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Acta Palaeobotanica 57(1): 109–118, 2017
DOI: 10.1515/acpa-2017-0006

e-ISSN 2082-0259
ISSN 0001-6594

Preliminary analysis of plant macrofossils from an Early Iron Age structure in Kærbøl, Denmark, with special emphasis on segetal and ruderal weeds

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Received 25 July 2016; accepted for publication 23 March 2017

ABSTRACT. The paper presents results from an archaeobotanical analysis of samples from an Early Iron Age building in Kærbøl, Denmark, and brings to light an interesting correlation between crops and weeds which most probably characterised the majority of Early Iron Age societies in Denmark. It is suggested that the weed species were the primary plants stored for various reasons and that the crops only accompanied them. The authors discuss the plausibility of interpreting weed species as food plants during the Danish Iron Age, and the possible function of the sampled structure.

KEYWORDS: segetal and ruderal weeds, food resources, crop processing, Early Iron Age, Denmark

INTRODUCTION

Segetal and ruderal weeds have accompanied humans from the very beginning of plant domestication and permanent settlement (Lityńska-Zając 2005). They grew in fields and near sites of various human activities. Nowadays they are considered mostly as an inconvenience, but in the past some of them could have been important for their nutritional and caloric value (Łuczaj 2008) and medicinal properties (Grieve 1931, Chiej 1984).

Plant macrofossil analyses of various contexts (Helbæk 1951, 1954, Henriksen 1994, Robinson 2000a) have shed light on the dietary habits of Early Iron Age (EIA) societies of Denmark. During the researched timeframe there seems to have been a general tendency to collect and store weed plants and their seeds.

This paper examines some aspects of crop and weed processing practices in Denmark at the turn of the eras before and after the birth of Christ, in a case study of an EIA building uncovered during a large-scale rescue project in Kærbøl in south-western Jutland, Denmark (Fig. 1). The structure was the only one sampled for archaeobotanical analysis.

An area of more than 1.2 ha was investigated during archaeological excavations (Fig. 2). The work uncovered a large number of houses from three different phases: three houses from the Early Pre-Roman Iron Age (500–300 BC), 70 houses from the EIA (mainly around the turn of the eras), and a series of farmsteads from early modern times (Feveile & Søvsø 2006). Thanks to previous (e.g. Webley 2008) and subsequent studies, the spatial structure of the EIA small farmsteads is well researched. They each usually consisted of three buildings: one longhouse, one or two outbuildings, and/or a four-post structure of debatable function.

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Fig. 1. Location of Kærbøl site on map of Denmark

The analysed material was recovered from a partly excavated structure. Due to incomplete exploration, the analysis of the spatial distribution of plant remains within the structure is limited. The main focus here is on sample content, probable uses of plants, and the possible function of the building. Three hypotheses are tested: the residues differed from each other in their botanical content, the weeds were the primary plants for storage and the crops accompanied them for various

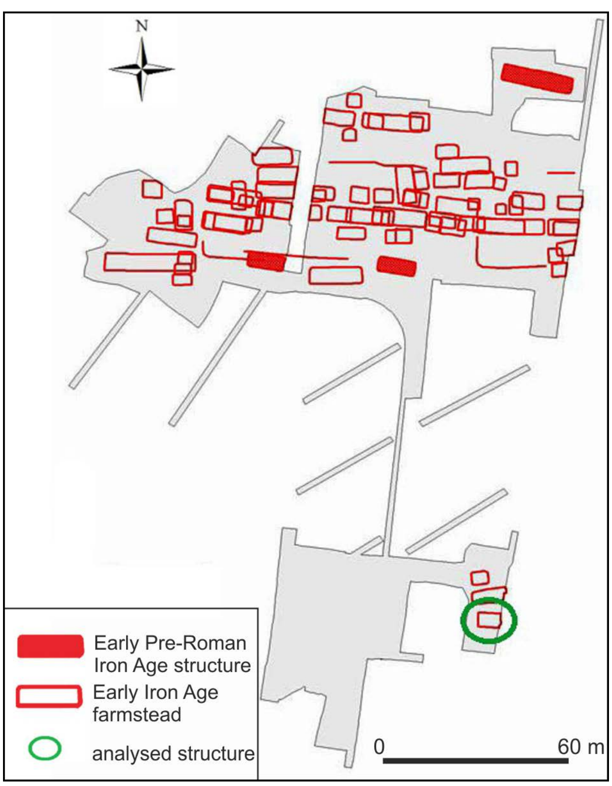

Fig. 2. Overview of excavated site, with the analysed structure

reasons, and the analysed building was used for economic purposes.

MATERIAL AND METHODS

We analysed nine flotation residues from the EIA structure (Fig. 3). Samples were taken from primary and secondary fills (Fig. 4) of six postholes, only three of which were sampled with distinction of the type of fill. Due to the location of the structure on the outskirts of the site and the lack of any younger/older features in the vicinity, the risk of contamination was limited to bioturbation (Schiffer 1987).

The volume of the floated residues ranged from 2.2 to 226 ml. The preserved plant material was charred. The samples were sieved throughout a set of sieves (mesh sizes 2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm) to separate plant macrofossils of different sizes. In two cases (samples ×34 and ×42) the >1.0 mm fraction was subsampled, only half of the sample was analysed, and the results were doubled, due to the high number of seeds and fruits. For sample ×35 only a quarter of the >1.0 mm fraction was analysed and the results were quadrupled. The other fractions were analysed completely.

The material was sorted under a low-power stereomicroscope (6.5–40×). The macroscopic plant remains were picked from the different sieved residues and identified from morphological characters. All macrofossil identifications were checked against the botanical literature (Mossberg & Stenberg 1994, Cappers et al. 2006, Jacomet et al. 2006) and compared with the modern reference collection of the Department of Archaeological Science and Conservation, Moesgaard Museum. Nomenclature follows Cappers et al. (2006) and Mossberg and Stenberg (1994), with ecological indicator values taken from Ellenberg and Leuschner (2012) and Hill et al. (1999). All identified taxa are presented in Table 1.

RESULTS

The analysed material contained 1061 crop grains and 12 459 seeds/fruits of weeds (Tab. 2). Sample ×34 contained the highest number of cereal grains and had the highest ratio of cereals (37%) to wild species (63%). In three other samples (×37, ×38, ×43) the share of crops was 10% or more. Weed diaspores dominated (96% or more) the remaining residues.

The cereal species at the Kærbøl site included naked and hulled barley (*Hordeum vulgare* var. *nudum*, *H. vulgare* var. *vulgare*), bread wheat (*Triticum aestivum*), rye (*Secale cereale*) and oat (*Avena* sp.) (Fig. 5). *H. vulgare* var. *vulgare* was the most abundant cereal.

Posthole A143, sample ×34, located at the south-west corner of the building, had the largest amount of grain (Tab. 2), followed by sample ×35 from posthole A144 ca 2.5 m east of A143.

Fig. 3. Plan of analysed house, with sample numbers

Interestingly, no traces of chaff were found in posthole A143, and the other samples contained only very few rachis internodes (8 or less).

Grains were detected in both primary and secondary fills, but the very small amount in primary fill (<6 grains/sample) suggests that the cereals were there due to the past activity of small rodents or to soil disturbance during sampling.

All the analysed samples contained high numbers of weed species; the ratio between total weed and total cereal remains is 10:1 (Fig. 6).

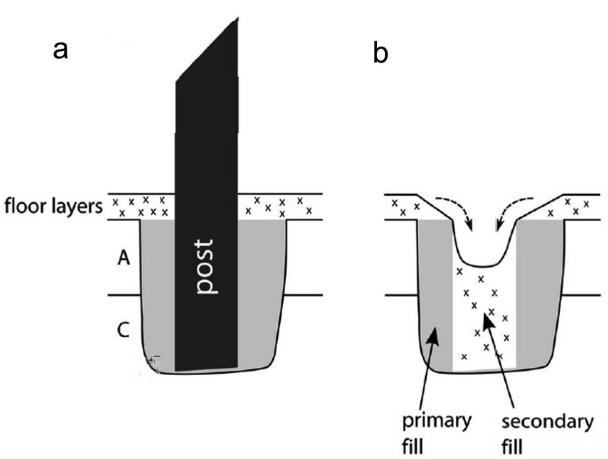

Fig. 4. Distinction of primary and secondary fills (after Grabowski 2014, fig. 5.4)

Redshank/pale persicaria (*Persicaria maculosa/lapathifolia*) was present in high amounts in all samples (Tab. 1), highest in sample ×35 (over 7300 specimens). Even when *Persicaria maculosa/lapathifolia* is removed from the diagrams, weed species still dominate crops in all samples. Goosefoot (*Chenopodium album*) was also present in all of the samples, in slightly lower amounts.

The weed distribution differed between primary and secondary fill. A group of plants occurred only in the samples from secondary fill: brome grasses (*Bromus* sp.), plants of the carnation family (Caryophyllaceae), sun spurge (*Euphorbia helioscopia*), hemp-nettle (*Galeopsis* sp.), common knotgrass (*Polygonum aviculare*), plants of the knotweed family (Polygonaceae), docks/sorrels (*Rumex* sp.), stitchwort (*Stellaria* sp.), black nightshade (*Solanum nigrum*) and plants of the rose family (Rosaceae).

Only seven of the weed plants were identified to species level. Two of them, *Fallopia convolvulus* and *Spergula arvensis*, grow in fresh soils and are indicators of sites of intermediate fertility. The other five (*Camelina sativa*, *Euphorbia helioscopia*, *Persicaria maculosa*, *Polygonum aviculare*, *Solanum nigrum*) also grow in fresh soils but can be found in richly

Table 1. Taxa identified at the Kærbøl site, with assignment to features (**X-no**: sample number; **A-no**: posthole number; **fill 1** – primary fill; **fill 2** – secondary fill)

X-no	34	35	36	37	38	40	41	42	43
A-no	143	144	144	145	146	147	147	148	148
Fill	2	2	1	2	2	2	1	2	1
Volume (ml)	141	116	2.2	31	178	122	19	226	10
Cultivated plants									
Hordeum vulgare var. *nudum* (naked barley)	48	22	1	6					
Hordeum vulgare var. *vulgare* (hulled barley)	259	63	3	22			2	10	
Hordeum vulgare (barley)	125	92	3	11	2	2	3	13	1
– rachis internodes				8		3		2	
Triticum aestivum (bread wheat)	2								
Triticum sp. (wheat)		6							
Secale cereale (rye)		1							
Cerealia indet. (cereals)	114	53	2	17	1	2	2	10	3
– awns				1					
– rachis internodes		4							
Fields and dry wastelands									
Avena sp. (oat)	6	8	1	1		1			2
Camelina sativa (gold-of-pleasure)				3					
Chenopodium album (goosefoot)	235	1428	43	54	4	26	61	183	35
Fallopia convolvulus (black bindweed)	14	67	1	2		1	1	15	2
Euphorbia helioscopia (sun spurge)		8		1				2	
Polygonum aviculare (common knotgrass)	4								
Persicaria maculosa (redshank persicaria)	5		1						
Persicaria maculosa/lapathifolia (redshank/pale persicaria)	718	7607	206	125	14	66	251	438	44
Solanum nigrum (black nightshade)		4							
Spergula arvensis (corn spurrey)	1	96	4		4	1	1	19	
Various									
Bromus sp./*Avena* sp. (brome grases/oat)				12		2			
Carex sp. (sedges)		6				3	1	2	
Carex sp./*Polygonum* sp. (sedges/knotgrass)							2		
Fragaria sp./*Potentilla* sp. (strawberry/cinquefoils)	1								
Galium sp. (bedstraw)	27	38	2	1		1	15	31	6
Galeopsis sp. (hemp-nettle)	8	24		1				2	
cf. *Linum* sp. (flax?)	2								
Polygonum sp. (knotgrass)	4								
Rumex sp. (docks/sorrels)	1	2							
Stellaria sp. (starwort)	11								
Caryophyllaceae (Carnation family)		8		2				2	
Fabaceae (bean family)	2	8			1	1	3		
Poaceae (grasses family)	1	10						1	1
Polygonaceae (knotweed family)		1		1		1			
Rosaceae (rose family)	1								
Indet.	70	68	7	7	1	11		9	1

fertile soils. *Fallopia convolvulus* and *Spergula arvensis* occurred in both fills, and the others only in secondary fill. Two explanations for this can be offered. Either the plants were delivered from two different locations (less and more fertile) or some of them were collected on purpose and stored together. It is possible that the species that occurred in the secondary fill were associated with human activities on the site. Whether they were brought to the site or grew around the household is an open question.

DISCUSSION

The contents of the samples appear to be quite uniform. They all consist of cereals and weeds and in all cases the weed plant

Table 2. Total number (including ratio) of cereal grains and weed species present in the analysed material. (**X-no**: sample number; **A-no**: posthole number; **fill 1** – primary fill; **fill 2** – secondary fill)

X-no	34	35	36	37	38	40	41	42	43
A-no	143	144	144	145	146	147	147	148	148
Fill	1	1	2	1	1	1	2	1	2
Volume (ml)	141	116	2.2	31	178	122	19	226	10
Cereals	638	284	10	57	3	5	9	33	10
Weeds	1093	9616	264	209	24	114	335	715	89
Cereals %	37	3	4	21	11	4	3	4	10
Weeds %	63	97	96	79	89	96	97	96	90
Total Cereals	1061								
Total Weeds	12459								

assemblage is dominant. They come from a building which unfortunately was not excavated completely. Based on its similarity to other EIA farmsteads uncovered at Kærbøl, the structure may have been a house or an outbuilding. Analysis of the archaeobotanical samples should help reveal the purpose for which the structure was used.

Here we divide the discussion of the diversity and quantity of the identified taxa into two parts. The first assumes that the weed plants were collected together with cereals during the harvest. The second considers the weed species as the principal plants stored, gathered without regard for cereals.

CEREALS AND AGRICULTURAL PROCESSES

According to Hillman (1984) there are around 30 different crop processing stages before cereals are prepared for human consumption. Tracing those processes in archaeobotanical material is not an easy task. Thanks to ethnographic studies (Hillman 1973, 1981, 1984, Jones 1984, Hastorf & Popper 1989, Jones et al. 2000), however, interpretative models have been constructed. They allow assessment of the processing phase from which the analysed material originates, because each stage is characterised by different products and by-products which remain in the record of plant macroremains.

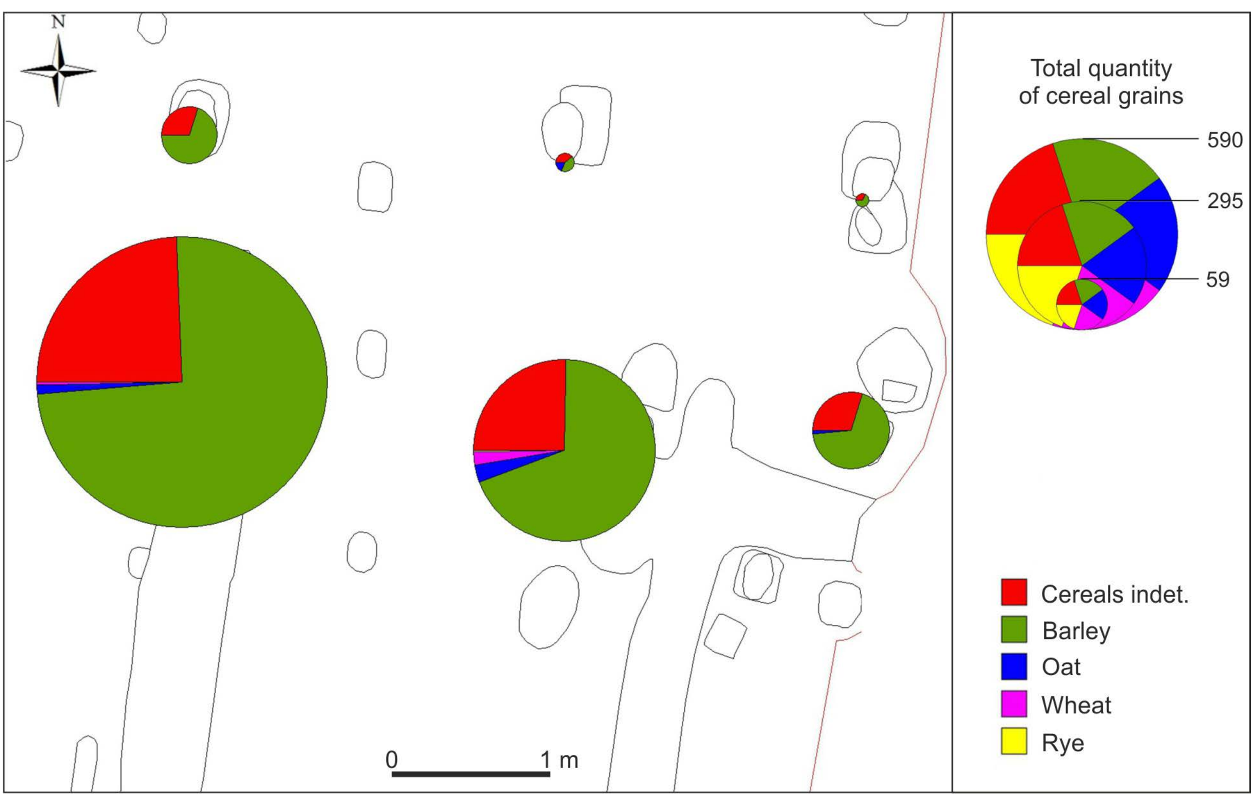

Fig. 5. Distribution and quantity of cereal grains found in secondary fill of postholes

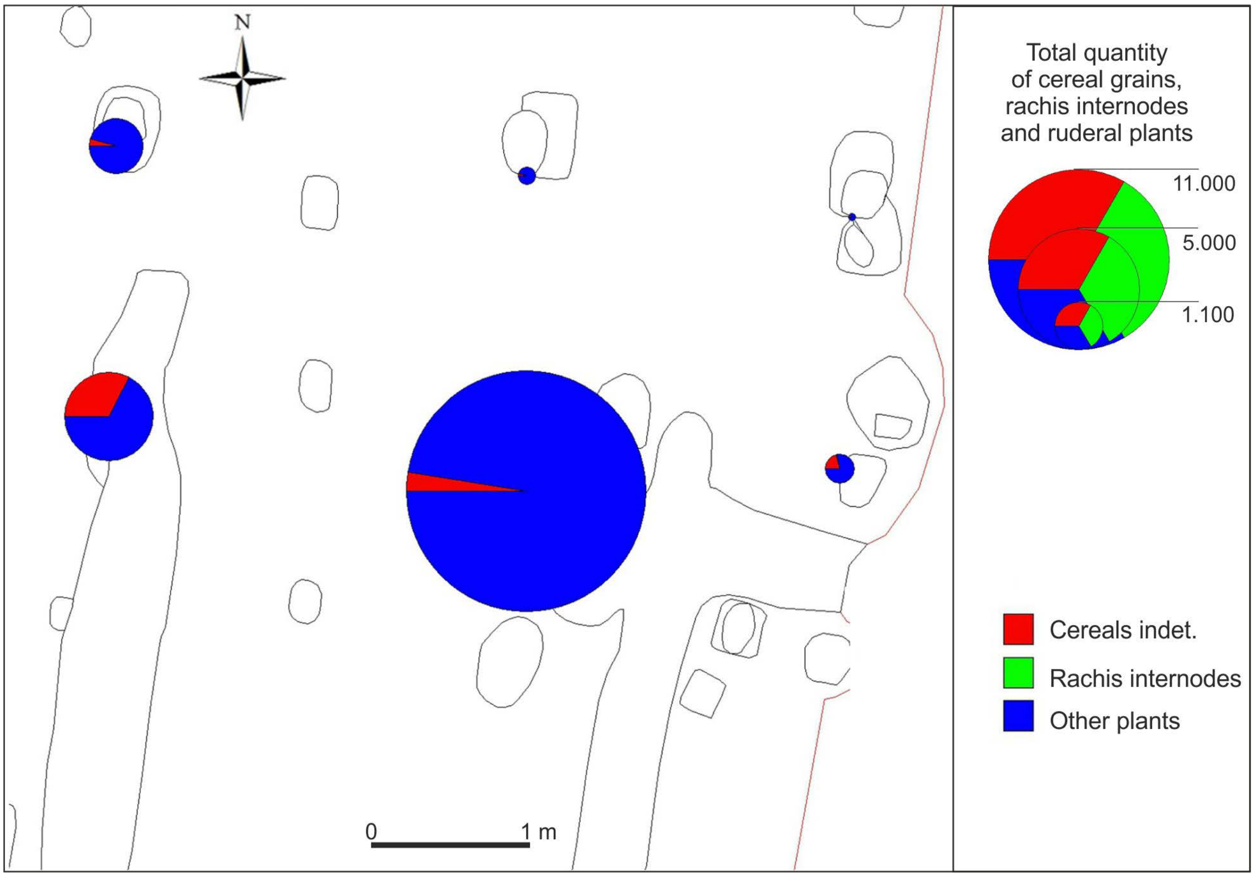

Fig. 6. Ratio between total number of cereal grains and arable weed species found in secondary fill of postholes

The material from samples ×34 and ×35 can be interpreted as associated with the last stage (hand-sorting) of crop processing (Hillman 1981). However, the samples were filled with seeds of small-seeded arable plant species that should have been removed during that process. None of the stages of barley processing proposed by Hillman (1981: fig. 6, fig. 7) cover such a situation. We suggest that the cereals from samples ×34 and ×35 resemble material after the last stage of crop processing, which was stored and awaited meal preparation. The weeds found in the samples could have been stored separately, next to or above the cereals (Alsleben 1995). During the destruction of the building they would have contaminated the grains.

The other samples contained a modest quantity of cereals, rachis internodes and awn fragments, and weed seeds in considerably lower numbers. Those assemblages, according to Hillman (1981, fig. 6), resemble the by-product of the second sieving, which could be stored for food or fuel.

Depending on the function of the analysed building, the space at the western end could have been assigned different roles. If the structure was an outbuilding, the area may have been used for storage; if it was a house, the space would have been used for cooking. However, there was no trace of a hearth or fireplace which might indicate a kitchen area in the excavated part of the building. We suggest that the western part of the structure was a site of the last stages of crop processing, including hand-sorting and storage of the products. This would be consistent with the general idea that most processing is done indoors in areas with rainy summers (Hillman 1981). Whether the structure was a multifunctional household (Grabowski 2014, fig. 5.6) or an outbuilding remains an open question.

The ratio between the two dominant forms, *Hordeum vulgare* var. *nudum* and *H. vulgare* var. *vulgare*, does not seem to differ from that found at other Pre-Roman Iron Age sites of western Jutland. *H. vulgare* var. *vulgare* slightly predominates at a few sites, but the clear dominance of var. *vulgare* over var. *nudum* is not apparent until advanced periods of the Roman Iron Age (Robinson et al. 2009, Grabowski 2014: 15).

Moreover, there is no difference in the distribution of cereal species within the excavated part of the structure. This suggests at least two possibilities. Perhaps the grain of different cereals was not kept separately. Alternatively, the same part of the building was used for storage of different species over the years; the material in the samples would show traces of all the species stored through the years. It is more likely that the crops were kept apart by reason of sowing in separate fields or during different seasons. If so, the crops could have been stored in individual piles in the part of the structure that was not sampled.

The identified weed species are summer annuals that "are the weed species which germinate in spring and are traditionally associated with summer crops" (de Hingh 2000: 156). They grow in communities of the Chenopodietea class (Jones 1992: 137) and may indicate spring sowing at the site (Bogaard et al. 2001).

In the case of the Kærbøl site, however, it seems that the weed species found in the samples were collected for special purposes and do not directly reflect the assemblage of a particular cultivated field. Moreover, it is possible that the material was disturbed by crop processing activities, which would lead to misinterpretation (Bogaard et al. 2005: 507). Therefore we omit a consideration of cultivation practices based on weed ecology.

WEEDS AS PREHISTORIC FOOD

There is a clear rise of the number of weed species in archaeobotanical samples from the Late Bronze Age onwards, most probably due to a change in cultivation techniques and field systems (Jensen & Andreasen 2011, Grabowski 2014) as well as an increase in the use of fertilisers on cultivated land. Manure from grass-eating animals contains many weed diaspores ready to germinate (Robinson et al. 1995, Boas 1997, Robinson 2000b, 2003, Jensen & Andreasen 2011).

The Kærbøl material clearly contained high amounts of weed species. The two dominant taxa in all samples were *Persicaria maculosa/lapathifolia* and *Chenopodium album*. We favour two of the many possible explanations of their high occurrence. Either the weed seeds were brought together with harvested cereals and stored separately after grain threshing, or they were collected separately. The first possibility was discussed above. Here we consider intentional gathering of those plants.

According to Helbæk (1951), prehistoric farmers may have had special fields for weed harvest. Other possibilities are that the plants were collected from fallows (e.g. Helbæk 1951, 1954) or were simply gathered in the vicinity. An assemblage collected from fields left for regeneration would contain weed species and perhaps some sporadic cereals that survived winter. Whether the weed seeds were by-products of crop processing or were intentionally collected, we may ask why and how they were stored.

During the EIA in Denmark, apparently there was a general tendency to collect and store ruderal and/or segetal weeds and their seeds. In a study of some investigated sites that contained similar material, Helbæk (1954) suggested that the seeds were stored for food, especially in connection with the high amount of *Persicaria lapathifolia* from an Early Roman Iron Age house in Alrum, and the high amount of *Chenopodium* sp. from Fjand. He also mentioned two sites, Ginderup and Østerbølle, where large deposits of corn spurrey (*Spergula arvensis*) and other segetal weed species were found along with cereals. *Spergula arvensis* (Karg 2012: 20) and *Chenopodium album* (Łuczaj 2008) are known from historical times for the use of their seeds as famine food, mixed with flour. Almost all parts of the plants are edible, but the seeds, produced in great numbers and with high dispersal, have the highest nutritional and caloric value. These qualities, together with the easy accessibility of the plants, which may be found in arable fields and near houses, make it a valuable food substitute. Gold-of-pleasure (*Camelina sativa*) is an edible oil-producing plant which was used for culinary purposes as early as the Bronze Age (Robinson 1994, Jensen & Andreasen 2011). During the Iron Age it still occurred along with flax (*Linum usitatissimum*) and was cultivated together in the same or separate fields (Jensen & Andreasen 2011).

Other finds of significant quantities of weed species, including *Persicaria maculosa/lapathifolia*, *Spergula arvensis*, *Chenopodium album* and sheep's sorrel (*Rumex acetosella*), were made at Overbygård (Henriksen 1994, Henriksen & Robinson 1996), Gørding Heath (Helbæk 1951), Stoustrup (Robinson 1993), Bøgely (Andreasen in print) and Præstestien

(Robinson 2000a). Two vessels filled with weed species were uncovered at Præstestien. One was from a grave (Robinson 2000a), and the second, possibly containing material used as food, was from a feature interpreted as an oven (Robinson 2000a).

Additional valuable information about Danish EIA dietary practices was gained from two bog corpses whose stomach and gut contents were analysed. The last meal of Grauballe Man consisted of *Persicaria maculosa/lapathifolia*, *Spergula arvensis* and *Rumex acetosella*. These were accompanied by many other weed species, cereal grains and chaff (including glume bases and straw) and grass stems. That kind of combination of large amounts of weed species with smaller quantities of grains and chaff fragments is commonly interpreted as threshing waste (Helbæk 1958, Viklund 1998, Robinson 2000b, Harild et al. 2007).

The stomach content of Tollund Man consisted mainly of *Persicaria lapathifolia*, *Linum usitatissimum*, *Camelina sativa* and *Hordeum vulgare* (both grains and rachis fragments), along with other weed species in smaller amounts (Helbæk1950). Ruderal plants could be gathered easily, due to high seed production (Behre 2008). In prehistoric times they were a supplementary part of the food economy (Helbæk 1960) on more or less equal footing with cereals. This seems more likely than their use only as a famine aliment.

Along with their economic use, some weeds were collected for medicinal purposes. Four species from the Kærbøl assemblage may belong to this group: redshank (*Persicaria maculosa*), common knotgrass (*Polygonum aviculare*), black nightshade (*Solanum nigrum*) and sun spurge (*Euphorbia helioscopia*). They were found in significantly lower amounts than *Persicaria maculosa/lapathifolia* and *Chenopodium album*, suggesting that if intentionally collected they were stored for purposes other than consumption.

Persicaria maculosa and *Polygonum aviculare* can be used both internally and externally for various treatments, including as a remedy for sores, stomach pains and kidney disorders (Moerman 1998, Grieve 1931, Chiej 1984). *Solanum nigrum* and *Euphorbia helioscopia* are considered to be poisonous plants, but if applied in the proper amount and by the right method they may also have curative effects. *Solanum nigrum* has been used for external and internal applications (Duke & Ayensu 1984, Moerman 1998), and *Euphorbia helioscopia* was believed to have anticancer (Duke & Ayensu 1984) and purgative effects and was used as a treatment for skin eruptions (Chopra et al. 1956).

The techniques of weed storage depended on the primary use and the manner of collection. If *Persicaria maculosa/lapathifolia* and *Chenopodium album* were gathered after successive stages of grain cleaning, they most probably would be stored in bags, organic containers or ceramic vessels (Helbæk 1951, Henriksen 1992). That storage practice ought to be easily observed in the concentration of weed species in the archaeobotanical samples, but if particular species were not always stored in the same area the distribution might be obscured. If the plants were collected and stored unthreshed they could have been kept in bunches lying on the floor or hanging on posts or on strings between posts. Then if the building burned, the plants drying on the posts would end up in the post holes.

The last explanation of the high amount of *Persicaria maculosa/lapathifolia* and *Chenopodium album* is that both grew close to the building and during its destruction their seeds contaminated all the samples. As mentioned before, the examined plants have high seed productivity and dispersal. They accompany human settlements, so contamination could have easily occurred (Behre 2008: 72).

The rest of the structure should be explored in order to fully determine the function and distribution of these taxa. Both the structure and the area around it should be sampled; that would help us understand the complete distribution, including the background. Rescue excavations are often under significant time and funding pressure, however, preventing detailed sampling.

CONCLUSIONS

The Iron Age settlements of Denmark are characterised by mixed agriculture with crop cultivation and animal husbandry (Webley 2008), supplemented by gathering of segetal and ruderal weed plants and exploitation of wild fauna (Jensen & Andreasen 2011). There seems to have been a general tendency to collect and store weed seeds all over Denmark.

The purposes of this could be for food, medicine or fuel, and probably depended on economic and socio-geographical factors.

The assemblage from Kærbøl does not depart from this scheme. Our analysis revealed that the structure was most probably used as an outbuilding to store food. Along with cultivated plants we identified large amounts of weed species. Redshank/pale persicaria (*Persicaria maculosa/lapathifolia*) and white goosefoot (*Chenopodium album*) were important components of the weed assemblage. Presumably they were collected as supplementary food, but this suggestion requires further studies.

ACKNOWLEDGEMENTS

We thank Dr. hab. M. Lityńska-Zając (Insitute of Archaeology and Ethnology, PAS) and Dr. P. Hambro Mikkelsen (Moesgaard Museum) for their help and valuable comments, and Prof. K. Wasylikowa (W. Szafer Institute of Botany, PAS) and two anonymous reviewers for comments and suggestions which improved the manuscript. The work was done during an internship at Moesgaard Museum (funded by Erasmus + programme).

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