Early medieval textile remains from settlements in the Netherlands. An evaluation of textile production

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Abstract

Many fragments of archaeological textiles have been found in the Netherlands during the last century. This article focuses on the way these textiles were made and used. How and where were textiles and clothes made and by whom? Was cloth production already a practice of specialists, acting in an extensive trade network, or was it a craft that mainly took place at the household level? To answer these questions 440 fragments of 265 different textiles, from 31 sites have been examined. Without exception these textiles were discovered in settlement context, mostly in the north of the country. The analysis of the remnants has resulted in the distinction of the different steps in the production process and insight in the way the textile products were used. The results show that many textiles are likely to have been produced at a household level. Only in a few cases were they made using special skills and tools or did the production process require much time. Some products, such as the finer fabrics, the fine needlework on several hats, fabrics with a raised nap, piled weaves and a veil-like garment, may be considered as the work of textile specialists. In this article it is argued that these specialists were either working for a patron or in an independent workshop.

Keywords: textiles, Early Middle Ages, production, craft specialisation, archaeology, Netherlands

1 Introduction and research problem

In 2008 the author started doctoral research on Early Medieval textiles (400-1000 AD) in the Netherlands.[1] The aim of this research is to achieve a better understanding at a practical and theoretical level of the production, function and use of clothing throughout the Early Middle Ages in the area now called the Netherlands. Looking beyond the practical function of clothing it can be observed that there are many social aspects to the way people make and wear clothes. The organisation of textile production is closely related to the way society was organized. By studying the mode of production it is possible to gain an insight into the social position of the craftspeople, ranging from domestic production for personal consumption to specialists sup-

plying their goods to others. Clothes themselves are also social markers. The identity of a person or a group of people is often reflected in the way they dress. Diversity and changes in clothing can therefore be related to the social structure of society and to changes that may have occurred in that society over time.

The last few decades saw an increase in research on Early Medieval textiles. After preliminary inventories and several publications on single sites,[2] the extensive survey of European textiles by Bender Jørgensen (1992) provided an insight into the development of cloth production in northern Europe (including the Netherlands) during this period. However, many questions remain on the technical and social aspects of the production and use of textiles and clothes in the Netherlands in this period. It is not clear how people dressed and how social or economic differences were reflected in clothing. Neither do we know how textile production was organised within and between different types of settlements. This article aims to provide some answers to the problem of textile production by the analysis of the large number of textiles found in Early Medieval settlements in the Netherlands.

2 Research question, data and methods

2.1 Research question

The main purpose of this article is to consider textile production in its social context. How and where were textiles and clothes made and by whom? Was cloth production already specialized and related to an extensive trade network or was it a craft that mainly took place at the household level?

To do so, it is necessary to reconstruct how textiles and clothes were made. It may be possible to identify indications for production other than for domestic consumption in Early Medieval society by the assessment of the degree of specialization in textile production.

There are several approaches to a contextual study of textile production. First, it is possible to study textile products with a view to understanding how the cloth was made. Second, one can ascertain the degree of specialisation needed to produce the textiles and the way these textiles would have been valued by the people using them. Third is the study of the tools used to produce textiles, their development and distribution within a settlement, which may point to locations where different parts of the production process took place. A comparison between different settlements might even give information about the relative importance of textile production at these sites. Lastly, an evaluation of the access to the raw materials for textile production, like wool and dyestuffs, and indications for overproduction may give a view on the role of a settlement in the textile trade. This type of information may be acquired with a landscape-centred approach where well-documented bone spectra from different sites are available. The focus of this article is however, the textiles themselves.

2.2 Data

2.2.1 Quality

The textiles discussed in this article have all been found in settlements in the Netherlands. Most of these finds were uncovered in the dwelling mounds (or *terpen*) of a predominantly rural society in the north of the country. Few burials have been found at these sites and textile remains are predominantly found in settlements. A small percentage was found in major centres

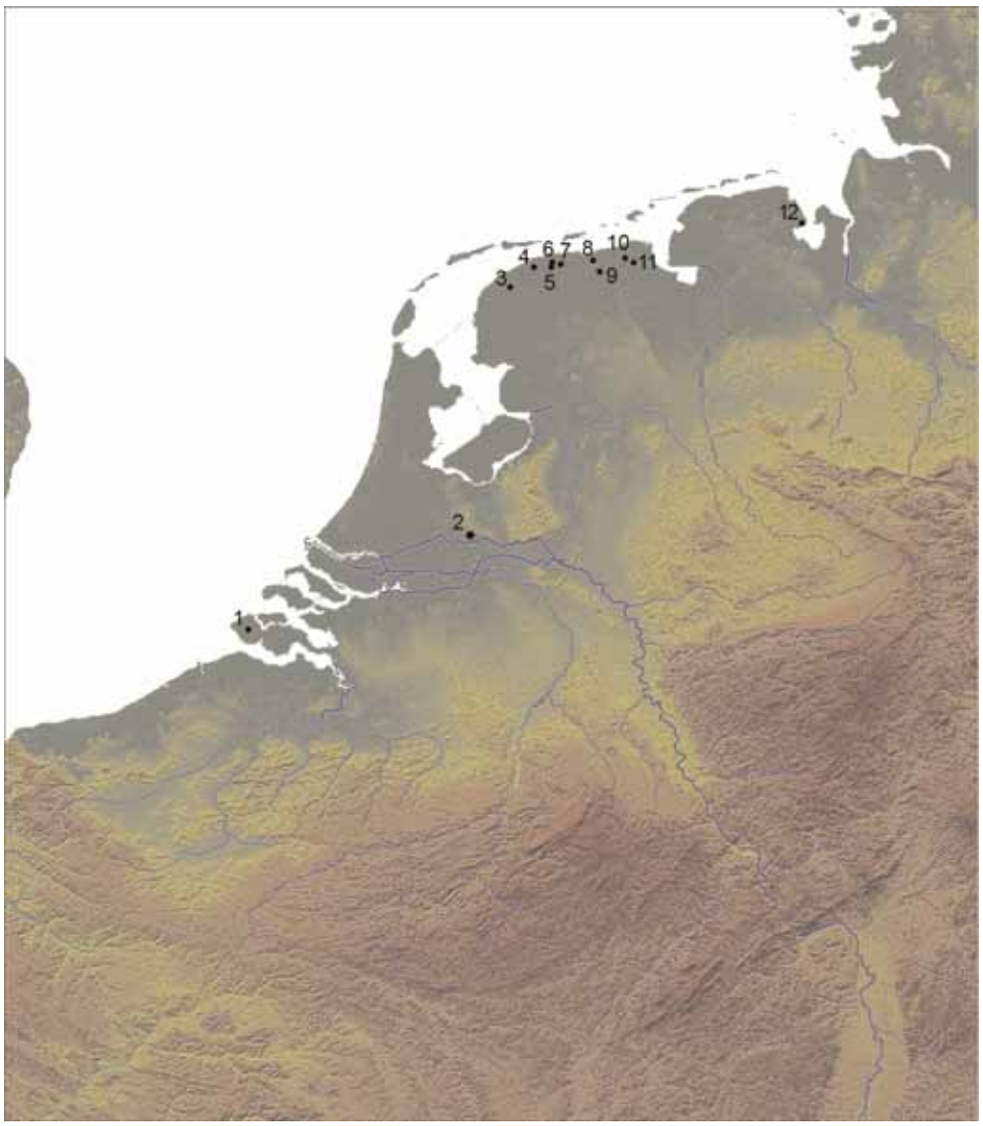

Fig. 1 Locations of sites mentioned in this article: 1. Middelburg, 2. Dorestad, 3. Hogebeintum, 4. Ezinge, 5. Dokkum, 6. Aalsum, 7. Oostrum, 8. Leens, 9. Ezinge, 10. Rasquert , 11. Westeremden, 12. Stadt Wilhelmshaven.

of a quite different character, such as Dorestad and Middelburg. Geographically and culturally the *terpen* differ from the towns of Middelburg and Dorestad. The *terpen* are considered to have more ties to Scandinavia, northern Germany and Anglo-Saxon England. Dorestad and Middelburg, situated on the edge of the Merovingian and Carolingian empire, are likely to have been more influenced by the regions in the south.

The textiles uncovered in these settlements have properties that make them worth treating as a separate find category among the body of textile finds from the Netherlands, in contrast to the textile fragments that have survived in cemeteries through the corrosion of metal artefacts. Although the cemeteries offer much better information for a chronological framework for textiles in use and for the reconstruction of clothes, they do not lend themselves easily to the examination of the entire process of production and use of textiles. Textiles found in settlements, on the other hand, contain information not only about how a fabric was spun, dyed and woven. They also give information about finishing processes and about how a fabric was put together, sewn, used and repaired. It is possible to cover a wide range of questions about the process of textile production on the basis of the often very large pieces of textile from the settlements.

site	habitation period of site	textiles are assigned to period:	N textile-fragments	N individual woven textiles	N individual cords, ropes and braids
Beetgum	350-900	350-500**	4	1	0
Blija	350-900	350-550**	2	1	1
Cornwerd	475-725	475-725**	7	0	2
Wetzens	350-900	500-900**	5	0	5
Jouwswier	350-900	500-900**	1	0	1
Kloosterwijtwerd	300-900	500-900**	5	4	0
Aalsum	300-900	500-700 and 750-900**	9	6	0
Dokkum, Berg Sion	500-900	Hat is dated between 568-651 cal AD; many textiles are associated with this find.	121	76	2
Westeremden	500-1000	500-1000**	44	26	1
Ulrum		600-800*	1	1	0
Leens		600-900*	94	41	10
Dorestad, Wijk bij Duurstede	600-900	600-900*	7	3	3
Oostrum, Mellemastate	500-900	700-900**	7	4	0
Oosterwijtwerd	350-900	700-900**	2	2	0
Anjum	700-1400	700-900*	1	1	0
Cornjum Dekema-/stoomterp	350-900	775-900**	6	3	1
Rasquert hat	350-900	Hat is dated between 800-900*	1	1	0
Middelburg	875-1600	875-1000*	28	12	0
Leeuwarden hoogterp	350-900		15	7	2
Ferwerd Burmaniaterp	350-900		20	12	3
Ferwerd Burmaniaterp II	350-900		1	1	0
Foswerd	350-900		6	4	0
Holwerd, dorpsterp	350-900		1	0	1
Menaldum	unknown		3	0	2
Kimswerd	300-900		2	1	0
Rasquert other finds	350-900		8	4	0
Sellingen/Zuidveld	350-900		3	2	0
Wijnaldum	100-1000		12	5	3
unknown, prov. Groningen	unknown		8	1	0
Teerns	350-900		2	1	1
Hoogebeintum	350-900		13	5	1
Wierhuizen	250 BC - 1300 AD		1	1	0
total			**440**	**226**	**39**

Table 1. Early medieval sites in the Netherlands with textile remains. The second column lists the entire habitation period of the site (after Taayke 1996; Knol 1993). The third column shows the period to which the textiles may be assigned. This is based either on associated excavated material (*) or to the fact that the majority of finds from a site is dated in this period (**).

There are, however, some disadvantages. Firstly, the textiles from the settlements are often poorly dated. This is related to the way many of these textiles have been recovered. The habitation of the earliest *terpen* dates back to *c.* 600 BC. After the third century AD a decline in population commenced, followed by a phase of scarce occupation. Population increased only after the fifth century and the *terpen* have been gradually raised up to their present heights. At the end of the nineteenth century the soil that had accumulated for centuries was discovered as a valuable fertilizer and therefore groups of diggers methodically dug away large parts of the mounds. These people sometimes had an eye for antiquities but as they dug straight from the top down, they could collect objects dating over 1000 years apart in one single day (Knol *et al*. 2005). As a result there may be textiles in the dataset spanning approximately the period from 500 BC to 1500 AD. On the other hand, scientifically excavated sites like Dorestad, Middelburg and older excavations at Zinge, Leens and Westeremden provide datable material (fig.1). In

Fig.2 The textiles from Cornjum (object nr. FM 120-411) were still in their original packaging from excavations conducted in the early 1900s (collection Fries Museum). Scale in cms.

some cases textiles are assigned to a period of several centuries, based on the fact that most other finds from these sites date from that period (table 1, **). However, some textiles can theoretically be dated to anywhere within the long period of habitation of a site. This makes it impossible to use this dataset as a whole to create a chronological framework for textiles in the Early Middle Ages.

A second disadvantage is that the dataset mainly consists of woollen textiles. During the Middle Ages people wore clothes made from animal fibres, such as wool, or plant fibres, like linen. Degradation of these fibres is caused by micro-organisms, oxidization and other chemical processes in the soil. Linen fibres break apart by a process of hydrolysis, which occurs under acid conditions. Wool on the other hand, like leather and fur, may dissolve completely in alkaline conditions and is much better preserved in acid soil (Huisman 2009). Since soils are generally acid or alkaline, it is more likely that only one of the two types is preserved at any one site. In every settlement that has been examined, soil conditions were acid, which means that the preserved textiles are made of wool. Information about linen could come from the cemeteries, which will be published in the next few years.

Lastly, it must be considered that the textiles found in refuse layers in settlements are literally refuse. The fragments are generally heavily worn, re-used and finally discarded as rags, making it difficult to ascertain their original function.

2.2.2 Dataset

The dataset consists of 440 fragments from 265 different textiles from 31 sites (table 1). Of these textiles, 80 have already been published in some detail.[3] The others have not been analysed until now. Some were still untouched and in their original wrapping from the early 1900s (fig. 2), or were still adhering to the clay from which they had been recovered. As a consequence, these textiles had to be cleaned with demineralised water and dried flat before analysis could take place.

The textiles may be divided into woven fabrics (226) and others like ropes, cords, braids and felt (39). The finds vary in size from small scraps of a few square centimetres to large pieces approximately 40 x 35 cm in size. The textiles are probably not only the remains of people's clothes but may also have been used for household needs such as bedding or sacking (see 4.1 for more information about the function of the textiles).

Seventy eight percent of the textiles can be assigned to a period of several centuries within the Early Middle Ages. These finds will be presented in this paper via discussion, tables and graphs grouped per site in chronological order. The other 22% will be treated as a separate group as it is not certain whether they are Early Medieval or older.

2.3 Methods

2.3.1 Some central concepts: skill and quality

The following discussion focuses on the concepts of skill and quality. *The Oxford English Dictionary* defines the noun 'skill' as: **1** the ability to do something well; expertise or dexterity. **2** a particular ability. Production of textiles was commonplace in Early Medieval society. Manufacture for daily clothes, household furniture, and sailing clothes must have taken up a considerable share of everyday life. From a study of working time conducted in 1760, it is known that up until the eighteenth century women in south Sweden worked at least eight months a year on textile production for domestic needs only (Andersson 2003). The techniques to make textiles were therefore widespread and embedded in the entire society. Skill in Early Medieval textile production must be conceived as the ability to make textiles of a higher level of skill, using refined techniques or expertise. Skill does not necessarily lead to finer textiles, there are many other reasons for which a textile may be valued. The quality of a textile and the way it was valued depends on its properties in relation to the use of the textile. It is often a combination of several properties, which makes a fabric suitable for a specific use. In cases of clothing it is obvious that a fine and technically complex fabric is very suitable and valuable. Fabric for sailing clothes, on the other hand, would have required other properties. A suitable sail cloth may very much resemble a fabric that in terms of clothing would be seen as of average quality (Cooke *et al.* 2002). The appearance of a textile may also be of significance because it can be just as important in signalling social status as the form or shape of a garment (Hammarlund *et al.* 2008). These properties are generally not easy to measure using standard analytical methods for archaeological textiles because these methods may describe textiles as technically similar while the naked eye conceives differences (Hammarlund 2005).

2.3.2 *Chaîne opératoire*

An important research question concerns differentiating domestic craftsmanship from production for a textile market via the analysis of textiles. A useful tool in this regard is the concept of *chaîne opératoire*, or operational sequence, which considers a production process as a sequence of (interrelated) actions influenced by technical possibilities and personal and cultural choices

(Skibo & Schiffer 2008). This implies a study of the individual steps in the process of textile production, which makes it possible to evaluate every action and to discern the general mode of production. In each step one can ask whether producers had access to the same materials, skills and tools in the making of the final product. Although this is a somewhat technical approach, it is useful for possibly distinguishing ordinary textiles from specialized products made by people with specific skills or tools.

2.3.3 The social modes of production

Olausson (1997) has pointed out that it may be possible to gain greater insight into social complexity by studying how production was organised. Her model, developed for Neolithic Scandinavia, has previously been successfully applied to textile production by Andersson (2003, 2007). Olausson recognises five levels of production in terms of specialisation. Table 2 shows the characteristics of the first four levels.

Household production can be present in any kind of society but if it is possible to identify the product of a specialist, this should indicate a higher level of social complexity. The products of these types of specialised production must surely have different characteristics. A craftsman, producing for his patron, will make a product that will heighten the status of this patron. His products will therefore have to show the time and effort the craftsman has put into them. An independent craftsman would not have the time to elaborate on his work in the same way. He would have to be efficient to make his money, suggesting that his products could therefore be characterised as efficient and standardised, requiring a minimum of production time and there should be little evidence of errors (Olausson 1997).

1. Household production	2. Household industry
• Production covers the household's needs	• Seasonal part-time production
• Household members possess the skills and knowledge needed	• Production scale beyond the needs of the household
• Raw material is commonly accessible	• Organised at household level
• Knowledge of manufacturing process is widespread.	• Surplus used for trade, exchange or tax
	• Production when spare time is available.
3. Tethered specialisation:	**4. Workshop industry:**
• A craftsman is linked to a patron and produces solely for him	• A financially independent craftsman
• Production by specialist	• production for a market
• Work is a full time occupation	• this type of production requires large demands and a higher degree of social complexity
• Specialist skills are enhanced by full time occupation.	• Products are made efficiently and standardized: the time and costs are reduced to a minimum
• Better quality products	• Full time production by a specialized craftsman
• High quality products are used by the patron as desirable gifts	
• Control of the skilled specialist adds to the power of the patron	

Table 2. Characteristics of the different modes of flint production defined by Olausson (1997) and applied on archaeological textiles by Andersson (2003).

Following this model an assessment of the textiles is needed regarding how they were made and whether there are indications of a specific type of production or specialization as pointed out in table 2. This is reflected in the details of the process of textile production, from producing yarns (collecting fibres and the fineness of the spinning), through the careful weaving, to the way the cloth was sewn into a garment. It is also useful to consider whether the quality of the

different steps in the process is the same or not. For instance, has the same level of craftsmanship been applied at each stage of the entire process of making textiles, or has part or parts of the process been of different levels? Lastly it is important to analyse how textiles were used after production and how they were possibly valued by the person or people using them. Therefore it is important to ask what they were used for, how they were sewn and how much effort was put into repairing them until they were finally discarded. It can be argued as to whether this is part of textile production, but these questions need to be taken into account when analysing the use, repair and value of a fabric.

2.3.4 Theory turned into practice

The textiles in the dataset are analysed to ascertain the degree of specialisation in the production process. To do so, every step of the production process has been considered. Analyses of spinning, weaving and needlework have been conducted by the author. These analyses involved describing the techniques used and the quality or craftsmanship visible in the thread, weave or stitching. Sections 3 and 4 include a discussion of the variables used in measuring these qualities. Fibre and dye analyses of several samples were done by P. Walton Rogers at the Anglo-Saxon Laboratory. The following sections will present the results of these analyses and a discussion of fibre processing, spinning, dyeing, weaving, finishing processes, sewing and repairing.

3 Textile production

3.1 Fleece processing

The end product of a woven fabric is determined from the start of the production process by selecting the proper fibres from a fleece. Analysis of the fibres in archaeological textiles provides information about the natural colour, type and fineness of the wool selected for specific types of textiles. The earlier fleece type analyses were conducted using a chronological model of fleece evolution from hairy to fine and evenly distributed fleeces (Ryder 1964). Modern critics have argued that this approach is not useful for archaeological textiles. Ryder's model does not take into account that the fleece from one single sheep varies greatly depending on which part of the body it came from. It also assumes that wool was used straight from a sheep when it is more likely that it was prepared, sorted and selected to create a better yarn (Christiansen 2004, Rast-Eicher 2008). Fleece analysis will therefore not provide chronological information but may provide evidence for the preparation of the fibre before it was spun into threads.

Recently the fleece type of several Dutch samples was analysed in order to compare these textiles to those from northern Germany (Walton Rogers 1995), Norway and Denmark (Bender Jørgensen & Walton 1986; Walton 1988) and Anglo-Saxon England (Walton Rogers 2007, 10-14, 62-64). Twenty-eight samples of Early Medieval textiles were selected for a quick scan of animal coat and natural pigmentation (table 3; analysis by P. Walton Rogers, the Anglo-Saxon Laboratory). All except two textiles proved to be made from sheep's wool. A textile from Beetgum was almost certainly made from the undercoat of goat. Only four textiles were made from white fleeces. Among these were unusual fabric types, not necessarily locally produced (a felt from Ferwerd and a gauze-like textile, or *Schleiergewebe*, from Leens).[4] The hat found at Oostrum (fig. 3) was also made from naturally white wool. Dark brown or black was the most common colour for twills and diamond twills.

site name	object code	pigmentation	original fleece colour
Ferwerd	101-883	**dark**: mod.on all	**dark**: mid brown
		light: none	**light**: white
Ferwerd	101-703	mostly none, occasional moderate	white
Teerns	16D-98/2	**dark**: mod. & dense all	**dark**: dark brown
		light: 10% dense	**light**: pale grey/off-white
Ferwerd	101-470/3	dense on all	brown/black
Ferwerd	101-470/6	mod.& dense on all	dark brown
Oostrum	35B-147/2	mostly dense, some mod.	black
Leens	1939-IV.13A/5	mod.& dense on all	brown/black
Leens	1939-IV.13A/7	none	white
Unknown	G2008-1.8	most none, occasional mod	white
Leens	1939-IV.37/2	**dark Z**: mod.& dense on all	Z = dark brown
		lighter S: light & dense	S = variable within yarn – mottled effect
Oostrum	35B-48/1	Z: 3% mod.	Z: white
		S: 3% mod.	S: white
		Stch: 24% mod.	Stch: fawn
Beetgum	46-95	Z&S: mod.&dense all	Z&S: dark brown
		Stch: dense&mod.	Stch: brown/black
Aalsum	33-373	Z&S&loose S: mod.& dense in uneven proportions	uneven brown and brown/black
Leens	1939-IV.18/1	tight Z2S: mod.&dense all	tight Z2S: dark brown
		Soft Z & S	Soft Z&S: mottled white/brown/black
		mixed non, mod. & dense	
Westeremden	1930/2a	**dark**: mod.all	dark: mid brown
		light: light	light: light brown
Westeremden	1930/4	mod-dense all	brown/black
Westeremden	1930/5a	mod-dense all	brown/black
Westeremden	1926/IX.29b	mod.all	mid brown
Kloosterwijtwerd	1910/I.195/3b	light-mod-dense	mottled brown
Sellingen/Zuidveld	Z.n.1	variable 5%-30% mod	mottled off-white
Leens	Xx	**plied**: none	**plied**: white
		mid stch: light	**mid stch**: fawn
		dark stch: mod.& dense	**dark stch**: dark brown
Westeremden	1921/I / 2	(a) none	(a) white
		(b) light-mod	(b) fawn
Berg Sion	A1913/11.223	**dark**: dense all	**dark**: black
	packet 1	**light**: 6% black	**light: white**
Berg Sion	A1913/11.223	Z&S: mod all	Z&S: mid brown
	packet 2: 'warp Z+S'		
Berg Sion	A1913/12.5B	**warp**: mod & dense all	**warp**: dark brown
		weft: 40% mod	**weft**: mottled brown/white
Berg Sion	A1913/12.5 zn2	all three: mod & dense all	dark brown throughout
Berg Sion	A1913/11.224	**light Z**: none & some light	**light Z**: off-white
		dark S: mod & dense	**dark S**: dark brown
Berg Sion	A1913/11.223D	all three: mod & dense on all	dark brown

Table 3. Textiles analyzed for fibre and natural pigmentation.
mod. = moderate; stch = stitching. (Analysis by P. Walton Rogers, The Anglo-Saxon Laboratory).

Several fabrics were woven in a colour pattern using threads of different colours and thus creating stripes or blocks within the fabric. Macroscopically, this technique has only been observed in five textiles, but based on results of microscopic analysis, we may assume that it was applied more frequently. Fibre analyses show that six out of 28 textiles (21%) were woven with naturally dark wool in one thread system and originally light wool in the other thread-system.[5] Among these were four textiles that had not been macroscopically recognised as such.

Seventeen samples from seven different textiles were selected for further analysis of fleece type (table 4). Warp, weft and any sewing thread or pile yarns were analysed separately. In order to identify the fleece type, 100 fibres were measured and the results plotted as a histogram.

Fig. 3 Hat found in Oostrum (object nr. FM 35B-48). The hat was made from naturally white wool which was dyed a light red. The decorative stitching was made in a darker red yarn (collection Fries Museum).

According to the range, mode, mean and degree of skew of the measurements, the samples were allocated to one of seven fleece-type categories: Hairy (H), Hairy Medium (HM), Medium (M), Generalised Medium (GM), Fine (F), Semi-Fine (SF; previously called Shortwool) and Fine/Generalised Medium (F/GM). Eleven of the samples were HM, one was GM, two M and three samples (all from the same textile, Beetgum lab.nos. 46-95) were goat fibre.

Only two textiles show evidence for the special preparation of wool. The white wools in warp and weft of the gauze-like tabby, or *Schleiergewebe*[6] have been allocated to the M category because of their symmetrical spread of the fibre diameters and their means between 30 and 40 microns, although the maximum diameter for the M type should be 60 microns and both yarns include a single fibre thicker than 60 microns in diameter (table 3). The wools in a similar textile from Hessens, Stadt Wilhelmshaven, in north Germany (He33a, and possibly also in He31c), were similarly difficult to categorise and it was suggested that they may represent an HM fleece from which the hairs had been stripped out. The same may be true of the Leens example (Walton Rogers, unpublished). These textiles are also found in Anglo-Saxon England and in Viking Age Denmark, Britain and Ireland, and it is possible that they represent trade goods produced in a specialist workshop (Walton Rogers 2007, 68-69).

The textile from Beetgum is made from goat fibres. The outer coat hairs are absent in this case, which may indicate that the underwool was combed directly from the animal during its spring moult.

The Dutch textiles resemble those from northern Germany. Previous research on 27 samples from mainly seventh to ninth century sites in northern Germany shows that the textiles were made from fleeces that are categorized as Hairy or Hairy Medium. Similar results were obtained from samples of raw wool found at the same settlements. This may indicate that the wool was processed in the settlement, making the woven textiles a local product. Many fibres were originally of a brown or mottled brown colour. White fleeces were only observed in 22% of the threads. In contrast to the Dutch textiles, all textiles were woven with wool which was originally the same colour in both warp and weft (Walton Rogers 1995, table 3). Some of the same fabrics and pigmented fleece types are also found in Anglo-Saxon England, although the English material has a larger share of white wool and a wider range of fleeces. The *terpen* evidence contrasts with the material from Norway, which shows a much more precise method of

Sample	Structure/Yarn	Range	Mode(s)	Mean±S.D.	Pearson Coeff. of skew, distribution	Medullas	Pigment	Fleece type
Beetgum								
46-95	2/2 twill: Z	12-67	16	22.9±11.1	+1.01, skewed positive	obscured (≥20%)	100% dense	Goat underwool
46-95	2/2 twill: S	11-73	16	22.5±10.4	+0.81, skewed positive	obscured (≥15%)	100% moderate & dense	Goat underwool
46-95	stitching	10-58	17	20.8±8.7	+1.05, skewed positive	obscured (≥10%)	100% moderate & dense	Goat underwool
Dokkum, Berg Sion								
Hat A1913/11.223D	2/2 diam: Z	16-70	27	34.3±11.0	+0.56, skewed positive	obscured (≥10%)	100% dense	Hairy Medium
Hat A1913/11.223D	2/2 diam: S	14-86	25	35.3±13.9	+0.77, skewed positive	obscured (≥5%)	100% dense	Hairy Medium
Hat A1913/11.223D	stitching	12-55	24, 25	32.5±10.8	+0.56, skewed positive	obscured (≥5%)	93% dense	Hairy Medium
A1913/11.224	fine tabby: Z	12-55,98	24, 25	29.0±11.9	+0.90, skewed positive	3% (1 kemp)	0	Hairy Medium
A1913/11.224	fine tabby: S	15-74, 94	19	25.6±10.1	+0.72, skewed positive	obscured	100% dense	Hairy Medium
Aalsum								
Hat 33-373	2/2 diam: Z	12-62	20, 27	30.1±11.3	+0.65, skewed positive	obscured	100% moderate & dense	Hairy Medium
Hat 33-373	2/2 diam: S	15-80	26, 27	38.8±13.9	+0.81, skewed positive	obscured	100% moderate & dense	Hairy Medium
Oostrum								
35B-147/2:	2/2 diam: Z	15-68	25	32.0±11.4	+1.00, skewed positive	obscured (≥1%)	100% dense	Hairy Medium
35B-147/2:	2/2 diam: S	21155	24	30.7±10.5	+0.43, symm/skewed	obscured	100% dense	Generalised Medium
Hat 35B-48/1:	2/2 diam: Z	14-67, 88	20, 27	30.8±12.5	+0.82, skewed positive	1% (1 kemp)	4% moderate	Hairy Medium
Hat 35B-48/1:	2/2 diam: S	15-68	25	28.2±9.8	+0.87, skewed positive	3%	3% moderate	Hairy Medium
Hat 35B-48/1:	stitching: S-ply	16-80	27	32.1±13.4	+0.96, skewed positive	*c.*6%	24% moderate	Hairy Medium
Leens								
1939-IV.3A/7	veil-weave: Z	20-52, 75	32	36.1±9.5	+0.22, symmetrical	2%	0	Medium
1939-IV.3A/7	veil-weave: Z	17-52, 65	30	34.6±9.0	+0.03, symmetrical	1%	0	Medium

Table 4. Fleece types in textiles from early medieval Netherlands. Statistics for each sample are based on the measurement of a diameter of 100 fibres. Measurements in microns (1 micron = 0.001 mm). 2/2 diam = 2/2 diamond twill. Analysis by P. Walton Rogers, The Anglo-Saxon Laboratory.

selecting and processing wool. The raw materials from the textiles from the *terpen,* found in the north German and Dutch settlements show a wider range of fleece types and a lack of carefully sorting which makes them closer in type to the Hessens-Elisenhof type textiles excavated in southern Scandinavia (Walton 1988, 153; Bender Jørgensen 1984, 130-1, Walton Rogers, unpublished).

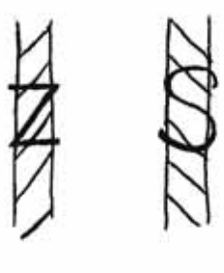

Fig. 4 The direction of the twist of a yarn is indicated as z or s.

3.2 Spinning

To spin yarns from fibres one needs a spindle whorl and a distaff. Depending on the direction the spindle whorl rotates, the threads are twisted either clockwise or anticlockwise resulting in z- or s-spun thread (fig. 4). Right-handed spinners generally spin clockwise (z-spun treads), but

accomplished spinners can change the direction of spin when needed. In order to make an even stronger yarn several threads may be twisted together, resulting in plied yarn (for example a 2zS-yarn is made out of 2 z-spun threads, plied S-wise). Among the woven textiles single twisted threads are most common. Plied yarn has been used only in a few cases (table 5). This small share of plied yarns is a great contrast to the (Roman) Iron Age when plied threads were used in the majority of textiles (Bender Jørgensen 1992, 49).

site	N tx single threads	N tx plied yarn
Beetgum	1	0
Blija	0	1
Kloosterwijtwerd	4	0
Aalsum	6	0
Dokkum	77	0
Westeremden	26	0
Ulrum	1	0
Leens	41	1
Dorestad	3	0
Oostrum	4	0
Oosterwijtwerd	1	1
Anjum	1	0
Cornjum	1	2
Middelburg	12	0
Leeuwarden	7	0
Ferwerd Burmaniaterp	12	0
Ferwerd Burmaniaterp II	1	0
Foswerd	4	0
Menaldum	0	1
Kimswerd	1	0
Rasquert	5	0
Sellingen/Zuidveld	2	0
Wijnaldum	5	0
unknown, prov. Groningen	0	1
Teerns	0	1
Hoogebeintum	5	0
Wierhuizen	1	0

Table 5. Distribution of textiles woven with single twisted threads or plied threads.

3.2.1 Quality of spinning

The quality of spinning can be ascertained by studying the thickness of the threads and the degree of regularity of the spinning. Presumably every woman in the Early Middle Ages could spin with a considerable degree of skill. Recent spinning experiments have shown that even nowadays one can, with a little practice, easily spin quite regular thin threads of about 0.5 mm with practically any type or size of spindle whorl.[7] We should however take into account that the breeds of sheep kept in the Early Medieval period had fleeces that were not as ideally suitable for spinning thin yarns as those bred nowadays. Thickness of threads has therefore been divided into 4 classes: <0.5 mm, 0.5-0.75 mm, 0.75-1.5 mm and >1.5 mm. The first category consists of very fine threads that needed careful spinning and more time to be woven into fabrics. The second category 0.5-0.75 mm may be regarded as the thickness that could easily be spun by any experienced spinner. The third and fourth categories are coarser or thicker yarns.

Wild (*et al.* 1998) and others have stressed the great advantages of digitally analysing the degree of twist in yarns because it enables researchers to distinguish the hand of individual spinners in a dataset and also the degree of experience of the spinner (Cork *et al.* 1996, Wild *et al.* 1998). Unfortunately this method was not available for this dataset, therefore the degree of

twist has been classified as low, medium or high or, in the case of irregularly spun threads, as a combination of these. The finer threads (up to 0.5 mm) are generally spun medium to high regularity, making a very strong yarn. The 0.5-1.5 mm thick threads show a wide range of twist, from low to very high. The very thick yarns are often barely spun, making a very soft thread.

Table 6 shows that most fabrics from well-dated sites were woven with threads of 0.75-1.5 mm thickness. The finest, <0.5 mm and 0.5-0.75 mm are both equally represented, while the group of >1.5 mm is represented only in small numbers. There are some differences between the three major textile sites, Dokkum, Westeremden and Leens. In Dokkum there is slightly more fine spinning, whereas Westeremden has a larger share of the 0.75-1.5 class. Leens shows significantly less fine threads and more very coarse yarns of the >1.5 mm class. Middelburg shows a completely different pattern with a dominance of fine spinning, 37% in the <0.5 mm and 29% in the 0.5-0.75 mm class.

site	<0.5mm	0.5-0.75mm	0.75-1.5mm	>1.5mm	site	<0.5mm	0.5-0.75mm	0.75-1.5mm	>1.5mm
Beetgum	0	0	2	0	Leeuwarden	0	6	6	0
Blija	1	0	1	0	Ferwerd Burmaniaterp	5	11	8	0
Kloosterwijtwerd	2	1	3	0	Ferwerd Burmaniaterp II	2	0	0	0
Aalsum	0	3	6	3	Foswerd	0	1	6	1
Dokkum	35	40	64	11	Menaldum	0	0	2	0
Westeremden	10	13	29	2	Kimswerd	0	0	2	0
Ulrum	0	0	0	0	Rasquert	0	2	6	0
Leens	12	14	25	21	Sellingen/Zuidveld	1	1	2	0
Dorestad	1	0	0	1	Wijnaldum	0	1	7	2
Oostrum	2	6	0	0	unknown	0	2	0	0
Oosterwijtwerd	0	0	2	0	Teerns	0	0	2	0
Anjum	0	0	0	0	Hoogebeintum	3	2	3	0
Cornjum	0	0	5	1	Wierhuizen	0	2	0	0
Middelburg	9	7	7	1					

Table 6a. Distribution of the thickness of spun threads per site and per group of sites.

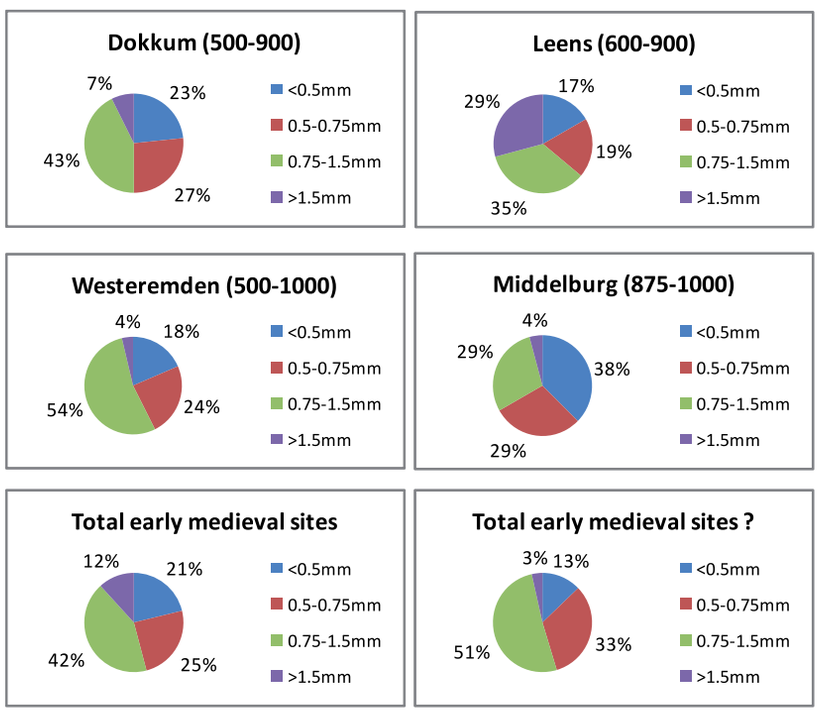

Table 6b. Graphic representation.

As stated before we may assume that it was possible to produce threads as thin as 0.5 mm despite the lower quality of the wool. Therefore there is no doubt that it would technically be possible to spin even finer threads. However, spinning and weaving these fine threads into equally fine fabrics would be more time consuming than spinning coarser threads and fabrics. These textiles consequently must surely have been more valuable than the coarser fabrics. The fact that more than 20% of the yarns are of this fine and time-consuming quality indicates that the people in these settlements either had time to produce this quality textile or sufficient wealth to purchase it, which may imply a certain level of craft specialization.

The majority of the spinning is of a much coarser quality. Instead of considering the technical limitations of the craftspeople, there may be other ways to explain this distribution. One very practical assumption may be that the settlements have yielded not only remains of clothes but also a large proportion of furniture or household textiles, which were not required to be of a very fine quality. Many pieces from the coarse section of the dataset however show traces of sewing and may have been primarily used as clothing. It may therefore be assumed that time was also an important factor in the choice of a certain quality of thread. As stated earlier, spinning and weaving fine threads is time consuming and had to be combined with numerous other tasks. Therefore an overrepresentation of rather coarse fabrics may indicate that the people involved generally did not have the time to put more effort into textile production. Neither would it suggest they had the means to let others do this work for them. Comparing the sites, Dokkum may perhaps be seen as an exception where there is an even distribution of threads up to 0.75 mm and thicker ones. Middelburg seems to be an important exception, but in reality it is not. The examples of fine spinning in the textiles from this settlement are in most cases only present in the warp. These fabrics have been made with a very thin and strong warp but very often with a much thicker weft. The production of these textiles is thus no more time consuming than for other rather coarse fabrics.

3.3 Dyeing

Many dyes were used in early historic times. A red colour was obtained by dyeing wool with dyestuff extracted from different species of dyer's madder. Archaeological evidence for the cultivation of *Rubia tinctorum L.* in the Netherlands is not available until the seventeenth century. There is historical evidence that dyer's madder did occur in the *terpen* area in the northern part of the Netherlands in the Early Middle Ages (Van Haaster 2001). Wild madder (*Rubia peregrina L.*) is known in the southern part of Great Britain and in the Mediterranean. Dyer's woodruff and bedstraw were also used to produce red colours as far back as the fifth century AD (Cardon 2003, 120-128). Red could also be obtained from the insect kermes creating a very strong and colourfast dye. This precious dye was produced in the Mediterranean and valued greatly in north-western Europe as a symbol for kings (Cardon 2003, 618). Lastly shades of crimson could be obtained using a dye extracted from the insect of the Porphyrophora species. Evidence of this dye has been found in a sixth century context in Germany.

Blue was obtained from woad (*Isatis tinctoria L.*). Woad has been known in the Netherlands since the Iron Age (Cappers 1994). Yellow dyes were extracted from weld (*Reseda luteola L.*), which was widespread in western Europe (Cardon 2003, 170). Remains of this plant have been found in Roman forts in the Netherlands (Pals 1997, 35). Another source for yellow dye is the plant Dyer's broom which has been identified in ninth century finds form York (Cardon 2003, 177). Purple was obtained from lichens of the genera *Ochrolechia* and *Umbilicaria*. This dye has been identified in ninth and tenth century finds form York, Dublin, London and Scandinavia (Cardon 2003, 501). Purple could also be extracted from marine molluscs but this was a very expensive way of dyeing. In the Late Roman period purple was associated with imperial majesty and in later periods it remained the colour for kings and synonymous with wealth. The

prestige of the colour purple increased with its scarcity. The dyestuff was not locally available and had to be traded form the Mediterranean or Brittany (Cardon 2003, 574). Different hues of brown would have been obtained using natural dyestuffs from bark and nuts that were readily available in any wooded area.

Only the wealthy could afford to wear certain colours because they were expensive to produce. To wear them was thus a social signal to the wearer's contemporaries, that they could afford this level of luxury (Hedeager Krag 1993). Analysing textiles for dyestuffs may therefore result in an indication of the wealth of the original wearer. There are, however, a few hurdles to overcome in relation to dye analysis. Natural dyestuffs deteriorate over time and will very often have disappeared entirely during the period the textile was buried. Consequently a negative result in dye analyses does not necessarily mean that a fabric was not originally dyed. Many dyes that were locally available, like the brown colours from nuts and bark, would also be hard to detect. It is generally very hard to discern the chemicals from these dyes from those naturally present in the soil because of their similarity to material found in the natural environment. It is therefore difficult to know exactly how colourful Early Medieval clothes were.

site name	object code	structure	original fleece colour	results of dye tests
Ferwerd	101-703	felt	white	yellow stain/dye
Leens	1939-IV.13A/7	tabby	white	no dye detected
Oostrum	35B-48/1	2/2 diamond twill	Z: white S: white Stch: fawn	hat: purpurin-rich madder stch: same but much stronger
Beetgum	46-95	2/2 twill	Z&S: dark brown Stch: brown/black	brown stain/dye
Aalsum	33-373	diamond twill	uneven brown and brown/black	no dye detected
Dokkum	A1913/11.223D	2/2 diamond twill	dark brown	hat: brown tannin-based dye stch: no dye detected
Sellingen/Zuidveld	Z.N.1	2/2 twill	mottled off-white	no dye detected
Dokkum	A1913/11.224	Tabby	**light Z**: off-white **dark S**: dark brown	no dye detected

Table 7. Results of dye analyses. mod. = moderate; stch = stitching.

Recently, seven textiles were selected for dye analysis (table 7). Dye could be identified in the hat from Oostrum (fig. 3), the body of which was made from a white fleece and had decorative stitching in fawn wool. The same madder type dye was present in both the textile and the sewing thread but it was much more concentrated in the stitching, making it likely that the ground fabric was light red, salmon or peach and the needlework a deep dull red. Chemically, the dye was dominated by purpurin but there was a trace of alizarin, which suggests that the dye came from the roots of *Rubia tinctorum L.* (Walton Rogers unpublished).

There appeared to be a tannin-based brown or black colorant in the headdress or hat from the site of Berg Sion (Dokkum)(fig. 5).[8] This is fairly exceptional since the headdress was made out of naturally brown wool, which in most cases would not have been dyed. Tannins are widely distributed in nature, especially in material from trees, and it is not always possible to recognise tannins deliberately applied as dye. In the case of the Berg Sion headdress, however, the colorant was detected in the main fabric of the hat but not in the needlework, which suggests that the tannins were present in a dye applied to give a solid black to the already naturally dark fleece colour of the headdress. The dye could have come from barks, nuts or oak galls.

No dye was detected in the Leens *Schleiergewebe*-tabby. This does not mean that the textile was not dyed. Other textiles of this type have proved to be dyed black, blue or purple (Walton Rogers 2007, 69).

Fig. 5 Hat or headdress found in Dokkum (object nr. a1913/11.223D). The hat was made out of naturally brown wool which was dyed deep brown. The wool used for the decorative stitching was not dyed (collection National Museum of Antiquities Leiden).

Previous research on Anglo-Saxon textiles has pointed out that naturally white wools were often dyed. Analyses of naturally brown or black samples nearly always had a negative result, meaning that in most cases these textiles were not dyed at all.

The textiles from the Netherlands and Germany (Walton Rogers 1995) are very similar in this respect. Dyestuffs have been detected in only a few textiles. Those fabrics that had certainly been dyed come from hats that had been sewn with great care (see 4.2 Needlework) and must have been valued for their appearance. The rest of the textiles were probably either originally (mottled) brown or black.

3.4 Weaving

3.4.1 Looms and their characteristics

The process of weaving large pieces of cloth was generally conducted on a warp-weighted loom (fig. 6, left). This type of loom would have stood slightly at an angle against the wall of a building. The vertical threads of the fabric, the warp, were hung onto the upper crossbeam of the loom and put under tension by attaching loom weights. These loom weights can be found in abundance at Dutch sites.

Another type of loom, known from the countries surrounding the Netherlands, is the two-beam vertical loom (fig. 6, right). This loom type was in use during Roman times and must have remained in use in parts of France during the Merovingian and Carolingian periods, re-emerging in more widespread use around the end of the ninth century (Henry 1998, 2005). The change of loom is associated with a predominance of a weave-type which hitherto had not

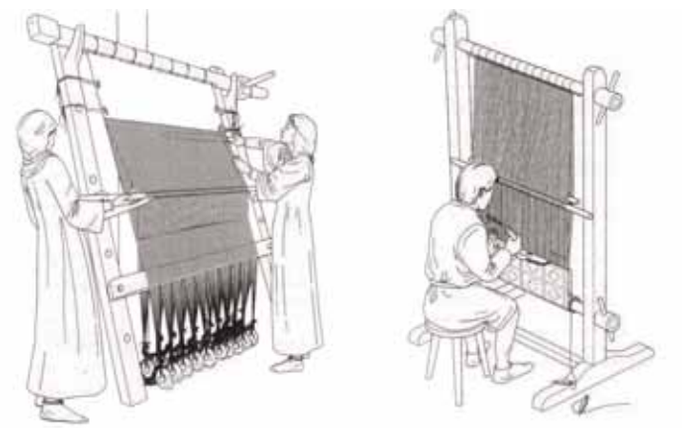

Fig. 6 Warp-weighted loom (left) and upright two-beam loom (right) (after Walton Rogers 1997).

been very popular, the 2/1 twill (fig. 6b). Moreover the shift from one loom type to the other may be related to a change in the organisation of textile production from a domestic basis to a more organized and centrally controlled production (Henry 2005). If and when this loom type was actually in use in the Netherlands is not certain.

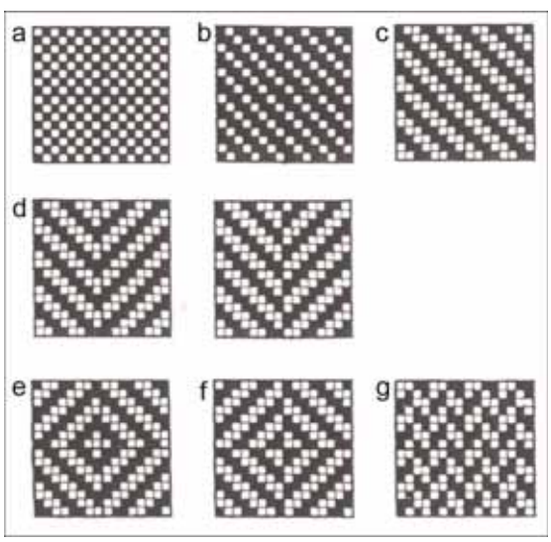

Fig. 7 Fabrics are made of a minimum two sets of threads that cross each other perpendicular. The way in which the horizontal threads (the weft) are woven through the vertical threads (the warp) defines the bind of the fabric. There are several types of binds present in the Dutch dataset.
a. Plain weave or tabby is found in a two varieties:
Tabby is a balanced fabric where warp alternates with weft every thread.
Repp-effect is used for tabbies where the thread count of one system is considerably higher than that of the second system. A weave is normally defined as such if it has a ratio of 1:2, or in fine fabrics, a difference of at least ten threads per cm.
b-g. Twills are found in a number of varieties.
2/1 twill (b) in which the warp passes over two and under one weft-thread.
2/2 plain twill or diagonal twill (c) in which the warp goes over two and under two weft-threads.
2/2 Herringbone or chevron twill (d) in which the weave is reversed in one system at regular intervals.
2/2 Lozenge twill (e) is a twill in which the weave is reversed in both systems creating a diamond-shape with a point repeat in the middle.
2/2 Broken diamond twill (f) is (similar to the lozenge twill) reversed in both systems with a displacement.
2/2 Cross twill or Kreuzköper (g) is a 2/2 twill in which the weave is reversed after every two threads.

From the tenth century onwards, historical texts mention a third loom type, the horizontal treadle loom (Cardon 1999, 412). The oldest finds in northwest Europe associated with this loom type are dated to the tenth century. In the beginning the width of the cloths produced on this loom was not very large. When weaving cloths of more than 1 metre width, one needed two weavers to operate this loom and it was only later that this became custom.

While the warp-weighted loom was very suitable for weaving broad cloths up to a length of 10 m, the horizontal loom was most effective when weaving narrow fabrics longer than 10 m (Cardon 1999, 415). The warp-weighted loom has no reed or batten, which may have affected the regularity of the thread systems. This irregularity is visible in the woven fabric in variable spacing of the threads and curving lines (Hammarlund *et al.* 2008).

No research has been conducted so far into the specific weaving tools that are associated with the various loom types, therefore the distribution of weaves presented below cannot yet be related to a type of loom.

3.4.2 The fabrics from Dutch settlements

Before discussing signs of specialization in weaving, a brief overview is required of the characteristics of the textiles from the Dutch settlements. This discussion will focus on the different techniques observed and their distribution across time and space.

Among the well-dated sites, nearly 50% of the textiles were woven in a diamond twill (table 7a & b). 2/2 plain twills are also present as a large group, followed by tabby, 2/1 twill, cross twill, herringbone or chevron twill and repp-effect tabby in small quantities. There are considerable differences between the major textile sites of Dokkum, Leens, Westeremden and Middelburg. Dokkum shows the largest variation of weaves, which is not remarkable since this site has yielded nearly twice as many textiles as Leens and three times as many as Westeremden. Dokkum has an equal number of diamond twills and 2/2 plain twills. Westeremden gives a very different picture with a large majority of diamond twills and very few 2/2 plain twills. In contrast, Leens shows considerably more 2/2 plain twills than diamond twills. Among the textiles from Middelburg (12 in total) we only see diamond twill and cross twill.[9] These different ratios among the sites may point to preferences for specific fabrics that were not necessary or required to the same extent at every site. There are considerably more 2/2 plain twills in many sites than previously documented in the diagram by Bender Jørgensen (1992 48, fig. 58).

Diamond twills show many patterns (table 8a). Some sites, like Dokkum, show a considerable variation of pattern repeats. In Westeremden on the other hand, a large majority of diamond twills are woven in pattern repeat 20/18, which points to a certain preference for this pattern there. This preference is also present in settlements across the border, such as Elisenhof and Hessens (Stadt Wilhelmshaven) (Tidow 1995, 359).

Several fabrics are woven in a spin-pattern. These patterns are created using both z- and s-twisted threads in warp or weft. The different direction of the twist of the yarns gives a very subtle but clear pattern. This pattern is present in 10 textiles.[10] All these textiles are rather coarse, the finest being spun in 10 x 8 threads per cm, but most are below 7 threads/cm. The pattern is present in diamond twills, 2/2 and 2/1 twill and tabby.

	tabby		repp-effect	2/1 twill z/s	2/2 twill		herringbone/chevron		lozenge twill z/s	cross twill z/s	Diamond twill		diamond twill pattern repeat																					
site	z/z	z/s	z/s	z/s	z/z	z/s	z/z	z/s	z/s	z/s	z/z	z/s	10/8	10/14	10/16	12/10	12/18	14/10	16/10	16/18	18/24	20/18	20/22	22/18	22/24	24/18	28/18	20/26	28/26	30/20	30/28	32/18	32/30	40/28
Beetgum						1																												
Blija				1																														
Kloosterwijtwerd						1						3					3																	
Aalsum					1	1						4										1				1				1	1			
Dokkum	1	5	1	4	2	29	1					33	1	1	1		3		1	1		1	1	1	1	1						1		1
Westeremden		1				3		1				21						1		1		10				2	2	1					1	
Ulrum									1																									
Leens	3				5	16					2	15					4			2		3											1	
Dorestad						1		2																										
Oostrum												4					1					1												
Oosterwijtwerd	1				1																													
Anjum						1																												
Cornjum						1						2																	1					
Middelburg										6		6				5																		
Leeuwarden					1							5									1					1								
Ferwerd Burmaniaterp					10	1						1												1										
Ferwerd Burmaniaterp II					1																													
Foswerd				1	1	2																												
Menaldum																																		
Kimswerd					1																													
Rasquert						1		1				3														2								
Sellingen/Zuidveld												2										2												
Wijnaldum					4	1																												
unknown, prov. Groningen						1																												
Teerns						1																												
Hoogebeintum					1	1						3												2										
Wierhuizen												1																						
total	**5**	**6**	**1**	**6**	**28**	**62**	**1**	**4**	**1**	**6**	**2**	**103**	**1**	**1**	**1**	**5**	**11**	**1**	**1**	**4**	**1**	**18**	**1**	**4**	**1**	**7**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**

Table 8a. Distribution of the weaves per site and per group of sites.

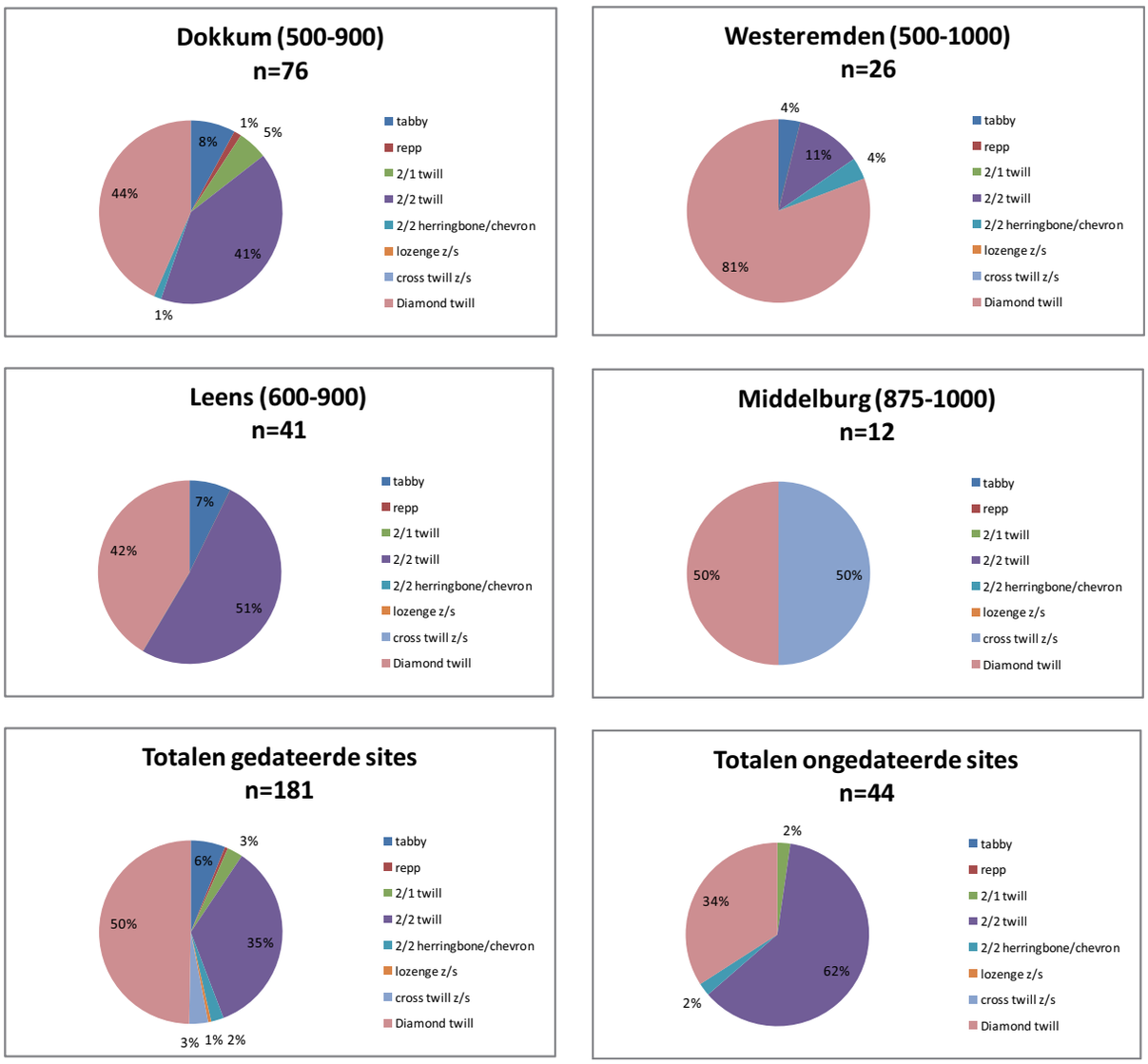

Table 8a&b. Graphic represntation of distribution of the weaves per site and per group of sites.

Borders or selvedges are observed in 25 textiles (table 9). Many of these borders are not reinforced at all, but are created by weaving the weft-thread immediately back into the fabric. This technique is, not surprisingly, mostly observed in rather coarse fabrics, but it is also present in a few of the finer textiles. Reinforced borders are present in 15 cases. These borders are made in tablet weave creating either a tablet woven band of three to six tablets or a tubular border (fig. 8). An example of a starting border in tablet weave was found at Hoogebeintum.[11]

site	objectnr.	type borders
Ferwerd Burmaniaterp	101-883	not reinforced
Ferwerd Burmaniaterp	101-890	tabletweave (4 tablets)
Ferwerd Burmaniaterp	101-470/6	tabletweave (6 tablets)
Hoogebeintum	28-321/3	tabletweave (4 tablets)
Wijnaldum	77A-102B	tubular selvedge
Dokkum	a1913/12.5 z.n.1	tabletweave (3 tablets)
Dokkum	a1913/12.5 z.n.2/1	tubular selvedge
Dokkum	a1913/11.226	not reinforced
Dokkum	a1913/11.236a	Starting border, not reïnforced
Dokkum	a1913/11.223m/1	tubular selvedge
Dorestad	WD375.3.1	not reinforced
Kimswerd	a1913/11.233	tubular selvedge
Kloosterwijtwerd	1910/I.195/3b	tabletweave (5 tablets)
Leens	1939-IV.27/9	tabletweave (3 tablets)
Leens	1939-IV.23	tabletweave (4 tablets)
Leens	1939-IV.13/5	not reinforced
Middelburg	00049-2	not reinforced
Middelburg	00049-3, -4 & -5	not reinforced
Middelburg	00049-7 & -8	not reinforced
Sellingen/Zuidveld	Z.n.2	tabletweave (3 tablets)
Westeremden	1921/I.76b	tubular selvedge
Westeremden	1930/I	tubular selvedge
Westeremden	1930/3a	tabletweave (3 tablets)
Westeremden	1930/8a	tubular selvedge

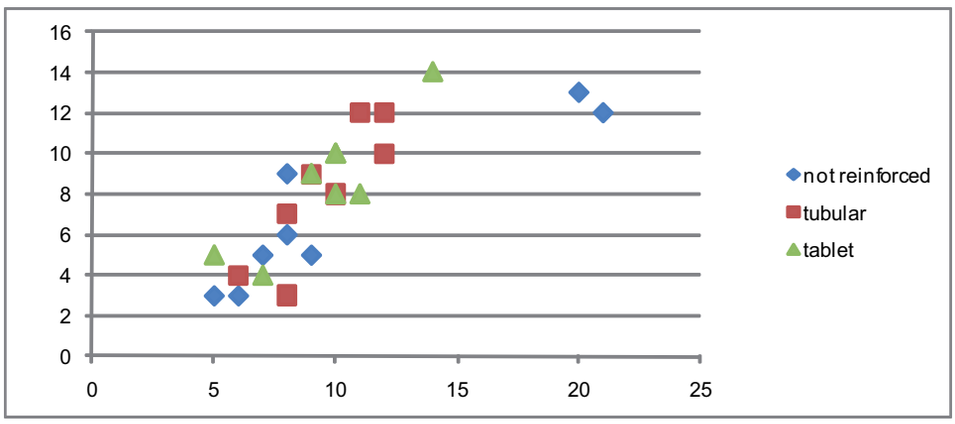

Table 9. The types of borders present (table) and the distribution in relation to the thread count of the main weave (graph). X and Y represent numbers of threads per centimeter.

3.4.3 Signs of specialization in weaving

There are several ways to identify possible specialization in the weaving process. One is the estimation of the time and effort spent. A common way of estimating this is by comparing the thread counts of the weaves. Weaving a fine fabric with a large number of threads per centimetre takes more time than weaving a coarse fabric with only a few threads per centimetre. It is therefore useful to divide the dataset into groups ranging from coarse to fine. However, a focus on thread count alone would not do justice to many of the textiles. A cloth does not necessarily have to be of a high thread count to be valued. A coarse but regularly spun and woven fabric may be very pretty and equally valued for its craftsmanship. So besides this quantitative approach one can consider the regularity of the weaving. Relevant variables might be whether or not faults are visible and whether the appearance of the fabric is regular or not. This is a subjective way of classifying the textiles, but nevertheless gives an impression of the skill of the weaving. Lastly, there are fabrics that needed special skills or specific tools to produce. These most likely are the products of specialized workers and must have been valuable goods.

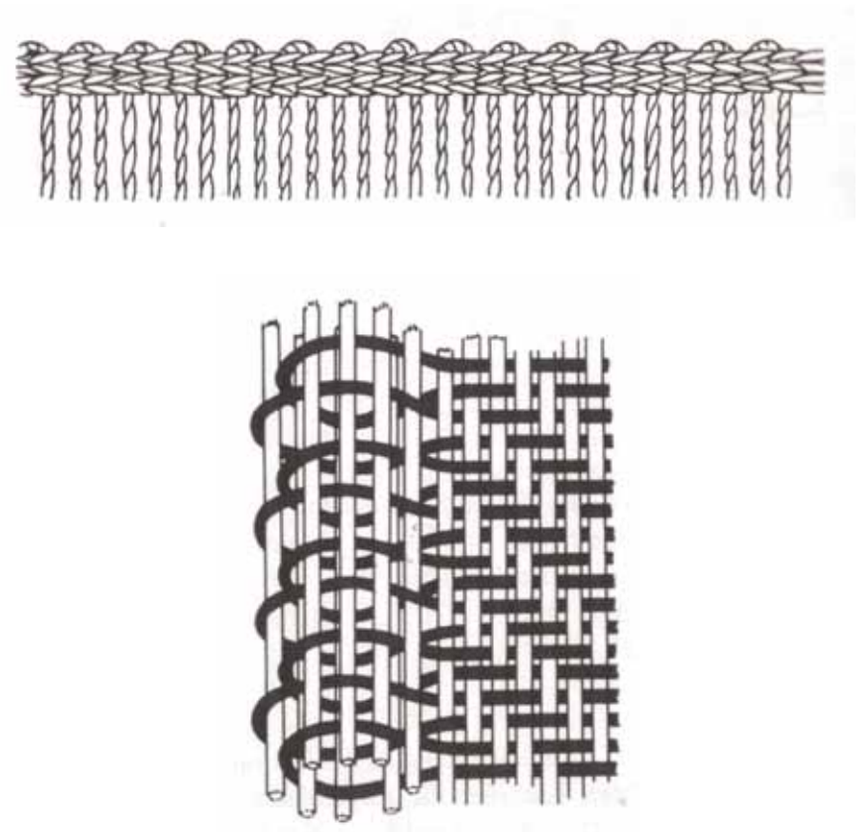

Fig. 8 Selvedges made in tablet weave: a tablet woven band and a tubular selvedge (after Schlabow 1976).

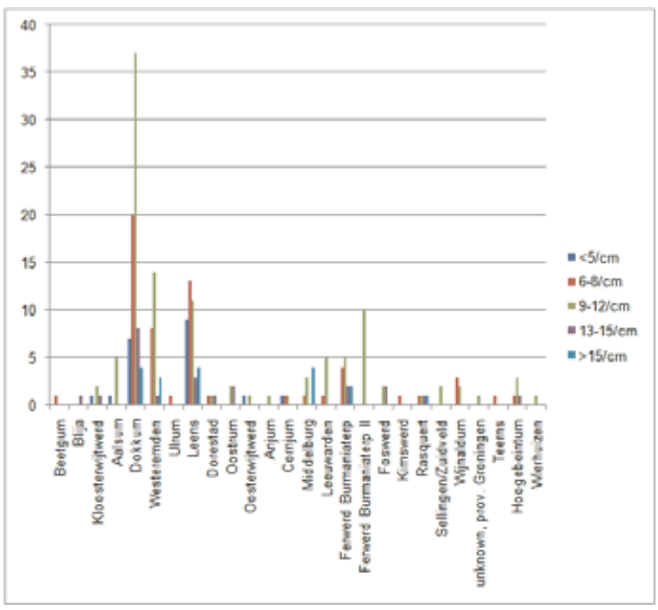

Fig. 9 Distribution of the different groups or qualities of weaving by site.

The fabrics may be divided by thread counts into five groups, ranging from very coarse to fine (fig. 9). The majority of the textiles have thread counts below 12 threads/cm. Only a small group may be considered as fine quality, but there are no fabrics finer than 28 threads/cm. There are slight differences between the sites (fig. 10). Leens has yielded more coarse fabrics, which may point to an overrepresentation of household textiles. In Westeremden and Middelburg this coarse group is missing altogether and both sites yielded considerable quantities of finer fabrics.

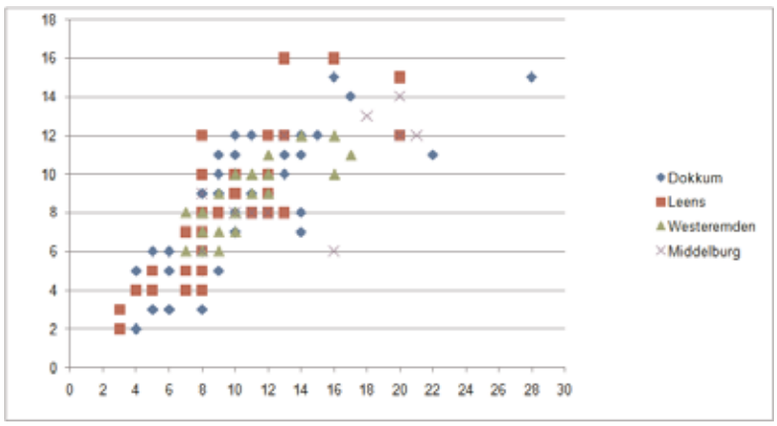

Fig. 10 Comparison of the quality of weaving between the sites of Dokkum, Leens, Westeremden and Middelburg. X and Y represent numbers of threads per centimeter.

There are two examples of very fine spinning and weaving in the dataset. First, the so-called *Schleiergewebe* or veil weave found in Leens (fig. 11).[12] This is a very fragile and open tabby, woven with z-spun threads of 0.2 mm and approximately 10 threads/cm. The fabric was woven out of naturally white wool[13] and was possibly used as headdress. The other, finer textile is another tabby (repp-effect) found in Dokkum. This fabric is a very dense cloth woven with 28 x 15 threads/cm.[14] Two colours of wool were used, white for the warp and dark brown for the weft. It is not clear whether the fabric was also dyed, since no dyes have been detected on the textile. Both these fabrics must have taken considerable time to produce.

Fig. 11 Veil-like fabric or Schleiergewebe found in Leens (object nr. 1939-IV.13A/7 & 1939-IV.13/1). Photo: M. Schouten (collection Groninger Museum). Scale in cms.

Comparing thread count and the regularity of the weave gives further information about the quality of the fabrics. The finer fabrics are often of a high and regular quality, as may have been expected, but this is also the case for most of the textiles in the middle group. This group, woven with approximately 10 threads per cm, was perhaps not necessarily of high value, but it may reflect the quality of work an accomplished weaver could achieve in normal circumstances. Using Olausson's model for production it may also be possible to classify these textiles as the products of an independent specialist as they are characterised as efficient and standardised, requiring a minimum of production time and with little evidence of errors.

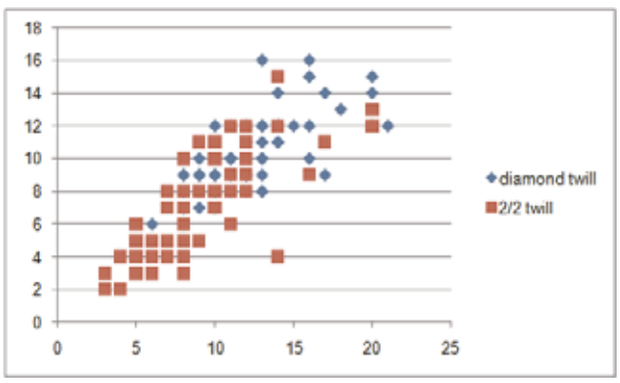

Fig. 12 Comparison of the quality of weaving between 2/2 plain twills and diamond twills. The diamond twills generally are woven with more threads/cm. X and Y represent numbers of threads per centimeter.

Another pattern emerges when the different weaves and their thread count are compared (fig. 12). 2/2 twills are generally coarser than their counterparts, 2/2 diamond twills. Technically, 2/2 twills are easier to weave than diamond twills and the fact that this bind is most often produced in low thread counts affirms its function as bulk product, which generally must have been used for general household needs. Diamond twills, on the other hand, were not made in coarse fabrics. The decorative pattern of this twill, combined with the higher thread counts and the technical difficulty, may point to a different value and use of this cloth type.

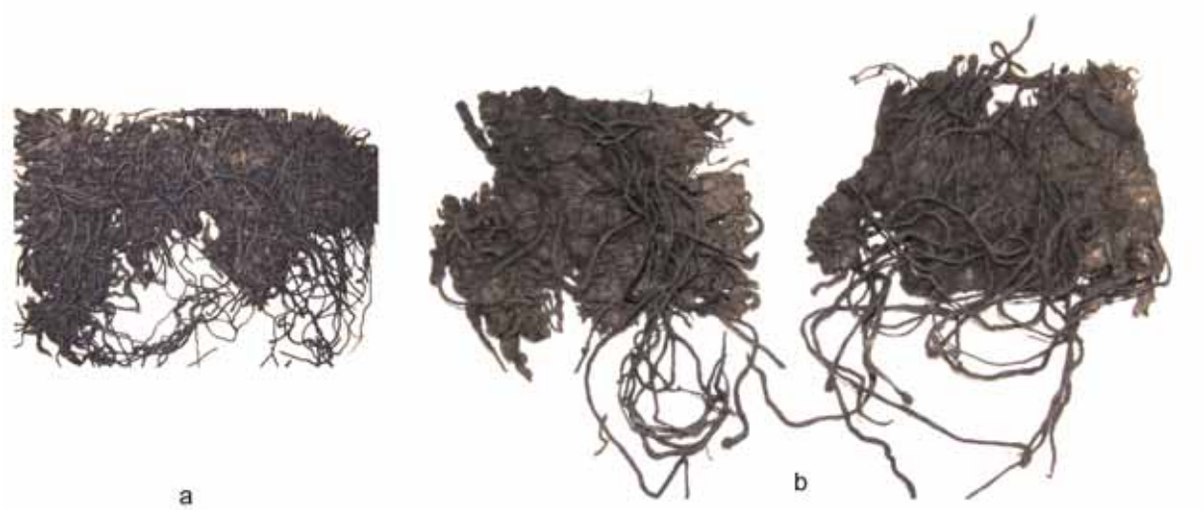

Fig. 13 Piled weaves found in Leens (left, object nr. 1939-IV.18/1) (collection Groninger Museum) and Dokkum (right, object nr. a1913/12.5 z.n.2/1) (collection National Museum of Antiquities Leiden).

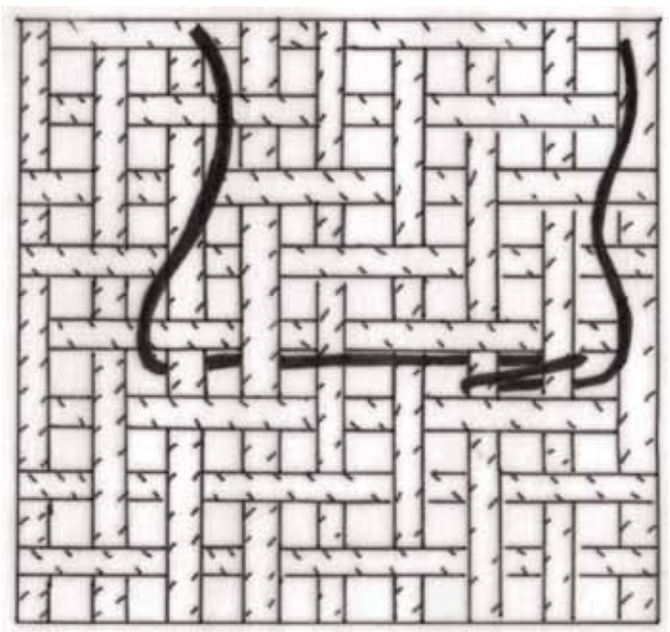

Fig. 14 Piled weave of Dokkum. The pile has been partially woven into the fabric.

Finally there is one type of fabric that required extra technical skill to produce, piled weave. Piled fabrics are sparsely represented in the Netherlands. Examples were only found in Leens and Dokkum (figs. 13 & 14).[15] These weaves are rather coarse, very thick and densely felted z/s 2/2 twills, with long strands of s-spun thread worked into the fabric and hanging from the surface. These threads had the same function as fur, causing water to drip down the threads instead of drenching the woven cloth beneath. This fabric was very suitable for cloaks, which has been confirmed by finds in England. There, this fabric has been mainly found in men's graves as a cloak or body cover. In some cases piled fabrics had been dyed (Walton 1989, 336; Geijer 1938, 132) and the quality of the wool suggests that they were luxury goods (Walton Rogers 2007, 85). The production site of piled fabrics from the fifth to the seventh century (presumably contemporary with the Dokkum textile) is unknown. From the eighth century onwards (contemporary with Leens) piled fabrics were traded from Ireland and Iceland and the Frisians also seem to have had a share in this trade. Texts mention that they were trading in a cloth called *villosa* that may have been used for this type of cloak (Gudjonsson 1962, 70, Walton Rogers 2007, 85-86).

In summary, it is possible to conclude that the coarser weaves were generally made in z/s 2/2 plain twills. These twills were quick and easy to make and were used for household needs, bedding, sacks, etc. The largest group of textiles consists of regularly woven 2/2 twills or diamond twills that could have been produced by any able weaver, so presumably production took place on a domestic level. Applying Olausson's model, the regularity and efficient production of these textiles may however also be interpreted as characteristic for the work of independent specialists. Only a small group of mainly z/s diamond twills are of a finer quality, which required more time to weave. It is not clear whether this production took place at the household level or at a specialist workshop. One can merely conclude that people did occasionally take the time to make these textiles or pay somebody else to spend their time weaving the cloth. The veil weave found at Leens and the two piled weaves from Leens and Dokkum are rare examples of textiles that were almost certainly objects of trade.

3.5 Felting

Felting is a process that takes place after weaving a fabric. It involves soaking the woven fabric in water and a fulling substance like soap or mud and then beating or treading it. The aim of this process is to make the fabric thicker, more dense and therefore warmer and waterproof. It is, however, not so easy to recognise whether or not a fabric was felted deliberately because a garment can get the same matted and felted surface when it is used in normal life through the friction of one piece of cloth onto another. On the other hand, the absence of a felted surface does not necessarily mean that a fabric was not felted. The matted surface can easily break away during excavation and finds processing, leaving a clean and unfelted appearance.

There are only a few textiles that show a felted surface. Several of these seem to have been primarily felted. The piled weaves (see 4.4), which were probably used as cloaks, must have been felted. These thick and dense fabrics were clearly meant to be waterproof and a felted fabric would greatly enhance the function of this garment. The mitten found in Dorestad (fig. 21), a thick mantle-like fabric from Dokkum and two pieces from Middelburg are also likely to have been felted.[16] In the case of the Middelburg textiles, it has been suggested that they have a raised nap (Leene 1964). The technique of raising a nap involved roughening up the surface of the fabric with teasels and afterwards shearing the surface back with large iron shears. This technique had been in use since the Roman period (Wild 1970) and is considered a specialist activity in the Early Middle Ages.

4. Function and use of textiles

The way in which the textiles were used may reflect how they were valued. Using a textile involves first sewing it into shape for its primary use, then wear and repair, eventually followed by secondary use, until it was finally discarded as waste. It would be expected that a valuable textile had been sewn with great care and, if necessary, repaired with equal care to maintain its function as long as possible. It is often difficult to ascertain the primary function of the textiles involved because of their fragmentary state. Nevertheless, a few semi-complete garments are present and a very large number of pieces with seams, hems and other stitching, make it possible to consider the overall quality of the needlework.

4.1 The function of the textiles

Several pieces of garments could be recognized, among which were hats, mittens and parts of sleeves. Gussets were also present, indicating the presence of tunic-like garments. These garments must be considered in detail, because they illustrate a broad variety of sewing techniques and may relate to the function of the textiles.

Six hats are known from Early Medieval settlements. These hats are all woven in diamond twills in a range of qualities.

The hat from Aalsum[17] (fig. 15) is made out of scraps of four different fabrics, with a thread-count of approximately 10 x 8 threads/cm. It is roughly sewn with whipstitches (fig. 25 1a) and running stitches (fig. 25 6c), using 1-2 mm thick plied sewing thread. The hem at the back was edged with blanket stitches (fig. 25 4a), while the hem at the front was folded back and attached with small whipstitches. The hat has undergone high quality repairs using small (5 mm) stitches and thin (0.7 mm) red thread.

Fig. 15 Hat found in Aalsum (object nr. FM 33-373) (collection Fries Museum).

Fig 16 Hat found in Leens (object nr. GM1939/IV:13/1) (collection Groninger Museum). (Photo: J. Stoel, courtesy of Groninger Museum).

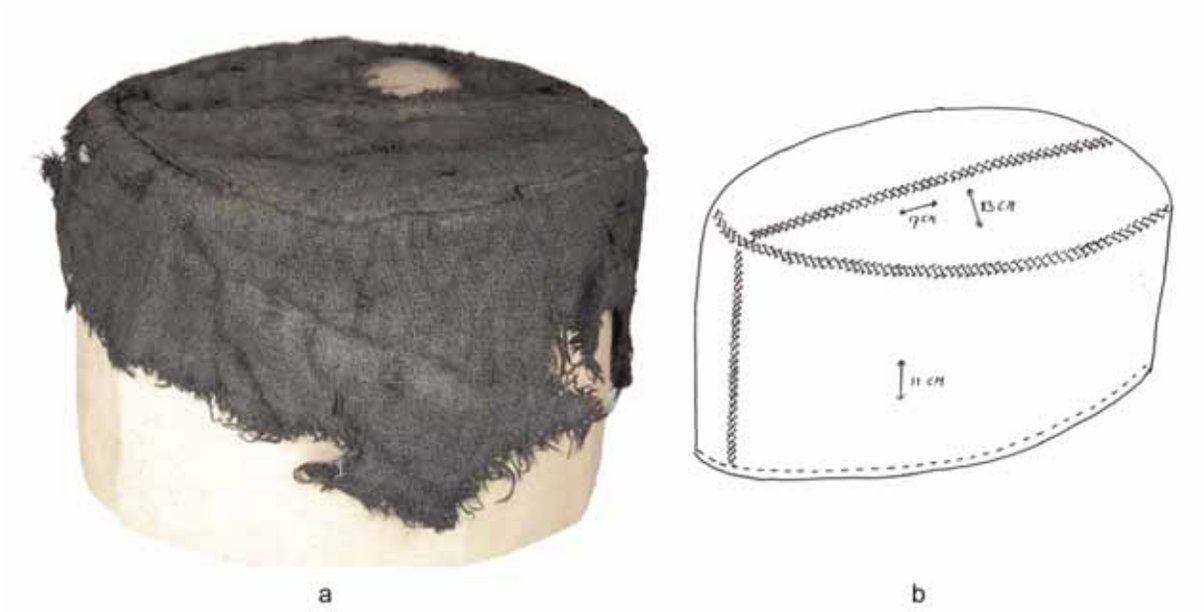

Fig. 17 Pillbox cap found in Leens (object nr. b1930/12.34/1) (collection Groninger Museum).

The settlement at Leens has yielded two hats. Well known is the hat illustrated in figure 16.[18] This hat was constructed from three pieces of different fabrics with thread-counts ranging from 8 x 7 to 12 x 9. The crown is attached to the sides with 5 mm wide (whip) stitches. Seam allowances are secured on the inside with 5 mm wide stitches. The hem is folded twice and coarsely secured with whipstitches more than 1 cm apart. The thread is a double z-twisted thread (Zimmerman, 2009). Another hat of Leens is present in the collection of the National Museum of Antiquities (fig. 17).[19] This so-called pillbox cap bears great resemblance to examples from the twelfth to the fifteenth century found in Greenland (Østergård 2004, 219-220). The hat was constructed from several pieces of the same diamond twill (thread-count 13 x 12) woven with fine threads but with many faults in the diamond pattern. It seems that the edges of the different parts of the hat were firstly folded double and secured with blanket stitches to prevent fraying. Subsequently, the parts were sewn together using a decorative stitch (fig. 27a). The hem of the hat is decoratively stitched through with a row of running stitches. The hat is damaged but shows no trace of repair (Brandenburgh in prep.).

Fig. 18 Decorative stitch applied to the hat from Leens.

The hat from Oostrum was made out of what was originally white wool dyed to a pale red shade (fig. 3).[20] The fabric is of good quality (0.5-0.7 mm threads, 14 x 12 threads/cm) and the hat was sewn with great care, using the same decorative stitch as the pillbox-cap from Leens (fig. 18 & 27a). This decorative stitch was probably of a deeper red colour, making it a contrasting and attractive decoration. The hem of the hat was secured with very small running stitches that are hardly visible from the outside. The hat was heavily used and repaired in many places. These repairs seem to be the result of one action because the same technique and same type of thread were used for all the repairs. The repairs are firm but rough, although the repairer tried to use fabric of equal quality to the original.

Fig. 19 Cap found in Rasquert (object nr. GM1928/VIII:1) (collection Groninger Museum). (Photo: M. de Leeuw, courtesy of Groninger Museum).

The cap from Rasquert (fig. 19) is made out of a fine diamond twill (17 x 9 threads/cm).[21] The crown and peak are attached with decorative stitches in s-twisted red yarn (fig. 27d). The seam was sewn with simple whipstitches and a decorative effect was obtained by drawing two threads through these whipstitches (Zimmerman 2009).

The headdress from Dokkum is made out of a rectangular piece of cloth with two side panels (fig. 5) woven in a diamond twill (14 x 11 threads/cm). The sewing was carried out with great care. Seam allowances were first secured with either blanket stitches or raised chain stitches. The seams were afterwards sewn using the same decorative stitch as in the hats from Leens and Oostrum. Dye analyses have shown that the headdress was dyed a deep brown whereas the sewing thread was probably not dyed. This decorative band would have contrasted with the fabric, like in the Oostrum hat described above. It is not altogether clear how the headdress was worn. It would be similar to those from Early Medieval Dublin and York (Wincott Heckett 2003, Walton 1989) if the decorative stitches faced front (fig. 20) (Brandenburgh in prep.).

Mittens are present in two sites, Dorestad and Aalsum (figs. 21 & 22).[22] In both cases coarse thick fabrics have been used, made of thin warp thick weft threads and woven with only a few threads per centimetre. The Dorestad mitten seems to have been primarily felted, which would have greatly enhanced its practicality. Both mittens were sewn very roughly with threads up to 2 mm in width.

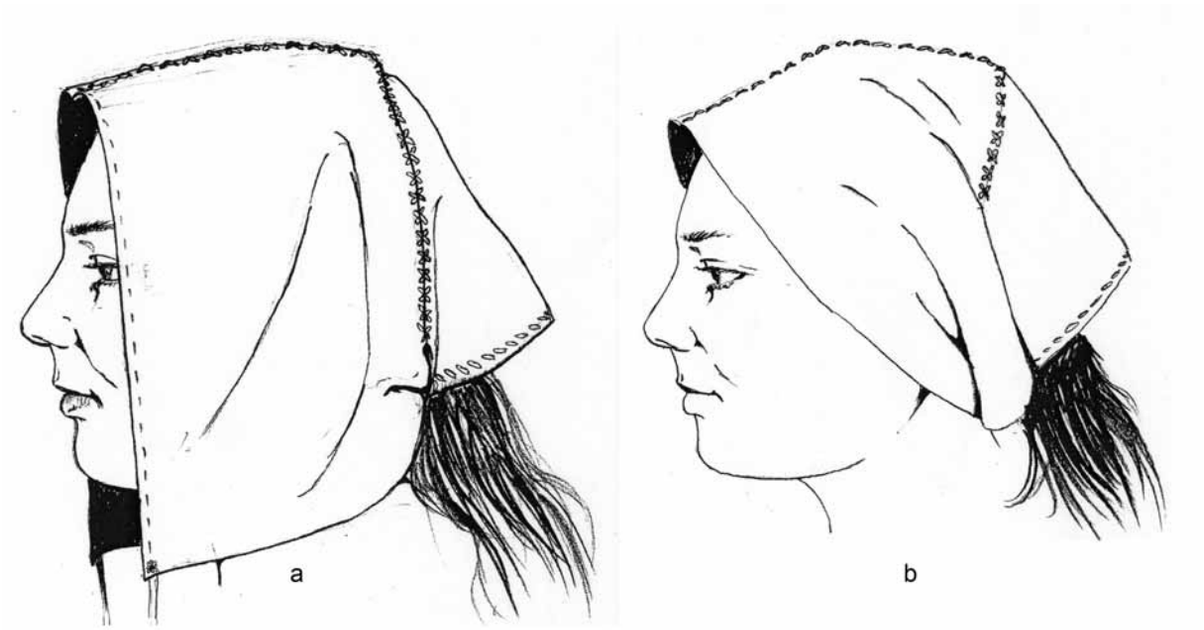

Fig. 20 Reconstruction of how the headdress from Dokkum might have been worn (object nr. a1913/11.223D) (collection National Museum of Antiquities Leiden).

Fig. 21 Mitten found in Dorestad (object nr. WD375.3.1) (collection National Museum of Antiquities Leiden).

Three pieces of fabric have been sewn into a tubular shape, presumably a sleeve of a tunic or similar garment.[23] The sleeve from Leens is woven in a plain 2/2 twill with 8 x 5 threads/cm. The narrow part of the sleeve has a diameter of 24 cm with a length of 21 cm remaining. The hem and seam are sewn with 1.5 mm thick plied yarn (Schlabow 1976). Several parts of sleeves were found in Middelburg (fig. 23). One is woven in diamond twill with 12 x 12 threads/cm. The diameter at the hem is 22 cm with a remaining length of 35 cm. The sewing uses irregular whipstitches and single and plied yarn. Another garment fragment consists of a sleeve and two side panels with a gusset sewn between (fig. 24). This garment was made out of a fine diamond twill with 21 x 12 threads/cm. The remaining length of the sleeve is 20 cm with a diameter of 26 cm. The sewing was done with fine running stitches using plied yarn (Leene 1964).

Fig. 22 Mitten from Aalsum (object nr. FM 33-374) (collection Fries Museum).

Fig. 23 Fragment of a sleeve found in Middelburg (object nr. 00049-1) (collection Stichting Cultureel Erfgoed Zeeland; Photo: H. Hendrikse). Scale divided into 5 cms.

Fig. 24 Remnants of a garment found in Middelburg: a fragment of a sleeve and several fragments, including a gusset, sewn together (object nr. 00049-2) (collection Stichting Cultureel Erfgoed Zeeland; Photo: H. Hendrikse). Scale divided into 5 cms.

Among the many textiles found in Dokkum one more is worth discussion. A large fragment 55 cm in length consisting of two rectangular pieces with a gusset (27 cm length) sewn between them (fig. 25).[24] Again the fabric is a diamond twill of approximately 12 x 12 threads/cm. Both rectangular pieces have selvedges, making a strong seam at the side of the body where the gusset is sewn in. The sewing is done using small stitches with a rather thin thread. Considerable wear and tear had occurred, making it necessary to repair the garment just above the gusset. The bottom of the garment is hemmed.

Some fabrics were certainly not used for clothing. Two examples have been found in association with feathers.[25] These textiles were probably used as mattresses or cushions. They were made in a plain 2/2 twill with 5-7 threads/cm. One fragment was woven with z-spun threads in both warp and weft, the other in spin pattern. In addition to these two pieces many more textiles presumably served as household-textiles at a certain moment in its life cycle, soft finishings like curtains, wall hangings, coverlets and cushions were present in every house. Other textiles may have functioned as sail cloth. In Scandinavia, and probably also in the Netherlands, sail cloth was produced in large quantities. It was an important part of textile production and sail cloths were used as a form of currency and means of taxation. Archaeological evidence of woollen sail cloth has pointed out that in later times they were made in a 2/1 twill with 8-9 highly twisted z-spun warp yarns and 4-6 low twisted s-spun weft yarns per cm. The resulting fabric was impregnated with a resinous material making it stiff and reducing airflow (Cooke *et al.* 2002). Fabrics of similar thread counts, thin warp threads and thick weft threads are present in the Dutch textile record and since they are too coarse to be clothing material, they most likely were used as sail cloths.

4.2 Needlework

126 Fragments have remains of hems, seams or other types of stitching. This makes it possible to identify a number of different seam and hem types (fig. 26 and catalogue) and ascertain the general quality of sewing in the dataset.

A study of the complete garments makes it possible to discern the order in which sewing was carried out. In hats, the edges of the different pieces were secured first to prevent further fraying and these pieces were then sewn together.

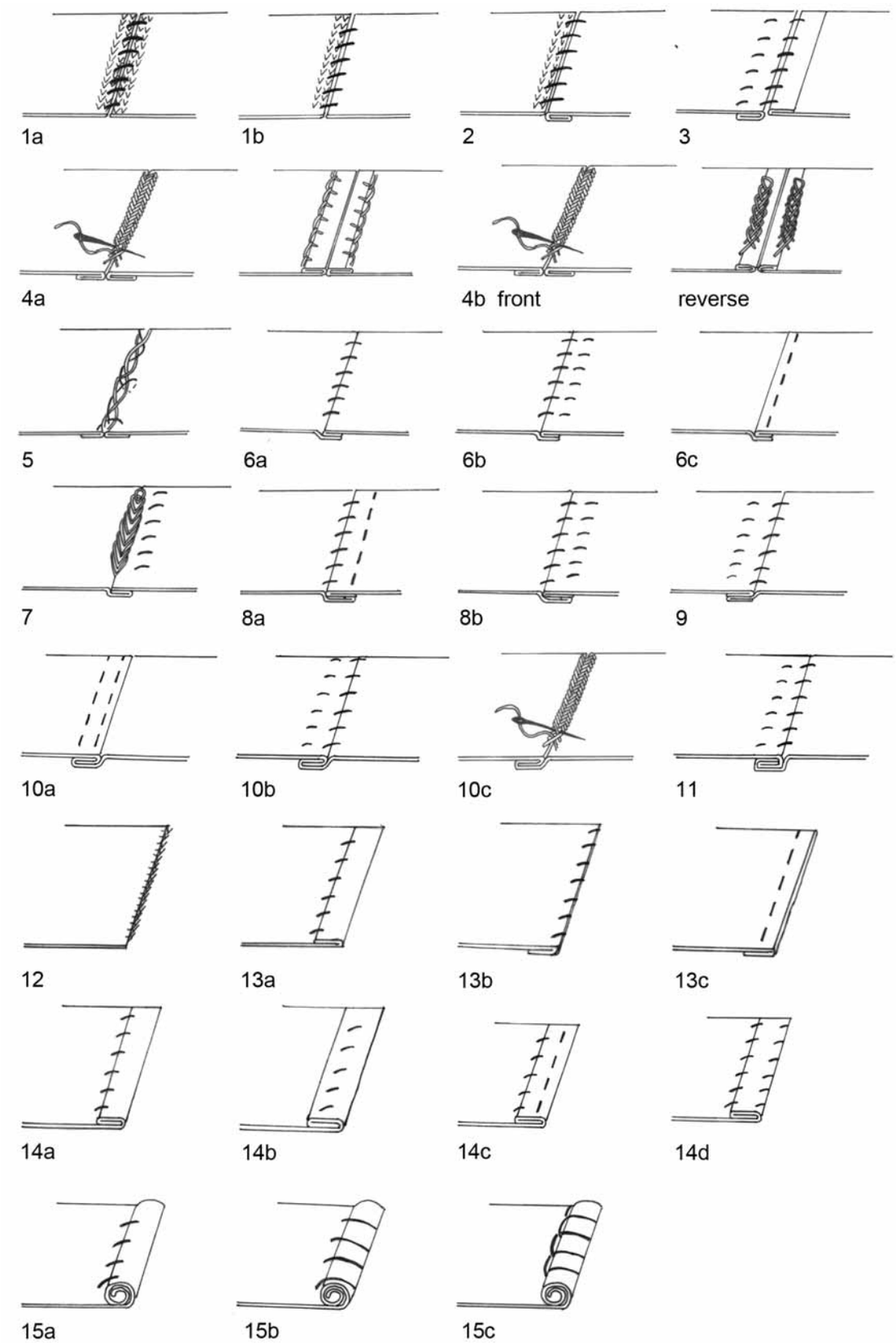

Fig. 26 Types of seams and hems present among the textiles from the settlements.

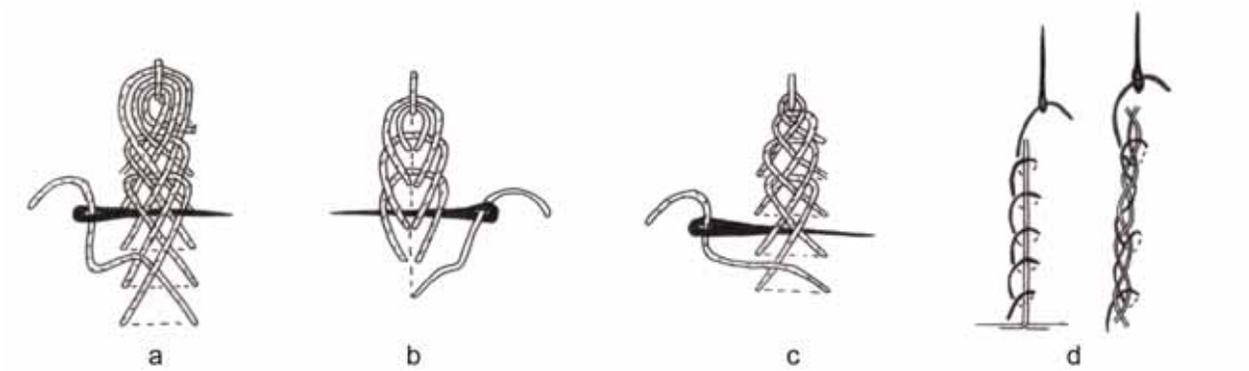

Fig. 27 Decorative stitches.
A. Raised plait stitch present on the hat from Oostrum, the pillbox cap from Leens and the headdress from Dokkum.
B. Heavy chain stitch, present on a textile from Leens (object nr. GM1927/VI.2/1).
C. Plait stitch used to secure the seam allowance on the inside of the headdress from Dokkum.
D. Decorative stitch present on the cap from Rasquert (after Zimmerman in press).

Most seams and hems show rather coarse sewing. The most popular stitch used by far is the whipstitch, which was often applied in big stitches more than 1 cm apart. Often sewing occurred using a 2zS plied yarn of 1 to 2 mm thickness or double threads, creating a strong join. Some of the textiles show more subtle needlework, as described above. In those cases thin sewing threads and smaller stitches were used. Several decorative stitches have been observed (fig. 27). An example of a heavy chain stitch (fig. 27b) was present on a fine diamond twill from Leens (20 x 15 threads/cm). [26] Two fabrics showed lines of running stitches that seem to have been decorative as well as functional.[27] The hats from Oostrum and Leens, as well as the headdress and garment from Dokkum and the garment from Middelburg, were especially carefully sewn. Both the inside and outside of the hats were sewn using decorative stitches (fig. 27c). Moreover, the use of the same type of decorative stitching (fig. 27a) on the outside of the hats in a contrasting coloured yarn gives the impression of standardisation in making these hats. Somewhat simpler versions of this stitch have also been observed on a pillow cover from the ship burial of Sutton Hoo (Mound 1) in Suffolk, in York and presumably also on a cushion from the tenth-century princely burial at Bjerringhøy (Mammen) in Denmark (Crowfoot 1983; Walton Rogers 2007, 101; Coatsworth 2005, 6). All these embroidered textiles may be considered as being of Anglo-Saxon origin (Coatsworth 2005, 24). The use of decorative stitching is self-evidently more than simply functional and may have been an indicator of wealth or status. The Dutch garments sewn using this technique were clearly of a superior status, as opposed to the majority of the textiles, and were therefore probably valued for their colour, decoration and craftsmanship.

Wear and repair is a common aspect of the textiles from the settlements, indicating that textiles in general (not only the fine textiles) were considered valuable objects. Pieces were added onto the original fabric in 65 cases. Textiles were used, repaired and reused for different purposes until they were completely worn out. Often only a seam or a worn out and patched area remains, suggesting that the remaining pieces of the garment were cut off and reused.

Repairs were in most cases sewn firmly, but often very roughly, leaving frayed edges visible. There seems to be no relation between the quality of the fabric and the way repairs were carried out. The hat from Aalsum, in contrast, which is probably the coarsest woven and sewn hat, was repaired in a very careful manner using small stitches and (probably) red sewing-thread. This may indicate that the wearers of the garments were possibly not the same persons as the people making them.

5 Craft specialisation in textiles

Only a few textiles found in settlements in the Netherlands are made using special skills, tools or requiring much time. It has been possible to distinguish the general way in which the textiles were produced and used in these settlements by analysing the different steps in the production process. Fibres were, in most cases, selected for spinning without careful sorting. The resulting yarns and fabrics were often coarser than expected, although a considerable regularity of spinning and weaving was observed. This distribution may be caused by an overrepresentation of household textiles, but it may also reflect the time available for making the textiles. These fabrics are likely to have been produced at a household level where the producer did not have time to take considerable care often resulting in a rather coarse product.

The examples of fine craftsmanship indicate that not all textile production took place at this level. Considerable quantities of fine spinning, weaving, and needlework have been observed, indicating that the higher quality work did not often end up as refuse in the settlements and may very well be present in larger numbers in the cemeteries. These products, like the finer fabrics, the fine needlework on the hats, the fabrics with a raised nap from Middelburg, as well as the veil-like garment and piled weaves may be considered as the work of textile specialists. Having recognized a certain degree of specialisation in the production of the textiles, the following step is to look into the way this specialised production functioned within society. Applying Olausson's model for craft specialisation it may be possible to differentiate between these specialists. During the Early Middle Ages the tethered and workshop types (types 3 and 4) are most likely to be represented. Unfortunately, there is only a small dataset of specialized products to deal with and these finds have characteristics of either levels of specialisation. The veil-like tabby from Leens can be assigned to both types, whereas the hats clearly show craftsmanship (type 3), but also standardisation (type 4) and (in a few cases) errors. The fact that these products are not only found in the Netherlands but also in other countries suggests either a large area of production or a considerable network of trade, which points to production organised in workshops rather that at a patron related level. The regularly woven but rather coarse twills found in abundance in the settlements may be interpreted as household production but they also show the efficient and standardized production characteristic of workshop industry.

The research problems described in the introduction to this article need further elaboration. More research needs to be conducted into the means and social organisation of textile production in the Netherlands, including an analysis of textile tools, raw materials and their distribution in and between a number of settlements. Furthermore, an analysis of several well-documented cemeteries should be conducted, addressing questions relating to the chronological development of textiles and their use as clothing among different groups in Early Medieval society.

Acknowledgements

This article could not have been written without the generous help of many people who shared their knowledge and provided access to the textiles discussed. I would like to express my thanks to Egge Knol (Groninger Museum), Evert Kramer (Fries Museum), Ernst Taayke (Provincial depot Nuis), Annemarieke Willemsen, Marianne Stouthamer and Robert Ritter (National Museum of Antiquities Leiden), Henk Hendrikse (Stichting Cultureel Erfgoed Zeeland), Piet van de Velde (Leiden University), Katrin Kania, Hanna Zimmerman, Sandra Comis, for opening her vast library on archaeological textiles and to Nick Digby and Isabelle Vella Gregory for editing my English text. Lastly I would like to thank Penelope Walton Rogers for conducting the necessary analyses on my fibre and dye samples and for sharing her knowledge built up in many years of textile research of the early medieval period.

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Notes

1. The PhD research was carried out at the Faculty of Archaeology, Leiden University.
2. Schlabow 1974 (textiles from the northern provinces); Zimmerman 2005 (Ulrum); Comis in prep. (Anjum); Miedema 1980 (Dorestad); Leene 1964 (Middelburg); Vons-Comis 1988, Van Es & Ypey 1977 (Zweelo).
3. Schlabow 1974 (some of the finds from Leens, Westeremden and a few other textiles from the northern provinces); Bender Jørgensen 1992 (some of the finds from Dokkum, Berg Sion), Zimmerman 2005/2006 (Ulrum); Comis in prep. (Anjum); Miedema 1980 (Dorestad); Leene 1964 (Middelburg); Zimmerman 2009 (hats from Rasquert and Leens).
4. Ferwerd 101-703, Leens 1939-IV.13A/7.
5. Ferwerd 101-883, Teerns 16D-98/2, Wijnaldum 77A-102B, Dokkum a1913/11.223/2, Leens 1939-IV.23
6. Leens 1939-IV.3A/7.
7. Ms K. Kania kindly showed me the skill needed during a spinning experiment at the Textilforum held in September 2009 in Eindhoven, the Netherlands.
8. Objectno. a1913/11.223D.
9. Middelburg is the only site where cross twill is observed.
10. Westeremden 1930/2a, Kimswerd a1913/11.233, Leens 1939-IV.37/2 & 1939-IV.37/5, Dokkum a1913/11.223

a1913/12.5b, a1913/11.223e, a1913/11.223r, a1913/11.223y/2 & a1913/11.223ff.

11. Objectno. 28-321/3.
12. Objectno. 1939-IV.13A/7 & 1939-IV.13/1.
13. No dyes were detected during dye analyses.
14. Objectno. a1913/11.224.
15. Dokkum a1913/12.5 z.n.2/1, Leens 1939-IV.18/1, 1939-IV.37/2, 1939-IV.37/4b, 1939-IV.37/6.
16. Dorestad WD375.3.1 , Dokkum a1913/11.226, Middelburg 00049-9, -11.
17. Objectno. 33-373. The hat from Aalsum is dated between 700-900 AD. It must be stressed however that this date may not be correct since it is not based on radiocarbon but on associated finds.
18. Objectno. GM1939/IV:13/1. This hat is dated between 700-1000 AD.
19. Objectno. b1930/12.34/1.
20. Objectno. 35B-48 from Oostrum is dated between 700-900 AD. It must be stressed however that this date may not be correct since it is not based on radiocarbon but on associated finds.
21. Objectno. GM1928/VIII:1.
22. Objectno. WD375.3.1 (Dorestad) and 33-374 (Aalsum). The Aalsum mitten is dated between 700/900 AD. This date is based on associated finds.
23. Leens 1939-IV.27/3, Middelburg 00049-1 and 00049-2.
24. Objectno. a1913/11.223m.
25. Leens 1939-IV.37/2 & 1939-IV.27/9.
26. Leens 1927/VI.2/1.
27. Leens objectno xx and G2008-1.8 (from an unknown site in Groningen).

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Appendix I

Glossary

Diamond twills: a type of weave in which the warp passes over 1 or 2 and under 2 weft-threads, creating a surface of diamonds.

Fraying: unravelling a piece of fabric

Fulling: treading or beating a piece of fabric to clean or thicken the fabric.

Gusset: Triangular piece of cloth sewn in between front and back panels of a garment to enlarge the garment on one side.

Hem: Border of fabric made by turning the edge inward and sewing it down.

Mitten: glove that encases the thumb separately and the other four fingers together (but I don't know if this also applies to medieval gloves)

Pattern repeat: Woven patterns are generally repeated at regular intervals. A pattern repeat indicates the amount of warp and weft-threads needed to complete a full pattern and start a new one. A diamond twill with a pattern repeat 20/18 for example means that the diamond is woven using 20 warp- and 18 weft-threads.

Piled weave: Fabric in which loops of threads have been inserted, creating a fur-like appearance.

Raised nap: Roughened surface of a woven fabric, created by brushing it with teasels.

Selvedge: edge of woven fabric, parallel to warp, woven in a way to prevent the edges from fraying. A selvedge is often reinforced to prevent the fabric from stretching.

Shears: cutting instrument with two meeting blades pivoting as in scissors or connected by a spring and passing close over each other edge to edge.

Spin pattern: Pattern in a woven fabric created by using both z- and s-twisted threads in warp or weft or both. The direction of the twist of the threads is clearly visible in the fabric, creating a very subtle pattern.

Tablet weaving or card weaving is a technique in which the loom is replaced by a set of flat rectangular cards or tablets. The longitudinal threads (warp) are passed through holes in the tablets and by turning these tablets a gap or shed is created through which the weft is woven.

Tabby: a type of weave in which the warp alternates with weft every thread. (note font)

Teasels: plant of the genus *Dipsacus* with prickly leaves and flower heads which have hooked prickles. These flower heads were used to roughen the surface of a woven fabric.

Twill: a type of weave in which the warp passes over 1 or 2 and under 2 or more weft-threads, creating a surface of parallel diagonal ribs.

Warp: longitudinal threads stretched on a loom through which a weaver passes the weft thread.

Weft: threads crossing from side to side interwoven with warp, creating a woven fabric.