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ORIGINAL ARTICLE

Retting pits for textile fibre plants at Danish prehistoric sites dated between 800 B.C. and A.D. 1050

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Abstract During the last decade, a new type of structure has been found at several archaeological sites in Denmark. These structures can be interpreted as having been used for retting the stems of textile plants such as *Linum usitatissimum* L. (flax), *Cannabis sativa* L. (hemp) and *Urtica dioica* L. (nettle). In order to obtain fine threads for textile production, these plants need to pass through several biological and technical processes. The first process is the retting of the plant stems to dissolve the pectin which fixes the fibres to the stalk. This can either be done by water retting, where the plant stems are soaked in lakes, rivers or waterlogged pits, or by field retting, where the stems are laid out in a field in order to absorb dew. The first method is shorter in time and the process is easier to control. In this article, details of archaeological structures are presented from eight sites in southern Scandinavia that can be interpreted as textile plant retting pits. The constructions of the pits are described, as well as the archaeological contexts and the relevant associated archaeobotanical records. Some of the presented sites, of which the oldest are dated to the late Bronze Age and early pre-Roman Iron Age (800–250 B.C.) and the youngest to the Viking Age (A.D. 750–1050), indicate a large-scale production of flax that had been underestimated up to now.

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Introduction

Prehistoric textiles made of plant fibres are rare in Denmark due to poor preservation conditions. The earliest record of a linen textile derives from the Slusegård graveyard on the island of Bornholm, dated to the early Roman Iron Age (A.D. 1–160) based on typo-chronology (Mannering 1995a; Trier 1996). So far, there have been only a few finds of flax textiles from this period in southern Scandinavia. The few pieces have often been interpreted as imports from the Roman Empire or the northern part of Germany (Bender Jørgensen 1986). The general impression among Danish researchers is that textiles made of flax were not produced in Scandinavia until the late Iron Age and Viking Age (A.D. 550–1050, Hald 1950; Østergård 2009).

In contrast to the textile finds, the archaeological record of flax seeds occurs much earlier (Viklund 2011): the oldest Danish finds of flax seeds are dated to the late Bronze Age. Since only single seeds have been detected so far, the general assumption is that flax was introduced to Denmark as an oil seed which was used for consumption and not as a textile plant (Henriksen 2003; Robinson 1995). By contrast, a piece of textile made of nettle from the Lusehøj grave mound near Voldtofte on the island of Fyn (Funen) indicates that the method of using plant fibres for textile production was already known as early as the late Bronze Age (Køie 1943; Thrane 1984). Recent studies of the Huldremose Woman, a pre-Roman Iron Age bog body found in north-eastern Jylland (Jutland) in 1879, have contributed with information about prehistoric textiles

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made of plant fibres. Fragments of a thin spun thread found in a peat sample close to the body proved to be plant fibres. This led to a thorough examination of the bog body and, surprisingly, there were distinct impressions of textiles on the chest and shoulders, as well as small pieces of textile on her back, made in a tabby style entirely different from the woollen textiles which were found close to the body in 1879 (Gleba and Mannering 2010; Mannering 2009). The Huldremose Woman probably wore a garment made of plant fibres and future analysis will, it is hoped, show whether it was made of flax, nettle or hemp. Strontium isotope analysis has been made of both the woollen textiles and the plant fibres from the Huldremose Woman to try and detect the provenance of the raw material. The results of these analyses show that the plant fibres were not of local provenance, whereas the wool derived from local and foreign sheep (Frei et al. 2009).

Recently a new type of feature was discovered in the Danish archaeological record which is closely connected to the production of plant fibres. In the following account features of this type from eight different sites will be described.

Historic flax retting

Flax has been grown for its fibres in Denmark until recently and the various processes for extracting the fibres are well known and described in the historical literature (Brøndegård 1979; Højrup 1974; Lunden 1941). From these sources we know that flax must undergo seven different processes before the fibres can be spun. In order to detect these activities in the archaeological context it is important to study how the processes were carried out in historic times and which features and tools might have been part of these processes. Figure 1 illustrates the sequence of operations, the structures, tools and waste connected to the extraction of flax fibres. It can be argued that the more elements are detected at an archaeological site, the higher is the possibility that flax and linen textile production had been performed locally.

The retting process

Flax stems consist of a variety of several cell layers, and the fibres that are used for textiles are situated underneath the bark of the stalk (Bjørn 1974). Pectin binds the different cell layers together. To extract the fibres it is necessary to dissolve the pectin by decomposing it with the help of microorganisms. This can either be done by field retting, also called dew retting, where the stems are laid out on the ground, or by water retting, where the flax stems are submerged in either stagnant or running water. Field retting is difficult to detect in the archaeological record compared with water retting, where the plant material has very much better conditions for surviving. Water retting can be carried out in lakes, ponds or water-filled pits, but experiments have shown that the best fibre quality is obtained by using running water in rivers or streams (Dewilde 1987; Mannering 1995b). Water retting pollutes the water and produces an unpleasant smell, and in historic times it was therefore often forbidden to use rivers for this purpose. The length of time of the retting process is dependent on the water temperature and starts at 12–13°C. A higher temperature accelerates the process. In pits with standing water the process tends to be shorter as higher temperatures are obtained more quickly. Experiments have shown that at temperatures between 17 and 20°C the retting process lasts about 5-10 days. Field retting takes about 2–5 weeks, depending on temperature and moisture (Dewilde 1987; Ejstrud et al. 2011; Mannering 1995b).

During the water retting process bacteria are developed under anaerobic conditions, in which fungi are eliminated. This results in flax fibres with a lighter colour. It is very important to control the retting process closely and stop it in time. Too little retting will make it difficult to extract the plant fibres, and too much will result in black fibres of a poor quality. The retting process is very complex and requires know-how and long-term experience to guarantee a high quality product. Nettle and hemp also need to be retted before fibres can be obtained from the stems.

Water retting is known to have been applied in Ancient Egypt and in the Roman Empire. The method is depicted in drawings from Egyptian grave mounds at Beni Hasan dated to 1991–1786 B.C. where the flax is shown being placed in small enclosures that were probably filled with water (David 1996). Pliny the Elder mentions water retting in *The Natural History*, Book 19.3:

> After the wheat harvest is over, the stalks of flax are plunged in water that has been warmed in the sun, and are then submitted to pressure with a weight; for there is nothing known that is more light and buoyant than this. When the outer coat is loosened, it is a sign that the stalks have been sufficiently steeped; after which they are again turned with the heads downwards, and left to dry as before in the sun: when thoroughly dried, they are beaten with a tow-mallet on a stone (Bostock and Riley 1855).

Material

Archaeological sites with evidence for textile plant retting

During the last decade, archaeological excavations have given evidence that water retting of textile plants was a

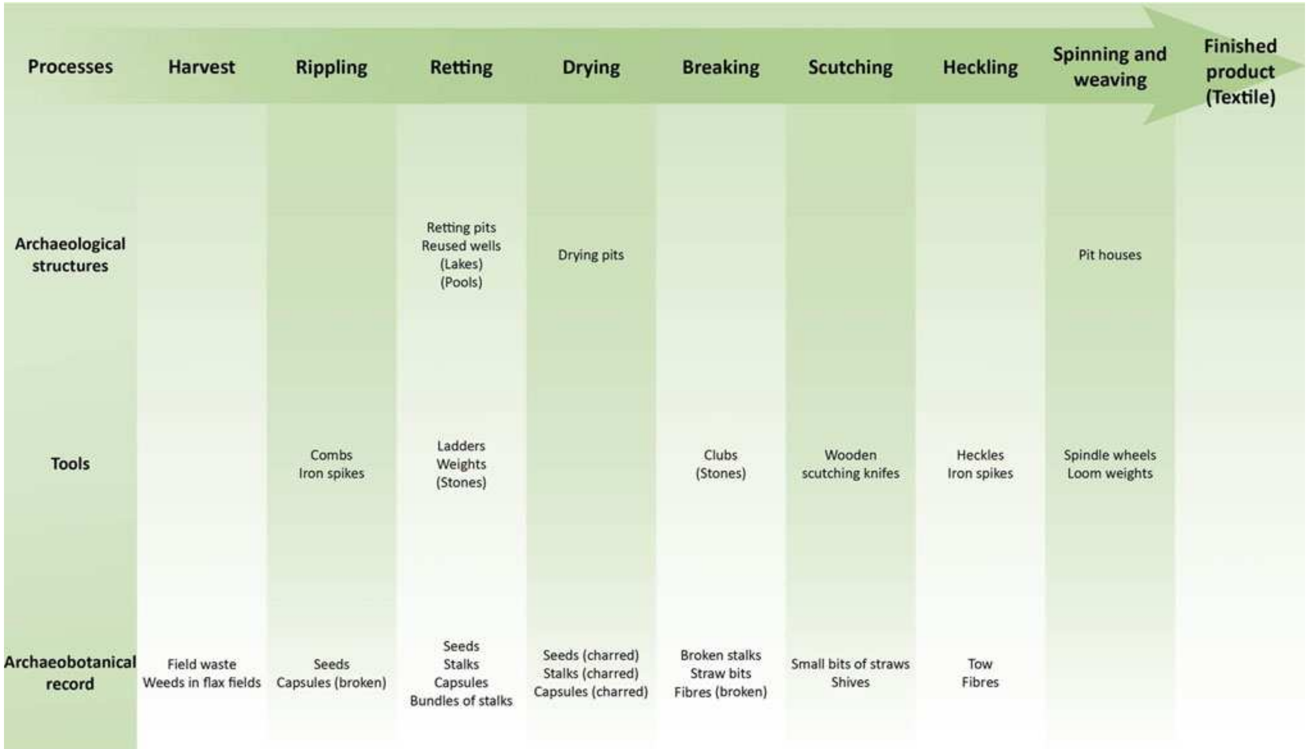

Fig. 1 Extracting the flax fibres. This shows the different processes in the extraction of flax fibres for textile production. In addition to this it also shows the different structures, tools and waste products connected to these processes which might be recognised in the archaeological record. Harvesting the flax is done by pulling it up by hand and this is probably hard to detect. After harvest, the seeds have to be removed by rippling before the retting process. Then the flax stalks have to be retted to dissolve the pectin that holds the stems together. Before breaking the stalks they have to be dried properly and because of the wet climate in Denmark, the drying process has often been done over fire in special drying pits (Højrup 1974, pp. 206–207). The breaking process is done either with a wooden club or a wooden breaker and after that the last bits and pieces of the stalks are removed from the fibres with a wooden scutching knife. Finally, the flax fibres are combed or heckled before they are ready for spinning and weaving (Brøndegård 1979; Højrup 1974)

method applied in Denmark as early as prehistoric times. Eight archaeological sites with finds of retting pits or wells are described in the following (Table 1). The rescue excavations were carried out between 1999 and 2005 by the Sydsjællands Museum (Museum of Southern Zealand), Odense Bys Museer (the City Museum in Odense) and Kroppedal Museum. The sites Næs, Frydenlund, Bjerggården, Helstedgård Sydvest, Seden Syd, Kragehavegård, Hvissinge Vest and Strandby Gammeltoft date between 800 B.C. and A.D. 1050. As shown on the map (Fig. 2), the sites are located on two islands. Five of them are situated on the island of Fyn, with a majority of sites near the city of Odense, and three of them on the island of Sjælland (Zealand). The fact that the sites with retting structures are mainly concentrated around modern towns is most probably due to the high building activity in these areas and thereby a greater chance of detecting such structures through rescue excavations. All the sites are situated on clay subsoil which facilitates excellent preservation conditions for organic material, such as plant finds. Sediment samples were taken from the retting pits at all the sites and, apart from the samples from Næs, the plant macrofossil analyses were performed at the National Museum of Denmark.

In the following, the expressions ‘pit’ and ‘well’ are both used as terms for waterlogged pits, although wells are defined as waterlogged structures with various types of linings, while waterlogged structures without any linings are defined as pits. The sites are presented in chronological order.

Results

Frydenlund

The site of Frydenlund is situated in the south-eastern parish of the city of Odense on a hillock of clay and was excavated by the City Museum of Odense in 2000 and 2005 (Bech 2007; Runge and Henriksen 2007). According to the archaeological finds the site can be dated between the late Bronze Age and the pre-Roman Iron Age. Probably

Table 1 Information about the eight sites included in the study, finds such as ladders and indications for textile production

Site	Dating	Number of wells/pits	*Linum usitatissimum*	*Cannabis sativa* L./*Urtica* sp.	Ladders in wells	Indications for textile production	References
Frydenlund	800–250 B.C.	52	Seeds, capsules				Bech (2007), Harild and Henriksen (2006)
Bjerggården	A.D. 1–160	1	Stems, seeds, capsules				Henriksen and Harild (2005). Therkelsen (2003)
Helstedgård Sydvest	A.D. 160–375	1	Stems, capsules, seed fragments				Henriksen and Harild (2005)
Seden Syd	A.D. 160–375	33	Stems (from 3 pits), seeds, capsules	*Urtica* seeds	1	Spindle whorls, loom weights	Henriksen and Harild (2005); Gotfredsen et al. (2009), Runge and Henriksen (2007), Therkelsen and Henriksen (2009)
Kragehavegård	A.D. 375–550	2	Seeds, capsule fragments	*Cannabis* seeds			Robinson et al. (2001)
Hvissinge Vest	A.D. 375–550	30	Seeds, capsule fragments	*Cannabis* pollen	8		Hansen (2001), Harild and Pedersen (2001)
Strandby Gammeltoft	A.D. 650–1000	1	Seed and capsule fragments	*Cannabis* seed (1)		Spindle whorls, loom weights	Henriksen (1997), Henriksen and Harild (2005)
Næs	A.D. 750–900	57	Stems, seeds, capsule fragments	*Cannabis* and *Urtica* seeds	2	Spindle whorls, loom weights, seem-flattener, bone needles	Hansen and Høier (2000)

due to poor preservation conditions, no distinct signs of houses were found; various types of pits and scattered post-holes were the only features discovered. A production area was excavated south of the site. A cultural layer consisting of a vast amount of burnt material covered an area of 20–25 × 100 m^2. No less than 52 wells/waterlogged pits were detected, which were circular in shape with a diameter of 1.5–3 m. The high groundwater level meant that most of the wells and pits were only 1 m in depth. They contained only a few archaeological objects which could help to determine their original function. In some of them a kind of lining made of wood and bark was still preserved (Fig. 3). Sediment samples from the bottom layers were taken from several of them. The samples contained seeds and capsules of flax and capsules of *Camelina sativa* L. (Gold of pleasure), a plant which is often associated with flax. In addition, many seeds of weeds and from plants growing in wetlands were determined (Harild and Henriksen 2006). ^{14}C dates made on flax capsules from three of the pits indicated that they were not contemporary, but were used during two time periods: between 800–410 cal B.C. and 420–350 cal B.C. (Runge and Henriksen 2007). Currently the described structures from Frydenlund represent the oldest known retting structures in southern Scandinavia.

Bjerggården

The single farmstead of Bjerggården is located on a flat heath plain at Seden, north of the city of Odense. The site was excavated by the City Museum of Odense in 2002. According to the archaeological finds, Bjergården dates to the early Roman Iron Age (Therkelsen and Krogh 2002). A longhouse and three small buildings, various pits and a well were excavated. The well measured 4 m in diameter and 1.75 m in depth. At the bottom, a wicker lining made of branches was found with a hollow tree trunk that was placed inside the lining (Fig. 4). The archaeologists discovered plant stems at the bottom of the well and four samples of sediment were taken for macrofossil and pollen analysis. The stems were identified as flax (Henriksen and Harild 2005). All the sediment samples contained small amounts of flax seeds, capsules and stems, as well as seeds and capsules of *Camelina*. The flax stems most probably represent the residues from a retting process that had been carried out in the well.

Helstedgård Sydvest

Helstedgård Sydvest was discovered and excavated by the City Museum of Odense in 2003 (Therkelsen 2003). Settlement remains were dated by archaeological finds to the late pre-Roman Iron Age period. Six dwelling houses, three

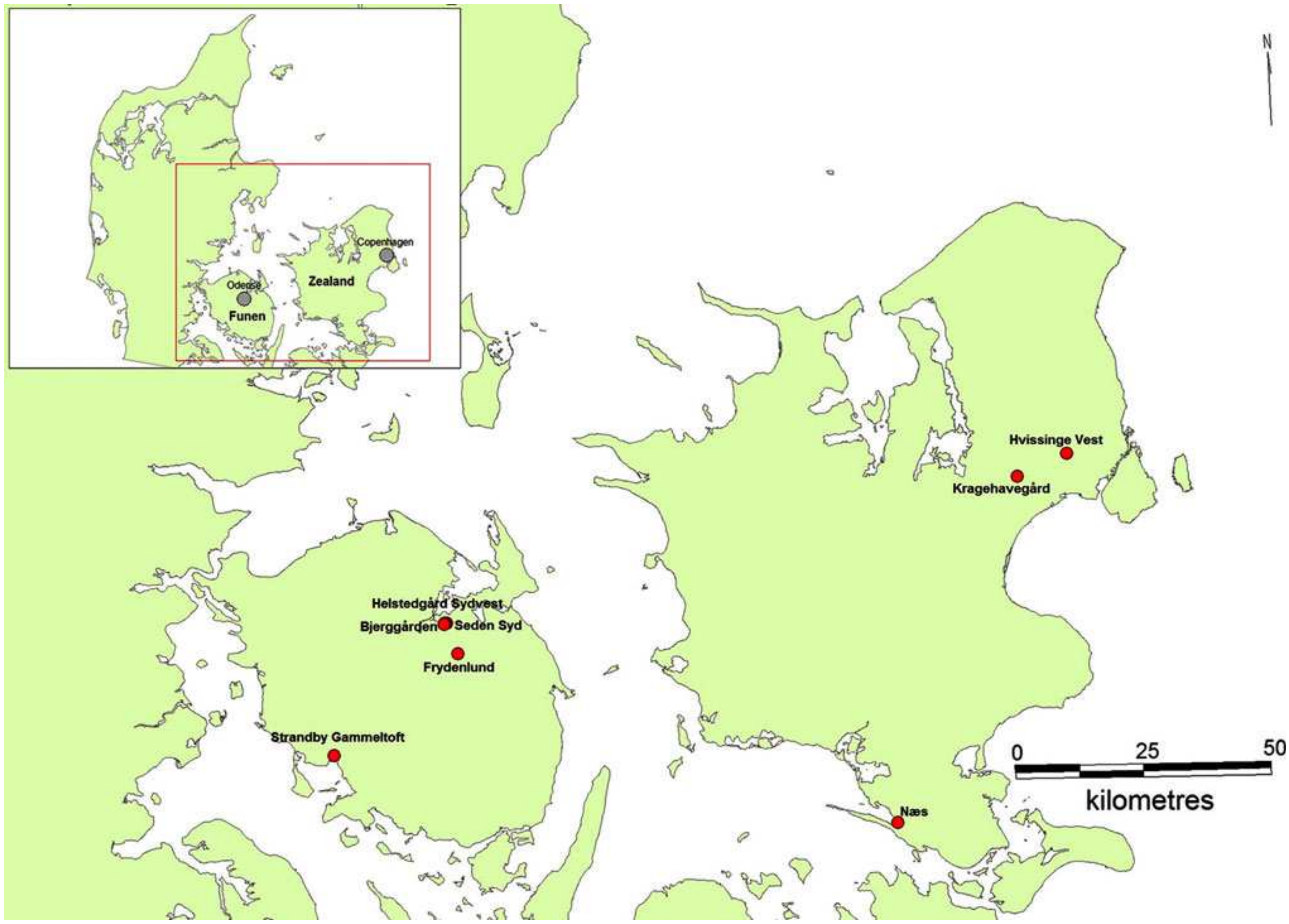

Fig. 2 The map shows the eight archaeological sites presented in this article. All sites are situated in the eastern part of Denmark on the islands of Sjælland (Zealand) and Fyn (Funen)

Fig. 3 One well from the site of Frydenlund that contained a lining made from a hollow tree trunk (Photo: The City Museum Odense)

smaller houses, several graves and five wells were found. The most interesting structure in this context was a huge well. It was so large (6.40 × 4.48 m in diameter and 2.35 m in depth) that it was excavated with the help of a mechanical digger. At 2 m depth a bundle of plant stems was found (Fig. 5). According to two archaeological finds the well is typo-chronologically dated to the early Roman Iron Age. Sediment samples were analysed and show that most of the stems derive from flax (Henriksen and Harild 2005). Both the upper and lower curved parts of the flax stems were present but almost no seeds or seed capsules were found. This indicates that seeds and capsules had been removed before the flax stems were placed in the pit (Maier and Schlichtherle 2011). The samples also contained seeds and capsules of *Camelina* and some weeds, which probably ended up in the pit because they were growing in the flax fields.

Seden Syd

Seden Syd is situated on a small morainic hill in a heath-covered plain, in the same area as Helstedgård Sydvest and Bjerggården (Fig. 2). Several farmsteads that are typo-chronologically dated to the late Roman Iron Age and early Germanic Iron Age were excavated between 2001 and

Fig. 4 The well from the site Bjerggården with a lining made of wickerwork. At the bottom of the pit, plant stems were discovered which were identified as flax (Photo: The City Museum Odense)

Fig. 5 Flax stalks found in a retting pit at Helstedgård Sydvest (Photo: The City Museum Odense)

2004 by the City Museum of Odense (Gotfredsen et al. 2009). The presence of more than 30 waterlogged pits and wells indicates that the site was more than just an ordinary farmstead. Both the cultural layer and a great number of the structures contained artefacts such as jewellery, glass and glass beads, combs, scrap from different types of metal production and large amounts of animal and fish bones.

The ground water level in the area is very high, which means that drinking water is easily accessible. Some of the excavated pits had a depth of only 0.5 m below the water table, but none of them was deeper than 1.5 m. At this depth it is necessary to support the sides with the help of linings, which consisted of wickerwork, wooden planks and, in one well, with a hollowed-out tree trunk. With such easy access to water it is highly unlikely that it was necessary to dig more than 30 wells just for the purpose of getting drinking water. At the bottom of three pits archaeologists found plant stems, some of them well sorted in bundles. Samples were taken and the stems were determined as flax (Henriksen and Harild 2005). Apart from the stems, all samples contained large amounts of flax seeds and capsules. Nettle seeds were also present in some of the pits. Several samples from pits which did not contain stems were also analysed and these, too, contained seeds and capsules of flax (Henriksen and Harild 2005). In addition, the archaeologists found in one of the pits a ladder made of a tree trunk with carved-out steps. In a second pit a stone was found on top of the flax stalks, possibly to weigh down the light flax stalks under water (Karg 2003; Therkelsen and Henriksen 2009). Seden Syd can be interpreted as a settlement with specialised production of different handicraft items such as jewellery but also textile production (Gotfredsen et al. 2009).

Kragehavegård

Kragehavegård is situated on the island of Sjælland and was excavated by Kroppedal Museum in 1999 (Hansen 2000). The settlement consisted of 11 houses and several fences which are typo-chronologically dated to the late Roman Iron Age and Germanic Iron Age. The excavation also revealed two shallow waterlogged pits, with depths of 1 m and 1.4 m below the excavation surface. One of the pits contained a few branches which might have belonged to a wooden lining. Samples for plant macrofossil and pollen analysis were taken from both pits. In the bottom sediment of one of the pits plant remains from flax, hemp and *Hordeum vulgare* (barley) were found, as well as seeds of aquatic and waterside plants, such as *Lemna* (duckweed) and various types of *Juncus* (rush) (Robinson et al. 2001). The pollen samples revealed *Cannabis*-t (hemp-type), *Secale cereale* (rye) and barley, and there were also various aquatic and waterside plants, such as duckweed, rushes and *Nymphaea* (water-lily). The presence of water-lily indicates that water from a pond or lake had been tipped into the pit.

Hvissinge Vest

Hvissinge Vest was excavated between 1999 and 2001 by Kroppedal Museum (Hansen 2001). The site is situated on Sjælland in an area with a fairly high groundwater level. The excavation revealed a settlement dated to the early Germanic Iron Age with 11–12 farmsteads, each consisting of a longhouse, one or two smaller houses, and often surrounded by a fence. More than 30 waterlogged pits were excavated. In eight of them wooden ladders were found (Ohlsen in press), and one of them is ^{14}C dated to cal. A.D. 400–500 (Hansen 2001). The pits differ in depth, ranging from 2 to 4 m. Sediment samples from three of the pits were examined for plant macrofossils and pollen. One of the samples contained a few flax seeds and capsule fragments. In all three of the pits, pollen from *Cannabis* (hemp) was found. The presence of both hemp pollen and flax seeds/capsules indicates that the pits were used for retting both plants (Harild and Pedersen 2001).

There is a field bearing the name "Hør", the Danish name for flax, close to the settlement. On this field 12 pits were excavated and interpreted as drying pits for flax stems after the retting process. Two of these pits were ^{14}C dated to cal. A.D. 240–420 and 320–540, showing that the drying pits were contemporary with the settlement (Ohlsen in press). According to all these features and finds it seems that both flax and hemp were used as textile plants at Hvissinge Vest. The large number of waterlogged pits shows that textile production played an important role during the Germanic Iron Age at that site.

Strandby Gammeltoft

Strandby Gammeltoft is a coastal settlement situated on the island of Fyn. It was excavated between 1995 and 1997 by the City Museum of Odense (Henriksen 1997). On the basis of the archaeological finds the site is dated to the late Germanic Iron Age and to the Viking Age period. More than 30 pit houses were excavated and most of them contained tools for spinning and weaving such as spindle whorls and loom weights. The houses have therefore been interpreted as small weaving huts.

At Strandby Gammeltoft only one 1.75 m deep well was found. It contained a lining of re-used timber branches and poorly-produced planks. The well lining was filled with mud and contained a large amount of plant material, such as flax seeds and capsules and one hemp seed (Henriksen and Harild 2005).

Næs

The Viking Age settlement of Næs is situated at the coast on a pronounced foreland in the south-western part of Sjælland, and excavations were carried out there between 1997 and 1999 by Sydsjællands Museum. Archaeologists detected four phases of a farmstead which chrono-typologically can be dated to the late Germanic Iron Age and the Viking Age (Hansen and Høier 2000). Adjacent to the main house and smaller outbuildings, 69 pit houses were excavated. In the floor layers of most of the pit houses, spindle whorls and loom weights were found, indicating that the houses were used as small workshops for textile production. In addition to this, the archaeologists detected more than 57 wells or waterlogged pits, most of them situated at the border of the settlement, on lower ground where the ground water is high. This resulted in very good conditions for the preservation of organic material. Many of the well linings were still intact and often constructed with interlaced branches or planks, frequently of re-used building timber. On the lower part of the foreland a more than 150 m long canal with two wells at the end was recorded. Wooden ladders were found in two of the wells. The great number of wells and the canal were a mystery until the archaeologists discovered several bundles of plant stems at the bottom of one of the wells. The stems proved to be flax and the wells were subsequently interpreted as retting pits (Hansen and Høier 2000). The wells were presumably situated at a distance to the settlement because of the bad smell produced during the retting process. The great number of wells and pit houses show that Næs was not only a small farmstead but probably an important textile production site.

Discussion

All the eight archaeological sites described here differ from each other, both in date and size: they range from large villages to small single farmsteads. As a common feature they all delivered finds of flax or hemp in either waterlogged pits or wells. The plant finds indicate that the wells were used for the retting of stems of these textile plants. The retting pits from the eight sites show the following characteristics:

- All are simple structures—sometimes with linings to stabilize the side walls
- Plant macrofossil and pollen analyses identified stems, seeds and capsules from flax, seeds from hemp and nettle or pollen from hemp
- Some of the pits contained ladders
- Some of the pits contained stones that were probably used as weights
- Macrofossils and pollen from aquatic and waterside plants such as *Juncus* (rush) and *Lemna* (duckweed) show that many of the pits had been left open for a long period of time unless these remains, like the water-lily pollen, arrived in water brought from a lake or stream to fill the pit.

How is it possible to argue that waterlogged pits with only small amounts of textile fibre plant remains were used for retting purposes? Looking at the samples from pits with flax stems, as for instance at Seden Syd, all of them contained a certain amount of flax seeds and capsules. Even if all the retted flax stalks had been removed from the pit there would have been some seeds and capsules left. It is more difficult to ascertain if a completely empty pit had been used for textile plant retting. The fact that stems are not always detected directly in the retting pits is not an argument against the pits being used for retting purposes. If the retting process had been successful, all the stems would have been taken out and further processed. Only in cases when something went wrong or where it was difficult to get hold of the stems, some would have been left in the well, and preserved under waterlogged conditions.

The pits from all the eight archaeological sites seem to have been in use over an extended period of time. It was necessary to stabilize the side walls of some of the pits with linings of wickerwork, planks, or hollowed-out tree trunks. However, the timber used for these purposes was often re-used building material. The fact that the retting process deteriorates the fibre quality if the retting water is used over a long period of time might explain the large number of pits at the sites of Frydenlund, Seden Syd and Næs. When the pits had been in use for a long period it was obviously necessary to construct new ones. It cannot be denied that some of the pits might have been used for drinking water before being used subsequently as retting pits. This might be the case for the pits at Helstedgård Sydvest, Bjerggården, Kragehavegård and Strandby Gammeltoft. At the sites of Frydenlund, Seden Syd and Hvissinge Vest the number of waterlogged pits exceeds the need for a sufficient supply of drinking water. Most of the pits must have been originally dug for other purposes. The number of wells at all these three latter sites is overwhelming compared to the period of occupation. This could indicate that retting was carried out on a larger scale than would have been necessary for self-sufficiency or local distribution of textile fibres. The large-scale retting at those sites indicates part of a specialized textile production that had probably already started in Denmark during the late Bronze Age period.

As an important fact, we can state that most of the presented sites are situated in areas with a high ground water level. This means that less work had to be invested in the past to dig out these pits. At Seden Syd some of the pits were not deeper than 0.5 m, which is a sufficient depth to soak plant stems in water for retting purposes. Even though most of the pits were not very deep, it had obviously been necessary to place ladders in some of them in order to facilitate the removal of the retted plant stems. At the sites of Næs, Seden Syd and Hvissinge Vest ladders were excavated in several wells (Table 1). At Seden Syd a ladder was found in a pit together with finds of flax seeds and capsules. Flax stalks are light and have to be held under water by weights such as stones or branches. It is possible to detect these weights in the archaeological material, as was the case in one of the pits at Seden Syd.

At Hvissinge Vest the wells were situated close to the single farmsteads, in contrast to the sites of Frydenlund and Seden Syd where the retting pits were located further away from the settlements. This might reflect a production of linen more attached to the single farm units.

At both the Frydenlund and Seden Syd sites, cultural layers covered large areas over and around the retting pits. The cultural layers contained large amounts of charcoal and stones made brittle by fire. This is also a feature which was present at Næs and can probably be connected with activities related to the drying of flax. Indicators of textile production, such as loom weights and spindle whorls, were only recorded at the three sites of Seden Syd, Strandby Gammeltoft and Næs.

The discovery of plant retting pits contributes to a fuller understanding of textile production in Denmark during prehistoric times. The retting pits represent one of the processes of extracting plant fibres, and the production of plant textiles can now be dated back several hundred years more. Currently we still lack evidence of most of the additional processes such as breaking and heckling (Fig. 1). This might be due to the absence of detailed studies of the archaeological material or to poor preservation conditions for wooden artefacts, such as clubs (Viklund 2011). At the Iron Age site of Feddersen Wierde, located in the marshland on the northwest coast of Germany, the preservation conditions for organic material were so excellent that it was possible to gain knowledge of various processes and handicrafts by analysing the plant material and the archaeological objects (Haarnagel 1979). Remains of flax, mainly uncharred, were found in large amounts scattered all over the settlement. The cultural layers contained small piles of pieces of broken flax stems. The remains were interpreted as the waste product—*Scheben* in German or *shives* in English—after the breaking and scutching of the flax stalks (Körber-Grohne 1967; Maier and Schlichtherle 2011). Such finds have not been identified yet from Danish sites.

The processing of textile plant fibres was until recently believed to have started during the Iron Age or the Viking Age. The new evidence presented here for fibre plant retting pits in Denmark as early as the late Bronze Age shows that plant fibres were being used even earlier.

Conclusion

Plant remains, such as pollen, stems, seeds and capsules of the plants flax and hemp were detected in a number of waterlogged pits at eight prehistoric sites in Denmark. These finds can be used as an evidence for the process of water retting of fibre plants during this early period. The location of the retting pits in relation to the settlement area, as well as the number of pits, can be used as an indicator for the scale and importance of textile fibre production, which would have been self-sufficient or large-scale production. This new knowledge will help archaeologists to get a better understanding of the economy of archaeological sites. The interpretation of pits for the use of textile plant retting purposes can now be tested at new excavations. Combining archaeobotanical analysis with archaeological observations is very important in order to understand the organisation of prehistoric settlements and the subsistence strategies of former societies.

Wells and waterlogged pits have often had a low priority in Danish rescue excavations because they are difficult, and therefore expensive, to excavate. However, most of these structures have excellent preservation conditions for organic material that should be analysed because the results contribute to a great extent to our knowledge and understanding of the subsistence and economy at a specific site.

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References

Bech B (2007) OBM 8416, Frydenlund, Arkæologisk Udgravning af brønde fra yngre bronzealder og førromesk jernalder. Arkæologisk Rapport nr 83, 2007. Odense Bys Museer

Bender Jørgensen L (1986) Forhistoriske tekstiler i Skandinavien. Prehistoric Scandinavian textiles. Nordiske Fortidsminder. Serie B, vol 9. Det Kongelige Nordiske Oldskriftselskab, København

Bjørn I (1974) Oldtidsdragt - Nutidstøj: Spinde-farve-væve-sy. Rhodos, Humlebæk

Bostock J, Riley H (translators) (1855) Pliny the Elder. The natural history. Taylor and Francis, London

Brøndegård VJ (1979) Folk og Flora. Dansk Etnobotanik. Rosenkilde og Bagger, Tønder

David R (1996) The Pyramid builders of Ancient Egypt: a modern investigation of Pharoes workforce. Routledge, London

Dewilde B (1987) Flax in Flanders throughout the centuries. History technical evolution, folklore. Lannoo, Tielt

Ejstrud B, Andresen S, Appel A, Gjerlevsen S, Thomsen B (2011) From flax to linen. Experiments with flax at Ribe Viking Centre. University of Southern Denmark, Esbjerg

Frei K, Skals I, Gleba M, Lyngstrøm H (2009) The Huldremose Iron Age textiles, Denmark: an attempt to define their provenance applying the strontium isotope system. J Arch Sci 36:1,965–1971

Gleba M, Mannering U (2010) A thread to the past: the Huldremose woman revisited. Archaeol Textile Newslett 50:32–37

Gotfredsen A, Henriksen M, Kveiborg J, Therkelsen K (2009) Fjordfiskere, strandjægere, håndværkere og handelsmænd i jernalderens Seden. Fynske Minder 2009:77–109

Haarnagel W (1979) Die Grabung Feddersen Wierde: Methode, Hausbau, Siedlungs- und Wirtschaftsformen sowie Sozialstruktur. Steiner, Wiesbaden

Hald M (1950) Olddanske Tekstiler. Nordisk Forlag, København

Hansen A (2000) Rapport of SØL 1310 Kragehavegård. Kroppedal Museum, Albertslund

Hansen A (2001) Rapport of SØL 1020 Hvissinge Vest. Kroppedal Museum, Albertslund

Hansen K, Høier H (2000) Næs – en vikingetidsbebyggelse med hørproduktion. KUML 2000:59–89

Harild J, Henriksen P (2006) Frydenlund and Toruplund. Nye hør fund fra Fyn. (NNU Rapport 4). The National Museum, Copenhagen

Harild J, Pedersen L (2001) Makrofossil- og pollenanalyser af materiale fra tre brønde ved Hvissinge Vest, Glostrup. (NNU Rapport 18). The National Museum, Copenhagen

Henriksen M (1997) Vikingerne ved Helnæsbugten. Fynske Minder 1997:25–58

Henriksen P (2003) Arkæobotaniske undersøgelser af materiale fra Bjerre Plads 7, en hustomt fra yngre bronzealder i Thy. (NNU Rapport 6). The National Museum, Copenhagen

Henriksen P, Harild J (2005) Hør-industrien på Fyn i yngre jernalder. (NNU Rapport 13). The National Museum, Copenhagen

Højrup O (1974) Landbokvinden. Rok og kærne. Grovbrød og Vadmel. Nationalmuseet 1974:200–221

Karg S (2003) Seltsame Gruben in einem Feuchtgebiet in Jütland, Dänemark. NAU (Nachrichtenblatt Arbeitskreis Unterwasserarchäologie) 10:43–46

Køie M (1943) Tøj fra yngre bronzealder fremstillet af nælde (*Urtica dioica* L.). Aarbøger for Nordisk Oldkyndighed og Historie. Det Kongelige Nordiske Oldskriftsselskab, København, pp 99–102

Körber-Grohne U (1967) Geobotanische Untersuchungen auf der Feddersen Wierde. Steiner, Wiesbaden

Lunden J (1941) Hør – Kvindens spindestof. In: Gruelund G (ed) Vore Klæder – spinde og vævestoffer. Gyldendal, København, pp 43–53

Maier U, Schlichtherle H (2011) Flax cultivation and textile production in Neolithic wetland settlements on Lake Constance and in Upper Swabia (south-west Germany). Veget Hist Archaeobot. doi:10.1007/s00334-011-0300-8

Mannering U (1995a) Der Fadeninhalt der Silberamulettdose H1/84, 1949–2. In: Hansen U (ed) Himlingøje – Seeland – Europa. Nordiske Fortidsminder Serie B, vol 13. Det Kongelige Nordiske Oldskriftsselskab, København, pp 168–169

Mannering U (1995b) Oldtidens brændenældeklæde. Forsøg med fremstilling af brændenældegarn. Naturens Verden 1995:161–168

Mannering U (2009) Huldremosekvinden og hendes dragt i Nationalmuseet. Dragtjournalen 3, nr 5:49–51

Ohlsen M (in press) TAK 1020, TAK 1061, Hvissinge Vest, 02.02.04, sb. 9. Sjællands Jernalder

Østergård E (2009) Glimt fra hørrens 1000-årige historie - set ud fra arkæologiske og recente fund. Dragtjournalen 3, nr 4:3–18

Robinson D (1995) Arkæobotanisk analyse af bronzealder gårdsanlæg og marksystemer ved Bjerre Enge, Hanstholm, Thy. (NNU Rapport 15). The National Museum, Copenhagen

Robinson D, Harild J, Pedersen L (2001) Arkæobotaniske analyser af materiale fra to brønde ved Kragehavegård, Høje Taastrup. (NNU Rapport 10). The National Museum, Copenhagen

Runge M, Henriksen P (2007) Danmarks ældste hørindustri. Fynske Minder 2007:145–165

Therkelsen K (2003) Rapport for OBM 5740 Helstedgård Sydvest, Seden Sogn, Åsum Herred, Fyns amt. Odense City Museum, Odense

Therkelsen K, Henriksen M (2009) OBM 9882 Helsted Sydøst/Seden Syd, Seden Sogn – Arkæologisk udgravning af værkstedsplads fra yngre romersk og ældre germansk jernalder. (Arkæologisk Rapport nr. 264) Odense City Museum, Odense

Therkelsen K, Krogh M (2002) Rapport of OBM 6845 Bjerggården, Seden Sogn, Åsum Herred. Odense City Museum, Odense

Thrane H (1984) Lusehøj ved Voldtofte – en sydvestfynsk storhøj fra yngre bronzealder. (Fynske Studier 13) Odense City Museum, Odense
Trier J (1996) Fiberundersøgelser af tekstilerne. Slusegårdgravpladse IV – keramikken, tekstilerne, skeletterne, de brændte knogler, tænderne. (Jysk Arkæologisk Selskabs Skrifter 14). Aarhus Universitetsforlag, Aarhus, pp 141–149
Viklund K (2011) Flax in Sweden: the archaeobotanical, archaeological and historical evidence. Veget Hist Archaeobot. doi: 10.1007/s00334-011-0325-z