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Plant Remains from the Late Iron Age/Early Viking Age Settlement at Gammel Lejre

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INTRODUCTION

During excavations at Gammel Lejre in 1986 (Christensen, this volume) a series of soil samples were taken for botanical analysis with the intention of investigating the agrarian economy of the site and the exploitation of plant resources. The samples taken were as follows:

House IV – the Great Hall: Samples were taken from postholes for internal roof-bearing posts and external supporting posts from both the east and west ends of the house. A total of 32 samples were collected representing all phases of the house.

Pit House V and Pit House XIV: A total of 12 and 6 samples respectively were taken at various points from the fills (*i.e.* floor layers) in these two pit houses.

Oven 473: A single sample was collected from a concentration of carbonised grain associated with the oven.

DATING

Precise dating of the individual postholes by allocating them to particular phases is difficult because most of them have been repeatedly re-used. Radiocarbon dates have been obtained for animal bones from some postholes and these suggest a period of use extending from c. 700 AD to c. 900 AD (Christensen, this volume). A sample of carbonised grain from Oven 473 gave a calibrated radiocarbon date (K-5868) of AD 680 (± 1 stand. dev. AD 660–780), i.e. in the earliest part of the occupation period.

METHODS

The soil samples were collected and processed by the excavators, under the direction of Tom Christensen, Roskilde Museum. The soil samples varied in size but the standard sub-sample size was 500 ml. The sub-samples were processed by flotation (Robinson & Jørgensen 1991) and the dried flots and residues were sent to the National Museum's Science Research Unit (NNU) for analysis. Here the various macroscopic plant remains in the samples were sorted and identified. The remains are stored at the National Museum.

RESULTS

With the exception of the sample from Oven 473, the numbers of plant remains recovered from each individual context were too small to enable statistically valid comparisons between contexts (van der Veen & Fieller 1982). At the same time the picture which emerged from each successive analysis was a remarkably consistent one. As a consequence of this and in order to make the results more accessible, the data from all samples from each individual structure have been combined. In the case of the Great Hall, the samples from the eastern and western halves have been treated separately. The results are presented in Table 1.

Where possible, the rye and barley grains have been measured and the results are presented in Table 2. With the exception of those from the oven, the grains were in a poor state of preservation. Measurement was difficult and the measurements are not as reliable as those performed on well-preserved specimens.

House IV – The Great Hall, West End: Twelve samples representing a total volume of six litres yielded 86.5 carbonised grains of which 42 (48%) were hulled barley (*Hordeum vulgare*), 21 (24%) were rye (*Secale cereale*), 4 (4.5%) were oats (*Avena sp*), 1 (1%) was naked barley (*Hordeum vulgare* var. *nudum*), and 18.5 (21%) could not be identified due to

Gammel Lejre												
Botanical analyses												
Latin name	English name	Part	House IV west – 12 samples 6 litres		House IV east – 20 samples 10 litres		Pit House V – 12 samples 6 litres		Oven 473 – 1 sample 0.5 liter		Pit House XIV – 6 samples 3 litres	
			total	%	total	%	total	%	total	%	total	%
CULTIVATED												
Avena sativa	Oats	Cary		4,5	19	17	1	6			2	0,6
Hordeum vulgare	Hulled Barley	Cary	42	48	28	25,5	1,5	9			113	38
H. vulgare var nudum	Naked Barley	Cary	1	1								
Secale cereale	Rye	Cary	21	24	20	18	2	12	700	100	44,5	15
		Rach									8	
Triticum sp	Wheat	Cary							1	0,1	1	0,3
Unidentified cereal		Cary	18,5	21	41	37	12	71			141,5	44
		Rach									5	
GATHERED												
Corylus avellana	Hazel	nfrg	1		5		5					
Rosa sp	Rose	Seed			1							
ARABLE/RUDERAL												
Agrostemma githago	Corn-cockle	Seed	1						3			
Artemisia vulgaris	Mugwort	achn									2	
Chenopodium album	Fat Hen	Seed	1				4,5		4		200	
Plantago lanceolata	Ribwort Plantain	Seed									1	
Polygonum aviculare	Knot-grass	Seed									2	
P. aviculare/convolvulus		fr									3	
P. convolvulus	Black Bindweed	fr									1	
P. persicaria	Persicaria	fr			19		1		2		3,5	
Rumex acetosella	Sheeps Sorrel	fr									1	
Stellaria media	Chickweed	Seed									2	
Veronica hederifolia	Ivy Speedwell	Seed			4		1					
OTHER												
Bromus sp	Brome	Cary							3		1	
Cirsium sp	Thistle	achn									0,5	
Fabaceae	Pea Family	Seed									8	
Galium sp	Bedstraw	Seed									3,5	
Papaver sp	Poppy	Seed									1	
Poaceae	Grass	Cary					1					
Rumex sp	Dock	fr									2	
Vicia sp	Vetch	Seed							4		1,5	
Claviceps sp	Ergot	sclr							1,5			
Unknown							7				2	

Abbreviations: Total = total number in sample; % = percentage of total grain in sample; cary = caryopsis; rach = rachis; nfrg = nut fragment; achn = achene; fr = fruit; sclr = sclerotium.

Table 1. Botanical analysis of plant remains from Gammel Lejre.

Measurements of rye grains, average (minimum-maximum)

	Oven 473	Great Hall	Pit House XIV
Total	50	25	9
Length	5.6(4.7–6.6)	5,2(4,3–6,4)	4,3(3,5–5,0)
Breadth	2.1(1.6–2.6)	2,2(1,7–2,7)	1,8(1,6–2,0)
Thickness	2.0(1.6–2.7)	2,0(1,6–2,6)	1,8(1,5–2,4)

Measurements of barley grains, average (minimum-maximum)

	Great Hall	Pit House XIV
Total	14	25
Length	5,1(4,3–6,2)	5,2(4,3–6,2)
Breadth	2,8(2,3–3,5)	3,1(2,2–3,6)
Thickness	2,2(1,8–2,7)	2,2(1,8–2,7)

Table 2. Measurements of rye and barley grains from Gammel Lejre

their poor state of preservation. In addition, there was a carbonised fragment of hazel (*Corylus avellana*) nut shell and one seed each of the arable weed species corn-cockle (*Agrostemma githago*) and fat hen (*Chenopodium album*).

Seventeen rye grains and thirteen barley grains could be measured.

House IV – The Great Hall, East End: Twenty samples representing a total volume of ten litres yielded 108 carbonised cereal grains of which 28 (25.5%) were hulled barley, 20 (18%) were rye, 19 (17%) were oats, and 41 (37%) could not be identified. In addition there were 5 carbonised fragments of hazel nut shell, a rose (*Rosa* sp) achene, and seeds of persicaria (*Polygonum persicaria*) and of ivy speedwell (*Veronica hederifolia*). Eight rye grains and one barley grain could be measured.

Pit House V: 12 samples representing a total volume of six litres yielded 16.5 carbonised cereal grains of which 2 (12%) were rye, 1.5 (9%) were hulled barley, 1 (6%) was oats, and 12 (71%) were unidentified. In addition there were five fragments of carbonised hazel nut shell and seeds of the arable weed species fat hen, persicaria and ivy speedwell. Seven seeds could not be identified. Two rye grains could be measured.

Pit House XIV: Six samples representing a total volume of three litres yielded 302 carbonised grains of which 113 (38%) were hulled barley, 44.5 (15%) were rye, 2 (0.6%) were oats, 1 (0.3%) was wheat, and 141.5 (44%) could not be identified. In addition there were 8 rachis segments of rye and 5 unidentified cereal rachis segments. Non-cereal remains included seeds and fruits from a range of weed species: mugwort (*Artemisia vulgaris*), fat hen (*Chenopodium album*), ribwort plantain (*Plantago lanceolata*), knotgrass (*Polygonum aviculare*), black bindweed (*Polygonum convolvulus*), sheep's sorrel (*Rumex acetosella*), and chickweed (*Stellaria media*). Other remains which could not be identified beyond genus level, but which almost certainly represent weedy species, include those of brome (*Bromus* sp), thistle (*Cirsium* sp.), pea family (Leguminosae), bedstraw (*Galium* sp), poppy (*Papaver* sp), dock (*Rumex* sp), and vetch (*Vicia* sp). Two seeds remain unidentified.

Nine rye grains and twenty-five barley grains could be measured.

Oven 473: One sample with a volume of 500 ml yielded 6.8 grammes (c. 700 grains) of carbonised cereal grains. All 700 grains were of rye with the exception of one wheat grain. In addition there were sixteen seeds of other species, including the arable weeds corn-cockle, fat hen, and persicaria and remains of brome and vetch. The sample also contained 1.5 sclerotia of the fungus ergot (*Claviceps* sp).

Fifty randomly selected rye grains from this sample were measured, no barley grains were present.

DISCUSSION

In any interpretation of carbonised plant remains from an archaeological excavation, it is important to remember that the material which is preserved represents only a tiny fraction of the total plant material which has passed through the site during the period of its occupation. These few plant remains have been preserved by contact with fire under special conditions such that they were charred and preserved rather than burnt and destroyed. At Gammel Lejre a large number of samples were taken from many different contexts. Despite the fact that these also represent several phases over a period of c. 200 years, the picture which emerges from each of them with regard to cultivated species is remarkably similar.

The arable economy

The analyses show that the arable economy was firmly based on hulled barley, rye, and to a lesser extent oats. Wheat was apparently of no great significance and other crop species are not represented. There is also a striking lack of imported or exotic species. This is in agreement

with what we know from other analyses from this period in Denmark, for example from Ejstrup in Vendsyssel (Robinson & Michaelsen 1989), from Øster Aalum in Thy (Rowley-Conwy 1988), from Kregme in northern Zealand (Robinson & Moltsen 1992), from Trabjerg in western Jutland (Aaby *et al.* 1992) and from later Viking Age sites at Århus, Søndervold (Fredskild 1971), Viborg, St. Skt. Pederstræde (Jensen 1986), and Viborg Søndersø (Robinson *et al.* 1992).

The arable weed flora

Arable weeds are, as the name suggests, plant species which grow in close association with cultivated crop plants. Today the term has mostly negative connotations in that weeds are generally undesirable in a cultivated crop. We have however considerable evidence for the fact that this was not the case in the past and that weed seeds were an important and welcome supplement to the diet particularly in times of shortage (Drury 1984; Robinson 1987). In the Iron Age we even have examples of the intentional collection of weed seeds for food. At Ginderup there was a find of pure corn spurrey (*Spergula arvensis*) (Jessen 1933), at Fjand there was a pottery jar full of fat hen seeds (Helbæk 1954) and from Borremose we have a pure collection of persicaria seeds (Robinson 1992).

With the exception of Pit House XIV, weed seeds are a rarity in the samples from Gammel Lejre. It seems likely that they were harvested along with the crops and are incidental contaminants, rather than being intentionally collected for food. The majority of species present, such as fat hen, ribwort plantain, knot-grass, black bindweed, persicaria, sheep's sorrel, and chickweed are common arable weeds and ruderals with archaeological records extending back to the earliest agricultural societies. Other weed species such as corn-cockle, mugwort, and ivy speedwell became common in later times but were either absent or very rare prior to the Viking period.

Corn-cockle is primarily considered as a weed of rye. It appears first in grain finds from the Roman Iron Age (Jensen 1985) and it was not until the Viking and Early Medieval times that it became an important and despised weed. The seeds of corn-cockle are large (2–3 mm in diameter) and they are covered with sharp spikes, which damage the wall of the digestive tract even though they have been ground. The seeds contain toxic saponins including one specific to the plant called githagenin. Large concentrations of corn-cockle seeds in grain and flour can cause illness and even death. Today this is no longer a problem as corn-cockle is now a very rare plant due to the use of modern agrochemicals.

Mugwort and ivy speedwell are still very common arable and garden weeds. They are not well represented in the archaeological record and these finds from Gammel Lejre are the earliest we have from the area which now constitutes present day Denmark (Jensen 1985).

Ergot

The sample from Oven 473 contained 1.5 sclerotia of the fungus ergot. Ergot is a fungus which infects members of the grass family resulting in the infected spikelets being replaced by long brown or purple-black sclerotia which contain a range of toxic alkaloids. Rye is a favoured host among cereal species and there are many historical records of poisoning resulting from the consumption of contaminated rye grain or flour. The symptoms are loss of blood circulation to the extremities which results in gangrene, accompanied by vivid nightmarish hallucinations. In the Middle Ages the illness was given the name St Anthony's Fire (Bove 1970).

The alkaloid content of individual sclerotia varies enormously, so it is difficult to ascertain how toxic a particular level of contamination is. Contamination of the order of 1% is generally enough to produce symptoms in humans, but prolonged consumption of grain or grain products contaminated with over 5% ergot is necessary before serious poisoning results. The level of contamination in the grain from the oven at Gammel Lejre is very low and falls well within the present day European Community limits laid down for grain harvested in Denmark (Levnedsmiddelstyrelsen 1988). Infection of the rye crop was therefore either very limited or active measures were taken to remove the sclerotia from the grain.

Distribution of plant remains within the site

The results from house IV the Great Hall and from Pit House V are very similar. The samples contain primarily cereal grains, non-grain cereal remains are absent and there are relatively few weed seeds. In the samples from the Great Hall there is an interesting difference between plant assemblages in the east and west ends of the house. In the west end hulled barley and rye are found in almost equal amounts together with relatively few oat grains. In the east end there are virtually equal amounts of all three

grain types – hulled barley, rye, and oats. The elevated proportion of oat grains in the east end of the house could possibly be interpreted as evidence for the presence of a byre or stable but this is extremely uncertain. In Medieval times the primary use of oats was for animal (i.e. horse) fodder and throughout the Iron Age and Viking periods it was normal for animal accommodation to be found in the east end of the house.

The sample from the Oven 473 is almost totally comprised of rye grains with only very occasional grains of wheat, weed seeds, and sclerotia of ergot. Non-grain cereal remains are absent. This sample represents processed grain which has been threshed, winnowed, and sieved to remove impurities. It seems probable therefore that it was in the oven for the purposes of being dried prior to grinding in a quern and that an accident led to it becoming charred. Experiments have shown that drying and roasting grain makes grinding considerably easier and gives a product of a much higher quality (Anne Bloch Jørgensen pers. comm.); drying is an absolute necessity if the grain has a moisture content over 20%.

The samples from the floor of Pit House XIV contain a higher concentration of grain than those from Pit House V. They also contain non-grain cereal remains (rachis segments) and weed seeds from a large number of weed species. There is a degree of similarity between the plant assemblage in this pit house and that from the pit house at Ejstrup (Robinson & Michaelsen 1989). The pit houses from Øster Aalum (Rowley-Conwy 1988), Kregme (Robinson & Moltsen 1992), and Århus Søndervold (Fredskild 1971) were found to contain a similar admixture of carbonised grain and weed seeds.

It seems likely that the plant remains in Pit House XIV represent partly-processed grain or grain processing bi-products, in contrast to those from the Great Hall, Pit House V and Oven 473, which comprise processed cleaned grain.

The relative sizes of the rye grains from these structures (table 2) tends to confirm this interpretation in that the rye grains from the Oven and the Great Hall are on average larger than those from Pit House XIV. However one must bear in mind the fact that it was only possible to measure twenty five rye grains from the Great Hall and nine from Pit House XIV and that poor preservation made measurement difficult.

The Oven sample (473), which we know represents prime grain (*sensu* Hillman 1981, 1984), contained grains with the greatest mean size. However grains from the Great Hall were only marginally smaller, suggesting that they too represent prime grain. In contrast, the rye grains from Pit House XIV were considerably smaller, which is consistent with them being tail grain which has been removed from the prime grain by sieving (Hillman 1981, 1984). If we look at the size of the barley grains however, another picture emerges. The barley grains from the Great Hall and from Pit House XIV are almost identical in size, with those from the pit house having marginally the greatest mean size. It is possible that barley and rye were processed and used in different ways at the site.

Rye in the Iron Age and Viking Period in Denmark and a new consideration of the Fyrkat rye

Ever since Helbæk's publication of the Fyrkat grain and his views on the origin and migration of rye in Europe (Helbæk 1977), there has been a great deal of discussion about both the origin of the Fyrkat rye (was it homegrown or imported?) and the introduction and integration of rye into Danish agriculture. Helbæk was of the opinion that, although rye was present as a weed around the time of the birth of Christ, and was of growing importance during the Iron Age, it was not until the Viking period that it became an established, adapted and integrated crop plant. Recent analyses have cast doubt on this view. Well-developed rye grains made up over half the contents of a small pottery cup in a late Roman Iron Age grave at Præstestien near Esbjerg (Robinson & Siemen 1988) and the stomach contents of the Huldremose woman, who dates from the pre-Roman Iron Age, were found to comprise a mixture of rye bran and remains of the cornfield weed corn spurrey (Brothwell *et al.* 1990). It appears that rye was of considerable importance already in the early Iron Age, but this can only be confirmed by further analyses of grain finds from the early Iron Age.

On the question of the Fyrkat rye, Helbæk was categorical "only one thing can be taken as given without further consideration: the Fyrkat rye was not cultivated on Danish soil" (Helbæk 1970, translated by Rowley-Conwy 1988). He thought that it was most probably imported from eastern Europe, perhaps from the Dvina or Dniepr regions. He gave the following reasons:

1. Size: the mean grain size of the Fyrkat rye is considerably greater than that of any other Danish find.
2. Purity: there are very few contaminant grains and weed seeds.

3. Exotic contaminants: the few weed seeds which were present include species not previously recorded from Denmark.

In order to explain the first two of these, size and purity, Helbæk argued that there was a requirement from a high agronomic level with each cereal being cultivated separately, carefully weeded and processed separately. At the same time there must be systematically organised trade in basic commodities with the buyer making demands regarding purity and quality. Helbæk maintains that these requirements could not be met in Viking Age Denmark.

Helbæk's conclusions have been questioned by among others Rowley-Conwy in his publication of the Viking Age grain find from Øster Aalum in northwestern Jutland (Rowley-Conwy 1988). With regard to purity, Rowley-Conwy cites his own work (Rowley-Conwy 1978, 1984) which shows that there was a separate cultivation of barley and various wheat species as early as the Bronze Age. With regard to size, Rowley-Conwy draws attention to the fact that the Fyrkat rye is from a storage deposit whereas other finds, including that from Øster Aalum, with which it is compared, are from scattered waste deposits. He then draws on Hillman's extensive ethnoarchaeobotanical work on crop processing in the Middle East (Hillman 1981, 1984) and concludes that the size difference between the Fyrkat rye and other finds is because the former represents prime grain whereas the latter comprise tail grain which has been removed from the prime grain by sieving. He supports his conclusion by reference to the large rye grains from storage deposits at the Swedish Iron Age site of Vallhagar. These are however

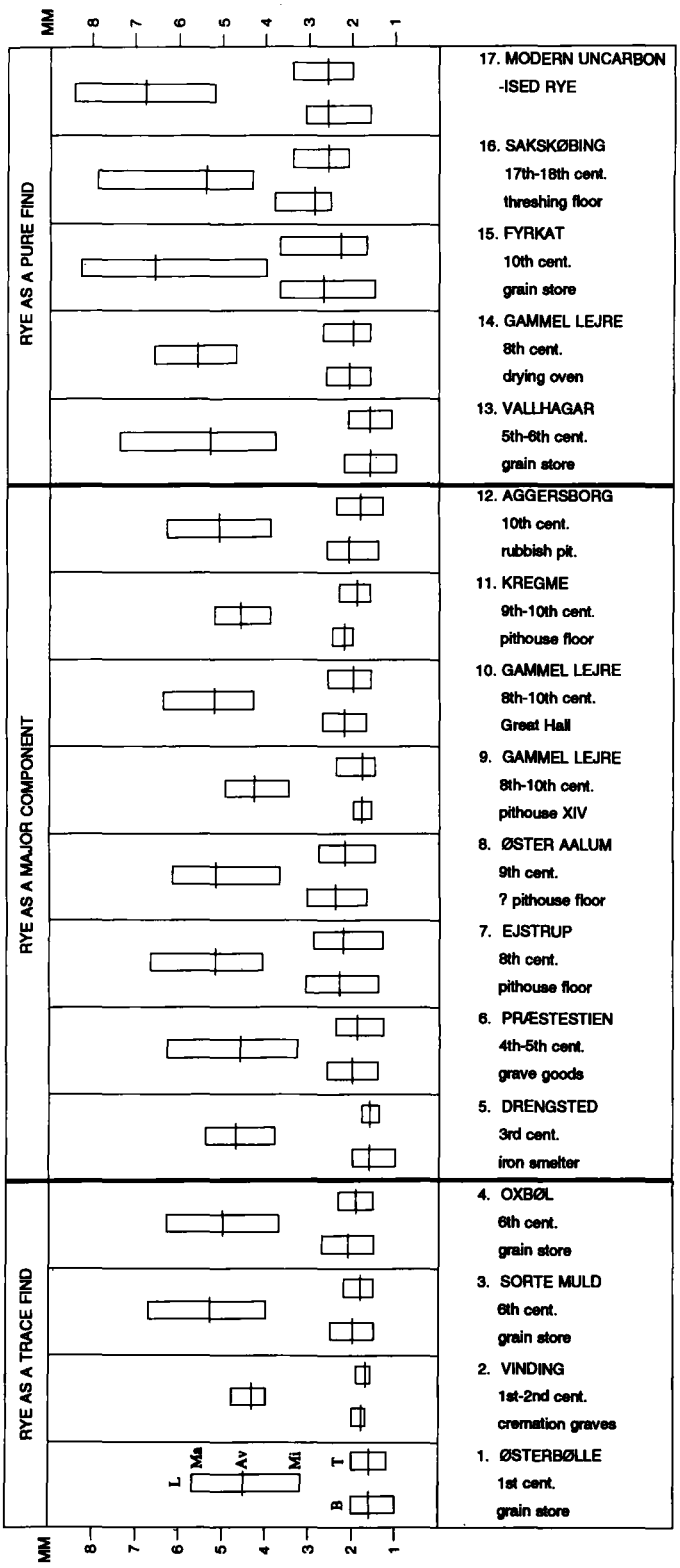

Fig. 1. Measurements of rye grains from Iron Age and Viking Period sites in Denmark. Measurements from Iron Age Vallhagar (Sweden), 17th-18th century Sakskøbing, and modern uncarbonised rye are included for comparison.
Sources:
1,3,4,5,12,15 – Helbæk (1977)
2 – Robinson (1992)
6 – Robinson & Siemen (1988)
7 – Robinson & Michaelsen (1989)
9,10,14 – this publication
11 – Robinson & Moltsen (1992)
13 – Helbæk (1955)
16 – Robinson (1991)
17 – modern rye measured by the author.
Abbreviations: L = Length, B = Breadth, T = Thickness, Ma = Maximum, Mi = Minimum, Av = Average.

still much smaller than the Fyrkat grains. Rowley-Conwy's arguments are quite convincing, but as he admits himself he takes no account of possible changes in the size of rye grains in both space and time. This weakness, he suggests, could be overcome by having examples of both type of deposit from one period at one site. This requirement is *almost* met at Gammel Lejre. We have examples of both prime grain (the Oven) and scattered waste with tail grain (Pit House XIV) but the number of measurable grains from the latter is small and we cannot be sure that the two grain finds are contemporaneous. One thing worth noting however is that the rye from the oven at Gammel Lejre is larger than that from Vallhager, which brings us back to the question of size. There are still no Danish finds which approach the Fyrkat rye in size (fig. 1). The grains are on a par with modern cultivated rye produced with all the advantages of selective breeding, artificial fertilisers, and herbicides. It is size, along with the presence of the so-called exotic species, which remains the strongest argument for the Fyrkat rye having been imported. For this reason alone I must join Helbæk and state that in the light of the evidence, including that which has emerged in the intervening two decades, the Fyrkat rye seems almost certain to have been imported.

SUMMARY

The analyses show that the arable economy at Gammel Lejre was based on hulled barley, rye and oats, the latter possibly serving primarily as animal fodder. Wheat is poorly represented and remains of other crop plants are absent, as are exotic or imported plants.

A range of weed species are represented in the samples but the total number of seeds is not great. This suggests that they were harvested incidentally along with the crop rather than collected intentionally for food.

A comparison of the plant assemblages from the various structures on the site reveal some interesting differences. Samples from House IV (Great Hall) and Pit House V appear to represent processed grain; non-grain cereal remains are absent and weed seeds are rare. The east end of House IV has an elevated oat content relative to the west end. This could possibly be seen as evidence for a stable, but this is very uncertain. Samples from the floor of Pit House XIV contain a higher concentration of plant remains than those from House IV and Pit House V. They also contain non-grain cereal remains (rachis segments) and a relatively large number of weed seeds. This, along with the relatively small average size of the grains, suggests the presence of tail grain – a processing biproduct (Robinson & Boldsen 1991).

The grain sample from the oven has obviously been processed and carefully cleaned; a very few weed seeds and sclerotia of ergot were the only contaminants. It seems likely that the grain was in the oven for the purposes of being dried prior to grinding on a quern, as drying greatly increases the ease of milling and the quality of the end product.

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