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Interregional networks in the late Viking Age? Insights from a burned pit house in the Viking-Age town of Aros, present-day Aarhus, Denmark (ca. 980 CE)

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ABSTRACT

The Viking Age was a dynamic period, with local centres and urban sites engaging to varying degrees in local, regional and interregional networks. While the role of certain northern towns in these networks is relatively well-known and the related knowledge up to date, other towns appear to have received comparatively little recent attention. This study aims to investigate the role of the Viking-Age town of Aros, present-day Aarhus, situated on the eastern coast of Jutland, Denmark, in interregional networks, by means of the interdisciplinary study of a rare context, excavated in 2009: a well-preserved burned pit house at the site of Bispetorv, dated to the late 10th century CE. What does the archaeological assemblage tell about the house and its occupants, what can be said about resource exploitation, and to what extent were the occupants of the late Viking-Age pit house involved in long-distance trade?

The study of the pit house at Bispetorv is based on an interdisciplinary approach, including analysis of inorganic artefacts, zooarchaeological remains, macrobotanical remains and carbonised wood collected from multiple layers, supported by a substantial number of radiocarbon dates. The outcomes are presented within the framework of other comparable published and unpublished sites in and nearby Aarhus including Søndervold and Skt. Clemens Stræde, as well as with other Viking-Age towns in northern Europe.

The analysis of Bispetorv reveals a predominance of artefacts and ecofacts associated with regional networks, with scant evidence of contacts with the Baltic Sea coast. While these results match the findings from other sites in Aarhus, and are comparable to other local centres, they are in apparent contrast to larger urban centres such as Ribe, Hedeby and Kaupang. Further research, based on a variety of methods, will have to show to what degree the currently available bioarchaeological results from Aarhus are representative for the remaining parts of the urban centre and to what extent long-distance contacts evolved over time.

1. Introduction

The Viking Age (ca. 750–1050 CE) was a period of major changes in northern Europe. At the threshold of this period, changes in maritime technology facilitated the development of long-distance maritime trade, and consequently, a number of urban sites, connected through far-reaching interregional networks developed in parallel with local centres. Viking-Age towns have received attention for decades, among

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which are relatively well-known sites such as Kaupang, Birka, Haithabu and Aarhus (e.g. Andersen et al., 1971; Arbman, 1940-1943; Blindheim et al., 1981; Jankuhn, 1937). In the last twenty years, new studies and overviews, often based on innovative methods, have become available about, for example, the Norwegian Viking-Age town of Kaupang and the Danish towns Viborg, Aalborg, Odense and Ribe (Fig. 1; Iversen et al., 2005; Runge et al., 2021; Sindbæk, 2007; Sindbæk, 2023a; Skre, 2007-2011). Excavations of Viking-Age Aarhus, however, have not received the international attention that they deserve yet. Even though many archaeological excavations have taken place in Aarhus since the mid-20th century (e.g., Andersen et al., 1971; Linaa, 2016), which also resulted in exhibitions (e.g. Damm, 2005; Skov and Varberg, 2011), and although a substantial number of publications and excavation reports are available in Danish (e.g. Jantzen, 2013; Madsen, 1996; Schiørring, 1984; Skov, 1998, 2006, 2008), internationally available synthesis studies are rare, while many details of Viking-Age Aarhus, including bioarchaeological data, are still unpublished.

Recent analyses suggest that the Viking-Age town of Aarhus was founded as a centre facilitating both local trade and the exploitation of coastal resources at the mouth of the Aarhus River just before 800 CE (Linaa, 2016, 2024). The town was positioned on the eastern coast of Jutland, about midway between Kaupang, in the 8th and 9th centuries an important trading place nearby the royal seat of Skiringssal in current Norway, and Haithabu on the southwestern Baltic coast, an important trade town from the 8th to the 11th century (see Fig. 1). The early town, which was unfortified and separated from the surrounding landscape by a shallow ditch, included a series of pit houses, which developed into a densely settled neighbourhood along the river in the first decades of the 9th century CE. While the first post-built houses are found in the late 8th/early 9th century, pit houses remained the main house type during the 9th and 10th century. By the early 10th century, Aarhus underwent significant development, marked by the demolition of major parts of the outskirts and the construction of a 9 m wide rampart encircling the central settlement (Linaa, 2016:71-74, 2024). This transformation mirrored similar fortification efforts in contemporary Haithabu and Ribe (Andersen, 1998; Croix et al., 2019) and can be related to geopolitical developments. In the late 10th century, the rampart in Aarhus was expanded (Fig. 2), as part of the strategic military measures to defend the town and country, which possibly also included warships (Ulriksen, 2004). The expansion coincides with the construction of circular ring-fortresses elsewhere in Viking-Age Denmark, i.e. Aggersborg, Borgring, Fyrkat, Nonnebakken and Trelleborg (Fig. 1), while towns such as Horsens were fortified around the same time (Jantzen, 2013; Kristensen and Poulsen, 2016; Linaa, 2016; Sindbæk 2024). The numerous place names around Aarhus referring to Viking-Age ship wharves and beacon hills have been interpreted as evidence of the importance of the fleet to the power and protection of the town and country (Damm, 2005:41, 101; Skov, 2008:224). Alongside its military role, Aarhus emerged as a

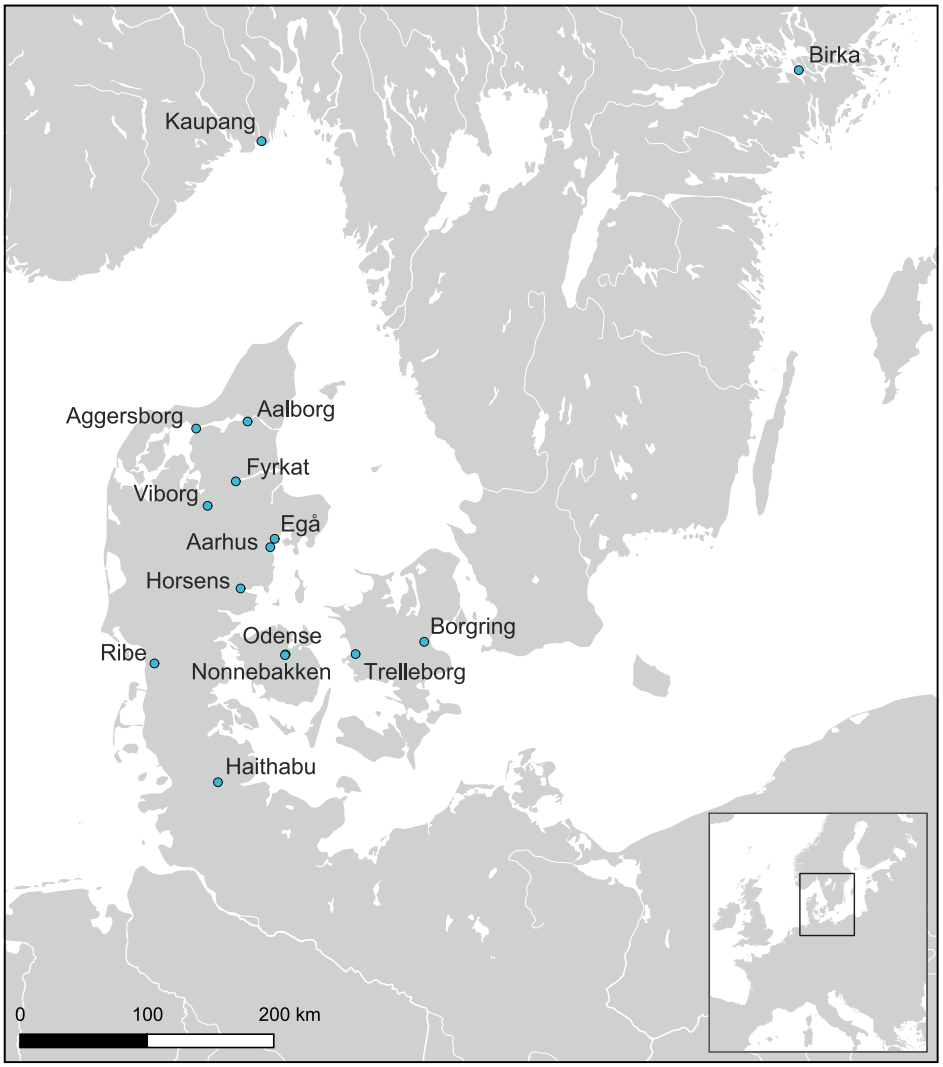

Fig. 1. Map of northern Europe showing Viking-Age towns and ring-fortresses that are mentioned in the text. Figure: Moesgaard.

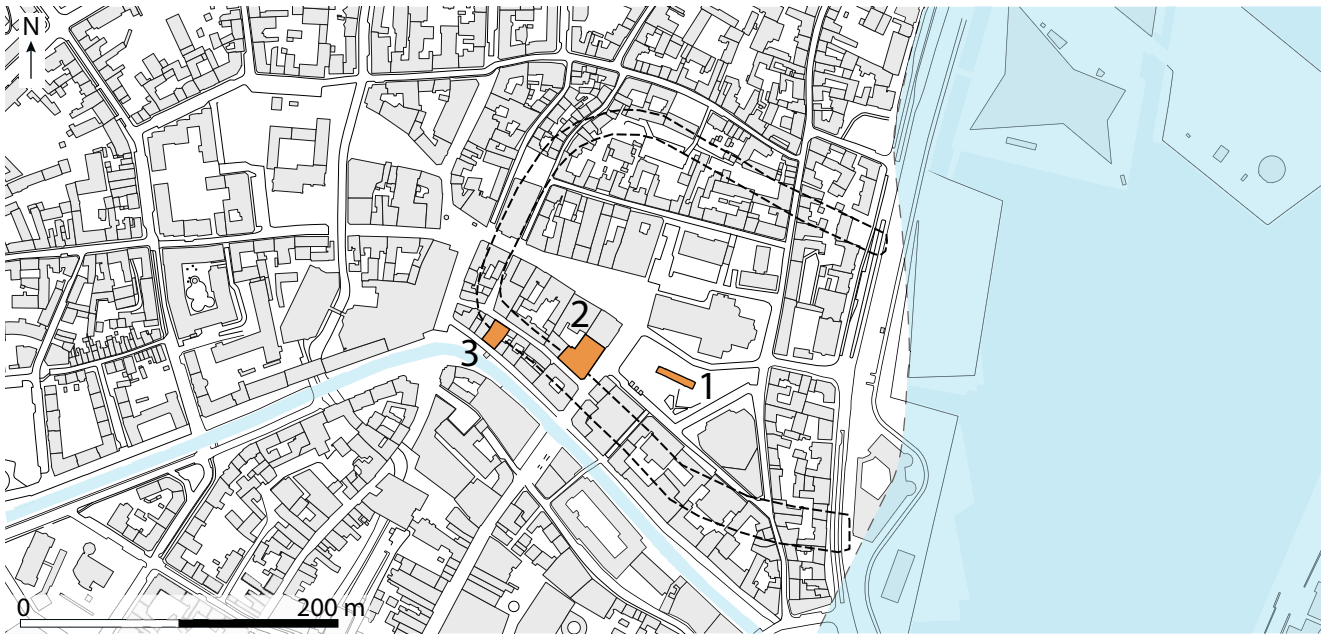

Fig. 2. Modern map of Aarhus showing the 10th century rampart (dashed line), a reconstruction of the Viking-Age coastline and three archaeological sites in Aarhus city centre 1) Bispetorv (FHM 5124), 2) Aarhus Søndervold (FHM 1393) and 3) Skt. Clemens Stræde 10 (FHM 4573). Figure: Moesgaard.

religious centre, as evidenced by the town being an episcopal see in 948 CE (Heinrichsen, 1968:69-70). These developments underscore the multifaceted nature of Aarhus in the late Viking Age as a trade centre, a military stronghold and a centre of religious activity.

In the late 10th century, a pit house burned down in Aarhus (Andersen et al., 1971), potentially representing a dramatic disaster. In the 10th and early 11th century, when parts of Norway were under Danish control, wars between King Harold Bluetooth and his successor Sweyn Forkbeard, and later between the Danish, Swedish and Norwegian kings over control of Norway, resulted in political instability in the wider region. Runestones from Aarhus dated to 970–1020 bear inscriptions about warriors killed in battle (Roesdahl and Wilson, 2006). There is a grave containing a skeleton with a shield and battle axe (Høegsberg, 2020), just as spears and arrowheads found during excavations of the ramparts serve as evidence of attacks on the town (Andersen et al., 1971:204; Søgaard, 1961:Fig. 8). Few written sources on life in Aarhus have survived, but the chronicler Adam of Bremen writes that the church was torched during an attack by the Norwegian King Harald Sigurdsson in 1046 CE (Heinrichsen, 1968:158-60). The remains of burnt Viking-Age houses excavated in the centre of Aarhus may bear traces of such dramatic events (Andersen et al., 1971; Bitsch, 2010b).

This paper examines a burned pit house located at Bispetorv (FHM 5124 Bispetorvet, the bishop square) in the heart of Aarhus, dating to the late 10th or early 11th century CE. Based on the current geography, the site was located perhaps 75 m north of the river Aarhus, along which it is expected that the harbour of Aarhus was located. The objective of the paper is getting a better understanding of the house and its inhabitants, their resource exploitation and to assess to what extent the inhabitants were involved in interregional trade networks (interregional: beyond the local region, i.e. beyond Aarhus' hinterland). This will be accomplished through zooarchaeological, macrobotanical, and charcoal analyses, given the substantial quantities of these materials found within the structure, supported by cereal isotope analysis and radiocarbon dating. Although the analyses took place years after the excavation, grid sampling, block sample collection, and the *in situ* discovery of a carbonised object during the excavation as well as the abundance of find material stored in the museum archives and the meticulous excavation of a large block sample enabled a high-resolution approach. The findings will be contextualised within the broader framework of zooarchaeological and macrobotanical data and new ^{14}C dates from the contemporary Viking-Age sites of Søndervold (FHM 1393), Skt. Clemens Stræde 10 (FHM 4573) and the rural site of Egå Gymnasium (FHM 4588) (Fig. 2). Søndervold and Skt. Clemens Stræde 10 are selected because they are the only other sites within the rampart of Aarhus for which substantial zooarchaeological and archaeobotanical data sets are available. Egå Gymnasium has been selected because it is the only rural site in the immediate hinterland of Aarhus from which relevant bioarchaeological, particularly zooarchaeological data, are available. Søndervold, situated 50 m west of Bispetorv, was excavated in 1963–1964 and revealed a burned pit house from the late 10th century (house CME) among earlier pit houses and traces of ramparts (Andersen et al., 1971; Klindt-Jensen and Andersen, 1964). Skt. Clemens Stræde, situated 200 m west of Bispetorv, was excavated in 2005 and revealed two pit houses and a later post-built, three-aisled longhouse inhabited during the 9th and 10th centuries (Bitsch, 2010a; Linaa, 2024; new data in this paper concern the post-built house). Egå, located 5 km north of Aarhus, revealed a 10th/11th century rural settlement with pit houses (Skriver, 2005; Linaa 2024). The sites in and nearby Aarhus will be presented within the framework of other nearby northern European Viking-Age towns, with a focus on bioarchaeological remains.

1.1. The site of Bispetorv

The excavation of Bispetorv (7 × 35 m^2) was carried out by Moesgaard Museum during 2009–2010 (Bitsch, 2010b). The oldest features included ca. eight pit houses and various other features, all dating to the Viking Age (Fig. 3a, ESM A:Fig. 1). Medieval and later structures that were detected are not discussed further here.

The main structure investigated in this study is the relatively well-preserved Viking-Age pit house A334 measuring 12.6 m^2 (Fig. 3b, ESM A:Figs. 2 and 3). Along three walls there were earthen wall benches reaching a height of ≥15–20 cm and covered with planks. In the southeast corner, a fireplace was present in a recess in the wall above a bench. The northern part of the house had suffered fire damage, evidenced by a 20 cm-thick layer of carbonised material. A much thinner carbonised layer was also observed in the southern part of the house. In the northwest, a carbonised plank wall supported by posts remained

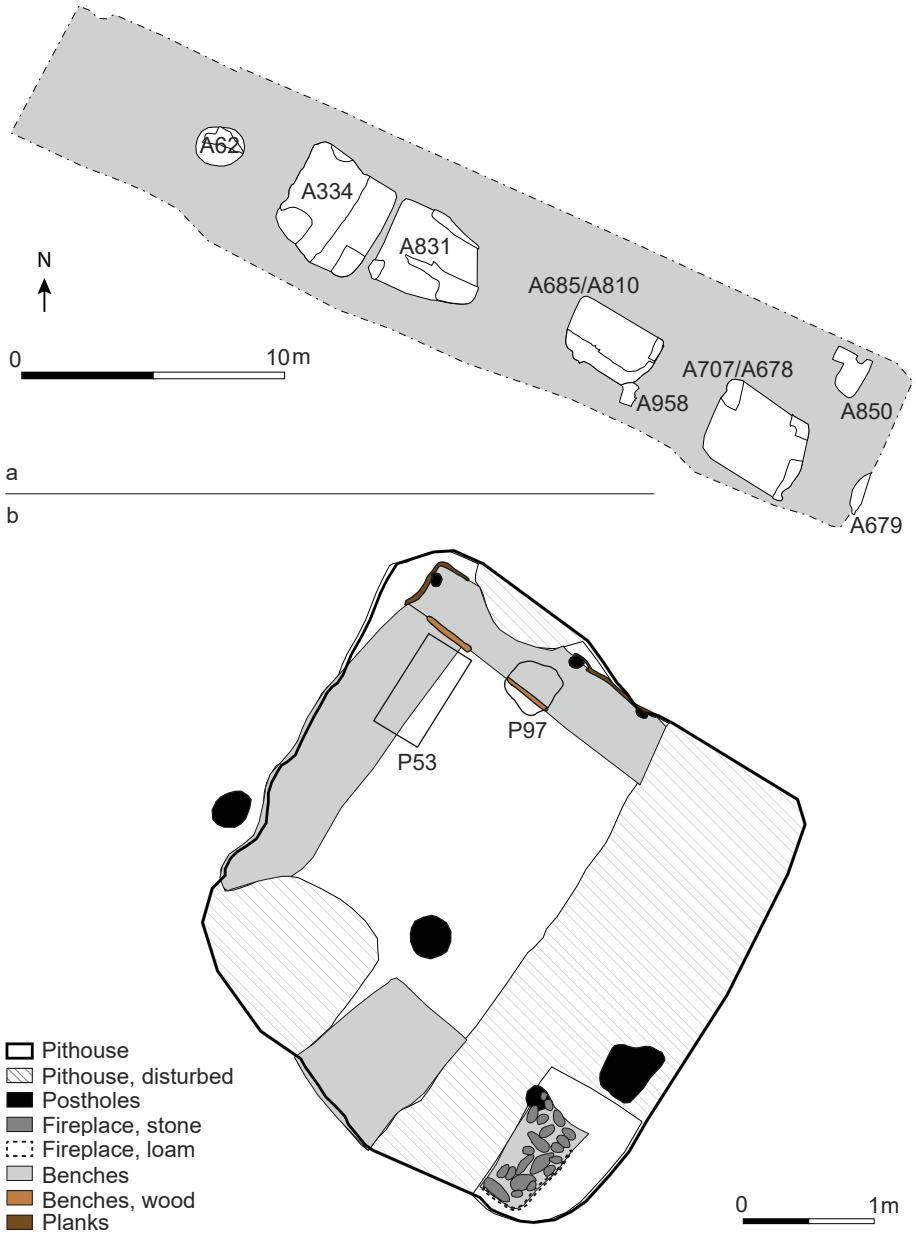

Fig. 3. Bispetorv (FHM 5124), a) pit houses and possible pit houses b) pit house A334, measuring 12.6 m^2 of which 7.5 m^2 was undisturbed. Figure: Moesgaard.

intact. Study of the stratigraphy during excavation suggested that the house was filled with refuse during or soon after the fire incident (Bitsch, 2010b).

The main contexts at Bispetorv investigated in the study are as follows:

- Features and objects associated with the use phase of house A334, including floor layers (A668-A670, A886), a fireplace (A825), the surface layer on top of the benches along the walls (A672-675), and carbonised object P97 (X2264, A858) from a bench.
- Burned layers A813 and A736 in A334 associated with the fire. A813 was found in the northern part of the house and described as the lower part of burned layer A736.
- Samples and objects from the backfill (A616, A665, A666, and A667) in house A334, expected to postdate the use phase of the house, but also containing carbonised construction wood from the house itself (ESM A:Figs. 3 and 4).
- Samples from other Viking-Age houses and features at Bispetorv including samples from activity layers, possible floor layers, and/or backfill from four pit houses (A685/A810, A831/A497, A850, and A958) and two unspecified house structures (A59 and A663), a sample from an oven (A833), and a sample from a burned layer from a pit (A841 in A822) (ESM A:Fig. 1).

1.2. Landscape and vegetation

Viking-Age Aarhus was located on the coast of eastern Jutland at a point where north–south transport routes crossed the Aarhus River. Eastern Jutland is characterised by a moraine landscape, consisting of elevated plateaus intersected by east–west oriented tunnel valleys (Fig. 4). The clayey and sandy soils are relatively nutrient-rich. The current mean summer temperature is ca. 17 °C and the annual precipitation ca. 550 mm. The modern-day potential natural climax vegetation consists of beech/hornbeam-, birch/poplar- and oak/elm/ash/linden-dominated woodland (*Fagus sylvatica/Carpinus betulus*, *Betula* sp./*Populus* sp. and *Quercus* sp./*Ulmus* sp./*Fraxinus excelsior/Tilia* sp.; Pedersen and Hansen, 1998; Påhlsson, 1994).

Sources about the former vegetation around Aarhus are limited.

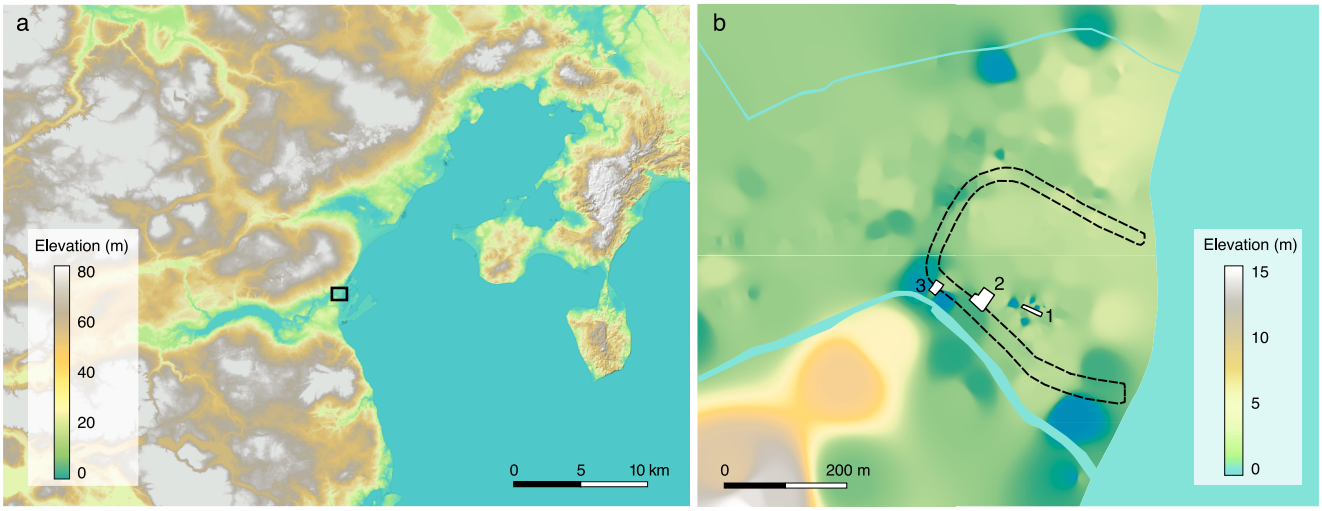

Fig. 4. Height maps as an indication for the Viking-Age landscape, a) Aarhus, larger region, digital terrain model (present-day surface). The location of figure b is indicated in black. b) Aarhus, city centre, digital elevation map based on an interpolation of subsurface levels derived from archaeological excavations; 1) Bispetorv (FHM 5124), 2) Aarhus Søndervold (FHM 1393) and 3) Skt. Clemens Stræde 10 (FHM 4573). Dashed line in figure b: Viking-Age rampart. The water body southwest of Aarhus is called Braband fjord. For the Viking Age, it is not completely clear to what extent it was a lake or a fjord, i.e. to what extent marine influxes occurred.

There are no written sources from the Viking Age that deal with the woodland cover and composition. Archaeological evidence and information based on place names suggests that the landscape was partially open and consisting of agricultural land from the Iron Age onwards (Linaa, 2016:30).

Regional pollen analysis from an area 25 km southwest of Aarhus suggests a replacement of oak, birch and hazel with beech and open grassland taking place before and during the Viking Age, with a gradual decline of oak from ca. 500 CE onwards, an increase of beech from ca. 800 CE onwards and substantial deforestation taking place shortly after 1000 CE (Søe et al., 2017). Pollen data from culture layers and the rampart in Aarhus tentatively support the presence of beech, oak, hazel (*Corylus avellana*), birch, alder (*Alnus* sp.), and potentially linden, elm, ash, hawthorn (*Crataegus* sp.), poplar and willow (*Salix* sp.) in the region (Jørgensen, 1971). Alder, willow and poplar may have grown along the river.

Although wood was used on a large scale in the Viking Age, early written sources postdating the Viking Age indicate that woodland was still available around Aarhus at that time. One source, dating to ca. 1315 CE, mentions the presence of various patches of woodland around Aarhus, used for fuel collection and pig herding, suggesting oak and/or beech, as well as fruit orchards, while another source dating to 1395 mentions the woodland that is still present north of Aarhus (Huebertz 1845; Rasmussen, 1992).

The woodlands offered not only plants but also animal resources. Additional ecotopes that offered food and many other kinds of materials were fields, meadows, and wetlands such as the river, Brabrand fjord 10 km west of Aarhus, and the sea (Fig. 4a).

2. Materials and methods

Radiocarbon age determination, Bispetorv, Søndervold and Skt. Clemens Stræde: The radiocarbon dating (ESM B) included ten samples of short-lived botanical remains collected from burned layers A813 and A736 and the backfill of pit house A334 at Bispetorv, ten samples from other houses and features at Bispetorv, four samples from pit house CME at Søndervold and three samples from an ashy activity layer (A324) in the post-built house at Skt. Clemens Stræde. Pretreatment and measurement of samples took place at Aarhus AMS Centre following standard laboratory protocols and procedures for reporting ^{14}C data (Olsen et al., 2017; Olsson, 1976; Philippsen et al., 2021; Stuiver and Polach, 1977).

Bispetorv, general: The majority of the sediment from Bispetorv was wet-sieved with 5 and 3 mm sieves. Burned layer A813 and parts of burned layer A736 were subjected to grid sampling (40 x 40 cm), subsequent flotation and sieving with 0.25 mm sieves. The original volume of the grid samples is unknown. Two grid squares, P84 and P87, were collected as a block sample (P53) and excavated indoors (Stenner, 2020). Features are indicated with A-numbers and sample numbers with X- and P-numbers, of which P-numbers primarily represent archaeobotanical samples. Analyses focused on house A334, e.g. the house, floor, benches and burned layers. Material from the backfill, other features, houses and sites was included based on availability of material and resources.

Inorganic artefacts, Bispetorv: The analysed inorganic artefact from Bispetorv, pit house A334, originated from the floor layer (A285, A668, A669, A670, A671 and A886), the top of the benches (A672, A673, A674 and A675), from fireplace A825 and burned layers A813 and A736. The artefacts were examined macroscopically, classified per material category and divided into artefact types.

Zooarchaeology, Bispetorv: The zooarchaeological analysis of Bispetorv (ESM C) concerned 101 samples from six different Viking-Age structures: four pit houses (A334, A685/A810, A831/A497, and A958) and two additional house floors/activity layers (A59 and A663). The samples originated from layers associated with the use of the structures i.e., floors, activity layers, a fireplace, and for A334, also layers associated with the burning of the house. Besides data from Bispetorv, unpublished zooarchaeological data from Skt. Clemens Stræde 10 and the rural site Egå are presented (Kveiborg, 2005; Ritchie, 2019). All zooarchaeological samples used in the study were wet-sieved. Most samples were collected from the 5 and 3 mm sieves, while a minor part from Bispetorv was collected from the 2 mm fraction of the heavy residue of archaeobotanical (P-) samples. The faunal remains were quantified using the number of identified specimens (NISP).

Macrobotanical analysis, Bispetorv and Skt. Clemens Stræde: The macrobotanical analysis from Bispetorv (ESM D) included 14 systematically collected grid samples and three additional samples from burned layers A813 and A736 in house A334, three samples from block P53 from burned layer A813, as well as a targeted sample from a burned layer in pit A822. The analysis from Skt. Clemens Stræde (ESM D) concerned one sample collected from the eastern part of an ashy activity layer (A324) in the post-built house. All samples were floated using a 0.25 mm sieve. When possible, a minimum of 500 plant remains was analysed per sample. In 14 samples from A813 and A736, dominated by relatively large amounts of botanical macroremains, subsamples were analysed.

Isotope analysis, Bispetorv: For the isotope analysis of house A334 at Bispetorv, nineteen rye grains from samples P57 and P85 from burned layers A736 and A813, respectively, were successfully subjected to isotope analysis of $\delta^{13}C$ and $\delta^{15}N$ within a framework of a larger study on cereal supplies of towns in present-day Denmark and Norway (Hammers, 2019; ESM E).

Charcoal analysis, Bispetorv: The charcoal analysis of Bispetorv (ESM F) included 31 samples from construction wood, the use phase of the houses (primarily burned layers A813 and A736) and the backfill from pit house A334, all material > 4 mm from block P53 from house A334, as well as 10 samples from four other pit houses (A685/A810, A831/A497, A850, and A958), two additional house floors/activity layers (A59 and A633), an oven (A833) and an ash layer in pit A822. Regarding the floated samples from the burned layers A813 and A736, 50 fragments > 2 mm per sample were analysed when possible. The construction wood and material from block P53, which was all handpicked, was ca. > 4 mm. The remaining samples were collected from the 5 mm sieve and/or handpicked. Carbonised object P97 was subjected to minimally destructive sampling only.

Phytolith analysis, Bispetorv: The phytoliths analysis was restricted to identification of the dominant morphotype in one sample from block P53. The phytolith nomenclature follows the International Code for Phytolith Nomenclature v. 2.0 (ICPT).

3. Results

3.1. Radiocarbon dates

The radiocarbon dates indicate that the use phase of house A334 ceased at around the late 10th to early 11th century (ESM B, including ESM B:Tables a-c). Comparison of dates from burned layers A813, A736 and the backfill show that the duration of the house modelled as all dates in one single phase can be narrowed down to a maximum of 50–100 years. The other pit houses at Bispetorv for which more than one date are available date to the late 9th /early 10th century (A685/810) and more widely to the 9th and 10th centuries (A831/497). The modelled end date for pit house A334 aligns well with the finds of two cross coins minted by Harald Bluetooth in Haithabu in 980 in burned layers A813 and A736 (see 3.2), since these offer a post-quem date for the fire that destroyed the house (cf. Moesgaard, 2011; Moesgaard and Hilberg, 2010).

Burned pit house CME at Søndervold dates to the late 10th century, showing that this house may be contemporary to house A334 at Bispetorv. Two of the three radiocarbon samples from Skt. Clemens Stræde date to the 10th century, while one sample suggests a late 9th century age. These samples are based on three cereal grains from a single botanical sample from a single feature. Importantly, the houses at Skt. Clemens Stræde were covered by the rampart, which is suggested to have been constructed between 920–940 (Skov, 2008), implying that the post-built at Skt. Clemens Stræde house must pre-date pit houses A334 at Bispetorv and CME at Søndervold.

3.2. Inorganic artefacts

The floor layers and benches of house A334, along with burned layers A813 and A736, contained 104 artefacts (Table 1, Bitsch, 2010b). Among these were common household items like two sun-dried loom weights and 28 sherds of locally crafted pottery with a hemispherical shape and inverted rims. Additionally, there were artefacts of possible local origin such as a small piece of chain mail on the floor (Pind, 2012) as well as two plain axes and two chisels, likely used for carpentry, in the burned layer. Imported artefacts comprised two hones (whetstones) and a fragment of a quern stone, all originating from present-day Norway. Forty-eight glass beads could represent imports but may equally have been produced locally with imported material. While most of these artefacts were associated with routine household activities and equipment, the presence of an iron scale weight (28 g, ca. 2 x 2 cm) hints at the use of silver in trade and commerce. Furthermore, the discovery of the two cross coins minted by Harald Bluetooth in Haithabu in burned layers A736 and A813 (P53) indicate direct or indirect participation in long-distance trade.

Table 1
Bispetorv (FHM 5124), artefacts from pit house A334 per material category. The artefacts from the benches are presented together with those from the floor layer because of the limited number of artefacts in both categories (Callmer groups cf. Callmer, 1977).

Category	Sub-category/ material	Floor layer and benches A285, A672-675	Burned layer A813	Burned layer A736	Total
Beads		37		11	48
	Segmented turquoise beads (Callmer group E)			3	
	Monochrome wound beads, green (Callmer group A)	35		5	
	Monochrome wound beads, blue (Callmer group A)	3	1		
	Monochrome wound beads, yellow (Callmer group A)	1			
Ceramic sherds		13		15	28
	Local, body sherds	13		13	
	Local, inverted rim			2	
Coins	Harold Bluetooth long-cross sterling, Haithabu		1	1	2
Hones		1		1	2
Loom weights	Sundried	1		1	2
Metal finds		10		11	21
	Weight, circular, with cross			1	
	Axes			2	
	Chisels			2	
	Chainmail fragment, 4 × 5 cm	1			
	Iron mount			1	
	Nails	1		2	
	Copper thread	1			
	Metal fragments, not further identifiable	7		3	
	Iron mount	1			
Quernstone	Schist			1	1
Total		62	1	41	104

3.3. Zooarchaeology

The analysed faunal assemblage from Bispetorv includes 4970 bone fragments of which 37 % originate from pit house A334. 491 fragments (27 %) of the analysed remains from A334 are identified to family or a lower taxonomic level (i.e., genus/species). For details on the zooarchaeological analysis, see ESM C (including ESM C:Tables a-g).

Although mammal bone fragments dominate, fish represent 71 % of the identified specimens (Table 2). This apparently contradictory finding is a direct result of differential fragmentation and preservation of mammal and fish bones (ESM C). At least 14 species of fish have been

Table 2
Bispetorv (FHM 5124), Skt. Clemens Stræde 10 (FHM 4573), and Egå Gymnasium (FHM 4588), summary table of the identified faunal remains, based on this study, Ritchie (2019), and Kveiborg (2005; only sieved remains included). Quantification based on the number of fragments (n).

Site		Bispetorv			Skt. Clemens Stræde	Egå Gymnasium
Feature		A334	Other	Total	Total	Total
Scientific name	Common name					
Reptiles, total		**1**	–	**1**	–	–
Serpentes	Snakes, unspecified	1	–	1	–	–
Amphibians, total		**2**	–	**2**	**5**	**6**
Anura	Frogs, unspecified	2	–	2	5	6
Fish, total		**637**	**1697**	**2334**	**6349**	**6**
Cyprinidae	Carp fish	7	1	8	35	–
Esox lucius	Pike	9	–	9	–	–
Perca fluviatilis	Perch	3	–	3	45	–
Anguilla anguilla	Eel	18	1	19	14	–
Salmonidae	Salmon/trout/whitefish	1	1	2	18	–
Squalus acanthias	Dogfish	2	–	2	–	–
Belone belone	Garfish	4	1	5	9	–
Clupeidae, cf. *Clupea harengus*	Herring	33	1	34	376	–
Cottidae	Sculpins	1	–	1	–	–
Gadus morhua	Cod	12	43	55	121	–
Melanogrammus aeglefinus	Haddock	1	9	10	62	–
Gadidae	Cod fish	191	755	946	5095	–
Trachinus draco	Greater weaver	32	–	32	3	–
Eutrigla gurnardus	Grey gurnard	–	–	–	5	–
Triglidae	Gurnards	–	–	–	12	–
Limanda limanda	Dab	–	–	–	1	–
Platichthys flesus	Flounder	–	–	–	5	–
Pleuronectes platessa	Plaice	–	–	–	1	–
Pleuronectidae	Righteye flounders	26	26	52	538	–
Scomber scombrus	Atlantic mackerel	7	4	11	9	–
Pisces	Fish, unspecified	290	855	1145	–	6
Birds, total		**4**	**11**	**15**	**73**	**6**
Gallus domesticus	Domestic fowl	–	2	2	13	–
Anser anser cf. *domesticus*	Domestic geese	–	–	–	2	–
Anatidae	Geese, unspecified	–	–	–	1	–
Anatidae	Ducks/geese, unspecified	–	–	–	2	–
Corvus corone/C. frugilegus	Crow/rook	–	–	–	1	–
Columbidae	Pigeons	–	–	–	1	–
Pandion haliaetus	Osprey	–	–	–	1	–
Aves	Birds, unspecified	4	9	13	52	6
Mammals, total		**1133**	**1414**	**2547**	**4821**	**1303**
Talpa europaea	European mole	–	–	–	1	–
Sciurus vulgaris	Red squirrel	1	–	1	2	–
Rodentia	Rodents, unspecified	14	–	14	15	–
Canis familiaris	Dog	–	–	–	1	5
Canis familiaris/Vulpes vulpes	Dog/fox	1	–	1	–	–
Felis catus	Cat	4	–	4	12	–
Martes cf. *martes*	Pine marten	–	–	–	2	–
Carnivora	Carnivores, unspecified	2	–	2	–	–
Bos taurus	Domestic cattle	42	29	71	96	76
Capra hircus	Domestic goat	1	2	3	1	–
Ovis aries	Domestic sheep	–	1	1	10	–
Ovis aries/Capra hircus	Sheep/goat	11	34	45	114	50
Equus cf. *caballus*	Domestic horse	1	5	6	7	9
Sus cf. *domesticus*	Domestic pig	83	58	141	319	102
Mammalia	Mammals, unspecified	973	1285	2258	4241	1061
Homo sapiens	Human	–	–	–	2	2
Vertebrata	**Vertebrates, unspecified**	**64**	**7**	**71**	–	–
Total number of fragments (N)		**1841**	**3129**	**4970**	**11,250**	**1323**

identified in samples from A334 and include species from marine, fresh and brackish waters (Table 2). This indicates the exploitation of local water bodies both inland (fjord and river) and at sea. The focus on regional resources is further indicated by the lack of large size cod associated with long distance trade (Perdikaris, 1999). Regardless of the method used, gadids, especially Atlantic cod (*Gadus morhua*), dominate (ESM C). However, analysis of the sampling methods used suggests substantial differences in the proportion of the different fish taxa depending on the mesh size used for sieving, underestimating the overall importance of small-sized taxa such as greater weever (*Trachinus draco*), herring (cf. *Clupea harengus*), and eel (*Anguilla anguilla*) (ESM C).

Amongst the identified mammal bones and teeth, remains of domestic pig (*Sus domesticus*) represent 58 %. Bones of cattle (*Bos taurus*) are also frequent (30 %), whereas remains of other domesticates are less numerous (Table 2). Based on the identified taxa and bone elements (ESM C), the ontogenetic age of the domestic mammals and the presence of numerous butchery marks, the majority of the remains from A334 represents ordinary household waste. In addition, a few foot bones from squirrel (*Sciurus vulgaris*), cat (*Felis catus*), and other small-sized carnivorous mammals may represent evidence for small-scale processing of furs/pelts, just as a few bone chips may represent small-scale bone working activities. Birds were present but could not be identified beyond class.

Generally, the analysed remains from other Viking-Age structures at Bispetorv mirror the picture based on the remains from A334, with cod and pig being the most important taxa based on the number of identified

specimens (Table 2, Fig. 5).

3.4. Macrobotanical analysis

All macrobotanical remains from Bispetorv were preserved in a carbonised state. The assemblage from burned layer A813 is dominated by rye grains (*Secale cereale* ssp. *cereale*) and further contain oat grains (*Avena* sp.) including cultivated oat (*Avena sativa*), a small quantity of barley grains (*Hordeum vulgare*) including hulled barley (*Hordeum vulgare* var. *vulgare*), a flax seed (*Linum usitatissimum*) and a glume base of probable hulled wheat (*Triticum* cf. *monococcum* ssp. *monococcum/turgidum* ssp. *dicoccum/aestivum* ssp. *spelta*) (Table 3, ESM D:Table a). Rye grains from multiple samples had an unusual silvery appearance. Looking at the spatial distribution of the crops in the grid samples, a clear pattern can be observed (Fig. 6a). Most samples are strongly dominated by rye, but oats dominate in the southeastern part of house A334 (P82 and P150). Barley is mainly found in the northeast.

Burned layer A813 contains a wide range of arable weeds, which form a minor part of the assemblage (Fig. 6b) (weeds: cf. Hansen, 1993; here also explicitly found in a cereal concentration). Weeds that are dominant in the rye samples, which generally contain more arable weeds than the oat-dominated samples, are brome including probable rye brome (*Bromus* sp., *B.* cf. *secalinus*), corncockle (*Agrostemma githago*), seeds of the legume-family (Fabaceae) including hairy tare (*Vicia hirsuta*), grasses (Poaceae), black bindweed (*Fallopia convolvulus*), hemp nettle (*Galeopsis* sp.) and nipplewort (*Lapsana communis*). In the oat-dominated samples in the southeast corner (P82 and P150), the arable weeds include corncockle, grasses, brome, rye brome, dock (*Rumex* sp.), goosefoot and fat-hen (*Chenopodium* sp. and *Chenopodium album*), and ribwort plantain (*Plantago lanceolata*) (ESM D:Table a). A813 did not contain finds of probably collected nuts, fruits or berries.

The large quantity of carbonised cereal grains in A813 can be interpreted as grain storage, with rye, oats and hulled barley stored separately. The low quantities of chaff and weeds show that the crops were most likely cleaned prior to storage. The presence of concentrations of Elongate dendritic phytoliths in block P53 indicates that remains of glumes, paleas and/or lemmas, however, were present, which may have fallen apart during flotation. Rye brome and corncockle (which appears most frequently in the rye-dominated samples) have often been associated both historically and archaeologically with rye cultivation within the former boundaries of Denmark from Roman Iron Age and later times (Fredskild, 1971:307, 316; Hansen, 1993; Helbæk, 1977:28-29). Corncockle, moreover, is known as a Viking-Age winter crop weed (Hansen, 1993; Mikkelsen, 2006).

In burned layer A736 (Table 3, ESM D:Table a), rye, oats (including cultivated oats), and barley (including hulled barley) are again the most prominent crops. Rye and oats concentrate in the southern part of the investigated part of the layer (samples P69 and P74), while barley is mainly found in the southeast (P74 and P93). A few flax seeds were present (P69 and P74). While the overall taxonomic composition of burned layers A813 and A736 is similar, the cultivated and collected taxa in the grid samples of A736 (Fig. 6c) show larger taxonomic variation than those of A813 that are dominated by a single taxon. This indicates that the samples from A736 are more mixed than the samples in A813, suggesting that A736 was more disturbed during or after formation of the layers.

The weed assemblage from layer A736 is very similar to that of layer A813, with corncockle and brome/probable rye brome predominating.

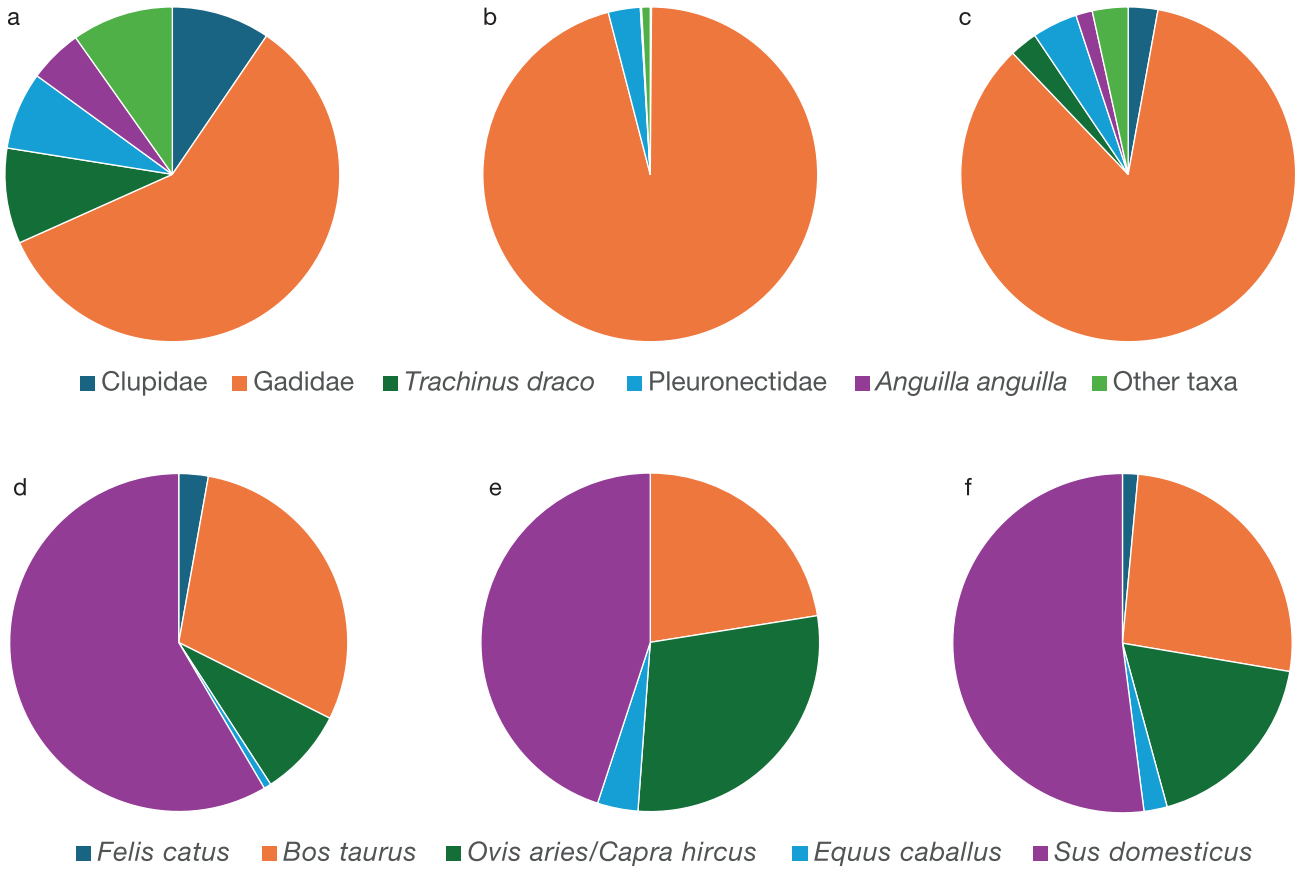

Fig. 5. Bispetorv (FHM 5124), the relative distribution of fish (upper part) and domestic mammals (lower part), a and d) pit house A334, b and e) other structures, and c and f) the total assemblage. Based on the number of identified specimens. Sample size: a) n = 347, b) n = 842, c) n = 1189, d) n = 142, e) n = 129, and f) n = 271.

Table 3
Bispetorv (FHM 5124) and Skt. Clemens Stræde (FHM 4573), summary of the macrobotanical data (see ESM D:Tables a, b for the complete data set). The number of seed/fruit fragments has been converted to whole numbers with a factor of 3:1, so that three seed/fruit fragments are counted as one complete seed/fruit.

Site		Bispetorv			Skt. Clemens Stræde
Feature		A813	A736	A841	A324
N samples		13	4	1	1
Scientific name	Common name				
Cultivated/collected plants					
Avena sativa (basal parts of florets)	Common oat (basal parts of florets)	2319	184	–	2
Avena sativa (grains with basal parts of florets)	Common oat (grains with basal parts of florets)	3129	154	–	2
Avena sp.	Oat	17,217	1527	3	123
Avena sp. (awns)	Oat (awns)	–	–	–	–
Avena sp. (lemmas)	Oat (lemmas)	–	14	–	–
Cf. *Avena* sp.	Probable oat	1075	140	–	4
Cf. *Avena* sp. (lemmas)	Probable oat (lemmas)	2	–	–	–
Cerealia indet.	Unidentified grain	14,025	698	18	38
Cerealia indet. (with sprout groove)	Unidentified grain (with sprout groove)	–	–	1	–
Cerealia indet.	Unidentified sprouts	–	–	1	–
Corylus avellana (nut shells)	Hazel (nut shells)	–	6	2	–
Hordeum vulgare var. *vulgare*	Hulled, six-rowed barley	90	98	17	26
Hordeum vulgare cf. var. *vulgare*	Barley – probable hulled, six-rowed	2	77	8	7
Hordeum vulgare	Barley	643	641	17	44
Cf. *Hordeum vulgare*	Probable barley	167	8	–	–
Cf. *Hordeum vulgare*	Probable barley (rachis segments)	–	5	–	–
Hordeum vulgare	Barley (with sprout/sprout groove)	–	24	–	1
Hordeum vulgare	Barley (rachis segments)	2	–	–	6
Hordeum sp./*Secale* sp.	Barley/rye	–	–	–	2
Linum usitatissimum	Flax	1	99	–	1
Cf. *Linum usitatissimum*	Probable flax	–	3	–	–
Prunus spinosa	Sloe (fruit stones)	–	3	–	–
Rubus idaeus	Raspberry	–	1	–	–
Secale cereale ssp. *cereale*	Rye	361,104	4843	2	9
Secale cereale ssp. *cereale* (with sprout)	Rye (with sprout)	290	–	–	–
Secale cereale ssp. *cereale* (rachis segments)	Rye (rachis segments)	32	–	–	–
Cf. *Secale cereale* ssp. *cereale*	Probable rye	9089	415	1	5
Triticum aestivum ssp. *aestivum*/ *Triticum turgidum* ssp. *durum*	Bread wheat/ hard wheat	–	–	–	5
Cf. *Triticum monococcum*/ *dicoccum*/*spelta* (glume bases)	Probable einkorn/ emmer/spelt (glume bases)	32	–	–	–
Other plants					
Agrostemma githago	Corncockle	17,548	161	–	–
Cf. *Agrostemma githago*	Probable corncockle	131	34	–	–
Amaranthaceae/ Caryophyllaceae	Amaranth family/ Carnation family	–	–	–	19
Apiaceae	Celery family	281	–	–	1
Asteraceae	Aster family	16	–	–	–
Brassica sp.	Cabbage	475	2	–	–
Bromus cf. *secalinus*	Probable rye brome	36,635	219	–	4
Bromus sp.	Brome	3095	86	–	1
Cf. *Bromus* sp.	Probable brome	3337	4	–	–
Caryophyllaceae	Carantion family	3	1	–	–
Centaurea sp.	Knapweed	19	–	–	–
Chenopodium album	Fat-hen	37	11	7	29
Chenopodium cf. *album*	Probable fat-hen	–	–	–	13
Chenopodium sp.	Goosefoot	86	3	3	12
Chenopodium sp. (mineralized)	Goosefoot	–	–	–	1
Carduus sp./*Cirsium* sp.	Thistle	35	–	–	–
Cf. *Cirsium* sp.	Probable thistle	13	–	–	–
Cyperaceae	Sedge family	–	–	–	1
Euphrasia sp./ *Odontites* sp.	Eyebright /Bartsia	40	–	–	–
Fabaceae	Legume family	779	19	1	1
Cf. Fabaceae	Probable legume family	200	–	–	–
Cf. *Fagus* sp.	Probable beech	26	–	–	–
Fallopia convolvulus	Black bindweed	534	17	–	2
Cf. *Fallopia convolvulus*	Probable black bindweed	27	–	–	–
Galeopsis sp.	Hemp-nettle	423	23	1	1
Galium sp.	Bedstraw	1	2	–	3
Lamiaceae	Sage family	36	–	–	–
Cf. Lamiaceae	Probable sage family	16	–	–	–
Lapsana communis	Nipplewort	941	–	–	–
Lithospermum arvense	Common gromwell	2	–	–	1
Lotus sp./*Trifolium* sp.	Bird'sfoot-trefoil/clover	36	–	–	–
Papaver cf. *rhoeas*	Probable field poppy	1	–	–	–
Persicaria lapathifolia/ *maculosa*	Pale persicaria / redshank	296	23	8	7
Cf. *Persicaria lapathifolia*/ *maculosa*	Probable pale persicaria /redshank	100	–	–	–
Pimpinella sp.	Burnet-saxifrage	189	–	–	–
Cf. *Pimpinella* sp.	Probable burnet-saxifrage	52	–	–	–

(*continued on next page*)

Table 3 (*continued*)

Site		Bispetorv			Skt. Clemens Stræde
Feature		A813	A736	A841	A324
N samples		13	4	1	1
Scientific name	Common name				
Plantago lanceolata	Ribwort plantain	13	–	–	–
Plantago cf. *lanceolata*	Probable ribwort plantain	3	–	–	–
Plantago sp.	Plantain	–	–	–	1
Poaceae	Grass family	755	31	2	13
Cf. Poaceae	Probable grass family	–	–	–	–
Polygonum aviculare	Knotgrass	26	1	–	1
Cf. *Polygonum aviculare*	Probable knotgrass	–	1	–	–
Polygonaceae	Knotweed family	1	–	–	–
Prunella vulgaris	Selfheal	2	–	–	–
Raphanus raphanistrum	Wild radish (fruits, lower segment)	–	1	–	–
Rumex acetosella	Sheep's sorrel	58	1	–	–
Rumex sp.	Dock	359	7	–	–
Silene sp.	Campion	51	–	–	–
Solanum sp.	Nightshade	–	–	1	–
Spergula arvensis	Corn spurrey	6	16	–	2
Cf. *Spergula arvensis*	Probable corn spurrey	1	–	–	–
Stellaria media	Chickweed	32	–	–	1
Stellaria cf. *media*	Probable chickweed	6	–	–	–
Stellaria sp.	Chickweed	14	1	–	11
Thlaspi arvense	Field pennycress	1	–	–	–
Cf. *Trifolium* sp.	Probable clover	13	–	–	1
Tripleurospermum inodorum	Scentless camomile	16	–	–	–
Cf. *Tripleurospermum inodorum*	Probable scentless camomile	16	–	–	–
Vicia hirsuta	Hairy tare	2278	57	–	–
Vicia hirsuta	Hairy tare (fruits)	20	–	–	–
Cf. *Vicia hirsuta*	Probable hairy tare (fruits)	1	–	–	–
Indeterminatae	Unidentified seeds/fruits	1383	13	–	12

Likely collected species are represented by a few remains of hazelnut (*Corylus avellana*), sloe (*Prunus spinosa*) and raspberry (*Rubus idaeus*) (Table 3, ESM D:Table a, Fig. 6c, Fig. 6d).

The crop assemblage from burned layer A841 in pit A822 consists of barley (including hulled barley), oats and rye (Table 3; ESM D:Table a; ESM D:Fig. 1). Potential arable weeds include a selection of those taxa attested in house A334 as well as nightshade (*Solanum* sp.) Collected wild plants include hazelnut.

The crop assemblage from the post-built house at Skt. Clemens Stræde consists of oats (including cultivated oats), barley (including hulled barley), rye, bread/durum wheat (*Triticum aestivum* ssp. *aestivum*/*Triticum turgidum* ssp. *durum*) and flax. The potential arable weeds include a wide range of taxa, mostly the same taxa as found at Bispetorv, though with a slightly higher occurrence of fat-hen (Table 3; ESM D: Table b; ESM D:Fig. 2). Most remains are preserved in a carbonised state, while a few weeds are mineralized.

3.5. Isotope analysis

The rye has a mean $\delta^{13}C$ value of –22.4 ‰, with a minimum of –23.8 ‰ and a maximum of –20.9 ‰. The carbon isotope values have a standard deviation of 0.7 ‰. The $\delta^{15}N$ values range from 2.0 ‰ to 12.3 ‰, with a mean value of 7.1 ‰ and a standard deviation of 2.0 ‰ (for further details see ESM E). The range of both the $\delta^{13}C$ and $\delta^{15}N$ do not give uniform information as to whether the analysed grains originate from a single field. Since experimental studies indicate that $\delta^{15}N$ values of 3 ‰ and higher are to be expected in crops that have been grown on manured fields (Bogaard et al., 2007; Fraser et al., 2011; Kanstrup et al., 2012; Szpak, 2014), the $\delta^{15}N$ values from Bispetorv of all but one cereal grain suggest medium to intensive manuring of rye.

3.6. Charcoal analysis

The charcoal samples from house A334 (n_{id} = 2083, 1.3 kg) contain charcoal of poplar (42 %), oak (40 %), hazel (6 %), beech (3 %), birch (3 %), ash (3 %), and small quantities of alder, willow, linden, maple (*Acer* sp.), apple subfamily (Maloideae) and cherry/plum/sloe (*Prunus* sp.) (ESM F, ESM F: Tables a and b).

The construction wood consists of six oak planks, representing heartwood from trunks (ESM F:Fig. 1). The eleven grid samples (n_{id} = 500, 135.7 g) from burned layer A813 contain much poplar (50 %) and oak (25 %) and a variety of other taxa besides (Fig. 7a). Block P53 ($n_{id\ wood\ taxa}$ = 1104, 836.1 g) that also contains layer A813 strongly mirrors this composition, dominated by poplar (51 %), oak (39 %) and ash (3 %) (ESM F: Table c). The samples from burned layer A736 (n_{id} = 200) mirror the general composition of the samples from A813 as well (Fig. 7b), particularly the samples of A736 that come from the north-western part of the house. The nine fill samples (n_{id} = 223, 329.4 g) stand out because they are dominated by oak (60 %) and contain relatively many beech (19 %) and hazel (14 %) fragments, but hardly any poplar (Fig. 7c), suggesting that it represents a separate layer resulting from different deposition processes. Feature A391 from next to a wall may represent construction wood.

The ten samples from other features at Bispetorv (n_{id} = 255, 44.4 g), although only representing a small quantity, differ substantially from house A334. In these samples, beech (43 %), hazel (26 %) and apple subfamily (14 %) are dominant, while oak and poplar together represent only 10 %. Part of this material may represent remains of wooden floors.

Block P53 allowed application of a high-resolution approach. Similar to the cereal grains, part of the charcoal had a silvery shine. The regular presence of impressions of cereals and weeds in the oak and poplar charcoal point also to very unusual carbonization conditions.

The oak wood from P53 includes many approximately radially-oriented plank fragments, partially laying in parallel (Fig. 8). Single and double thin radial strips of ash, in one case bound together with linden bark, were found perpendicular to these oak planks (ESM F: Fig. 4). Although not confirmed by grooves made with tools such as a cooper's croze, the oak wood's radial orientation and ash bands suggests that it may represent a stave-built vessel, held together or decorated with ash (cf. Morris, 2000:2280–2282).

The poplar remains are also clearly worked, forming a gently curved, larger wood fragment of at least 50 cm length or height. It may be fragments of a hollowed roundwood vessel that could have been complemented with a separate base (cf. Morris, 2000:2280–2282), possibly used for cereal storage. Alternatively, it could concern a trough or furniture. For further details see ESM F.

Various poplar fragments show the presence of fungal hyphae and insect galleries, indicating that the objects had been in use for a while. Some of the poplar fragments from other samples have a similar shape and thickness, and thus likely had the same function as the finds from P53.

While the charcoal from house A334 on the one hand shows the use of a wide range of taxa, it also shows selective use of taxa for specific

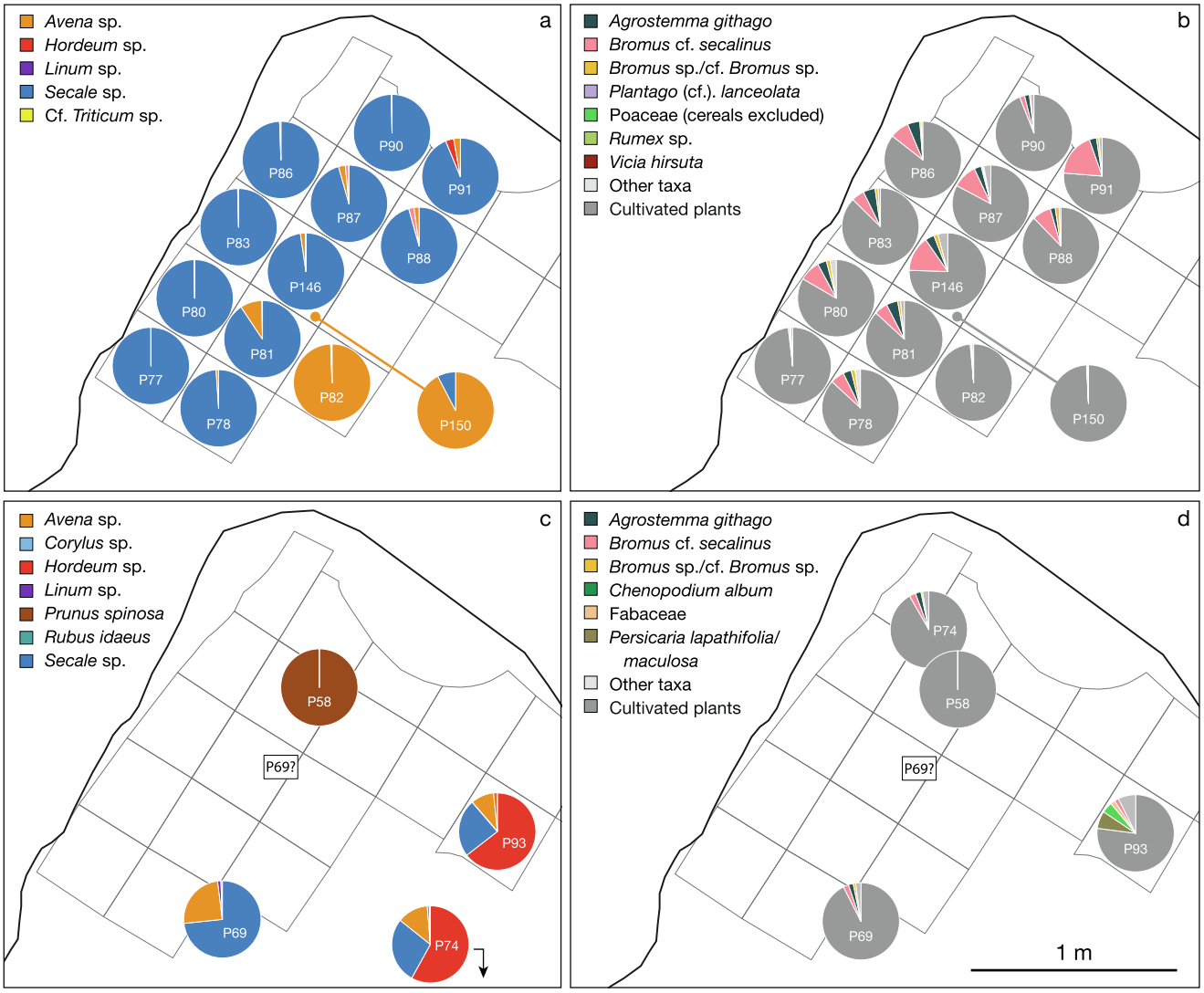

Fig. 6. Bispetorv (FHM 5124) a) burned layer A813, the distribution of cultivated plant taxa in the analysed samples. Note: the sample size per pie chart differs, range 1,214–135,348; b) burned layer A813, the distribution of cultivated versus other plant taxa in the analysed samples, with the three or (in the case of equal numbers) the four most common wild taxa singled out. Range of the sample size = 1,238–166,470; c) burned layer A736, the distribution of cultivated and collected plant taxa in the analysed samples. Range of the sample size = 3–6,651; d) burned layer A736, the distribution of cultivated and collected versus other plant taxa in the analysed samples; with the three or (in the case of equal numbers) the four most common wild taxa singled out. Range of the sample size = 3–7,721. The position of P69 is uncertain since two collected samples had the same number. P74: for precise location, see Fig. 7b. Figs. a-d: See ESM D:Table a for raw data. The number of fragments in corresponding tables have been converted to whole numbers from a factor of 3:1 in the charts, so that three seed/fruit fragments are counted as one complete seed/fruit. Chaff remains are not included in the charts unless only chaff is present; probable ("cf.") determinations have been included. *Hordeum* sp. = *Hordeum vulgare*, *Linum* sp. = *Linum usitatissimum*, Secale sp. = *Secale cereale* ssp. *cereale*, *Triticum d./m./s.* = *Triticum turgidum* ssp. *dicoccum*/*Triticum monococcum* ssp. *monococcum*/*Triticum aestivum* ssp. *spelta*, *Corylus* sp. = *Corylus avellana*, *Plantago* (cf.) *lanceolata* = *P. lanceolata* and *P.* cf. *lanceolata*. Taxa that are not visible in the pie charts are present in small quantities (see tables).

purposes: use of strong and durable oak wood for the construction wood, use of willow and hazel withies for the basket and use of poplar for containers. Poplar wood is soft, easy to split and has an even structure, which makes it easy to work (Taylor, 1981; Westphal, 2006). The predominance of other taxa in the houses other than A334 probably indicates that house A334 only reveals a narrow range of furniture, artefacts and activities from Viking-Age Aarhus.

3.7. Basket P97/X2264

Carbonised object P97 (X2264) (Fig. 9a), found on one of the wall benches in the northern part of the house (Fig. 3b), is interpreted as a round, large-sized, loose basket. The basket was placed on top of a linden board, which may represent a bench fragment (see Fig. 3a), a shallow bowl or the bottom of the basket. Elements of both the basket and its woven elements are very well preserved. The basket's rim is formed of (at least) two wooden branches or splints that form a hoop, consisting of hazel and willow, one twisted around the other (Fig. 9b). The rim supports the whole basket by keeping the body weave tight and preserving the overall roundness of the object.

On the inner side of the basket and on the reversed one, the body weave of the basket could be recorded, revealing the use of the twinning technique (ESM F). On the reverse side the twinning shows a pattern with the wefts going once under the warp and twice above it (ratio 1:2). Also, the selvage, i.e. the element where the body weave joins the rim, is woven in simple twinning technique. There, the terminal warps are folded at a right angle towards the inner area of the vessel; they are tightened at the rim twinning and under the visible body weave

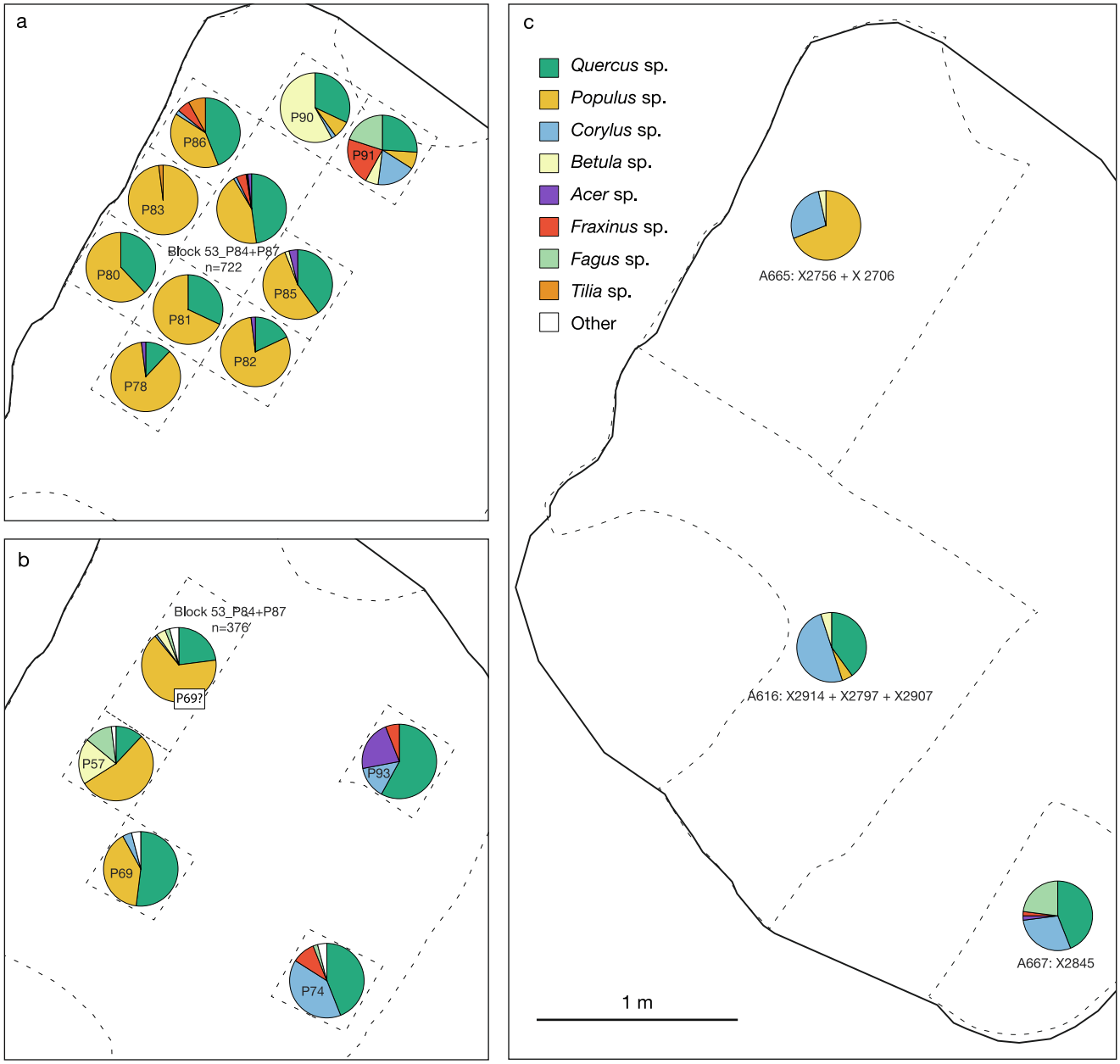

Fig. 7. Bispetorv, charcoal frequency in house A334, a) burned layer A813; b) burned layer A736; c) backfill layer (A616, A665 and A667). Based on charcoal fragments; see ESM F:Table b for the weight data. Fig. 7a, b: n_{id} per sample = 50 with exception of block 53. Fig. 7c: combination of multiple samples per feature, n_{id} per feature varies (20–100), see ESM F; samples with small sample sizes are not shown. The position of 69 is uncertain since two collected samples had the same number.

(Adovasio, 1977:36, Wendrich, 2012:315-216, Fig. 9, for further details see ESM F). The weaving technique of the rim as well as the fact that the basket was placed on top of a linden board suggest a basket of relatively large volume used for the transport or storage of heavier goods.

4. Discussion

4.1. Pit house A334: age, function and site formation processes

Pit house A334 in Viking-Age Aarhus, presumably constructed of oak (as was common elsewhere, Reilly et al., 2016) and utilised during the late 10th/early 11th century, suffered a significant fire sometime after ca. 980. Observations made during excavation indicate that the fire started in the north of the house, away from the hearth (Bitsch, 2010b:12). At Søndervold, 50 m to the west, a contemporaneous burned pit house was found. It can therefore be speculated that the two pit houses burned down during the same event, possibly caused by an attack on the town (see ESM B:Fig. 7). The coins and radiocarbon dates indicate that the fire occurred in the first decades of the 11th century at the latest, and thus did not result from the attack in 1046 CE described by Adam of Bremen (Heinrichsen, 1968:158-60).

The finds from pit house A334 are diverse and do not reveal a single function or profession, but instead a household where a variety of activities went on such as woodworking (based on finds of axes and a chisel), textile production (loom weights) and trade (coins and weight). The chain mail fragment could hint that the occupant of the house had or once had a military role. The zoological remains primarily represent ordinary household waste. Based on the context of a burned house and the presence of the large quantity of cereal grains interpreted as storage find, the material may possibly also represent stored food that got lost in

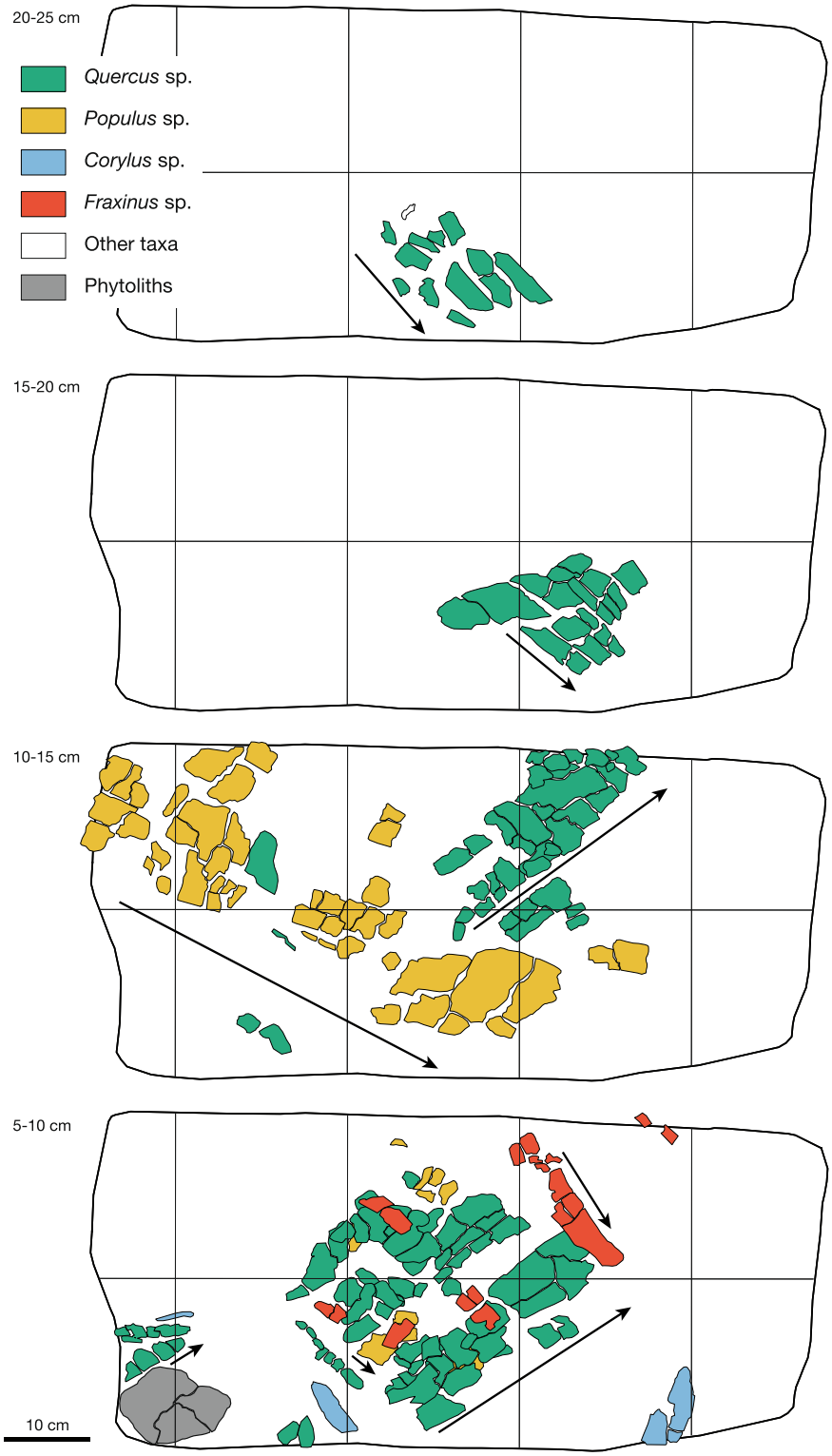

Fig. 8. Wood charcoal from block P53 ($n_{id\ wood\ taxa} = 1104$; 20–25 cm = top). See ESM F including ESM F:Table c for further details. The phytoliths represent cereal chaff. The arrows indicate the direction of the wood vessels in charcoal fragments, corresponding with the longitudinal direction of trees. The oak remains in the layers 15–20 cm probably formed part of the same plank(s), stave(s) and/or artefact as the oak remains in layer 20–25 cm, continuing from one layer into the next. Similarly, many of the oak remains in the layers 5–10 cm probably formed part of the same plank(s), stave(s) and/or artefact the oak wood in layer 10–15 cm.

the fire, but this cannot explicitly be demonstrated due to the burned and fragmented preservation state of the remains. Besides household waste and possibly stored food, the zoological remains also provide possible evidence of fur/pelt processing and small-scale bone working. Burned layer A813 probably represents cereal grain storage of manured winter rye, cultivated oats, and hulled barley, possibly stored in poplar containers, while at least one oak container and a basket were also present in the house. Remarkably, the inventory of pit house A334

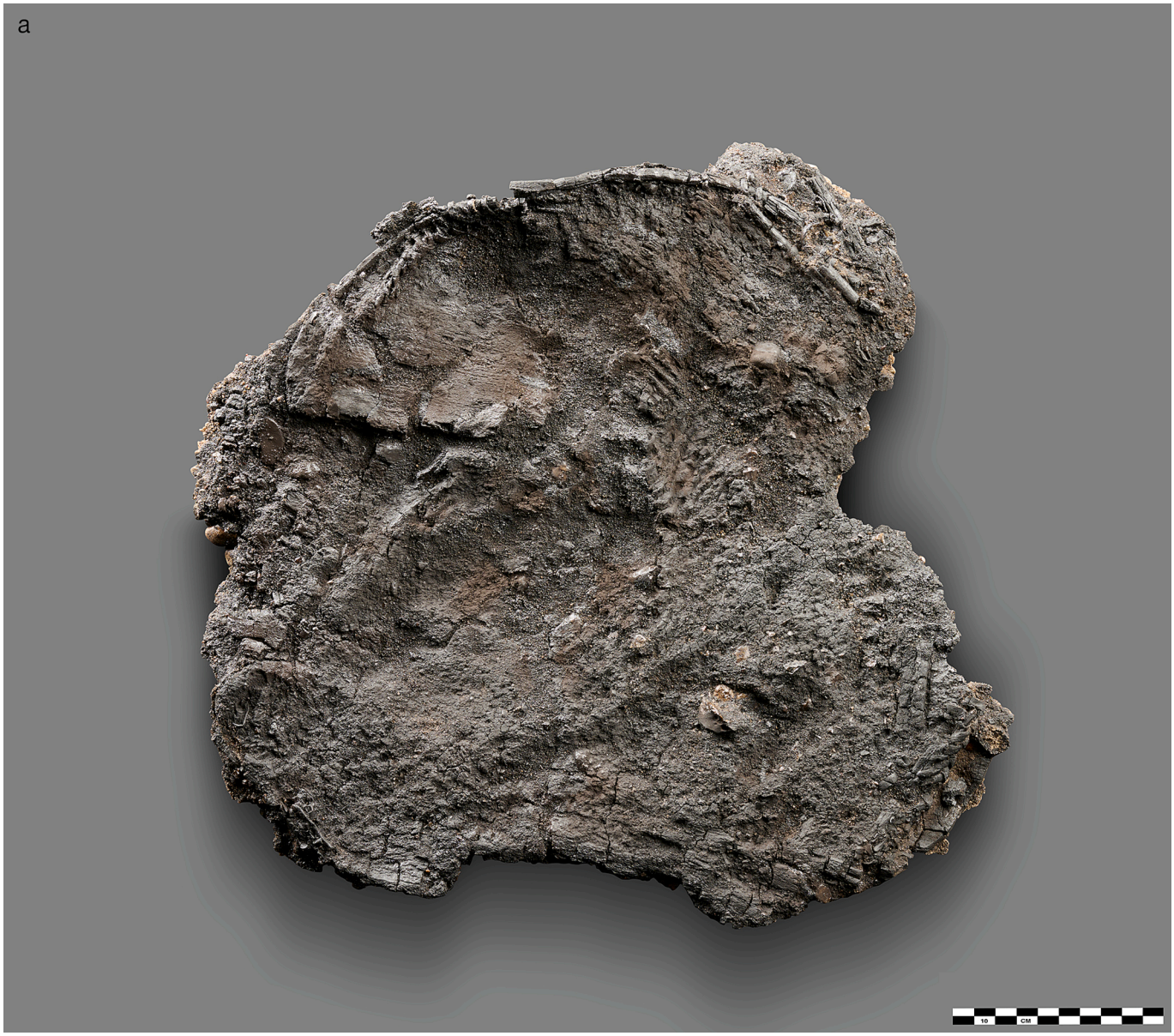

Fig. 9. Bispetorv (FHM 5124), carbonised object P97/X2264 interpreted as a basket. a) overview top. Rim visible at the top of the photograph b) detail of the basket's rim. Photos: Moesgaard.

strongly resembles that of house CME at Søndervold, which provided evidence of pottery, turned wooden vessels and a spoon, tools used for woodworking and textile production, as well as whetstones, horse gear including spurs and a stirrup fragment that could indicate an occupant's military role, a variety of metal tools, jewellery including bronze remains and glass beads, clothes, turned wooden vessels, an antler comb, small bone and antler tools, and burned cereals. Evidence of woodworking and textile production, as well as beads, iron nails, and fragments of, e.g., combs, grinding stones and whetstones were also found at Skt. Clemens Stræde (Andersen et al., 1971:124, 144, 210; Bitsch, 2010a).

The presence of large quantities of carbonised cereals and charcoal in layer A813 of house A334, along with the excellent preservation conditions indicated by the preservation of a basket, points to a burning temperature of 200–400 °C and probably towards the lower end of this range (Charles et al., 2015; Jacomet and Kreuz, 1999). The silvery appearance of both grains and charcoal as well as fruit impressions in the charcoal indicate a highly unusual formation process (Barfod et al., 2025). Both the radiocarbon dates, predominantly restricted chronologically, and the excellent preservation, confirm the observations in the field that the burned goods in the house became covered by the fill layer shortly after the fire disaster.

4.2. *Resource exploitation in and around Viking-Age Aarhus*

The faunal assemblage from Skt. Clemens Stræde is remarkably similar to that from Bispetorv, both concerning the range of taxa and proportions of identified taxa (Ritchie, 2019; Table 2). Like Bispetorv, the Skt. Clemens assemblage can be interpreted as household waste, with only minor evidence of workshop activities including small-scale processing of furs/pelt. The latter is indicated by the presence of a few bones from small-sized mammal species such as squirrel, cat, marten (*Martes* sp.), and mole *(Talpa europaea)*. As at Bispetorv, remains of fish (especially gadids) predominate (Table 2; Fig. 10a), just as the identified species and the moderate size of the cod indicate the exploitation of local fishing waters both inland and at sea (Ritchie, 2019). Furthermore, it is

Fig. 9. (*continued*).

striking that pigs make up more than 50 % of the identified specimens from domestic mammals at both sites, just as sheep and goats seem to have been of minor importance in Viking-Age Aarhus (Table 2; Fig. 10b).

The faunal assemblage from Søndervold, although including >100,000 bone fragments, cannot be included in the comparison because of the admixture of Viking-Age material with that of a later period and because all bone material was collected without sieving (Møhl, 1971). The latter methodological aspect generates representational differences with faunal assemblages from Bispetorv and Skt. Clemens Stræde, e.g., concerning the importance of herring and the size of cod.

At the rural site of Egå, pigs are, like at Bispetorv and Skt. Clemens Stræde, well-represented, making up 43 % of the wet-sieved identified mammal bones (Table 2, Fig. 10b). Similarly to Aarhus, the majority of the pig bones found at Egå were slaughtered at a young age, attesting that pig husbandry primarily served human consumption (Kveiborg, 2005). In contrast, cattle, of which the proportion is slightly higher at Egå than at Bispetorv and Skt. Clemens Stræde, were primarily used as draught animals or for milking and breeding rather than for human consumption. This is indicated by the fact that most of the cattle were slaughtered at subadult/adult age and that some of the adult animals were rather old, based on tooth wear analysis (Kveiborg, 2005). Also, the number of horse bones are slightly higher at Egå than in Aarhus. This tendency for a larger relative share of horse bones at rural sites in comparison to the urban centres is also known from other Viking-Age and Medieval sites (Gotfredsen, 2005; Kveiborg, 2022; Kveiborg and Jensen, 2021).

While analysis of worked zooarchaeological remains was not part of the analyses of Bispetorv, Skt. Clemens Stræde and Egå, earlier studies of worked zoological remains provide complementary information. ZooMS analysis of 34 bone and antler combs from Bispetorv, Søndervold and Store Torv (900–1000 CE, directly northwest of Bispetorv), dating to the 9th to 11th centuries, has shown the selective use of predominantly red deer as well as the presence of eight finished combs of reindeer antler imported from present-day western Norway (and/or Sweden) at Søndervold (Ashby et al., 2015). None of the 19 sampled comb remains from Bispetorv were made of reindeer (Ashby et al., 2015, unpublished information, pers. comm. A. Coutu, 2024). In addition to the combs from Søndervold, an excavation at Skt. Clemens Torv has yielded a pin of walrus ivory dating to ca. 1000 CE, presumably originating from Greenland or the Barents Sea (Skov, 1998:242-243).

The macrobotanical assemblage from Skt. Clemens Stræde ($n_{samples} = 1$) was similar to that of Bispetorv but contained a larger variety of crops (see below). Like at Bispetorv, the burned pit house CME at Søndervold ($n_{samples} = 11$, Fredskild, 1971) contained a concentration of carbonised grains of rye and hulled barley. Also at this site, cereal chaff was rarely observed, but ashy rye deposits are mentioned, possibly representing phytoliths from rye chaff. An additional crop found in this house is garden pea (*Pisum sativum*). Collected plants found at other Viking-Age structures at Søndervold ($n_{samples} = 13$) are hazelnut, blackberry (*Rubus fruticosus*) and raspberry. Comparing all three sites, hulled barley and rye, found on all sites, and oats, found at Bispetorv and Skt. Clemens Stræde, stand out as the dominant crops at the three sites. The importance of other cultivated and collected taxa in Aarhus, including bread/durum wheat, possible hulled wheat, flax, pea, hazelnut, sloe, blackberry and raspberry, is harder to ascertain. The weed assemblages are to a certain degree similar; several of the most prominent weeds are the same. Corncockle and rye brome, large weeds that are difficult to remove during crop cleaning, commonly occurred in rye-dominated samples at both Bispetorv and Søndervold. These results match the general trend in samples from elsewhere in Viking-Age Denmark (see 4.3). Collection and use of wild plants is also known

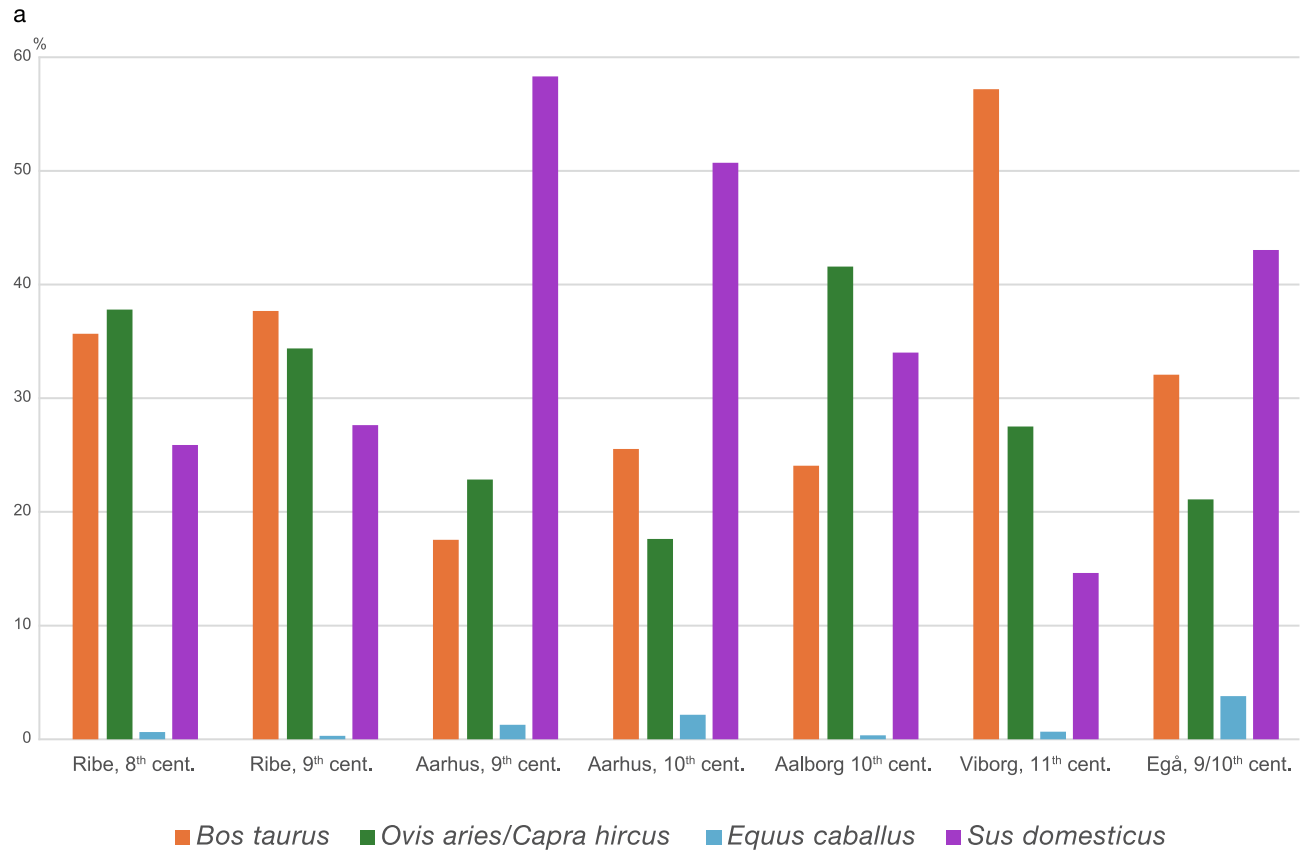

Fig. 10. Viking-Age sites in Jutland, the relative proportion of a) the main domestic taxa and b) fish at Ribe, Aarhus, Aalborg, Viborg and Egå based on NISP: the Number of Identified Specimens. Data: Ribe after Enghoff (2006b: table 1); Kveiborg (2022: table 11.4). Aarhus after Ritchie (2019) and this study. Aalborg (Algade 28) after Kveiborg and Jensen (2021: Fig. 145). Viborg after Enghoff (2005: table 3). Egå (sifted remains only) after Kveiborg (2005). Sample size fish Fig. 10a: Ribe 8th century: n = 2812, Ribe 9th century: n = 389, Aarhus 9th century: n = 6349, Aarhus 10th century: n = 1189, Aalborg: n = 1077, Viborg: n = 2876. Sample size domestic taxa Fig. 10b: Ribe 8th century: n = 5651, Ribe 9th century: n = 3633, Aarhus 9th century: n = 547, Aarhus 10th century: n = 267, Aalborg: n = 1467, Viborg: n = 745, Egå: n = 237.

from other Viking-Age sites (Out et al., 2025; Robinson, 2009).

The wood assemblages from Bispetorv, Søndervold and Skt. Clemens Stræde are difficult to compare since detailed analyses are only available for Bispetorv. Bispetorv shows the availability and use of a wide range of deciduous taxa. At Søndervold, large quantities of wood were used for infrastructure along the rampart. The planks are said to be made of oak (Vinther et al., 2017), but wood identifications are lacking. Other finds at Søndervold include ten wooden plates and vessels, some of beech and birch, and some with traces of turning (Andersen et al., 1971:242), as well as a concentration of linden bark in house CME (Fredskild, 1971). A few identifications from the site of Skt. Clemens Stræde that certainly date to the Viking Age include alder, birch and willow, while a larger variety of taxa were retrieved from the following centuries (Bitsch, 2010a; Mikkelsen, 2005). There is one more site, Snekkeeng, ca. 3.5 km from Aarhus, interpreted as a shipyard dating between 797–1266 CE (Madsen and Vinner 2005:95), for which 37 wood identifications are available, including single identifications of pine (*Pinus* sp.) and common yew (*Taxus baccata*) (Jensen, 2023; Mikkelsen, 2001; Tjelldén, 2022). Both pine and yew will have been very scarce or absent in the vegetation around Aarhus and may well have been imported, either from elsewhere in Jutland or from further away.

The large quantities of wood at Bispetorv, Søndervold and Skt. Clemens Stræde in Aarhus suggest that wood was widely available. Indeed, the reconstruction of woody vegetation around Aarhus based on pollen and written sources going back to the 14th century, although partially covering a different locality and period respectively, tentatively support the hypothesis that around 900/1000 CE deciduous woodland was present around Aarhus. For oak, probably used in large quantities, it is unclear from how far away it was collected, but its frequent presence indicates that there was at least no shortage.

4.3. Aarhus: Evidence of imports and participation in interregional networks?

Although the find assemblage from house A334 at Bispetorv indicates that the occupants were either directly or indirectly involved in interregional networks and trade, as indicated by imported objects such as the whetstone and quern stones from present-day Norway, the scale weight, and the coins minted in Haithabu, the wide variety of inorganic artefacts does not reveal any traces of imported luxury products such as the Rheinish pottery or Tating Ware found in Haithabu or Kaupang (Janssen, 1987; Pilø, 2011). There are, moreover, no finds of glass vessels, gilded beads, carnelian, crystal beads or silks, or finds of hacksilver, dirhems or European coins as found in Haithabu and especially in Ribe (Baug et al., 2023; Deckers, 2023; Feveile, 2023; Keller, 2023; Linaa, 2016, 2024; Moesgaard, 2015; Radtke, 2007; Sindbæk, 2023a,b; Skov, 2008). This absence indicates that the occupants of the pit house were primarily embedded in regional networks. The sites of Skt. Clemens Stræde and Søndervold, the latter contemporary with Bispetorv, seem to show a similar image. Luxury import products are scarce and finds of Baltic-type pottery (Feldberger types, ceramic plates from Mecklenburg-Vorpommern, Menkendorf types, and other sherds showing similarity

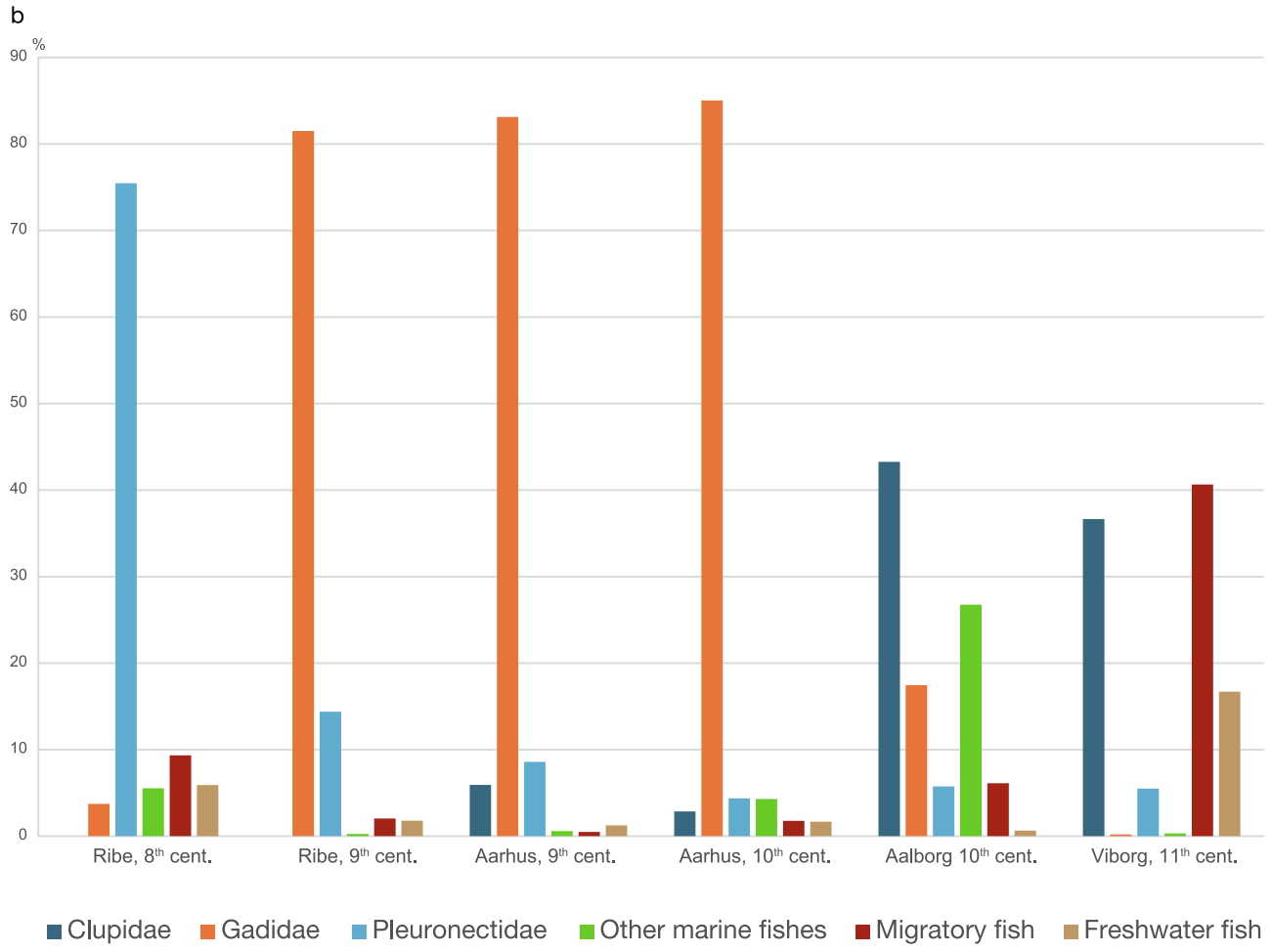

Fig. 10. (*continued*).

with finds from Sweden and the Baltics) are rare and were produced locally (Andersen et al., 1971; Bitsch, 2010a; Linaa, 2016, 2024). The exception is a glass shard with reticella decoration (Andersen et al., 1971:124) with parallels known from Kaupang and Ribe (Gaut, 2011; Feveile, 2023). Thus, the inorganic artefacts do not indicate contacts to the large Baltic or Norwegian towns. However, they do show similarities with the material from e.g. Odense and Aalborg, towns which regarding this time period have been described as primarily local and/or regional centres (Runge and Henriksen, 2018:16-21; Runge et al., 2021).

Although imported precious metals were not found in the studied pit houses, they were present in Aarhus as well as in the wider region. Examples include a gilded bronze mount from a drinking horn found ca. 20 m from Bispetorv (Søgaard, 1961:8-9, find year 1898), while an elite equestrian burial with elaborate gilded horse tack was found at Fregerslev, 17 km from Aarhus (Pedersen and Bagge, 2021). The artefacts themselves were probably produced in southern Scandinavia, as indicated by their decorative style. In addition, a hoard of seven silver bracelets was recently found at Elsted, ca. 10 km north of Aarhus (Reher-Langberg, 2024a, b). While also these bracelets were presumably made in southern Scandinavia, one of them is similar to a bracelet type originally known from present-day Russia and the Ukraine, while the style and ornamentation of the others are known from other bracelets found in Scandinavia as well as England and Ireland (*ibid.*). A find that is even more directly indicative of participation in interregional networks consists of hacksilver and Baltic jewellery found at Randlev, 25 km south of Aarhus (10th century, Jeppesen, 2000).

In line with the evidence from the inorganic artefacts, the currently available bioarchaeological data of Bispetorv, Søndervold and Skt. Clemens Stræde hardly give indications of the use of imported plants and/or animals, so the most parsimonious interpretation is that the bioarchaeological remains reflect exploitation of resources collected from Aarhus' hinterland. Concerning zooarchaeology, the exact origins of the animals used in Aarhus are difficult to decipher based on the existing data. It is likely that some of the animals were kept in the urban centre, whereas others were brought in from the countryside, either on the hoof to town or processed in the town's periphery, like Egå. Especially the identified fish taxa and the size of the cod and flatfish point to exploitation of local resources rather than large-scale import. This may also apply to domestic animals, not least omnivore species such as pig and fowl, which may have been used to reduce the accumulation of food waste inside the urban centre. The finished combs from Søndervold and a walrus ivory pin indicate the presence of non-local people and/or possibly interregional trade down the line in finished products (Ashby et al., 2015), but evidence of local processing that would demonstrate participation in trade of a substantial scale is absent.

All crops, weeds and potentially gathered plants from Bispetorv, Søndervold and Skt. Clemens Stræde are well-known from other Viking-Age sites in northern Europe (Andreasen, 2020; Behre, 1983; Jensen, 1985; Jensen, 2022; Kveiborg and Jensen, 2021; Robinson, 1994a,b; Robinson et al., 2009). While all taxa could have grown anywhere in Denmark (Brøndegaard, 1978–80; Hansen, 1993), there is no reason to assume that the crops or collected plants were imported from distant geographical regions.

The isotope analysis does not exclude import but also allows for the possibility of crop cultivation near Aarhus. The $\delta^{13}C$ values from the Bispetorv rye are on average higher than those of barley, oats and wheat

from other studies in northwestern Europe (e.g. Aguilera et al., 2017; Ballantyne et al., 2017; Bogaard et al., 2013; Brinkkemper et al., 2018; Fraser et al., 2011; Gron et al., 2017; Kanstrup et al., 2012, 2014; Lightfoot and Stevens, 2012), suggesting that the crops were cultivated in an area with relatively low water availability. While this may be related to the level of precipitation, it may also reflect a sandy field substrate (Heaton, 1987; Kohn, 2010; Tieszen, 1991). The values may therefore reflect the sandy soils of Jutland, i.e., western Jutland, central Jutland, the western part of eastern Jutland (west of Braband Fjord), Djursland northeast of Aarhus, as well as sandy patches that form part of the moraine landscape in East Jutland.

The charcoal assemblage from Aarhus so far does not provide any evidence of rare or exotic woody taxa indicative of import, while the selective use of wood at Bispetorv indicates that the woodlands offered a variety of taxa. The use of extra-local woody resources in Viking-Age Aarhus matches the outcomes of dendrochronological studies from contemporaneous sites in Denmark that indicate, with a few exceptions, most wood was collected regionally (locally) and that import of Baltic oak to southern Scandinavia only started in the 14th century (Daly, 2022). Nevertheless, the carbonised wood assemblage may reflect exchange of at least knowledge and possibly of people, as indicated by possible parallel finds from other Viking-Age towns. A possible parallel for the oak container built with ash strips kept in place with linden bark could be an oak stave-built vessel with ash strips known from Viking-Age Lund (Graham-Campbell, 1980:15, 195). The worked poplar could represent a hollowed vessel, for which parallel finds could be a poplar bucket with ash laths around it from York (mid 9th to early 10th century, Morris, 2000:2282) and a 9th-11th century bucket from Haithabu (taxon unknown, Westphal, 2006:46, 156).

4.4. Bioarchaeological evidence of regional exploitation at Aarhus in apparent contrast to other Viking-Age towns?

Comparison of zooarchaeological data from Viking-Age Aalborg, Viborg and Ribe (Enghoff, 2005, 2006a,b; Hatting, 1991, 1998; Kveiborg, 2022; Kveiborg and Jensen, 2021) shows that the relative frequency of osseous remains from domestic mammals and particularly the identified fish bones differ significantly between the sites (Fig. 10). This suggests that like in Aarhus, people in these urban centres first and foremost exploited regional resources. This interpretation is based on the assumption that distribution via long-distance trading networks would result in relatively similar resources exploitation in the various regions while instead zooarchaeological evidence differed from region to region from the Bronze Age onwards already, regarding both livestock and wild resources including fish (Benecke, 1994; Kveiborg, 2008; Kveiborg and Jensen, 2021; Nyegaard, 1996). There are some indications of long-distance transport though: ZooMS analysis of bone and antler combs from Aarhus, Ribe and Haithabu has shown the presence of combs of reindeer antler from present-day Norway (Ashby et al., 2015; Muñoz-Rodriguez et al., 2023). While the finds from Ribe indicate import and local processing of reindeer antler, i.e. substantial interregional trade, the finds from Hedeby and Aarhus do not demonstrate local processing and may originate from visitors or represent trade of finished products only, which could have been traded down the line.

Studies from elsewhere in northwestern Europe indicate an increased focus on marine fishing during the 10th-11th century, especially targeting gadids and herring (Barrett et al., 2011; Barrett and Orton, 2016; Enghoff, 1999). This development may also be reflected in the material from Jutland, Denmark, by the clear shift from flatfish (Pleuronectidae) to gadids in Ribe and the high proportion of herring in the 10th-11th century samples from Aalborg and Viborg (Fig. 10b). These trends are not visible in Viking-Age Aarhus, which may, however, only apparently be a contradiction, since gadids were an important resource in the Aarhus area since the Mesolithic (Enghoff, 2011) and since Bispetorv and Skt. Clemens Stræde do not cover the period during which an increase of herring could be expected. Isotope and aDNA-analyses, which have indicated the import of cod from the northeastern Arctic (modern northern Norway) to Haithabu (Barrett et al., 2008; Star et al., 2017), may shed further light on this.

As in Aarhus, most crops and collected plants in comparable Viking-Age towns in northern Europe were of regional origin. There are a few indisputable exceptions though. Based on, e.g., the arable weeds, import of rye has been suggested for the ring-fortress Fyrkat (980 CE; Helbæk, 1977; Robinson, 1991:196-197; though see Rowley-Conwy, 1988). Additionally, there are unique early finds of oregano (*Origanum vulgare*), walnut (*Juglans regia*), peach (*Prunus persica*) and grape (*Vitis vinifera*) known from the 8th century (pre-Viking-Age) trading site of Ribe and Viking-Age Haithabu and Lund (Behre, 1983; Hjelmqvist, 1961; Jensen, 2022; Robinson et al., 2006), demonstrating contacts with the south. Some other taxa such as millet (*Panicum miliaceum*), alpine clubmoss/groundcedar (*Lycopodium alpinum/complanatum*) and hop (*Humulus lupulus*) could have grown locally, and millet may have simply been a local arable weed, but finds of these taxa are rare and may indicate adoption of new practices and/or possibly interregional import from the south and potentially present-day Norway (*ibid*; Hall, 2004:294; Kveiborg and Jensen, 2021; Robinson et al., 2006). It should be noted, however, that the number of analysed waterlogged samples with uncarbonised remains from these other towns is larger than for Aarhus, meaning that the apparent differential evidence of long-distance transport may be explained by differential preservation.

Wood and charcoal analyses from other Viking-Age towns support the macrobotanical analyses, concluding that the majority of the wood, including the construction wood, was most likely collected regionally and not obtained via long-distance trade (Barrett et al., 2007; Behre, 1983; Callesen et al., 2005; Daly, 2022; Malmros, 2005; Reilly et al., 2016). However, a few portable objects of fir (*Abies alba*), pine, box wood (*Buxus sempervirens*) and single oak staves from Ribe, Haithabu, Viborg and Dublin were imported via long-distance trade (Behre, 1969, 1983; Callesen et al., 2005; Croix et al., 2023; Daly, 2022; Reilly et al., 2016; Westphal, 2006). At Haithabu this concerned 9 % of the wood (Behre, 1983:103). Detection of imported oak is based on dendro-provenancing. Since the numbers of published portable wooden objects from Aarhus to which dendro-provenancing has been applied is so far relatively small, it remains unknown whether similar import and trade was really absent in Aarhus or is just not documented yet.

Summarising, the bioarchaeological data from Viking-Age towns show that the majority of organic resources were obtained in the regional hinterland, while a small quantity of finds, such as reindeer antler and portable wooden objects, was indisputably obtained via long-distance trade. Apparent differences between Aarhus and other sites may on the one hand represent real differences, but on the other hand be overstated, since the outcome may be affected by comparison of different chronological periods, different methodologies, differences in the quantities of waterlogged, uncarbonised macrobotanical remains studied, and differential availability of portable objects that have been subjected to dendro-provenancing.

5. Conclusions

This compilation of material from an exceptionally well-preserved burned pit house at the site of Bispetorv, presented in comparison with the contemporary sites of Søndervold, Skt. Clemens Stræde and Egå, sheds new light on Viking-Age Aarhus and the role of its inhabitants in interregional networks. The pit house at Bispetorv was constructed in the late 10th century CE and subsequently burned in an event in the first decades of the 11th century. The analyses of artefacts, zooarchaeological remains, macrobotanical remains and charcoal indicate that the house was used for a wide range of presumably routine household activities, including textile production, carpentry, fur/pelt processing, small-scale bone working and storage of food, but also point to involvement in trade and possibly warfare, as indicated by finds of coins, a weight and a piece of chainmail. A fire, potentially representing a so far unknown major

event in the town, resulted in the destruction of the northern part of the house and a major loss of food and artefacts. The same fate befell a pit house with an apparently very similar function at Aarhus Søndervold, approximately 50 m to the west. Although alternative explanations cannot be excluded, the event may represent an attack, as weapons have been found in the rampart that surrounded the town from the late 10th century onwards.

Bispetorv, Søndervold and the post-built house at Skt. Clemens Stræde reveal scarce indications for direct or indirect interregional contacts: Two coins minted in Haithabu, soapstone, whetstones, quern stones and reindeer combs from present-day Norway (which was partially under Danish control at that time), and locally produced pottery in the style of Baltic ware. Moreover, a pin of walrus ivory (Skov, 1998:242-243), the place name "Haithabu" on a runic stone, a reference to "Ketill the Norwegian" on a rune stone (Roesdahl and Wilson, 2006), a coin minted in Aarhus during the reign of Magnus the Good with the inscription "Lifsig in Arosei" (Linaa, 2016:159; Lifsig being an Anglo-Saxon name), and carbonised wood finds from Bispetorv all support that some interregional exchange of people, knowledge and practices took place. However, there are no indications of large-scale interregional trade; the occupants or owners of the pit houses at Bispetorv, Søndervold and Skt. Clemens Stræde seem to have been primarily involved in local and regional networks. Although particularly antler remains from Aarhus provide "evidence of craft specialisation and exchange networks consistent with an urban economy" (Ashby et al., 2015; Skov, 2006), the evidence of varied assemblages of imported goods that would indicate processing of raw materials in specialised workshops supplied via interregional networks is limited (cf. Sindbæk, 2007; though see Skov, 2006:655). Indeed, the occupants of the pit houses presented in this study left hardly any discernible traces that definitively link them to involvement in either interregional networks with major towns such as Birka, Ribe, Haithabu, or Kaupang or to networks that stretched along the North Sea and via the eastern Baltic into western Asia (Asingh and Jensen, 2022; Hedenstierna-Jonson, 2020; Shepard, 2008). This picture is also generally true for other Viking-Age sites in Aarhus, as becomes clear from a recent analysis of artefacts from 18 excavations in Aarhus, including pottery, glass beads, objects of bone and antler, objects of stone (e.g., soapstone vessels, whetstones, and quernstones), coins, weights and other metal objects (Linaa, 2016, 2024). With few exceptions, the same situation applies to contemporary pit houses in Odense and Aalborg (Runge and Henriksen, 2018). The above-presented evidence of interregional contact for Aarhus matches a comment by chronicler Adam of Bremen that Viking-Age Aarhus was a shipment port when travelling to Funen, Sealand, Scania and Norway (Schiørring, 1984:14).

Bispetorv and Søndervold date to a period during which Aarhus had an important role as a trade centre, a centre of religious activity and a military stronghold. The paucity of evidence for interregional contacts in Viking-Age Aarhus, at least in the late 10th century, may partially reflect the fact that Aarhus, although located at an accessible coastal position in the geographical centre of Viking-Age Denmark, had a different role in the interregional networks than, for example, places like Ribe, Haithabu and Kaupang at their zeniths (Sindbæk, 2007; Skov, 1999:603). The precise cause is not clear; it may potentially be related to Aarhus' geographic location in relation to the major interregional trade routes of the studied period (focussing on the one hand on exchange via the North Sea and on the other hand on the Rus route via the Baltic to western Asia), the types of activities taking place in Aarhus and/or the type of resources available in the hinterland, representing everyday resources rather than luxury products. On the other hand, as argued above, apparent differences may also be overstated, since import of particularly bioarchaeological remains in other towns has partially been demonstrated by methods that have not yet systematically been applied to find assemblages from Aarhus on a large scale. Moreover, other aspects such as the time period covered and preservation conditions may play a role. This may also for Kaupang explain the apparent contrasting evidence of interregional contacts between artefacts and ecofacts (Barrett et al., 2007:307).

In order to verify the above-presented results and to get a better understanding of both the daily life of people in Aarhus, the availability of resources, and participation in interregional networks, further research is needed. On the one hand, a recent study of inorganic artefacts from fifteen other sites has indicated that the observed tendencies are representative for Aarhus as a whole before, during and after the time period studied here (Linaa 2024). On the other hand, the bioarchaeological find assemblage from Aarhus that has been studied so far is of modest size and additional methods may give complementary information. Thus, particularly concerning the bioarchaeological evidence only new excavations and analyses can tell whether the observed tendencies are representative for Aarhus as a whole and during the complete Viking Age. An area that could theoretically provide additional information about interregional trade is the area closer to the river, where, based on the infrastructure during Aarhus' earliest phase, the harbour is expected to be situated. However, this area may have suffered from erosion by the river and is expected to be destroyed during later urban expansions.

For future studies, interdisciplinary analysis of inorganic artefacts, dendrochronology, wood/charcoal analysis including age/diameter analysis to study woodland management, phytolith analysis, isotope analysis of faunal and botanical remains, including waterlogged, uncarbonised remains could be particularly helpful to address many types of questions about the relationship between people and their environment, as well as import and exchange (cf. Boyd and Stone, 2021). Such interdisciplinary bioarchaeological studies, combined with detailed analyses of the inorganic artefacts and the application of geoarchaeological methods (e.g. Sulas et al., 2022; Trant et al., 2024), are not only relevant for the understanding of exchange, import and trade in Viking-Age Aarhus, but are of relevance for any Viking-Age or medieval site.

CRediT authorship contribution statement

Welmoed A. Out: Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Jacob Kveiborg:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Conceptualization. **Peter M. Jensen:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Conceptualization. **Casper S. Andersen:** Writing – review & editing, Visualization, Data curation. **Mila Andonova-Katsarski:** Writing – review & editing, Writing – original draft, Formal analysis. **Neeke Hammers:** Writing – original draft, Investigation, Formal analysis, Conceptualization. **Marie Kanstrup:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis. **Kenneth C. Ritchie:** Writing – review & editing, Investigation, Formal analysis. **Cecilie Stenner:** Writing – review & editing, Visualization, Investigation, Data curation. **Jette Linaa:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2025.105096.

Data availability

Please see the supplementary files for the primary research data.

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