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Guido Helmig, Barbara Scholkmann, Matthias Untermann

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Address

Heini Kirjavainen
 Department of Cultural Studies
 Archaeology
 University of Turku
 Henrikinkatu 2, FIN-20500 Turku
 heini.kirjavainen@netscape.net

every piece of tabby was woven by a professional weaver? The most intriguing numbers can be found in woollen 2/2twill cloth, 21.4 % in warp but 39.3 % in weft. Certainly not all of the 2/2twill cloths can have been professionally woven. When counting is combined with dyeing, the figures sink in numbers to 17.3 % in warp and 16 % in weft and the same effect it has on woollen tabby cloths, 17.6 % in warp and 17.9 % in weft. Can this mean that more professionally produced cloths went through dyeing and more home made cloths were in use without any colour at all? As it comes to coarse goat hair textiles they have very standardised figures

for only 8.9 % in warp and 10.9 % in weft. They can be regarded as "professionally" woven cloths although not in the same sense as the other cloth types mentioned above.

In the end it can be said that there are textiles woven by professional weavers at the end of 14th century and in the beginning of 15th century. But textiles are also imported, i. e. broadcloth (and goat hair textiles). There are domestic textiles, i.e. *vadmal*, woollen tabby, 2/2 twill and 2/1twill cloth woven by skilful craftsmen but there are certainly some home made textiles among them. Surely there has been a dyer with a great skill in Turku.

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cloth was imported mainly from Flanders at the end of the 14th century, there was import from Holland and England during the 15th century (Taavitsainen 1982, 24). However, import was not a straightforward line from the city of origin to Turku, cloth was imported via Hanse towns such as Reval, Lübeck or Danzig (Kerkkonen 1981, 468). Broadcloth can be considered as a basic comparative material in the study of standardisation because it was highly developed and finished cloth product. Standardisation and control regulated weaving as it has been for example in Elbing where statutes (1420) ordered "sollten Gewebe etwa 8 Fäden in der Kette haben" (Maik 1998, 225).

Coarse woollen cloth is called *vadmal* in Scandinavia, *sarka* in Finnish. *Vadmal* is domestic woven coarse and often fulled fabric (Strömberg/Geijer/Hald/Hoffmann 1974, 91). The Finnish word *sarka* is supposed to have its name from weaving a narrow cloth with a horizontal loom (Kaukonen 1962, 330). These cloths are very suitable for northern atmosphere, they are very warm, water and wear resistant. It is supposed that although no written sources survived, *vadmal* weaving had been regulated by statutes (Kuujo 1981, 165). In the 16th century *vadmal* has been a valued unit for payment (Kaukonen 1982, 415). As it comes to *vadmal* cloths in Åbo Akademi site they are very coarse, and threadcount varies from 7 to 10 threads in warp and from 6 to 12 threads in weft. There are 23 pieces of cloth and 78.3 % has been dyed, mainly in red. The high figures in dyed fabrics and the results of dye tests can be indications of the presence of a dyer.

There are 41 pieces of plain woollen tabby cloths of which 80.5 % has been dyed. This group is in between coarse (41.5 %) and medium fine (58.5 %) cloths. The coarse ones have 5 to 10 threads in warp and 6 to 10 threads in weft. Medium fine cloths have 11 to 16 threads in warp and 9 to 14 threads in weft. But in this case coarse does not mean thick cloth but a cloth with a low cover factor i.e. warp and weft threads are not so close together, the higher the cover factor, the closer the threads in two thread systems (Schjølberg 1998, 210). In other words: warp and weft threads have space to move around (Hammarlund 1997, 27).

Woollen 2/2 twill cloths are quite numerous with 63 pieces. Threadcount varies from 6 to 22 in warp and from 5 to 30 in weft. Coarse fabrics cover 61.9 % and medium fine 34.9 %,

two fragments are fine with 3.2 %. Although this is the largest weave group there are 60.3 % of dyed fragments in this group. This figure is lower than in tabby cloths. The quality of cloth is more heterogeneous but in spin combinations this group has only Z-S and Z-Z combinations. Woollen 2/1twill cloth is represented with ten pieces. Threadcount varies from 9 to 20 in warp and from 7 to 14 in weft. 40 % of this type has been dyed and fulled but only on one side.

Three examples of goat hair textiles were taken as an own group. These are very thick and coarse fabrics spun in plied yarn Zs/s in warp and weft. Threadcount varies from 2.5 to 3 in warp and from 2 to 2.5 in weft. These fabrics have been used as wrapping material for trading goods. The same kind of fabrics have been found all around Europe including Novgorod and they all have standard appearance (Bender Jørgensen 1986, 95–96). They can be regarded as "imported" cloths. Goat hair textiles have been woven certainly by a specialised weaver, like for example in Lübeck a "*Harmaker/Haardeckenmacher*" (Tidow 1982, 169).

Summa summarum: the standardisation is high in the group of broadcloths, with 18.2 % in warp and 15.6 % in weft. As it can be seen, the weft has been more evenly woven than warp. There must have been very skilful weavers at work and the standardisation and regulation controlled the cloth production intensively. To point this out, when imported broadcloth arrived from different towns in Europe one cannot be amazed how evenly they were woven. When comparing these standardisation numbers to figures of *vadmal*, 18.4 % in warp and 14.9 % in weft appear as quite similar numbers. It can be assumed that at least *vadmal* was produced by professional weavers. Woollen tabby cloths, 26.6 % in warp and 27.9 % in weft and woollen 2/1twill cloths, 27.4 % in warp and 22.8 % in weft, have rather the same figures and higher numbers than broadcloth and *vadmal*.

2/1twill weaves have been considered as professionally woven fabrics because they are very often combined with the appearing of professional weaving either on vertical or horizontal looms (Lindström 1976, 291), but since the number of 2/1twills are so low and scattered, no conclusions can be made at this point. It is worth noticing the high rates of dyed tabby and variation in spin combinations could it be assumed that not

softness, the right side was more water resistant because of longer fibre Z-spun thread (Custafsson/Waller 1987, 157). There are other combinations (7 pieces) with plied yarns but they are not to be considered here.

Colour in archaeological textiles is nearly always in different hues of brown that has been caused by burial. It can not be said with a great certainty what the original colour of a textile is without chromatographic analyses. Only nine dye samples were sent for the analysis in York Textile Research in Archaeology because eight of them seemed to be dyed in red colour when microscopic research was executed. York test results were very positive, all of the samples had been dyed in red, four of them with imported dyer's madder (*Rubia tinctorum* L.) and the rest of the samples in local bedstraw (*Galium verum* L. or *Galium odorata* L.). Dyer's madder was cultivated in Europe in the Middle Ages and bedstraw is native in Finland but it grows in Europe, too (Walton 2001). Also one black/brown sample was tested and the result was alder bark (*Alnus glutinosa* L.) which is common in Europe and in Scandinavia (Walton 2001). Alder bark and bedstraw is known in Finnish ethnographic sources as well (Vuorela 1983, 495–496). A hint of blue was detected in one purplish and one bright brick red sample. This was analysed as woad (*Isatis tinctoria* L.) which is most probable because indigo from India reached Europe in higher amounts until later (Walton 2001). Mysterious 'yellow X' was detected but it could not be identified although it is quite common in Scandinavian dye samples (Walton 2001).

There are 78.3 % of tabby weaves dyed, 63.1 % of 2/2twill weaves and 40 % of 2/1twill weaves dyed. The figures are quite high and they are based on microscopic survey only, but tested against those with chromatography analysed samples they could be give some kind of presentiment of the textiles in Åbo Akademi site. All in all it can be said that there are textiles dyed with imported dyes, dyer's madder and woad which were used by professional dyers in urban centres.

Cloth Types and Quality

What were the quality requirements for the cloth produced by professional weavers? Here quality is not understood by the fineness and lustrous of a cloth. It is understood as specific

properties which cloth has to have to be professionally woven. So when these qualities appear in many pieces of cloth in standardised measures it can be assumed to be an 'industrial product' (Hoffmann 1974, 284; Gjøl Hagen 1988, 115). What are these specific elements needed? Variation is then of interest. Professionally made cloths have lesser variation in warp and weft, they have higher mean quality than home made cloths (Gjøl Hagen 1988, 126). Weft can be considered as a matter of weaver's skill to weave a proper fabric and so it can contain more variation than warp (Gjøl Hagen 1988, 364-365). Threadcounts had been standardised in warp and weft, width of a cloth and weaves were simplified that they were easy and fast to construct and to weave. Horizontal looms were introduced in Europe around the year 1000 (Hoffmann 1974, 258) and it is highly probable that they were used in Åbo Akademi site at the turn of the 15th century. At least there are few shuttles and about ten wooden pulleys to support this assumption. Horizontal looms are connected with professional weavers in urban centres (Hoffmann 1974, 261). The treatments after weaving such as fulling and dyeing with imported dyes support the idea of developed urban crafts. For the archaeological textiles in question, the answer can be achieved by studying the grade of standardisation (Gjøl Hagen 1988, 126). This is expressed with a standardisation coefficient that is low in more professionally woven fabrics and high in domestic woven cloths (Gjøl Hagen 1988, 128).

Weave types were divided in groups of cloth types: broadcloth, *vadmal*, woollen tabby, 2/2twill and 2/1twill weave. Broadcloth is fine and high quality cloth made in short wool. It is fulled, teaselled i.e. the nap of the cloth is raised and then sheared (Strömberg/Geijer/Hald/Hoffmann 1974, 44). There are 14 pieces of broadcloth of which 85.7 % have been dyed mostly in red. Ten pieces are medium fine fabrics whose threadcount varies from 11 to 18 threads per cm. Six out of a total of 24 cut-offs were found in this textile group. Broadcloth was imported in Finland in the Middle Ages. First mention of domestic produced broadcloth in Turku is in the account book of the 16th century in the castle of Turku (Melander 1944, 2). This is probable because there are only mentions of imported broadcloth in medieval written sources (Hausen 1910, 204; Hausen 1921, 193; 197). According to the written sources broad-

Medieval Archaeological Textiles in Turku

Heini Kirjavainen

Turku (SW Finland); cloth import; broadcloth; vadmál; domestic and professional weaving

The archaeological excavations were taking place in the medieval city of Turku, SW Finland by Turku Provincial Museum in the year 1998. Åbo Akademi site (Turku I/7/4) situated in central area of medieval Turku. It was a dwelling site and had many implications to activities of artisans (Saloranta 1999, 25). Nearly 1400 pieces of woven and felted fabric were found, yarn, string or rope, pieces of plait and bundles of fibre. Textile implements were found as well. The fragments were dated at the end of the 14th century and the beginning of the 15th century. Fragments of textiles were found all over the excavation site in the lowest layers but there were two concentration areas at both end of the excavation site. They were very heterogeneous cultural layers containing dung and other remains of human activities (Excavation Report 2000). There are no differences in the cloth types found on either side, nor any concentration of any specific type. This textile material is to be considered as one group, it can be taken as a sample of textiles. In this preliminary article 154 textile are discussed. The main questions to be asked are: What kind of textiles there are? Were the textiles produced by professional weavers? Was the cloth imported or domestic? The number of textiles to be studied is about one quarter of total capacity but the number includes almost all the textiles that had been under conservation so far. A very limited amount has been published on medieval archaeological textiles in Finland, and only one article comes to mind which deals with the textiles of Mätäjärvi, Turku excavations in 1975 and 1982 (Ikäheimo 1989, 156–157).

Textile remains found in the ground are called archaeological textiles. They have been pre-

served under very special conditions. They may have been in contact with metals such as iron or bronze. Metal salts have replaced the textile fibres totally or partially (Bender Jørgensen 1986, 85). This can be considered in the case of pre-historical burials in Finland. Or under the waterlogged conditions and/or dung and garbage layers protected by thick layers of stratification. In this case preservation stage is best in the lowest layers of excavations. Vegetable fibres rarely survive burial unlike wool and other animal fibres (Bender Jørgensen 1986, 85). There are only few fragmental pieces of vegetable fibre that have survived, some yarn, few bundles of flax fibre and some linen cloth attached to a coarse woollen cloth. Most of the survived textile fragments are made of wool, few of them goat hair.

Before the year 1998 only a limited amount of medieval textiles were excavated. Some fragments have been found earlier but nothing on a large scale in Finland. All in all, there have been numerous excavations with medieval textile finds in Europe, as in Oslo (Kjellberg 1979), Lund (Blomqvist 1963; Franzen/Geijer 1968; Lindström 1970), London (Pritchard 1982), Lübeck (Tidow 1982), Amsterdam (Vons-Comis 1982), Elblag (Maik 1998) and Århus (Lorenzen 1971).

Textiles of Åbo Akademi Site

There has been carried out a basic research of textiles. Weave, threadcount, direction of spin and colour of the cloth was analysed and attained knowledge has been converted to a study of weaving standard and techniques and cloth import. Furthermore the basic weaves

tabby, 2/2twill and 2/1twill are divided in sub-groups according to the qualities of a cloth i.e. broadcloth, vadmal (coarse woollen cloth), woollen tabby, woollen 2/2twill cloth and woollen 2/1twill cloth. Textile fragments are not very large, average length is 13.2 cm and width 8.8 cm. Only ten pieces could be identified as a part of garment, 24 pieces were cut-offs and the rest 120 pieces were used in unidentified function.

There are three basic weave types found in the textile material. Tabby weave in which each weft thread passes over one and under one warp thread. 2/2twill weave in which two weft threads pass over two and under two warp threads. 2/1twill weave in which one weft thread passes over one and under two warp threads. Warp are the longitudinal threads that are attached to a loom. Weft are the transverse threads that is passed through the warp threads in a shed back and forth (Crowfoot et al. 1992, 213–214). 2/2twill is the most numbered with 84 pieces (54.5 %) of all textile material studied. Tabby weave is in the second place with 60 pieces (39 %) and the last one is 2/1twill with only 10 pieces (6.5 %). This combination of weaves does not correspond with any North European weave combination during the 14th and 15th centuries where the most common combination tabby or 2/1twill comes in first and then 2/2twill comes in second or third (Maik 1998, 217). This overwhelming number of 2/2 twills can be seen as specialisation to weave just one type of weave or as a need for this kind of weave for special purposes for example fulling and dyeing coarse woollen cloth (*vadmal*).

Threadcount means the number of warp and weft threads counted in one centimetre. Mean value of threads in all textile fragments is 10.7 threads in warp and 8.8 threads in weft, they are relatively coarse fabrics in question. The reason for this could be that in coarse fabrics there were two kinds of wool fibres found, coarse hairy and finer under wool that had been mixed together while spinning the yarn. This wool might have originated from local sheep, but no scientific fibre analysis has been executed yet.

Thread can be spun in S- or Z-twist, the stroke in the centre of a letter shows the direction of a twist in thread. Spin combination (S-S, S-Z, Z-Z, Z-S) means the direction of twist in a warp and weft thread (Crowfoot et al. 1992, 213). There are several spin combinations in

Åbo Akademi textile material. The most dominant combination is Z-S (44.8 %), next is Z-Z combination (26.6 %) of all the textile material studied. These two combinations are most prominent with 2/2twill weaves. Z-S combination makes the cloth soft and supple and it is easier to full. Fibres of the thread in different combination overlap each other and that makes cloth softer. However the fibres of a thread in the same combination make cloth very hard and tight (Gustafsson/Waller 1987, 156). As it comes to vadmal in Åbo Akademi material this makes sense because 60.9 % of them has Z-S combination and 34.8 % of them Z-Z combination. In order to make a good quality *vadmal*, the weaver has to be taking these notions under consideration. Different spin combinations have been used to get the best out of yarn qualities for specialised weaving (Gustafsson/Waller 1987, 156).

There are all four combination to be found in tabby weaves: S-Z (51.7 %), Z-S (20 %), Z-Z (11.7 %) and S-S (10 %). The results of spin combinations are quite different compared with other European textile material (see page 2 for references of the excavations in Europe). It seems that nowhere else were the S-Z spin combination used in so great quantities than in Åbo Akademi tabby material. Very often it is hard to distinguish a tabby warp from weft but can the figures be so wrongly interpreted? Did the weaver has some kind of special effect on mind? For example *crepe de chine* i.e. a modern tabby cloth that has S-Z combination and a characteristic shrinking (Gustafsson/Waller 1987, 160) and it gives a nice uneven texture to a cloth. Same kind of notions was made in the Mons Claudianus Project in Egypt that it has no difference if S-spun yarn is used in warp or weft in tabby weaves especially when the *crepe* effect is desired (Hammarlund 1997, 29). The other combinations are much more common in medieval textile material for example S-S combination is found in foreign broadcloth too.

Furthermore Z-S combination is the most dominant with 2/1twill weaves (70 %), next Z-Z with only two pieces (20 %). The Z-S combination is most practical when 2/1twill comes in question. The warp effect on the right side of a cloth is always to be seen i.e. the diagonal lines of twill weave are visible and the fluffier weft thread is more visible on the other side. This side was usually full for its warmth and