisk kontext, en metodstudie av yngre järnåldersboplatser i Skåne (University of Lund, Institute of Archaeology, Report Series* 58, 1996); EAD., *Textilproduktion i Löddeköpinge - endast för husbehov?, (Löddeköpinge RAÄ skriftserie,* 2000).

different sizes. This result led to the research project, *Spinning wool, now and then*, and the aim was to gain further understanding of how the size of the spindle and the choice of raw material affects the fineness of the spun thread.[4]

Thus, in 1998, a number of spinning experiments were made using spindles, consisting of a spindle whorl and a wooden spindle, which were reconstructed on the basis of Viking Period finds from Haithabu. The experiment was conducted together with Anne Batzer at the Historical-Archaeological Experimental Center at Lejre in Denmark. A good understanding of knowledge and craft skills had been developed here and Anne Batzer has been head of the textile section since 1990. She is an expert spinner and weaver and her work also includes the reconstruction of archaeological textiles (see Pl. XLVa-b). The experiments were made with wool, using a range of spindle whorls of varying sizes. The spindle whorls employed in the experiments weighed 5, 10, 20 and 30 grams, respectively. The raw material for the spun thread consisted of wool from Norwegian breeds of sheep; this type of wool is similar to the fiber qualities in archaeological textiles from the early Middle Ages. As the quality varied between individual sheep, two series were spun with wool of a different fiber character. Furthermore, each spinning experiment included a sample of mixed wool, of combed wool and wool from the undercoat (see table).

The spinning experiments showed that:

- a difference of only 5-10 grams in the weight of the spindle affected the fineness of the spun thread.
- using spindles of group 1 and 2 and combed wool it was possible to spin fine thread, suitable for fabrics with a high density of thread per cm.
- spindles of group 3 and 4 produce a thicker thread, suitable for sail cloth and outer garments.
- to acquire a specific quality of spun thread, whether fine or thick, requires experience and knowledge of spinning.
- the results of the spinning experiments should be seen as a framework for the quality of thread produced by different sized spindles: it would be possible to spin even finer thread from lighter spindles, and thicker thread from heavier.
- spinning is time consuming, regardless of the quality of the required thread and size of spindle employed. The amount of time spent is the same for a spindle weighing 7.5 grams as for one that weighs 36 grams. Variation in work time is defined instead during weaving by the quality of cloth required: a fabric with a high density consumes considerably more spun thread than a coarser fabric.

While it is difficult to know how much time textile production consumed in the Viking Period, it is nevertheless important to attempt some estimates. The calculations used here are based on Anne Batzer's experience, and on projects Eva Andersson and Anne Batzer have conducted together at Lejre.[5]

The length of thread that can be spun from 1 kilo of wool varies according to the quality of the wool fiber, and to the thickness required for the finished thread. Experiments with spindles clearly show that the size of the tool affects the thickness of the thread, and also the variations of length yielded for the different thicknesses. Using mixed wool with relatively fine fibers, a spindle with a spindle whorl weighing 5 grams will yield 14,000 m of thread per kilo of wool. Alternatively, using mixed wool with coarser fibers and a spindle whorl weighing 30 grams, the yield will be only 3,900 m. To produce cloth with a density of 12 threads per cm it is necessary to use spun wool with a thickness that is equivalent of 6,500 m of thread per kilo.

The Viking trading port of Haithabu in Schleswig-Holstein (see Pl. XLVc) had a considerable population: an estimate for the most active period of settlement is 1,000. On the basis of this population, it is possible to give a rough picture of household production.

4 E. ANDERSSON & A. BATZER, "Sländspinning med ull i vikingatid och nutid," *Eksperimentel Arkæologi. Studier i teknologi og kultur, Historisk-Arkæologisk Forsøgscenter* (forthcoming).

5 ANDERSSON & BATZER (*supra* n. 4).

It is important to bear in mind that there are numerous factors that cannot be considered in such an estimate. One is the gender distribution at the settlement, as well as the proportion of children to adults. Furthermore, hierarchical differences in terms of social status must have been reflected in clothing and household textiles. Finally, the rate at which new clothes were produced is unknown: archaeological textiles from Haithabu show that old clothes were mended and probably recycled.[6]

Assuming that half the population in Haithabu needed new set of clothing, it would be necessary to produce 500 complete sets of clothing. The requirement would then be around 1,500 kilos of wool and/or flax. This is equivalent to a herd of 750-1,000 sheep. If the fabric for this clothing had a density of 12 threads per cm,[7] and was woven in a simple 2/2 twill, then the people in Haithabu had to spin nearly 10 million meters of thread. Note that this is a conservative estimate. Imagine how much thread the spinners had to spin in the palaces in ancient Greece just to get enough thread for the most common pieces of clothing.

The time consumed by spinning the wool is difficult to calculate; we may assume that a spinning woman in the Viking Period was considerably faster than a modern textile worker. However, the actual spinning is the least time-consuming element when producing thread. *The process involves the combing and preparation of the wool before spinning, and the finishing of the thread in terms of winding and stretching the skeins of spun wool.* The experiments thus indicate an output in the region of 20 m of spun thread per hour.

As for the weaving, older sources suggest that it was possible to produce around 70 cm of cloth per day on a vertical loom.[8] This is in accordance with the results from vertical looms used at Lejre; here weavers produce between 70 and 80 cm of cloth per day. The calculations are based on a cloth with a width of 1 m and a density of 12 threads per cm. To produce a 70 x 70 cm piece of cloth around 1,680 m of spun wool is needed. Mounting the loom takes around two days.

The results of the experiments confirm that the production of textiles would have consumed a significant part of the inhabitants time. An important finding is that the most time consuming element of the process was the production of the spun thread.

In the most recent project, textile production at Birka in Sweden was investigated from a local, a regional and a wider North European perspective. The analysis included Birka, six rural hinterland settlements in the Mälar Valley (Pl. XLVd) and the Viking Period trading settlements of Haithabu in Schleswig-Holstein and Kaupang in Norway (Pl. XLVc).[9]

Comparison with the Haithabu finds demonstrated clear similarities in textile production. This is particularly notable in the spindle whorls, where the range of weights corresponds well with the finds from Birka, although the fluctuations in the weight of the Birka spindle whorls are marginally higher. The correlation is interesting insofar as the spindle whorls under study are made from a variety of materials: at Birka 50% of the items under study are made of stone; in Haithabu 88% of the items are made of ceramic (see Pl. XLVe spindle whorls/material). At Birka, 76% (235 items) weigh between 5 and 35 grams: the proportion of this group at Haithabu is 94% (709 items). The proportion of these weight groups (5-35 grams), however, is almost identical at the two settlements (see Pl. XLVf spindle whorls/weight). There is also a correlation in the diameter of the spindle whorls.

In conclusion, the analysis demonstrates that both Birka and Haithabu had a varied textile production, and that the range of products was similar at both sites. The light spindle whorls indicate a substantial output of high-quality thread, equivalent to the worsted yarn used for high quality textiles. At the same time, the tools reveal evidence for the production

6 I. HÄGG, "Textilfunde aus der Siedlung und aus den Gräbern von Haithabu," *Berichte über die Ausgrabungen in Haithabu* 29 (1991) 276.

7 Most common among the finds from the late Iron Age/ Viking Period are wool fabrics with a density of 10 to 20 threads per cm, see L. BENDER JØRGENSEN, *Forhistoriske Tekstiler i Skandinavien (Nordiske Fortidsminder Serie B. Bind* 9, 1986).

8 Personal communication, Anne Batzer.

9 E. ANDERSSON, *Tools for Textile Production from Birka and Hedeby (Birka Studies* 8, 2003).

of domestic textiles on a scale which could meet the demands of large populations at these settlements. The presence of heavy spindle whorls indicates that the demand for sail cloth could also be satisfied.

The textile evidence from the Linear B tablets

There are spindle whorls in nearly every Aegean excavation, varying in materials and size. Lindy Crewe summarizes our problem: "Spindle whorl attributes are recorded selectively by archaeologists, and in most cases, a single dimension, such as height or diameter, are the only data provided. The most important criterion - weight - is rarely recorded."[10] Fortunately, information on spinning and textile production can also be gained from the Linear B inscriptions. We know of large-scale Mycenaean textile production, with hundreds of workers, their children and rations.[11] We also know the standardized Mycenaean textile products, which are recorded in many palaces. The palace scribes record cloth types and their equivalent in wool:[12]

1 *pa-wo*	=	1.67 units of wool	=	5 kilos of raw wool
1 *tu-na-no*	=	3 units of wool	=	9 kilos of raw wool
1 *164	=	6 units of wool	=	18 kilos of raw wool
1 *te-pa*	=	7 units of wool	=	21 kilos of raw wool
1 *te-pa pe-ko-to*	=	10 units of wool	=	30 kilos of raw wool

In Linear B studies, it was thought that these must be very large and heavy pieces of cloth. Experimental archaeology, however, shows that much - in some cases ca. half - of the raw wool is discarded and if the palace scribes are listing the raw material in their records, it would reduce the amounts of wool in the textiles considerably. The amounts are still large, but more reasonable now:

1 *pa-wo*	=	5 kilos of raw wool	=	2.5 kilos of clean wool
1 *tu-na-no*	=	9 kilos of raw wool	=	4.5 kilos of clean wool
1 *164	=	18 kilos of raw wool	=	9 kilos of clean wool
1 *te-pa*	=	21 kilos of raw wool	=	10.5 kilos of clean wool
1 *te-pa pe-ko-to*	=	30 kilos of raw wool	=	15 kilos of clean wool

We know that the Mycenaean textile industry was specialized and was organized around a strict division of labor. We have several groups of women with very specialized designations. But, as Eva Andersson has shown, one of the most time-demanding process in textile production was the sorting, cleaning, selection and preparation of the wool. In Linear B, however, we have no trace of this work. There are some spinning women (*a-ra-ka-te-ja*), but they are few considering the many thousands of kilometers of thread from the 100,000 Cretan sheep.[13] One wonders whether the Linear B documentation on textile production records a

10 L. CREWE, *Spindle Whorls. A Study of Form, Function and Decoration in Prehistoric Bronze Age Cyprus* (1998) 2. On spindle whorls in the Aegean, see E. BARBER, *Prehistoric Textiles: The Development of Cloth in the Neolithic and Bronze Ages with Special Reference to the Aegean* (1991) 51-68.

11 J. KILLEN, "The Textile Industries at Pylos and Knossos," *Pylos comes alive. Industry+Administration in a Mycenaean Palace. A Symposium of the NY Society of the Archaeological Institute of America and Fordham University, in memory of Claireve Grandjouan (May 4-5, 1984)* (1984) 49-64; ID., "Epigraphy and Interpretation in Knossos WOMEN and CLOTH Records," *Texts, Tablets and Scribes. Studies in Mycenaean Epigraphy and Economy offered to E. L. Bennett, Jr.* (1988) 167-183. NOSCH (*supra* n. 2) 37-43.

12 J. KILLEN, "The Wool Industry of Crete in the Late Bronze Age," *BSA* 59 (1964) 9; ID., "The Knossos Lc (Cloth) Tablets," *BICS* 13 (1966) 105-109; ID., "A Problem in the Knossos Lc(1) (Cloth) Tablets," *Hermathena* 118 (1974) 82-90; ID., "The Knossos Ld(1) Tablets," *Colloquium Mycenaeum. Actes du sixième colloque international sur les textes mycéniens et égéens tenu à Chaumont sur Neuchâtel (7 au 13 sept. 1975)* (1979) 157, n. 13; ID., "The Find-Places of the Tablets from the Western Magazines at Knossos: Some Matters arising," *Minos* 31-32 (1996-1997) 123-132.

13 100,000 sheep yield 75,000 kilos of raw wool, and we can reduce it to 37,500 kilos of wool after cleaning and washing. According to Eva Andersson's estimates above (table), one kilo of clean, *mixed* wool can yield 14 km of thread spun on a 5 grams spindle, or 3.9 km of thread spun on a 30 grams spindle. 37,500 kilos of cleaned and prepared Cretan wool could thus provide between 525,000 km (5 grams spindle) and 146,250 km (30 grams spindle) of thread!

period of the year in which the spinning was mainly finished and the weaving and decoration of the cloth remained, because our documentation nearly seems to start with the manufactured thread. This raises the question of what kind of thread the Bronze Age women could make, and how much time it would take to spin all the wool issued to the workers for textile production. And here the Scandinavian experimental archaeology may help.

The Scandinavian experiments gave parameters for the output in thread from 10 grams of wool, depending on the spindle size, the weight of the spindle whorl and the quality and type of wool. They showed, for example, that one kilo of clean and prepared wool of mixed quality gives 3.9 km of thread spun on a heavier spindle (30 grams), or 14 km of thread spun on a light spindle (5 grams). These results are interesting for Aegean archaeology because very small spindles tend to be classified as *conuli*, or as buttons or other decorative objects in the Aegean (see below). It is also interesting that these results on spinning techniques may give the Aegean archaeologist an idea of the type of thread spun on a site.

We are quite well informed about the obligatory textile work called *ta-ra-si-ja*.[14] From the Linear B inscriptions, it seems as though every women in this system was supposed to deliver one piece of cloth, either of the quality *te-pa* (21 kilos of raw wool) or of the quality *pa-we-a* (5 kilos of raw wool). As a test case I used the *te-pa* type of cloth and compared it to what the Scandinavian archaeologists know about textile production.

The Scandinavian experimental archaeology and the expert spinners and weavers estimate that one person would be able to spin an average of 20 meters of thread per hour, *including* the time for preparing the wool and finishing the spun thread. These calculations may be used to estimate the time a Mycenaean woman spent on her corvée of one *te-pa*: One *te-pa* requires 21 kilos of wool. For a rough estimate, let us say that, after the cleaning and preparation of the wool, 10 kilos of clean wool was left. Using mixed wool, Eva Andersson and her colleagues have shown that with 10 grams of wool of good fiber quality, they could obtain 140 m of thread on a light spindle (5 grams). With mixed wool of secondary fiber quality, they could obtain 39 m on a heavier spindle (30 grams) (See table). When this is applied to the Mycenaean *te-pa* of 10 kilos, that would give 39 km of thread spun on a heavier spindle, or 140 km of thread spun on a light spindle. The experiments showed that one could produce 20 m of thread per hour, that is, 1 km in 50 hours. Assuming the same skills for spinning for a Viking and Mycenaean woman, and a (textile) working day of 10 hours, the spinning of the thread for one *te-pa* would require more than 1,950 hours, that is, 195 days of work for one person with a 30 grams spindle, and 7,000 hours, that is 700 days of work with a 5 grams spindle. The fact that (1) *te-pa* cloth is not recorded as decorated cloth, (2) it is demanded in large quantities, and (3) requires large amounts of wool, would suggest that *te-pa* is a more coarse type of textile, of secondary fiber quality which was spun on a heavy spindle. We should also not forget that after the spinning comes the next steps of mounting the loom, weaving, sewing and mending of cloth. Thus, to be able to make one *te-pa* a year for the Mycenaean palace, one must assume that the whole household was mobilized, children as well, and that this corvée demanded a considerable amount of time. This challenges John Killen's interpretation of the *ta-ra-si-ja* corvée, when he writes that: "Such evidence as we have on the matter suggests that the amount of work carried out by each worker may have been relatively small."[15]

It has been observed that the Mycenaean palaces set two kinds of *ta-ra-si-ja* corvée for the groups of women workers: groups with an ethnic designation have targets of *te-pa* cloth which are about four times bigger in terms of wool than the targets of *pa-we-a* cloth for groups with an occupational designation.[16] This does not seem fair! The difference in targets has been explained by the number of workers and by the qualities of cloth. The experimental archaeology may add some more information on the last point. If the difference in quality

14 See the papers by KILLEN (*supra* n. 12) 105-109; ID., "Some Thoughts on *ta-ra-si-ja*," *Conference on the Mycenaean Palatial System, Cambridge (1-3 July 1999). Proceedings of the Cambridge Philological Society. Suppl.* vol. n. 27 (2000); NOSCH (*supra* n. 2) 43-61; EAD., "Two Observations on the Knossos Lc(1) Targets," *11th International Mycenological Colloquium in Austin, Texas, (8-12 May 2000) Hesperia Suppl.* (forthcoming).

15 KILLEN (*supra* n. 14).

16 NOSCH (*supra* n. 14).

between *pa-we-a* and *te-pa* is also due to the types of thread, that is, to the types of spindle whorls, then the difference becomes much less important: A village woman would need 195 days to spin the 39 km of coarse thread for one *te-pa*. A more specialized textile worker, with only 2.5 kilos of clean and prepared wool for a piece of *pa-we-a*, would be able to make 35 km of fine spun thread with a light spindle, and it would take her some 1,750 hours, that is, 175 days to spin it. So although *te-pa* requires four times more wool than *pa-we-a*, the use of different spindle whorls would reduce the difference considerably, and if we assume that the weaving, finishing and decorating of the *pa-we-a* needed more time than the *te-pa* production, we may end up with a similar time spent on the production of *te-pa* and *pa-we-a*, despite the initial differences in wool quantities.

Conuli

In the Aegean, there has been an on-going discussion of the so-called 'conuli,' or 'buttons,' the very small and light (ca. 8-9 grams) rounded objects with a hole. They are found in palaces, in settlements and in graves. Already Persson, in the 1920's,[17] proposed that we should see them not as spindle whorls but as buttons or beads. This was followed by Arne Furumark, who writes: "These round perforated objects, chiefly of clay or steatite, have usually been considered to be spindle whorls, but it is highly probable, not to say certain, that most of them were used as buttons."[18] S. Iakovidis, in 1978, published the comprehensive paper "On the Use of Mycenaean 'Buttons,'"[19] and advocated for a new interpretation of the conuli: they were attached to the ends of cords or girdles, or dress weights hanging from the lower rim of the skirts.

Generally, in the publications of these small conical objects, much emphasis is put on their typology, decoration, chronology, materials, and mostly the dimensions are given. The weight is rarely recorded. The standard size is, according to Iakovidis, 24-25 mm in diameter, 15 mm in height, and weighing 8-9 grams.[20]

Aegean archaeologists often do not consider them as spindle whorls: they either seem too small, or too light. A problem is that there are no clear criteria for defining a perforated object as a spindle whorl, or, for example, as a button or bead. S. Iakovidis suggests that spindle whorls are much flatter than conuli and have wider undersides.[21] Jill Carrington-Smith sets the minimum weight of a spindle whorl to 12 grams.[22] Lindy Crewe uses the shape and size of the perforation as criterion, but also sets a minimum weight of 10 grams.[23] The suitability of conuli as spindle whorls has almost never been tested.[24]

17 A.W. PERSSON, "Fouilles d'Asine 1922," *Årsberättelse 1922-1923, Bulletin de la société royale des lettres de Lund 1922-1923* (1923) 37: "A ce sujet je tiens à faire remarquer que les petits objets de pierre coniques et perforés qui dans la littérature archéologique portent le nom de fuséoles sont sans doute des buttons. C'est l'archéologue grec, M. Keramopoulos qui le premier a attiré mon attention sur ce fait: c'est une opinion encore inédite. Keramopoulos m'a fait remarquer qu'exactement le même type de buttons se trouve encore sur le vêtement national grec." See also O. FRÖDIN & A.W. PERSSON, "Rapport préliminaire sur les fouilles d'Asine, 1922-1924," *Årsberättelse 1924-1925, Bulletin de la société royale des lettres de Lund 1924-1925* (1925) 43, 84.

18 A. FURUMARK, *The Chronology of Mycenaean Pottery* (1941) 89.

19 S. IAKOVIDIS, *BSA* 72, 113-119 and plates 24-25.

20 IAKOVIDIS (*supra* n. 19) 115.

21 IAKOVIDIS (*supra* n. 19) 115.

22 J. CARRINGTON-SMITH, "Spinning and Weaving Equipment," *Excavations at Nichoria. vol. 2, The Bronze Age occupation* (1992) 681, 685.

23 CREWE (*supra* n. 10) 11-13 (min. 4 mm perforation, in Cyprus the whorls have perforation diameters of 5-19 mm). See also the discussion of the perforation of beads and whorls in R. LIU, "Spindle Whorls: Part I. Some Comments and Speculations," *The Bead Journal* 3 (1978) 87-103.

24 CARRINGTON-SMITH (*supra* n. 22) 694, n. 4: "I have attempted spinning with a steatite conulus of average size, weighing 10 grams, with a maximum diameter of 0.02 m and a height of 0.016 m. I used a souvlaki stick 0.003 m in diameter as the spindle. It was just possible to spin, but it was singularly difficult. It was not easy to grasp the spindle to give it an effective twirl, and the small whorl did little to aid or prolong its rotation. The spindle kept stopping, which resulted in the thread continually breaking. The experiment was not a success." The use of a long spindle probably explains the problems encountered since light spindle whorls require a short spindle (see table).

While these small conical objects may have had various functions, their function as spindle whorl should not and cannot be ruled out. In Scandinavia, even today in Lejre, they spin using such small objects. And since we have conuli in most Mycenaean centers, we wonder if they could not testify to the demands of the standardized Mycenaean textile production for fine woolen or linen cloth, at least before becoming buttons or decorative elements.

Textile research is a relatively neglected field of research in archaeology, even though people have always needed cloth and clothing. In the industrialized societies of today, textiles have become cheap and self-evident. We have lost the connection with the process of textile manufacture, and with the understanding of the work behind textile manufacture. The results presented in this paper are, of course, based on experiments and hypotheses of today. It is, however, our hope that these results will elucidate the technology and amount of work accumulated in the textile production in any ancient society. The Mycenaean society is a particular case because we have the evidence from the written sources of a large scale textile production organized by the palaces.

Textile research in the Aegean has especially been affected by the fact that so few archaeological textile have come to light in Greece. In Northern Europe, and especially in Scandinavia, on the contrary, the many finds of archaeological textiles have certainly put a focus on textile research. In the Aegean area, we believe that through the study of the texts (which are completely lacking in Scandinavia) and a quantitative contextual recording of the textile tools, a new perspective on the textile production can be gained. Of major importance is evidently the interpretation of objects and tools as textile tools, their function and variations in the typology. Here the knowledge of textile workers, who still practice the ancient techniques, cannot be overestimated. The more we work the field the more question arise. We hope, through this multi-disciplinary approach, to be able to present a better and clearer picture of textile production and its place in society and economy.

Eva ANDERSSON and Marie-Louise B. NOSCH

LIST OF ILLUSTRATIONS

Pl. XLVa Spindles reconstrcuted on the basis of Viking period finds from Haithabu. Photo © Eva Andersson.

Pl. XLVb Groups of spindle whorls from in Scania, Sweden. Each group is found in the same house and culture layer. Photo © Eva Andersson, Lund.

Pl. XLVc Scandinavia, Ports of trade included in the project. 1 Haithabu, 2 Kaupang, 3 Birka.

Pl. XLVd The Mälar Valley . Settlements included in the project: 1. Valsta; 2. Säby, Uppland,; 3. Sanda: 4. Viby; 5. Pollista; 6. Säby , Södermanland; 7. Birka.

Pl. XLVe Spindle whorls from Birka and Haithabu and their materials (Birka outer ring).

Pl. XLVf Spindle whorls from Birka and Haithabu and their weight (Birka outer ring).

TABLE

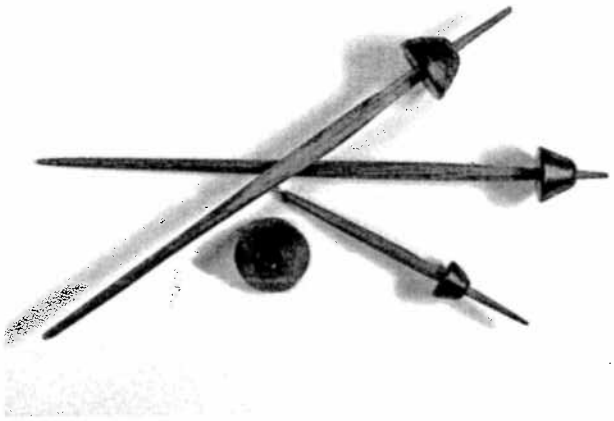
Spinning experiments[25]

Spindle whorl weight	Spindle size	Wool quality and type	m/10grams incl. waste	Estimation of km/kg of wool incl. waste
5 grams	short	1. combed	201.5	20.15
5 grams	short	2. combed	179	17.9
10 grams	long	1. combed	169.5	16.95
10 grams	long	2. combed	101	10.1
20 grams	long	1. combed	123	12.3
20 grams	long	2. combed	59.5	5.95
30 grams	long	1. combed	71	7.1
30 grams	long	2. combed	39	3.9
5 grams	short	1. mixed	140	14
5 grams	short	2. mixed	117	11.7
10 grams	long	1. mixed	123	12.3
10 grams	long	2. mixed	92	9.2
20 grams	long	1. mixed	108	10.8
20 grams	long	2. mixed	52	5.2
30 grams	long	1. mixed	60.5	6.05
30 grams	long	2. mixed	39	3.9
10 grams	long	1. undercoat	53	5.3
10 grams	long	2. undercoat	52	5.2
20 grams	long	1. undercoat	41.5	4.15
20 grams	long	2. undercoat	39	3.9
30 grams	long	1. undercoat	30	3
30 grams	long	2. undercoat	26	2.6

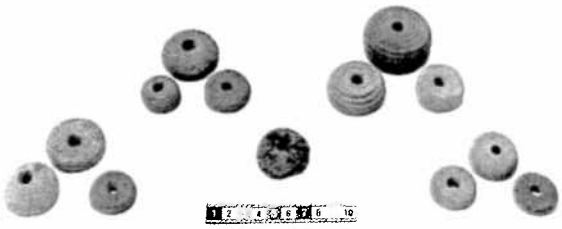
Spinning equipment:

group 1: whorl of 5 grams, short spindle of 2.5 grams.
group 2: whorl of 10 grams, long spindle of 5-6 grams.
group 3: whorl of 20 grams, long spindle of 5-6 grams.
group 4: whorl of 30 grams, long spindle of 5-6 grams.

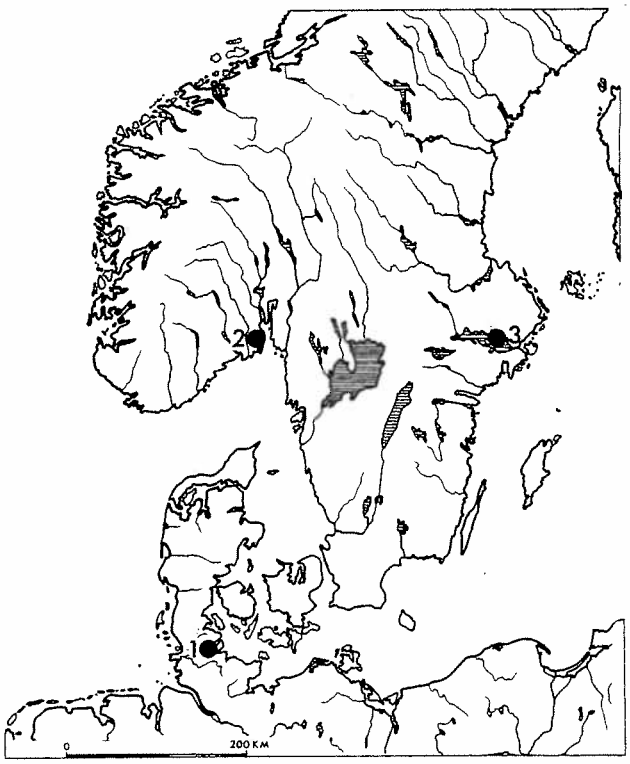
25 From ANDERSSON (*supra* n. 1). Eva Andersson informs that here the wool losses in the spinning process were not calculated, which means that the respective lengths of thread had actually been obtained with less than 10 grams, probably 8 grams.



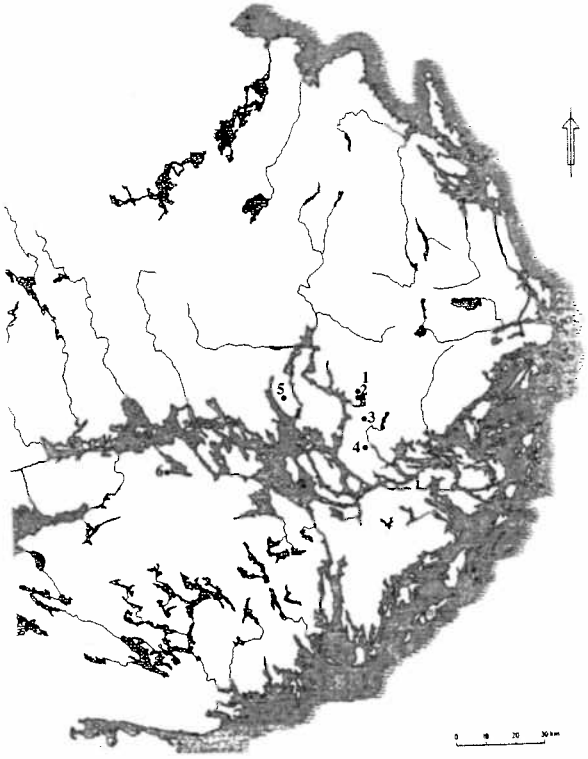
a



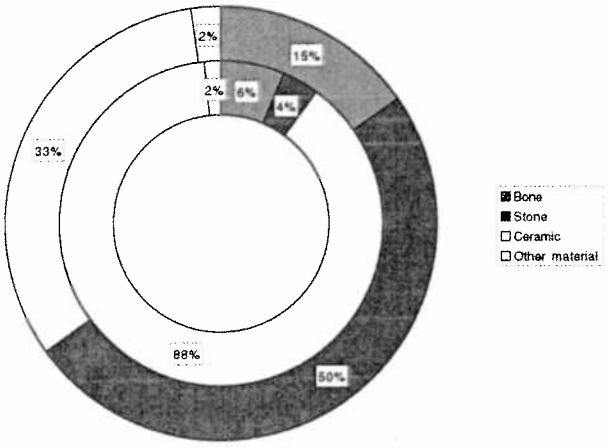
b


1
2
3
0
200 KM

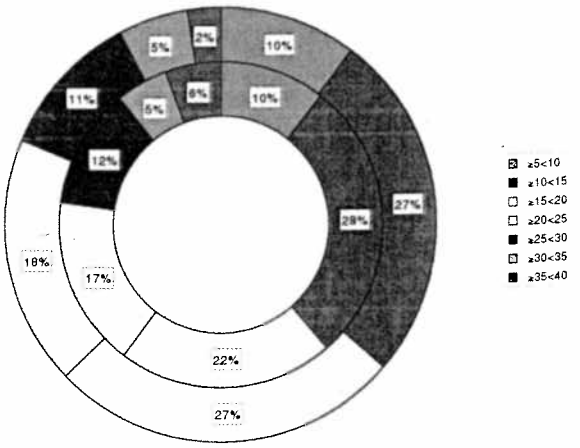
c


1
2
3
4
5

d


2%
15%
2%
6%
4%
33%
88%
50%
Bone
Stone
Ceramic
Other material

e


5%
2%
10%
11%
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27%
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≥5<10
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f