Danish Journal of Archaeology

2025
Volume 14

Danish Journal of Archaeology

This innovative journal is dedicated to the presentation, discussion and interpretation of the archaeological record of southern Scandinavia in its international, regional and local context. Providing a platform for publication and debate for professionals from the museum as well as the university sectors this journal is open for empirical, methodological and theoretical contributions covering all time periods and all kinds of archaeology with relevance for the Scandinavian, Baltic, and North Atlantic regions. In addition, the journal may publish articles of wider theoretical, discursive or global reach.

The *Danish Journal of Archaeology* includes original research articles, news and discoveries, and discussion pieces with the intention of fostering open debate about the archaeological record in its broadest sense and the position of archaeology as a discipline in the modern world.

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ISSN: 2166-2290
Layout: Katrin Atzbach, Højbjerg, Denmark
Cover: Early Bronze Age cult axe from Lunde in Vindafjord, Rogaland, and rockcarvings from Kråkhaug in Sola, Rogaland (Collage: K. Atzbach, article from Kristine Orestad Sørgaard).

Contents

Editorial

Rune Iversen, Helene Agerskov Rose, Sarah Croix, Xenia Pauli Jensen, Thomas Grane and Lasse Vilien Sørensen

This year's editorial discussions have both included specific issues related to the individual articles and more general considerations. Regarding the latter: Artificial Intelligence (AI) and Large Language Models (LLM) are being widely adopted in both the public and private sectors. Significant perspectives can undoubtedly be achieved by using AI and LLMs, but there are also major concerns regarding intellectual property infringement, loss of academic integrity, lack of transparency, questions about the validity of AI-generated data etc. At the *Danish Journal of Archaeology*, we acknowledge the value of responsibly applied AI tools in archaeologic-al research and scholarly writing. However, we believe that AI cannot replace human critical thinking or expertise, and that authors should remain fully responsible and accountable for all content presented in their work.

To stay on top of the developments and to ensure transparency in the work that we publish, we introduce an AI policy for the journal, which can be accessed on our webpage About the Journal | Danish Journal of Archaeology. The policy means that for all articles submitted after 1 January 2026, authors must declare and fully describe any use of AI. We are aware that technology develops fast and we will therefore continuously review and update our policy, as compliant AI tools and best practices continue to evolve.

This year's volume of the *Danish Journal of Archaeology* offers 11 exciting contributions by a number of Scandinavian and international scholars. The published articles are widely distributed across time and space: spanning the whole of prehistory, from the Mesolithic to the Viking Age, and include studies focused on northern Germany, Denmark, Sweden and Norway. At the *Danish Journal of Archaeology*, we appreciate this diversity and are happy to publish more studies from our neighbouring countries, as these place the archaeological record of southern Scandinavia in a regional context, which is one of our main goals. Another goal that we pursue is diversity of applied methods and theory, and also in this respect, the present volume offers a range of interesting approaches. These include paleoenvironmental reconstruction, experimental archaeology, use wear analysis, theoretical discussions and analysis of legacy data.

Out and Kuijper present a paleoenvironmental reconstruction of the Magleholm site at Vedbæk, northeastern Denmark, based on analysis of molluscs and botanical macroremains. Apart from providing information about the vegetation and landscape, the study also shows which resources were available to the people living in the Vedbæk fjord area during the Mesolithic Ertebølle period and the succeeding Early Neolithic.

The article by Stenak focuses on the lithic technology of the Neolithic Pitted Ware culture, applying an experimental archaeology-based perspective to the characteristic tanged flint arrowheads made from retouched blades. By working through the production sequence, Stenak is able to correlate the different arrowhead types with specific production stages. He thereby contributes with new technological and craft-based perspectives to the ongoing debate on the Pitted Ware arrowhead typology.

In the article 'The potential of overlooked material in museum repositories' Blank et al. revisit grave materials from the Falbygden area in western Sweden by combining archaeological, osteological, biochemical and geochemical methods. Through a multifaceted approach to the skeletal remains, the authors obtain new knowledge of burial practices, subsistence, health and mobility in the Late Neolithic and Early Bronze Age.

Walsh et al. present new insights into the evolution of burial practices based on legacy data from a tumulus at Karlstrup, Denmark. Here, there is a long and complex history of re-use, and by analysing cultural traits within a cultural evolution framework, the authors trace the degree of change, continuity and coherence in burial traditions across the Late Neolithic 'Dagger Period' and Early Nordic Bronze Age.

Another example of new analyses of legacy data is Solberg and Schäfler's study of Early Bronze Age swordsmanship, based on museum artefacts mainly recovered during the 19th century and with only very limited contextual information. By applying a combination of use wear analysis and experimental archaeology, they demonstrate differences in wear mark distribution and clustering and suggest that these represent two contemporary local variations in fencing styles.

Sørgaard's article, which deals with the Late Neolithic transition from nomadic hunter-gatherers to sedentary farmers in southwestern Norway, goes beyond the traditional socioeconomic approaches and argues for a novel reshaping of human perceptions and their role in the world. The shift involved inter-human perspectivism and a growing focus on ancestral rituals, from simple commemorations to elaborate hero cults, with comparative insights from the Late Bronze Age supplementing the limited local archaeological record.

Schaefer-Di Maida's article on the Pre-Roman Iron Age burial ground at Mang de Bargen in northern Germany combines a traditional presentation of layout, burial rites and grave goods with environmental data. This enables a broader, regional contextualisation and a new approach to the process of transformation at the specific site and in the region in general.

The increasing use of metal detectors in Denmark has led to the discovery of numerous new artefact types, including Roman folding knives. Søndergård et al. present a small group of recent finds of figural handles of Roman folding knives from southern Scandinavia. They propose a Roman provincial origin for these, based on their examination of iconographic features, archaeological context and supplementary use of metallurgical analyses.

The research potential of metal-detecting finds has also been utilised by Jens Ulriksen in an extensive review of stray finds relating to warrior equipment from eastern Denmark in the Late Germanic Iron Age. By considering the distribution of these finds in the landscape and comparing the different types of objects represented to the known weapon burials from Bornholm, Ulriksen addresses previous interpretations of warrior organisation in this period as being based on a system of conscripts. His differing interpretation instead emphasises the importance of social bonds and mutual obligations.

Also focusing on metal objects, in his article Mats Skare revisits the question of the evolution of animal styles in the period *c.* AD 600-800 in the historical context of the beginning of the Viking Age. Through a re-evaluation of the definition of the Gripping Beast Style, Style III/E, Style 2.5/D, and Style II and their interrelationships, Skare returns to the iconography of the styles and proposes an animistic reading of their content. Their evolution thus reflects changing and opposing world views, clearly distinguishing between the Christian and non-Christian spheres of western and northern Europe.

Through digitisation and GIS mapping of unpublished lists of finds and constructions, Søren Sindbæk and Mogens Larsen revisit the excavation of the Viking Age fortress of Trelleborg during the 1940s. This allows them to study the recovery strategy of the excavation and examine the spatial distribution of the finds. They identify different work areas that were unrelated to the buildings of the fortress, contradicting the theory that the finds were left behind in a hurry when the fortress was unexpectedly destroyed.

We hope you will enjoy this volume!
The editorial team

A paleoenvironmental Reconstruction of Magleholm, Vedbæk, based on Molluscs and botanical Macroremains

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ABSTRACT

Magleholm was excavated in 1978, 1983 and 1984 under the direction of E.B. Petersen as part of the Vedbæk project. This paper aims to provide a paleoenvironmental reconstruction of the site based on analysis of molluscs and botanical macroremains from 16 samples, covering 80 cm of a profile from a trench excavated in 1984. The samples primarily reflect the environment at the time of the Mesolithic Ertebølle culture while a few samples in the upper part of the profile reflect the environment during the Early Neolithic Funnel Beaker Culture. Apart from providing information about the vegetation and landscape, the data also illustrate which resources were available to people.

The bottom of the profile consists of practically sterile sand. A major part of the profile, consisting of gyttja that was poor in plant and mollusc taxa, reflects the environment of a brackish lagoon. The uppermost three samples, at least partially corresponding with the Neolithic, show a reduction in salinity, resulting in a more diverse combination of brackish water and freshwater taxa. Most taxa in the upper samples represent taxa of shallow open water, salt marshes and border zones alongside freshwater bodies, while some plant taxa represent vegetation of dryland terrain. While some finds of wood charcoal and carbonised fish remains point to human activity, none of the seeds and fruits in the profile were carbonised.

Comparison with earlier environmental data indicates that this new study on the one hand confirms, and on the other hand complements, results from earlier studies at Magleholm. Since archaeobotanical studies from both the Vedbæk fjord and Mesolithic sites in Southern Scandinavia in general are relatively rare, this study underlines both the potential of and need for additional botanical macroremains analysis at comparable archaeological sites.

ARTICLE HISTORY
Received
26 May 2025;
Accepted
10 October 2025

KEYWORDS
Mesolithic, Neolithic, seeds and fruits analysis; Molluscs; Mesohaline paleoenvironment.

Introduction

Magleholm, located 20 km north of Copenhagen in Denmark (Figure 1), was discovered in 1937 by Avnholt (1944, 61-63) and excavated in 1978, 1983 and 1984 as part of the Vedbæk project (Christensen 2014, 10; Petersen et al. 2015: Table 11:1). This project, led by Erik Brinch Petersen, concerned the excavation of multiple sites located in the former Vedbæk fjord[1] undertaken by the National Museum of Denmark and the University of Copenhagen, which were accompanied in some years by the University of Madison-Wisconsin (*e.g.* Petersen et al. 1979, 1982, 2015).

The site of Magleholm, located at 5.10 masl on a former hill, was characterized by disturbed settlement traces on the sandy top of the hill and refuse embedded in gyttja and peat layers on the slopes. The zone with refuse on the slopes has been described as an outcast zone. The 66 m^2 of the trenches from the 1983/1984 excavation, of which 15 m^2 was excavated systematically, were located on the northern and southern slopes of the hill (Christensen 1982, 98-99; Petersen 1985, 2). Based on flint and pottery finds, the site has been attributed to the Early, Middle and Late Ertebølle Culture as well as the Early Neolithic Funnel Beaker Culture (Christensen 2014, 10-14; Juel and Kjær 2015, 221; Petersen 1982, 148; Petersen et al. 2015: Fig. 13.1). The Ertebølle finds were recovered from gyttja layers while the Funnel Beaker finds were found in the upper gyttja and peat

Figure 1. Location of Magleholm. The former fjord area, indicated with the dark grey line, matches the 5 masl-line. White and dashed line: roads and railway (Figure: graphical department at Moesgaard, after Petersen et al. 2015, 206).

deposits (Christensen 1982, 2014). Six radiocarbon dates, collected primarily to reconstruct the landscape development and shoreline displacement (Petersen et al. 2015, 66), range from *c.*5000 to 2600 BCE (Table 1; Christensen 1982, 93; 2014, 40; Petersen et al. 2015, table 11:2; Sørensen 2014, 134), corresponding with the Atlantic and Subboreal (Christensen 2014, 10-12).

Archaeological analyses of the Vedbæk project published so far focus on the flint, pottery, zooarchaeological remains, human remains, isotope analysis of the human remains, wooden artefacts, molluscs used as artefacts, use-wear analysis, pollen analysis, and the reconstruction of sea levels (*e.g.* Aaris-Sørensen 1982; Albrethsen and Petersen 1977; Christensen 1982, 2014; Enghoff 1995, 71; Jensen and Petersen 1985; Mørck et al. 1999; Petersen 1982, 1984, 7-13; Petersen et al. 1979, 1982, 2015 and references therein). For Magleholm and various other sites in the Vedbæk area, it is argued that the lithic assemblage included "quite a selection of lithic types with much primary lithic work and *debitage*", that the archaeozoological assemblage contained "a mixture of marine and forest species" and that there is evidence for occupation during most seasons, though without explicit evidence of occupation during winter, since this is difficult to demonstrate (Petersen et al. 2015, 156).

Further details on Magleholm are scarce. Compared with the other sites studied as part of the Vedbæk project, Magleholm represents a relatively long cultural sequence (Petersen et al. 2015, 45). The site was subjected to radiocarbon dating and pollen analysis to reconstruct sea levels (Christensen 1982, 2014; Petersen et al. 2015, 20, 68). The presence of domestic animals is demonstrated by a goat bone fragment (Sørensen 2014; Table 1: 3799-3647 BCE, 2σ). The fish assemblage at least during the Mesolithic was dominated by gadids (Gadidae, 70%) and further contained spurdog (*Squalus acanthias* Linnaeus, 1758, 22%), flatfish (Pleuronectiformes, 5%: particularly European plaice, *Pleuronectes platessa* Linnaeus, 1758, and flounder, *Platichthys flesus* Linnaeus, 1758), eel (*Anguilla anguilla* Linnaeus, 1758, <1%) and some remains of other taxa (Enghoff 1995, 71), indicating the occurrence of marine or brackish conditions (Møller and Carl 2010).

Despite excellent preservation of organic material at multiple sites in the area, botanical macroremains analysis was not undertaken systematically as part of the Vedbæk project including at Magleholm, or is at least not published internationally. One exception is an archaeobotanical analysis from Maglemosegård (*c.*5500-3600 BCE, Christensen 2014, 39; see also Christensen 1982, 93), carried out by G. Jørgensen (Petersen et al. 2015, 193, no context data presented). Information about finds of seeds and fruits is thus restricted to larger remains found during sieving: It is reported that hazelnut shells (*Corylus avellana* L.) and acorns (*Quercus* sp.), including carbonized remains, were found

Lab. No.	Material	Age (years uncal BP)	Age (years cl BCE, 2σ)	Age (years cl BCE, 1σ)	Depth (masl)	Sediment	Section	Layer	Excava-tion year	Reference
K-3151	Wood, *Alnus* sp.	4390±90	3346 (95.4%) 2886	3314 (3.4%) 3296 3286 (9.3%) 3240 3104 (55.6%) 2904	2.86	Limnic gyttja	Ø199, N325	layer 9	1978	Petersen et al. 2015
K-3150	Wood	4250±90	3261 (0.3%) 3251 3100 (94.9%) 2572 2513 (0.3%) 2504	3010 (4.7%) 2982 2934 (27.5%) 2838 2816 (36.1%) 2668	3.65	Limnic gyttja	Ø199, N325	layer 9	1978	Christensen 2014
K-4178	Wood (branch), *Alnus* sp., charred	4650±85	3636 (82.0%) 3312 3298 (0.7%) 3285 3272 (0.2%) 3269 3241 (12.5%) 3103	3618 (6.2%) 3586 3530 (62.1%) 3348	2.86	Gyttja rich in detritus and *Ruppia* fruits	Ø200, N317,45	layer 3	.	Christensen 2014
OxA-27117	Bone, *Capra* sp.	4961±34	3894 (2.0%) 3880 3799 (93.4%) 3647	3772 (51.0%) 3702 3680 (17.3%) 3656	.	.	.	.	1978	Sørensen 2014
K-3149	Wood	6180±100	5357 (0.5%) 5347 5332 (93.3%) 4881 4872 (1.7%) 4846	5293 (6.2%) 5265 5218 (62.1%) 5000	3.15	Sand	Ø199, N315,50	layer 6	1978	Petersen et al. 2015
K-3148	Worked wood	6270±100	5473 (4.4%) 5428 5416 (91.0%) 4996	5331 (40.5%) 5204 5178 (27.8%) 5064	2.40 - 2.70	Sandy gyttja	Ø199, N318-320	layer 8	1978	Petersen et al. 2015

Table 1. Magleholm, radiocarbon dates from profile Ø 199 (Christensen 1982, 93).

at multiple sites, as well as remains of crab apple (*Malus sylvestris* Mill.) (Petersen et al. 2015, 82; no details per site). On the one hand, one can argue that botanical macroremains analysis was still developing within archaeology in the 1970s and early 1980s. On the other hand, sampling of botanical macroremains at wetland sites had already started in Europe at this time (*e.g.* Bakels 1981; Becket 1978a,b; Behre 1969, 1976; Casparie et al. 1977; Gaillard and Lemdahl 1988; Göransson 1988; Jacomet et al. 1989; Körber-Grohne 1967; Out 2010, 2012; Out and Dörfler 2017; Schlichtherle 1990), also by scholars in Denmark (Fredskild 1969; Troels-Smith 1960). Pollen analysis was incorporated in the Vedbæk project, and such data are available for Magleholm (Christensen 2014, 13-14).

This paper presents new identifications of seeds and fruits as well as molluscs from sixteen sediment samples from a profile at the site of Magleholm. The aim of the study is to reconstruct the environment and natural vegetation at the site and to assess whether there is evidence of handling of plants by people. Most of the analysed samples cover the Mesolithic while the uppermost samples cover the Early Neolithic.

Paleogeography of the Fjord and Stratigraphy of Magleholm

During the Boreal and Early Atlantic, a lake was present in the Vedbæk area, as indicated by the presence of gyttja, containing freshwater molluscs, on top of the glacial sand (Christensen 1982, 98). The gyttja sequence was covered by peat rich in seeds of bogbean (*Menyanthes trifoliata* L.). This lake had a size comparable to that of the fjord at the time of the highest sea level. Depending on the location, the thickness of the lake deposits varies widely, from a few tens of cm up to 2 m (Christensen 2014, 6). The lake deposits are not documented in the earlier published profile from Magleholm (Christensen 1982, 6).

The Mid-Holocene development of the Vedbæk area is characterized by the gradual rise of the relative sea level, which resulted from a global eustatic sea-level rise (Bennike et al. 2023, 449; Christensen 1982, 2014; Petersen 1982, 141). As a result of this gradual rise, salt water flooded the Vedbæk valley in the early 7th millennium BCE, creating a shallow inlet with numerous islands and peninsulas (Petersen 1984, 8; Petersen et al. 2015, 20). At the entrance of the fjord a beach ridge formed, leaving open only a narrow entrance to the fjord (Petersen et al. 2015, 23), resulting in the development of a lagoon. Stratigraphically, the changes in the landscape can be observed as a sharp transition from peat to marine gyttja (marine gyttja: see Discussion). At Magleholm, located in the western and relatively sheltered part of the Mesolithic Vedbæk fjord, this gyttja layer was *c.*1 meter thick. It was further noted that at Magleholm, especially on the island's east side, this gyttja contained layers of sand, gravel and stones, indicating a relatively dynamic environment in comparison with other sites in the fjord (Christensen 2014, 10).

The sea reached its highest level in the area during the middle Holocene. Some prehistoric sites in the Vedbæk region were submerged at this time but Magleholm always remained an island during the Atlantic and Subboreal. The maximum sea level was a result of the eustatic sea level rise on the one hand and the glacio-isostatic land uplift on the other hand. Due to the latter, sites in certain parts of Denmark that were coastal sites during the Atlantic, including Magleholm, are now located above sea level (Christensen 1982, 94; Petersen 1984, 7; Petersen et al. 2015, 44-45).

Between 3850 and 3700-3600 BCE (date according to Christensen 2014, 40, based on palynology and radiocarbon date K-4178, see also Table 1), a detritus gyttja layer was deposited containing some Funnel Beaker pottery sherds (Christensen 2014, 11). This layer, only observed at Magleholm, was earlier interpreted as a subboreal transgression (Christensen 2014, 11; see also discussion). Pollen and macroremains analyses indicated the presence of tasselweed (*Ruppia* sp.) in these deposits (Christensen 2014, 10).

Shortly after 3500 BCE or at least before 3000 BCE (date according to Christensen 2014 40, based on radiocarbon dates K-3150 and K-3151, see also Table 1), the connection of the lagoon to the sea closed (earlier interpreted as a regression of the sea level), resulting in the deposition of coarse limnic detritus gyttja in what became a freshwater lake 100-150 m wide and 1 km long. These freshwater deposits have particularly been found further away from the former lagoon edges and have also been attested at Magleholm (Christensen 1982, 98-99, 2014, 10-14, layer 3 and layer 9/upper part layer 3). In the northern and southern trenches of Magleholm, a calcareous gyttja was observed on top of the marine gyttja and beneath the limnic detritus gyttja, at the bottom containing small individuals of cockle (*Cardium* sp., now called *Cerastoderma* sp.) and mud snails (*Hydrobia* sp.), indicating a transitional brackish environment (Christensen 1982: 91, 98, 99: layer 10, Christensen pers. comm. 2025).

The limnic gyttja is covered by peat, representing the paludification of the freshwater lake (infill with marsh vegetation). At many places the peat has degraded due to dehydration and cultivation practices (Christensen 2014, 6).

Materials and Methods

The Samples: their Context, History and Analysis

In 1984, L.B.M. Verhart of the National Museum of Antiquities in Leiden, the Netherlands, participated in the excavation of Magleholm and collected 16 sediment samples from the south profile of trench 2, covering 85 cm. After collection the samples were taken to the Netherlands and subsequently sieved and analysed by W.J. Kuijper, at that time working at the archaeobotanical laboratory at the Faculty of Archaeology of Leiden University. In 2023, W.J. Kuijper handed the resulting documentation over to W.A. Out.

With the exception of sample 1, which is twice as thick as the others, all samples had a height of *c.*5 cm and a volume of *c.*200 cm^3. Since the main focus of the analysis concerned the molluscs, the samples were sieved with a 0.5 mm sieve, implying that the smallest seeds and fruits, for example those from *Juncus* sp. (rushes) may be lost. Interpretation of the molluscs is based on Gittenberger et al. (2004), Glöer (2002), Götting (2008), Kuijper (2000) and Muus (1967). The nomenclature of the molluscs is based on Gittenberger et al. (2004) and Welter-Schultes (2012). The seeds and fruits were identified using the reference collection of the Faculty of Archaeology, Leiden University. The nomenclature of the seeds/fruits is based on Duistermaat (2020). The analysed molluscs are stored at Naturalis Biodiversity Centre, Leiden, the Netherlands. The majority of the botanical macroremains were discarded after analysis since the assemblage did not contain rare taxa or other finds that were considered relevant to preserve.

Context of the investigated Profile and Layers

The profile drawing of the investigated samples mentions the south profile of trench 2, referring to the dy-line (diagonal trench?) and mentions 74 (m?) as a location marker. The sample location is estimated to be located *c.*10 meter from the earlier shore of the fjord (notes W.J. Kuijper 1984). Generally, the layers can be interpreted as refuse layers (Christensen 2014, 10) and as an off-site zone, since the gyttja layers represent the fjord rather than the dry island. Based on Christensen (2014, Fig. 7), the disturbance at the bottom of the peat layer above the investigated samples is interpreted as resulting from removal of Neolithic find material. It is not clear precisely how the studied profile relates to the profile where the radiocarbon dates presented in Table 1 were taken (further discussed below).

Results

Studied Profile

Figure 2 and Table 2 show the sampled profile and descriptions of the layers. The lowest sample consisted of glacial sand with scattered stones. The sediment of the remaining samples consisted of gyttja. Peat was present above the samples.

The identifications of molluscs, seeds and fruits, and other finds from Magleholm, trench 2, are shown in Figure 3. Samples throughout the profile contained sand and charcoal, suggesting that the entire analysed profile may correspond with periods of human activity. Small flint fragments were particularly present in the lower part of

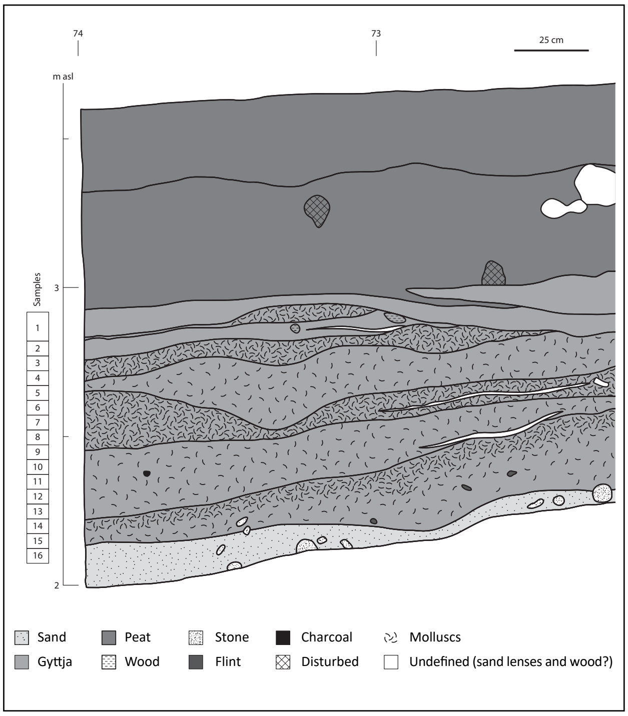

Figure 2. Magleholm, trench 2, south profile, dy-line. The samples were collected at "74" (m?) (Figure: graphical department at Moesgaard, after a drawing by L.B.M. Verhart).

the profile (samples 11, 12, 15 and 16 at 2.07-2.17 and 2.27-2.37 meter above sea level). Carbonised fish remains and carbonised culms were observed in two different samples (at 2.27-2.37 masl). Especially the lower samples contained leaf fragments and buds. Finally, various samples contained small uncarbonized fish remains, which are expected to belong primarily to small fishes, *e.g.* the common goby (*Pomatoschistus microps* Krøyer, 1838), that may have ended up naturally at the sample location.

Molluscs, Foraminifera and Ostracods

Most layers present in the studied profile contained molluscs, some more than others. The top of the layer at 2.12-2.22 masl (samples 14-15) was particularly rich in molluscs. This may indicate that apart from molluscs' growth, there was little sedimentation. The top of the layer at 2.27-2.47 (samples 9-13) was rich in broken molluscs. In other layers, the shells were mostly found as complete single shells. Shell fragmentation primarily

Depth (masl)	Sample nr.	Sediment	Description
2.82-2.92	1	Gyttja	1: coarse gyttja containing few molluscs. Thin layer with molluscs at the transition of samples 1 and 2, after 50 cm wedging out in a thicker layer with many molluscs
2.77-2.82	2	"	2-3: gyttja containing few molluscs and some wood fragments
2.72-2.77	3	"	3-4: gyttja containing many molluscs
2.67-2.72	4	"	4-5: gyttja containing some molluscs
2.62-2.67	5	"	5-9: gyttja containing many molluscs. Sand lens
2.57-2.62	6	"	
2.52-2.57	7	"	
2.47-2.52	8	"	
2.42-2.47	9	"	9-13: gyttja containing some molluscs. Top of this layer: many broken molluscs
2.37-2.42	10	"	
2.32-2.37	11	"	
2.27-2.32	12	"	
2.22-2.27	13	"	
2.17-2.22	14	"	14-15: gyttja, top rich in molluscs. Flint and stones present. Charcoal fragment. Sand lens
2.12-2.17	15	"	
2.07-2.12	16	Grey sand. Glacial deposits	16 and below: sand; stones present

Table 2. Magleholm, trench 2, south profile, description of the studied layers and samples.

Figure 3. Magleholm, trench 2, the identifications of molluscs, botanical macroremains and remaining finds (absolute numbers). Depth: meter above sea level. Sample 1 is located at the top of the sample series and sample 16 at the bottom (see also Table 2). Note the larger sample volume of sample 1. Scale of x-axis if not indicated: 0-10. Bars: counted quantities. Dots: estimated quantities: ● = some, ●● = some tens, ●●● = many tens, ●●●● = some hundreds, ●●●●●= many hundreds, ●●●●●● = thousands (Analysis: W.J. Kuijper. Figure: graphical department at Moesgaard).

Figure 4. Sample 14, containing lagoon cockles, sand and pebbles (Photo: W. Kuijper).

resulted from sampling and sieving. Paired shell valves were rare; these have been reported for levels 2.27-2.32, 2.72-2.77 and 2.82-2.92 masl (samples 12, 3 and 1).

The lowest sample from the sand layer contained single fragments of mud snail and cockle shells that are considered intrusive and did not contain any seeds or fruits. The gyttja sample directly above the sand layer contained more mollusc remains but was relatively poor in molluscs compared to the other samples.

In the majority of the remaining gyttja samples, the mollusc fauna is poor in taxa and rich in individuals. Three mollusc taxa were present in all these samples: the common mussel (*Mytilus edulis* Linnaeus, 1758), the spire snail (*Hydrobia ventrosa* Montagu, 1803, also called *Ecrobia ventrosa* Montagu, 1803) and the lagoon cockle (*Cerastoderma glaucum* Bruguière, 1789) (Figure 4). The constant presence of these taxa as well as the practical absence of obligate marine taxa indicate that brackish conditions prevailed.

The common mussel, represented by few remains per sample in the lower half of the profile (until and including sample 8 at 2.47-2.52 masl) and tens of remains in the upper half of the sample, occurs in marine and brackish water environments.

The spire snail, present with up to hundreds and even thousands of shells per sample, occurs in shallow, calm, brackish water zones without tide or with small tidal amplitudes. It tolerates relatively extreme conditions and tolerates both influxes of freshwater as well as weekly and yearly fluctuations of saltwater. At 2.82-2.92 masl (sample 1 at the top of the sample series), both juvenile and adult individuals were reported, which indicates their local presence. At 2.77-2.82 masl (sample 2), the shells of the spire snail were found deposited in layers. Also, the sediment at 2.72-2.77 (sample 3) contained layers of unspecified shells.

The shells of the spire snail regularly showed holes caused by either the bristleworm (*Polydora ciliata* Johnston, formerly *Polidora ligni* Webster) or the boring sponge (*Cliona celata* Grant) (Cadée and

Figure 5. Sample 1, containing shells from the brackish- and freshwater molluscs spire snail (common), common pond snail (see text), Nautilus ramshorn, ramshorn snail and flat valve snail, Leach's Bithynia and a pea mussel (Photo: W. Kuijper).

Wesselingh 2005, 40-42; Muus 1967, 91). Thickenings on the inner sides of the shells indicate that the organism affected living spire snails.

The lagoon cockle, represented by tens of shells, lives in stagnant or slowly flowing waters and is characteristic of brackish water environments. It can survive periods of fresh or marine water supply, but under true marine conditions it is replaced by the common cockle (*Cerastoderma edule* Linnaeus, 1758) – a taxon which was not found at Magleholm. At 2.82-2.92 masl and 2.67-2.77 masl, thus in the top of the sample series, both juvenile and adult individuals of the lagoon cockle have been reported, and at 2.72-2.77 masl, doublets, including empty doublets, have been reported, which all indicates their local presence.

Apart from the common mussel, two more mollusc taxa were found that are characteristic of marine or brackish waters: the rough periwinkle (*Littorina saxatilis* Olivi, 1792) and the mud snail (*Hydrobia ulvae* (Pennant, 1777), synonym *Peringia ulvae* (Pennant, 1777)). The rough periwinkle was found at 2.17-2.47 masl (samples 9-14). At 2.27-2.32 masl (sample 12), both juvenile and adult individuals were present, indicative of local occurrence. One of the samples that contained finds of the rough periwinkle (sample 9 at 2.42-2.47 masl) also contained foraminifera, unicellular organisms that occur in brackish and marine environments. The mud snail was present at 2.82-2.92 masl (upper sample 1).

The upper layer at 2.82-2.92 masl (sample 1) stands out from the other samples because it contains not only taxa indicative of marine or brackish conditions that are present in all gyttja samples, but also a variety of freshwater molluscs present in small quantities. This concerns the common pond snail (*Radix balthica/labiata* interpreted as *R. balthica* (Linnaeus, 1758)), Leach's Bithynia (*Bithynia leachii* (Sheppard, 1823)), the white ramshorn (*Gyraulus albus* (O.F. Müller, 1774)), the Nautilus ramshorn (*Gyraulus crista* (Linnaeus, 1758)), the ramshorn snail (*Planorbis planorbis* (Linnaeus, 1758)), a pea mussel (*Pisidium* sp.), the flat valve snail (*Valvata cristata* (O.F. Müller, 1774)) and the common valve snail (*Valvata piscinalis* (O.F. Müller, 1774)) (Figure 5). These taxa were not present in a single, thin layer, but were mixed with the shells of brackish and marine water taxa. Many of the freshwater taxa were represented by juveniles, implying that they may have been transported via small freshwater streams into the lagoon.

The ostracods at 2.32-2.37, 2.52-2.57 and 2.72-2.92 masl (samples 11, 7 and the upper three samples), which not only occurred as single carapaces (shells) but also as doublets in samples 11, 2 and 1, do not give direct information about the salinity of the environment. They may represent taxa that live in freshwater, brackish water and/or saltwater conditions.

Plant Macroremains and green Algae

The seeds and fruits from Magleholm were well-preserved. The ecological group that is quantitatively dominant in the studied profile is the group of salt marsh taxa and water plants that tolerate brackish conditions. The species that occurs in all samples except from the sand sample at the bottom of the profile is beaked tasselweed (*Ruppia maritima* L.), a pioneer water plant of shallow brackish water (max. depth 70 cm), which tolerates changes in salinity but does not occur in the sea, represented by tens of fruits per sample (Figure 6). The taxon flourishes in stagnant to slow-flowing water with limited water level changes, such as the low water table zone of areas affected by tide. Peduncles (culms) of up to 4 cm have been found, indicating that the species occurred locally. The occurrence of beaked tasselweed together with horned pondweed (*Zannichellia palustris* L.), spiny naiad (*Najas marina* L.), fennel pondweed (*Stuckenia pectinata* (L.) Börner) and stonewort (*Chara* sp.), as is the case in the upper three samples at 2.72-2.92 masl, points to the presence of the plant community of the *Ruppion maritimae*. This community occurs in shallow, clear, calm, brackish water under mesohaline to polyhaline conditions (Iversen 1934, 24; Schaminée et al. 1995, 29-30).

Similar to tasselweed, fruits of common/spear-leaved orache (*Atriplex patula* L./*prostrata* Boucher ex DC.) were found in relatively many samples. Based on the common presence at Magleholm of taxa that indicate brackish or marine conditions, these fruits are interpreted as spear-leaved orache,

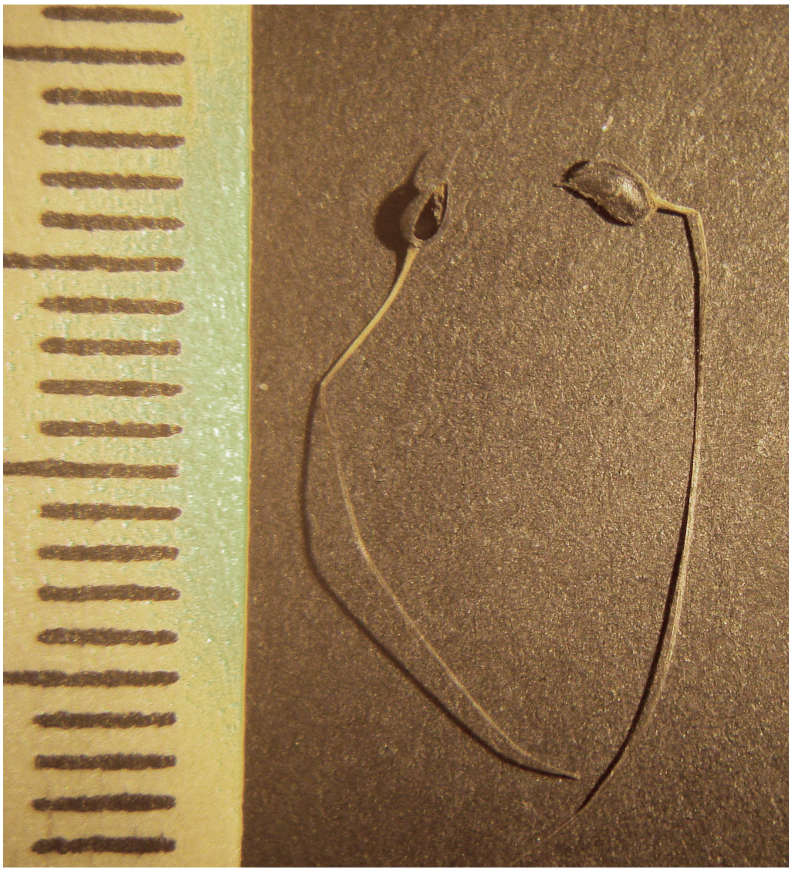

Figure 6. Beaked tasselweed, dried, but very well preserved (Photo: W. Kuijper).

a species that occurs on open, moist, nitrate-rich terrain and at drift litter zones on the beach and in salt marshes.

Other salt marsh taxa whose fruits occur occasionally in the profile are sea aster (*Tripolium pannonicum* (Jacq.) Dobrocz., formerly *Aster tripolium* L., 2.32-2.37 masl, sample 11), annual seablite (*Suaeda maritima* (L.) Dumort, 2.52-2.57 masl, 2.77-2.92 masl, samples 7, 2 and 1) and grassleaf orache (*Atriplex littoralis* L., 2.82-2.92 masl, sample 1). Annual seablite is usually found in the intertidal zone and in salt marshes. Since only small quantities are present, these seeds may have been transported with marine influxes occurring during relatively extreme high-water events.

A second group represented by the seeds and fruits in the profile are taxa indicative of alder carr, water edges, freshwater marshes and (to some degree) dune valleys, including common alder (*Alnus glutinosa* (L.) Gaertn.), cyperus sedge (*Carex pseudocyperus* L.), great fen-sedge (*Cladium mariscus* (L.) Pohl), hemp-agrimony (*Eupatorium cannabinum* L.), European bugleweed (*Lycopus europaeus* L.), common reed (*Phragmites australis* (Cav.) Steud), lakeshore bulrush or softstem bulrush (*Schoenoplectus lacustris* (L.) Palla or *tabernaemontani* (C.C.Gmel.) Palla), bitter nightshade (*Solanum dulcamara* L.), water pepper (*Persicaria hydropiper* (L.) Delarbre), sedge (*Carex* sp.) and possible chickweed (cf. *Stellaria* sp.). Of these, cyperus sedge, great fen-sedge, European bugleweed, reed, bulrush, bitter nightshade and hemp-agrimony tolerate brackish or slightly brackish conditions, while hemp-agrimony can also be found on beaches (Weeda et al. 1988-1994). In contrast, alder explicitly does not tolerate brackish conditions. Bulrush is found in six different samples throughout the profile. The remaining taxa are also found throughout the profile, but only sporadically and hardly ever with more than three taxa in a single sample. The largest number of taxa from this group of water edges, freshwater marshes and dune valleys occur at 2.82-2.92 masl in sample 1 at the top of the profile, which also contains freshwater molluscs and a larger diversity of water plants.

A third group of plants represented in the profile are plants of dryland terrain, including both woodland taxa such as lime (*Tilia* sp.), birch (*Betula* sp.), European hazel (*Corylus avellana*) and blackberry (*Rubus fruticosus* L. agg.) as well as taxa of open, nutrient-rich terrain such as white goosefoot (*Chenopodium album* L.) and possibly trodden terrain (*Polygonum* cf. *aviculare* L.). Some of these taxa occur particularly in the lower and middle part of the profile at 2.22-2.27 masl (sample 13), 2.32-2.37 masl (sample 11) and 2.52-2.57 masl (sample 7).

Discussion

Environment

In a major part of the profile (samples 15-4, 2.07-2.72 masl), the mollusc fauna, with the common mussel, the spire snail and the lagoon cockle as dominant taxa, as well as the common plant taxa beaked tasselweed, bulrush and orache, indicate the presence of a brackish lagoon, with predominantly annual variations in salinity caused by seasonal variation in the freshwater supply and evaporation. The water was calm, clear and shallow, with a depth of *c*.0.5 m. The presence of the common mussel indicates that the water body was connected to the open sea.

The assemblage at 2.72-2.82 masl (upper samples 2 and 3) includes a greater diversity of salt marsh plants, water plants that tolerate both brackish and freshwater conditions, and ostracods, than the samples below at 2.12-2.62 masl, indicating that an environmental change occurred. The upper 10 cm of the profile (sample 1) contains freshwater molluscs and taxa of water edges, freshwater marshes and dune valleys, including taxa that do not tolerate brackish conditions, and indicate a decrease in the salinity of the lagoon.

With the exception of only a few remains and taxa, the taxa of dry terrain are mostly found in the lower half of the studied profile (at 2.22-2.57 masl, samples 13-7) that represent two different stratigraphical layers. Although it is not clear what the size of the Magleholm island was at this time, these taxa could represent the vegetation on the island, thus indicating erosion and rolling or washing down of seeds and fruits. Alternatively, it may concern remains of vegetation at other dryland patches in the lagoon transported via water.

The upper 10 cm of the profile (2.82-2.92 masl, sample 1) contain relatively many seeds and fruits of taxa of water edges, freshwater marshes and, to some degree, vegetation of dune valleys, including common alder. Such vegetation may have occurred on the slopes of Magleholm island or elsewhere along the borders of the lake. The seeds and fruits may also have been part of a drift litter zone deposited by water (Cappers 1993). In any case, the sample represents a thanatocoenosis, i.e. remains of taxa that did not all live contemporaneously at the same spot but instead represent multiple habitats, since alder does not tolerate brackish conditions while some of the molluscs that occurred locally are indicative of brackish water environments. Considering the thickness of the sample (10 cm) and the occurrence of shells in layers, another explanation for the coexistence of freshwater and brackish water taxa is that periods and/or influxes of more and less brackish water alternated.

Indications of human Impact

The macroremains assemblage contains various edible taxa, including hazelnut, blackberry, sea aster, annual seablite and water pepper, amongst others. However, none of the seeds and fruits were found in a carbonized state, fragmented in such a way that demonstrates handling by people in the past, or found in a context, quantity or concentration that assures deposition by people. While people thus potentially may have used various of the taxa present, there is no explicit evidence of such use. The best indications that the investigated profile intersects refuse layers comes from the finds other than molluscs and seeds and fruits, such as the presence of sand lenses in the gyttja that may have resulted from either storms or erosion of the island, and small fragments of flint and the remains of charcoal present in most samples. A flint fragment (0.0183 g) from 2.32-2.37 masl (sample 11) was possibly worked.

Comparison with earlier published Information about Magleholm

Despite the lack of radiocarbon dates from the studied profile, which may potentially become available when a site report about Magleholm appears, and despite it being unclear how the earlier studied profile and the new profile relate to each other precisely, the analysed data and data from earlier published profiles from Magleholm can be compared with each other. The brackish gyttja in the investigated profile, with a thickness of 60 cm, may correspond with the earlier described marine gyttja layer, which was *c.*1 m thick elsewhere at Magleholm. The investigated samples indicate a brackish rather than a true marine environment, but there was indeed a connection to the open sea, and the earlier description "marine" can probably primarily be interpreted as opposite to limnic, i.e. freshwater conditions. Whether the earlier reported subboreal transgression, dated between 3850 and 3700-3600 BCE and registered at Magleholm only (Christensen 2014, 11), is present in the studied profile is not clear. Elsewhere in the profile, at 50 cm distance from the analysed samples, a layer rich in molluscs is present between the layers of samples 1 and 2 and perhaps this layer represents the transgression phase. Concerning the earlier reported transgressions and regressions, it should be noted that today the interpretation that large fluctuations as have been observed in the Vedbæk fjord represent oscillations of the global sea level changes is subject to discussion (see *e.g.* Yu 2003, 16 and the discussion in Bennike et al. 2023, 449).

The upper part of the profile at 2.72-2.92 masl, *i.e.* the three upper samples, represent a gradual transition of the lagoon to a freshwater lake. However, since the upper sample still contains taxa indicative of brackish conditions, this sample must predate the closing of the connection with the sea that was dated to "shortly after 3500 BCE or at least before 3000 BCE" (Christensen 2014, 12). The peat present above the investigated profile matches the peat found in earlier studies at Magleholm and represents the infill of the freshwater lake.

The earlier pollen analysis of Magleholm aimed to date samples and layers and focused much on whether these pre- or postdated Landnam phases.

Tasselweed was regularly found, as well as dinoflagellates (*Hystrix* sp.), confirming the brackish conditions. Similar to the current study, the pollen analysis does not show dominance or frequent occurrence of obligate marine plant taxa. Also the Chenopodiaceae and Asteraceae, which may include salt marsh taxa, do not reach include high percentages.

Short Comparison with other Locations

Brackish waters commonly occurred along the Danish coast during the middle Holocene. Locations from which macroremains and mollusc data are available and that point to environmental conditions that are comparable to Magleholm include *e.g.* Brabrand fjord (eastern Jutland), Syltholm (Lolland) and Gilleleje (northern Sjælland). Brabrand fjord had an open connection to the sea between 7500 BCE (8500 cal BP) and 3500-900 BCE (5200-2900 cal BP). The mollusc assemblage contained taxa of marine and brackish conditions, while the macroremains assemblage was characterized by scarce finds of particularly tasselweed and additionally a few remains of horned pondweed (Bennike et al. 2022, 111-112). At the coastal zone of Syltholm, slightly more saline conditions occurred during the Middle Holocene than at Magleholm (Bennike and Jessen 2023, 37-39; Bennike et al. 2023: phase with tasselweed, horned pondweed, charophytes, mud snail, cockle, periwinkle and common mussel). At Gilleleje, beaked tasselweed and spiny naiad dominate the macroremains sample from a profile dating to 5100-5300 BCE, but the frequent presence of the common cockle indicates that the environment must have been more affected by the sea than at Magleholm. Like at Magleholm, also at this location the samples show a combination of taxa from a brackish water environment and dryland taxa (Henriksen and Jessen 2014, 2015).

Conclusions and wider Perspective

The analysis of molluscs and botanical macroremains presented above provides a paleoenvironmental reconstruction of the Mesolithic and Neolithic site of Magleholm in the Vedbæk fjord. The sample location, located at *c.*10 m distance from the shore of a brackish water lagoon that ultimately changed into a more freshwater environment, can be interpreted as an off-site location. Indications of human activity include small pieces of flint, charcoal, carbonized fish and carbonized culms. The botanical macroremains give information about the vegetation present in the larger area, including salt marsh vegetation of the brackish lagoon, woodland vegetation and later also vegetation of water edges, freshwater marshes, beaches and dune valleys. Although the environmental reconstruction of Magleholm is based on data from only a single sample column, the data are relatively consistent and compatible with earlier environmental reconstructions of the lagoon. While the plant data from Magleholm hardly provide concrete evidence of plant use, they do give information about the vegetation types present in the fjord, the environment that the people living at Magleholm experienced on a daily basis and the plant resources that were available to them (*cf.* Schepers 2014).

Since the publications by Zvelebil (1994) and Mason and Hather (2002), the number of macrobotanical analyses of Mesolithic sites has shown a strong increase all over Europe (*e.g.* Antolín et al. 2016; Bishop 2021; Bishop et al. 2014, 2015; Deforce et al. 2013; Jensen et al. 2024; Lagerås et al. 2021; Lopez-Doriga 2016; Out 2009; Ptáková et al. 2021). On the one hand, macrobotanical studies in Denmark, also of Mesolithic sites, have a long history (*e.g.* Broholm 1924, 19-20), but on the other hand, information on plant use in the Mesolithic in this region is still relatively scarce, as recently discussed in a review by Termansen et al. (2024). Data from coastal Mesolithic sites are even rarer. The present study from Magleholm, although having its limitations because of the absence of more precise context information, thus makes an important contribution, even more since there are hardly any other botanical data sets available from the Vedbæk fjord. Hence, this study underlines both the potential of and need for additional botanical macroremains analysis at comparable archaeological sites. Additional archaeobotanical analyses of other Mesolithic sites in Scandinavia, as well as sites that cover both

Mesolithic and Neolithic occupation phases, would be highly relevant, for example to shed light on the use of both food plants and those that provided raw materials, as well as on the character and extent of human impact on the vegetation and how this interplay developed through time, to get a better understanding of former societies and cultural processes (*e.g.* Bakels and Van Beurden 2001; Bakels et al. 2001; Holst 2010; Kubiak-Martens et al. 2015; Out 2008a, b; Out and Verhoeven 2014; Schepers and Bottema 2020; Sørensen and Karg 2014; Wolters 2016; see also Blaesild et al. 2024; Groß et al. 2018). In this respect, the current PhD project by Signe Sangill Termansen at Aarhus University, focusing on submerged coastal Mesolithic sites, is expected to provide an important contribution to the understanding of plant use in Southern Scandinavia.

In the case of future excavations of similar Mesolithic and Neolithic sites with partially waterlogged deposits, it would, in so far the presence of undisturbed deposits allows, be relevant to combine an off-site environmental study like this and palynological analysis, ideally including multiple cores, with analysis of grid sampling and analysis of both carbonized botanical macroremains of samples from the slopes and dry parts of the dune, analysis of samples of carbonized and uncarbonized, worked and unworked wood, and, for example, phytolith and starch analysis of food crusts, grinding stones and/or dental calculus from human teeth. Applying such a multi-proxy approach within the framework of a wider archaeological study could give a reconstruction of the use of a broad range of plants, covering the use of plants, including wild plants, for food, fuel and craft, while it could also contribute to the understanding of activity zones, the function of archaeological features, and depositional and taphonomical processes. Given the scarcity of archaeobotanical data so far, especially from Mesolithic sites, future excavations have a strong potential to gather a wealth of new data.

Acknowledgements

The authors are grateful to L.B.M. Verhart for sample collection, L.V. Sørensen and T.Y. Abrahamsen for information about the site history, M. Kanstrup and J. Olsen of the Aarhus AMS Centre and the Oxford Radiocarbon Accelerator Unit Research Laboratory for Archaeology and the History of Art for information about radiocarbon dates (K-3150, K-4178 and OxA-27117), M. Andonova-Katsarski, O. Brinkkemper, M. McClatchie and M. Monck for literature suggestions, J. Kveiborg for ecological information about the fishes, C. Christensen, C. Jessen, O. Bennike and P. Rasmussen and three reviewers for helpful comments and suggestion, and the graphical department of Moesgaard for the figures.

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.

Notes

1 The Vedbæk water body was not always a fjord but was connected to the sea during the period studied in the project (discussed further below).

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A Craft Perspective on Pitted Ware Point Typology

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ABSTRACT

The Pitted Ware Culture of the Neolithic in southern Scandinavia is famous for its tanged flint points made from retouched blades. Scholars have long agreed that there are three distinct types, A, B and C, and academic discussions have suggested various regional, functional and chronological differences. However, in these discussions the technological perspective is largely overlooked. In this paper, the author presents technological evidence to correlate Pitted Ware point types to different production stages, within the same production process, which explains the typological differences. The results show that the initial crested blades present the ideal morphology for the type C points, which explains the form, flaking, length and scarcity. The type A points follow the morphology of blades from the later stages of production, which corresponds to their shape and length and their more numerous appearances in the assemblages. Blades from the intermediate production stage correspond to the B type. This study suggests that all Pitted Ware point types are derived from the same production process, and the typological differences are closely linked to the distinct blade morphologies that occurred during the production.

ARTICLE HISTORY
Received
03 April 2025;
Accepted
19 August 2025

KEYWORDS
Neolithic; Pitted Ware Culture; Lithic technology; Typology; Experimental archaeology.

Introduction

During the Neolithic in Scandinavia, the phenomenon of the Pitted Ware Culture (3400-2200 BCE) appears (Iversen et al. 2021). This Neolithic culture is known for a more hunter-gathered-like society with distinct material culture, like Pitted Ware pottery and cylindrical blade cores, but most importantly for this paper - the Pitted Ware flint points, that are synonymous with this culture. These projectile points are distinctive and captures the imagination of what Stone Age life must have been like – likely quite brutal to the modern eye.

Several scholars have written dedicated works on the Pitted Ware Culture, its chronology and its typologically distinctive forms (Becker 1951, 1955; Edenmo et al. 1997; Iversen 2010). In this article, the author will shed new light on some of the discussions of the Pitted Ware Culture, only this time focusing on what the flint technology can reveal from a craft perspective.

The author has been involved in craft reproductions, lithic analysis and experimental archaeology since 2012 with a specialization in Neolithic flint technology. This experience has come to use in the reproduction of cylindrical blade cores, blade manufacture and Pitted Ware point production. A total of 11 cylindrical blade cores have been produced and blade production has been carried out until the cores were exhausted. A selection of blades from each core has been flaked to form the distinct tanged point types. During this production, a number of observations have been made that will shed new light on the Pitted Ware point typology and the associated technology. The observations in the experimental material have been compared to the archaeological finds from Denmark, namely Helgeshøj in Taastrup (Sparrevohn 2016), Musefælden and Neden Skiden Enge on Djursland (Rasmussen 2020), Ginnerup on Djursland (Klassen et al. 2023) and Kirial Bro and Kainsbakke on Djursland (Rasmussen and Boas 1982; Wincentz 2020).

The central finding is that the typological distinction between Pitted Ware points of type A, B and C correspond to separate production stages where the morphology of the flint blades limits the range of possible modifications when producing projectile points. In essence, Pitted Ware point morphology is defined by the production stage from which the blade was produced.

Research Context

The Pitted Ware Culture in Denmark was defined in the 1950s by Carl Johan Becker (1951), who defined the culture based on the distinctive Pitted Ware ceramics, cylindrical blade cores and tanged flint projectile points. Three types of arrowheads (A, B and C) were defined with a number of subtypes for each main type (Becker 1951). All three types share a flaked tang, a mostly symmetrical outline and are all made of straight flint blades. The type A is a simple projectile point with minimal edge retouch around the tip and tang of the blade. The type B is characterized by further retouch, as both the edges and ventral side of the tip and tang are flaked, some with serrating edge retouch. The type C is characterized by a triangular cross-section and has flaking that covers nearly all three sides, often with a fine, serrated edge (Becker 1951).

Since the 1950s, a number of Pitted Ware sites have been discovered in southern Scandinavia, and the possibility of a chronological subdivision of this culture was discussed on the basis of the tanged flint points (Becker 1951; Iversen 2010; Rasmussen 1986). This theory likely arose from the general archaeological thought of prehistoric cultures as developing from simple towards complex or refined, especially when looking at the technology. This general trend is found in the development from the Stone Age, to the Bronze Age and into the Iron Age – all the way to modern technology (Thomsen 1836). This is the idea of a growing sophistication with its regressions and explosive break-throughs, but with a general trend towards the better. One such example, that scholars dealing with the Pitted Ware chronology must have been aware of, is the flint dagger typo-chronology of the Late Neolithic in southern Scandinavia and northern Germany (Hübner 2005; Lomborg 1973). In this case, the flint daggers are advancing in technological complexity and technique throughout the period, again, a general developing sophistication. Following these ideas, it seems obvious that the Pitted Ware point type A resembles simplicity by having minimal modification of the blade. The type B is slightly more refined with more extensive modification. Lastly the type C, which is highly modified, most refined, and has three flaked sides with serrations. The natural conclusion is that these differences represent the same kind of increasing sophistication, which developed over time, making the typology a typo-chronology. This idea was presented already in the late 19th century (Müller 1888). However, as Rune Iversen has pointed out, there is no reason to think of this typology as a basis for subdivision of the Pitted Ware Culture in a chronological sense in southern Scandinavia (Iversen 2010; 2015, 42-44). This paper argues that the contemporaneous nature of the Pitted Ware point types is rooted in the production sequence, which clearly connects all types to the same craft procedure.

Experimental Reproduction

In order to study the technology behind the Pitted Ware points, the author has reproduced the production sequence, based on the finds of blade cores and points from the period. To the author's knowledge, no complete assemblage suitable for a complete refitting of a blade production from the period has been found. This means that the production is puzzled together from the indications on the Pitted Ware finds, and analogies to other blade production processes that have been studied and analysed (Pelegrin 2006; Sørensen 2006; Sørensen et al. 2013). In the following section, the method of replication is described with emphasis on the critical observations that underline the interpretations of the Pitted Ware technology.

Preparing the Core

Reducing raw flint nodule to a ready blade core requires strategic reduction, in order to establish a cylindrical preform with two platforms, one at each end, and one or more pronounced front ridges or crests, stretching from end to end, which is the prerequisite of initiating the blade production. These crests are used to steer the first blades to run true across the face of the core (Figure 1). This core morphology is reached using direct percussion with hammerstones and further refined flaking using indirect percussion with antler punches (Bye-Jensen 2011, 68). These are tools consistent with the finds from the site at Ginnerup (Klassen et al. 2023).

At this stage, the blade core is at the maximal length and will, in turn, produce the longest blades. These initial blades, that are removed from the prepared crests, called crested blades, are three-sided (trihedral) and one core only yields up to around four of this blade type. Pitted Ware core preforms with prepared crests and crested blades have been discovered at sites like Musefælden and Neden Skiden Enge on Djursland (Rasmussen 2020, 147). A core preform from Musefælden is 16 cm long and slightly conical with three prepared crests (Rasmussen 2020, 147).

The creation of the core requires flaking of the surfaces, which will steer the blade morphology as the blades detach across the flaked surface. This means that the earliest blades are rather thick and will have meandering edges (Figure 1). In order to produce Pitted Ware points from these blades, a straightening of the edge is required. The straightening of the blade edges is done by pressure flaking from the edges, which covers all sides of the blade.

As defined by Becker (1951), the degree to which the blades have been modified or flaked, determines the typological classification. Consequently, the crested blades cannot be flaked into points of type A or B, since the crested blades do not follow the required morphology. These initial crested blades precisely mirror the morphology of the type C point, by being trihedral and longer than later blades, which also is reflected in the archaeological record (Iversen 2016, 76). In order to use the crested blades in the production of projectile points, a modification of the blade is needed. This will in most cases result in the flaking of all three sides, since the blade is trihedral, which demands a classification as a type C point. In general, the type C points are the largest of the group, the record being 18,6 cm (Becker 1958; Iversen 2016, 76). The lengthy type C points coincide with the length of the core at this earliest stage where it is at its largest. Undoubtedly, short type C points can be identified in the assemblages, but must simply be attributed to the fact that blades can be shortened, but never made longer.

Figure 1. Experimental bi-polar cylindrical blade core with detached crested blade (Photo: S. Stenak).

Additionally, the true trihedral cross-section of a type C projectile point that has three edges, is exceptionally difficult to create from a blade that does not have three edges. Flaking a type C point from a trihedral blade is the only plausible way of retaining the three edges, which falls in line with the observations of both the length of the crested blades and the required edge straightening, as described above.

In order to regularize the core and begin the serial production of straight, regular blades, a number of semi-regular blades are removed following the crested blades (Figure 2). These blades are characterized by being relatively long as they are detached during the early stages of production. In addition, the technological function of these blades is to remove irregularities from the core face left by the preparation of the preform. This leaves irregular

Figure 2. Experimental bi-polar cylindrical blade core with detached intermediate blade and experimental type B point (Photo: S. Stenak).

sections on the dorsal face of the blades, which requires retouch to regularise. These blades are used to produce the type B Pitted Ware points, since they require further modification compared to the more regular type A.

Later in the reduction, the core is shortened repeatedly by platform rejuvenation, in order to prepare the core for further blade removals. As a consequence, the blades become shorter. Also, the core is continuously regularised by the removal of blade sequences, making the blades increasingly straighter and thinner (Figure 3). These blades meet the requirements of making the type A Pitted Ware points. The type A points are relatively thin, short and regular with minimal need for shaping retouch. The regular blades of the middle and late stages of production are significantly more numerous, since they belong to the stages of production where blade removals are the result of ridges, or erases, left by the previous blades. The repetitious blade production is carried out until the core is discarded by being flawed or used up as seen at numerous sites like Ginnerup (Klassen et al., 2023), Kainsbakke (Rasmussen and Richter, 1991) or Kirial Bro (Rasmussen and Boas, 1982). The useful blades are modified by retouch in accordance with the blade, some requiring more modification than others to straighten (Figure 3).

Discussions

In some aspects, the Pitted Ware point technology is characterized as rather opportunistic, meaning, that blade cores were not only fashioned from raw nodules of flint, but also from repurposed flint axes. Blades from repurposed square-sectioned flint axes are known from several sites like Helgeshøj (Sparresvohn 2016) and Kainsbakke (Rasmussen 1991, 35) (see Figure 4). This interpretation might also explain why the type A points are still considered the earliest type, even after Iversen has reiterated that the three types are contemporaneous in Denmark (Iversen 2015). If the type A truly is the first Pitted Ware point type, then it may be plausible that the characteristic cylindrical cores, producing crested blades, as described previously, was not a central technology from the onset, but was developed shortly after. Strictly looking at the flint points, any straight and thin blade can be used to produce the type A, it does not have to come from a prepared and planned production with that intent.

This is an important point to stress, since it is possible to produce blades for Pitted Ware points of type A and B without initiating the production by crested blades. Using a natural flint nodule as a core, or simply shaping the core using direct percussion can constitute the prerequisite of the blade production. This would lead to a blade production, only allowing for type A and B points to be made, which, in turn, could explain early Pitted Ware sites with no type C points in the assemblages. This would be an argument in favour of a typo-chronological development, where the technology moved from simple to advanced, by the addition of crested-blade technology and the type C points later in the Pitted Ware Culture. However, this seems like

Figure 3. Experimental Pitted Ware projectile points alongside their respective blade. From left to right: Crested blade and corresponding type C point, regular blade and corresponding type B point, late-stage regular blade with corresponding type A point (Photos: S. Stenak).

an unlikely scenario considering the technological complexes surrounding the Pitted Ware Culture.

Crested blades were part of flint blade technologies of Scandinavia since the Late Upper Palaeolithic Hamburgian Culture, and blades and cores with this distinct preparation can be attributed to periods throughout both the Mesolithic and Neolithic (Pelegrin 2006; Weber 2008, 85). Moreover, the central lithic technology of the Neolithic in southern Scandinavia is the square section technology used in the production of axes, chisels, daggers and blade cores. The dominant of these are the square sectioned axes that are flaked with four longitudinal "crests", and the technology is remarkably similar to the crested blade cores. With this in mind, it seems highly unlikely that the crested blade technology was not developed from the onset of the Pitted Ware Culture, especially considering the number of Pitted Ware points made from blades detached from repurposed square sectioned axes (Figure 4). With these considerations in mind, the crested blades were likely a technological component from the onset of the Pitted Ware Culture in Denmark, which leaves little reason to think of the type C arrow points as a late type and type A as an earlier type.

Another argument for a subdivision of the Pitted Ware Culture, based on the point typology, is that the type A is more numerous on the earlier sites, whereas the type B and C are more dominant on later sites (Iversen 2016, 82). The technological explanation would be that of technological refinement during the Pitted Ware Culture. Considering the arguments above, one explanation could be that the goal of the blade production in the early Pitted Ware Culture was shorter and thinner blades for projectile points, even if crested blades were part of the production of blades. The crested blades were not deemed fit for projectile point production, but as the technology advanced,

Figure 4. Pitted Ware points from Helgeshøj, Denmark. From left to right: Type C point showing the original crested blade morphology, two type B points made of blades from repurposed ground flint axes (Photo: Mette W. Skjødt).

they were included, which turned into the type C points as we have defined them now. This would explain the typological distribution of Pitted Ware points from sites with no type C points, but finds of crested blades like Alvastra Pile Dwelling in Sweden (Browall 1986, 294; 2011, 185-197; Malmer 2002, 103-111).

As stated earlier, the crested blades used for the type C points are few in number in the production, which limits the access to this resource. The most abundant blades from the core are shorter, thinner and more regular blades suitable for type A points. This distribution of blade types mirrors the distribution of Pitted Ware point types found on sites in Denmark and western Sweden. Out of 1567 Pitted Ware points, classified by Rune Iversen, type A covers 75.7% of finds, type B covers 15.1% and type C covers 9.2% (Iversen 2016, 76). The same relative distribution of blade types can be observed in the reproduction. The experimentation shows that a blade core yielding 35 usable blades, no more than four crested blades are produced, and of these, not all are detached intact or usable for projectile points. This further supports the idea of Pitted Ware point typology as directly associated with the blades from various production stages.

In the 2011 experimental reproductions of Pitted Ware points done by Bo Madsen, it was observed that almost every blade from the core was usable to produce Pitted Ware points (Bye-Jensen 2011, 68). The experimental results of this study support the observations made by Bye-Jensen, in that only the rejuvenation flakes from the platform and the core front were unsuitable for point production. If this analogy is applicable, this could imply that the Pitted Ware point production was defined by the blade morphology as the blade production was effective at producing suitable material throughout the stages with minimal waste products. The point production was not limited by focusing on a very specific blade morphology that seldomly occurred like the Levallois points (Crassard and Thiébaut, 2011).

The interpretations as presented in this paper does not imply that no technological developments were made during the Pitted Ware Culture. Craft refinement is likely to have evolved throughout the culture, and may be observable in the archaeological assemblages, but the criteria used in the current typology does not offer such a division. In southern Norway and western Sweden, the tanged blade point technology was implemented in the early Middle Neolithic without evidence of type C Pitted Ware points (Olsen 2020, 130). At this early stage, the technology was focused on using the regular blades for the production of points with minimal retouch. Later, during the Middle Neolithic, the type C points were introduced in these geographical areas, which suggests a technological development in Pitted Ware point morphology.

In regards to the subtypes (A1-A3), that are defined by being retouched from either the ventral or dorsal side of the blade (Becker 1951, 189), there are no major technological comments to be made. The subtypes seem to be variations defined in modern literature to distinguish regional or other variation. Retouching blades from the ventral or dorsal side does not offer any significant differences in the production techniques. In some cases, the flint-knapper may be forced to flake from the opposing side to the intended, as a result of flaws in the blade or a crushing of the edge. However, in general, the blades can be modified in any which way the knapper chooses with ease.

In the experimental archery, using reproductions of type A Pitted Ware points, Bo Madsen used direct hammerstone percussion to retouch the points into shape, as opposed to pressure flaking (Bye-Jensen 2011, 68). The type A points does not require controlled, pattern-like flaking to shape the cross-section of the Pitted Ware points, like the type C. The type C points could not have been produced using hammer stone retouch, since this technique does not offer the fine, controlled flaking as seen on this type. However, the simple type A points are made of regular blades, which require minimal modification, and the steep retouch left by the hammer stone is consistent with the flaking seen on the tip and tang of some type A points. Additionally, the serrated edge retouch of some type B Pitted Ware points can be produced by both pressure flaking and hammer stone retouch. Simply crushing another flake perpendicular to the edge of the blade will create serrations. These possibilities of differing techniques also implies that technological developments could have been made during the Pitted Ware Culture. It is possible that pressure flaking was a later adaptation to the technology, which enabled the flaking of the type C points and finer examples of type A and B. However, if the point types are contemporaneous, the explanation could simply be that some type A points could have been made using hammer stone retouch, even if pressure flakers were part of the tool kit. Moreover, a steep and irregular retouch can be achieved by both hammer stone, antler or even copper tools, which means that the retouch seen on the type A Pitted Ware points cannot be exclusively linked to any production tool type.

In the 2016 article on Pitted Ware point typology, Iversen discussed the idea of attributing various functions to the three point types. Additionally, Bye-Jensen (2011, 77-78) has presented an interpretation of the functions of the Pitted Ware point types, hypothesizing a varying hunting related function to each sub-type (A0-A3) and a warfare and/or ceremonial function of the B and C types. The more recent finds at Helgeshøj sheds new light on this functional division, since all main types (A, B and C) are represented in the assemblage, all with clear indications of impact fractures (Sparresvohn 2016). This suggests that at all point types were used in a similar fashion, at least at Helgeshøj.

This paper presents no evidence to contradict the idea of varying functions attributed to the point types, but an argument to be made in this discussion is that the blade morphology likely plays a part in the interpretation of the three types. It is entirely plausible that the distinctly different point types correspond to separate functions, but we may also think of these different forms as derived from the types of blades available. A thick, crested blade requires more reshaping and narrowing retouch, in order to become a projectile point. A thin, straight and short blade requires little modification to become the same. By retouching a fragile blade edge, the edge will become serrated unless it is dulled by grinding. This is a simple and effective action that should be included in the understanding of why the points look the way they do. The root of this discussion is in essence the way we perceive craft and innovation of the past. In modern archaeological research it is easy to put forth ideas of prehistoric creative ingenuity that goes beyond the constraints of the material. Flint, clay, amber, wood and all other craft materials have natural properties that steer the innovation within the craft. The available material and its properties dictate on par with human ingenuity, how material innovation is developed. The question becomes: where does material understanding end and human ingenuity begin?

By making these suggestions, the author is applying a flint-knapper's logic that may transcend time and space. We cannot know what past thinking was like, but in flint-knapping we can know how the morphology could have been achieved, and in some cases how it must have been achieved.

However, one must not be blinded by the kind of inferences made in experimental flint-knapping (Eren and Meltzer 2024, 4). Experimental flint-knapping does not replicate past thinking or practice, but can present articulated arguments that contribute to our understanding of the past.

Conclusions

This study suggests that all Pitted Ware point types are derived from the same production process, and what defines their morphology is the stage from which the blade was produced.

Pitted ware points of Becker's (1951) type C correspond to points made from blades of the initial blade production. These crested blades are at the maximal core length, they are three-sided and are the least numerous of the blades from a core. Furthermore, this type of blade requires invasive flaking, in order to shape into a projectile point. These factors correspond to the archaeological finds, as the type C is the longest of the point types, has invasive flaking of all three sides and is only represented as 9.2% of the Pitted Ware tanged points (Iversen 2016, 76).

Points of Becker's type A correspond to blades from later production stages where the blades are increasingly regular, shorter, thinner and most numerous. In the archaeological assemblages, the type A represents 75.7% of the Pitted Ware points (Iversen 2016, 76), which mirrors the dominance of the regular blades of the experimental production.

The type B points correspond to all the blades from the intermediate stage by being non-crested with a medium build. These blades require less modification than the crested blades, but more than the regular blades.

This builds on the suggestion that the Middle Neolithic Pitted Ware point typology is rooted in the production stages, which challenges the idea of a chronological development between the three main types in Denmark. The idea of a growing technological refinement during the Pitted Ware Culture in Denmark, following the tanged point typology, is severely challenged by the technological analysis, however, it remains likely that technological refinement did take place in regards to how the points were produced and the level of refinement.

Acknowledgements:

I would like to acknowledge the two anonymous peer-reviewers for their insightful and constructive reviews of this paper. Also, I would like to express words of gratitude to Rune Iversen for guidance and valuable comments on the text and concepts.

Funding details

This paper did not receive any funding.

Declaration of interest

None.

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The potential of overlooked material in museum repositories

Revisiting grave materials in Falbygden through multiproxy analyses

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ABSTRACT

In this article we aim to highlight the potential of forgotten grave materials in our museum depositories for gaining insights into prehistoric life. By applying a multi-proxy approach to the skeletal remains of two graves of uncertain types from Falbygden in western Sweden, we were able to acquire new knowledge of burial practices, subsistence, health and mobility in Late Neolithic and Early Bronze Age communities. One of the studied graves proved to be the earliest attested gallery grave in the area, while the other is one of the few known graves from the first period of the Bronze Age. The results indicate that some overlooked excavated materials in our depositories might stem from certain time periods from which we think archaeological remains are lacking and/or from practices which are not fully understood. These remains may prove to be important for our understanding of prehistoric societies when thoroughly studied combining archaeological, osteological, biochemical and geochemical methods.

ARTICLE HISTORY
Received
15 November 2024;
Accepted
18 February 2025

KEYWORDS
Multi-proxy approach; Osteology; Archaeology; Stable isotope analysis; Radiocarbon dating; Peptide analysis; Strontium isotope analysis; Late Neolithic; Early Bronze Age.

Introduction

Museum repositories are unique sources of new knowledge about the past and are thus invaluable for research. Even poorly documented materials can provide useful information to improve our understanding of prehistoric societies, not least in view of the latest developments in scientific methods. These overlooked remains may in fact represent time periods where we lack known material and/or poorly understood practices. In this study, we want to highlight the burial customs and lifestyle of Stone Age and Early Bronze Age people by studying two forgotten materials stored in the repository at Falbygden Museum.

Our knowledge of the Stone Age in Falbygden is mainly based on studies of megalithic graves and their contents (Ahlström 2009; Sahlström 1932; Sjögren 2003). The megalithic graves in Falbygden consist of dolmens and passage graves from the Early and Middle Neolithic (*c.*3500-3000 BC) Funnel beaker complex (TRB) and hällkistor/gallery graves from the Late Neolithic (2200-1700 BC, see Blank 2021, 13; Blank et al. 2020, 2) period. The material from the megalithic graves has been collected mainly in the early 20th century when most of the graves were only partially investigated, although later excavations also occur (e.g., Cullberg 1963; Persson and Sjögren 2001). The focus of interest has been on the numerous and impressive passage graves found in the area, although in recent years new knowledge about the dolmens and gallery graves have come to light (Blank 2021; Blank et al. 2020; Sjögren et al. 2023). Wetland finds, deposits, loose finds, and settlements have also contributed to what we know about the Stone Age communities in Falbygden and the surrounding area (e.g., Sjögren 2003; Sjögren et al. 2017; Sjögren et al. 2019; Weiler 1994). The Early Bronze Age (1700-1100 BC) period in the area is less studied and the confirmed burials from this period consist of the continued use and reuse of gallery graves and low profiled cairns (Blank 2017; Sahlström 1932; Weiler 1994).

Substantial archaeological and bioarchaeological work has been carried out on the relatively well-preserved skeletal remains from the Middle Neolithic passage graves (Rascovan et al. 2019; Seersholm

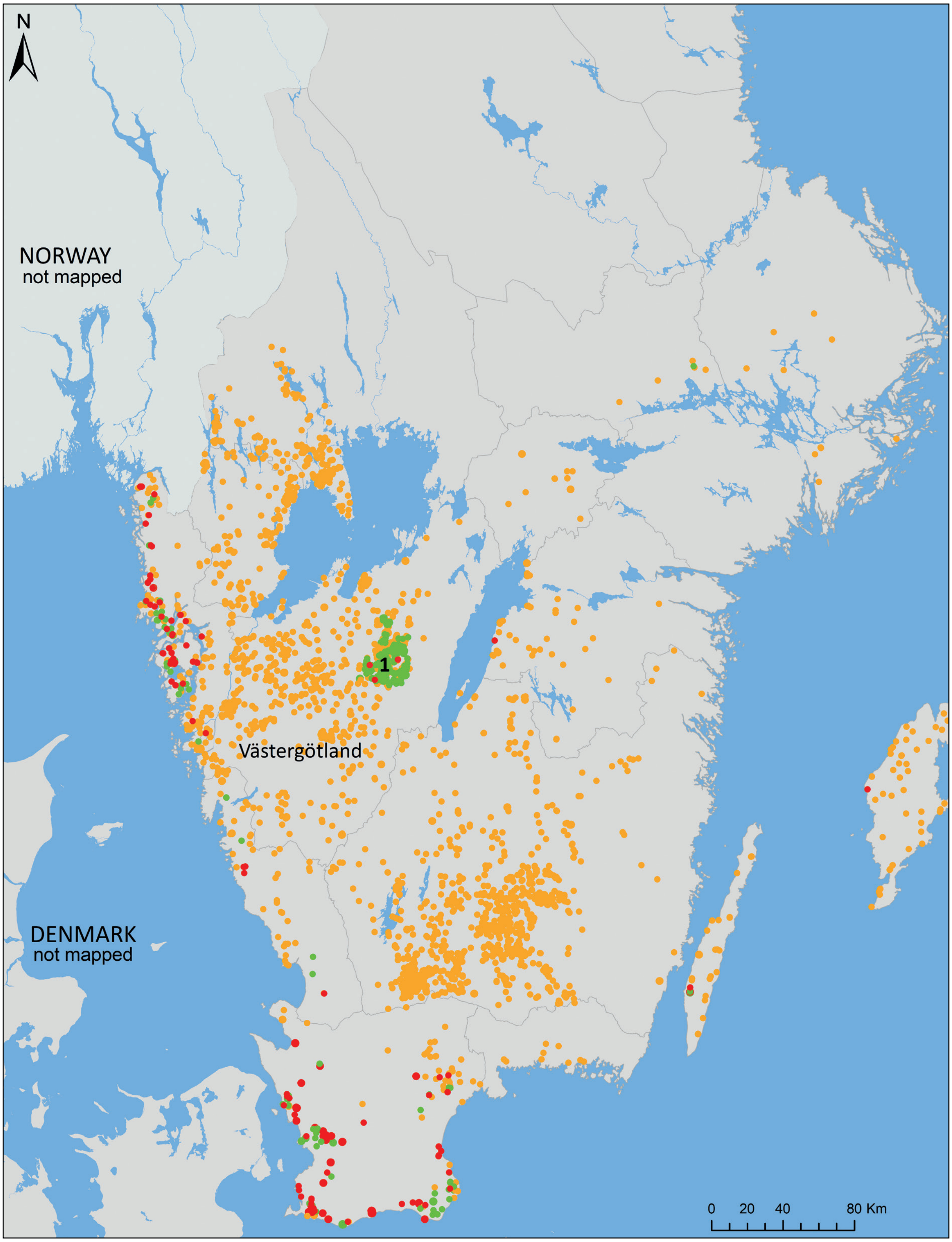

Figure 1A. Overview of southern Sweden with the distribution of megalithic graves (red dots: dolmens, green dots: passage graves, orange dots: gallery graves). 1: Falbygden (see figure 1B).

et al. 2024; Sjögren 2017; Sjögren et al. 2009; Skoglund et al. 2012; Skoglund et al. 2014) and Late Neolithic gallery graves (Blank et al. 2018a; Blank et al. 2020; Blank et al. 2021), as a consequence of recent methodological advancements in archaeology. These studies have provided new insights into the chronology of interments, as well as the diet, health, and mobility of the interred individuals. Furthermore, analyses of Middle Neolithic burials have evidenced outbreaks of plague (*Y. pestis*) thousands of years prior to the 14th Century AD pandemic (Rascovan et al. 2019; Seersholm et al. 2024). Much of our knowledge is thus based on the remains and relics with varying states of preservation that have been collected over the years.

The burials with poor bone preservation (often fragmented and leached) as well as the graves with co-mingled and/or few skeletal remains have however been unprioritised since they were considered to not contribute to the understanding of the actual burials or Neolithic society in general. Several graves in the area have been damaged by farming or other activities and are therefore difficult to assign to a specific type and/or time period. These materials are often considered troublesome and tend to be avoided in research. Other neglected materials are the ones with minimal documentation. New methodological developments within the last few years might however change this situation and increase our knowledge about people also outside the areas with the most favorable preservation. This article is based on two such assemblages. Both assemblages consist of a few artefacts and bone remains from severely damaged graves.

We provide here an in-depth study of two graves in Högstena and Kymbo, Falbygden (Figure 1A and 1B), where the preserved bones are few, fragmented, and macroscopically in poor condition. The aim is to illuminate the scientific potential of these neglected skeletal remains, when using a multi-proxy approach by combining osteological, archaeological, chronological, geochemical and biomolecular methods.

Material and Methods

Introduction

The study included archive research at Antikvarisk-topografiska arkivet (ATA), Stockholm and Falbygdens museum (FM), Falköping, literature studies and investigating and typological dating

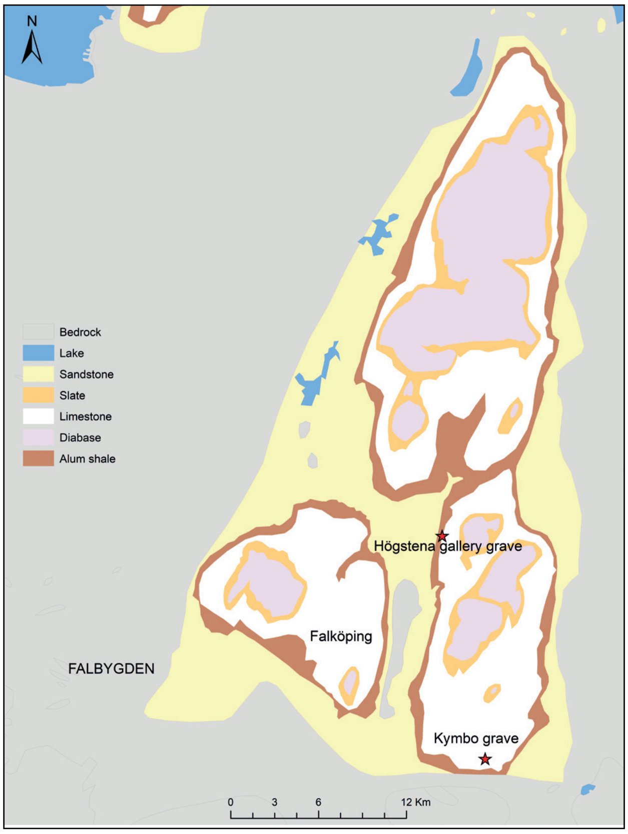

Figure 1B. 1: Falbygden. Close-up of Falbygden showing the Högstena and Kymbo sites.

of the find material. For typological dating of the daggers, we used Apel (2001) and Blank (2022) interpretations of Lomborgs types (1973). For typological dating of the amber and metal finds, museum collections and literature (see result section) were used.

Osteological analysis was conducted on all remains. Samples for radiocarbon, stable isotope and peptide analyses were selected from as many different individuals as possible. The osteological results were decisive for the sampling process as we wanted to ensure that no individual was sampled multiple times. We applied a Minimum Number of Individuals (MNI) approach and targeted the same skeletal element from the same side or used clear age indicators to separate unique individuals when a different skeletal element was sampled.

In addition, three of the sampled individuals from the Högstena grave and one from the Kymbo grave were analysed for ancient DNA (aDNA). However, the bones did not yield sufficiently preserved genetic material.

Högstena, Olof Ingemarsgården

This presumed grave was found in 1932 when the landowner removed a limestone slab in the field. He found two flint daggers and observed some unburnt bones. The site was then investigated by Gustav A. Hellman, antiquarian at the Swedish National Heritage Board, who collected the unburnt skeletal remains, a bone awl and a flint flake (FM1075). Apparently, some smaller limestone slabs had been removed from the same area earlier. Hellman (1933) concluded that these were the remains of a destroyed gallery grave. The size of the grave was estimated to be 3 m x 1.5 m (in a north-south direction) and to a depth of about 0.4 m, based on the size of the slab and the distribution of the skeletal remains (Hellman 1933).

The grave is registered as a gallery grave in the Swedish National Heritage Board's register (FMIS, Högstena 45:1). The nearest archaeological sites consist of a passage grave *c.*50 m northwest of the gallery grave, a Stone Age settlement about 100 m to the west and another passage grave *c.*100 m southwest of the site (FMIS). The site is located about 11 km northeast of the city of Falköping and the prehistoric remains in Högstena parish are dominated by megalithic graves from the Middle and Late Neolithic period.

In this study, the finds were examined, and the bone assemblage underwent osteological analyses. Six human bones (one fibula, one mandibula with molars, and four femora) were sampled for radiocarbon dating, stable isotope analysis and one tooth was subjected to amelogenin peptide and strontium (Sr) isotope analysis (see below).

Kymbo, Backgården

This site is not registered in FMIS. It was found in the 1930s during a rearrangement of the road to the Backgården farm in Kymbo. The site was located approximately 75 to 100 m from the main road and was described by the road builder as a small cairn filled with stones and soil (Forntidskort FM 1677:1-5, notes from 1941). The finds were handed to the local Falbygden museum and consisted of an iron key, an iron mounting, a bronze button, an amber bead, a few pieces of charcoal, and fragmented burnt and unburnt bones. At the same occasion an east-west oriented gallery grave measuring about 3 m x 1 m was found, which had been constructed completely underground (notes from the Falbygden Museum archives-Kymbo parish). It is unclear if these two structures were connected.

Kymbo is located about 15 km southeast of Falköping city, and the area is rich in Iron Age sites. The nearest prehistoric sites consist of an Iron Age cemetery with fourteen round stones settings located *c.*150 m southwest of the site, and a stone age settlement *c.*500 m northwest of the assumed grave. No gallery graves are registered in Kymbo parish, but three passage graves are listed in the FMIS register, the closest of which is about 650 m from the grave.

From this grave assemblage, we studied the finds and conducted osteological analysis. Four human individuals (one mandibula with one first molar as well as two loose premolars and one loose first molar) were sampled for radiocarbon dating, stable isotope, Sr isotope and peptide analysis (see below). In addition, one bovine bone and one dog tooth were sampled for radiocarbon dating and stable isotope analysis (Supplementary material 1).

Osteology

The remains from both gallery graves were severely fragmented and poorly preserved (Figure 2) which significantly limited the amount of information that could be gained osteologically. There is, however, nothing in the fragmentation pattern that suggests intentional breakage of the remains; the assemblages constitute primarily cortical bone and teeth, which is expected from taphonomic processes of non-anthropogenic origin. The aim of the osteological analysis was therefore primarily to get insight into the minimum number of individuals and, if possible, retrieve demographic information, such as age and sex. The osteological information was thus considered to contribute to a deepened understanding of the usage of the graves and possible differences in diet and mobility related to age and sex.

Figure 2. The bone material from the Kymbo grave.

Because of the limitations associated with the poor preservation, there was a necessity to apply the osteological analysis pragmatically. The number of inhumed individuals was assessed through an MNI approach, through calculations of the most frequently occurring skeletal element from the same side with recognisable landmarks, such as distal humerus. Age, size and robusticity were used as discriminators in the calculations.

Sex estimations based on primary characteristics of the pelvis (Milner 1992; Phenice 1969) could not be carried out since relevant elements were absent. Preliminary sex could be assessed in one case based on secondary characteristics of the cranium (Acsádi and Nemeskéri 1970). Substantially different dimensions of joints and long bones were further used for preliminary sex estimations in a few cases.

Subadult age was estimated using dental development (Ubelaker 1978) and epiphyseal fusion (Scheuer and Black 2000). Adult age was estimated using dental attrition (Brothwell 1981). Considering the individuality in dental attrition depending on diet and other cultural and ecological factors, we only used attrition to divide young adults with low levels of attrition from older adults with high levels of attrition.

Amelogenin peptide analysis

Amelogenin peptide analysis is a new technique that can be used to uncover the biological sex of skeletal remains, which for various reasons cannot be determined by osteological methods. The method was developed by Stewart et al. (2017) and provides a minimally destructive and robust tool of identifying the biological sex by acid etching of tooth enamel and following identification of sexually dimorphic isomers of amelogenin peptides.

The analyses reported in this study were performed at the Archaeological Isotope and Peptide Research Laboratory (AIPRL) at the Archaeology Department at Durham University and at the School of Pharmacy and Biomolecular Sciences, University of Brighton, United Kingdom. The procedure of amelogenin peptide extraction of the teeth was carried out following the Stewart et al. (2017) method. The preparation and analyses are described in detail in Rogers and Montgomery (2023) and Stewart et al. (2017).

Radiocarbon dating and stable isotope analysis

Radiocarbon dating is a groundbreaking and since long, well-established method of dating dead organic material by measuring the amount of ^{14}C present in the sample. The method was developed in the 1940s by Willard Frank Libby (1965) and has since then had a major impact on our understanding of prehistory. Stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$ values) on human bone collagen is a widely used method in archaeological research of estimating possible reservoir effects and general consumption patterns in prehistory (Sealy 1986, 2001). The consumption of aquatic foods can affect radiocarbon dating results. This is caused by the fact that carbon consumed by organisms in the water is older than that consumed by organisms on land (Philippsen 2013; Siegenthaler et al. 1980).

The $\delta^{13}C$ value is used for estimating if the protein intake was mainly from marine or terrestrial sources, while the $\delta^{15}N$ value reflects the trophic level of a consumer with increasing values higher up in the food chain (Sealy 1986). Nevertheless, nitrogen isotope fractionation is complex, and the enrichment seems to vary between species as well as between individuals due to differences in diet composition, as well as to physiological and genetic variation (Hedges and Reynard 2007). Furthermore, $\delta^{15}N$ values can be affected by breastfeeding, the consumption of juvenile herbivores (as these are one trophic level above their mothers), physiological stress and the intake of manured crops (Bogaard 2012; Fraser et al. 2011; Fuller et al. 2006; Hedges and van Klinken 2000).

The radiocarbon dating and carbon and nitrogen stable isotope analysis were conducted at the 14Chrono Centre at Queen's University in Belfast, United Kingdom. The Belfast laboratory employs AMS measurement and methods with several cleaning steps including ultrafiltration. Collagen was extracted through a modified Longin method (Longin 1971), developed by Brown et al. (1988). The samples were pretreated using a simple ABA treatment, followed by gelatinization and ultrafiltration with a Vivaspin filter cleaning method (Reimer et al. 2015). A Thermo Flash 1112 elemental analyser coupled to a Thermo Delta V mass spectrometer (EA-IRMS) were used to measure %C, %N, $\delta^{13}C$ and $\delta^{15}N$ of the sample. For more information about the different steps of the sample preparation and radiocarbon and stable isotope analysis see Reimer et al. (2015).

Strontium isotope analysis

In recent years, the study of human mobility in prehistory has seen a breakthrough by the employment of Sr isotope analysis (e.g. Blank et al. 2021; Nehlich et al. 2009; Oelze et al. 2012; Snoeck et al. 2020). Strontium originates mainly from weathered rock minerals and the isotope ratio of the bioavailable Sr largely reflects the local geology, which depends mostly on the type and age of bedrock (Faure 1986). Strontium passes through soil and water into the biosphere and enters the food chain and the human skeleton. The relatively small mass differences between the different Sr isotopes, together with the lack of preferential metabolic processing, mean there is minimal isotopic fractionation (Bentley 2006). Therefore, the Sr isotope ratio can be used to trace mobility if consumption of local water and food can be assumed. Other factors such as an extensive intake of marine foods can also alter the Sr isotope ratio (Blank et al. 2021). Moreover, it should be kept in mind that the samples only reflect a specific time span of the individual's life, depending on for example when the sampled enamel of a specific tooth was crystalized, and that mobility only can be detected if the Sr isotope ratios differ between the areas where the movement took place. For more detailed information on Sr isotope methodology see Bentley (2006) and Faure (1986).

The find sites in this study are located in Falbygden, which chiefly comprises Phanerozoic sedimentary and intrusive rocks surrounded by older Precambrian crystalline bedrock and thus has distinctive Sr isotope signals, quite different from the neighbouring regions (Ahlberg et al. 2013; Blank et al. 2018b). However, glacial deposits add to the complexity of bioavailable Sr and may affect or mask the signatures characteristic of the under-

Figure 3. The intact flint dagger recovered from the Högstena grave.

lying bedrock. The available Sr isotope baseline for Falbygden and the larger province (Blank et al. 2018b), thus, makes this area even more suitable for mobility studies through Sr isotope analysis.

In this study we employed Sr isotope analysis using an ESI NWR 193 nm excimer laser ablation system coupled to a Nu Plasma II (upgraded to Nu Plasma 3) multicollector ICP mass spectrometer (LA-MC-ICP-MS) at the Swedish National Research facility Vegacenter at the Swedish Museum of Natural History, Stockholm. The analyses were conducted in September 2023. A fin spine from a velvet belly lantern shark (*Etmopterus spinax*) was used as the primary standard to which data were normalised to correct for mass bias and intra-session instrument drift; secondary standards comprised teeth from a hare (*Lepus timidus*) and a sperm whale (*Physeter macrocephalus*) previously characterised in-house by thermal ionisation mass spectrometry (TIMS), as well as the USGS reference basalt glass BCR2-G (GeoReM preferred values, Jochum et al., 2005). The instrument was tuned to suppress oxide formation (ThO/Th < 0.5%) to minimise isobaric interferences by CaPO-based polyatomics on mass 87 (Mulder et al., 2023). Each analysis comprised a line *c*.250 µm long with a spot size of 130 µm; where tooth size permitted, 14 such lines were ablated from the dentine-enamel junction (DEJ) to the tip of each tooth, thus covering the complete time of tooth mineralization. Data and analytical settings are fully reported in supplementary material 2. For more information about the analytical procedure, see Boethius et al. (2022).

Results

Typological dating of the finds

Högstena, Olof Ingemarsgården

Two flint daggers were recovered from the Högstena gallery grave, one of which was an intact dagger and the other a piece of a broken dagger. Both are made of southern Scandinavian flint and are of the early Lomborg types; the intact one is a type II (Figure 3) and the fragmented one is a type I/II dagger. According to the typological dating of the daggers (Apel 2001; Blank 2022; Lomborg 1973) we can assume that the grave was already used in the first part of the Late Neolithic. A small flint scraper was also found and handed in to the museum. The recovered bone awl was osteologically estimated to be either sheep or goat and further determined to be sheep according to ZooMS analysis (Blank 2021, 55). The sheep bone was radiocarbon dated (see below).

Kymbo, Backgården

The remaining artefacts from the Kymbo grave consist of an iron key, an iron mounting, a bronze button, and an amber bead. The iron key is of a Late Iron Age type (see Nordström 2021). A Late Iron Age date may also be assumed for the bronze button and the Iron mounting. Similar buttons have been found at Helgö, Uppland and dated to 200-800 AD (Holmqvist et al. 1961, 1964). The amber pendant is fragmented and can only be assigned to the Neolithic period in general (see Axelsson et al. 2015; Ebbesen 1995a, 1995b, 2002).

Osteology

Högstena, Olof Ingemarsgården

The MNI of the Höstena grave was estimated to be four: two adults and two children. The postcranial bones associated with the adults indicate one gracile and one substantially larger and more robust individual. It is plausible that the differences in size indicate individuals from one of each sex, but the results are not conclusive. None of the adult remains were possible to assess to specific age or age-group. However, considering that none of the bones evidenced degenerative lesions, it is possible that none of the adults died in advanced age. *Ligamenta flava* (ossified ligaments in the neural canal) was found in one thoracic vertebra. The incidence of *Ligamenta flava* increases with age but could affect individuals in their 20s and 30s as well (Kudo et al. 1983). The lesion is common and usually doesn't cause any discomfort. Advanced cases could affect the nerves of the spine, and cause numbness and affect the ability to move (van Oostenbrugge et al. 1999).

Subadult bones were few: a mandibular fragment with a developing first molar *in situ*, a fragmented femur, metacarpals and metatarsals, and a larger fragment of a clavicle. The development of the first molar is consistent with an age of approximately five years, which is also in accordance with the size of the femur. The sizes of the metapodials and the clavicle were smaller than could be expected from a five-year-old, which indicates the presence of a younger child of approximately two-three years.

In addition to the human remains, a burnt bovine vertebra was identified in the material.

Kymbo, Backgården

The MNI of the Kymbo grave is also four; one older adult, one adolescent or young adult, and two children, approximately six and twelve years old.

The MNI calculation is based on preserved teeth and differences in development and attrition. Most skeletal parts were large and robust, which might indicate male sex. One fragment of a temporal bone, however, exhibited a mastoid process of female characteristics. A few of the larger and more robust bones evidenced osteophyte formation of the joint, which might point to a more advanced age.

A few animal bones were also found in the bone assemblage, which were determined to be dog and bovine.

Amelogenin peptide analysis

All five teeth that were analysed yielded results. Only one tooth from the Högstena grave, a child of the age of *c*.5 years (Hog3), was analysed and provided positive results for AMEL-Y peptides and is thus determined to be of the male sex. Teeth from all four individuals of the less preserved Kymbo grave were analysed and yielded three negative and one positive AMEL-Y peptides. The results of the peptide analysis thus confirm the osteological sex assessment of one male and one female adult. Contrary to the preliminary osteological assessment, the young adult, KY2, was determined to be male and the old individual KY3 to be female. This could either point towards the presence of an additional older male in the assemblage, which was not represented by preserved teeth, or that the

Sample ID	Site	Age of death (years)	AMEL-X	AMEL-Y	Sex
K1677:1	Kymbo	*c*.12	Present	Absence	Female
KY1	Kymbo	6-7	Present	Absence	Female
KY2	Kymbo	15-20	Present	Present	Male
KY3	Kymbo	old ind.	Present	Absence	Female
Hog3	Högstena	*c*.5	Present	Present	Male

Table 1. Results from amelogenin peptide analysis.

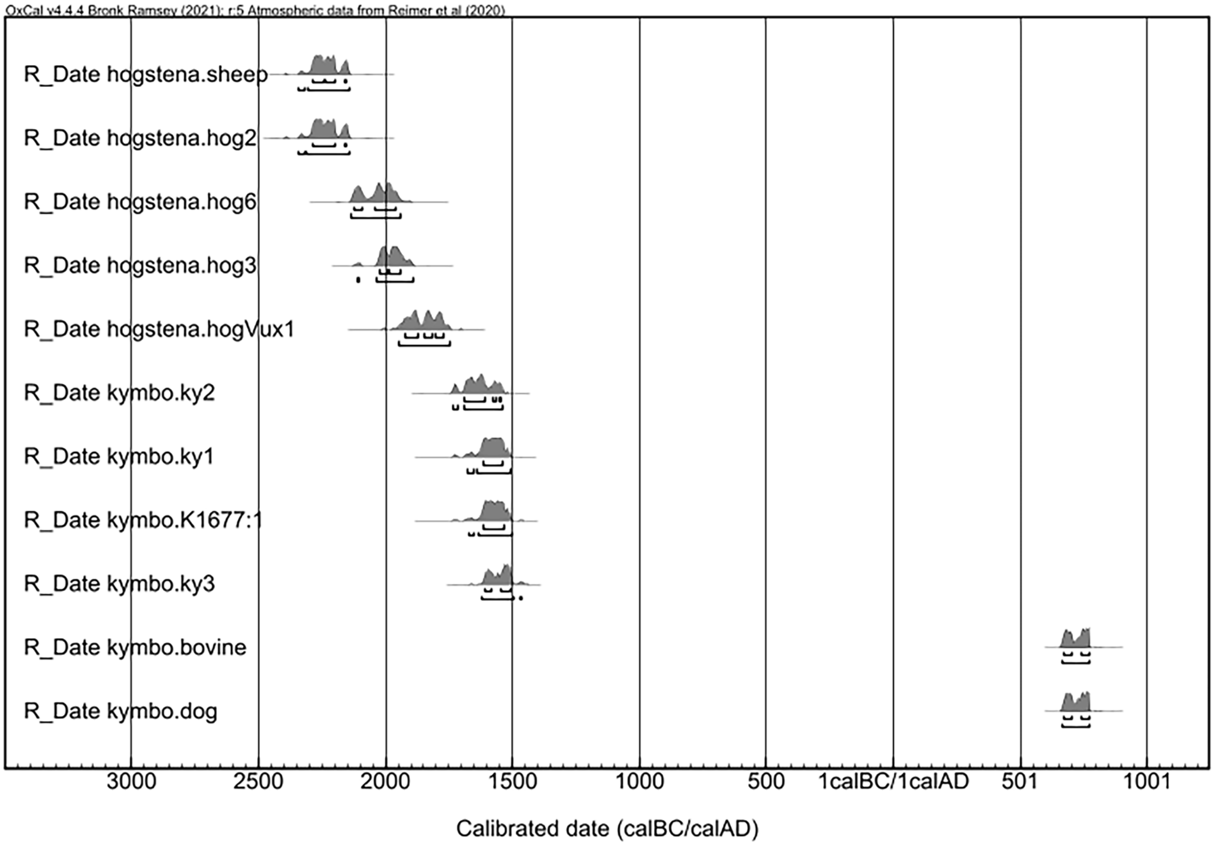

Figure 4. Calibrated radiocarbon ages of human and animal remains in the Högstena gallery grave and the Kymbo grave. Oxcal version 4.4, Bronk Ramsey (2021) with atmospheric data from Reimer et al. (2020).

results reflect the problems in accurately assessing sex in the youngest and oldest age groups based on secondary or tertiary morphological traits where young males might carry female morphological traits and old females might be more robustly built, hence being sexed as males. Both children turned out to be of female sex (Table 1).

Radiocarbon dating

In this study, twelve samples were sent for radiocarbon dating. Of these, two failed due to poor quality of the collagen (Hog4 and Hog5). For the remaining samples the reported values for C:N atomic values ranged from 3.1 to 3.3 which is well within the recommended range, indicating well preserved collagen (Bronk Ramsey et al. 2004; van Klinken 1999). Furthermore, the $\delta^{15}N$ and the $\delta^{13}C$ values (see below) do not indicate any signs of a reservoir effect caused by the consumption of protein from marine or freshwater sources. In figure 4, all radiocarbon dates from humans and animal remains, including the date of the already published bone awl (Blank 2021), are plotted showing the 95.4% and the 68.2% probability spans.

In the Högstena gallery grave the radiocarbon dates are rather dispersed. The two earliest dates, from the sheep bone (awl) and one of the children (a fibula-Hog2), span from 2340 to 2140 cal BC, 95.4% probability, which covers the transition between the Middle and Late Neolithic as well as the first part of the Late Neolithic I (2200-1950 BC). These two dates do not overlap with the rest of the radiocarbon dates from the grave. Hog6 and Hog3, representing an adult individual and the ca. 5 years old boy, both date to the Late Neolithic I, although the boy has a slightly later date that spans into the second part of the Late Neolithic. The latest date in this grave belongs to an adult individual of unknown sex (HögVux1) and spans between 1950 and 1750 cal BC (95.4% probability), within the Late Neolithic II.

The radiocarbon ages from all four individuals in the Kymbo grave overlap. The results from the

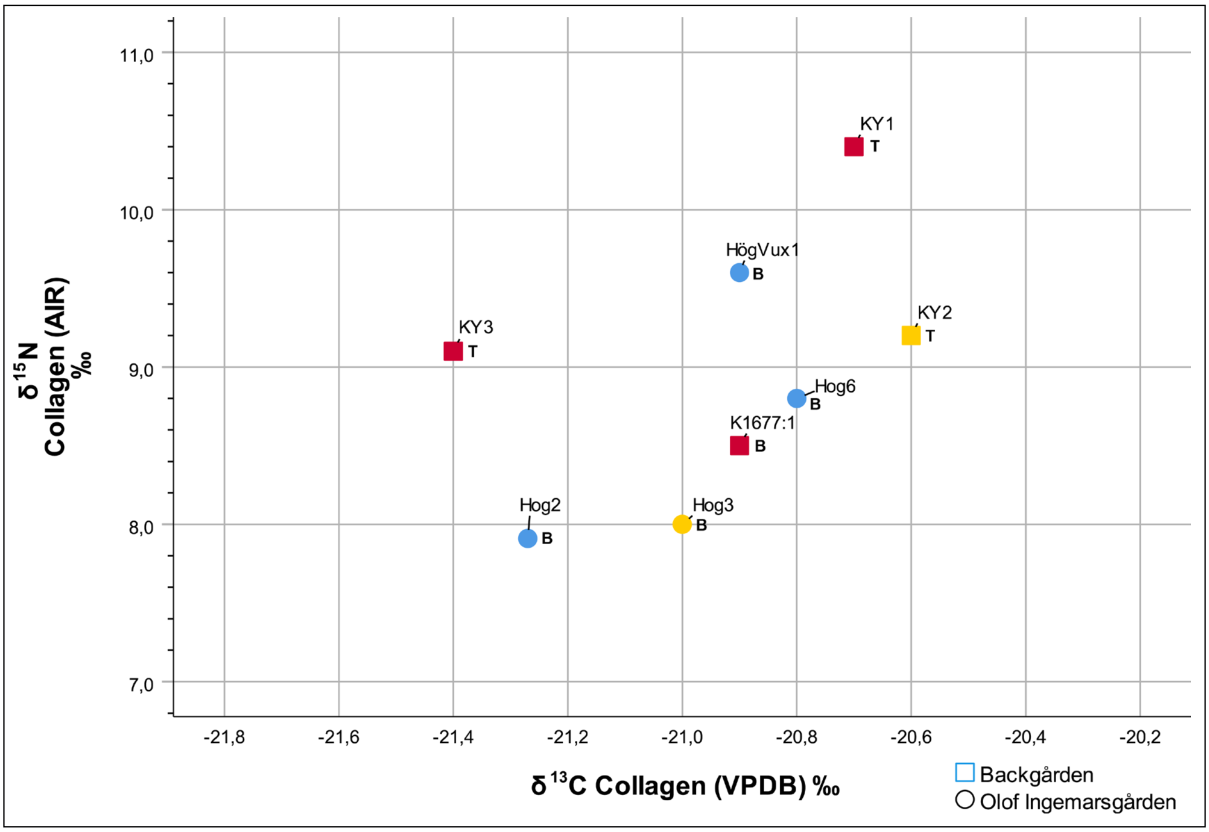

Figure 5. Scatterplot of δ^{13}C and δ^{15}N values (‰) from human remains in the investigated graves. Squares: Kymbo, Backgården grave. Circles: Högstena, Olof Ingmarsgården. Red: female. Yellow: male. Blue: unknown sex. T: tooth. B: bone. Data from supplementary material 1.

three female individuals are very similar while the dating of the young adult male (premolar-KY2) is slightly earlier and has a more expanded range. The dates more or less range within the Bronze Age period I (1700-1500 cal. BC). The radiocarbon ages from the two animals are also very similar, spanning from 660 to 770 cal. AD, which is concurrent with the Late Iron Age metal finds in the grave (see above).

Stable isotope analysis

The same samples that were successfully radiocarbon dated, also yielded stable isotope data. In general, the teeth yielded higher δ^{15}N values than the bone samples, which already have been pointed out in a previous study of Neolithic and Early Bronze age individuals in Falbygden (Blank 2021). This might suggest a change in diet based on age, but we do not have stable isotope values from both tooth and bone from the same individual to confirm such an assumption. Furthermore, the only two samples that represent an adult diet (bones from adult individuals) are Hog6 and HögVux1, while the remaining samples reflect the protein intake between the ages of *c.*3 and 12 years (bones from children and teeth, Supplementary material 1). The observed pattern might also result from a breast-feeding effect in the teeth, nevertheless the bone samples from the two young children (Hog2 and Hog3) have the lowest δ^{15}N values of 8‰ of them all (Figure 5).

In the Högstena gallery grave, only bones were analysed and the δ^{13}C values range from -21.3‰ to -20.8‰, while the δ^{15}N values span from 7.9‰ to 9.6‰. The highest δ^{15}N value belongs to the youngest burial and the only skeletal remain dated to the second part of the Late Neolithic (HögVux1), suggesting that this individual consumed more protein from a higher trophic level than the other individuals or consumed proteins from a place with a deviating baseline.

In the Kymbo grave the δ^{13}C values vary between -21.4 and -20.7‰, and the δ^{15}N value

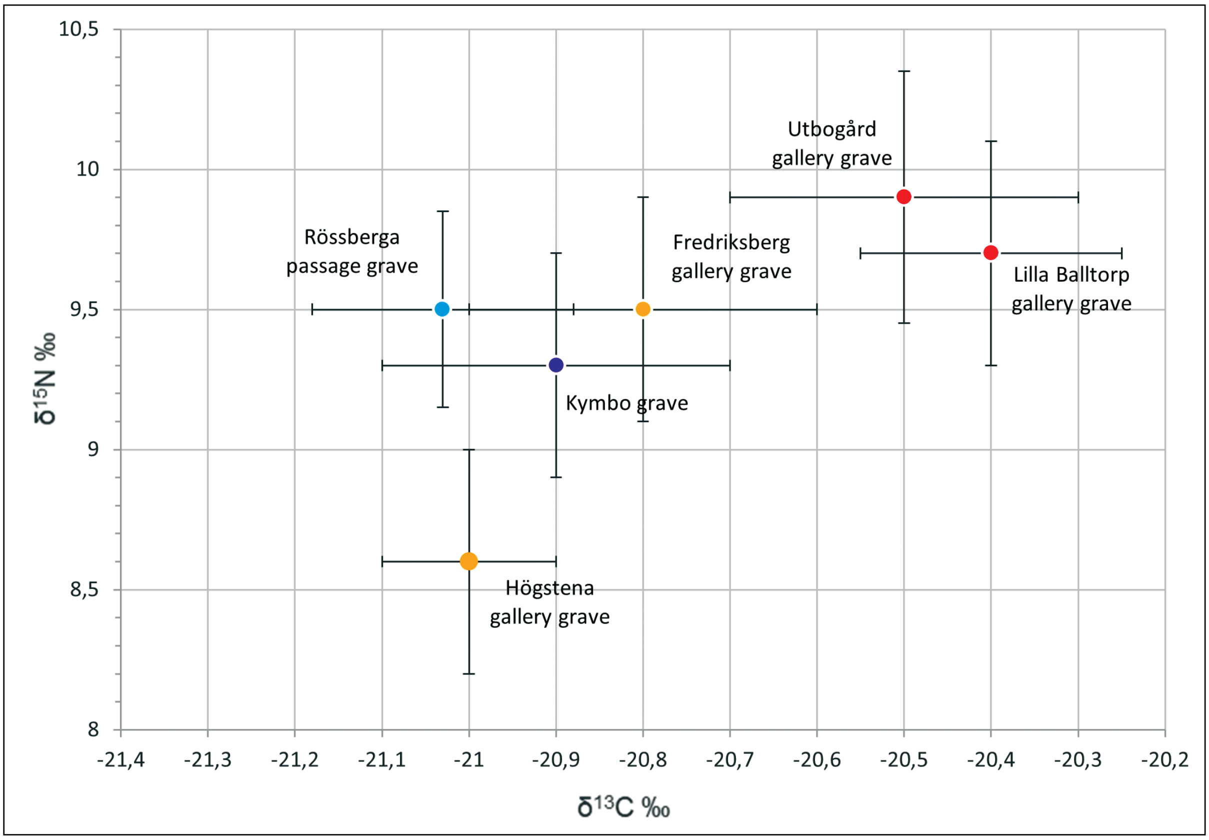

Figure 6. Mean values (‰) with standard deviations (SD 2) of $\delta^{13}C$ and $\delta^{15}N$ from human remains in graves from Falbygden. Data from supplement 1, Blank et al. 2018, and Blank 2021, appendix 1. Högstena gallery grave N=4, Kymbo grave N=4, Rössberga passage grave N=28, Fredriksbergs gallery grave N=22, Utbogård gallery grave N=8, Lilla Balltorp gallery grave N=33 (Blank 2021, Appendix 1). Purple: Early Bronze Age dates. Red: Late Neolithic II and Early Bronze Age dates. Yellow: Late Neolithic I dates. Blue: Middle Neolithic dates.

between 8.5 and 10.4‰. The lowest $\delta^{15}N$ value was measured in the mandible from the *c.*12 years old girl (K1677:1) and the highest in a first molar of the *c.*6 years old girl (KY1). The high $\delta^{15}N$ value may be a result of breastfeeding, as the roots of the first molars begin forming at the age of three (Fuller et al. 2006; Hillson 1996).

In figure 6, the average stable isotope values of the skeletal remains from the Högstena and the Kymbo grave are plotted along with measurements from human remains found in other Middle and Late Neolithic megalithic graves in Falbygden.

According to figure 6 the highest means in both $\delta^{13}C$ and $\delta^{15}N$ values can be observed in the large gallery graves with port-holes, Lilla Balltorp and Utbogård, where the human remains date to the Late Neolithic II and the Early Bronze Age. The Kymbo grave would be expected to plot with these graves, considering the Early Bronze Age radiocarbon dates, but instead it clusters with the Middle Neolithic Rössberga passage grave and the Fredriksbergs gallery grave containing remains radiocarbon dated to the Late Neolithic I.

The sheep bone from the awl, yielded a $\delta^{13}C$ value of, -21‰ and a $\delta^{15}N$ value of 4.2‰. It is dated to the transition between the Middle and Late Neolithic and is the only sheep from the area which can be affirmed to belong to the period between the last part of the Middle Neolithic and the Early Bronze Age. In addition to this bone, a couple of goat bones have been radiocarbon dated to the second part of the Late Neolithic, which yielded similar $\delta^{13}C$ values (*c.*-21‰) and slightly higher $\delta^{15}N$ values (*c.*4.5‰, Blank 2021, paper V). Furthermore, a few Middle Neolithic sheep bones, which yielded similar $\delta^{13}C$ values but higher $\delta^{15}N$ (*c.*6.5%) values are known from Falbygden (Blank 2021, paper V). The stable isotope results of the two other animal bones, radiocarbon dated to the Iron Age, are reported in supplementary material 1.

The trend of higher $\delta^{13}C$ values in individuals dated to the Late Neolithic II than in the Middle Neolithic and Late Neolithic I human remains which have been observed in Falbygden (Blank 2021), can also be attested here, nevertheless, the trend does not seem to continue into the Early Bronze Age. The $\delta^{13}C$ values in the Högstena gallery grave, with radiocarbon dates spanning from the transition between the Middle and Late Neolithic into the first part of the Late Neolithic, are similar to the values in the Middle Neolithic Rössberga passage grave.

The lowest $\delta^{15}N$ values appear in the Högstena grave and these values only slightly overlap with the $\delta^{15}N$ values in the Kymbo grave (Figure 6). The same shift can be observed with a slightly lower $\delta^{15}N$ value in the sheep bone from the Högstena grave compared to the values yielded from Middle Neolithic sheep bones from Falbygden (see above).

Strontium isotope ratios and mobility

The spatially resolved Sr isotope data obtained through the laser ablation analysis provide significantly higher resolution for understanding mobility in the sampled individuals than only informing on local versus non-local childhood origin. From the Högstena gallery grave only one individual was sampled for Sr isotope analysis, a first molar from a 5-year-old boy. From the Early Bronze Age grave at Kymbo, four teeth, two first molars and two premolars, from four different individuals, three females and one male were sampled. These teeth reflect the Sr isotope signals from early childhood. The first molars reflect the first years of childhood (between the ages of *c.*1.3-3.3), and the premolars crystallize between the ages of *c.*3 and 6 (Goodman et al. 1980; Reid and Dean 2006).

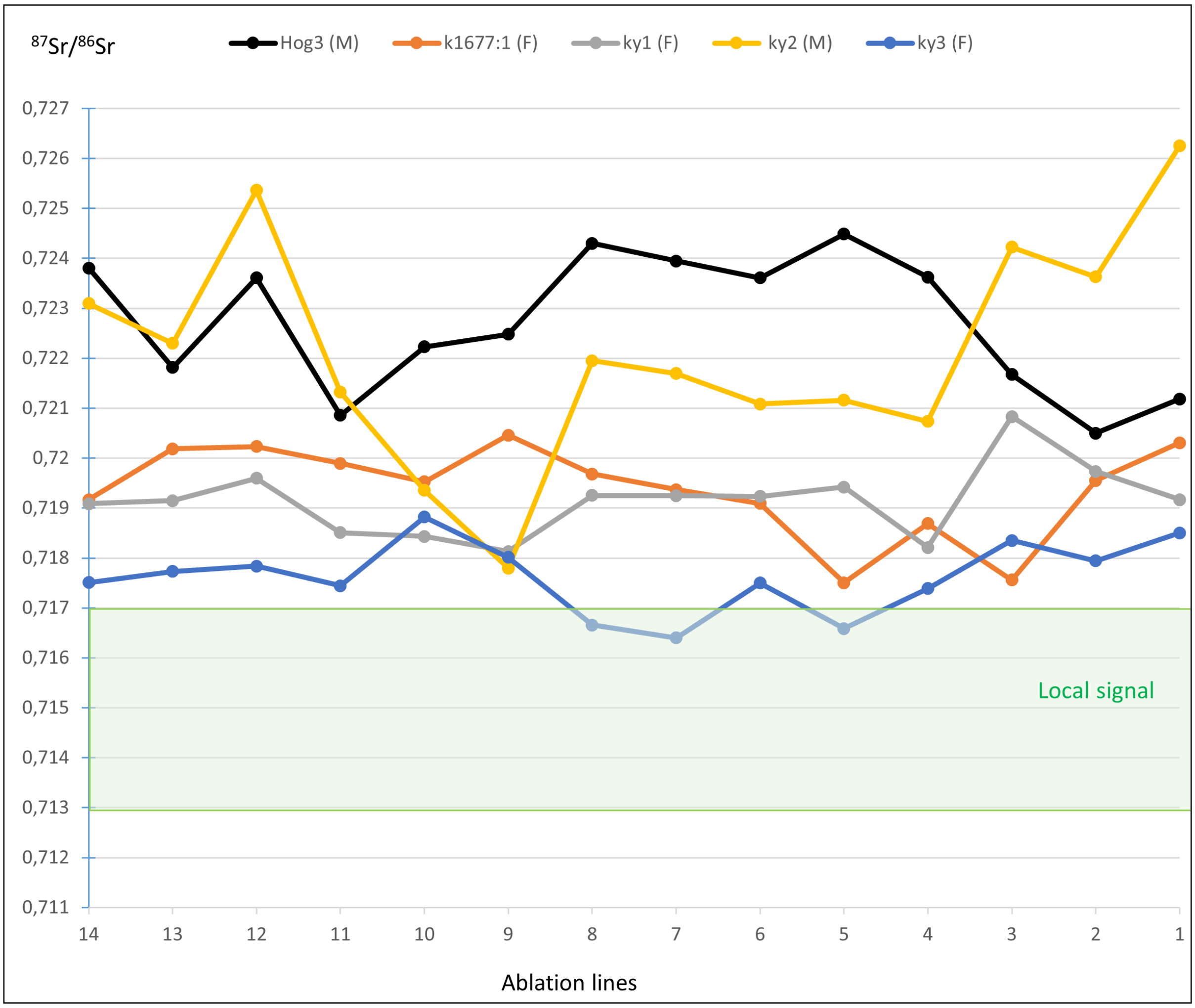

Figure 7. The sequential strontium isotope results from the teeth sampled from the four individuals. The local signal is based on Blank et al. 2018b. Number 1 on the x-axis represents the DEJ and number 14 the tip of the tooth.

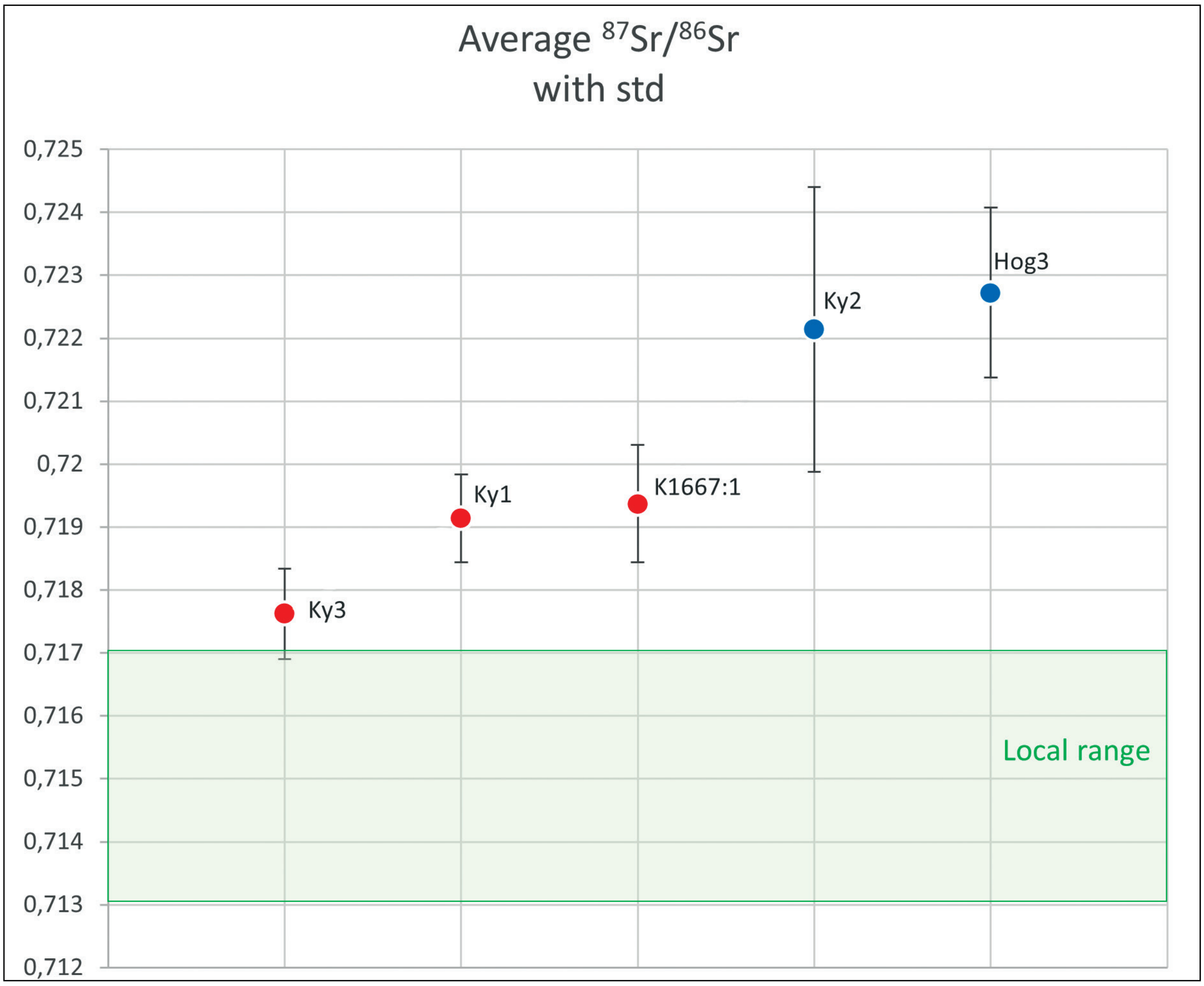

Figure 8. The average strontium isotope ratios plotted with the standard deviations (SD 2) of the four teeth. Red circles: females. Blue circles: males.

All of the sampled teeth measured non-local Sr isotope ratios (Figure 7, 8). The females, two children and one adult, yielded rather consistent Sr isotope ratios between 0.716 and 0.721. Bioavailable Sr isotope ratios within this span can be found a few km outside the sedimentary area of Falbygden, in other parts of Västergötland (Blank et al. 2018b; Figure 9) and further away (Boethius et al. 2022). The lowest Sr isotope ratios, between 0.716 and 0.718, belong to an old female from the Kymbo grave. These ratios are present in the outskirts of Falbygden and might be found a few kms from the grave (Figure 9). The male individuals on the other hand, exhibit higher ratios up to *c.*0.726, which are found further away in a restricted area of central Västergötland but are more common east and northeast of Falbygden (Blank et al. 2018b). The male individuals also show a higher standard deviation and more variation within the teeth which may indicate movement in the landscape during early childhood (Figure 7). The Sr isotope ratio averages of the teeth indicate that these five individuals may have spent their early childhood in three different locations, possibly in the outskirts and neighbouring areas of Falbygden.

Discussion and conclusion

The bone material in the graves does not necessarily represent all the buried individuals. In many of the old excavations only parts of the skeletal remains were collected, especially skulls. In the case of the studied sites, various bone elements and even smaller fragments were saved. Nevertheless, the graves were already damaged by farming when they were excavated.

The Högstena grave is the earliest attested gallery grave in the region, confirmed by radiocarbon dating, with the exception of a few human bones

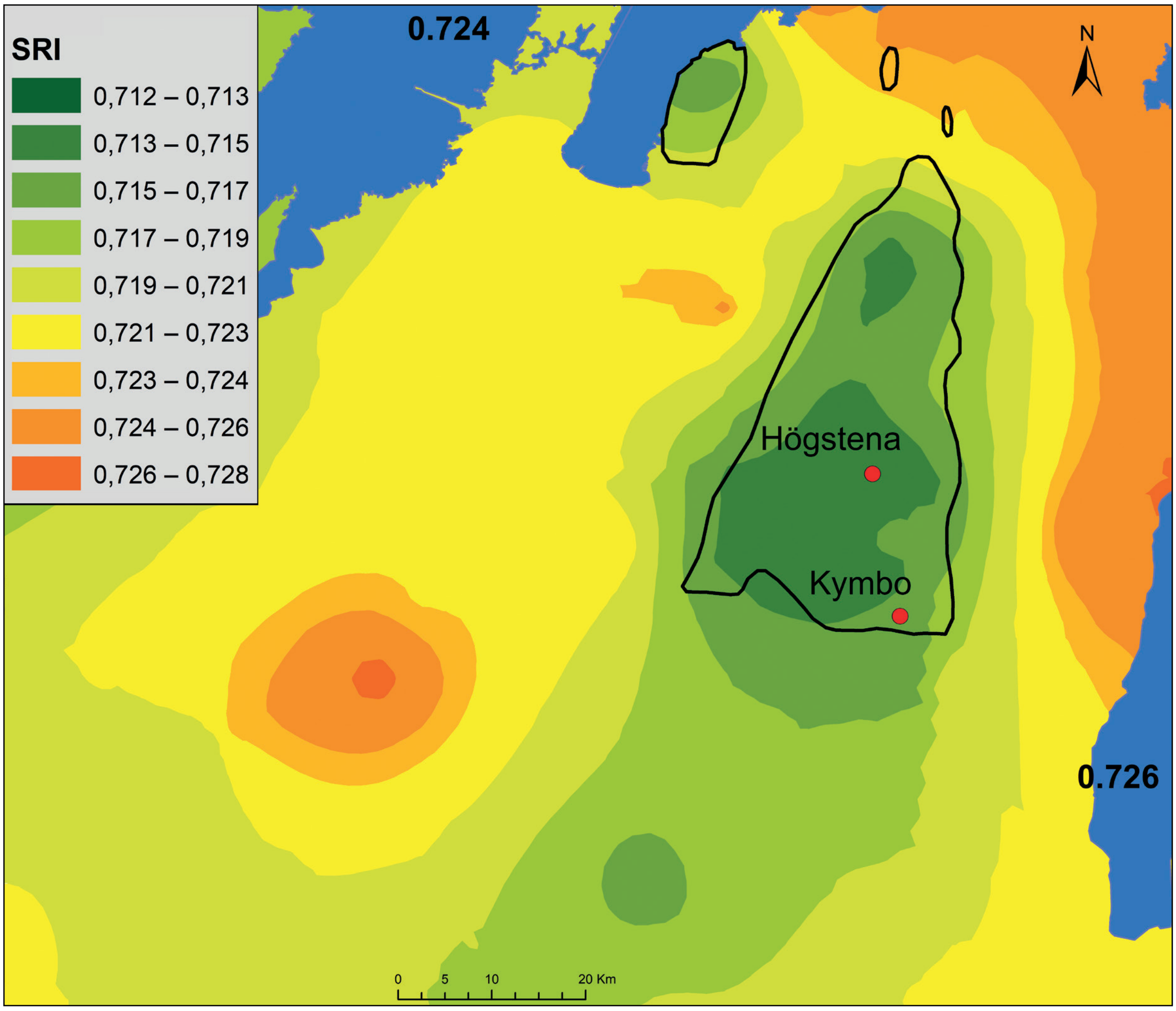

Figure 9. Investigated graves plotted on baseline map from Blank et al. 2018b. SRI: Sr isotope ratio. 0.724: Sr isotope ratio of lake Vänern, 0.726: Sr isotope ratio of lake Vättern.

dated to *c.*3000 cal BC recovered from a couple of gallery graves that may be explained by the deposition of skeletal parts from older graves or relics (Blank et al. 2020). The estimated small size of the grave and the early radiocarbon ages coincide with previous research that suggested that the smaller gallery graves are younger than the larger ones (Blank et al. 2020).

The radiocarbon ages in the Högstena gallery grave indicate that the grave has been used at least at two or three different occasions, which agrees with the general assumption of successive inhumations as the dominating burial practice in gallery graves (Ahlström 2009; Blank 2021; Tornberg 2018; Weiler 1994).

The Kymbo grave is the first grave that has been directly radiocarbon dated to the Early Bronze Age in Falbygden. There are radiocarbon dates of human remains from this period in gallery graves as well as in passage graves (Blank 2016; Blank et al. 2020; Persson and Sjögren 2001), but these graves were constructed earlier. There are some documented Early Bronze Age graves determined by typological dating of the finds, but only a few can be attributed to the first period (Oldeberg 1974; Sahlström 1932, 1939; Weiler 1994). Thus, this study indicates that we might already have excavated materials belonging to time periods from which we think we lack evidence and that overlooked remains (due to poor preservation, poor documentation, or small amount of fragmented and mixed bones) may provide information on the chronology and origin of the human bones as well as new insights into burial practices. By revisiting the museum collections and archives, and conducting multidisciplinary investigations on neglected materials, materials of uncertain origins or age, or materials which are difficult to interpret, untold stories can come to light and new knowledge of prehistory may be accomplished.

There is no detailed description of the cairn, and it is also possible that the cairn and the mentioned gallery grave might have been connected. The Bronze Age cairns in the area are generally low profiled, and sometimes contain stone cists. The Stora Lycke grave in Falbygden, is an example of a low cairn that covered a 2 m x 0.5 m large stone cist constructed below ground, and in many aspects resembles some of the Late Neolithic gallery graves. The cist contained skeletal remains from one or several inhumations and was typologically dated by the finds to the second part of the Bronze Age. Several deposits of burnt human bone were also recovered from the cairn (Sahlström 1939, 36-39). There are also examples of Late Neolithic gallery graves which have been covered by Bronze Age cairns (Blank 2016).

According to the radiocarbon dates, the individuals in the Kymbo grave may have been placed here at one single event, although several occasions within a rather short time span cannot be ruled out. The animal bones and the metal artefacts were deposited in the grave, possibly at one single event, in the Vendel period of the Late Iron Age. Reuse of older graves, including a variety of different practices, such as burials, depositions of artefacts and animal bones or other types of activities altering the grave constructions, was a common phenomenon during the Late Iron Age and has been attested in several Swedish regions including Falbygden (Artelius 2004; Blank 2016; Sjögren 2003). The radiocarbon dates together with the sex determinations and age estimations support the hypothesis that these graves were possibly family graves with representatives of both sexes and all ages. Numerous studies support close biological kinship between the human remains found in megaliths and other cemeteries during the Neolithic (e.g. Fowler et al. 2022; Schroeder et al. 2019) in other European contexts, and a recent aDNA study of Middle Neolithic passage graves in Falbygden demonstrates that several generations of the same families were buried also in these graves (Seersholm et al. 2024).

Considering the stable isotope data from these two graves, it is difficult to know if it is representative for the two time periods in question, the transition between the Middle Neolithic and the Late Neolithic, and the Early Bronze Age I, as there are very few burials radiocarbon dated to these periods in the study area. Nevertheless, the relatively low stable isotope values in the Middle Neolithic/Late Neolithic bones from the Högstena may strengthen the hypothesis of a change in the values towards slightly higher $\delta^{13}C$ values and more varied stable isotopes at the onset of the second part of the Late Neolithic (Blank 2021). The reason for this change is still not resolved, but one suggestion is that a cooler and more humid climate related to the 4.2 ka BP event, may have affected the stable isotope values of crops and/or might have triggered changes in subsistence strategies and, thus, dietary patterns. The climatic event, which actually encompasses *c.*2450-1900 cal BC caused climate changes with regional variations in Europe (Butruille et al. 2017; Kleijne et al. 2020). Even though the effects on Scandinavia have been questioned (McKay et al. 2024), oxygen isotope studies from inland southwestern Sweden confirm a change toward a more unstable and humid climate with cooler temperatures from about 2000 cal BC (Hammarlund et al. 2003; Seppä et al. 2005). The unstable climate may have led to more diverse cultivation and husbandry practices regarding the composition of livestock, where the animals were kept and what they were fed, the locations of the fields, and the amount of fertilisers used etc. (Blank 2021, paper V). The lack of Late Neolithic and Early Bronze Age animal and plant remains in general and from the area is unfortunate, but an ongoing study with the aim of analysing domestic animals and crops for stable and oxygen isotopes, may help resolving this issue.

The lower values in the Early Bronze Age Kymbo grave may indicate that the Late Neolithic II is the phase with deviating stable isotope values. However, it could also be explained by social or cultural differentiations resulting in different diets between people who were buried in large gallery graves and small cairns.

Overall, the stable isotope values suggest a terrestrial protein intake with little or no marine or freshwater input. Thus, the $\delta^{13}C$ and the $\delta^{15}N$ values are consistent with a terrestrial based diet, which is dominating in the Neolithic TRB and Late Neolithic and Early Bronze Age societies of southern Scandinavia (Blank 2021; Blank et al. 2023; Kirleis et al. 2014; Sjögren 2017; Tornberg 2018).

The Sr isotope values indicate that most of the buried individuals consumed water and food from elsewhere or spent their childhood outside of Falbygden. At this time the most likely scenario is that the Sr isotope ratios reflect movement in the landscape confirming a high degree of mobility in the region during the Late Neolithic and Early Bronze Age (Blank et al. 2021; Blank et al. 2023). The increasing human mobility in the Late Neolithic compared to the earlier period may also have resulted in changes and more variation in the stable isotopes values. Taking into consideration that the Sr isotope baseline, subsistence strategies and food traditions may have varied between the different locations where the people grew up.

The peptide analyses revealed that the male individuals most probably moved into the area from further away than the female individuals. Furthermore, it seems like the male individuals, which were sampled in the two graves, for some reason have been more mobile or exposed to a more geographically varied diet during childhood than the female individuals, or, at least, have been exposed to more varied Sr isotope ratios in the early years of their life. This pattern might be consistent with a tradition of male children being introduced to pastoral practices, such as transhumance early in life while female children might have been involved in other types of duties. In a strontium isotope study of a Neolithic settlement in Germany, transhumance was claimed to have been identified in young children (Nehlich et al. 2009). Furthermore, ethnographic studies of pastoralists support that the transfer of knowledge relating to subsistence and cultural practices commenced in early childhood (Bira and Hewlett, 2023). Nevertheless, the different patterns of Sr isotope variation in our case might also have other explanations, hence, other comparative studies are welcomed to increase the dataset.

This article demonstrates that the use of scientific analyses can actually help us to understand grave sites for which we have little or poor archaeological data and to better distinguish between different burials. The application of sex dimorphic amelogenin peptides on poorly preserved remains can strongly contribute to the understanding of burial practice and biosocial utterances in past societies. Not only can peptide analysis be used to confirm or dismiss ambiguous and uncertain osteological sex assessment, but the analysis can also provide sex determinations of subadult remains that are impossible to sex osteologically. This peptide analysis is not only cost-effective, but it is also performed on the hardest biological tissue, which is most likely to survive taphonomic processes. Thus, it is possible to determine the sex of a higher proportion of the inhumed individuals than when only using skeletal traits. Further, poorly preserved remains are presently unlikely to yield sufficiently preserved genetic material, thus hampering a fruitful outcome of archaeogenetic results. For this reason, poorly preserved remains have been neglected within the scope of archaeogenetic research. We argue that it is time to revisit the graves that were previously scientifically passed over, since some of the biochemical methods that were developed in recent years can significantly contribute to new knowledge of past populations when contextualised, especially in multi-proxy endeavors.

Acknowledgments

We thank Falbygdens museum for giving us access to their archives and repository and for enabling the sampling of the bone material. We thank 14Chrono Centre in Belfast for conducting the radiocarbon dating, and stable isotope analysis, and AIPRL in Durham for performing the peptide analyses. We acknowledge Vegacenter for provision of facilities and experimental support. Vegacenter is funded by the Swedish Research Council as a national research infrastructure (Dnr. 2021-00276). This is Vegacenter publication number 084. We are very grateful to Rune Iversen and the reviewers for helpful comments and suggestions.

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Supplementary Material

Material see also .xlsx-attachment

Re-thinking a Sacred Space

The evolution of burial practices as seen from a Bronze Age tumulus from Karlstrup, Denmark

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ABSTRACT

In this paper, we use a cultural evolution framework and methods to explore how continuity and change can be observed in a relatively small, enclosed space – a single prehistoric burial mound, from Karlstrup, Denmark, with a long and complex history of re-use.

This burial mound was extensively used and re-used across the Late Neolithic 'Dagger Period' and Early Nordic Bronze Age. Although archaeologists have long acknowledged the burial traditions of these two periods as quite distinct from each other, there is still much to be explored regarding what – if any – cultural evolutionary relationships there may be between societies across these periods (i.e., whether Nordic Bronze Age uses of sacred spaces, such as burial grounds, can be shown to have evolved from pre-existing Neolithic uses). By mapping a series of 41 cultural traits across the many funerary entities within burial Mound 4 at Karlstrup, we trace the degree of change, continuity, and coherence (i.e. cultural evolution) between Late Neolithic and Early Nordic Bronze Age burial traditions across time. We then relate these findings back to contemporaneous changes in notions of identity and social status in later European prehistory. By examining the evolution of the use biography of this mound, we relate changes in the sacred landscape with the changing social and economic circumstances of the deceased individuals buried in the mound, as well as the living individuals and communities that constructed them during a transitionary period of prehistory in flux.

ARTICLE HISTORY
Received
13 June 2023;
Accepted
07 April 2025

KEYWORDS
Late Neolithic 'Dagger Period'; Early Nordic Bronze Age; Burial mound; Cultural evolution; Cultural phylogenetics; Sacred landscapes.

Introduction

The prehistoric landscape remains a very visible aspect of everyday life in Southern Scandinavia, including frequent monumental burial mounds (see, e.g., Holst 2013, 32-33). These burial mounds line the main transport routes and settlement enclaves across the region, as they have since their construction in prehistoric times (Klassen 2014). The patterning of such monumental constructions not only marks out and delimits territories, but also symbolically reflects positional relationships between past peoples, the dead, and their surroundings (Müller 1904). Although archaeologists are well aware of the long continual use of such burial places and monuments, continuing even into the Iron Age (e.g., Holst et al. 2013), the evolutionary relationship (cultural descent or relatedness) of one burial tradition to another remains little explored from an evolutionary archaeology perspective.

Over the last few decades analytical methods for investigating cultural evolution have been used by anthropologists and archaeologists for their utility in modeling evolutionary relationships between units of culture, from artefacts to languages to socioeconomic systems and beyond (see e.g., Gjesfjeld and Jordan 2019; Gray, Bryant, and Greenhill 2010; Mace and Holden 2005; Jordan 2015; Mace, Holden, and Shennan 2005; Prentiss 2021; Straffon 2019). Here, we apply a cultural evolution methodology to the interpretation of a demarcated sacred space – a large burial mound (Karlstrup Mound 4) whose final construction dates to Period II of the Early Nordic Bronze Age (ENBA) (Frei et al. 2019). The approach taken here will be familiar to archaeologists interested in modeling cultural change from an evolutionary perspective (e.g., Buck and Meson 2015; Gjesfjeld and Jordan 2019; Prentiss et al. 2022, 2023; Straffon 2019).

Figure 1. Mound 4 at Karlstrup during excavation in 1965 (National Museum of Denmark).

Figure 2. Location of Karlstrup Mound 4 (FF 020505-04) marked by black star. Map generated using QGIS freeware and Natural Earth basemaps.

Increasingly in recent years, archaeological applications of cultural evolution methodologies (e.g., Matzig et al., 2024; Perreault 2019; Prentiss et al. 2023, 2025; Riede et al. 2024; and see review in Matzig et al. 2023) have highlighted how novel applications of evolutionary theory and methods – including tree-thinking – can contribute valuable insights into the broader processes, impacts, and implications of culture change in the past, as well as to specific case studies thereof, providing otherwise elusive means to "illuminate the unobservable past" (Evans et al. 2021: 9). Cultural evolution studies have also been used similarly in other contexts/areas to assess relationships of change within delimited spaces. Most relevant for the present study is the work done by Prentiss et al. (2020) looking at generation-scale change over time in a single prehistoric pithouse at the Bridge River village site in the Mid-Fraser Canyon region of British Columbia, Canada and by Last (1998), who examined a single Bronze Age burial mound at Barnack, Cambridgeshire, UK.

In terms of Mound 4 at Karlstrup (FF 020505-04), we have approached our cultural phylogenetic analysis on the presumption that, given the site's consistent use as a burial space spanning centuries and across Late Neolithic (LN) and ENBA cultural complexes, there may have been some level of cultural continuity between the different temporal funerary traditions undertaken at the site. Support for this hypothesis would take the form of a coherent evolutionary pattern of descent with modification from the earliest burial practices through the subsequent burial sequence(s). Here, we use a cultural phylogenetic approach in a case study of Karlstrup Mound 4. In so doing, we investigate cultural change across the use-life trajectory of this single burial mound across centuries.

Mound 4 at Karlstrup

Prior to its excavation under the supervision of National Museum of Denmark's C. L. Vebæk in 1965-6, Mound 4 at Karlstrup was a fairly large tumulus (over 4 m; Figure 1). It was located southwest of Copenhagen, roughly eight kilometers north of Køge, Denmark (Figure 2). Mound 4 was one of a cluster of tumuli that were excavated to make way for a nearby industrial purposes. The burial mounds sat on a low, grassy plain with a clear view of Køge Bay and the Baltic Sea (the coastline lies less than two kilometers to the east). Excavations revealed a complex stratigraphy resulting from the burial of at least 31 individuals

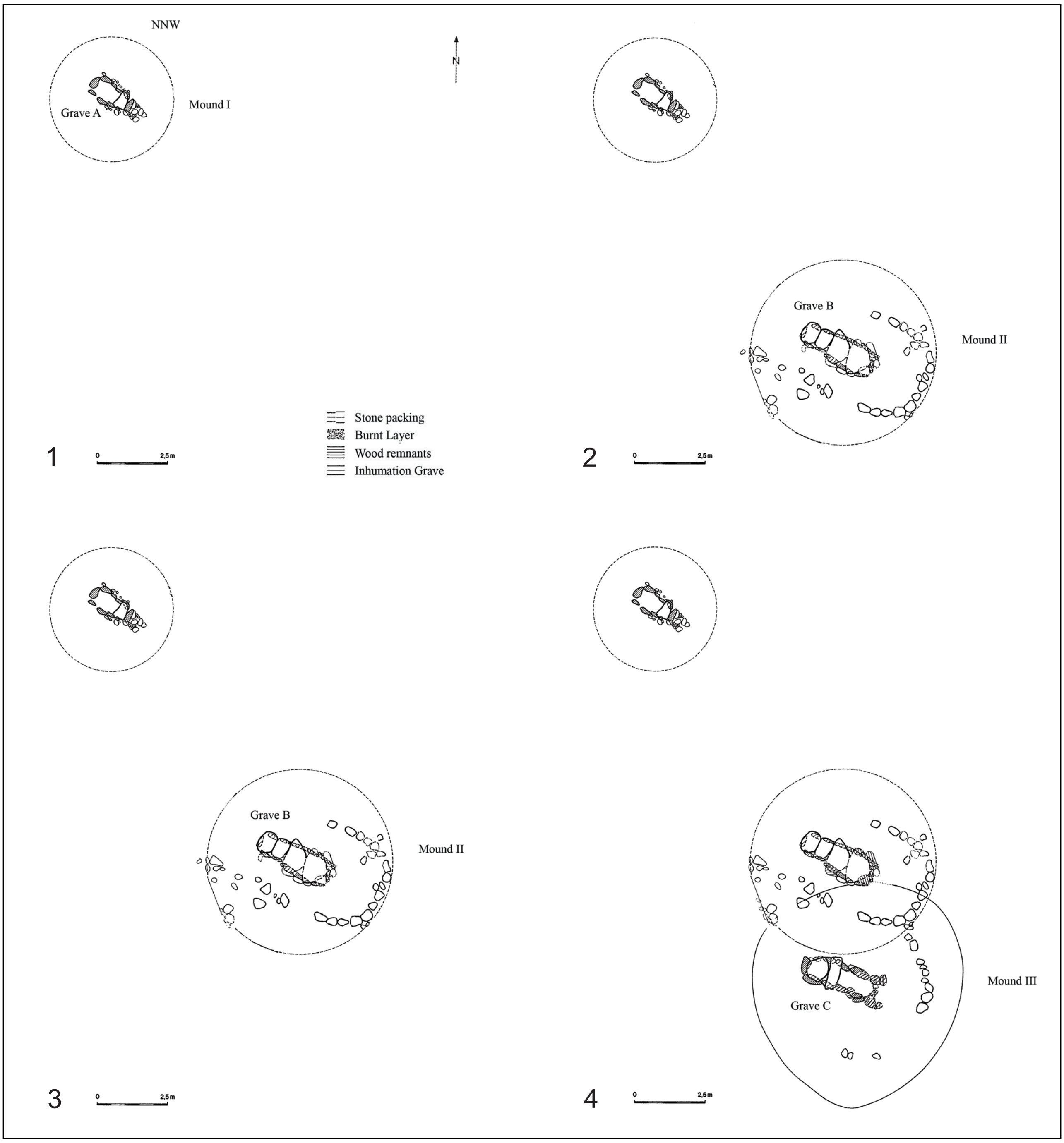

Figure 3. Site map of Mound 4 at Karlstrup showing the LN construction phases of the mound in terms of features and graves over time from left to right. Site map after Aner and Kersten (1973, 182).

in no less than 16 separate graves from an estimated seven or eight separate mound construction phases spanning the Late Neolithic to the Early Nordic Bronze Age (Figure 3).

Stepwise mound construction events such as those evident at Mound 4 were common during the Nordic Bronze Age (e.g., Haseloff 1938). These use and construction events span centuries from the LN 'Dagger Period' (start *c.*2350 BCE; see review in Stafford 2003) to Periods I-II/III of the ENBA (*c.*1700-1200 BCE; see summary in Randsborg 1996). The final burial in the mound was that of two men equipped with rich grave goods, buried together in a large tree-trunk coffin (hereafter 'Grave Q' after Aner and Kersten 1973, 182, though the grave is also referred to as XVI; Vebæk, 1966).

Theoretical background of Neolithic to Bronze Age burial changeover and problematization

Again, although Karlstrup Mound 4 was part of a mound group in the immediate vicinity, here we focus on Mound 4 as a single unit in order to explore the many use and re-use interventions conducted at this particular burial mound over its use-life. We have chosen this due to the fact that Mound 4 comprises a complex narrative of sequential funerary events. Unsurprisingly, given the long use-life of the mound, those activities changed over time. As such, the mound reflects diverse manners of utilizing space. Over generations, the mound was modified and expanded. New graves literally replaced and overlapped older ones. This is not an unusual occurrence; barrow construction was a reoccurring theme of prehistoric life that both shaped and was shaped by those living with and interacting with these features of the sacred and mnemonic landscape (cf., Brück 2004; Holst et al. 2001; Holst and Rasmussen 2013).

New identities and reckonings of the sacred space and those in it must have been imagined, reformed and replaced (cf., Last 1998) by different peoples using the same spaces over time. Echoing Bloch (1982) and others, Sørensen (2014) points to the handling of the dead as well as the timing and placement of their bodies as evidence for the recognition of death as a social rite of passage. Moreover, Sørensen argues, death rituals were a sort of performance which was enacted both for the living as well as for the deceased. In this way, death rituals were a means of "negotiating communal relations in the absence of the deceased" (Sørensen (2014, 169) as well as between mind/matter, humans/things and culture/material culture (Oestigaard 2004, 23). In this sense, the differential treatment of the dead between the LN and the ENBA illustrates a resetting of social relationships simultaneously within the living community as well as between the living and the dead and between those (e.g., ancestors) already invested in a grave/cemetery and those joining them (the recently deceased).

For much of the Neolithic, burial was generally organized on a communal level, with placement of deceased individuals (or simply their bones) in shared burial spaces (Ebbesen 2004). With the influx of the Single Grave Culture (a local derivative of the Corded Ware Culture in Denmark), as its name implies, there was a change in funerary practices in which graves became less communal (e.g. gallery graves) and more focused on individual (and double) burials in stone cists, covered by low mounds (Ebbesen 1980; Iversen 2016, 165; Jensen 1982). During this period, rather exceptional social and economic changes were taking place. Local and in-migrating populations were interacting across the region at differing levels and tempos, with the result being increasingly complex social and material culture throughout Southern Scandinavia (Kristiansen 1989; 1994; Vandkilde 1996). This trend continued through the 'Dagger Period' of the LN into the ENBA (Lomborg 1973; Vandkilde, Rahbek, and Rasmussen 1996; Johannsen 2023). By the Bronze Age, increased social hierarchy had become a prime factor leading to differential treatment of the dead (Clarke and Cowie 1985; Renfrew 1982; Rowlands 1980; Sherratt 1982, 1994; see also Reiter 2014).

Importantly in relation to our choice of exploratory analysis by means of cultural phylogenetics, from the earliest LN (*c*.2500-1700 BCE) through to Periods I-II burials of the ENBA (*c*.1700-1300 BCE), funerary activities at Karlstrup bear both notable differences as well as similarities (Randsborg 1996). While Mound 4 is not unique in its size or its complexity, the peculiarities of its graves give insight to changing traditions and ways in which meanings were symbolized with each new activity (i.e., burial) at the site. These changes can be modelled from an evolutionary perspective. Thanks to the excavators' thorough photographic documentation and systematic excavation (specifically, Vebæk's 1966 excavation report and photographs housed in the archives of the National Museum of Denmark), we can also visually explore this burial mound's use-life from its earliest incarnation (a suite of communal LN gallery graves/stone cists) through to its final manifestation as a large mound and the double-grave of two high-status men which marked Karlstrup Mound 4's final burial (Walsh et al. 2022). This final burial capped off a nuanced narrative of burial practice within this single large barrow. By better understanding the cultural evolution of the mound, we gain a handle on whether or not the changes in burial practice reflect natural extensions of previous traditions (inherited culture), or whether those changes were more likely to have been the result of outside influences (cultural blending or borrowing, or outright replacement). In addition, this kind of analysis has several supplementary benefits. By studying the 'life-history' or 'biography' (e.g., Kopytoff 1988; Tringham 1995; Gosden and Marshall 1999; Peers 1999) of the mound, we open a window to how the local LN and ENBA communities who buried their dead there took part in an ostensibly constant re-imagining, re-thinking and re-use of the sacred landscape and their place within it (cf., Holst and Rasmussen 2013; Lewis 2007, 80-82). As Holst and Rasmussen (2015; see also Oestigaard and Goldhahn 2006, 28.) point out, there was likely a considerable obligation within and among communities to participate in burial mound construction (and adaptation) over a considerable long period of time and across different burial traditions. Therefore, the development of burial mounds reflects not only aspects of ritual praxis but also features of social cohesion (and coercion) related to the ways through which social order was maintained over time (cf., Last 1998).

The original excavations at Karlstrup were conducted and reported on by C. L. Vebæk (1966). The LN graves there have also been described by Klaus Ebbesen (2004). Both Vebæk's and Ebbesen's descriptions are in Danish. Vebæk's original reporting can also be found transcribed into German in Aner and Kersten (1973), and Ebbesen's (1995) also describes some of the LN materials also in German. Hence, it is necessary here to provide an overview of the details of the burials at Mound 4 in English to provide an accessible picture of mound formation.

Construction of the burial mound

Late Neolithic beginnings

The construction events at Karlstrup Mound 4 were not a single event (Figure 4). Rather, the complex that we today refer to as Karlstrup Mound 4 comprised numerous mounds that were gradually joined together into a single large mound by subsequent construction phases. It appears that the first mound at Karlstrup Mound 4 was a single low mound constructed in the Neolithic to cover a stone cist (Grave A).[1]

Figure 4. Photographs of the final phase of excavation, showing the original ground level at Mound 4 at Karlstrup. These features evince the first stages of mortuary use at the site. Left: view from the northwest with cist Grave D in the foreground, Grave B in the middle, and Grave C, in the center-background. Right: aerial view of the same stage of excavation as at left viewed from the southeast; Grave A is above and to the right of Grave D (center right of photograph) (Photos: National Museum of Denmark).

The stone cist was oriented northwest-southeast with four support stones on either side and a single stone at each end. It measured roughly 1.7 by 1.25 meters on the outside, but had a smaller interior (0.70 by 0.50 meters). A single capstone covered the northwest end of the cist. No remains were preserved (note that we have coded this feature as cist grave because that is consistent with this type of feature for the LN, but we have also coded for the absence of any human remains).

During the same period, another small mound was built a few meters to the southeast of Grave A with a diameter almost twice that of its neighbor. The mound covered a relatively large well-built stone cist and included four thin, flat capstones (Grave B). This cist was also oriented northwest-southeast. It measured 2.85 by 0.85 meters in the northwest but widened out to 1.25 meters at the southwest end. Lengthwise, both sides were made from four upright stones and each end was closed by a single end stone. A ring of stones was set in a loose oval around the cist, partly marking out the edges of the low mound erected over it. Inside the cist lay the bones of four individuals: three children and one adult, all without grave goods. Immediately to the southwest of the cist lay a stack of small stones of unknown purpose.
In addition to the stone cists under each of the two original mounds, a pit of roughly one meter in diameter and about one-meter-deep was dug at some point during this initial phase (Figure 3). It was located roughly a meter to the southeast of mound II. The pit contained discarded LN ceramic and earthenware sherds. An oblong pavement of stones (*c*.2 x 1 m, oriented northwest-southeast) was also uncovered about five meters to the southwest of the mound covering Grave B and west of that covering Grave C. Devoid of cultural materials, its position and dimensions could indicate that it served as a staging area, perhaps for ritual purposes such as the display or even excarnation of a body prior to placement in a cist.

Next, another low mound was built slightly overlapping the previous one. This mound's stone cist (Grave C, oriented west-northwest by east-southeast) included five stone uprights on the north and six to the south. The northwest end was delimited by an end stone. The cist was covered by a packing of stones and earth and closed off by a setting of flat stones. Two capstones partially covered the northwest end. Lengthwise, the cist measured 2.70 to 2.90 meters. Width varied from 0.50-0.70 meters. Inside were the remains of five individuals. Osteological analysis identified three children (aged 2-3, 12 and 14-15 years). Alongside these was the extended burial of an individual aged *c*.18 years, who was later identified as female, measuring just 1.50 meters tall. Her skeleton showed signs of severe spinal deformation, which would have given her a hunched posture. She was supine with her head to the northwest. The bones of the subadults were piled in the northwest area of the cist in the space above her head (Figure 5). Two bones from another adult individual were also present. Associated grave goods included two amber beads and a small flint dagger (Aner and Kersten 1973; Vebæk 1966).

Importantly in terms of the chronological development of the site, one of the cists from this mound (Grave D) can be dated to the LN/ENBA transition based on the flint daggers present in the grave (see below). It was built between the mounds of Graves A and B. Next came another relatively low mound (mound D/IV). Like the others, Grave D was oriented northwest by southeast. The cist consisted of three stone uprights on the northern side and four on the south, with a single end stone to the northwest. The southeast end was open. Lengthwise, the cist measured 2.50-2.60 meters and was 0.55-0.85 meters in width. The enclosure was between 0.60-0.65 meters deep. There were no capstones. Vebæk (1966) posited that capstones may have been removed during the construction of the later graves G and H. A loose stone packing of white stone lined the floor (similar to LN features described by Pape 2019). Inside the cist were the remains of eight individuals (five males, two females and one individual of indeterminate sex). At *c*.20 years, one of the females was a younger adult, while the others were adults (Aner and Kersten 1973; Vebæk 1966). Two of the male individuals were relatively tall (1.72 and 1.75 meters, respectively) for the period (Bennike 1985: 50). These two individuals' skeletons also suggested that they died while apparently healthy and in their physical prime. However, the other remains indicate that several individuals suffered from

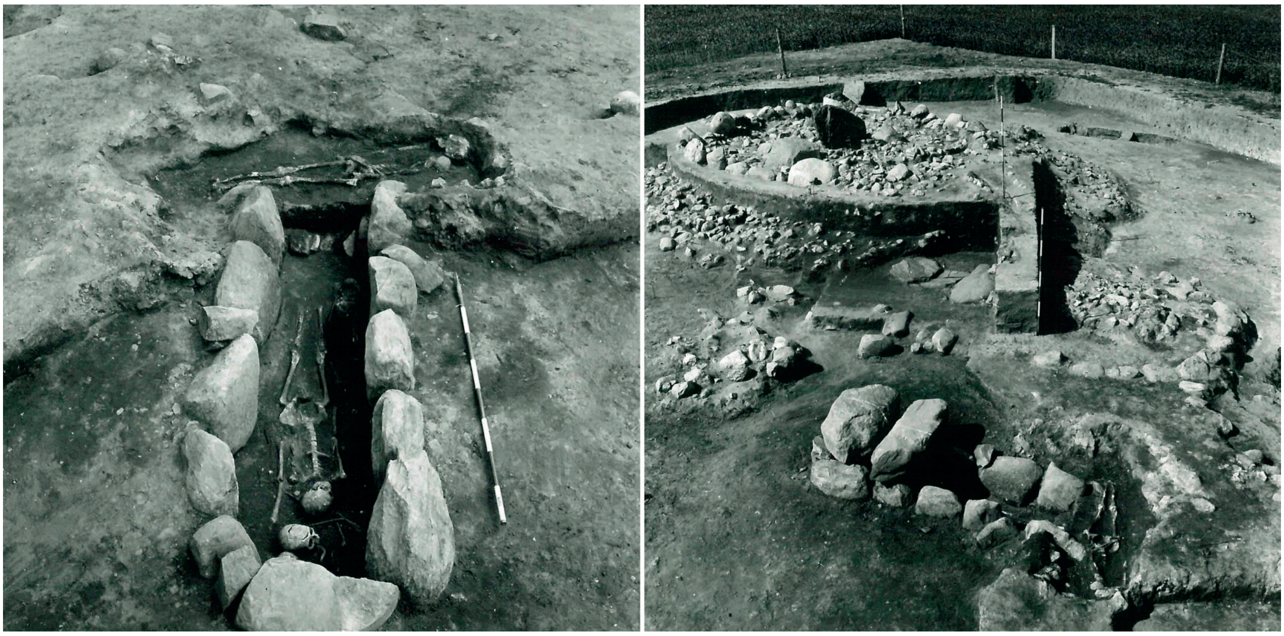

Figure 5. Left: Grave C, view from the NW looking SE. The inhumation grave E can be seen in the background; Right: Overview from the south, Grave C in the foreground with capstones still in place and exposed and Grave E; in the middle ground the capstones of Grave B are still in place at the ground surface; in the background, the stones set over Grave D can be seen (Photos: National Museum of Denmark).

disfiguring and likely painful cases of gout. Grave goods consisted of two flint daggers (Type IVC and IVA, respectively; Lomborg 1973), a small slate pendant, a small, flat, chisel-shaped piece of slate and a clay vessel.

Grave E was deposited around the same time as those just described. It was a single, extended inhumation laying on its right side with no grave offerings. Grave orientation was almost directly south to north, with the deceased individual's head to the south. This burial was above and to the southeast end of stone cist C, so we may presume the interment took place at least sometime after Grave C (Figure 6).

Around this time, another single extended inhumation with no grave goods was inserted into the existing mound. This grave (Grave F) was oriented northwest-southeast and was placed southwest of the base of mound II and at the northwest edge of mound III. The stratigraphy of its placement is difficult to ascertain. It is possible that Grave F lay near the cleft between the peripheries of the two adjacent mounds. Alternatively, this grave may also have had its own low mound, effectively extending the northwest portion of mound III and perhaps bridging the gap between mounds II and III along their western margins.

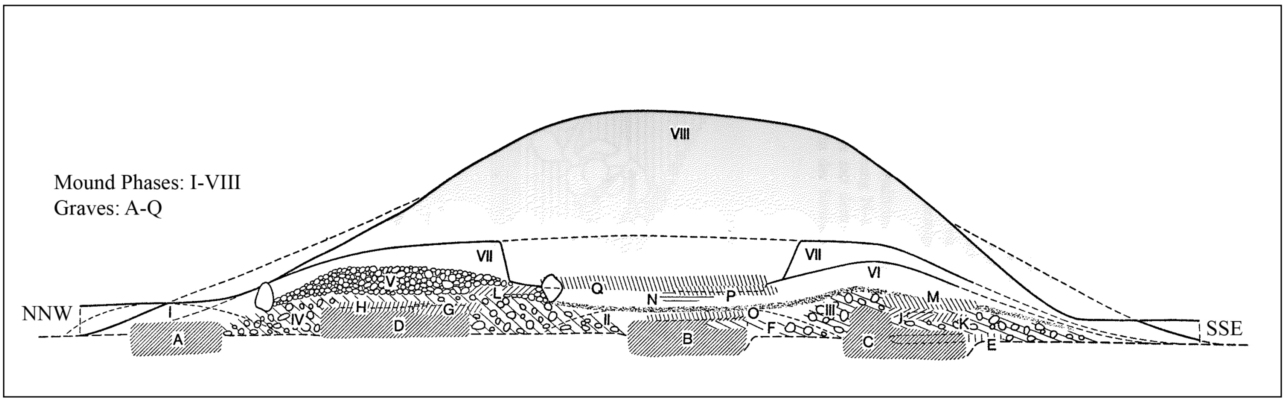

Figure 6. Profile of the Mound 4 construction sequence (After Aner and Kersten 1973, 183).

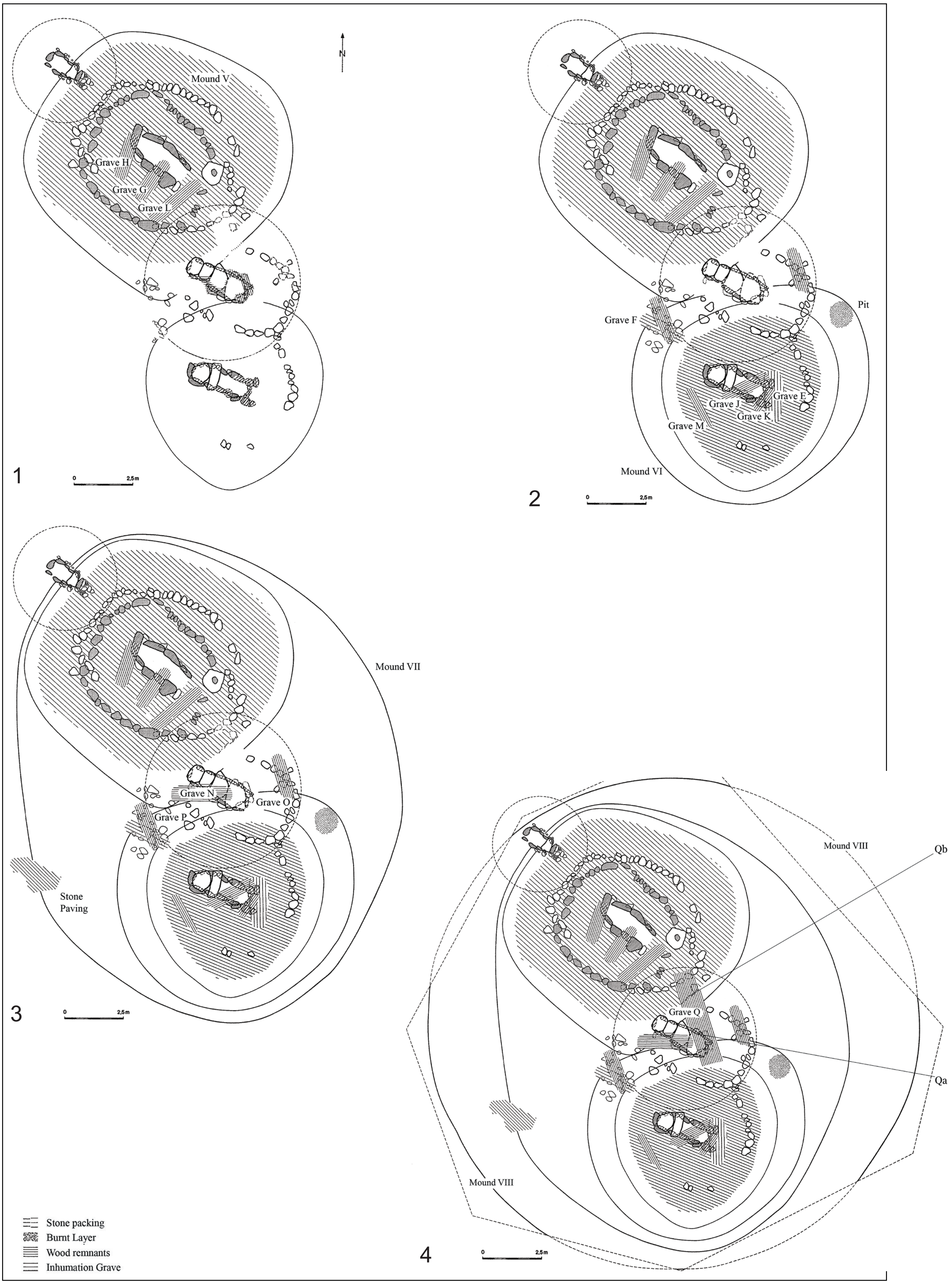

Figure 7. Site map of Mound 4 at Karlstrup showing the ENBA construction phases of the mound in terms of features and graves over time from top left to right (Site map after Aner and Kersten 1973, 182).

New materials, new motifs and a radical transition

The next few construction phases ushered in an extensive expansion of what was by then a small funerary complex of low barrows covering stone cists (Figure 7). Here we begin to see evidence of a systematic reuse and modification of the existing sacred landscape. Rather than situating new graves across the surrounding area, the existing low mounds were conspicuously re-used, to the extent that burials were placed directly atop the previous mounds and with new, higher burial mounds built over them. In at least two cases, earlier burials were disturbed in this process (in both cases some capstones were even removed, exposing earlier cists) (Aner and Kersten 1973; Vebæk 1966).

This brings us to Graves G, H and L[2] which were three roughly concomitant inhumations placed at equivalent depths, each in their own wood coffins (see Boye 1986). The graves most likely date to the earliest phase of the ENBA Period I. The coffins were lain on a stone packing roughly 5 by 6.2 meters in diameter which was installed directly across the top of mound IV. Construction atop the mound partially disturbed the earlier stone cist (Grave D) beneath, which likely explains the displacement of Grave D's capstones. A pile of large stones formed an offset ring enclosing the coffins. While each grave was oriented generally southwest to northeast, Grave H was oriented at a slightly sharper angle. Graves G and H were roughly two meters in length each and were covered by intermingled stone cairns, suggesting that these two burials took place at or near the same time. The coffin in Grave L was considerably longer, measuring around 3 by 0.5 meters, and it lay outside and immediately to the south-southeast of the stone cairn which covered Graves G and H. A flint strike-a-light rested to the right side of the deceased individual in Grave L. This grave was oriented approximately southwest to northeast. In each of these three, the deceased's head was at the southwest end.

Graves J, K and M were all also interred atop the preexisting mound III. Likewise, their placement also partially disturbed the capstones of the earlier cist; some bones appear to have been removed as well. Each of these three inhumations were placed within what were likely tree-trunk coffins. Graves J and K were covered by a turf-built mound (mound VI) of their own. Grave J was oriented northeast to southwest, with the deceased's head to the northeast (Aner and Kersten 1973; Vebæk 1966). Placed above and to the northwest of the head lay bronze tweezers and an axe, both of typically Nordic style. To the right of the individual's head lay a bronze dagger. At about waist-level lay a flint strike-a-light and a bronze belt-hook. Several unidentifiable fragments of bronze were also recovered. Nearly parallel to this grave lay Grave K. Grave K contained an inhumation with the head to the south-southwest. No grave goods were present (Aner and Kersten 1973; Vebæk 1966).

Vebæk (1966) suggests that thick layers of charcoal and burnt human bone observed in the last two sets of burials indicate some form of sacral funerary practice in which bones from the earlier cist graves were disbursed, removed and presumably burned.

Grave M was another inhumation burial which was also presumably in a tree-trunk coffin. This grave was dug into the southwest verge of mound VI. The grave was oriented north-northwest by south-southeast, but there was no indication of which direction the deceased had lain and no grave goods were evident (Aner and Kersten 1973; Vebæk 1966).

Early Nordic Bronze Age repossessions

Continued mound expansion saw the penultimate burials: those of Graves N, O and P. Each of these was situated more or less between existing mounds V and VI, effectively bridging the gaps between those adjoining tumuli.

Grave O was an inhumation burial in what had probably been a tree-trunk coffin. The coffin was oriented north-northwest by south-southeast, with the head to the southeast. Grave P was similarly an inhumation, probably in a tree-trunk coffin and was oriented north-northwest by south-southeast. No human remains survived to indicate the positioning of the deceased. Both Graves O and P may have been dug into mound VII after it had been constructed, presumably as the intended tumulus to house Grave N (see below).

Figure 8. The pair of men in Grave Q seen from the east-southeast. Individual A is on the left, with sword in the crook of his left shoulder, and individual B is on the right. The cairn piled over Graves G and H can be seen in the background, with the resting place of Grave L's oak tree-trunk coffin roughly between the two in the center-right of the image (Photo: National Museum of Denmark).

Grave N consisted of a tree-trunk coffin burial, oriented east to west and set into the channel between mounds V and VI. The coffin measured 2.40-2.50 meters by 0.65-0.70 meters. Grave N was noteworthy in that it contained the remains of a large male, who was accompanied by rich grave offerings. His height was estimated between 1.85-1.90 meters (*c.*13-18 cm taller than the average male of his day; Bennike 1985). He lay extended and supine with his head to the east. His left arm was bent so as to rest over his abdomen. His grave goods included a bronze razor with a spiral handle placed to the right of his head. A bronze belt-hook was at his right hip. At either side of his head lay fine gold coils, presumably worn in his hair (Aner and Kersten 1973; Vebæk 1966). He also wore a spiral ring of gold on one finger. Both bronze and gold objects attest to this individual's wealth and status in ENBA society. Mound VII was erected over this burial. This was a flat-topped tumulus roughly 1.5 to 2.0 meters in height. This covered and merged together all the previous mounds under one roof, creating a single barrow which was both squat and broad. However, one more funerary event would mark the end of this grave complex. A final double grave (Grave Q) would eventually be dug deep into mound VII so as to be situated just above Grave N. This was then covered by a single tumulus (mound VIII), which was twice as high as the previous one, and which included the final grave at its center.

Grave Q: a conventional yet exceptional grave

A discussion of the final grave in the burial mound, Grave Q, has been presented by the authors elsewhere (Walsh et al. 2022). However, a brief overview is necessary here for clarity. Grave Q consisted of two men buried together. Osteological analysis by Pia Bennike identified both individuals as robust and tall males (mean height of 1.72 meters; Bennike 1985: 51). Individual A – a man with a sword – would have stood 1.85-1.90 meters tall. His companion – Individual B – was only slightly shorter. The pair were placed together in a massive oak tree-trunk coffin measuring over 4.5 meters long and 1.0 meter in diameter. They were laid with their heads at opposite ends of the coffin (Figure 8). Individual B was placed in the grave first with his left arm flexed across his chest. Individual A was laid with his arms at his sides, with a sword in its scabbard tucked in the crook of his left shoulder. Their legs overlapped; Individual A's left knee resting over B's left foot.

Both individuals possessed a typical 'masculine' assemblage associated with high-status males during this period. In addition to the sword, Individual A had a single-edged knife, a pair of decorated tweezers and a horse-headed razor all of bronze and a flint strike-a-light. He also possessed two bronze fibulae and three double-buttons, including one large button with amber inlay. Recovered from remnants of a pouch placed at his waist were a set of six small wooden sticks covered with bronze oxide, along with two bronze fishhooks wrapped in woolen cord. He also possessed a fragment of thick, spiral-decorated gold sheeting.

Individual B had fewer possessions, but was nonetheless buried with a considerable assemblage. From a similar pouch at his waist were two small fragments of worked wooden sticks (one with a lengthwise notch), a small roll of bark or leather, a horse-headed bronze razor, a fragment of bronze that may have been remnant of either tweezers or a flattened awl, a flint strike-a-light and fragments of what was probably a bronze knife (Randsborg 1968).

Randsborg (1968) dated Grave Q typologically and relative to the earlier graves upon which it rested, to Montelius sub-Period II-III (Montelius 1899), noting that decoration on the gold fragment buried with Individual A has parallels in the later Urnfield Culture. Radiocarbon dating of Grave Q by Frei et al. (2019) place the burial between 1500-1300 calBCE, i.e., in Period II. Hence, by that time this sacred space had been in active use for at least 300-400 years and Grave Q marked the end of the mound's use-life (see discussion in Walsh et al. 2022).

Strontium isotope ($^{87}Sr/^{86}Sr$) analyses of the men in Grave Q suggest that their origins were non-local to present-day Denmark, excluding Bornholm (Frei et al. 2019). Thus, we have a case in which two high-status, non-local men (at least one of whom was indicative of the elite warrior class) were buried together, with legs overlapping, in a large oak tree-trunk coffin (see Walsh et al. 2022). Their grave was dug into the existing large tumulus, and the mound which was constructed over this last burial doubled the mound's previous height.

Methods: A single mound, evolving?

Elsewhere, cultural evolution studies of ritual architecture have shown that such structures often represent cohesive cultural norms with long-lasting traits transmitted between related groups (e.g., Cochrane 2015; Jordan 2015). Aspects such as location, general features, structure size and shape, building techniques and materials, as well as details reflecting social structure and cosmology are often incorporated into ritual monuments. In this way, features or design elements were proscribed in or towards various directions or features of the landscape, or the structure itself. Often, such constructions also reveal rules regulating the placement of objects (including skeletal remains and grave offerings), features and the locations of ritual activities, including the prescribed and proscribed uses of sacred spaces.

We hypothesized that within the singular sacred space at Karlstrup Mound 4, there may also have been a level of cultural continuity between the different temporal funerary traditions practiced there. Support for this hypothesis would take the form of a coherent evolutionary pattern of descent with modification from the earliest burial practices through the subsequent burial sequence(s). To determine whether there is an evolutionary pattern (e.g. of descent from LN to EBA funerary tradition) within the cultural traditions at Mound 4, we considered each burial or compound set of burials as a taxonomic unit ('taxa') within an evolutionary model. In this way, each unit represents a synchronic moment in the diachronic trajectory of the space's use-life. We compiled trait data for each grave, accounting for variations in grave type and contexts, as well as to the material constituents of each burial assemblage (Table 1).

Archaeologists perceive of cultural change as noticeable variations in past behaviors and practices and their material culture correlates (e.g. house building styles, pottery formation or decoration and burial practices). Here, we recorded the various features and contexts – the character traits – of each identifiable grave at Mound 4. These traits include the presence (1) or absence (0) of the following: stone cist, wood coffin, multiple interments (three or more individuals), single grave, double grave, low barrow, high barrow (over roughly two meters in height), stone cairn, traits N1, S1, E1, and W1 indicate the primary cardinal direction of the burial where possible determined by the evident or most likely general position of the head rather than feet (Grave A contained no discernible human remains and thus its directionality is based merely on its relation to the adjacent LN cists. Traits N2, S2, E2, W2 indicate secondary intercardinal directions. A grave in which the deceased individual was interred with their head to the northwest would be coded N1, W2 (e.g., Grave C), whereas a grave in which an individual was interred with their head to the south-southwest would be coded S1, W1, S2 (e.g., Grave H). This coding system was devised to avoid the potential of creating dependent variables that could possibly bias the weight of certain directions over others. In some of the LN cists it is difficult to

Grave	Cist	Coffin	Multi	Single	Double	Barrow_Low	Barrow_High	Cairn	N1	S1	E1	W1	N2	S2	E2	W2	Child	Adult	Male	Female	Mixed	Supine	amber	flintdagger	SaL	SlateArtefact	ClayVessel	tweezers	bronzeax	bronzedagger	belthook	bronzerazer	haircoils	fingerring	bronzesword	fibula	bronzeknife	goldfrag	doublebutton	fishhook	gold
GraveA	1	0	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveB	1	0	1	0	0	1	0	0	1	1	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveC	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveD	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveE	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveF	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveG	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveH	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveJ	0	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
GraveK	0	1	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveL	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveM	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveN	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1
GraveO	0	1	0	1	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveP	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GraveQa	0	1	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	1	1	0	0	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	1	1	1	1	1
GraveQb	0	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0

Table 1. Graves (taxa) and character traits matrix used to generate the study's phylogenetic models.

determine the directionality of individuals as the remains are jumbled or because individuals were placed in the grave in ways that do not simply conform to the lengthwise orientation of the grave space (e.g., in Grave D at least one individual appears to have been placed in the cist in a hocker position with their left side up, with their head and flexed legs perpendicular to the lengthwise orientation of the cist), but other skeletal remains in the same cist had a prone orientation parallel to the length of the larger enclosure. In each case, we have attempted to discern the most likely orientation that the burial may have been seen to possess during its use, as e.g., based on the position of skulls versus lower extremity elements or where end stones or capstones indicate possible opening points also in relation to the position of skeletal remains and grave goods. Demographic traits reflect child, adult, male, female, and position of the interment is recorded as mixed (in cases where the remains of multiple individuals have been significantly jumbled together or where the likely position of bodies is undeterminable) or whether supine/extended (e.g., as in a tree-coffin). Grave goods are represented by: amber, flint dagger, strike-a-light (SaL), slate artefact (i.e., pendant), clay vessel(s), bronze tweezers, bronze ax, bronze dagger, bronze belt-hook, bronze razor, hair coils (regardless of material), finger ring (regardless of material), bronze sword, fibula (regardless of material), bronze knife, gold fragment, bronze double button, fishhook, and the mere presence of any gold (as an indicator of status oriented wealth).

As our approach to Karlstrup Mound 4 comes from looking at a single archaeological unit – a single burial mound (itself a palimpsest of smaller mounds that were gradually united by subsequent building phases into a single large mound) that evinces a systematic pattern of re-use over a relatively long period of time and during which significant cultural changes occurred, we employed two evolutionary tree-building methods: neighbor-joining network analysis (NeighborNet) using Splitstree4 (Bryant and Moulton 2004; Bryant et al. 2005; Huson and Bryant, 2006; see also Gray et al. 2010) and a Bayesian phylogenetic tree model using BEAST 2 (Bouckaert et al. 2019; Drummond and Bouckaert 2015; Drummond and Rambaut, 2007; Gray and Watts 2007; Pagel and Mead 2006; see also Gjesfjeld and Jordan 2019). For each analysis, we used the presence/absence of the 41 traits described above that are evident across the sixteen graves in Mound 4 at Karlstrup (Table 1; note that one trait [W2] is unrepresented in the data; we have kept this trait in the data matrix for replicability purposes, to show that this grave orientation was at least considered during data collection). The individuals in Grave Q are included as separate 'taxa' for the purposes of our analyses because they each have a distinct identifiable directional orientation and their own distinguishable

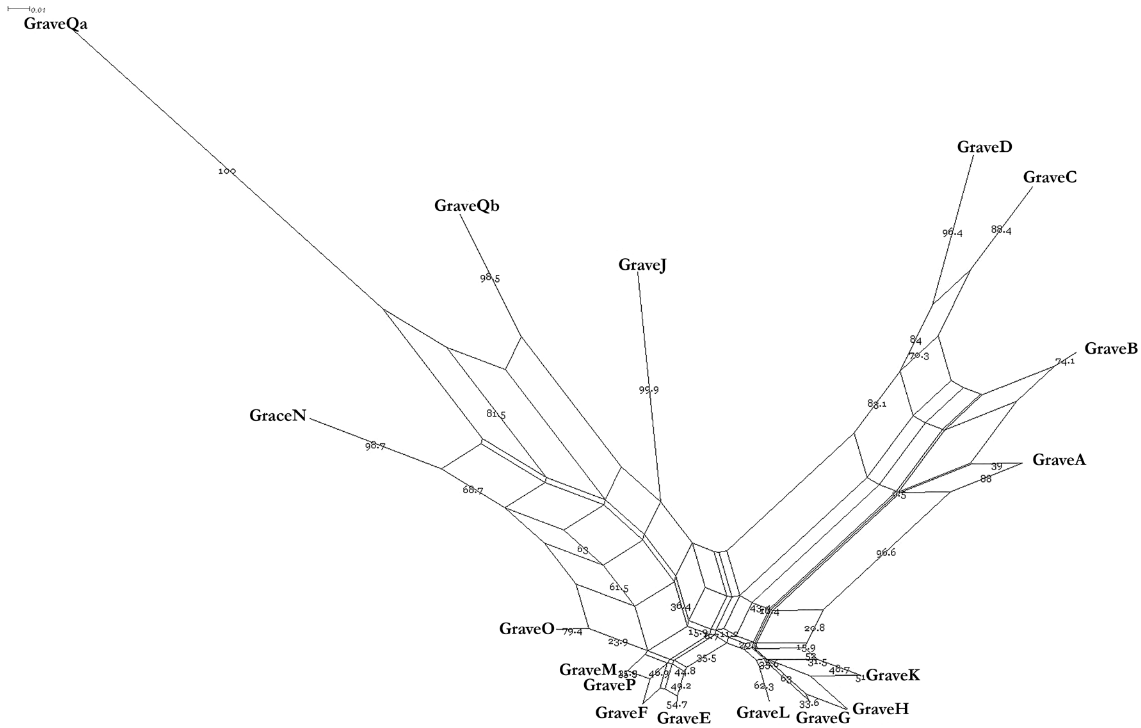

Figure 9. NeighborNet 'split graph' showing the results of the analysis of the burial data given in Table 1.

grave goods. For the Bayesian analysis, following Gjesfjeld and Jordan (2019) and Prentiss et al. (2022) we ran 12 different models with variable settings (see Prentiss et al. 2022: 7-8). We then calculated Bayes factors using the end likelihoods of each model to determine the best-fit model: Model 5 (M5). We generated a maximum clade credibility tree (MCCT) based on M5 using TreeAnnotator (Heled and Bouckaert 2013) and visualized that tree using FigTree[3], both from the BEAST 2 suite. We should note that the trees generated for each of the 12 models were topologically identical in terms of the branching scheme, with minor variations only in their respective branch lengths and posterior probability values. M5's settings were: Gamma Category Count: 4, Clock Model: Relaxed Clock Exponential; Priors: Yule tree; MCCT chain $1x10^7$ and all other settings default.

Results

The NeighborNet split graph shows a temporally differentiated trajectory (Figure 9; from right to left from the LN graves A-C-/D through to the later well-equipped ENBA graves J, N, P, and Q. This pattern is supported by a Delta score of 0.2996 and a Q-residual score of 0.03797, both goodness-of-fit indices indicative of tree-likeness (Holland et al. 2002; Gray et al. 2010). The Delta score is a value between 0 and 1 in which the higher the score the more evidence of blending and borrowing between taxa – i.e., homoplasy in evolutionary terms (Holland et al. 2002; Gray et al. 2010; Prentiss et al. 2015), whereas the Q-residual score is also a value between 0 and 1 where 0 indicates a complete lack of reticulation and higher values indicate more reticulation. Combined, our Delta and Q-residual scores indicate a tree-like pattern in the changes over time that occurred at Karlstrup Mound 4. The ENBA graves split into three clades, with Grave E, F, M and P in one group, Graves G, H, K, L, and O in another, and J, N, P, and, finally, Q in another. However, this is the result of just a few trait variants: the E, F, M, P group are coffin graves with no distinguishable remains, while the G, H, K, L, O group are all variants of south-oriented graves also with no distinguishable remains. These individuals were not accompanied by significant wealth in the form of metal goods. Thus, despite these minor differences, we may view the central grouping of ENBA graves as a

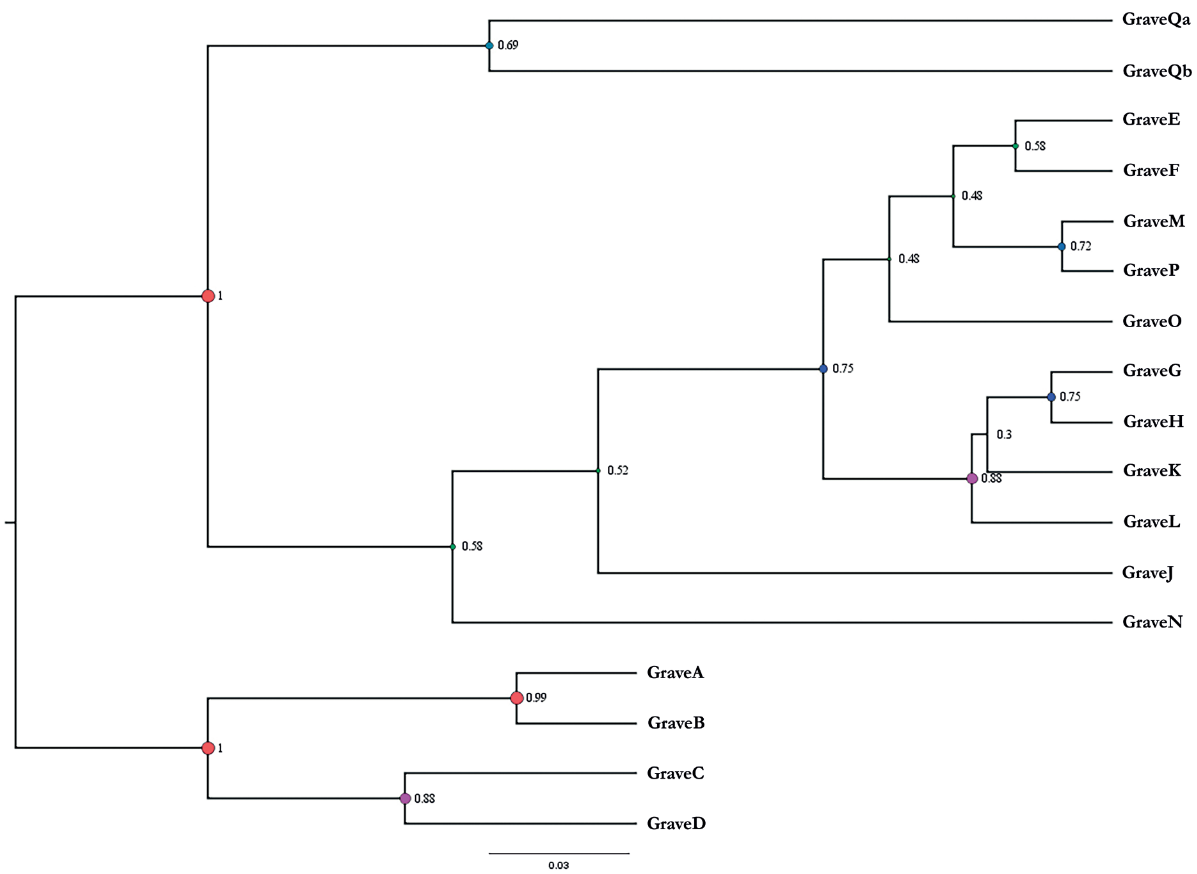

Figure 10. Phylogenetic Maximum Clade Credibility Tree (MCCT) generated in BEAST 2. We have rooted the phylogram in Grave A. Note the strong posterior probability values supporting the distinction between the LN and ENBA cultural traditions.

singular phenomenon: tree-trunk coffin graves of various orientations with not much extant material in the way of preserved grave goods. This leaves us with the far-left clade comprised of Graves J, N, and Q, the ENBA graves with grave goods. These distinctions are further supported by exceptionally strong bootstrap scores for the separation of the LN graves from the ENBA graves (bootstrap score: 98.6) and the final Grave Q from the rest of the ENBA graves (bootstrap score: 88.7).

The MCCT (Figure 10) generated in BEAST 2 (Bouckaert et al. 2019; Drummond et al. 2005; Drummond et al. 2006; Lewis 2001) shows a similar branching pattern to the split graph.

Discussion

The results of our cultural evolutionary analyses indicate that the burial traditions at Karlstrup Mound 4 show considerable differences between the LN and the ENBA despite the use of the same sacred space over the *longue durée* of the mound's use-life. However, there is distinct coherence within temporal traditions throughout the LN and ENBA graves and the trajectory of the ENBA graves changes over time in the sense that grave assemblages generally became more complex, culminating in richly furnished elite graves and finally a single compound burial of two elite men.

We see a strong discontinuity between the LN graves, the bulk of the ENBA graves, and the final few ENBA interments, with Grave Q standing out distinctly. There appears to be no evidence for descent with modification relationships between LN practices and the introduction of novel ENBA practices. The ENBA graves are further divided between the earliest graves and the later, more extravagant final burials, which branch off early on the dendrogram despite being later in the burial sequence. The strong relationship *within* clades indicates temporal 'pockets' of cultural coherence:

momentary or perhaps adjacent-generational practices during the LN and during the ENBA, respectively. The latter funerary practices appear to have become more complex over time with increased expressions of material wealth in the form of grave goods and in the extension of the burial mound itself. The high bootstrap scores indicated in the NeighborNet split graph and the high posterior probability values at particular branching events in the MCCT support that coherence within clades is strong. This points to that the cultural traditions reflected by each grouping represent distinct cultural variants expressed even in the space of what appeared on the surface as a single large burial mound prior to Vebæk's excavation.

The clear split between the LN and ENBA graves suggests a rather dramatic cultural change, perhaps even a significant population replacement between these phases. At the very least it connotes considerable changes in cultural norms even at this highly localized scale.

Coherence within temporal traditions and LN and ENBA identity formation

Collective types of interment for multiple individuals in the same enclosure were common during much of the Neolithic throughout much of Europe. It has been suggested that this reflects the communal nature of group and individual identities during that period (e.g., Ebbesen 1983, 2004; Kaul 1994; Tilley 1994; Bradley 2002; Blank 2021). In anthropological terms, such distinctions have been theorized to reflect different paradigmatic understandings of selfhood: one general understanding focused on the individual and the other focused on collective and inclusive identities ('dividual') (e.g., Dumont 1980; Strathern 1988). Taylor's (2007) concept of 'buffered' and 'porous' selves provides a similar ontological corollary. On the one hand, sharing in an inclusive collective identity appears to have been paramount and was often intrinsically tied to early egalitarian socio-economic conditions. Over time, the focus shifted towards individuals being set apart in one way or another, often delimited by increasingly exclusive units, such as status, wealth or clan/household membership. These concepts need not be mutually exclusive, and manifest to varying degrees within any given population (for discussions see Fowler 2004; Smith 2012).

It is well established that as society became increasingly hierarchical through the emergence of chiefdoms and increased control of wealth and resources during the LN and into the ENBA (sensu Renfrew 1973; Sherratt 1987, 1994), individual graves (rather than communal ones) became progressively commonplace. By the beginning of the ENBA, individual interments were the norm, reflecting autonomous expressions of individual socio-economically-reckoned identities. However, the multiple graves from the LN were an entirely different phenomenon from the formal double- and triple- graves which came later (such as Grave Q). The LN cists at Mound 4 would have been relatively unobtrusive in the landscape. While each construction phase would have required co-operation for the movement and placing of the largest stones, the scale of construction is not clearly indicative of social organization at the level of either of Renfrew's (1973, 1974) 'Chiefdom' models. What these features do at least suggest is a communal concept of identity reflected in the treatment of the dead, in which bones were regularly intermingled, over-laid and probably even moved and removed at various stages of each grave's use (see discussion Kaul 1994).

Each of the initial phases of ENBA graves in Mound 4 comprised a single inhumation in a coffin with a low turf mound erected over it. This includes the purposeful appropriation and re-use of the sacred space itself from the previous burials in the vicinity. The lack of grave goods in these graves is telling. We may presume that preservation in the mound was relatively good given the objects recovered from both earlier and later graves. It seems that the majority of individuals in graves E-O (excluding J) were not buried with precious objects such as bronzes (which were more likely to have been preserved). Of course, they could have been buried with other types of finery such as textiles, which simply have not survived. This indicates a material distinction even between the elites of ENBA Periods I and II: over time, wealth became expressed more consistently and with increasing extravagance (see below). It may also be that at this early stage of the ENBA, metal items were more regularly kept in circulation, through e.g. curation or recycling (Vandkilde 2014), among the living rather than deposited with the dead.

At Karlstrup Mound 4, there is also a notable change in the orientation of the graves and of the deceased individuals within them, from approximately northwest-southeast oriented graves with the head of the deceased to the northwest (with little variation) in the earliest graves, to approximately southwest-northeast oriented graves with the deceased's head to the southwest (with some variation) later. A number of the ENBA graves appear to purposefully disturb earlier mounds and graves, possibly to assert the legitimacy of the newly deceased onto the existing funerary landscape (cf., Bátora et al. 2012; Millett 1990). This was evident from the thick layer of burnt remains interspersed throughout the fill of the newer ENBA mounds just above Graves G-H and J-K as mentioned above. While it is impossible to say for certain, the excavation and burning of bones from the earlier graves could have constituted two very different rites. On the one hand, this may reflect a feature of ancestor worship – a re-mingling of the earlier inhabitants of the sacred space with the resting place of the newly deceased, symbolically transforming the newly dead into ancestors. In contrast, it could also have represented a ceremonial re-claiming of the sacred space for the newly deceased – an abnegation, erasure, and perhaps even focused desecration of the old to make room for the new. A further hint at this possibly is the conspicuous placement of the stone footing, burnt remains, and the coffin burials (G, H, L atop mound IV and J, K, M over mound III) themselves directly atop the earlier LN grave feature. Indeed, the various negotiations taking place in the development of a funerary landscape like that at Karlstrup Mound 4 are myriad, highly symbolic, and in many ways likely acted to reinforce and sometimes transform social and political positions, far more for the sake of the living than the dead (Oestigaard and Goldhahn 2006). In either case, a radical re-understanding of space was in process.

There is also obvious continual re-use of the sacred space, albeit in ways that varied over time. These results suggest that we should consider how culturally congruent local and perhaps even regional communities *actually* were or were not within their respective periods. This is important because the site suggests quite different and distinct cultural traditions playing out over time –not a relatively slow accumulation of different traits that one may be expected of descent with modification from the LN to the incipient ENBA and through to ENBA I-II. While there may be gradual change between the burials of the ENBA over time (i.e. the increasing accumulation of wealth in the form of grave goods), change from the LN to the ENBA is abrupt.

Regardless of any difference in identity formation there may have been between the LN and ENBA at Karlstrup, the stark split between the LN and ENBA usages of the site leaves us with an interesting conundrum: whence did these cultural changes originate? The site seems to have been continually and consistently treated as a sacred space – albeit a rethought and reconceptualized one – for the expression of funerary identities across several centuries. Why did the means of expressing those identities change, although place and burial group appear to have remained constant?

In answer, it is useful to turn to the precepts of the New Mobilities Paradigm (Sheller 2018, 2021; Sheller and Urry 2006; Urry 2007; van der Sluis et al. 2020; for archaeological applications see Reiter and Frei 2019; Reiter et al. 2021). This interpretive framework suggests that our conception of mobility should include the movement of persons as well as the exchange of ideas, cultural materials and exchange commodities. Certainly, the changes in the funerary events described at Karlstrup Mound 4 might have been influenced by changes in mobility experienced by those living in the vicinity during different times. Previous studies examined considerable numbers of LN and ENBA individuals (Frei et al., 2019; see also van der Sluis et al. 2020), with Frei et al. having conducted the largest multidisciplinary human mobility investigation to date of skeletal remains from a total of 88 individuals buried within present-day Denmark and dating to the 3rd and 2nd millennia BC. While their data revealed that mobility of people seems to have been continuous throughout LN and ENBA, there was a "clear shift in mobility patterns from around 1600 BC onwards, with a larger variation in the geographical origin of the migrants, and potentially including more distant regions" (Frei et al., 2019, 1). Frei et al. also revealed that the men in Grave Q discussed herein were different, in that they have the highest strontium isotope ratios of their entire dataset (Frei et al. (2019). This may in turn suggest that more complex trajectories of cultural transmission were at play across the late prehistoric landscape in which diverse peoples and ideas moved around rather more dynamically than the early culture-historical theories of migration have tended to consider.

Some of the final ENBA interments in Mound 4 (Graves N and Q; as well as J) very clearly represent the graves of elites buried with typical high-status 'masculine' assemblages (i.e., a variety of grave goods including weaponry, ornaments, and typical 'male' kit) and under mounds that reflect costly tolls on both labor and landscape in their construction (Holst et al. 2013). For example, mound VII erected over Grave N effectively enveloped all of the previous graves and mounds at the site. This hints at this individual's social status, as his burial can be seen to symbolically (en) close the use of the burial ground. However, numerous other interments were not so furnished. These dramatic differences in funerary practices illuminate that the people interring, building, maintaining and replacing graves and mounds at this site over many generations – even spanning entire socio-economic and cultural historical paradigms – were constantly re-imagining and re-configuring what the existing monuments (and the dead within them) meant. Across generations, this would likely have transformed what those meanings represented within the community, prevailing society at large, and upon the sacred landscape. These new understandings would likely have reflected the political landscape as well, as ENBA mounds were highly symbolic of the existing social inequalities of the time (Holst et al. 2013). Graves built upon graves built upon graves symbolically both established and in some cases overrode relationships between the living and the dead across time, a phenomenon seen across the northern European Bronze Age world (e.g., Johnston 2021, 82; Last 1998). While these considerations must have in some way(s) determined who, where, how and even if new graves were incorporated into the site and into a sacred landscape, it also seems that there were few if any hard and fast rules dictating exactly how this was necessarily manifested.

We find support for the hypothesis that the sacred space represented at Mound 4 – while continually recognized as sacred ground through its use as a burial place spanning both LN and ENBA usage – must have been re-interpreted often by the living communities making use of it. The space was not being gradually modified so much as re-configured and likely re-imagined by those doing so. This is evident by temporal phases between that of the LN and the onset and the final stages of the ENBA burials, respectively. But this may also have been the case even between the elites in the first ENBA burials still interred with very little evidence of material wealth and those that eventually follow which appear to be exceptionally wealthy burials rounding out the final phases of the mound's use-life (i.e., Graves J, N, and Q).

Conclusion

Our analyses suggest that Karlstrup Mound 4 represents a palimpsest of changing burial practices and reflected identities within a single burial mound. The burial traditions enacted within it evince a punctuated difference between the LN use of the space and that of the ENBA. But there remains considerable coherence within the LN burials and the ENBA burials, respectively. Even so, the same sacred space consistently remained important as such. This itself implies a level of continuity for funerary rituals which reflect highly diverse traditions that varied considerably between the LN, ENBA Period I, and ENBA Period II/III. The pattern suggests a series of major shifts in cultural norms and values playing out elsewhere between the LN and the ENBA, as well as within the ENBA. Recent genomic studies indicate significant population replacements at various points during the Late Holocene across much of Europe (e.g. Allentoft et al. 2015, 2024; Olalde et al. 2018; Papac et al. 2021). One result of these broader events was the remarkably wide-spread and varied use of burial mounds and accompanying ideologies and funerary traditions (e.g. Borgna and Celka 2012). But, the changes over time observable in the burials at Mound 4, particularly at the schism between the LN and earliest ENBA appears to have been a rather sudden change in traditions occurring 'off camera' as it were. This does not look like an uninterrupted population gradually taking on new cultural variants. It appears that new types and extents of grave goods and aspects of funerary practices were introduced abruptly with little or no evidence between temporally adjacent graves for dynamic descent with modification between the LN and ENBA. Then, within the ENBA we see wealth and status increasingly manifested over time. That the space was reused for diverse mortuary practices indicates that it was nevertheless recognized as an important place on the sacred landscape, but one that could also be appropriated, molded, re-thought, re-imagined, and re-configured as and when it was deemed necessary by the local population. Ultimately, this re-use of the burial mound(s) may reflect scenarios such as acts of ancestor worship or a ceremonial re-claiming of the sacred space by erasing the old to make physical and metaphysical room for the new. Both of these possibilities (and myriad others) suggest a profound re-interpretation of the funerary landscape. Whatever the case may be, while the vicinity remained sacred, its use does not appear to have conformed to any particular 'norm' for very long. At Mound 4, sacred space remained sacred space, but its use changed with the times.

Acknowledgments

We are grateful to the Carlsberg Foundation for their support through the 'Semper Ardens' research grant CF18-0005 (Tales of Bronze Age People) and grant CF15-0878 (Tales of Bronze Age Women), both to Karin M. Frei. We would like to thank Helene Agerskov Rose and two anonymous peer reviewers for their valuable comments.

Notes

1 The precise order of the LN cists is somewhat speculative, as these were probably built more or less concomitantly. The stratigraphy and the position of the graves relative to the general circumference of the mound sequence at least suggests the order presented here.

2 The numbering system skips the letter 'I' so as to avoid confusion with the mound construction phases listed in Roman numerals.

3 http://tree.bio.ed.ac.uk/software/figtree/ (Accessed 14 March 2023).

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Local Variations in Swordsmanship

Metalwork Wear Analysis on eight Swords and a Spearhead from Early Bronze Age Jutland

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ABSTRACT

This study is centered around local variations in swordsmanship in Bronze Age Denmark. This is studied through Metalwork Wear Analysis (MWA) of eight Early Bronze Age swords and one spearhead from Jutland, three of which were studied in greater detail. The material is primarily from period II and III from Aalborg Amt. Results show high levels of swordsmanship but also demonstrate a remarkable difference in wear mark distribution and clustering. Two contemporary but distinct styles of fencing with swords are therefore suggested through MWA. MWA of the spearhead showed signs of slashing use, which shows that the notion of spears being only thrusting weapons, is too simplistic. Finally, the general results of the MWA have been put into its European context, by comparing the patterns to ones from Italy and Britain. The material studied showed different clustering patterns than seen in Italy in Britain. Furthermore, it is suggested that Northern Jutland fencing style was less focused on the binding of sword blades, as well as being based more on sword versus spear combat, than sword versus sword combat, as is the case in Britain and Italy.

ARTICLE HISTORY
Received
02 September 2024;
Accepted
21 February 2025

KEYWORDS
Early Bronze Age; Metalwork Wear Analysis; Combat; Swordsmanship.

Introduction

This paper is a study of swordsmanship in Early Bronze Age Jutland, primarily northern Jutland. While the study of Bronze Age weaponry in Scandinavia can be traced back to the earliest developments of the field (Montelius 1885, Müller 1895, Rygh 1885), the study of how they have been used is a recent development (Hermann et al. 2020, 1041). The most potent development of this new wave of Combat Archaeology is the use of experimental archaeology and its combination with use wear analysis, which have been coined as Metalwork Wear Analysis (MWA) (Dolfini and Crellin 2016). This allows for greater understanding of martial practices of the past, and serves as the backbone of this study, as we analyze and discuss differences in fencing styles through MWA of eight swords and one spearhead from Early Bronze Age Jutland.

As we started on this project, we examined several palstaves, swords and spearheads for combat wear marks. Nine artefacts, eight swords and one spearhead, were suitable for analysis and served as the basis of this study. All the artefacts discussed in this study date to the first half of the Nordic Bronze Age (1700-1100 BC). The spearhead and two of the swords were chosen as case-studies for this paper, which serve as interesting evidence of differences in fencing styles in Early Bronze Age Jutland.

Past studies of Bronze Age swordsmanship have generally tried to get an overview of the fencing practices of the period through MWA of a large sample size (Bridgford 2000; Hermann et al. 2020; Horn 2013; Kristiansen 1984). This study has instead focused on a smaller sample size, which has been studied in detail, to understand the specific use wear patterns, rather than a single overarching system (Figure 1). This study attempts to understand the specific use of the two swords and a spear, and the system which governs the technical and martial application of the weapons in question. These results will then be seen in the broader chronological and geographic context, thanks to the study of Hermann et al. (2020).

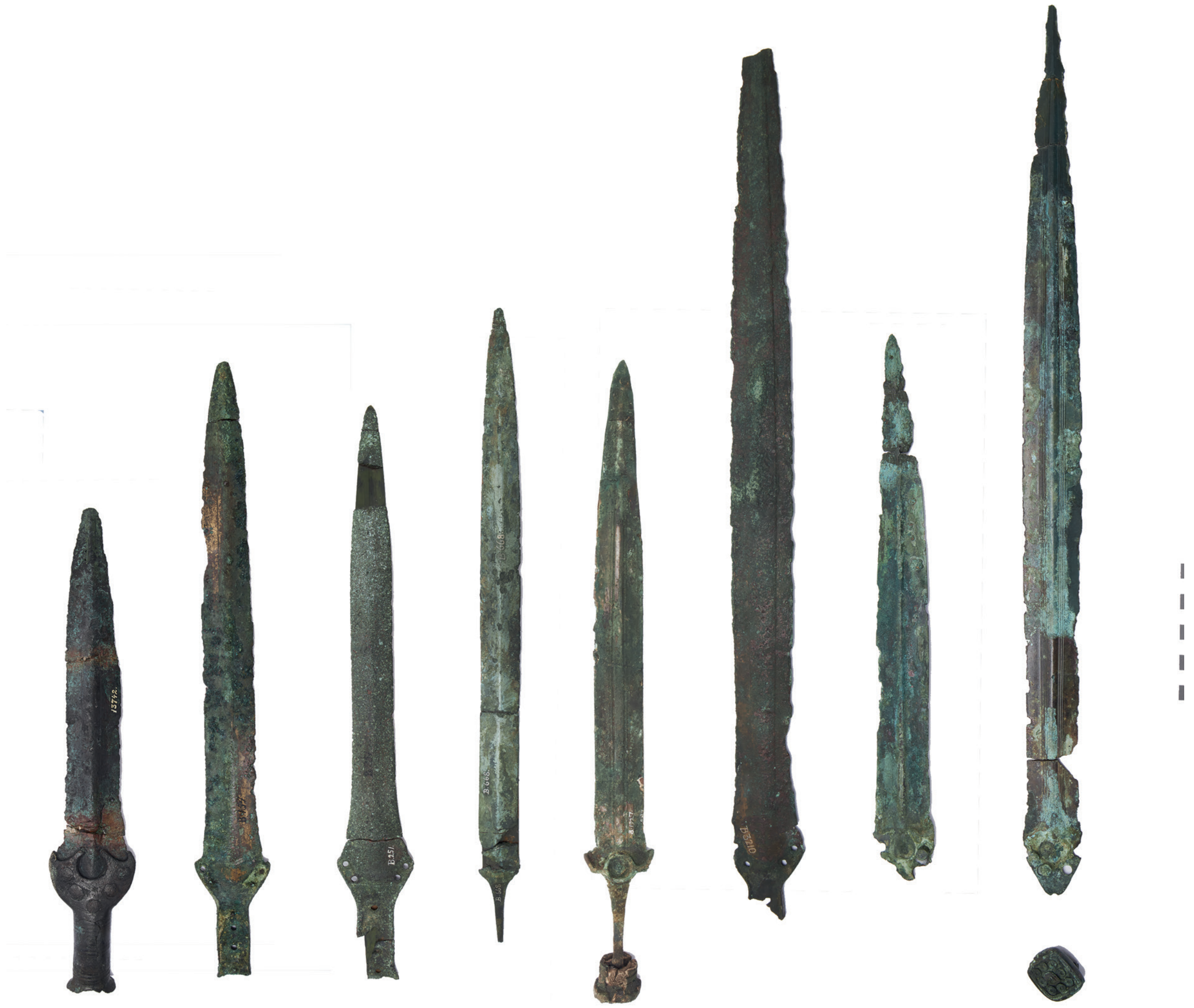

Figure 1. The swords examined in this study. From left to right: 13742, B154, B251, B668, B1927, B3210, B6656, “Sword from Jelling” (Photography: Rasmus Bak Meng, digitally combined by Gustav Hejlesen Solberg, both National Museum of Denmark).

Material

All the weapons were analyzed at the National Museum of Denmark and belong to this museum’s collection. A number of swords, spears and palstaves were first examined to see if they were preserved well enough for MWA to be possible. Two out of three palstaves were excluded from the study, as their edges were too badly preserved. One palstave was examined that was in excellent condition, but it did not have any wear marks and was therefore excluded from the study. Furthermore, multiple swords were not included as their blades were poorly preserved.

Eight swords and one spearhead were chosen to be included in this study. The spearhead and all the swords, except one from Jelling, were found in Aalborg Amt in northern Jutland. The swords date from period II and period III of the Early Nordic Bronze Age. The swords represent different but generally contemporary types. The material examined in this study was already out of storage and prepared for the *Die Funde* project and was therefore accessible for study by the authors. This ease of access was the main reason for these artefacts to be chosen.

The swords examined were 13742, B154, B668, B251, B1927, B3210, B6656 and a sword from Jelling without an inventory number.

The first sword of these to be received by the National Museum of Denmark is 13742, which was registered in 1854 and is a solid-hilted type, dating to period II. The blade is 23 cm long and is therefore the shortest in this study. The find circumstances for 13742 are unknown.

B154 was registered and found in 1867 and came from a burial mound in Overlade parish. B154 is a flange-hilted sword dating to period III. This sword was chosen as one of the case-studies.

Another flange-hilted sword is B251, which arrived at the museum in 1968 from pastor Jacobsen from Hobro, was found on a field in Aalstrup parish. B251 is also dated to period III.

The rod-hilted sword, or *griffangel*, B668 is from period III and was registered in 1871. It was discovered in 1868 in a burial mound in Aarestrup parish.

B1927 was registered in 1878, and is a rod-hilted sword, or *griffangel* of Ottenjahn's G2 type (Ottenjahn 1969, 71). It dates to period III, and it was found in a burial mound together with a gold ring in Ulstrup parish.

The flange-hilted sword, B3210, and parts of the leather sheath came to the museum in 1883. The dating of the sword is period II-III. B3210 was found in a burial chamber in a mound together with a tutulus and a comb.

B6656 is the blade of a hilt-plated type, without the tip, featuring a large midrib along the entire blade. It arrived in the museum in 1897. The blade was found in a burial mound in Giver parish. Due to the state of the artefact an exact dating is harder, but most likely period II.

The other focus sword in this study is a hilt-plated sword from Jelling, dating to period III. Little is known of this sword as it has not been registered and only recently found in storage without a museum number.

Lastly, B1693, a spearhead of Valsømagle-type, dating to period IB, was examined in this study. This spearhead was received at the National Museum in 1877 by teacher Petersen from Strandby parish. It weighs 196.4 grams and is 23.6 cm in length.

Method

The material was analyzed through MWA. This method compares blade damage to reference collections of both experimental trials as well as other archaeological examples (Hermann et al. 2020). A Dino-lite digital microscope was used to undertake this task (see Horn 2013, 15 for discussion). Both edges of all the weapons were examined from the hilt and towards the tip. Every likely wear mark was registered. These were identified according to the system published by Hermann et al. (2020), with the difference that an estimation of the likelihood of the wear marks being produced in combat and not by corrosion was noted for every wear mark. The likelihood was registered as either low, medium, or high, based on multiple factors. These factors are the general preservation of that part of the blade, the presence or lack of displaced material and the likeness of the wear mark's profile to that of the reference collection (see also Horn and Holstein 2017).

To compare the blades of different lengths we chose a similar method as Hermann et al. (2020), and used their formula of $y=(d/D)*100$, where d is the distance of the mark from the tip and D is the sword's total length. Unlike Hermann et al. (1060), we used the length of the blade disregarding the hilt. This was done as some of the grips were not preserved on the analyzed material. These calculations were used in the section *The eight Swords in a European Context,* to compare the generalities of the material studied in this paper, with the Italian and British material studies by Hermann et al. (2020).

Most of the use wear could be categorized according to Herman et al. (2020). Two possible wear marks were found on a sword from Jelling that did not correspond with any wear registered by Hermann et al. (2020), Horn (2013), Kristiansen (2002) or Hester (2018). On the sword from Jelling was an indentation which looked similar to what Hermann et al. call 'toothed notch', which they have not been able to reproduce in experimental trials. The major difference is that this wear mark has rounded sides, where the toothed notch has straight edges (Figure 2).

On the same sword was a mark which seems to be a notch on the blade with an almost square profile (Figure 3). This has some similarity to the straight graze or sharp notch and could perhaps be explained as a combination of multiple different types of wear marks being produced on top of one another. This type of notch has not, to the authors' knowledge, been seen on any other blades until now.

Figure 2. An unidentified type of wear mark with rounded sides on the sword from Jelling (Dino-lite photograhy: Gustav Hejlesen Solberg, National Museum of Denmark).

Figure 3. An unidentified type of wear mark with an almost square profile on the sword from Jelling (Dino-lite photograhy: Gustav Hejlesen Solberg, National Museum of Denmark).

Some of the wear marks were difficult to determine what category they should be ascribed to. Round notches, indentations, wide-angled notches, and rectangular indentations all share general morphological aspects in their profile. These wear marks exist on a spectrum that defies the categorization at some points. During the analysis, and with the later work with the results, some wear mark categorizations were changed, as our experience with the categorization grew. Furthermore, determining wear surrounding breaking points of blades can be difficult, and was for that reason not included in this study (Horn 2013, 14).

Two of the swords examined, B668 and B251, have in the process of preservation been glued to a piece of wood. This did not just make it more difficult to determine the weight of the objects, it also made MWA more difficult, as the wood interfered with the outline of the edge. Despite this, it was still possible to do an adequate and satisfactory MWA on these swords.

A report was produced for each weapon with a picture of each wear mark alongside general information, like length, weight and point of balance. These have then been simplified into a spreadsheet with all the information of the wear marks, which has served as the basis of the use wear analysis of each weapon which will be presented in this article.

Relevant wear marks on the studied artefacts were interpreted with a focus on *Diagnostic Combat Marks* and *clustering* (Hermann et al. 2020, 1057-1061). Diagnostic combat marks are types of wear marks that can be attributed to specific fencing actions, through experimental trials (Hermann et al. 2020, 1057; Gentile and Van Gijn 2019; Gentile, van Dijk and Ter Mors 2024). These are of particular interest for this study, as they can tell us how different parts of the blade were used. Clustering refers to the close distribution of wear marks. If wear marks are clustered together on the blade, it can show that the one who used the weapon, were capable of repeat behavior, which can be linked to higher levels of swordsmanship (Hermann et al. 2020, 1059). Thus, the study of clusters and diagnostic combat marks, can show patterns of different ways of fighting, or as we will call it, different *styles of fencing*. A style of fencing is defined by a likeness of wear mark patterns across multiple contemporary weapons, as will be shown in the sections below. With a larger sample size, it might be possible to show not just variation in style but perhaps demonstrate different schools of fencing. MWA is still a new approach and under development (see Dolfini and Crellin 2016). Revisiting these blades might be possible in a few years, with more possibilities for interpretation.

Results

This section will present the material analyzed in this study, with a focus on the material that was not chosen for the case-studies, as the two swords and spearhead and their wear marks are described in their respective case-study.

- The sword 13742 shows signs of use in the form of wide-angle notches (3), sharp notches (3), round notches (3), double notch (1), straight graze (1) and curved graze (1).
- MWA of B251 showed micro-notches (10), rectangular indentation (1) and round notch (1).
- The wear marks of B668 are wide-angle notches (4), micro-notches (2), bulge (1), sharp notch (1) and round notch (1).
- The wear marks of B1927 consists of rectangular indentations (2) and micro-notches (6).
- The wear marks of B3210 comprises of wide-angle notches (5), sharp notches (2), round notches (6), rectangular indentations (5), straight graze (1), irregular graze (1), curved grazes (2) and micro-notches (4).
- The wear marks of B6656 consists of wide-angle notches (3), sharp notches (2), round notch (1), rectangular indentation (1), double notch (1), straight graze (1) and micro-notches (2).

In total the study revealed 134 wear marks comprising of wide-angle notches (18), sharp notches (10), round notches (14), double notches (2), indentations (20), rectangular indentations (16), a bulge (1), straight grazes (3), irregular grazes (4),

Inv. Nr:	B 3210	B 1927	13742	B 1693 (Spear)	B 154	B251	Jelling	B 6656	B 668	Total
W-A. notch	5	0	3	0	2	0	1	3	4	18
Sharp notch	2	0	3	0	0	0	2	2	1	10
Rd. notch	6	0	3	0	0	1	2	1	1	14
Db. notch	0	0	1	0	0	0	0	1	0	2
Indentation	0	0	0	1	3	0	16	0	0	20
Rect. indentation	5	2	0	1	2	1	4	1	0	16
Bulge	0	0	0	0	0	0	0	0	1	1
Tip pressure	0	0	0	0	0	0	0	0	0	0
St. graze	1	0	1	0	0	0	0	1	0	3
Ir. graze	1	0	0	0	1	0	2	0	0	4
Cu. graze	2	0	1	0	0	0	1	0	0	4
Micronotch	4	6	0	0	10	10	5	2	2	39
Others	0	0	0	0	0	0	3	0	0	3
In total	26	8	12	2	18	12	36	11	9	134

Table 1. Overview of all wear marks found during this study (Andreas Jæger Manøe Schäfler).

curved grazes (4), micro-notches (39), a compression cut (1) and two different unknown wear marks (2) (Table 1).

Discussion

This section will discuss the implications of the registered wear marks, specifically in relation to the three weapons analyzed in separate case-studies. The case-studies aim to relate the results to other studies of Bronze Age weapons and add to the discussion of fencing in this period. Finally, the last section will discuss how the distribution of wear marks across all eight of the swords, relate to the tendencies seen in Italy and Britain.

Case-study: Spearhead B1693

This spearhead of Valsømagle-type was the only spear examined for this study. Other than the wear marks, it is worth noting that the bottom edge of the spear has been resharpened from the middle towards the end of the edge (Figure 4). This was the only case of resharpening that was found during this study.

Horn (2013) analyzed 154 spearheads from Southern Scandinavia for wear marks, which is the largest study of Early Bronze Age spearheads from the study area, as other weapons, particularly the sword, have received the majority of the attention of scholars (Bridgford 2000; Bunnefeld 2016; Hermann et al. 2020; Kristiansen 1978, 1984, 2002; Molloy 2011). Of the spearheads examined by Horn (2013), a total of 127 showed signs from use with the majority of wear marks being notches and curvature or bending.

During MWA of the spearhead two wear marks were discovered (Figure 4). These were on the same side of the edge. These were a rectangular indentation and a normal indentation. In Horn's (2013) study, which does not differentiate between rectangular indentation and other indentations, 37% of the studied spearheads have indentations. The two most common types of wear are not present on this spearhead.

The rectangular indentation was only produced in the testing of Hermann et al. (2020, 1058-1059) when a blade is being blocked by a static parry by another weapon. This type of wear mark is only produced on the slashing weapon, and not the defending one. This points to the likelihood that B1693 was not a spear only used for thrusting, but it was also for slashing (Horn and Karck

Figure 4. MWA of B1693. The rest of the "indentations" which seem to be on the blade all look more like the product of corrosion rather than use (Photography: Rasmus Bak Meng, Dino-lite photograhy: Gustav Hejlesen Solberg, both National Museum of Denmark).

2019, 11). In the case of this spear, it shows none of the signs that one would expect from a thrusting weapon, i.e., tip-pressure and bending, but two cases of wear that correspond with slashing use.

Furthermore, the idea that spears were not only used for thrusting and throwing, but also shows use of striking or slashing, is not only evident on the spear analyzed in this study. This is further supported by a study conducted by Anderson (2011), that through experimental testing and MWA of Late Bronze Age spearheads from Britain showed that those too were used not only for thrusting. This does not mean that spears were not used for thrusting, but the notion that 'spears are for thrusting' is too simplistic (see also Tarbay et al. 2021,15). Recent studies attribute tip-pressure and bending to be prevalent of one-handed spear usage, which could point to B1693 being used in a two-handed manner (Gentile, van Dijk and Ter Mors 2024, 11). The dichotomy of 'thrusting sword or cutting' has also been criticized by Clements (2007), who showed that this is a modern way of thinking. B1693 supports this notion that a great value of a weapon is being able to use it in multiple ways.

Case-study: Sword B154

The sword B154 is a flange-hilted sword from period III and was acquired by the National Museum in 1867 from a headmaster from Borregård, in Ranum parish. It has a weight of 320.9 g and a length of 42.8 cm. This sword showed 27 signs of use. These include indentations (3), rectangular indentations (2), flattening (1), micro-notches (10), irregular graze (1), and blow marks (11). The blade is generally well preserved, and MWA was possible on most of the blade. The tip is not connected to the rest of the blade anymore but could be refitted with confidence.

This blade shows signs of measured, well trained, and high levels of swordsmanship (Hermann et al. 2020, 1072). The blow marks on the side of the blade show a remarkable concentration (Figure 5). Eleven blow marks are concentrated on a section measuring 1 cm in length on the flat of the blade. On this area of the blade there is no verdigris, which give doubts about the authenticity of these blow marks. There are numerous spots on both sides of the swords without verdigris. There can be a large variation of verdigris, even on objects from the same hoard, such as the Torsted and Viby hoards (Becker 1965; Jensen 1978, 19). No blow marks were visible on the other

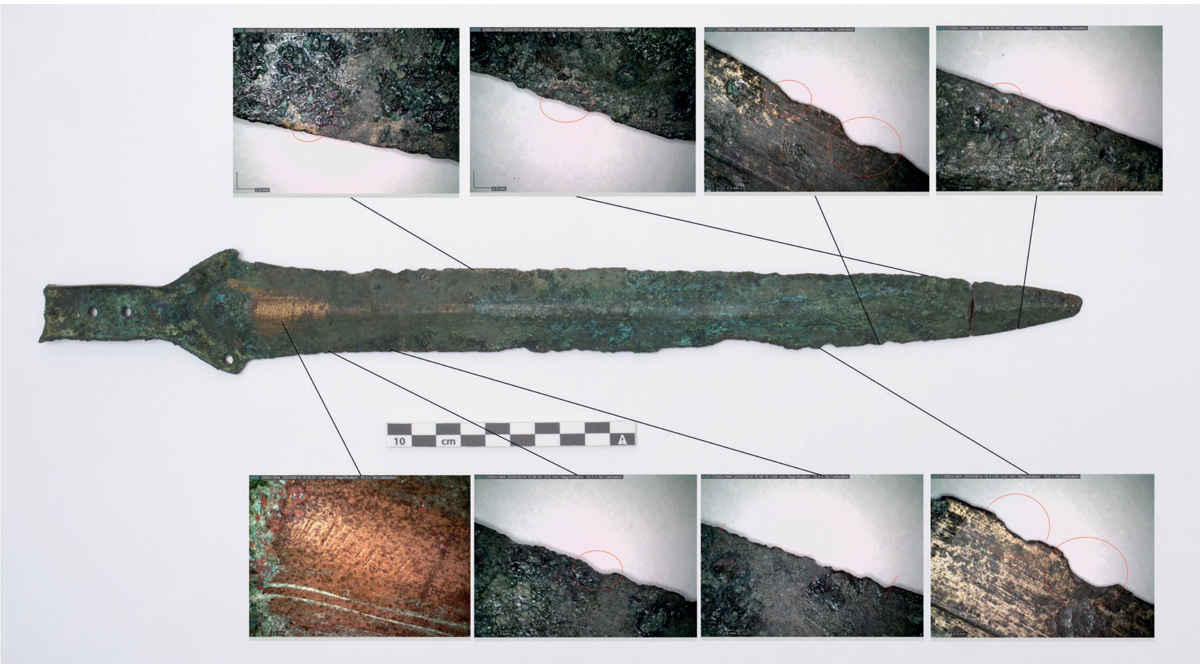

Figure 5. MWA of B154 (Overview photography: Rasmus Bak Meng, Dino-lite photograhy: Gustav Hejlesen Solberg, both National Museum of Denmark).

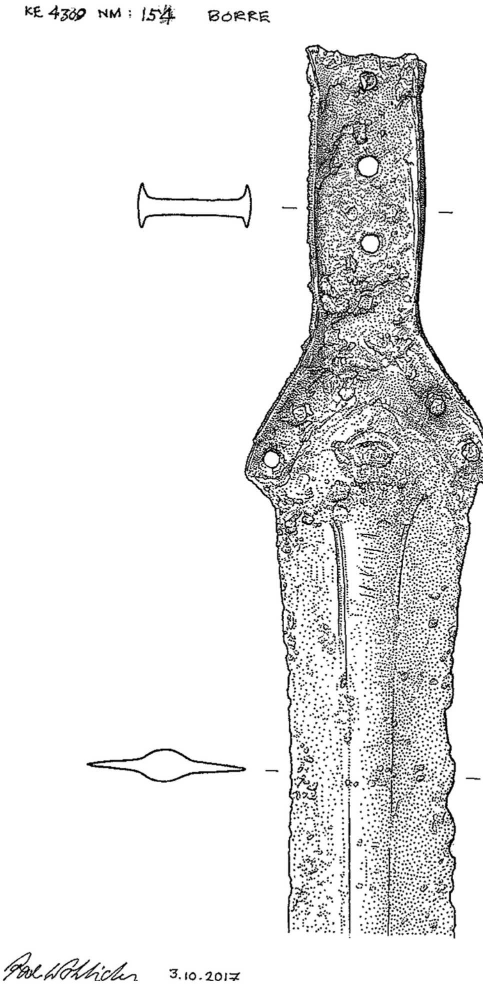

Figure 6. Drawing of B154 from the unfinished publication of Aalborg Amt for the project “Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachensen”. Note how the blow marks are visible on the side of the blade. The drawings are produced to a degree where preliminary MWA can be undertaken without having the object in hand (Drawing: Poul Wöhliche).

side of the blade. One side of the blade measures 13 total wear marks, as the other only measures three, pointing to the weapon being held in the same way each time it was in use, with there being a dominant and a non-dominant edge. The same tendency of having more wear marks on one edge over the other was also observed on the swords 13742 (8 to 3), B1927 (6 to 2) and B251 (11 to 1).

From 6.0 cm to 7.4 cm from the grip is located a cluster of nine small notches on the dominant edge. Only one other micro-notch is seen on the non-dominant edge of the blade. Micro-notches have been argued to be a by-product of other marks and are usually found together with larger wear marks (Hermann et al. 2020, 1059-60). This is not the case with this sword. It could be a possibility that the concentration of blow marks and the cluster of micro-notches are signs of the sword being used in training rather than in full speed fighting. The repetition of movements in training could very well leave intense clusters on specific parts of the blade as seen in this example.

Furthermore, this sword showed two cases of rectangular indentation. These are located close to each other circa 23 cm from the grip. In the experiments by Hermann et al. (2020, 1058-1059), rectangular indentations were produced exclusively on the attacking sword when it hit a static block. This is perhaps a situation one would expect to be more likely to happen in a training situation than in an actual combat situation. Hermann et al. (1058-1059) also mentions that they have a group of four archaeological swords that show rectangular indentations and bending, which they hypothesize were achieved from the user trying to parry with the flat of the blade. The sword, B154, does not show any signs of bending, but it does have blow marks on the side of the blade, which could further support this hypothesis. Hermann et al. (1059), further hypothesize that due to one of their swords being damaged during a parry with the flat, that ‘(...)*one presumes that Bronze Age fencers would have avoided flat parries as much as possible*’. B154, with its cluster of eleven blow marks to the flat of the blade, shows clear signs that flat parrying was practiced intentionally in the Bronze Age (Figure 5, Figure 6).

These rectangular indentations form a group with an irregular graze and indentation on the dominant side and flattening and an indentation on the non-dominant side. These are all connected to attacking actions in the experiments by Hermann et al. (2020, 1057-1058). These marks are all grouped between 23 cm to 31 cm from the grip and show up on both sides of the edge. It therefore seems that there has been a strong preference in the training with, or the use of, this sword to parry with the flat of the blade, or the dominant edge close to the grip, and attack with both edges with part of the blade that is closest to the tip. This corresponds with the tendency observed by Kristiansen (2004, 178) on other swords from Denmark and Hungary, where the

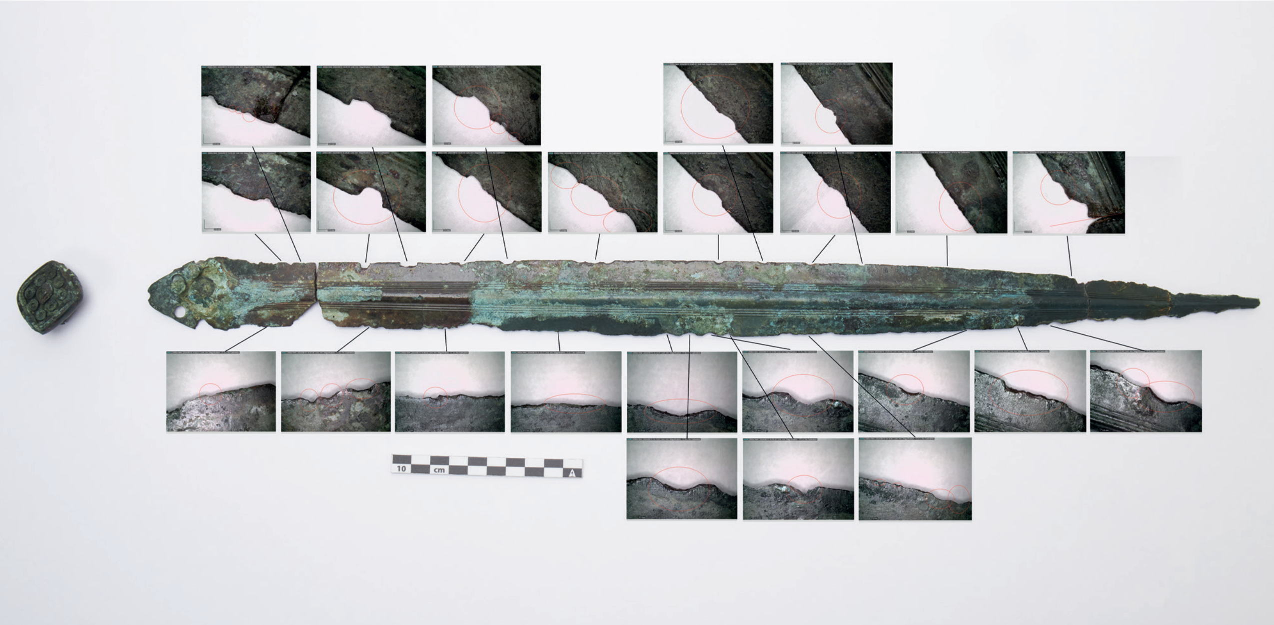

Figure 7. MWA of the sword from Jelling (Overview photography: Rasmus Bak Meng, Dino-lite photograhy: Gustav Hejlesen Solberg, both National Museum of Denmark).

part of the blade closest to the grip is generally used for defending and the tip is usually used for attacking. The remarkable concentration of these wear marks is clear evidence of the deliberate martial technique, which served as foundation for this sword's use.

Case-study: Sword from Jelling

This sword was uncovered in Jelling and is a hilt-plated type and is dated to period III. Unfortunately, no museum number is associated with the find and information about it has been lost. It weighs 563 g and has a length 59 cm without the handle. The pommel cap is preserved but no longer connected to the blade (Figure 7).

This sword shows 38 signs of use. This was the highest amount of any of the eight swords that were examined in this study. These include indentations (16), round notches (2), rectangular indentations (4), flattening (2), micro-notches (5), irregular grazes (2), sharp notches (2), curved graze (1), wide-angled notch (1), compression curl (1) and two unidentified types of wear mentioned in the method section. The last c. 8 cm of the tip is not preserved to a degree that it can be examined for wear marks.

In contrast to the sword B154, which showed a clear favor of one edge above the other, the same cannot be said for this sword. 18 of the wear marks are on one edge and 20 are on the other. This points to a different fencing style that utilizes both sides of the blade equally, compared to the other. The other possibility is that the wielder of the sword had no preference to which way it should be held, thus changing which way the sword is held between uses. Another explanation is that it was wielded by multiple people during its use time. According to Bunnefeld (2022, 76), a sword is mostly buried with its owner and most likely shows the fencing style of the buried individual. Therefore, if we accept that swords are tied to an individual, then the explanation that the sword from Jelling was used by multiple people should be dismissed. Furthermore, the same pattern of wear marks is also seen on the swords B668 (5 to 4) and B6656 (6 to 6).

Looking at combat indicative marks on this blade, it also shows a clear variation of fencing technical application compared to that was seen on B152. Firstly, rectangular indentations appear on this blade four times. These are located as close as 4 cm from the grip, all of them below 16 cm. This stands as a contrast to what was examined on B152, where signs of attack were located near the point of the blade. The sword from Jelling does have attacking marks closer to the tip of the sword, namely two irregular grazes, the furthest being at 41.5 cm. This blade does not comply with the tendency put forth by Kristiansen (2004, 178), that the part of the blade closest to the hand is used to defend and the tip is used to attack.

The same can be seen on the sword B3210 which also has rectangular indentation 4.5 cm from the grip and 51 cm from the grip. This sword has 10 wear marks on one edge and 17 on the other, thus the fencing style used with this sword does show similarities with the sword from Jelling.

This is not to say, that the use of the sword from Jelling does not have a pattern. There are multiple clusters present on the blade, which show that repeatable actions while wielding the blade did occur. Close to one of the rectangular indentations at 4 cm from the grip there is a sharp notch and two micro-notches within 0.5 cm. This could point to it not being the only time this part of the blade was used to attack. The same could be argued for the rest of combat indicative marks on the blade. All except one of them, are placed within 1 cm of another wear mark. Though one should remember that one action can produce multiple wear marks close to each other (Hermann et al. 2020, 1055-1056). In the case of the sword from Jelling, it seems likely that these clusters were not all produced from single actions, as the pattern persists on six occasions.

This blade shows less obvious groupings of wear marks compared to B154, but the fact that this sword has multiple clusters, while other parts of the blade are untouched, do point to the skill of the one who used the sword (Hermann et al. 2020, 1072). It shows a clear difference in fencing technique that is usually ascribed to chronological, geographical, temporal, or personal differences. But as this sword is from a region close to the other swords, and other swords from Northern Jutland show the same pattern, also from the same period, it seems likely that at least two different styles of fencing existed at the same time and place. Nonetheless, the sword from Jelling is a testimony of a fencing system that uses the entire blade for attack, and perhaps also defense, which includes attack with, in fencing terms, the strong of the blade (Hester 2018, 43).

The eight Swords in a European Context

As the method of MWA is applied to an increasing number of weapons from various places and time periods, regional and temporal differences in swordsmanship become increasingly evident. Kristiansen (2002, 2004) argues for a homogeneous fencing style being present throughout Europe based on wear analysis of swords from Denmark, Hungary, and Austria. Though it should be mentioned that he argues for a change in fencing style from being dominantly based around stabs, to being based around cuts in the transition from period II to III in the Nordic Bronze Age (Kristiansen 1984, 194-195). This argument is based primarily on the typological development of blade shapes as well as resharpening of the blades, rather than use marks. As the swords 13742 and B6656 are dated to period II and B3210 could be from period II as well, and the rest of the swords being from period III, one could expect this change to be visible in this study, but this is not the case. Though it might be, if a larger sample size was examined.

The detailed study by Hermann et al. (2020) on the other hand has shown temporal and spatial variations of wear marks, which they have argued to show an evolution of swordsmanship. Their study is based on swords from four periods of the British Bronze Age; Penard, Wilburton, Ewart Park and Llyn Fawr, and two periods of the longer Italian Bronze Age; the Middle and Recent Bronze Age. Most striking is the lack of clustering on the swords from Britain in the Penard period, and the wide distribution of grazes, which Hermann et al. (1072) argue is evidence of an early and immature martial tradition. Having a large amount of combat indicative marks for attacking use of the sword on the lowest part of the blade is seen on these swords, which is not unlike the sword from Jelling and B3210 mentioned in the previous section. But these swords do show clustering, which speaks in favor of them being used in a defined martial tradition.

When comparing the placement of the wear marks on the eight swords, to the Italian and British swords, there are similarities to be found (Figure 8). The swords examined in this paper are equivalent in time to the Middle and Recent Bronze Age in Italy and the Penard and Wilburton periods

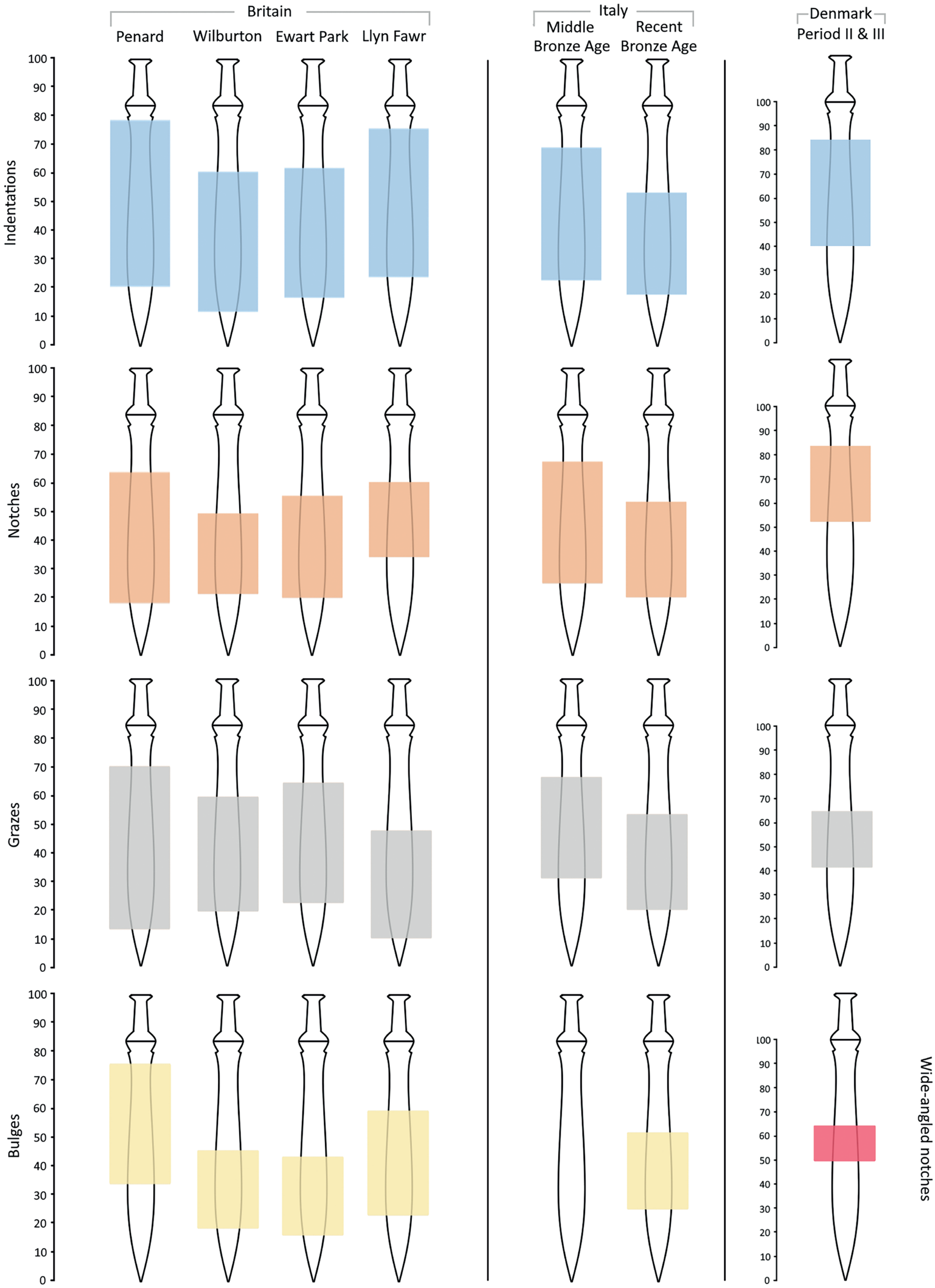

Figure 8. Schematic illustration of MWA patterns observed on material from Britain and Italy after Hermann et al. (2020). Not enough bulges were seen on the material studied for this paper, to include them in the comparison. Wide-angled notches were included as a separate category, as these were common to find in the Danish material, but rare in British and Italian material.

in Britain. It is curious then that there is an apparent likeness between the distribution of notches and indentations between the Early Bronze Age in Denmark and the later occurring Llyn Fawr period in Britain. This is the case with indentations and notches but not grazes. The fact that only eight swords have been analyzed and the fact that are 600 years between the two periods, probably suggests that the connection is only by chance. One should remember that this is based on only eight swords, which have been shown to have been used in different ways, despite their chronological and geographical similarity. More material should be analyzed to better understand the relationship between Bronze Age swordsmanship in Denmark and the rest of Europe.

A notable difference between the weapons analyzed in this study and those from Italy and Britain is the pattern of wide-angled notches found on six of the Danish swords (Table 1). This type of wear mark was rarely observed on British and Italian swords where wide-angled notches were only produced in experiments when the edge of a sword met the edge of a spear (Hermann et al. 2020, 1057). If this is the only way these marks can be produced and they are interpreted correctly, then this could point to the possibility that fencing between spears and swords was more common in the Early Bronze Age of Denmark, than it was in Britain and Italy.

Furthermore, bulges are quite common on the Italian and British swords, which have been argued to be evidence of a fencing style, where blade on blade binding is practiced (Hermann 2020, 1058). Only one bulge was found on the eight swords studied here, that being on B668. This could point to the possibility that fencing in this region was different from the ones practiced in Britain and Italy, by not being based on blade binding. Another possibility is that these swords were used to fight spears more often, as supported by the large amounts of wide-angled notches.

The general conclusion of the distribution of the wear marks on the eight swords included in this study, is that they are different to those found in Italy and Britain, indicating different martial practices. But more importantly, the detailed study of fewer examples highlights the individual variation of fencing practices. When a large amount of weapons is analyzed in a search for an all-inclusive fencing system, then this is done at the cost of understanding the variation in fencing practices that this article has highlighted. Perhaps, studies like this one will help us understand individual fencers' practices. With enough overlap between patterns of specific fencers, then we can discuss fencing styles shared between a few people. With enough weapons showing similar clustering, then perhaps different schools of fencing could be discussed. Similarities between different schools of fencing can finally point towards tendencies in overarching regional and supraregional martial practices, but only by looking at fencing practices at different levels, can we truly understand the practice. Assuming that a single fencing system exists in a given time and place should be challenged, and looking at smaller groups could improve the study of swordsmanship. If this was expanded upon, then perhaps regional perspectives could be improved, if one were to find a considerable overlap between patterning from different regions.

Conclusion

This study has provided insight into the particularities of fencing styles in Jutland in the Early Nordic Bronze Age. In the small study of eight swords, it is possible to suggest that, at least two, different styles of fencing were likely present at the same time and place. The type of sword did not have any obvious connection with the use wear patterns. One style favored the use of one edge over the other, while the other style used both edges equally. Furthermore, comparing wear marks on original swords to marks produced during controlled testing by Hermann et al. (2020), has made it possible to determine what part of the blade is used for attack, and what part is used for defense. This also varied between the swords studied here, with some showing wear marks connected to the act of attacking throughout the entirety of the blade, while others only had them at specific parts of the blade. Clustering and patterning were common on the swords studied, which show a general high level of swordsmanship, but with a difference in martial practices. Further studies using MWA of Bronze Age weaponry are needed to better understand the variation of the Danish material, but this paper has shown that even small sample sizes can provide valuable insight into the particularities of different fencing styles.

Acknowledgements

Thanks to Professor Ulla Mannering for lending us a Dino-lite for this study.
Thanks to the *Die Funde* project for allowing us to examine the material.
Thanks to the two anonymous reviewers and the editors for making this paper better.

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Inter-human perspectivism and ancestor veneration in Late Neolithic/ Early Bronze Age Southwestern Norway

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ABSTRACT

The transition of nomadic hunter-gatherers into sedentary farmers marks the beginning of the Neolithic period. However, the Neolithic was more than just a social and economic transition. It signified the onset of a new worldview which re-defined ways of thinking about the world, and the role and place of humans within it. As such, this era encompassed a lot more than simply the adoption of new technologies and the formation of new social structures. Drawing on ethnographic work on north Asian ontologies, this paper argues that the Late Neolithic (LN) transition in Rogaland, Southwestern Norway, was marked by a shift to inter-human perspectivism. This shift was accompanied by a growing interest in ancestral perspectives, leading to an increase in ancestor-oriented rituals that ranged from simple commemorative practices honouring the deceased to elaborate public spectacles and hero cults. While the primary focus of this paper is on the Late Neolithic/ Early Bronze Age, comparative insights from the Late Bronze Age are included, particularly in the discussion of hoards, due to the relative scarcity of material from Rogaland.

ARTICLE HISTORY
Received
10 January 2025;
Accepted
06 September 2025

KEYWORDS
Ontology; Ancestor rituals; Late Neolithic (LN); Nordic Bronze Age (NBA); Inter-human perspectivism

Introduction

The last years have witnessed a growing interest in ontological otherness in archaeology and related disciplines (Alberti 2016; Alberti and Marshall 2009; Alberti et al. 2011; Harris and Cipolla 2017; Henare, Holbraad and Wastell 2007; Holbraad 2009a, 2009b; Holbraad and Pedersen 2017; Thomas 2015). Within the new ontological framework, differences in how we relate to each other and the world, is understood, not as a matter of culture or worldview, but as a matter of ontology, of being. The ontological turn is thus a move away from the assumption that fundamental differences in human experience and perception are attributable to a particular culture or worldview. Rather than treating other people's beliefs as cultural representations, an ontological approach allows multiple worlds or realities to coexist. There is not one world "out there", independent of and prior to our knowledge, but multiple worlds, each as real and concrete as our own. In a very real sense then, people are seen to inhabit different worlds, one as real as another, but with conflicting values and facts. The archaeology of ontology contributes to this debate by exploring, not only how prehistoric societies conceived of and apprehended the world, but also how non-modern ontologies differed from one another.

About 4000 years ago, the prehistoric cultures of Southwestern Norway underwent a series of profound changes, as former hunter-gatherers gave up their nomadic lifestyle and settled down to become farmers (Fredh, Prøsch-Danielsen and Jensen 2018; Glørstad and Prescott 2009; Hjelle, Prøsch-Danielsen and Soltvedt 2017; Hjelle et al. 2018; Prescott and Glørstad 2012; Prøsch-Danielsen and Høgestøl 2006; Prøsch-Danielsen, Prescott and Holst 2018). A new lifestyle took hold, replacing indigenous beliefs and traditions with new, and radically different, concepts and notions. Along with this came new social and political institutions, technological advances, monumental architecture as well as economic and dietary changes. By the late centuries of the third millennium BC, agriculture was firmly established as the main source of livelihood, and the early farming communities formed part of elaborate networks of trade and interaction, reaching across Northern Germany, Denmark, Southern Sweden, and Southern Norway. From this time onwards, elaborate burials and ritual hoards also begin to appear with more regularity in the archaeological record, indicating a growing concern with lineage and ancestry.

The question addressed in this paper is whether these changes coincided with a more profound ontological shift, one that increasingly positioned ancestors as active participants in the social fabric of the living. In this context, ancestry may have emerged as more than a conceptual framework – it may have become a lived, reciprocal relationship, actively sustained through commemoration and ritual practices.

Ancestors in Scandinavian archaeology

The idea that ancestors were central to the experiences and practices of the first farming population in Norway, aligns with longstanding interpretations of LN and NBA burial practices, which are often thought to involve elements of ancestor veneration (Brøndsted 1958; Jennbert 1993; Kaliff 1997; Sverdrup 1933; Wangen 1999). Similar ideas have been put forward in Rock Art research, where certain images have been interpreted as depicting ancestral or heroic and mythical figures (Kaul 2005; Melheim 2022; Vandkilde 2013; Østmo, 1997, 2017). Numerous studies have emphasised the potential role of burials and Rock Art in fostering connections with the past, imbuing it with immediacy and relevance and reinforcing social cohesion by linking communal identities to shared cosmological and ancestral narratives.

With the recent emphasis on shapeshifting in prehistoric iconography (Ahlqvist and Vandkilde 2018; Goldhahn 2019), attention has centred on how the magic of transformation and metamorphosis may be evoked through depictions of fantastical, potentially semi-divine creatures. Through carving and sculpting, these extraordinary beings were depicted not only in imaginative and awe-inspiring forms but also as active participants in the social world of the living. In this way, ancestors and other mythical or heroic beings were brought into being – not merely as individuals of the past but as dynamic entities continually shaped and sustained through ritual practices.

Defining ancestor veneration

The term ancestor veneration has faced criticism for its broad and often indiscriminate application to a wide range of cultural practices. Whitley (2002), for instance, has argued that the term functions as an overly simplistic catch-all label, grouping together potentially diverse and context-specific activities under a single category. While the archaeological record provides abundant evidence of interactions with the dead, an uncritical reliance on the term ancestors risks oversimplifying the intricate beliefs, rituals, and socio-cultural dynamics that underpin ancestor-related practices. However, as Insoll (2011, 1047) contends, the concept of ancestors remains valid in archaeological interpretation when applied with appropriate care and nuance, and considered alongside related phenomena, such as sacrificial practices, whose configuration and significance are dynamic and subject to change over time.

In the ethnographical literature, the term ancestor veneration is generally used to refer to a set of practices based on the belief that the dead have a continued existence beyond physical death and that dead forbears are able to influence the lives of their descendants (Astuti 2007; Astuti and Bloch 2013, 104-106; Bloch 2010, 54). It has been recognized as an universal aspect of religion (Steadman, Palmer, and Tilley 1996), however, in a recent study by Peoples, Duda, and Marlowe (2016, 270-277) active ancestor worship (defined as a belief in ancestral beings who remain active in human affairs) was found to be absent in animistic cultures. Although rare among hunter-gatherers in general, it occurs more frequently in complex societies where kinship plays an important socio-economic role (Peoples, Duda, and Marlowe 2016, 275).

Ancestor veneration is common throughout the world, particularly in parts of Asia, Africa, and Latin America. It is often an integral part of the culture, influencing everything from daily life to religion and politics (Hill and Hageman 2016b). In general, ancestors are regarded as superhuman

Figure 1. Two small pots and two slate pendants from a possible Late Neolithic stone cist at Hodne in Klepp, Rogaland (Photo: Annette Græsli Øvrelid, Museum of Archaeology, University of Stavanger).

beings, capable of intervening in human affairs. They can be called upon for protection and guidance and asked to assist in disputes about inheritance and land ownership. The remembrance of ancestors is also central for understanding how people make sense of the world and their place in it (Hill and Hageman 2016b, 30-31). Ancestors are often the subject of myths and legends, shaping people's cultural identity and sense of belonging. Typically, ancestor veneration involves ritual practices intended to remember, honour, and appease the ancestors, such as offerings, monument building, and other acts of reverence shown towards the deceased (Hill and Hageman 2016a, 55-68).

The emergence of commemorative monuments: Honouring memories and ancestor heroes

Monuments have long served as powerful symbols of remembrance, honouring loved ones and other members of the community, while offering comfort and connection to those left behind. Monuments can take various forms, ranging from simple stone blocks or modest heaps of stones to more intricate structures. Whether simple or elaborate, they fulfil a variety of roles, reflecting the complex ways in which communities and individuals engage with memory, identity and loss. Through their physical presence, monuments preserve legacies in a visible form, anchoring the past within the physical and cultural landscape. Additionally, they can be used to signal territorial claims to land, demonstrating the significance of ancestry and tradition in shaping social and political structures.

In Southwestern Norway, there is no evidence of monumental burials prior to the LN, suggesting graves were simple pits dug into the ground without a covering mound or cairn. The earliest mounds to appear were simple constructions of stone or earth, covering a stone lined cist, within which the remains of the dead were interred. LN stone cists have been documented primarily in eastern Norway, particularly in the inner part of Østfold, as well as along Norway's southern coast, stretching from the Oslo Fjord through Rogaland and further along the western coastline (Solberg 2006; Østmo 2011). While the eastern examples typically feature open, rectangular cists designed for successive burials, the western examples are predominantly closed, single-room structures, in which the deceased were interred with items such as daggers and points (Østmo 2011). A small number of such graves have been found in Rogaland. At Austrått in Sandnes, a spearhead or a repurposed lanceolate dagger was discovered alongside now-missing pottery in a "beautifully constructed" chamber beneath a mound measuring 1.5 meters in height and 10 meters across (Helliesen 1903, 73). Another LN burial was excavated at Hodne in Klepp, where a possible cist – evidenced only by an upright slab – was uncovered, containing two small pots and two slate pendants (Figure 1) (Hauken 2003; Helliesen 1905, 72). Other finds reported included cremated bones.

Figure 2. Reconstructed burial mound at Rege in Sola, Rogaland (Photo: Terje Tvedt, Museum of Archaeology, University of Stavanger).

North of the study area, in Selje, Western Norway, archaeologists recently uncovered a stone-lined cist dating to around 2000 BC, containing the remains of at least five individuals (University Museum of Bergen 2023). This is the first grave of its kind to be found outside of Østfold in Southeastern Norway. Its discovery hints at the spread of a new burial custom, suggesting that such practices were beginning to take root in regions beyond their traditional geographic boundaries. A somewhat similar yet lesser-known collective burial was excavated by Jan Petersen in Sømme, in Rogaland, in 1931. Here, a rectangular chamber measuring 3.5 meters in length and 2.5 meters in width was discovered, containing the unburnt remains of at least six individuals, radiocarbon dated to 1885-1745 cal BC (Høgestøl 2003, 107). The number of individuals has recently been updated to 13 (Sean D. Denham, personal communication, August 29, 2025). A circular mound, measuring 12 meters across, was raised above them. Seven upright slabs may have formed part of a passage or divided the chamber into compartments. No artefacts were recovered.

The move towards more monumental burial customs may have transformed burials into more than resting places for the dead; they may have become sites where the living could return to honour and reflect on the memories of the deceased. This change probably reshaped how communities understood their connection to the past, emphasizing continuity between the living and the dead. This developing practice likely laid the groundwork for the large-scale, communal burial rites that emerged during NBA period II, when burials became increasingly complex and elaborate (see Myhre 2004; Møllerop 1962). High status individuals were now buried in a cist or a piled stone construction, covered by an earth and stone-built mound (Austvoll 2017, 424, 2019, 21). Many of these graves are richly furnished with objects in bronze and gold. Notable examples include the Rege-mound in Sola in Rogaland (Figure 2), situated in an area with the largest concentration of NBA-mounds in Norway, comprising over 56 excavated mounds and 3 cairns (Austvoll 2019, 22). Another significant site is Reaheia in Karmøy, one of Scandinavia's most elaborate burial sites, and one of the few where barrows are arranged in a line. Excavations have produced several rich finds, including a twisted armring of gold and fragments of hammered gold leaf.

These barrows were part of a broader 'tumulus' complex that emerged in Northern and Central Europe in the Middle NBA (Holst 2013, 103). They probably served a variety of commemorative

Figure 3. Early Bronze Age cult axe recovered from a spring in Lunde in Vindafjord, Rogaland (Photo: Adnan Icagic, University Museum of Bergen, University of Bergen).

and performative functions, the most pressing of which may have been to commemorate and honour the dead (Brück and Fokkens 2013, 97; Darvill 2013, 144; see also Goldhahn 2008).

New ritual practices: The emergence and significance of ritual hoards

The LN also saw the emergence of new forms of ritual activity. From this period onwards, there is a marked increase in ritual hoards – from a handful in the Early and Middle Neolithic to several dozen in the LN. A majority of these were buried in bogs or other wetlands like rivers, lakes, or fens. While most Early and Middle Neolithic bog finds are single finds (mostly incomplete axes, of which a majority could be accidental losses), LN bog finds occur both as single finds and as hoards, containing hundreds or even thousands of objects. Among the largest hoards in Norway is one from Hauskje in Rogaland, numbering 26 flint daggers and more than one thousand flakes. There is also a number of dry land hoards from this period. These are collections of objects buried together in the ground, or under or besides large rocks. The meanings of ritual hoards are not known, but they are often thought to represent offerings to ancestral spirits (Karsten, 1994; Kaul, 2003). Although offerings may have served various purposes, one of their most significant (albeit likely unintended) roles may have been to endow the ancestors with agency, allowing them to emerge as active and dynamic participants in the social and spiritual fabric of life.

From the 15th to the 13th century BC, offering rituals appear to have undergone several changes (Kristiansen 2013, 87). Flint daggers, scrapers, and other utility items were to some extent replaced by offerings of a more ceremonial character, suggesting a new concern for ritual performance (Nordby and Sørgaard 2020). Cult axes and other ritual implements associated with chiefly authority and possibly divine or ancestral power (Kristiansen and Larsson 2005, 266), such as spiral gold arm rings, have been recovered from hoards from NBA period II (Figure 3). Solar/spiral motifs are also evident in female elite burials from this period, particularly in the Klepp region of Jæren, where it appears in the form inhumation graves furnished with bronze ornaments.

The use of ceremonial artefacts as offerings continues into the Late NBA, with several depositions of a more cultic character (Kaul 2003,

Figure 4. Gold serpent from Hesby in Stavanger, Rogaland (Photo: Annette Græsli Øvrelid, Museum of Archaeology, University of Stavanger).

26). These include the bronze lurs from Revheim in Stavanger (period V), two torques from Vårå in Karmøy (period VI), a spiral decorated sword from Eia in Sokndal (Period IV) along with several other Scandinavian finds, among them the bronze hybrids from Vestby in Oppland, Eastern Norway (Bjørn 1929; Hagen 1954; Lund and Melheim 2011; Rosenqvist 1954), the bronze figures from Grevensvænge in Næstved (Djupedal and Broholm 1952; Iversen 2014), and the two-faced, horned bronze figure from Kallerup in Thy, Denmark (Enevold 2024; Posselt and Møller 2023). Mention should also be made of a gold figurine of a serpent from Hesby in Stavanger, which offers an interesting parallel to the snake-horse figurine from Fårdal in Denmark (Figure 4) (Kjeldsen and Sørgaard 2023, 79). The serpent is a stray find lacking contextual information; however, it is generally believed to date from the NBA/Early Iron Age. Objects like these, among many others, may have held important ritual or ceremonial functions, serving to consolidate myths and making them tangible in the present moment, while possibly shaping the myths themselves, influencing their content and narrative (Kjeldsen and Sørgaard 2023, 78-82; Melheim 2022, 212; Nordby and Sørgaard 2020, 143).

Given these developments, it seems likely that some form of ancestor veneration was practiced, perhaps widely, among the early farming population of Southwestern Norway. Although ancestor rituals may have existed in some form long before the introduction of agriculture, it was not until the later centuries of the third millennium BC that they became common. A remarkable number of tools and weapons now found their way into the water, most likely as offerings, and from the middle of the second millennium onwards, dozens of burial monuments were raised. One of the questions that arises from this is whether these changes were part of a wider ontological shift towards inter-human perspectivism?

Ancestor veneration and inter-human perspectivism

In a discussion of animism and totemism in North Asia, Pedersen (2001) argues that ancestor veneration is a special form of perspectivism, primarily focused on inter-human metamorphosis. The term 'perspectivism' was originally developed by Eduardo Viveiros de Castro (1998, 2004) to describe a set of ideas and practices found in Amerindian ontologies but has since been applied to other parts of the world, such as North and Inner Asia (Holbraad and Willerslev 2007; Pedersen 2001; Willerslev 2004). Perspectivism refers to a mode or view of the world where humanness is thought to be relative to the perspective of the observer. Animals perceive themselves as humans and humans as their prey. Conversely, humans see other humans as fellow beings and animals as potential prey (Viveiros de Castro 2004, 466). The idea is that different species apprehend the world from different points of view. What humans perceive as nature may be culture to another species (Viveiros de Castro 2004, 471). Naturally, perspectivism fosters a deep interest in understanding how animals think and perceive the world.

At its core, perspectivism holds that humanity is shared by all beings, humans and animals alike (Viveiros de Castro 2004, 465). Although outwardly different from us, animals have a human soul, with their physical bodies acting as coverings that conceal their true human essence. In this view, the body – its shape, size, strengths, and functional capacities – is the primary factor distinguishing one species from another. Ontological identity, thus, is not biologically given; it is not located in a person's body but constructed through the eyes and experiences of other beings.

Inter-human perspectivism differs from perspectivism in having a human focus. It is widespread among pastoral groups inhabiting the southern parts of Mongolia and Siberia (Pedersen 2001). Rather than trying to internalize an animal's point of view through hunting magic and other ritual practices, inter-human perspectivists seek the perspectives of past human beings (Pedersen 2001, 423). The primary focus of much ritual activity is to see the world through the ancestors' eyes and share their perspectives (Pedersen 2001, 423).

One of the differences between perspectivism and inter-human perspectivism thus has to do with the number of available perspectives: Whereas perspectivism provides access to a multitude of perspectives (through shamanistic journeys, out-of-body experiences etc.), inter-human perspectivism limits perspective taking and identification with the nonhuman other. It is first and foremost an attempt to see the world from the ancestors' point of view.

LN/NBA inter-human perspectivism in context

A central question is thus whether the early farming population of Southwestern Norway may have practiced some form of inter-human perspectivism. The concurrent emergence of phenomena such as sedentary communities, monumental architecture, and offerings is probably not coincidental but rather reflects a change in attitudes towards ancestors and a growing concern with kinship and descent. As people became less dependent on wild animal foods, traditional animal spirits may have lost their importance and increasingly have come to be seen as detached from the human world, uncaring about things like soil fertility and crop yields. Ancestors were closer to humans and may therefore have been perceived as more interested in human affairs, desiring offerings, and devotion in exchange for protection and benevolence for the living.

As human-ancestor relations became increasingly institutionalized in the first half of the second millennium BC, the significance of offerings may have changed. Ancestor rituals may have become more complex, moving from simple offerings to large theatrical performances enlivened by costumes and props (Nordby and Sørgaard 2020). Gradually, the rituals may have been more focused on individual ancestors and their accomplishments, perhaps signalling the beginning of an ancestor cult.

Changes are also evident in the mortuary practices of the LN/Early NBA. Over the centuries, burial mounds evolved from simple stone constructions into large and complex structures, erected to honour and commemorate the dead. Secondary burials were often inserted into the mounds at a later date – a practice characteristic of the Late NBA in Southwestern Norway (Bauer and Østmo 2017, 247; Dahl 2016; Myhre 1998, 143-144). Again, this may indicate that a hero cult was established by the Late NBA. This hypothesis aligns with the broader pattern of Late NBA imagery, which includes numerous depictions of possibly heroic figures (Skoglund 2015; Vandkilde 2013), often with oversized bodies and accentuated calves (see Fahlander 2019). At the site Kråkhaug in Sola, for example, an oversized (possibly headless?) being is depicted with accentuated calves, possibly holding a large axe (Figure 5). The figure is positioned to the left, and above, three other, smaller individuals, who seem to be participating in a sexual ritual (Kjeldsen and Sørgaard 2023, 78-79). While alternative interpretations do exist for this and similar oversized figures (see Fahlander 2019), their often exaggerated human attributes and weapon carrying privileges suggest

Figure 5. Oversized human figure with accentuated calves, possibly holding an axe. Kråkhaug in Sola, Rogaland. (Photo: Åge Pedersen, Museum of Archaeology, University of Stavanger).

extra-human qualities commonly associated with ancestors, warrior heroes and other mythical figures (Vandkilde 2013). In practice, distinguishing between these roles can be challenging, as ancestors may have featured in myths (Kaul 2005), or certain individuals may have either claimed mythic status, or acquired it over time.

Compared to regions with particularly rich concentrations of Rock Art, such as Østfold in Eastern Norway and Bohuslän in Sweden, human and animal depictions and ceremonial scenes are relatively uncommon in Rogaland. While such motifs do exist, they tend to be simpler and less detailed (Kjeldsen and Sørgaard 2023, 84). Rogaland nevertheless reflects the broader Scandinavian trend of a heightened focus on human figures and ceremonial scenes during the Late NBA. This development marks a distinct shift from the Early NBA, which is primarily characterized by stylized motifs such as ships, cup marks, circles, and geometric patterns (Kjeldsen and Sørgaard 2023, 84).

Skogslund (2015) interprets the marked increase in human depictions during the Late NBA, particularly after 800 BC, as indicative of a significant shift in societal dynamics. These depictions, characterized by a growing attention to detail – showing humans engaged in activities such as riding horses, participating in marriage rituals, and ploughing – differ from the more stylized and abstract human representations so typical of the Early NBA. Skoglund suggests that this change signals the emergence of a new aristocracy, who may have sought to justify and solidify their elevated social status by emphasizing their grandeur and claiming legendary status. In doing so, they intertwined their lives and ambitions with that of important ancestors or mythical figures, legitimizing their status and ambitions as both desirable and inherently natural.

Conclusion

It seems likely, based on the available data, that the first farming population of Southwestern Norway practiced some form of inter-human perspectivism, probably resulting in an increased importance of ancestor spirits. While there is no single agreed upon definition of ancestor veneration, certain commonalities do exist, including the belief that ancestors live on after death and that they have the power to influence – for good or evil – the lives of their descendants. Ancestor veneration can thus be understood to comprise a broad variety of ritual practices intended to commemorate, honour, and appease the dead, including various ritual expressions, offerings and the construction of monumental burials. In Southwestern Norway, monumental burials and ritual offerings began to appear with regularity after 2300 BC, suggesting a preoccupation with the ancestors' views and experiences of the world. Initially, ancestor rituals may have consisted of simple offerings of tools and weapons. Over time, the rituals began to take on a more theatrical style, possibly integrating elements of drama and performance. In the Late NBA, ancestor veneration probably evolved into a cult of heroes and heroines. Local chiefs or clan groups may now have tried to legitimize their rule by claiming descent from an important ancestor.

Acknowledgements

I would like to thank the anonymous reviewers for their thoughtful reading and insightful comments, which have significantly improved the paper.

Funding details

This work was supported by the University of Stavanger.

Declaration of interest

There are no conflicts of interest related to this work that could compromise the integrity of the study.

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The transformative Pre-Roman Iron Age of the North

The example of the Mang de Bargen cemetery

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ABSTRACT

This paper presents the Pre-Roman Iron Age component of the cemetery at Mang de Bargen in Northern Germany. Thus far, the primary focus of investigations at this site has been on the Bronze Age. However, evidence indicates that intense activity also occurred during the pre-Roman Iron Age, which was not limited to the cemetery but also manifested in the surrounding area. The Iron Age is characterised by significant changes and innovations, particularly in material culture. This study examines these developments, with a particular focus on relative and absolute dating. The cemetery features demonstrate not only a new, institutionalised practice of cremation, but also a new approach to collecting the burnt bones at the pyre and their placement in the urn. Moreover, some urn burials are enclosed with different types of ditches – a custom that can be situated within a supra-regional context. Furthermore, the osteological investigation indicates a shift in age composition at the transition from the Late Bronze Age to the pre-Roman Iron Age. By integrating environmental data from pollen profiles and find distribution patterns, the cemetery can be contextualised within a region undergoing a transformation with the advent of the pre-Roman Iron Age, exhibiting a notable surge in activity.

ARTICLE HISTORY
Received
18 September 2023;
Accepted
24 Marts 2025

KEYWORDS
Northern Germany; Urnfield; Early Iron Age; Grave goods; Funerary rites.

Introduction

The cemetery of Mang de Bargen (district of Segeberg) has been analysed in the context of the prehistoric social and environmental history of Schleswig-Holstein based on interdisciplinary research within the Collaborative Research Center (CRC) 1266 “Scales of Transformation - Human-Environmental Interaction in Prehistoric and Archaic Societies”. This analysis allows reconstructions of moments of transformation to be made. The cemetery, which was used for burials from the Late Neolithic to the end of the pre-Roman Iron Age (*c.*2200-90 BC), has been the subject of extensive investigations with a particular focus on the Bronze Age material (Schaefer-Di Maida, 2023a,b). However, the pre-Roman Iron Age (*c.*500-90 BC) has only been addressed to a limited extent. The transition to the pre-Roman Iron Age represents a central and drastic change, which can be recorded in several aspects. These include grave construction, material culture and other features appearing on the cemetery and in the immediate surroundings. This contribution will present and discuss these features in the archaeological and environmental data. In order to achieve this, the graves and their associated burial complexes are presented and discussed anew with reference to absolute and relative dating as well as osteological investigations. The complex distinction between finds and time phases, as well as grave constructions, demonstrates that the pre-Roman Iron Age constitute a multi-layered development comprising different phases. These phases illustrate sequences of social and environmental changes at the local level. This prompts the question of the extent to which social changes are actually concomitant with environmental-archaeological transformations and to what extent these transformations are correlated with changes in iron technology. The introduction of new resistant cereal varieties, such as rye, could indicate a potential reaction to possible environmental crises. Moreover, it is pertinent to inquire whether these developments can be discerned at the regional and supra-regional levels. The cemetery at Mang de Bargen and its immediate surroundings thus yield a wealth of findings that permit the formulation of new hypotheses regarding the structure of society.

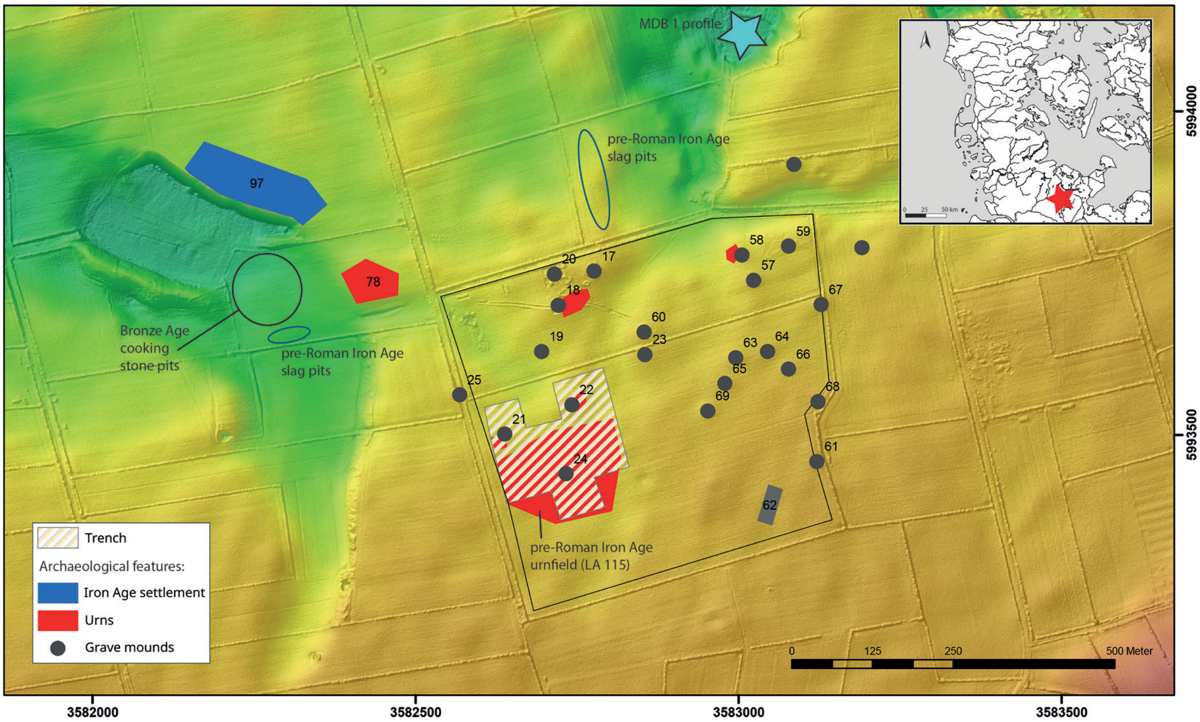

Figure 1. The cemetery of Mang de Bargen and surrounding prehistoric activities (Data after Lütjens 2014 and DGM2 © GeoBasis-DE/LvermGeoSH; graphics: S. Schaefer-Di Maida).

State of Research on the pre-Roman Iron Age on a local and regional scale

Pre-Roman Iron Age Chronology in Schleswig-Holstein

The study of the Iron Age in Schleswig-Holstein has its roots in the research conducted by Mestorf in the nineteenth century (1885). Subsequently, Knorr (1910) and Schwantes (1911; 1935; 1952) addressed the regional development of the pre-Roman Iron Age, delineating the Jastorf, Ripdorf, and Seedorf phases. The research of Hingst (1959; 1974; 1980; 1983; 1986; 1989) ultimately established a new standard for the Schleswig-Holstein region, as he developed a chronology for the early and late pre-Roman Iron Age based on metal and ceramic forms, incorporating material from a range of cemeteries. In 2013 and 2021, Kneisel presented a new analysis of the transition from the Bronze to the Iron Age based on material culture. In the present-day Danish region, the classification of the Iron Age proposed by Jensen (2005) is of particular relevance. For Mecklenburg-Western Pomerania, a chronology based on the work of Keiling (1969) is available. In light of the aforementioned studies on the chronology of the Iron Age, the artefacts from the Mang de Bargen cemetery were classified and verified using absolute dating.

Research in Mang de Bargen

The cemetery is situated within the municipality of Bornhöved, located in the district of Segeberg in the northern region of Germany (see Figure 1). To the north of the site are lakes that were formed as a result of repeated glacial erosion processes causing the terrain to sink to an elevation of approximately 30 metres above sea level. To the south, the area is bordered by a moraine, which attains its greatest elevation of 83 metres above sea level at Grimmelsberg. In the Late Neolithic and Bronze Ages, groups of burial mounds were constructed around the moraine. Their construction on top of natural hills was preferred. The group of grave mounds at the Mang de Bargen site (LA 17-25, 57-69) represents the highest concentration of barrows in this region. The long period of use, spanning the Late Neolithic (2200-1800 BC), the Early Bronze Age (1800-1100 BC), the Late Bronze Age (1100-530/500 BC)[1] and the Pre-Roman Iron Age (530/500-90 BC), demonstrates that this burial ground was continually visited and utilised for burial purposes. Furthermore, it suggests that in later phases, reference may have been made to existing barrows.

The initial mapping of the barrow groups within the designated working area was conducted by Schwerin von Krosigk in 1976. The Mang de Bargen site was designated as group "K" within this mapping process. With regard to their states of preservation, dimensions and heights, 23 barrows and one long bed (LA 62) were recorded for this group. However, no further description was provided (e.g. Schwerin von Krosigk 1976, 106-108). In 2004, 2005 and 2014, the Schleswig-Holstein State Archaeological Office conducted archaeological investigations at the site as a result of gravel mining activities. With the exception of one barrow (LA 57), all visible barrow areas were subject to excavation (Lütjens 2014, 30-32). Some of the graves had already been significantly disturbed and were only discernible through the remnants that remained, while others had been extensively destroyed and no longer provided any indication of former burial mounds or burial complexes. Parallel to the archaeological investigations, a study of the soils and colluvial layers was also conducted (Dreibrodt et al. 2009, 481-483), as well as the reconstruction of the vegetation and settlement history of the *Bornhöveder Seenkette* (BMFT project "Ecosystem Research Bornhöveder Seenkette"; DFG project "Neolithisation in Schleswig-Holstein", Wiethold 1998, 55-59). In 1997, a comprehensive laminated pollen profile of Lake Belau (*c.*4 km from Mang de Bargen) was created and analysed for the first time with the aim of making archaeological-ecological comparisons (Wiethold 1998). This also formed the basis for further environmental-archaeological investigations conducted as part of the CRC 1266 project. The Belau off-site pollen profile and a near-site pollen profile enabled the reliable reconstruction of the site and its surroundings, thus facilitating a comparison of archaeological and environmental data (Feeser et al. 2023; Schaefer-Di Maida 2023a).

Funerary activities

In total, the site comprises 17 burial mounds, 60 urns in the mound areas and 201 further urn burials in an adjacent area. Additionally, the site includes other features, such as postholes, cooking stone pits, hearths, an oven complex and a pyre.

In the Late Neolithic period (2200-1800 BC), the cemetery was used for the burial of individuals in barrows, which may also have undergone multiple phases of construction. In the Early Bronze Age (1800-1500 BC), the construction of burial mounds persisted, albeit with a notable decline in complexity. For instance, the number of stone structures erected for burial purposes diminished. However, a considerable number of bronze objects were discovered within the graves, particularly during Period II (1500-1300 BC). The construction of the final burial mound (LA 57) is dated to approximately 1300 BC, which also marked the first example of cremation burial. The cremated remains of the corpse were interred in a tree trunk coffin, thus not yet indicating a change in grave construction. Subsequently, the practice of burial in a mound was superseded by the deposition of cremated remains on stone pavements, a custom known as the *Leichenbrandschüttung*. The transition in burial practices is most evident around 1200 BC, marking the beginning of the Late Bronze Age (1100-500 BC). This shift is not only reflected in the emergence of a new burial custom (urn burials) but also in the introduction of novel grave goods, predominantly personal items such as razors, toilet utensils, and jewellery. This coincides with a surge in burial activity at the site. The greatest concentration of Bronze Age graves is observed during Period IV (1100-900 BC), around 1000 BC. The cremations were situated in close proximity to the barrows, thus enabling the individual cremations to be attributed to specific grave mounds. A notable decline in burial activity is discernible from Period VI (700-500 BC) onwards, accompanied by a shift in the range of material culture forms. The advent of the pre-Roman Iron Age is marked by a notable shift, with a surge in burial activity at the site. The urns were interred in a cemetery situated in close proximity to the burial mound area, with some of them enclosed by ring ditches. Moreover, the grave goods now demonstrate significant shifts in the range of types and materials, indicating the emergence of new cultural and technological influences (e.g., the appearance of belt parts). The level of burial activity remained relatively low until the onset of Iron Age Phase I b (480-390 BC). Phase I b is followed by a gradual increase in burial occurrences at the site, which accelerates around 390 BC, marking the onset of Phase I c (390-300 BC). This is followed by a slight period of stagnation with Phase I d (300-250 BC), after which a very steep increase occurs with Phase II a (250-150 BC). However, this declines rapidly again to Phase II b (150-90 BC), which continues to decline rapidly till the end of Phase II c (90-60 BC).

Iron Age burial activities

Cemetery LA 115

Cremation burial ground LA 115 is situated in the south-western section of the Mang de Bargen burial ground. In addition, the site encompasses the burial mounds designated LA 21, 22 and 24. The excavation area spanned 3.4 hectares. In a significant portion of the 1.8-hectare area in the southern and eastern regions, the topsoil was removed without supervision using a bulldozer, wheel loader, and excavator until it reached the gravel. Furthermore, the colluvial terrain depressions in the eastern area were also removed down to the subsoil, resulting in the destruction of all features in these areas. Some features remained intact, including LA 22 and 24. In contrast, the area to the northwest covered an area of 0.9 hectares and was opened under the supervision of archaeologists. In some cases, the features had been partially ploughed and disturbed, resulting in the documentation of only their position. To the south of the excavation trench, topsoil removal was intermittently overseen in a further area of 0.8 hectares. If possible, urns were retrieved as a single unit and the material from disturbed graves was sieved. It is unlikely that the excavation has uncovered the full extent of the burial ground. It is possible that further burials, particularly to the south and west of the area, could not be investigated. In contrast, the distribution of burials to the north and east of the excavation site appears to have thinned out, suggesting the presence of a peripheral zone within the burial ground. Since 2019, the area has been entirely removed by gravel mining, rendering it unsuitable for further investigation. A total of 312 features were identified as being of archaeological significance during the course of the excavations. Of these, 201 were cremation burials, which exhibited a considerable range of preservation states. In some occurrences, only the remains of vessels or cremated remains served as evidence of the former existence of a burial. As proposed by the archaeological excavator Burkhardt, the cremations can be classified into three main categories: 181 urn graves, 14 cremated remains, and six grave complexes. The remaining features can be classified into the following categories: 25 sites of pottery and/or cremated remains, 22 post pits, 20 discolorations, 12 stone traces, 12 ring ditches, nine hearths, six pits, three stone pits, one cooking stone pit and one pyre.

Graves

The distribution of the graves across the excavation area was relatively uniform. The irregularities are primarily attributable to the unmonitored removal of the topsoil in the southern and eastern regions. The graves were embedded into the natural soil. At times, the graves were found to be interred within colluvium (in 13 cases, representing 7% of the total). The discovery of an urn covered by colluvial layers (feature 225) provides a temporal marker between the graves.

Urn graves

The typical arrangement of urn graves involved the interment of the urn within a stone structure, which was typically surrounded by a shell of stones. This structure included a base stone, which supported the urn, and a capstone, which covered the urn and sealed it within the structure. In some cases, a vessel was positioned over the urn in lieu of a stone, probably to serve as a cover. The condition of the graves was dependent on the state of preservation of the excavation areas with the quality of the stone protection varying considerably. The categories used to describe the condition of the graves were as follows:

1. Good: stone protection can be completely reconstructed
2. Medium: stone protection consists only of parts, especially the bottom
3. Poor: the stone protection and the urn are largely destroyed
4. Very poor: the urn grave can only be located on the basis of surface finds and the construction is completely destroyed.

The construction of the urn graves was typically limited to a stone shell, which could comprise stone slabs or boulders. As a result of the predominantly moderate preservation, only the bottom stones and slabs of the construction were preserved (69% = 125 urn graves), allowing for the assumption of a more or less compact and closed stone shell. The presence of a stone covering with a capstone was observed in only 5% of the graves (9 graves). In some occasion, the urns were covered with a vessel (4 graves, 2%), sometimes, the stone protection was covered with a stone pavement, which could be reconstructed, and two urns were placed in stone cists (features 90 and 346). A construction could not always be identified, suggesting that the urn was not placed in a free-standing manner but rather that the structure was largely dismantled (6% = 10 urn graves). It is not possible to determine the location of these urns within the cemetery, as this would only reflect the degree of preservation and not the spatial distribution of the urn graves. The dating of the urn graves was primarily based on the analysis of associated artefacts and ceramic forms (see Schaefer-Di Maida 2023a). The majority of the urn graves are dated to the pre-Roman Iron Age. Two urn burials could be dated to the Late Bronze Age (features 92 and 321).

Depositions of cremations

The cremation deposits were predominantly constructed as a stone shelter, which was constructed using boulders and stone slabs. In three cases, the only evidence discovered was an accumulation of stones. In the absence of stone protection and accumulation, a single stone was observed at the base of the cremation deposit, which may be indicative of a former construction, being already destroyed. In one instance, only a discolouration remained, and the find was the sole cremation deposit (Find 360) enclosed by a ring ditch. In his report, Burkhardt highlights the notable concentration of cremated remains within a confined space, which led him to hypothesise that a former storage container made of organic material may have been used for the burnt bones (Burkhardt 2014). Containers of a similar nature are known from the Groß Timmendorf cemetery (Fischer 2000, 35). The cremation deposits of LA 115 yielded no datable grave goods.

Dating and finds

In the cremation graves, the majority of the artefacts were belt components, including belt hooks, belt accessories, belt rings with and without ferrules, and belt straps. Furthermore, dress pins were frequently placed with the deceased. The pins were of various types, including Holstein pins, a three-disc head pin, nail-head pins, swan-necked pins and rolled-head pins. Additional artefacts includes a ball brooch, an eye ring, an awl, an amber bead, and a knife fragment. A description and discussion of the Late Bronze Age and Iron Age material can be found within the monograph which deals with the site in question (Schaefer-Di Maida 2023a,b). The relative dating of the finds is largely consistent with the absolute dating, which is based on the radiocarbon dating of cremated bones from 28 graves, representing 14% of the total number of burials from the site (Figure 2).

The three oldest dates fall around 2450 uncalBP (KIA-55433, KIA-55434, KIA-55450) and thus within the Hallstatt Plateau and, consequently, do not allow a more precise dating than between 800 and 400 calBC. The following three dates (KIA-55446, KIA55424, KIA-55448) are more precise, as they provide a shorter time span and suggest the earlies use of the urnfield between 726 and 395 calBC, i.e. between mid/end Period V and Phase I b. A 68% probability shows a beginning only around 500 calBC and an end around 400 calBC, which would imply Phases I a to I b for pioneer burials on the urnfield. Subsequent burial activities show a more or less frequent time horizon between 405 and 60 calBC, i.e. between the middle/end of Phase I b and the end of Phase II c, whereas with a 68%

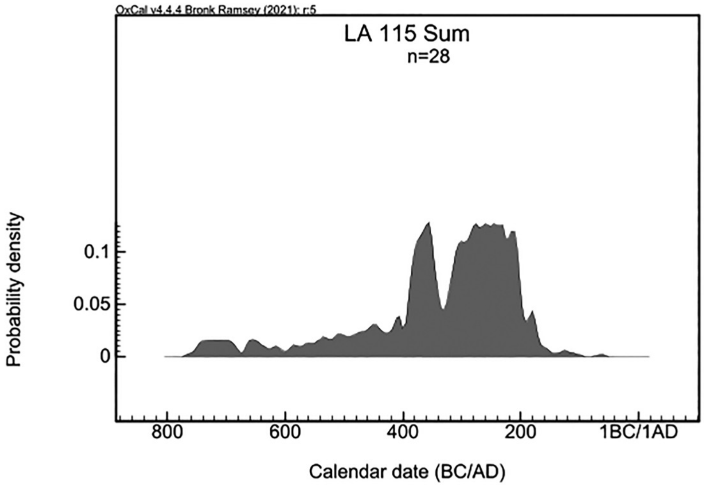

Figure 2. Sum calibration of absolute dated graves from the pre-Roman Iron Age urnfield LA 115 at Mang de Bargen (Graphics: S. Schaefer-Di Maida).

probability we could assume an activity up to 100 calBC, which would translate into a relative phase classification up to the end of PhasevII b. Based on these dates from the urnfield, two phases of burial activity could be identified: an early phase between 700 and 400 calBC, and a later phase between 400 and 60/100 calBC. As only a relatively small part of the burials from LA 115 have been dated, the exact burial horizons remain unclear. The grave goods confirm the use of the urnfield between the end of the Late Bronze Age and Iron Age Phase II b. With the help of the finds, a main period of use seems to correspond with Phase II a, i.e. between 250 and 150 BC, which is consistent with the larger number of absolute dates falling within this period (Figure 3). A comparison of absolute and relative dates shows that the relative dating horizons of the finds are in some cases narrower than those of the absolute dates and are therefore even more significant for the reconstruction of the burial sequences (cf. Rose et al. 2024).

The material from the end of the Bronze Age and the Pre-Roman Iron Age consists mainly of pottery, bronze, and iron. Around 480 BC, at the transition from Iron Age Phase I a to Phase I b, there is a marked change in the find material, meaning that the beginning of the Iron Age still has a Bronze Age echo before it changes significantly with the introduction of new find types and objects: As far as pottery is concerned, we can only mention the Late Bronze Age tripartite tureen (Schaefer-Di Maida 2023a, 171). As far as metal finds are found, a three-disk head pin (*Drei-Scheiben-kopfnadel*, ibid. 146) on bronze and iron indicates the first use of iron. An eyelet ring (Ösenring, ibid. 151-152) with two eyelets and an eyelet lug shows only new forms, not new types of objects.

The Phase I b of the Pre-Roman Iron Age shows a paucity of evidence pertaining to urns from the site, i.e. the rarity of complete or reconstructible urns. It is worth noting the presence of a bipartite tureen (ibid. 170-171). In particular urn burials dating up to the end of Phase I c, are accompanied by a number of other items, including strap end fittings (*Riemenzungen*, ibid. 2023a, 157), tongue belt hooks (*Zungengürtelhaken*, ibid. 153) and belt rings (*Gürtelringe*, ibid. 155-156). Such finds are known for their longevity. Belt rings occur until the end of Phase II b, particularly in conjunction with short ferrules. As an example, for this longevity, it can be mentioned, that Rose has proposed a long-lived phase for simple belt rings in the context of the Aarupgaard urnfied from Denmark, which is dated to the beginning of Phase I c (Rose 2020, 230-231, Fig. 60). Furthermore, the following objects were found in association with the burials: The assemblage comprises an iron pin with a nail-shaped head (*Nagelkopfnadeln*, Schaefer-Di Maida 2023a, 146), a fragment of a triangular belt hook (*Dreieckiger Gürtelhaken*, ibid. 153) devoid of a central rib, swan-necked iron pin fragments (*gekröpfte Nadeln*, ibid. 146-147), a swan-necked rolled-head pin (*gekröpfte Rollenkopfnadeln*, ibid. 147), and a total of six belt plaques (*Gürtelbeschläge*, ibid. 156-157), two belt rings, an iron knife, a ball-brooch (*Kugelfibel*, ibid. 150), an awl, eight one-piece iron clasp-arm belt hooks (*einteilige Haftarmgürtelhaken*, ibid. 154), a bronze Holstein pin (*Holsteiner Nadeln*, ibid. 147-148), a plate belt hook (*Plattengürtelhaken*, ibid. 154-155) or fragment, a bean-shaped amber bead,

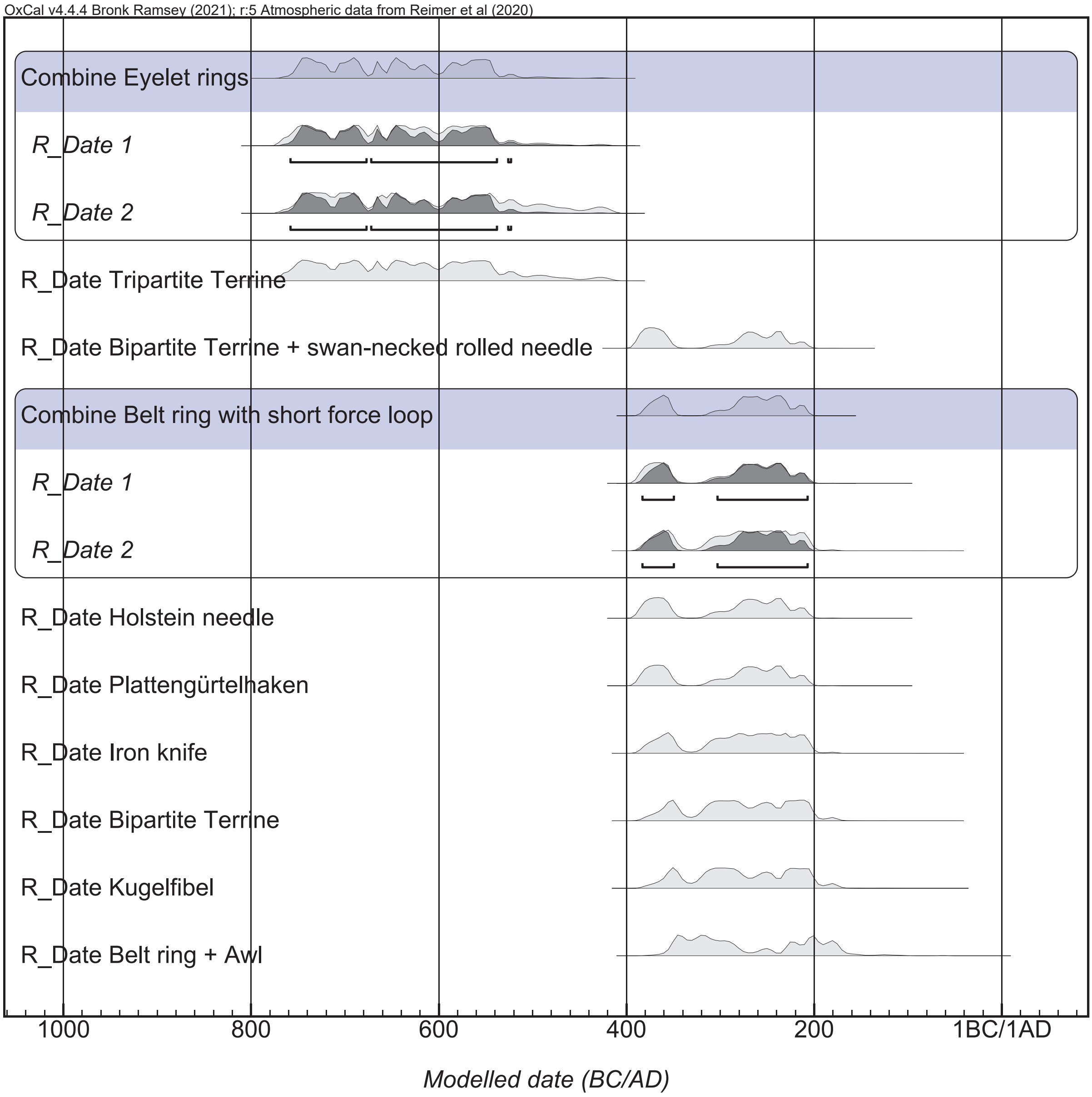

Figure 3. Calibration and combined calibration of absolute dated findings from selected graves (Graphics: S. Schaefer-Di Maida).

and the spike of an iron ring brooch (*Ringfibeldorn*, ibid. 149-150).

Changes in the find material between 700 and 90 BC.

The period between 700 and 90 BC can be divided into four main phases at the Mang de Bargen site (see coloured markings in Figure 4). The three Iron Age phases have already been recorded in this way in other studies (Schneider 2006; Kneisel 2013, 98-99., Figs. 30-31; Kneisel 2021).

The initial phase, which belongs to the Bronze Age, is designated as Period VI. This period introduces new forms and, for the first time, bimetal. However, it adheres to the established object categories of Bronze Age finds, namely pins and rings.

Schmidt (1993) observed a shift in the typological spectrum for the entire region of Schleswig-Holstein with the advent of period VI, which marked the conclusion of previous material culture traditions while simultaneously witnessing an influx of southern influences, particularly from the Hallstatt area in phase Ha D (e.g. swan-necked pins with ribbed or bowl heads) (Schmidt 1993, 113, 118, 150). There is amble evidence to suggest that exchange networks to the south were intensified during this phase. The incorporation of

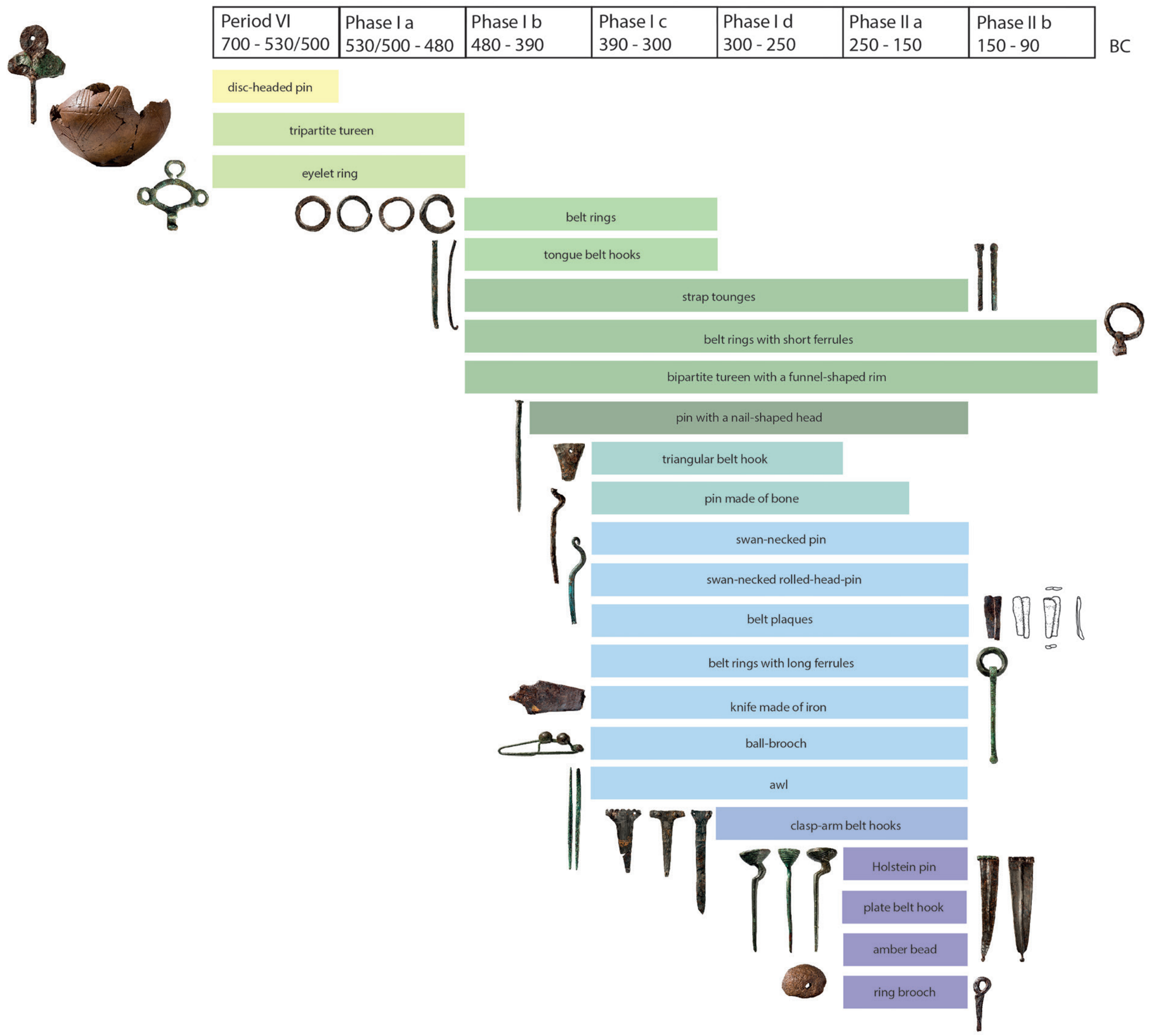

Figure 4. Formal und typological changes in the material during the pre-Roman Iron Age (Graphics: S. Schaefer-Di Maida).

object categories that are occasionally encountered, such as pins, was maintained, although their form underwent modification (for further details, see Kneisel 2021, 21). Moreover, Endrigkeit was able to ascertain comparable developments in the depot finds. The inventory appears to be primarily Wendelringe, pins, metal rings, buttons (horse accessories), and iron objects, while tools were no longer present (Endrigkeit 2010, 76). Consequently, the tradition of depositing 'female' deposits was sustained, a practice that continued into the early Pre-Roman Iron Age (Endrigkeit 2010, 106).

In Phase I a (530/500-480 BC), some of the new forms are retained, but the initial object categories are specific to this phase. For example, eye rings emerge as a notable feature. Moreover, the objects crafted from iron are met for the first time at this point. The material from Phase I a can thus be unambiguously attributed to the beginning of the Pre-Roman Iron Age in terms of form and material evolution. However, at the local level it still exhibits some adherence to Period VI formations. In light of these observations, it can be posited that Phase I a represents a transitional phase between the Bronze and Iron Ages. Phase I b is characterised by the emergence of find categories that can be unambiguously attributed to the Pre-Roman Iron Age, albeit with a discernible residual influence from the Bronze Age. The current spectrum is dominated by belt rings, tongue belt hooks, strap end fittings and nailhead pins. Subsequently, Phase I c marks the advent of a new phase, characterised by the emergence of novel forms. Belt hooks assume a triangular shape, pins are more frequently cranked, belts are fitted with fittings, and belt rings are equipped with long-shaped ferrules for the first time. Moreover, the ball brooch was introduced. This spectrum persists until the start of Phase II a, which marks the commencement of the fourth and final phase. During this period, clasp-arm belt hooks, Holstein pins, and plate belt hooks emerge as the dominant finds. Furthermore, the number of bimetallic objects also increases significantly with this phase. The distinction between different artefact types is also evident when considering data from a supra-regional perspective. This reveals the emergence of a new pattern in which metal belt hooks and brooches assumed an increasingly prominent role in burial rituals. Conversely, items such as razors and tweezers became less common (Kneisel 2021, 23).

Osteological investigations on cremated bones

The human remains of six urns and one pyre feature were subjected to analysis from the urnfield (Storch 2023). Four female individuals, who died between the ages of 25 and 40, and one male individual, who reached an age of 25 to 60, were identified from the urn graves. Among the female remains, bones displaying the pathological abnormality of Worm's bone were observed, which is likely a simple anatomical variation. The hypervascularisation observed in the male individual may be indicative of inflammatory processes, which could also have been caused by parasitic infection (Storch 2023, 18-20). It is not possible to determine whether this was the cause of death. Five cremations were examined from the pyre (feature no. 286); however, a sex and age identification could not be made due to the preservation of the bone material. Furthermore, the identification of the bones as human or animal remains from the pyre is uncertain, with only one case indicating a probable cremated human (Storch 2023, 20, 44). 30 cremated human remains were identified during the sampling process for dating (in collaboration with Helene Rose, CRC-subproject G1). It is notable that the majority of the deceased were of an adult age at the time of death (Schaefer-Di Maida 2023a, Fig. 35). Only one urn belonged to a child who must have been under the age of six at the time of death. The overall age distribution thus presents a clear picture with a predominance of adult burials, which is in stark contrast to the urn burials of the Late Bronze Age, that showed a significant number of children's graves (Schaefer-Di Maida 2023a, 209-216). It is interesting that the early Iron Age child burial was interred in the barrow area of LA 18, alongside the other children of the Late Bronze Age. It may have been deliberate to situate this child in the vicinity of the older child burials, rather than within the urnfield.

Ditch systems

12 of the urn graves of the urnfield LA 115 were enclosed by a ditch (Figure 5), which typically surrounded one grave or up to eight graves in a ring (e.g. ring ditch no. 184, Figure 6). The dark humus filling of the ditches made them clearly visible during the excavation process. The widths of the ditches measured from 0.2 to 0.7 m, whereas the diameters ranged from 1.8-10 m. The orientation of these graves was always northwards, which Lütjens interpreted as evidence of a deliberate arrangement (Lütjens 2014, 32). Two of the ditches were only partially reconstructable (features 181 and 319). The ditches exhibited a variety of profiles, including trough-shaped, cylindrical, post-like, and irregular. In only one case did the ditch adopt a square shape (Feature 9, Ring Ditch No. 2), while another ditch was rounded-rectangular and ring-shaped (Feature 175, Ring Ditch No. 7). It is not possible to determine the spatial arrangement of the ditches in the cemetery.

The graves situated in the aforementioned ditch no. 7 are not constrained by a specific temporal framework. However, the ditches were used for repeated burials during the Pre-Roman Iron Age. It seems probable that social factors, rather than chronological considerations, were the primary concern in the placement of the graves. The occurrence of ring ditches on Late Bronze Age and Iron Age cemeteries is relatively rare. They are recorded in the district of Pinneberg during the Late Bronze Age (Schmidt 2018, 24-33), in north-eastern Lower Saxony during the Late Bronze Age (Fries and Näth 2008, 167-168),

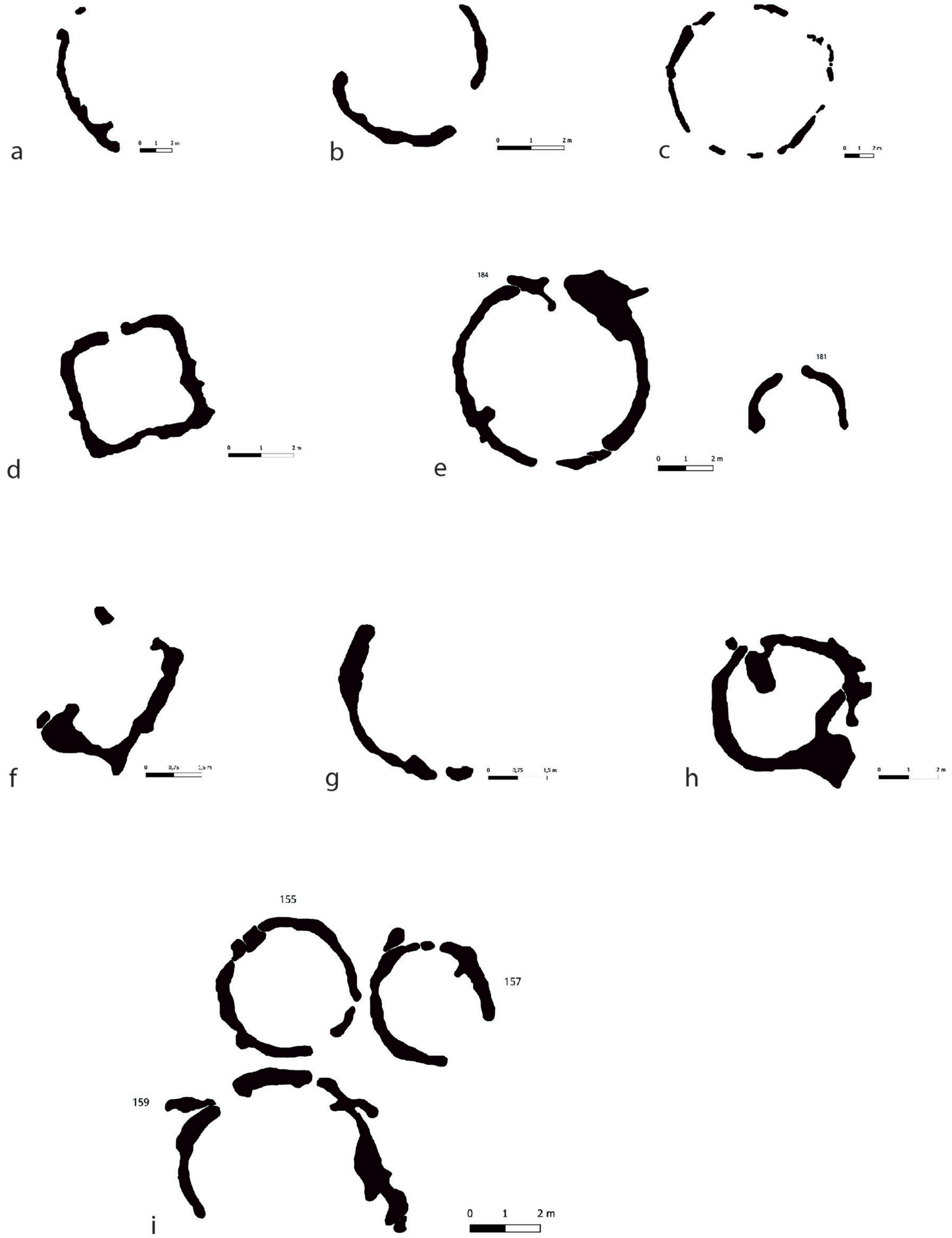

Figure 5. The ditches of the Pre-Roman Iron Age urnfield LA 115 at Mang de Bargen: a - feature 319; b - feature 376; c - feature 32; d - feature 9; e - feature 184 and 181; f - feature 175; g - feature 143; h - feature 257; i - features 155, 157, 159 (Graphics: S. Schaefer-Di Maida).

in Denmark, particularly in South-East Jutland (c. Qvistgaard/Grundvad 2023; Rose and Egelund Poulsen 2023; Rose 2020; Møller et al. 2020; Becker 1961), in the Netherlands, and in Belgium (Beek and Louwen 2012, 48, 50-52; Verlinde 1987, 198-200). They manifest in a wide variety of forms. In Mang de Bargen, the predominant form is a circular ditch with the occasional appearance of a square ditch structure. Keyhole-shaped and rectangular forms have been documented in

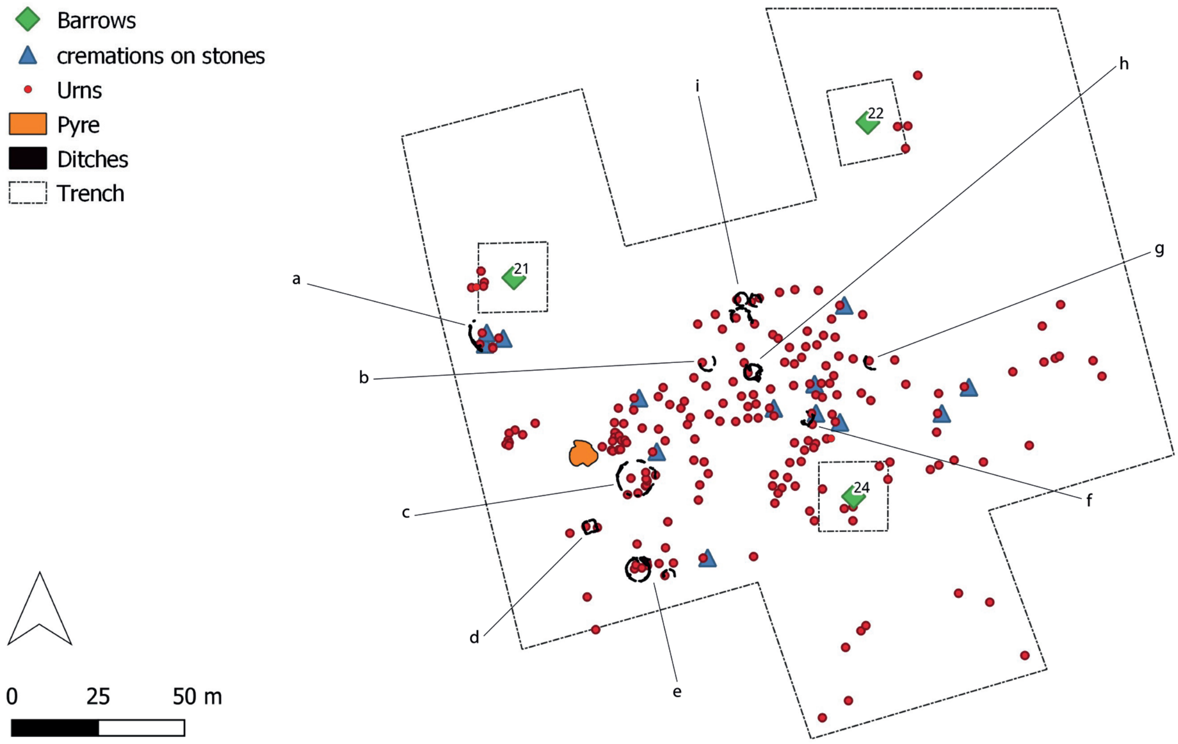

Figure 6. The spatial dirstribution of the features and the identification of the different ditches at the urnfield of LA 115 (Graphics: S. Schaefer-Di Maida).

Overijssel, Netherlands (Verlinde 1987). It can be assumed that multiple burials within such a barrier-like construction are part of a symbolic demarcation or enclosure of social connections, for example familial, hierarchical, or social. At the Groß Timmendorf site, several urns have been discovered beneath stone pavements. It has been demonstrated that the burials did not usually take place at the same time (Fischer 2000, 38), as is also the case at Mang de Bargen. The ditches at Mang de Bargen are analogous to those at Aarupgaard in south-west Jutland, Denmark, from the Pre-Roman Iron Age (500-200 BC). Here, each urn was surrounded with a ditch (Rose 2020; Rose and Poulsen 2023).

Further findings from the cemetery area

Find concentrations

The analysis revealed the presence of cremated remains, pottery, and charcoal at 25 features. These findings suggest that these materials may have been displaced finds or the relocated remains of cremations (Schaefer-Di Maida 2023a, Fig. 36). A significant proportion of the sites yielded evidence of cremated remains, with 28% of the sites displaying concentrations of ceramic material. A smaller proportion of the total number of sites, 16% (4 sites), exhibited both categories of finds. A mere two sites (8%) exhibited solely charcoal concentrations. These features are distributed across the entire excavation area.

Cooking stone pits and stone pits

Three stone pits were distributed evenly across the area, indicating that they were likely constructed recently to collect stones and remove them from the agricultural land. A cooking stone pit was identified in the far west of the trench. It was dug into the in-situ soil and composed of heat-crushed stones. A date cannot be assigned due to the absence of finds, but cooking stone pits dating to the Bronze Age are known from the cemetery and the surrounding area (Schaefer-Di Maida 2022).

Pyre

In the western section of the excavated area, a layer of burnt earth measuring 5 × 6 m was uncovered. This layer was 20-25 centimetres thick and comprised charcoal, heat-crushed stones, calcined bones, and pottery sherds. The layer exhibited an amorphous to slightly rounded shape, while its profile was bowl- to trough-shaped with an irregular base, which had been cut into the in-situ soil (Schaefer-Di Maida 2023b, plate 266). In the excavation report, Burkhardt posits that the feature is the remainder of a pyre, a hypothesis that seems highly plausible given the presence of multiple burnt layers and a considerable quantity of cremated human remains, in addition to objects that could be interpreted as ritual remains (e.g., scattered ceramic vessels). The cremation layer contained a considerable number of Iron Age sherds without any evidence of secondary firing and could therefore only have been deposited there subsequent to firing activities. The pottery assemblage comprises the remains of funnel-rim vessels, which may have been profiled in two or three sections. Such vessels are characteristically thin-walled with multiple handles leading Burkhardt to hypothesise that they were of a settlement pottery variety. Nevertheless, the possibility of its use as grave pottery cannot be discounted. The sherds do not permit a more precise dating than Pre-Roman Iron Age. The broken vessel indicates either that communal activities took place at the same site following a cremation process or that grave pottery was shattered (the intention behind this act is unclear). The cremated remains and pottery sherds originate from the same stratum, and no stratigraphic boundaries are evident. This eliminates the possibility of the cremation site undergoing a transition from pyre to waste disposal area. Instead, the site may have served as a location for the cremation of the deceased and for communal activities, or it may have been used exclusively for the deposition of cremated remains in urns. The presence of animal bones within the feature may also be explained by communal activities (Storch 2023). The cremation site was surrounded by six postholes, four of which were located to the north and two to the south. The distribution of the posts is highly irregular, suggesting the possibility of a unique roof construction, such as a slanted roof, or even a post position without a roofing structure. This could have served a functional purpose in relation to the ustrine.

Other finds

The area of the urnfield yielded several postholes and hearths, yet no stratigraphic connections were discerned. Six pits, which were distributed across the area in a seemingly haphazard manner, were excavated. One of the pits was oval in shape and exhibited a trough-like profile. The pit was situated within a ring ditch between the urns of features 39 and 192, and it is possible that it was associated with those burials. If so, a date for the pit can be assigned to the Pre-Roman Iron Age, although the purpose of the pit remains uncertain.

Pollen analysis

From the middle of the Bronze Age Period V (900-700 BC) until the beginning of the Iron Age with Phase I a (530/500-480 BC), a phase of increased forest clearance (*c.* between 750 and 450 BC) is discernible at the Mang de Bargen site. While the number of lime trees (*Tilia*) declines, the pollen profile indicates an increase in beech trees (*Fagus*). The notable reshaping of the local wetland and bog vegetation indicates a change in the hydrological regime. Feeser (2023) states that the increased forest clearance may have resulted in an uptick in groundwater levels. At the cemetery at Mang de Bargen relatively few burials are recorded during this period. Moreover, significant alterations in the grave goods are observed in the periods preceding and succeeding 700 BC, as well as 500 BC. From the outset of the Iron Age, Phase I to Phase II a (450-200 BC), there was a notable decline in soil erosion and the spread of lime (*Tilia*). Conversely, there is an increase in the presence of dung fungus spores (*Sporomiella* and *Podospora*). In general, the evidence suggests that soil depletion and the spread of broom heather (*Calluna vulgaris*) occurred during this phase. This may have been linked to hydrological changes or a change in land use, for example more grazing.

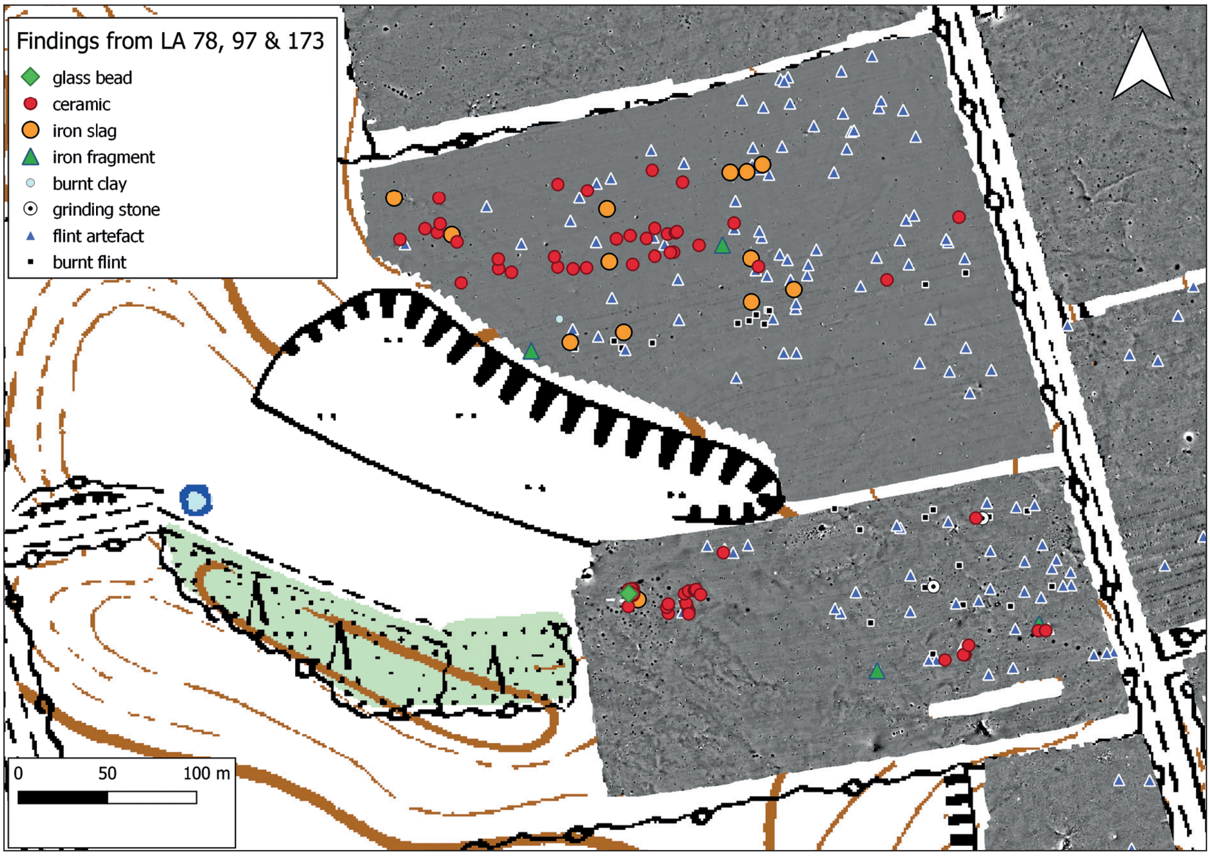

Figure 7. Pre-Roman Iron Age activities near the cemetery of Mang de Bargen (Graphics: S. Schaefer-Di Maida).

At the site, the number of burials increases at this time, initially at a gradual rate and subsequently at a more rapid pace. Moreover, a Pre-Roman Iron Age settlement site (LA 97) is located to the north-northwest of the cemetery (approximately 750 meters as the crow flies, see Figure 1 and 7). This suggests that the use of the area increased during this phase.

The final phase is dated to circa 200 BC, marking the beginning of Phase II a of the Pre-Roman Iron Age. This period is characterised by an elevated burial intensity at the urnfield site, though this subsequently declines slightly. The pollen profile indicates the start of rye (*Secale*) cultivation, which initially emerged as a weed in the crop spectrum. Given that rye is able to thrive in poor soil conditions and under unfavourable climatic circumstances, it is probable that it was particularly well suited to the region when environmental change occurred. Feeser (2023) suggests that its cultivation may be interpreted as a potential response to soil depletion, a phenomenon also observed at other sites in north-west Germany during this period (Behre 1992, 243). Moreover, the cultivation of rye also facilitated the harvesting of particularly long straw, which could then be employed for animal husbandry (e.g. horses) and roofing (Willerding 2006, 617). This suggests potential changes in house construction as well as the keeping and care of animals.

There is a shift in the non-tree pollen spectrum, with an increase in cruciferous plants (*Brassicaceae*) and a notable prevalence of field thistle (*Spergula avensis*), bird's knotweed (*Polygonum aviculare*), and fleabane (*Persicaria maculosa*). Additionally, the occurrence of ribwort plantain (*Plantago lanceolata*) has increased considerably, which can be used as an indicator for open landscapes and settlement activities.

Summing up: The advent of the Iron Age, along with the subsequent phases of change, is not only discernible in the archaeological evidence but also in the environmental data. Consequently, the emergence of new cultural influences has resulted in the documentation of novel subsistence strategies that may have been precipitated by hydrological processes of change.

Local and regional developments during the Iron Age

As mentioned above, there are Iron Age settlement features 750 m to the NNW of the Mang de Bargen site (see Figure 1 and 7, with site LA 97). In 2017, an initial surface inspection yielded a considerable number of finds, including pottery and slag. Moreover, a modest area containing urns from the Late Bronze Age/Pre-Roman Iron Age was unearthed in the surrounding area, situated approximately 450 metres to the north-west of the site (see Figure 1, LA 78). To the west, a cooking stone pit from the Bronze Age was excavated; it was covered by a cultural layer from the Pre-Roman Iron Age comprising several stone pavings. The discovery of ceramic sherds, slag remains, iron finds, and a green glass bead in this area indicates the presence of further parallel activities in the vicinity of the cemetery (Figure 1 and 7; Schaefer-Di Maida 2023a, 49-51, fig. 15, fig. 40).

In the southern area, in close proximity to the cooking stone pits, two slag pits and the remnants of a smelting furnace were unearthed. Further slag pits were identified at a distance of approximately 150 metres to the north of the Mang de Bargen cemetery. These were arranged in a relatively linear formation comprising approximately 20 pits, with some occurrences of three pits in close proximity. This indicates that the surrounding area was utilised concurrently with the burial activities within the cemetery, and that the iron grave goods from the graves were likely produced locally. The dating of the slag pits is still pending. Nevertheless, the slag pits may provide insight into the precise moment when iron was extracted on the site, potentially marking a pivotal shift in the society's dependence on raw materials and finished products from other regions. At present, the available data on the Schleswig-Holstein settlements are insufficient to permit an evaluation of whether this transformation was also expressed in other aspects of society. However, the transformations in the supra-regional form and material development of the finds illuminate a considerably transformative and complex phase (Schmidt 1993, 146-148). The Mang de Bargen site thus represents a significant contribution to the field of Iron Age research, offering insights into the complexity of this particular region.

Pre-Roman Iron Age Transformations

A notable rise in burial activity can be observed at the beginning of the Pre-Roman Iron Age, with a particular concentration in the urnfield LA 115. Conversely, no further secondary burials are identified in the Bronze Age barrow areas at this juncture. Two secondarily buried urns at barrow LA 18 (features 64, 76) could be dated to Phases I a and I b. The transition between Phases I a and I b is characterised by a change in the range of grave goods including various pins, eye rings and, from Phase I b onwards, mainly belt parts. The majority of the objects were crafted from iron, even though bronze objects were also observed. Bimetallic objects are primarily identified in Phase II a. However, as Fischer (2000, 111) notes, the presence of iron does not necessarily signify a transition to a new cultural phase, as it was already utilized in certain regions of Schleswig-Holstein prior to this period. Nevertheless, slag pits from the immediate vicinity indicate the presence of local iron extraction, the absolute dating of which is still pending. It may be posited that the start of new grave goods was concomitant with the emergence of local iron production, which could account for the pronounced shifts in material culture. The evidence from the Mang de Bargen site is of great significance in this regard, as it demonstrates a distinct autonomy in metal production, thereby introducing new dynamics into the social structure. The introduction of iron smelting and processing introduces a multitude of novel labour sectors, co-operative patterns, social domains, and organisational structures that did not previously exist. The complex patterns of change evident in the grave goods could thus be interpreted as evidence of various social changes and social structures. Of particular significance is the grave placements in conjunction with ditches, as they may serve to accentuate the nuances of group dynamics and social stratifications that may have existed not only in the afterlife but also in the realm of daily life. Although the construction of Iron Age graves for urn burial did not differ from that of Late Bronze Age examples, their surrounding by ring ditches could indicate a shift from the relatively uniform structures of the Late Bronze Age to the emergence of stratified social formations. It is

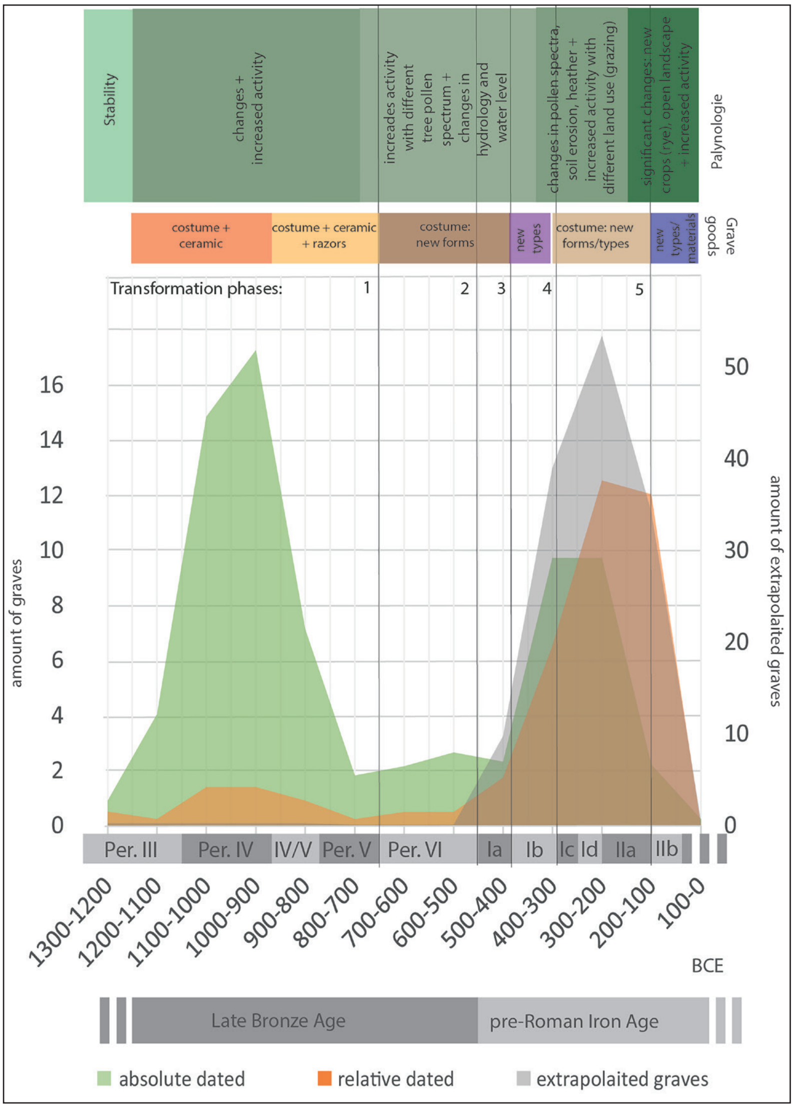

Figure 8. Human-environmental transformations at the cemetery of Mang de Bargen (Graphics: S. Schaefer-Di Maida).

possible that these ditches represented symbolic demarcations or enclosures of social connections, such as familial, hierarchical, or social.

Metal grave goods from the Pre-Roman Iron Age are more frequently thermally deformed, suggesting that they were frequently exposed to fire during cremation. Consequently, they may be classified as 'pyre goods' (Hofmann 2008, 158). Moreover, the Iron Age has yielded evidence of a pyre site containing a multitude of bones, which are presumed to originate from a variety of firing processes. In contrast, the Late Bronze Age lacks evidence of substantial bone deposits in pyre-like areas. Consequently, the start of the Iron Age is marked by a discernible shift in the manner of cremated remains collection and their deposition in urns. It seems plausible that the practice of cremation became more prevalent and perhaps even institutionalised during the Iron Age, as shown by the presence of post-cremation constructions around the pyre at the site. Conversely, the completeness of the cremated remains may have become less of a priority when deposited in the urns. It is, however, not possible to exclude the possibility that the cremated remains underwent further phases of body treatment prior to being deposited in the urn. Consequently, the process preceding burial may have become more complex with parts of the cremated remains being removed, used elsewhere or deposited.

In conclusion, four principal phases of transformation can be identified at Mang de Bargen and in the surrounding area (Figure 8):

1) The transition to the Pre-Roman Iron Age between 700 and 480 BC saw no significant change in the material spectrum, indicating a gradual transition also observed on other cemeteries in Schleswig-Holstein (Fischer 2000, 111; Hofmann 2008, 477). This is exemplified particularly in Phase I a, where the new

forms of Period VI are still present, but the initial new forms emerge, thus marking the transition to the Pre-Roman Iron Age. This is followed by further developments in shape and find categories, which unfold in a sequence of three subsequent phases. Between 700 and 530/500 BC, the level of burial activity is initially low, and the first changes can be observed in the pollen distribution, which are particularly indicative of hydrological changes and are accompanied by a change in tree pollen.

2) In the period between 480 and 390 BC, new forms with an Iron Age character became increasingly prevalent in the archaeological material. The number of burials increases markedly during this phase, and parallel to this, there are clear changes in the pollen composition. These indicate hydrological changes, grazing and a different land use with more grazing, as well as a general increase in activity. It is probable that these changes are connected to the smelting furnaces, slag pits and settlement finds in the area.
3) Between 390 and 150 BC, the extensive land-use activities persist, while new forms in the material emerge. It seems plausible that the potential increase in autonomy within the iron production process may have been a contributing factor in the diversification of forms observed in the region.
4) From 150 BC onwards, new forms and find types emerge once more, while others lose significance. The production of bimetallic objects is on the rise, which in turn indicates the existence of distant sources of raw materials. The cultivation of rye also demonstrates a transfer of knowledge. The number of burials at the site has increased markedly. This activity is also reflected in the pollen spectrum, indicating a significant level of settlement activity in open landscapes.

In conclusion, it can be stated that the settlement and land use activities increased significantly during the Pre-Roman Iron Age. The finds and features not only reflect new cultural influences but also, it may be presumed, social changes.

Acknowledgment and funding details

The research presented here was conducted under the aegis of the CRC 1266 project 'Scales of transformation – Human-environmental interaction in prehistoric and archaic societies' at the University of Kiel within its subproject D3 'The Bronze Age in North Central Europe: Scales of transformation' (PI: Jutta Kneisel) and funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 290391021 – SFB 1266. Furthermore, the author would like to thank Susanne Storch, Helene Agerskov Rose and Katharina Fuchs for their anthropological research as well as Ingo Feeser and colleagues for the palynological research. Moreover, this contribution would like to thank the Archäologische Landesamt Schleswig-Holstein (ALSH) for providing the find and sample material.

Declaration of interests

No conflicts of interest are known by the author in relation to the material addressed in this manuscript.

Notes

1 In the chronological terminology of Schleswig-Holstein, the division into the Older Bronze Age and Younger Bronze Age is in use. However, this corresponds to the same absolute chronological classification into the Early and Late Bronze Age as that used in this paper.

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Fold it

Recent finds of figural handles from Roman folding knives in Denmark

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ABSTRACT

A few years ago, an article on Roman folding knives in Denmark would have been unfeasible, as this small and distinct group of artifacts had not yet been identified. However, the increasing use of metal detectors in Denmark has led to the discovery of numerous new artifact types, some readily identifiable and others less so. The identification process of this new type began with the discovery of a complete folding knife in Gl. Rye cast in copper alloy. While initially proposed to be of Roman origin, this attribution was met with skepticism due to the early dating it implied, resulting in a lack of consensus among both detectorists and archaeologists.

Subsequent discoveries of similar folding knife fragments have since emerged, beginning with a find from Oslo, Norway, followed by two fragments from different regions in Jutland, Denmark, as well as a fragment from a distinct handle type uncovered in Zealand, Denmark. To date, these represent the entirety of identified fragments from southern Scandinavia. This article presents and contextualizes this material.

Moreover, the article argues for a Roman provincial origin of these artifacts. It examines their iconographic features and archaeological context, complemented by metallurgical analyses. These analyses reveal a metal composition closely resembling that of Roman sestertii minted in the 1st century AD. It also narrows the origin of the copper ore to two different areas within the Roman Empire, supporting the proposed Roman provenance.

ARTICLE HISTORY
Received
17 June 2024;
Accepted
01 April 2025

KEYWORDS
Roman folding knives; Metal detector finds from Roman provinces; Figural knife handle; Metallurgical analysis; Roman import.

Introduction

Finds from the Roman Provinces are increasing as detectorists search the fields for stray-finds in present day Denmark. It should be noted that the use of metal detectors is legal in Denmark, and this hobby saw a significant rise in popularity during the COVID-19 pandemic. Coins, fittings, brooches and other metal objects with an origin on the continent south of Limes are being entrusted to the local museums in ever growing numbers. These finds indicate that the barbarians had a keen interest in silver and other valuable objects from the continent. Some of these items were deposited in graves, others offered to the gods, yet others circulated the realms of the living.

Among this latter group of artifacts, a new type emerged in 2020, discovered within the plough layer of a field in East Jutland, Denmark (Figure 1). Metal detectorist Henrik Manse Dupont

Figure 1. Complete folding knife from Gl. Rye, Jutland (Photo: Museum Skanderborg).

Figure 2. The fragmented side plates of similar type as figure 1, left from Oslo right from Hjørring (Photo: Vivian Wangen / Michael Ejstrup Nielsen).

Figure 3. The side plate fragment from Melby (Photo: Museum Nordsjælland).

unearthed a small object that was identified as a Roman folding knife with a figural handle through a British online detectorist forum. Reactions in the Danish counterpart to this forum were divided, with some participants being optimistic about its Roman origin, while others speculated it could date to the Renaissance or even later. Some suggested it might be a sailor's knife, given its resemblance to a figurehead. Museum experts shared the same uncertainty, unable to provide a definitive judgment regarding its date.

During this debate, a fragment of an identical object was identified in northern Jutland, Denmark. Around the same time, a similar fragment was reported from a location near Oslo, Norway (Figure 2).[1] Subsequently, another fragment was identified on the Danish island of Zealand (Figure 3). As this article was in preparation, yet another well-preserved fragment came to light, discovered 25 km south-east of the first find in East Jutland (Figure 4).

Figural knife handles are rare in Scandinavia at any point in history. Although examples of bone handles with standing figure motifs exist from the Medieval period (Bencard 1975; Reinholdt 2009, 14-17, 112-115) and the Renaissance (Hobberstad et al. 2020, 29; Papin and Soulat 2017, 1-8), these belong to fixed knives rather than folding knives, representing a distinct category.

Given that the folding knives discussed in this article are all stray finds without archaeological context, a metallurgical analysis was conducted on one of the pieces. The article begins with an overview of Roman folding knives, followed by a presentation of the Scandinavian finds, with an emphasis on the finds from Gl. Rye and Melby, and a discussion of their iconography and archaeological context. The results of the metallurgical analysis will then be presented and evaluated, concluding with an assessment of how and why Roman folding knives may have found their way into Barbaricum.

Roman folding knives – an overview

The folding knife is a simple yet ingenious tool which dates back at least to the 6th century BC in Europe. From the second half of the 1st century AD, folding knives with figural handles gained popularity in the Roman provinces, a trend that persisted into the 4th century (Mercklin 1940, 351). These handles were typically crafted from bone, antler, ivory or cast in copper alloy. Other materials such as amber, jet and possibly wood, were also used.

Most knife handles from the Roman Empire appear to have been cut or cast as a single piece, though the quality of illustrations in publications

Figure 4. The well-preserved side plate fragment from Odder (Photo: Museum Skanderborg).

Figure 5. Typical motif of the figural handles found in Roman Britannia; hound chases hare (Photo: Wikimedia commons).

often makes it difficult to confirm construction details when they are not explicitly described. However, in a general description of Roman knife handles, Riha notes that many were assembled from two identical side plates (Riha 1986, 30), akin to the examples discussed in this article.

The craftsmanship of these knives varied widely, ranging from rudimentary to highly elaborate pieces of art (Bartus 2007). The blades, typically made of iron, are rarely preserved due to corrosion. Functionally, Roman folding knives resemble modern Swiss Army knives, with blades riveted to the handle at one end, enabling them to fold. These knives were relatively small, usually measuring 7-9 cm in length, and were possibly designed to be carried in a leather drawstring pouch or suspended from a chain (Ridgeway 2019, 15).

The folding knives occur in relatively high numbers across the northern frontiers of the Roman empire, especially in Gaul, Germania and Britannia (distribution maps in Bertrand 2021, fig. 4; Bartus 2010, fig. 3). The provinces of Germania and Britannia have yielded an extensive variety of finds. Notably, the regions around the German cities of Trier and Köln appear to have been epicenters for the production and popularity of folding knives with figural handles (Faust 2000, 2004, 2008; Fries 2008; Mercklin 1940, 252).

The difficulty in determining the distribution of Roman knife handles arises from several factors. Firstly, many older finds are labeled fundort unbekannt ("findspot unknown"). These artifacts often originate from undocumented excavations, donations of private collections, or stray finds near known sites (Kovač 2019). Secondly, the use of metal detectors, which has led to an abundance of finds in the British Isles, is prohibited in many countries, including Italy. This restriction creates a skewed image of the knives' distribution. Auction catalogues displaying folding knives suggest that metal detectorists find them in other regions as well, but due to strict legislation, these artifacts often end up in private collections rather than museums.

Despite these challenges, it is possible to gain an impression of the knives' distribution by examining examples with known contexts. The distribution appears to follow a broad west/northwest-east/southeast belt, stretching from Britain to the southern coast of Turkey. Very few handles derive from the Italian peninsula. Bartus has a few examples found near Ostia, but otherwise none have been published (Bartus 2007, 205). Numerous examples have been documented in the region corresponding to modern Hungary (Bartus 2007), plus a handful from the Roman city of Mursa in Pannonia, present-day Croatia (Kovač 2019). Three additional examples have been identified in the Roman province of Dacia, now Romania (Vass 2009, 298), and the easternmost known piece is a handle depicting an eagle, discovered in Cilicia on the southern coast of modern Turkey (Canli 2020).

The northernmost example documented until recently was an asparagus-shaped handle found at the Roman castellum Laurium in the Netherlands (Hoss 2009), but Bartus mentions a gladiatorial example from a necropolis in present day Poland and proposes this as exported to the babarians outside of the Limes (Bartus 2010, 30). However, the examples discussed in this article now extend the known distribution further north, representing the first finds of such knives beyond the Limes in the northern direction (Søndergaard 2021; Søndergaard and Aarsleff 2021).

The variety of motifs on Roman knife handles is both broad and colorful, catering to diverse tastes. Among the most common are handles featuring various types of gladiators (Bartus and Grimm 2008; Bartus 2010; Jackson and Friendship-Taylor 2003; Kovač 2019). Handles depicting Roman gods and copies of popular statues were also highly favored (Bertrand 2021; Fries 2008, 32–36; Kovač 2020; Rüsch 1981). Additional motifs include erotic scenes (Faust 2004, 190-192), animals and hunting scenes (Figure 5) (Dufrasnes 2007; Fries 2008, 26-28). Asparagus was another recurring motif (Hoss 2009), as were the more peculiar handles shaped like table legs (Bartus 2007, 220-224; Fries 2008, 24-27; Mercklin 1940, 345-346).

Although clear patterns of preference are evident, isolated examples of motifs are also encountered. While Mercklin's classic work provides a comprehensive catalog of handle types, the best visual documentation can be found in Bertrand (2021, plates III-V).

The distribution of these handles aligns closely with the movement of Roman troops, with most examples originating from areas near Roman towns. Beyond stray finds and discoveries made with metal detectors, the documented contexts of these handles generally fall into two categories: grave goods or items that were accidentally lost. The latter category includes handles from Britain, the Netherlands, Germany, and Romania, often associated with military camps or forts (Allason-Jones and Miket 1984, 300; Hoss 2009; Ronke 2003). Notably, only the Dacian example mentioned by Vass is proposed to have originated from a weapons deposit or workshop (Vass 2009, 295).

A few examples have been recovered from Roman villas (Jackson and Friendship-Taylor 2003), baths and roads within towns (Faust 2000, 294; Fries 2008, 27; Rüsch 1981), suggesting that these knives were part of daily necessities, carried and sometimes lost at various urban locations. Only a very limited number have been found in sanctuaries, including one from a temple site in Trier, though no further contextual details are available (Fries 2008, 27). Another example, discovered in Turkey, was recovered from a possible votive deposit in a necropolis (Canli 2020). A striking example depicting a gladiator was recovered by divers from the River Tyne at Corbridge, near Hadrian's Wall. This particular find could be interpreted as both a loss and a possible deliberate deposit (Ravikumar 2024).

Due to their appealing motifs and recognizable features, Roman folding knives are more commonly found in auction catalogs or private collections (Faust 2004) than in archaeological excavations. However, a significant number have been unearthed in graves dating from the 2nd century to the mid-4th century AD. A handle depicting a lion was recovered from a richly equipped inhumation grave at the necropolis of St. Severin near Köln (Höpken and Liesen 2013, 458). Bertrand describes an example featuring a panther from a female inhumation grave at a necropolis near Bordeaux (Bertrand 2021, 90), which closely resembles a panther-shaped ivory handle with a chain from the Londinium cemetery of Newark (Ridgeway 2019, 15). The latter was associated with the remains of a young female, and stable isotope analysis on the bones indicates she spent most of her childhood in the Mediterranean region. Another example, depicting Hercules, originates from the Roman town of Mursa and was recovered from an inhumation grave that was not professionally excavated (Kovač 2020, 215). A particularly striking bone handle, also representing Hercules, was recently discovered in a richly furnished female grave near Bonn (Figure 6) (LVR-Amt für Bodendenkmalpflege im Rheinland 2019). Mercklin has several examples from older graves, both inhumation and cremation graves containing folding knives (Mercklin 1940). These contextual indicators suggest that both men and women owned folding knives, which is not surprising given their utility and cultural appeal.

Efforts have been made to determine the precise use of these knives (Riha 1986, 40; Vass 2009, 298), but the varied contexts of their findspots indicate that they served a range of purposes – similar to modern folding knives. They may have been used to slice fruit, clean nails or cut threads, among other functions. Their presence in graves strongly suggests they were items of personal use and joy. Bartus proposes that knives with gladiatorial motifs might have been souvenirs from gladiator shows (Bartus 2010, 44), akin to contemporary memorabilia like band T-shirts or football scarves. Other types of handles may also represent souvenirs or personal gifts. The variety of themes mirrors those found in hairpins from the same period. Like the knife handles, the quality of hairpins ranges from masterfully crafted pieces of art to poorly executed examples (Bartus 2007). These small, portable items, adorned with popular and recognizable motifs from Roman culture, likely appealed to the new inhabitants of the expanding empire, offering an affordable yet fashionable accessory.

Figure 6. From a well-furnished sarcophagus of a young woman, derives the artistically handsome Hercules shaped handle, excavated in Bonn (Photo: J. Vogel, LVR-Landes-Museum Bonn).

Material

A complete folding knife from Gl. Rye, Jutland

In 2020 a folding knife was entrusted to Museum Skanderborg (Søndergaard 2021). The iron blade, partly rusted, was sitting inside the shaft clearly revealing the identification of the object (Figure 1). The figural handle is constructed from two mirrored side plates and a back piece, riveted together at the top and secured with a larger pin at the bottom, which originally allowed the blade to fold in and out of the handle. The knife handle measures 8.8 cm in length, 1.7 cm in width, the back piece 1 cm.

The handle depicts a person in profile – presumably male – apparently standing with one leg in front of the other on a rectangular base. The arms are held at an angle, hands resting on the chest. Something – maybe cloth – encircles the neck of the figure and extends around the back of the head. From here on it gets more diffuse as some sort of decoration extends from the front of the head to the elbow of the figure. At the back this decoration is divided by a furrow.

The knife was found in the plough-soil of a cultivated field. No archaeological surveys have been conducted in the area, but an old parish description mentions settlement evidence from the Roman Iron Age (AD 1-375 in Denmark), including "stone paving and several pottery shards."[2] In 2009, Museum Skanderborg excavated a burial site 1 km to the east, dating to the Early Roman Iron Age (AD 1-174). This site included eleven richly furnished inhumation graves containing glass beads, copper-alloy brooches and buckles, ceramic vessels, and iron knife blades (Christensen 2009).[3]

The immediate vicinity exhibits a high density of Roman Iron Age artifacts, indicating substantial settlement activity in the area. Within 300 meters of the knife's findspot, three Roman denarii were recovered using metal detectors. One

Figure 7. Knife handle with Attis wearing a phrygian cap (Photo: Ross Thomas, British Museum).

coin, depicting Faustina Senior, was struck around AD 140; the other two are heavily worn and indiscernible, though Roman coins in Denmark are typically dated from the Flavian Dynasty onward (Horsnæs 2010, 27).

A folding knife from Melby, Zealand

The find from Melby represents a different type than those previously mentioned.[4] It consists solely of a side plate from a folding knife, appearing to have been torn or wrenched from the rest of the knife (Figure 3). The fragment measures 6.8 × 1.8 cm, is 0.5 cm thick and contains three rivet holes. Two of these are incorporated into the figure itself, while the third and largest hole is located at the base of the figure. This base rivet likely served as the pivot for the folding mechanism, like the example from Gl. Rye.

Despite wear, the handle retains a discernible level of detail, suggesting that the figure represents a griffin, characterized by the head of an eagle and the body of a lion. The figure may be depicted holding a staff, though it is also possible that this feature is a structural element of the side plate, intended to provide additional stabilization.

Iconographic analysis

The griffin on the example from Melby is a well-known motif from the Roman period, frequently appearing in mosaics, statues, sarcophagi, and as furniture fittings. It also appears in other contexts, such as the weapon sacrifice at Vimose (Funen, Denmark), excavated in the mid-19th century. Among the finds from Vimose was a bronze griffin head believed to have been part of a gladiator helmet, with a comparable example from Pompeii (Pauli Jensen 2003, 237).

Although no direct parallel to the Melby find has been identified, lions are known to appear on other knife handles, such as an example from Trier (Faust 2000, 294) and a handle in the shape of an eagles observed by Deschler-Erb (1998, 358 as well as in Canli 2020). This raises the question of whether the choice of a griffin or lion carried specific symbolic meaning or whether such motifs were used purely decoratively. The diverse range of motifs found on knife handles suggests that the figures could serve various purposes, from conveying deep symbolic meaning to being mere ornamental features on everyday objects.

Identifying direct parallels to the finds from Gl. Rye (Figure 1), Hjørring, Oslo (Figure 2), and Odder (Figure 4) within the boundaries of the Roman Empire has proven impossible. At first glance, the type resembles a ship's figurehead; however, such motifs were not in use until the 17th century.

The iconography of this type remains enigmatic. Even with the advantage of four fragments, the motif continues to elude definitive interpretation. The cloth extending from the figure's head could be likened to a Phrygian cap, most famously associated with figures such as Orpheus and Mithras. However, Orpheus is rarely depicted without his lyre and does not appear to have been a favored subject in small-scale representations. Mithras, a Roman deity of Persian origin and the central figure of the mystery cult bearing his name, offers another possibility.

The Mithraic cult was particularly popular in the northwestern provinces of the Empire, where numerous Mithraea have been unearthed (David 2021; Hensen 2014). The cult's height of popularity coincides with the peak of folding knife production, though no Mithraeum earlier than the second half of the second century has yet been found (David 2021, 426). A further potential identification is Aion, a deity linked to the Mithraic cult as the personification of cyclical eternity – an essential concept in a cult emphasizing rebirth and eternal life (Cohen 2014, 14-18). Roman representations of Aion often depict him as a youthful figure with a lion's head, wings, and coiling serpents around his body (Levi 1944, 275-277). Some sculptural depictions even show a snake protruding from the head, resembling a Phrygian cap. The coiling feature around the legs of the knife handle figure may evoke serpents, while the modeled and divided upper back could represent Aion's wings (Levi 1944, 283). However, membership in the Mithraic cult was secretive, making it unlikely that adherents would openly display their affiliation through portable objects.

A unique folding knife in the British Museum[5] features a motif of Attis, another Phrygian cap wearer (Figure 7). While this example does not directly parallel the types from Jutland and Norway, it demonstrates the existence of other, singular motifs.

Alternatively, the cloth around the head and neck of the knife from Gl. Rye (Figure 1) might suggest the figure represents Hercules wearing the skin of the Nemean Lion. However, this interpretation seems improbable, as knife handles depicting Hercules consistently portray him differently (Figure 7). He is typically shown with his club, either resting on his shoulder or nearby, and always depicted as a powerful, muscular figure. It seems highly unlikely that a worshipper of Hercules would present him with a blissful, almost foolish smile.

An intriguing archaeological discovery in a cemetery in 2023 may introduce a new perspective. A 70 cm-high statue of the sea god Triton was found near Thaynham in Kent. This unique statue depicts Triton with a lower body consisting of two coiling, elongated fish tails and fins protruding from both shoulders (Canterbury Trust 2023). Although the headgear of the knife handles is not mirrored in this find, the discovery opens up the possibility of a maritime interpretation for the lower body. However, Triton is also rarely depicted without his attribute, the trident. While male mermaids occasionally appear in Roman sculpture and mosaics, they were never a popular motif in small-scale representations. The overall composition of the standing profiled person is similar to that of the table leg type (Bartus 2007, 220-224; Fries 2008, 24-27; Mercklin 1940, 345-346), though these usually depict animals, especially lions.

The complete folding knife (Figure 1) from Gl. Rye was discovered during the COVID-19 pandemic, a period that brought unique challenges but also plenty of uneventful evenings. Many such were spent emailing photographs of the knife to museums, collections, curators, and researchers specializing in Roman small finds and Roman sculpture. Despite widespread interest and consensus that the piece appeared to be Roman, no one had encountered anything quite like it.[6]

More recent finds

At the initial stage of writing the present article, two side plates of the same type were identified (Figure 2). Both were discovered by metal detectorists – one near Hjørring in northern Denmark and the other near Halmstad, south of Oslo, Norway.[7] These fragments were examined only through photographs, but they match the complete example from Gl. Rye in form and detail. Initially, these fragments were misidentified as furniture fittings.

The Hjørring fragment was found alongside artifacts dated to the Roman Iron Age, including a gold ring, brooches and a denarius struck under Hadrian.[8] Although the immediate area remains unexcavated, three nearby grave urns of the same date suggest the presence of a cemetery within a 500-meter radius.[9] The Norwegian fragment was recovered from a field rich in Bronze Age grave mounds (Askebingen, Gravfelt). The detector finds from the area spans a date from Iron Age to late Medieval. [10]

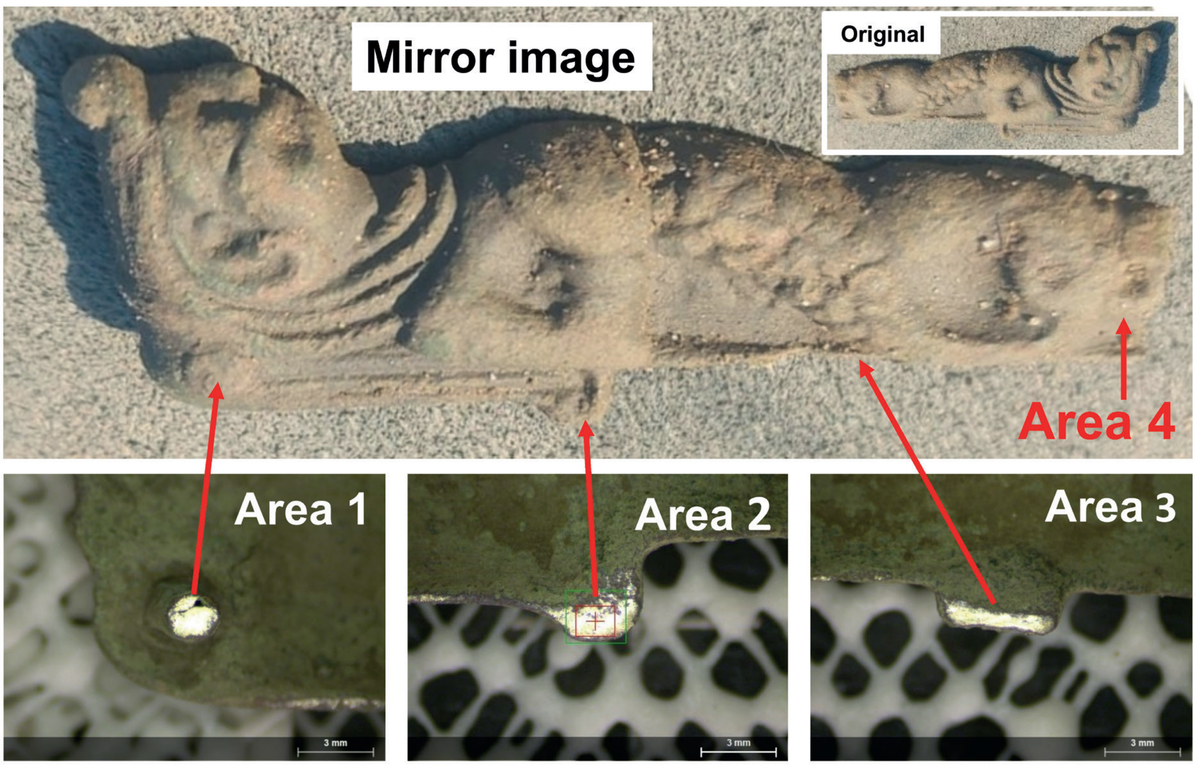
During the preparation of this article, a new side plate fragment was unearthed near Odder, approximately 25 km southeast of Gl. Rye (Figure 4).[11]

It was the only Iron Age artifact recovered during the detector survey, and no other evidence in the vicinity links the area to this era.

This fragment, measuring 5.2 cm in length (with the base and feet missing) and 1.7 cm in width, belongs to the same typological category as the previous examples. The preservation of this piece allows for sharper observation of its iconographic details. Notably, one leg exhibits the appearance of a scaly fish tail, coiling from the abdomen towards the backside. However, the absence of the feet precludes a definitive understanding of the features below the scaly area. While this fragment aligns with the typology of the complete knife, the additional details introduce complexities to its interpretation, that gave rise to doubts about the date of the knives due to the enigmatic and inexplicable nature of the iconography. A quite undesirable situation to encounter while we were in the midst of writing the article about the first discovery.

Archaeometallurgical analysis

The remarkably well-preserved and almost modern-looking handle fragment from Odder (Figure 4) was discovered during the preparation of this article. The exceptional condition of this piece had us on the brink of disbelief in our own conviction of a Roman date, thus prompting us to conduct analyses to better understand its composition and the potential provenance of the metal. This approach would also allow us to assess whether the Odder fragment aligns metallurgically with other Roman artifacts or deviates in a manner that might challenge its proposed antiquity.



Area	Cu	Zn	Pb	Sn	Ni	Cr	Fe	Si	P	K	Ca	Al	Ti
1	72.61	24.97	1.29	0.00	0.01	0.06	0.14	0.61	0.01	0.17	0.00	0.14	
2	75.06	21.60	1.63	0.00	0.18	0.07	0.47	0.83	0.00	0.15	0.02		
3	75.57	21.54	1.64	0.00	0.18	0.08	0.48	0.37	0.01	0.11	0.01		
4 (corr.)	56.35	2.55	3.71	0.17	0.02	0.01	3.50	19.60	2.85	1.07	3.64	6.33	0.20

Figure 8. Composite image showing the three areas cleaned for analysis (Areas 1-3) on the backside of the Odder sideplate (bottom images, scales = 3mm; in relation to the frontside of the object (note the top main image is mirrored horizontally to correspond with the sampling images; original orientation inserted top-right). The µ-XRF results are embedded in the image; note that Area 4 is the corroded metal surface, hence corr.).

Full methodological details and results are provided in the analysis report published elsewhere (Birch and Andreasen 2023). However, an overview of the methodology and key findings will be provided here.

Three areas were surface polished to expose fresh metal for micro-X-ray fluorescence (μ-XRF) analyses, two small areas on the side plate and one on the rivet (sampling locations and μ-XRF results shown in Figure 8). The composition was determined to be that of a high-zinc brass (alloy of copper and zinc), also referred to as a 'pure-brass' or 'alpha brass' (Scott 1992, 19-20), containing around 75 wt% copper (Cu), 23 wt% zinc (Zn) and around 1.5 wt% lead (Pb), with minor/trace amounts of nickel (Ni), chromium (Cr) and iron (Fe). A single analysis performed on the corroded surface yielded very low Zn contents, with elevated concentrations of elements commonly associated with corrosion (i.e. iron at 3.7 wt%), revealing a markedly different composition, showing the importance of analysing clean metal. Chemical mapping of the fresh metal surfaces yielded elemental maps consistent with a cast microstructure, with no signs of any further working or annealing (Figure 9). The rivet (area 1, Figure 8) on the backside directly corresponds to the cloth-like feature that continues towards the frontside of the object; this neat alignment visually disguises the rivet pin manufactured, making it impossible to discern it at all.

Zinc contents of Roman brass-alloys can be used as a crude method for distinguishing early Roman brasses from later brasses, owing to the decreasing trend in Zn content. Each time brass is re-molten, it loses approximately 1/10th of its Zn contents (Caley 1964, 83; Dungworth 1997, sec. 8.2); a 25 wt% Zn brass can reach around/below 15 wt% Zn within five or six generations of re-melting. This loss of Zn, due to its volatility is observed over time in Roman brass coinage, decreasing from ≈25 wt% Zn to ≈10 wt% over the course of 150 years (1-150 CE), as well as in other Roman style brass objects and fittings (Dungworth 1995, 1997; Jouttijärvi 2009, 2017).

These ancient brasses (Cu-Zn alloys) are mentioned by Pliny the Elder as the aurichalcum used to mint Roman coinage (Caley 1964; Healy 1978). Whilst low-Zn brasses (≈ 15 wt% Zn) have a typically golden colour or gold-like appearance, high-Zn brasses (≥ 20 wt% Zn) have a characteristic greenish-yellow colour (Craddock 1978).

The high Zn content of the brass side-plate here indicates that it is likely to fit chronologically with early Roman brasses from the 1st century AD (Craddock 1998; Dungworth 1997, sec. 6.3.1 and 7.5). The Zn concentration of the Odder side-plate sits neatly in the main (normally distributed) peak of high zinc brasses in the histogram of Zn contents from the 2100+ analyses of Roman copper-alloys (brooches and military fittings) from the 1st century AD in Denmark (Jouttijärvi 2009). No Sn was detected in the fresh metal exposed from the Odder side-plate (beneath detection limits), only in the surface corrosion (<0.1 wt% Sn), which corresponds well with the low (or absent) Sn levels analysed in Augustan (27 BC-AD 14) brasses,

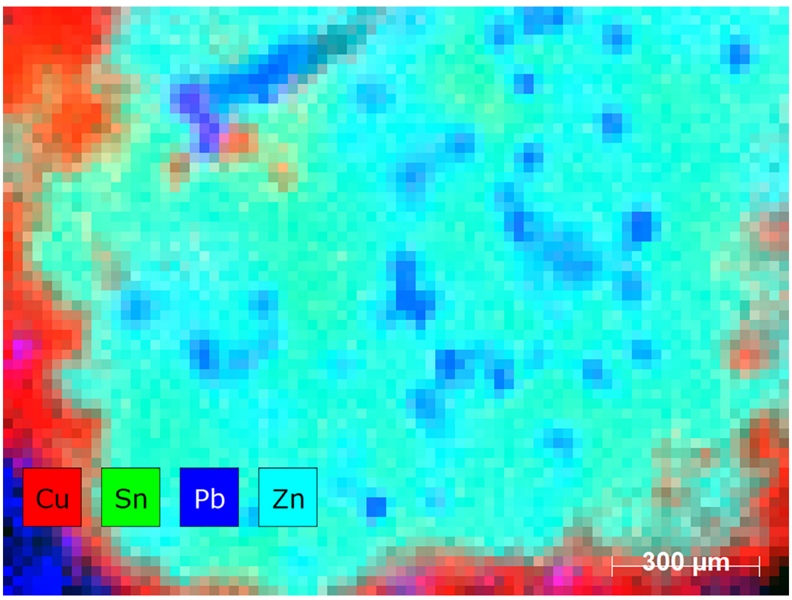


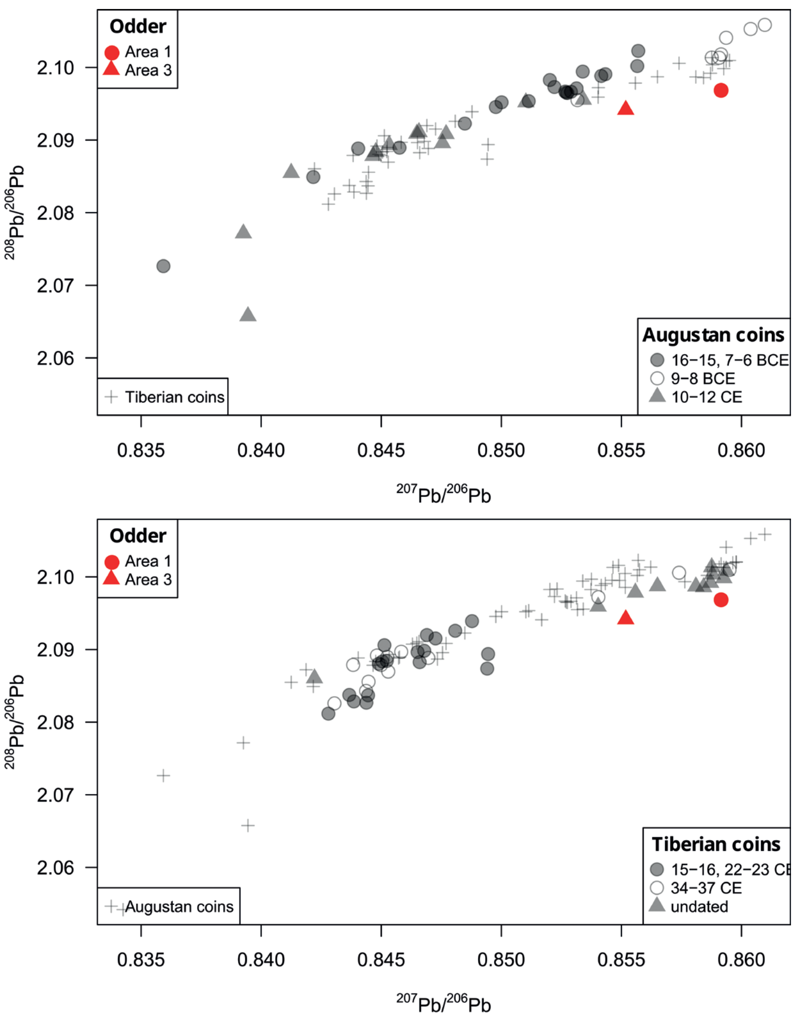
Figure 9. Composite chemical map of area 1 showing the distribution of the main elements (labelled and corresponding to colours, inset), showing the different metallic phases in the alloy; insoluble Pb globules (blue) in the primary phase (Cu-Zn) with the corroded surface (red) showing Cu depleted in Zn.

where it has been highlighted that more than half of them (56%) have very low to undetectable (<0.25 wt%) Sn contents (Merkel 2021, 253). Roman Imperial brass coinage such as sestertii and dupondii were minted from high Zn brasses, while Roman brass metalwork in general is characterised by low Zn brass alloys (Caley 1955, 1964; Craddock 1978; Di Fazio et al. 2019).

Due to the identification of the Odder side-plate as being a high Zn 'pure' brass, likely Roman, it was decided to further investigate the provenance of the metal of the artefact using lead (Pb) isotope analysis. Two micro-scrapings were taken from the exposed clean metal, one from the side-plate itself (area 1 Figure 8) and one from the rivet (area 3 Figure 8). The Pb-Pb model age was calculated from the Pb-isotope composition (Albarède et al. 2012), resulting in model ages of 387 and 383 million years ago (mya).

The lead isotope ratios compare favourably with those published for Roman brasses (see Merkel 2021), especially those used to mint Early Roman Imperial coinage as shown in Figure 10 (see Klein et al. 2004), and in particular those minted under Augustus (27 BC-AD 14) and Tiberius (AD 14-37). The fact that the two isotopic compositions from the same object are slightly different indicates that the rivet may be manufactured from a different brass, however the similarity in composition would likely preclude this. Instead, it seems likely that the slight difference in Pb-isotope results reflects a degree of inhomogeneity in the brass used to manufacture the object, however this variability falls within the range of values displayed by Augustan and Tiberian brass coinage.

Both the metal composition and the Pb-isotope values are highly similar to high Zn brasses published from Early Imperial Roman coinage,



Area	^{208}Pb/^{206}Pb	^{207}Pb/^{206}Pb	^{206}Pb/^{204}Pb	^{207}Pb/^{204}Pb	^{208}Pb/^{204}Pb	Pb/Pb model age (mya)
1	2.097	0.859	18.163	15.604	38.089	388
3	2.094	0.855	18.263	15.618	38.245	333

Figure 10. Comparison of the Pb-isotope ratios of the two Odder samples (area 1 and 3) with Early Imperial Roman copper-alloy (namely brasses) coinage (reference data from Klein et al. 2004).

making this a likely anthropogenic source for the metal used to cast the Odder side-plate. When the potential dating of the source metal (coinage) is considered, the Odder artefact may be amongst the earliest Roman imports in Denmark (see Hansen 1987).

The same result is indicated by the lead isotope analysis that was performed on two samples: one from the rivet and one from the side plate. The high amount of zinc indicates that the material has not been re-melted several times as zinc is volatile when heated, meaning that zinc is lost during re-melting/-cycling of brass. This is evident in ex Roman brass coinage, where the zinc contents decline over a 150-year re-melting cycle from 25 wt% to around 10 wt% (Birch and Andreasen 2023, 10).

The lead (Pb) content is too low to discern whether it has been added or is part of the original copper ore. For either option the composition is consistent with Roman brass objects of the 1st century AD (Birch and Andreasen 2023, 15). The lead isotope composition points towards Roman mines and Roman metals as a source. Analysis of Roman military fittings and brass coinage of the Augustan and Tiberian era are comparable to the results from the side plate, and it is even possible to narrow the origin of the copper ore to two different areas within the Roman Empire (Birch and Andreasen 2023, 17).

When compared to published lead isotope reference data of ores, the nearest Euclidean neighbours are ores from the Rhine/Rhenish Massif (Eifel region, Germany) as well as the Iberian Pyrite Belt (IPB) in the Iberian Peninsula, which are both consistent with the Variscan orogeny (380-280 Ma). Both these regions show evidence of Roman mining for lead that are at least contemporaneous with Augustan copper and brass (Eifel region), if not mined earlier since the Roman Republic (Iberian Peninsula) (Bode, Hauptmann and Mezger 2009).

Discussion

Key Findings and Context

The scattered finds of folding knife fragments in Southern Scandinavia (Figure 11) suggest they were not a dominant import object from the Roman Empire. However, it is plausible that many more unidentified fragments remain unidentified in drawers and museum archives.

The absence of folding knives in burial contexts in South Scandinavia suggests that they were considered objects to be used and thus showed off as often as possible, rather than luxury items. As the contextual overview of finds in the Empire indicates, this type of artifact belongs in several different contexts, and the path from practical to very personal was probably short.

Trade and Distribution

The distribution of folding knives in South Scandinavia appears to mirror the trade routes of Roman coins (Horsnæs 2010, 33, fig. 8) and other Roman imports (Lund-Hansen 1987). This distribution was not in a direct line from the Roman provinces to the findspots. Rather, it is proposed that Roman coins circulated within Barbaricum for extended periods before reaching their final destinations (Horsnæs 2010, 187), and folding knives likely followed a similar trajectory.

Roman coins in Norway are scarce and they seem to have reached Norway via Jutland (Horsnæs 2010, 176). The fact that the Norwegian type corresponds to the fragments from Jutland raise the possibility of their production as part of a single batch. Maybe the fish-like appearance of the handle motif did not find customers within the Empire, and instead it was allocated to the North where the design would be sufficient to impress the receiver. Detailed metallurgical analyses of additional fragments could help verify the batch-hypothesis.

Provincial Origins and Iconography

The folding knives were in use from the 1st century but reached their peak popularity between the mid-2nd and mid-4th centuries AD, functioning both as practical tools and as markers of personal identity and taste. Interestingly, folding knives are rarely found in Rome or Italy, which may be reflected in differences in preservation, publication practices,

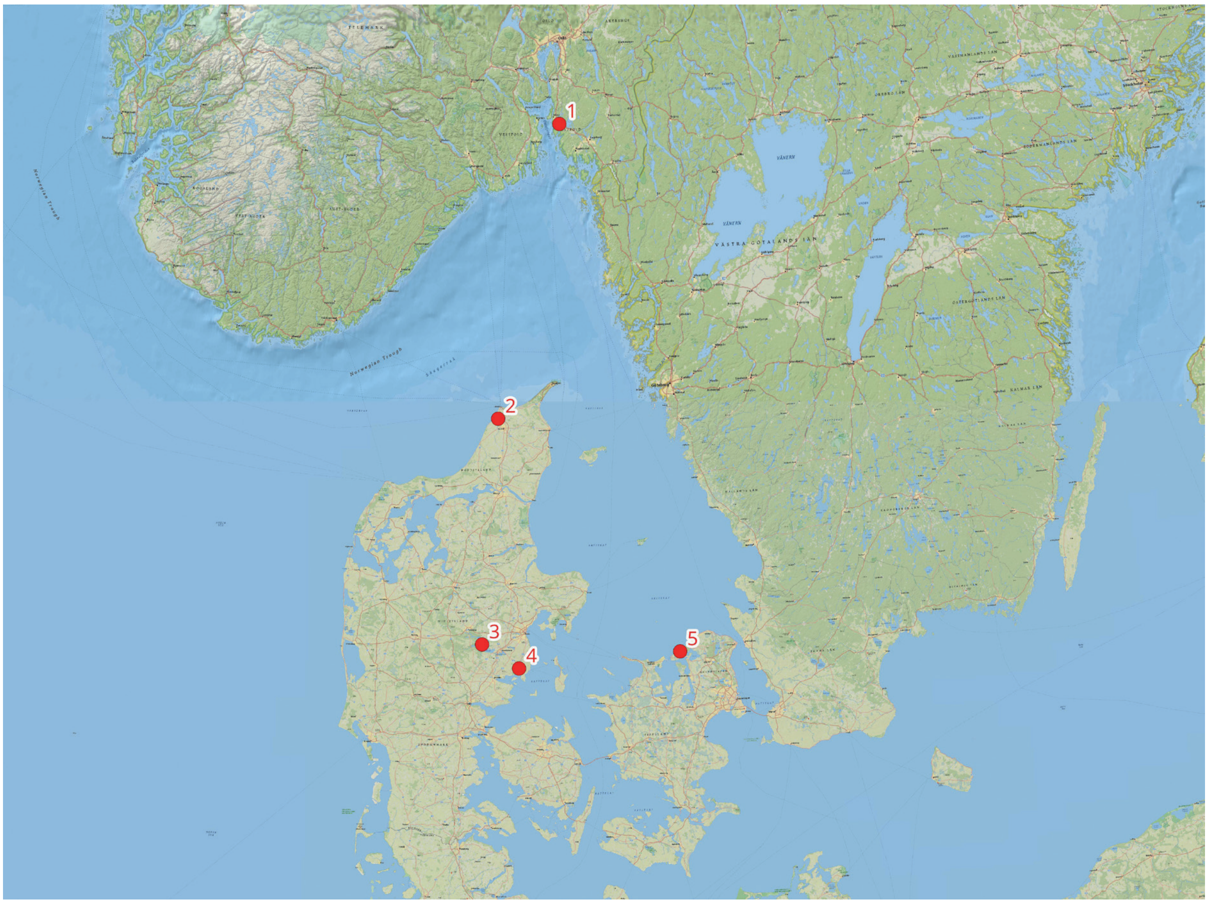


Figure 11. Distribution of folding knives in Scandinavia. 1: Askebingen (C57552), 2: Kærsgård (100615-97), 3: Gl. Rye (160405-140), 4: Odder (DIME 156143) 5: Bakkekammen, Melby (010505-164).

or perhaps cultural preferences of the past. Rather than originating in Rome itself, these knives seem to have been crafted in provincial workshops that catered to local tastes.

The iconography of these knives – including motifs such as gladiatorial scenes, eagles, and lions and even asparagus – demonstrates a strong connection to Roman cultural symbols. However, their appeal lay not in their direct association with the city of Rome but in their embodiment of Roman provincial identity. The Melby knife exhibits iconographical elements widely recognized within the Empire. The Odder fragment and its companions are less recognizable in terms here off, but material, size, design and construction mirror the overall group of folding knives.

Metallurgical analysis of the Odder side plate revealed a copper alloy composition similar to Roman sestertii of the 1st century AD, likely sourced in mines in the Eifel Mountains near Trier – proposed as one of the main hubs for production of folding knives (Mercklin 1940, 352) even though the varied quality indicates a somewhat liberal market of production within local workshops (Kovač 2019, 116). A thorough investigation of style combined with metallurgical analysis of several knives of the continent might clarify if the copper alloy pieces are a specialty of the Limes area, whereas the bone carved might be manufactured anywhere. The result of the analysis reinforces the interpretation of Scandinavian folding knives as provincial products influenced by Roman culture.

Conclusion

The archeometallurgical analysis provides valuable insight into the folding knives' composition, closely resembling that of 1st-century brass fittings and coins. While it does not yield an exact date, the absence of signs of re-melting – common in post-medieval copper alloys – makes a medieval or Renaissance origin highly unlikely. This, combined with the manufacturing style and folding mechanism, which align with knives found in several Roman provinces, particularly Britannia and Germania, strongly supports a Roman provenance. Only one fragment was analyzed but as this fragment was identical to the three other fragments, it seems fair to conclude that they derive from the same region as well.

Although no exact iconographic parallels have been identified for the fragments from Jutland, Norway, and Melby, the diversity of motifs in Roman material culture suggests that these knives fit within the broad artistic repertoire of the Empire. Similar unique types have appeared in catalogues, reinforcing the interpretation of these knives as Roman provincial products. As such, they should be considered imported objects, akin to other Roman goods such as glass and silver coins.

The smoking gun (or knife, really!) would be the discovery of an example in a grave of Roman Iron Age date in Southern Scandinavia or an exact parallel to one of the presented types in a Roman context. Until such evidence emerges, the findings presented here provide a strong basis for further study and may help bring new examples to light – either through fresh discoveries or the reassessment of previously overlooked finds in museum collections. Continued metallurgical and stylistic analyses will further refine our understanding of these objects and their role in the complex networks of trade and cultural exchange between the Roman world and Southern Scandinavia.

Acknowledgments and funding

The authors wish to thank M. Ejstrup Nielsen for his kind help regarding the folding knife fragment from Kærsgård (Hjørring), as well as Rasmus Grove Bøttger for handing over his knife to us for further analysis. Thanks to Vivian Wangen from Kulturhistorisk Museum, Oslo, for providing photos and information on the sideplate from Oslo as well as the late Ross Thomas from British Museum for going deep into their cellars to shoot photos on demand.

The study was partially funded by The Agency for Culture and Palaces.

Notes

1 Oslo: Unimusportalen C57557 (wrongly described as a fragment of furniture fitting, but dated to Roman Iron Age and of possible continental origin) and VHM 00566 Kærsgård (100615-97).
2 Authors' own translation: Boplads fra Romersk Jernalder med Stenlægninger og mange Lerkarskaar. 160405-140 Gl. Rye.
3 160405-205 Katrinesminde I.
4 010505-164 Bakkekammen, Melby.
5 Inv. 1772,0312.87, British Museum.
6 The number of people the images were sent to is too comprehensive to list here, but many thanks to each and every one for their time and eagerness to reply, suggest and discuss.
7 Oslo: Unimusportalen C57557 (wrongly described as a fragment of furniture fitting, but dated to Roman Iron Age and of possible continental origin) and VHM 00566 Kærsgård 100615-97.
8 VHM 00566 Kærsgård 100615-97.
9 100615-64, 100615-45, 100615-58.
10 www.kulturminnesok.no 22299.
11 DIME 156143.

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Organizing Warriors in the 6th and 7th century AD

The Evidence of the Stray-finds in East Denmark

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ABSTRACT

Late Germanic Iron Age weapon burials from Bornholm, Denmark, have been used to suggest the presence of a Merovingian inspired organization of warriors including conscripts. This article compares these burials' inventory, focusing on the first part of the Late Germanic Iron Age (AD 520-630), to the distribution of similar types of metal stray-finds. Mapping the stray-finds from Bornholm indicates the whereabouts of the warriors and it is discussed whether this can contribute to a plausible representation of warriors and a geographically rooted organization of warriors. This evidence is tested on equivalent stray-find material from Sjælland and adjacent islands where weapon burials are almost absent. The study shows a difference between the burial inventory and the stray-finds regarding relative numbers of specific object types, and it is clear that the standardized set of weapons originally assumed to picture the conscripted warrior cannot be found.

It is proposed that answers to how, why and in what numbers armed men were gathered are to be found in a combination of the martial mentality and ideology of the society in general and in a social code of conduct with mutual obligations between free men and leaders and between leaders of different ranks.

ARTICLE HISTORY
Received
02 February 2024;
Accepted
13 December 2024

KEYWORDS
Late Germanic Iron Age Denmark; Military organization; Warriors; Weaponry; Metal objects; Stray-finds; Metal-detecting

Introduction

The present study addresses the question of the distribution and types of stray-finds of metal as convincingly reflecting the assumed presence of a Merovingian inspired organization of warriors during the period from *c.*AD 520 to *c.*AD 630 in present day Denmark (Jørgensen 1990; Jørgensen and Nørgård Jørgensen 1997)(Figure 1). It discusses the possibility of using stray-finds to indicate the whereabouts of the warriors and whether this can contribute to a plausible representation of numbers, relation to specific archaeological sites or complexes and, thus, a geographically rooted organization of warriors. The data suggest the existence of tentative districts including a significant site surrounded by less significant locations holding parts of weaponry. The organization behind this seems to be rooted in a martial mentality and a social code of conduct with mutual obligations between free men and leaders.

Background: Organizing Warriors

To circumscribe the overall issue of warrior organization in the Late Germanic Iron Age, it is necessary to establish – or at least seek to – *how*, *why* and *in what numbers* the warriors may have been recruited.

The 'how' amongst other things raises the theoretical question whether a leader had a right to call on free men to fight for his cause and if they were obligated to appear. The earliest reliable mentioning of military duties of the Danes to their king dates from AD 1085, when a naval force – the 'leiðang' – is mentioned in a written account (Skansjö and Sundström 1988). There has been speculation if this naval organisation was a reality earlier in the Viking Age, but in a thorough study historian Niels Lund (1996) concluded that there is no evidence of military duties based on landed property prior to the late 11th century Denmark. Accordingly, previous mustering of armed forces must have relied upon other sorts of obligations or agreements.

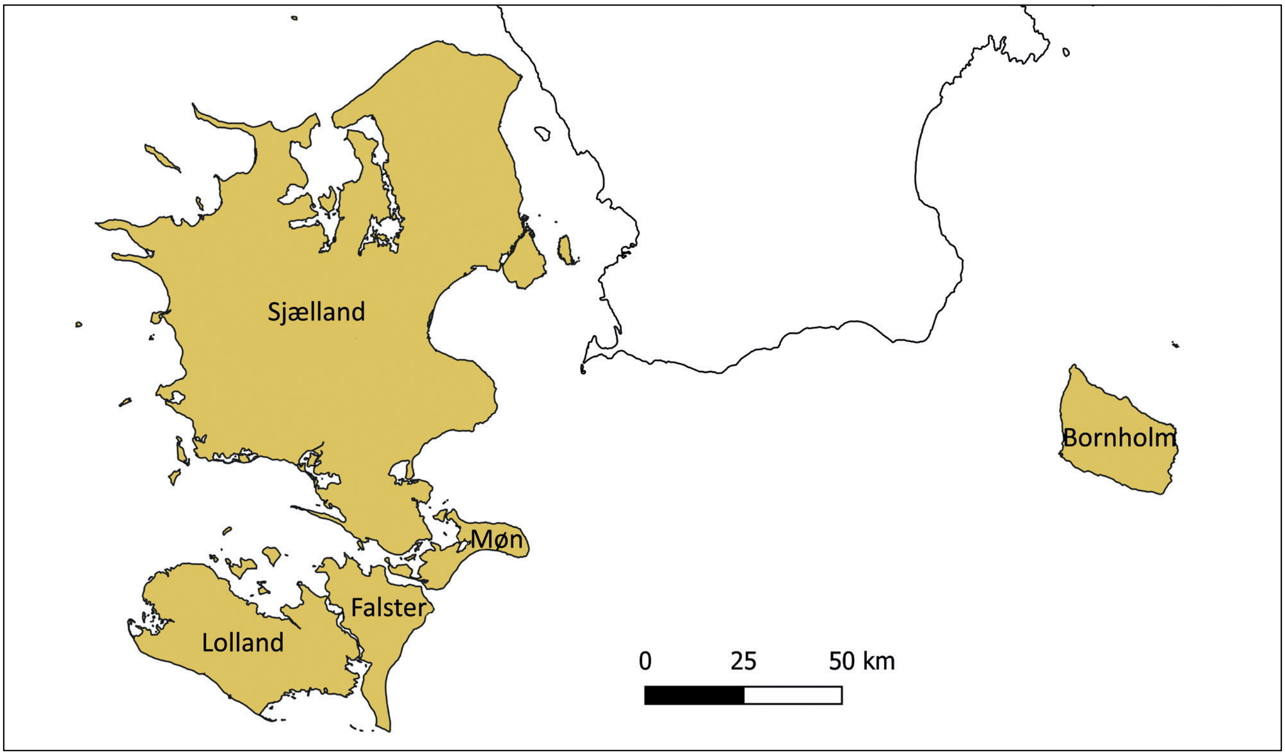

Figure 1. The eastern part of South Scandinavia. The islands included in the survey are named (Illustration: J. Ulriksen).

The 'why' points towards the question of the dedication of the warrior. Most people would appreciate a summons to defend one's own village or local area as an obligation and to one's own benefit, while combats farther away may be perceived as less important to die for. Taking into account a supposed warrior-focused mentality permeating the Germanic Iron Age society (*c*.400-*c*.700) participating in feuds and expeditions may have been seen as an obligation and of importance to establish and maintain the esteem of the single warrior and of his family and kin. In all kinds of texts from the 6th to the 13th century AD mentioning Scandinavian affairs in the second half of the 1st millennium AD, respect towards a free man rested on his wisdom, his wealth and his pedigree but was closely linked to his abilities as a warrior of honour (*e.g*., Fulk, Bjork and Niles 2008; Olrik 1898, 1910; Søby Christensen 2002). This does not mean that every free man acted in a way comparable to the glorification in the texts of certain fierce deeds and attitudes, but it is beyond doubt that it was an ideal of the day and age.

'In what numbers' the warriors gathered is of some importance regarding the 'why'-question above. Feuds between families may have been the typical conflict and according to saga texts partakers first and foremost were kin. The saga texts deal, most of all, with incidents from Viking Age and medieval Western Norway and Iceland and rely on an Icelandic oral tradition dating from the 9th to the 13th and 14th century, when some legends were written down. In other words, the nature of the conflicts may reflect Norse traditions more than South Scandinavian ones several centuries older. However, violent and ultimately deadly struggles related to the concept of honour between families are well-recorded events in socio-economic settings comparable to the Germanic Iron Age, both in 11th and 12th century South Scandinavia (Fenger 1971) and farther away in time and space in 18th and 19th century Corse (Knudsen 1989, 202, 223, 229).

Beyond small-scale skirmishes between the odd freemen the outline of more elaborate conflicts is detectable in songs, legends and other written accounts. The attack on 'Gallia' of a naval force lead by the king of the Danes in the early decades of the 6th century is mentioned by Gregory of Tours in his 'History of the Franks' (Søby Christensen 2013, 93) and it must have been an enterprise involving several ships and crews. Later, during the first half of the 9th century the kingship of the Danes was a combat zone between several pretenders rooted in the same kin and more than once battles between two parties with large scores of warriors (*i.e*., armies) occurred

(Rimbert 1926). How the warriors were summoned and why they participated are not recorded, though, and their numbers are obscure.

Weapon Burials as an Indicator of a Military Organization

Based on a study of burials from the island of Bornholm archaeologist Lars Jørgensen (1990) published an attempt to dig deeper into the question of the military organization of the Late Germanic Iron Age in South Scandinavia. Evaluating the swords – spatha and five types of seaxes – from *c.*30 inhumation burials, Jørgensen (1990, 50) established that the succession of the types followed the typological and chronological development of the seaxes in Central Europe. Including the analysis of the family structure, settlement pattern and inheritance systems Jørgensen (1988, 1990) suggested that the weapon burials combined with richly furnished female burials from *c.* AD 550 to AD 630 reflected a society competing for social status (Jørgensen 1990, 88-89, 94). Jørgensen stressed that the weapon burial practice was highly influenced by Merovingian tradition during these specific decades and that there were active connections to the Frankish and Alemannic areas (Jørgensen 1990, 41-44, 48-50, 89, 92). Jørgensen (1990, 92) pointed at the high score of male burials containing weapons on Bornholm (*c.*75%) mirroring the Merovingian practice and accordingly proposed that high ranking men from Bornholm might even have served at the Merovingian courts.[1] Returning home, they brought with them the concept of a princely retinue of high-ranking warriors, who Jørgensen (1990, 94) suggested are found for instance in the burials of Glasergård 1 and Kobbeå 1 (Figure 2).

Further work on exposing weapon burials as a proxi for military organization in South Scandinavia from *c.*AD 520 to *c.*AD 800 has been executed by archaeologist Anne Nørgård Jørgensen (Jørgensen and Nørgård Jørgensen 1997, 60-117). Nørgård Jørgensen suggested that during the Late Germanic Iron Age the standard armament for free men was a sword, a lance and a shield. For 'the better-off warriors' a horse seems to have been part of the set-up (Jørgensen and Nørgård Jørgensen 1997, 97-98).

The combination of weapons in burials from the second quarter of the 6th century to the end of the 8th century to some extent follows the same lines in Scandinavia as in the Merovingian area on the Continent. The heyday of the lively contacts between the Merovingian area and Scandinavia occurred in the decades around AD 600 while the remainder of the 7th century witnessed a weakened exchange of ideas on burial practice, weaponry and organization (Jørgensen and Nørgård Jørgensen 1997, 115). Consequently, Nørgård Jørgensen proposed that Merovingian military strategy and organization were adapted at least in parts of Scandinavia (Jørgensen and Nørgård Jørgensen 1997, 109-110). This implied a leader controlling an armed force consisting of his retinue followed by foot-soldiers who may have been conscripted among free men mustering with a standardized set of weapons.

Anne Nørgård Jørgensen assumed that the weapon burial-rite identified in her survey applied to the central part of South Scandinavia too, *i.e.*, Denmark, even though weapon burials are almost absent (Jørgensen and Nørgård Jørgensen 1997, 105). Some decades later we can draw the conclusion that nearly no new weapon burials have been excavated in Denmark.[2]

Contrasting this, there has been a considerable increase in the number of metal objects retrieved from ploughsoils using a metal detector including bits and pieces of weapons from the Late Germanic Iron Age. Furthermore, there are parts of horse gear and mounts from scabbards and baldrics comparable to objects from the weapon burials of Bornholm. Even though out of their original context the stray-finds may be indicative of a military organization as suggested by Nørgård Jørgensen.

Surveying a Military Organization

The starting point of this survey is the island of Bornholm where the contents of the weapon burials dating from the 6th and early 7th century can be compared directly to the numerous stray-find material retrieved by amateur metal detectorists since the 1980s. In order to test the results from Bornholm the assemblages of stray-finds from the island of Sjælland and the adjacent islands of Møn, Lolland and Falster have been chosen (see Figure 1).

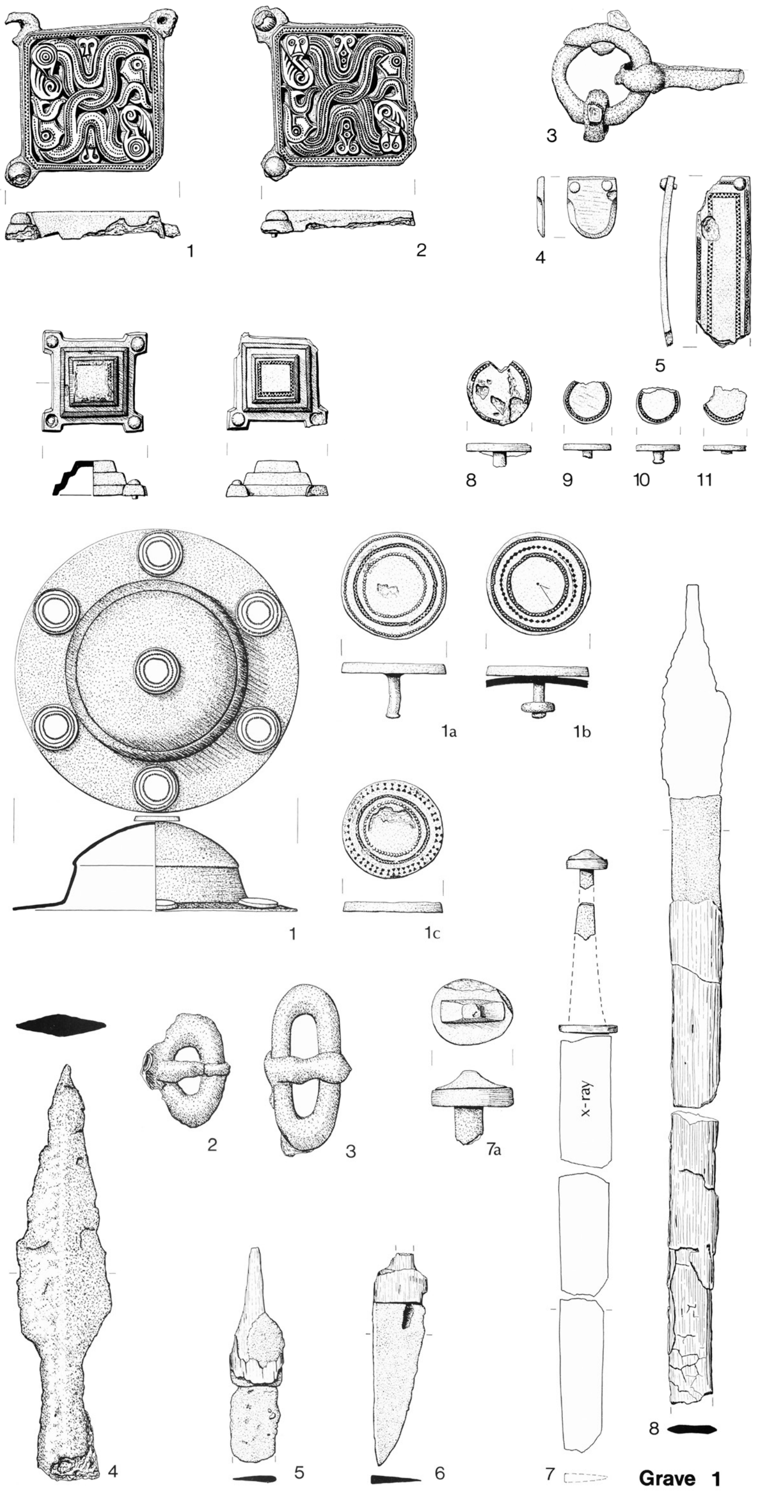

Figure 2. Inventory of the weapon burial Glasergård 1, Bornholm (after Jørgensen 1990, Plates 29-30).

Materials

The period in question is based on the chronology of both female and male equipment from Bornholmian burials. Thus, the beginning of the period of study is Anne Nørgård Jørgensen's Scandinavian Phase I (520/530-560/570) based on weaponry, while the end is related to both Nørgård Jørgensen's Scandinavian Phase II (560/570-610/620) as well as to the end of Lars Jørgensen's Phase 1C *c*.AD 630 based on the jewellery sets from female burials (Jørgensen and Nørgård Jørgensen 1997, 28-38, 63-70; Nørgård Jørgensen 1999, 120-124, 141-146).

Within this chronological frame there are 27 burials containing weapons, 25 of which are from Bornholm while one burial is from the island of Møn and one is from North-east Sjælland.[3]

The chronologically diagnostic objects are the weapons. Typically, they are made of iron and organic materials and only occasionally the sword pommels, shield bosses and lance heads include parts made from copper alloy. Of the 27 weapon burials in this survey 24 contain a sword of which only six have a copper alloy pommel. Of nine lance heads three have copper alloy rivets and five of 10 shields are associated with copper alloy rivets.

Representativity and Method

In the study, 1269 East Danish sites with objects found by metal detecting have been screened for artefacts and types of weaponry of relevance have been mapped. The distribution patterns of weapon-related finds are systematically compared with the general settlement pattern within the two areas of research, *i.e.*, Bornholm and Sjælland with adjacent islands. In the absence of archaeologically excavated settlement data, metal detector finds from so-called 'metal detector sites' (*Da*: detektorpladser) are used to define settlements and evaluate the type of settlement respectively.

Being part of the modern-day state of Denmark all of the islands of the survey area have benefited from the same liberal codex for private metal detecting since the 1980s (Dobat 2016, 52-56; Trier Christiansen 2016). Thus, there is a comparable situation regarding the retrieval of metal objects. The need for similarity concerning the recovery of the stray-finds means that the Swedish province of Skåne located between Bornholm and Sjælland has to be left out. In Sweden, private metal detecting has long been forbidden and professional metal detecting by museum archaeologists follows the development-initiated archaeology (*e.g.*, Lingström 2016; Rundkvist 2008). Neither the number of single finds nor the number and distribution of sites can be compared to the Danish record in a scientific way. Thus, the material from Skåne is not comparable to the material from Bornholm or other parts of Denmark.[4]

Stray-finds are almost entirely retrieved by metal detector enthusiasts searching fields for archaeological objects as a hobby. Using this material for scientific purposes carries with it some problems of representativity. Picking areas to detect is mostly the detectorists' own choice and even though they are sometimes guided by museums' registrations of previous finds it mostly comes down to intuition and not least the permission to survey granted by the landowner. Accessibility to land or the contrary is of great importance to distribution maps of stray-finds as hundreds of hectares may be out of bounds for the metal detectorists if an estate denies surveying. Inaccessible areas are also a consequence of modern urban communities craving more and more space. The Greater Copenhagen area covers more than 400 km^2 of East Sjælland and placename evidence indicates that Late Germanic Iron Age settlements have been built over during the 20th century without any archaeological control.

Most detectorists in Denmark have a developed understanding of the stray-finds' archaeological potential, consequently using GPS to register each object retrieved from the ground. A bias connected to the scientifically speaking non-organized metal detecting is that sites where objects are found frequently are revisited again and again because it is more fun to catch a 'fish' than to go home empty-handed. In this way some sites may gain the label 'metal rich' while other locations are under-prioritized and their archaeological potential unrevealed.

It almost goes without saying that metal objects retrieved from the ploughsoil have not had the best preservation conditions and to some extent every piece of metal is corroded except for gold. Many objects are broken into more parts, some are unrecognizable, and many must be considered lost (Trier Christiansen 2016, 25-28).

The metal detectorists only rarely dig up hits on iron partly due to the extreme number of modern bits and pieces of scrap-iron in the ploughsoil and partly because iron objects are normally not rewarded as treasure trove by the National Museum. This is a well-known bias of the stray-find material and the flaws are illustrated in case a dedicated search prioritizes iron as much as copper alloy. Then, parts of weapons, tools, brooches, spurs, chest mounts, and ingots may be among the finds (*e.g.*, Ulriksen 2018, 163-181; Kildetoft Schultz 2025). Furthermore, rust never sleeps and iron objects generally degrade faster than copper alloy. Due to massive corrosion iron objects can be hard to identify in the field and consequently they are often discarded before reaching a museum's specialist.

Museum	Abbreviation	No. of screened sites	No. of LGIA sites	No. of relevant objects
Bornholms Museum	BMR	397	263	78
Museum Southeast Denmark	KNV	234	143	61
Museum Lolland-Falster	MLF	198	90	4
Museum Nordsjælland	MNS	50	22	2
Museum Vestsjælland	MVE	242	188	129
ROMU	ROMU	80	64	40
Kroppedal Museum	TAK	68	32	4
Total		1269	802	318

Figure 3. The number of locations surveyed and relevant objects distributed in museums regions. Objects from burials are not included.

From a metal detecting point of view, it is likely that just over half of the 27 burials included in this study would have a chance of being found as stray-finds in the ploughsoil because of the parts of copper alloy associated with the sword, lance, and shield.[5] In order to increase the possibility of finding traces of the warriors among the stray-finds this study includes specific mounts from helmets, baldrics, scabbards, and shields, strap-ends, strap-gliders, strap-rivets, belt buckles, strap-distributors from horse harnesses, mounts from saddles, and bridles – all made of copper alloy, silver or gold. The specific types are either found in the Bornholmian weapon burials or they can be associated with warriors' equipment in other parts of Scandinavia or the Merovingian area within the period in question (Arwidsson 1934; Menghin 1983; Nørgård Jørgensen 1999).

The metal objects in this study are registered and stored in the regional museums of East Denmark and the National Museum in Copenhagen. The objects from the Late Germanic Iron Age are counted in the thousands originating from several hundred individual locations (Figure 3).[6] As a consequence, assessing and valuating every original object has not been an option and the museums' finds registration has been the gateway. In the study the identification of specific types of artefacts is of the essence and, thus, it is not reliable to use lists of finds or databases generated at the museums. Instead, the museums' digital registration photos of metal objects have been the key to identify the relevant types. However, taking registration photographs of the objects has not been a routine until digital cameras were available at most museums – that is within the last 10-15 years – and at some museums photo-registration has been suspended at times.

Not all of the registration photos have been of a quality allowing the identification of an object because of a blurred or otherwise corrupted image. Another obstacle proved to be missing photos of the reverse of some objects. Notably, disc shaped copper alloy rivets and top discs from shields can only be identified convincingly if the reverse of the disc can be scrutinized. Disc shaped brooches are more or less identical to the rivets and top discs in size and decoration and the only thing that differs is the presence of either a brooch clasp or a central pin. In cases where identification has been uncertain the specific object has been ruled out.

Consequently, the finds in this study are not in any way amounting the total number but must be regarded as a sample of objects mostly retrieved during the last couple of decades. That is a period, though, when new generations of much better metal detectors have been available, and the number of locations has been rocketing and so has the number of objects from both 'old' sites and new (*e.g.*, Dobat 2016, Fig. 1, Fig. 6).

Results

Bornholm

Weaponry

Most of the 25 burials containing weaponry, mounts from baldrics or horse harnesses have been found in large cemeteries with more than 100 burials

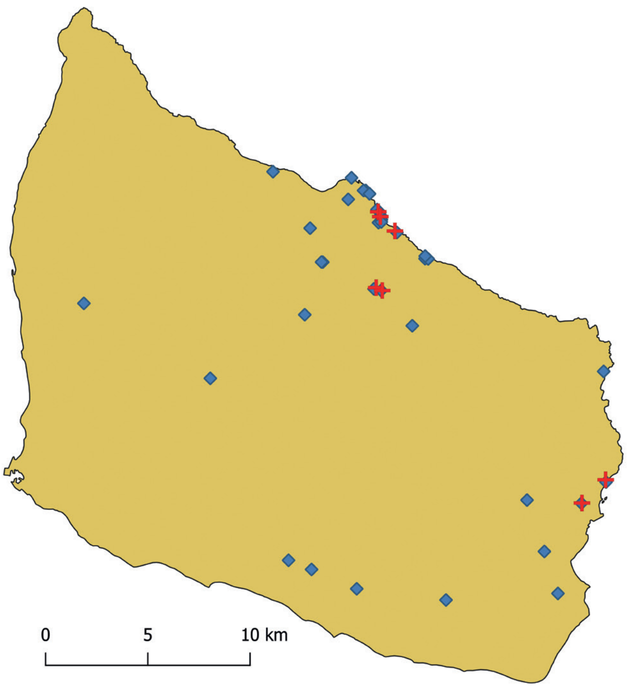

Figure 4. Cemeteries on Bornholm with burials containing weaponry, mounts from baldrics or horse´s gear dating from the decades between AD 520 and AD 630 (red crosses). Other burials dating from the Late Germanic Iron Age are marked with blue lozenges. Map contains data from the Danish Geodata Agency supplied by the author.

covering several centuries. They are located on the coast southeast of Gudhjem and *c*.2.6 km inland on high terrain *c*.100 m.a.s.l. overlooking the sea to the north. On the east coast close to Nexø two confined burial grounds have been found, one close to the shoreline and one *c*.750 m inland (Figure 4).

Regarding stray-finds as a reflection of weapon burials it must be noted that some diagnostic elements are under-represented in the metal detector material, the prestigious sword for instance. Of the 25 weapon burials 22 contain a sword, but only six of these have a pommel or a part of the hilt made of copper alloy. Another prestigious element is the horse. Among the weapon burials, one contained skeletal remains of the animal together with harness parts, while three other burials included only parts of a bridle or strap-distributors. Most equestrian objects in all four burials were made from copper alloy, thus being 'detectable'.

Taking the lance and the shield into account five of the 25 weapon burials contained associated rivets of copper alloy, and regarding buckles, mounts and strap-distributors from the baldric only seven of the 25 weapon burials would have had a chance of being spotted by a metal detectorist.

The distribution of stray-finds belonging to the warrior's equipment – the spatha, seax, (pommel and mounts from the scabbard), the shield (copper alloy rivets and top-discs from shield bosses and handles) and the lance (domed rivet heads of copper alloy) – may indicate a concentration in the southwest part of the island.[7] All three weapon types are represented at the otherwise rich find area at Smørenge[8] while parts belonging to the sword including a silver ring-knob are scattered towards the coast (Figure 5).

Another concentration is connected to the central place of Sorte Muld[9] in the northeast corner of the island, and not too far from the cemeteries in the Gudhjem area are Kobbegård[10] and Lehnsgård[11], both with more pieces of weaponry.[12] At Sandegård[13] to the southeast a pommel from a seax and a pyramid shaped scabbard strap-glider have been found.

The distribution of mounts, buckles, strap-ends and horse harnesses[14] stresses the importance of Smørenge and Sorte Muld, and the lance rivets from Sandegård are joined by four pieces of buckles and mounts (Figure 6). The west coast shows a more dispersed picture, but it is noteworthy that at Nordre Mulebygård[15] a couple of lance rivets and a scabbard mount have been found and from Gammel Skovgård[16] is a gilded silver ring-knob from a sword pommel and a mount from a baldric.

Indications of a Settlement Pattern

Regarding brooches as supposedly reflecting settlements, their distribution indicates discrete settled areas or districts in the southern and western part

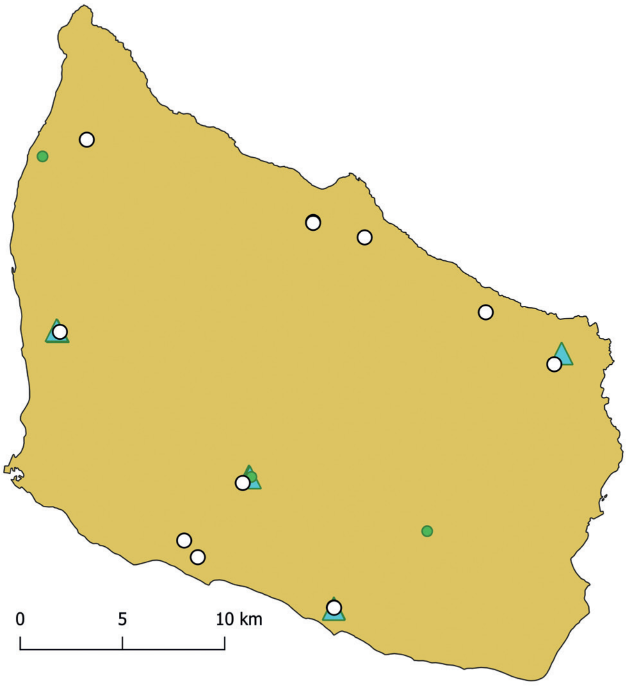

Figure 5. Distribution of stray-finds from Bornholm deriving from the sword (white dot), the shield (green dot) and the lance (blue triangle). Map contains data from the Danish Geodata Agency supplied by the author.

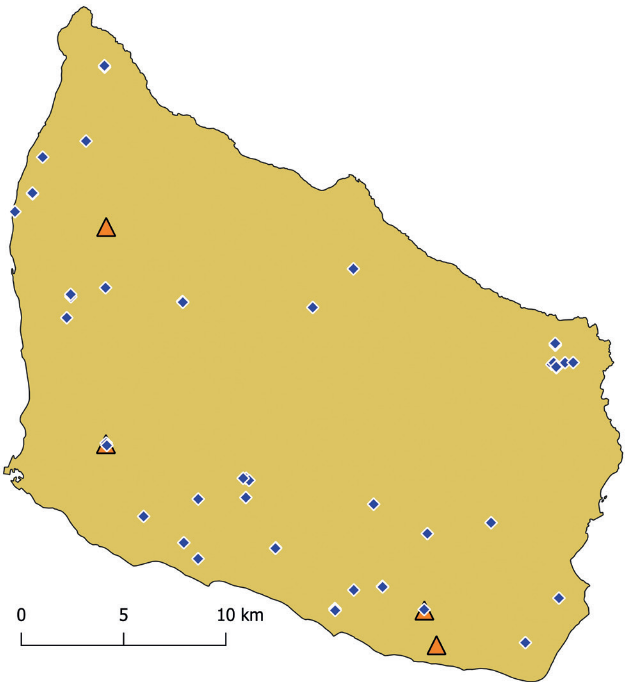

Figure 6. Distribution of stray-finds from Bornholm deriving from buckles, mounts and strap ends (blue lozenges) and horse´s harness (orange triangle). Map contains data from the Danish Geodata Agency supplied by the author.

of the island while the northwest part has a more even (or scattered) distribution (Figure 7). Some of the find-less areas are woods, urban areas or otherwise uncultivated ranges where metal detectorists typically do not survey (*cf.* Jørgensen 1990, Fig. 53; F.O.S. Nielsen 1994, Fig. 16). Other areas are actually surveyed by metal detectorists but have not yet generated objects relevant to this study.

Combining the distribution of the brooches with the warrior related stray-finds the 'metal detector sites' of the island are used to point out locations of relative significance (Figure 8). Sites labelled 'significant' have more objects of types comparable to the contents of the weapon burials. They may also contain gold foil figures (Watt 2008a, 43). Furthermore, sites with a relatively large number of metal objects dating from the period in question, *i.e.*, 15 or more items are assessed.

In spite of the paucity of warrior related finds Sorte Muld (meaning 'Black Earth') has been in focus for decades, not least because of an extra-

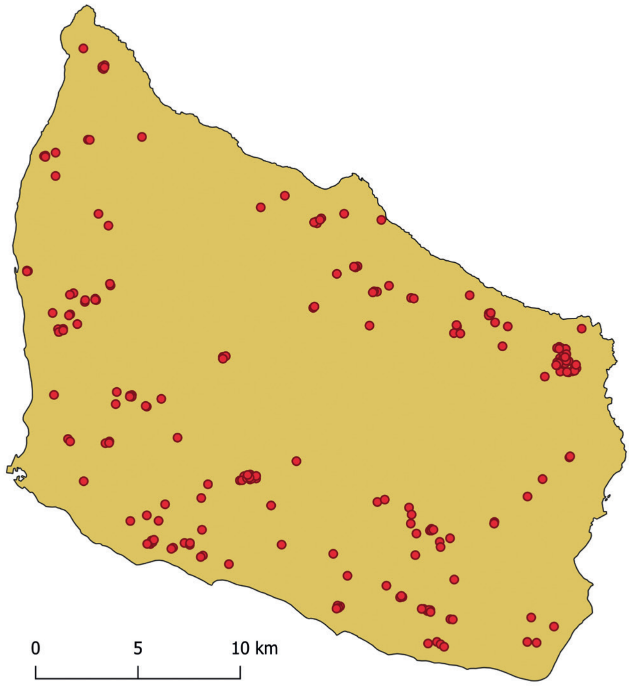

Figure 7. Distribution of sites with one or more of *c*.300 brooches dating from *c*.AD 520-630 on Bornholm. Map contains data from the Danish Geodata Agency supplied by the author.

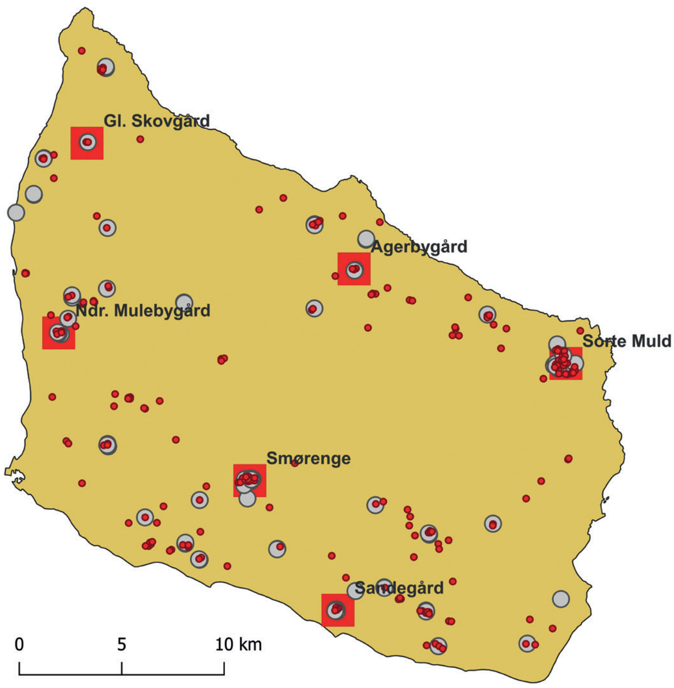

Figure 8. Settlement sites on Bornholm regarded as 'significant' (red square) in relation to the distribution of the warrior related finds (grey dot) as well as brooches (red dot). Map contains data from the Danish Geodata Agency supplied by the author.

ordinary quantity and variety of metal objects (Watt 2008b, with further references). The site is a 'complex of settlements/finds' where Sorte Muld itself is perceived as the centre (Watt 2006, 151; Christensen et al. 2008, 146-148; Jørgensen 2009, 336-337). All together the Sorte Muld complex covers *c*.1 km^2 of relatively high terrain rising from *c*.40 m.a.s.l. to *c*.70 m.a.s.l. and sits between *c*.1 km and 2 km from the coast. Small-scale excavations have shown a thick culture layer with objects from the Roman Iron Age to the Viking Age, but evidence of the settlement structure or individual houses or farms is very limited (Sørensen 2008). In the light of the culture layer and the stray-finds the Sorte Muld complex is special indeed, flourishing from the Roman Iron Age and peaking during the 5th century. After this there is a gradual decrease from the mid-6th century to the 10th century (Lund Hansen 2008a, 69).

In the area of the cemeteries near Gudhjem are more locations with metal objects or other sorts of stray-finds. Rytterbakken[17] is situated only 150 m

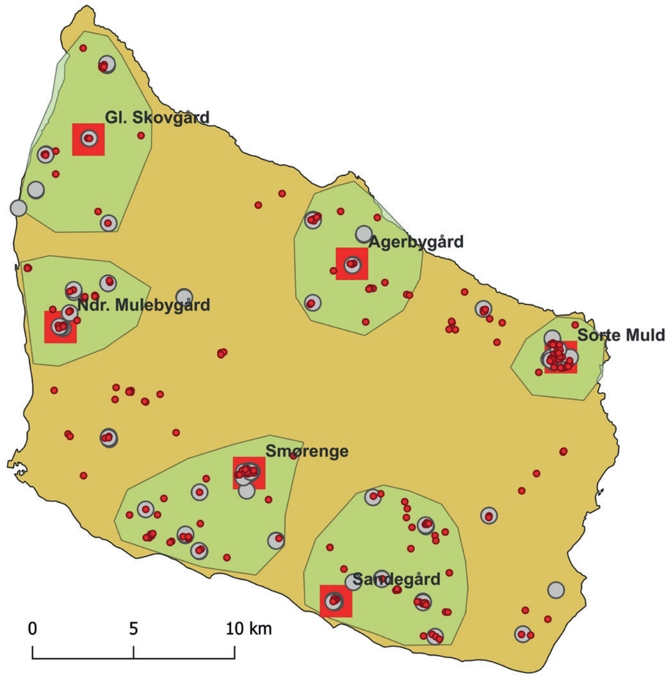

Figure 9. Tentative districts on Bornholm based on stray-finds are marked. For legend see Figure 8. Map contains data from the Danish Geodata Agency supplied by the author.

from the large twin-cemetery of Bækkegård and Glasergård, but despite nine brooches no object relating to the warrior´s equipment has been found as yet.

*C.*4 km away, Lehnsgård and Kobbegård are located in high terrain *c.*2.5 km from each other overlooking the Baltic Sea 1-1.5 km to the north. Apart from the few objects relating to weaponry – from Lehnsgård two sword pommels and from Kobbegård a sword pommel and shield boss' top-disc – the find material does not excel.

Agerbygård 1.4 km to the west of Bækkegård and Glasergård sits on high ground *c.*105 m.a.s.l. almost in the centre of a 1.7 km by 0.8 km large 'island' bordered by steep gorges with narrow brooks on three sides while more even terrain opens an entrance way from the south. Metal detecting has revealed a fair amount of objects dating from most of the 1st millennium AD and not least from the Late Germanic Iron Age. Among the metal-finds are a strap-end and 15 gold foil figures that may indicate a settlement of significance. Additionally, nine brooches have been detected. A limited trial excavation of *c.*700 m^2 has documented a culture layer and some postholes (Watt 1998, 209-214).

Sandegård in the southeast part of Bornholm is situated *c.*1 km from the sea. The site holds a sword pommel, a scabbard mount, lance rivets, strap-distributors from horse harnesses, strap-mounts and buckles. Considering the other metal objects Sandegård has a continuous representation from the Roman Iron Age to the Viking Age. There are more than 20 brooches from the period AD 520-630. A survey of the contents of phosphate in the soil and the presence of a culture layer reflects a settlement area, not a burial ground (Watt 2006, 154-155).

Smørenge is located on the southern part of the island too but further inland. Metal objects dating from the Roman Iron Age to the Viking Age have been found within an area of 1 km by 0.5 km formed by a flat hill, which is to some extent bordered by bogs and swampy patches. Among the finds from the settlement are two lance rivets, a silver sword pommel, a shield rivet and belt buckles as well as more than 20 brooches. Further, more than 80 gold foil figures have been found (Nielsen and Watt 2019).

On the western part of the island two lance rivets and a scabbard mount have been retrieved at Nordre Mulebygård together with seven brooches.[18] The site is located on even terrain 1.5 km from the sea. Both to the north and south are steep-sloping gorges with brooks.

In the hinterland of Nordre Mulebygård, some 2 km away, the site Møllegård[19] has produced gold foil figures and 12 brooches. Møllegård sits on a hilltop *c.* 70 m.a.s.l. with rather steep sides to the west and facing two gorges with brooks to the south and the north. A passage towards more even terrain is open to the east. According to the rest of the metal

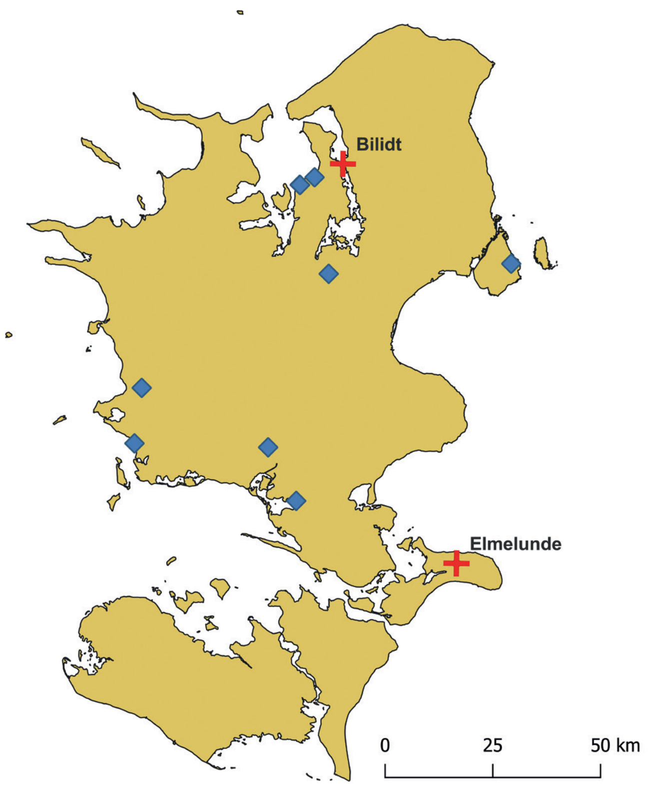

Figure 10. Sjælland and adjacent islands with burials dating from the Late Germanic Iron Age (blue lozenges). The weapon burials dating from AD 520-630 are marked with red crosses. Map contains data from the Danish Geodata Agency supplied by the author.

finds the settlement has most likely existed from the late 4th to the 11th century AD.

In the northwesternmost part of the island Gammel Skovgård is situated on a prominent hill top *c.* 105 m.a.s.l.[20] From the topsoil a ring-knob of gilded silver, a T-shaped mount from a baldric, and a disc brooch in cloisonné-technique have been retrieved. The only reason for the site not to be pointed out as 'significant' in the first place is due to the fact that only four brooches from the relevant period have been retrieved.

Including Gammel Skovgård there are six locations almost evenly dividing the rural zone of the island between them (Figure 9). There is room for a seventh site on the eastern part of the island in the Nexø-area, though. Here, more burials have been excavated including two weapon burials close to the coast, but traces of a relevant settlement have not yet been found.

Sjælland and Adjacent Islands

On Sjælland there is one weapon burial containing a seax and a rectangular scabbard mount of tinned copper alloy dating from AD 570-630 (Ravn 1989).[21] The inhumation grave was found in a beach ridge at Bilidt in Frederikssund accompanied by 26 other burials scattered along the coast of Roskilde Fjord, most of them disturbed by gravel digging and undated (Figure 10).[22]

On the island of Møn, a weapon burial has been excavated north of the village of Elmelunde containing the skeletal remains of a male with a spatha and a shield (Nørgård Jørgensen 1989; 1999, 236-237). The burial was found in a pronounced dead ice landscape with wide views to the lower morainic terrain to the northwest, west, and southwest. A recent survey with metal detector of its surroundings has not revealed further objects or signs of additional burials.[23]

The stray-finds of the weapons,[24] the baldric[25] and the horse harness[26] are present in most parts of Sjælland, in the westernmost part of the island of Lolland, and in the eastern part of the island of Møn (Figure 11-12).

Seen from a helicopter perspective, clusters of finds appear: on the Stevns peninsula in Southeast Sjælland, in Central Sjælland close to the town of Ringsted, in Southwest Sjælland close to the town of Korsør, in Mid-west Sjælland northeast of the town of Slagelse and in West Sjælland around and south of Lake Tissø. The northern part of Sjælland has a more scattered distribution pattern with no

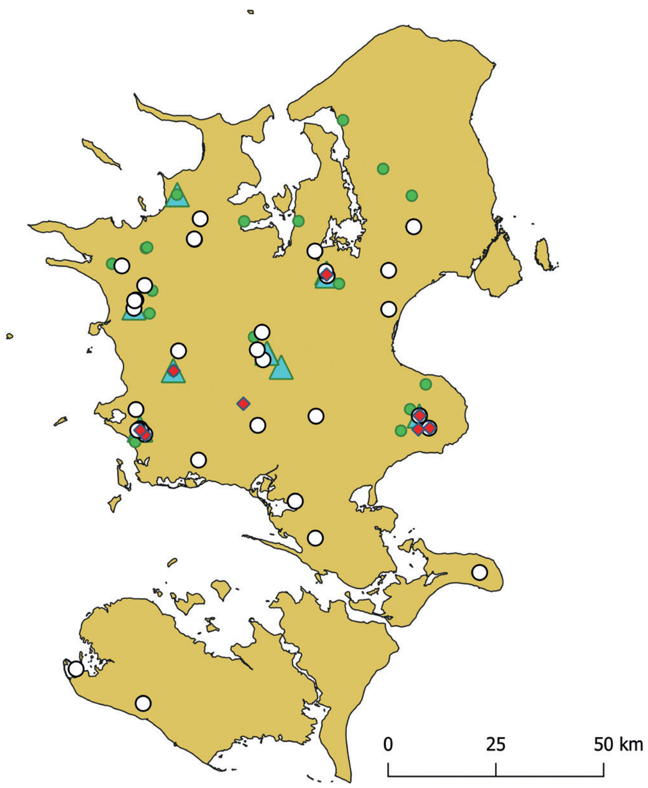

Figure 11. The distribution of stray-finds of parts of swords (white dot), lance (blue triangle), shield (green dot), helmet (red lozenge). Map contains data from the Danish Geodata Agency supplied by the author.

apparent clusters except for the Lejre area south of Roskilde Fjord. The southernmost part of Sjælland does not present a clear pattern even though a dispersed cluster is detectable on the peninsula south of the town of Næstved. On Møn the objects derive from fields west of Magleby, while the finds from West Lolland are dispersed.

The geographical distribution of the different types of warrior related objects is not even. While pieces belonging to the sword, the baldric and the horse harness are present in most parts of Sjælland this is not the case concerning lances and shields. Lances are mostly concentrated on the western part of the island with the exception of a single find on Stevns.

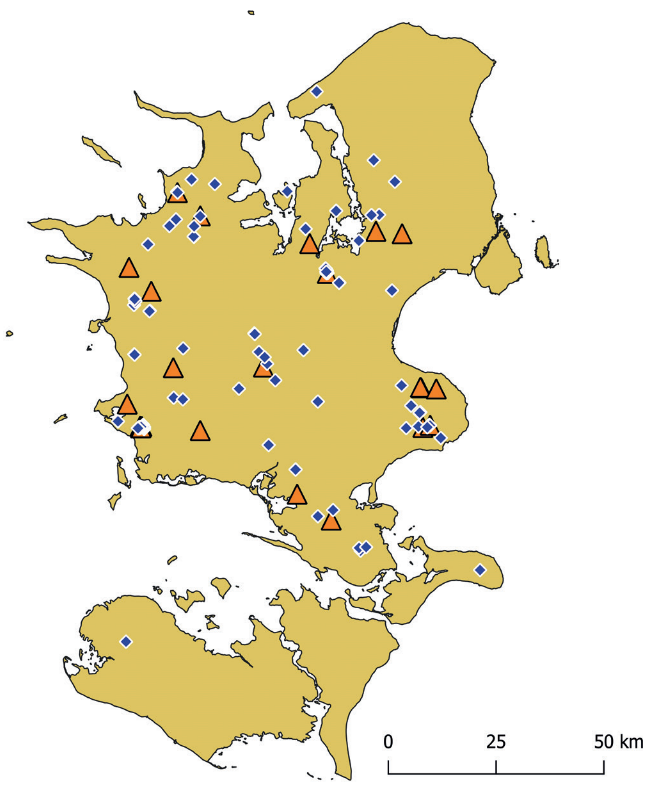

Figure 12. Distribution of parts of the baldric (blue lozenge) and the horse harness (orange triangle). Map contains data from the Danish Geodata Agency supplied by the author.

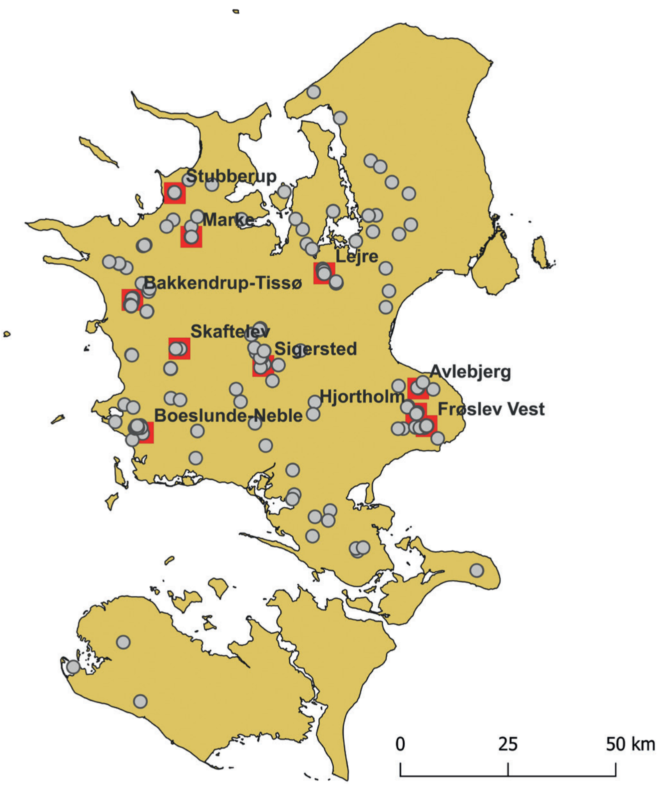

Figure 13. Settlement sites on Sjælland and adjacent islands regarded as 'significant' (red square) in relation to the distribution of the warrior related finds (grey dot). Map contains data from the Danish Geodata Agency supplied by the author.

Shields are present in most parts of Sjælland but are not seen in South Sjælland and the islands. Regarding mounts from helmets, they have been found on Stevns, in Southwest Sjælland, Central Sjælland and at Lejre.

Connecting the distribution of warrior related objects to a recognized settlement pattern certainly has its downfalls in a limited and geographically biased number of excavated farms and villages. Nevertheless, there are excavated sites and some of them are particularly interesting. Further, 'significant sites' holding both objects from the warrior's equipment and more than 15 metal objects from the period in question are considered (Figure 13).

The most substantial concentration of objects is connected to a complex of archaeological sites surrounding the neighbouring villages of Neble and Boeslunde in Southwest Sjælland. The terrain is characterized by a marked dead ice ridge through the central part of the complex flanked by undulating ground moraine. 13 pieces of shields, eight pieces related to swords, four rivets from lances and two mounts from helmets have been found within an area of 67 ha around Neble.[27] Furthermore, a sword pommel and a shield rivet have been found south of Boeslunde.[28] There have only been limited excavations carried out in this extraordinarily rich complex so there are no particulars regarding houses or the layout of a settlement (Albris 2014, 70-75; Museum Vestsjælland 2022; H. Nielsen 1997). Apart from the warrior related objects 111 brooches have been found.

Gudum belongs to the Mid-west Sjælland cluster.[29] The place name has been interpreted as 'home of the Gods' (Kousgård Sørensen 1985). In a terrain sloping from a plateau to a ford crossing a small river, a shield boss' top-disc, a mount from a helmet, a lance rivet and a bit for a horse have been found. In the same fields a large amount of metal objects dating from the Iron Age to the Scandinavian Middle Ages has been retrieved by metal detectorists, but none dating from AD 520-630 (Claudi-Hansen and Axboe 2019). A limited trial excavation has been carried out in order to establish the presence of a settlement, but the results were not conclusive (Borake 2019, Appendix II, 50-63).

In the Mid-west Sjælland cluster is the metal detector site of Skaftelev.[30] The only warrior related item is a mount from a baldric, but 26 brooches from the period have been retrieved. The neighbouring village of Hallelev also has metal objects among which are a sword pommel, a rare fitting of gold and cloisonné picturing a human face and 12 brooches.[31] Together Hallelev and Skaftelev stresses the impression of an area of importance, situated in a landscape where ground moraine and a dead ice area meet.

Bakkendrup belongs to the West Sjælland cluster.[32] The site is overlooking Lake Tissø beyond a wide-stretched wetland area to the east and south-east. More limited bog land is bordering the site to the west, while the river valley and adjoining wetlands of the river Halleby Å are to the north. Access to this promontory is possible from the south. To the north and east of the present-day village metal detectorists have found pieces of a sword, a shield, a lance and 21 brooches.

Just opposite Bakkendrup on the northside of Halleby Å is the cult and residential complex of Tissø dating from the 6th to the 11th century. All in all, the archaeological traces cover *c.*52 ha on elevated terrain bordered by the lake, wetlands and Halleby Å, while access is possible from the north. The name of Lake Tissø is referring to either the god of the Aesir, Tyr, or 'god' as such, stressing a cosmological dimension supported by offerings of weapons, tools and jewellery dating from the 6th to the 11th century found in the lake (Jørgensen 2009, 338-344). In this study the focus is on the earliest phase of the residential complex established in the mid-6th century at Bulbrogård in the northern part of the area (Bican 2010). Even though Bulbrogård is considered an important site until the late 7th century only two parts of a sword and two strap-ends are included in the survey.[33] At Fugledegård to the south – the area of the second residential complex from the late 7th to the 11th century – a belt buckle and a strap-end have been found.[34] An aspect of interest is the proximity of the above-mentioned Bakkendrup site to the Tissø complex and considering the topography it is possible that Bakkendrup has formed a sort of gateway to the residential site on the northern side of the river valley. Whether this has been the case as early as the 6th and early 7th century is uncertain, but a Viking Age bridge indicates the crossing point over the Halleby Å (Schülke 2007, 49). The importance of the Tissø complex is stressed by other locations with pieces of weaponry that have been found around Lake Tissø.[35]

The area to the north of the Tissø complex does not form a clear cluster but more sites contain pieces of weaponry and some more substantially than others.

One of these is Stubberup, a specialised landing site on the brink of the nowadays drained Lammefjord.[36] Shield and lance rivets, horse harness, mounts and buckles have been found along with 20 brooches within an area of 7 ha. Excavations have revealed pit houses, which is typical for a landing site (Ulriksen 1998, 159-165; Andersen 2004).

Marke is another metal detector site some 3 km to the south of the Lammefjord situated on a low hill protruding into wetlands bordering a small river.[37] Here, a sword pommel and a buckle have been found together with 22 brooches.

In the border-zone between East, West, North and Central Sjælland is Lejre renowned through myths and archaeology as a unique location (Christensen 2007, 2015). Lejre is forming a complex of archaeological sites dating from the 6th to the 11th century and covering *c.*32 ha along a small river dividing a pronounced dead ice area to the west from an even ground moraine formation to the east.[38] Lejre is considered a central cultic site and as the residence of a magnate or king. Impressive halls, large and small three aisled longhouses, and a workshop area of pit houses have been excavated on the west side of the river while a 7th century mound and burial ground from the 10th century are situated on the other side. Here, more ship settings have dominated the promontory most likely since the Late Germanic Iron Age.

At Lejre, weapon-related objects are two pommels, two shield rivets and two lance rivets. Further, there is a piece from a horse harness and 14 buckles, strap-ends and mounts. Besides the warrior related objects more than 30 brooches have been found.

No location stands out particularly for the Central Sjælland cluster, even though the fields surrounding the village of Sigersted have delivered 16 brooches and an extraordinary gold belt buckle.[39] *C.*1 km away a piece of a bridle has been found.

Some kilometres north of Sigersted, at Gyrstinge Nord[40], a shield rivet and two buckles have been found, and from Allindemaglegård[41] on the north side of Lake Gyrstinge are a pommel and two shield rivets. However, none of the sites have brooches in any significant number.

On South-east Sjælland the peninsula of Stevns holds the most obvious concentration of warrior related objects.

In the southern part of Stevns are more sites forming a dispersed cluster in itself. Here, the village of Frøslev is of particular interest as the place name indicates an elite site. According to Sofie Laurine Albris (2025, 346) the name includes the Old Danish noun **frø̄*, related to Gothic *frauja* 'lord', which may be identical to the name of the god Freyr.

In the fields to the west of the present-day village a sword pommel, a top-disc from a shield boss, a mount from a helmet, a strap-distributor for a horse harness, a strap-end and two belt buckles have been found.[42] From the same period are 10 brooches. A trial excavation has revealed many features and houses dating from the Roman Iron Age or Early Germanic Iron Age as well as the Scandinavian Middle Age, which corresponds with a large part of the metal detected objects. Until now there are no buildings from the 6th and 7th centuries. Some 4-500 m to the southwest is a contemporary site with a mount and a part of shield-on-tongue belt buckle together with 16 brooches.[43]

*C.*3.5 km to the northwest of Frøslev is Hjortholm where metal detectorists have found a part of a sword pommel, two scabbard mounts, a mount from a baldric, a lance rivet, three shield rivets and mount, two mounts from helmets, two buckles and a strap-end.[44] Further, there are 20 brooches, one of which is S-shaped in gilded bronze with cloisonné inlay, and two dies for gold foil figures. Limited excavations have revealed more three-aisled houses dating from the Pre-Roman Iron Age, the Roman Iron Age and the Germanic Iron Age, which corresponds with other metal objects from the site.

The village Hellested sits on high terrain close to the river valley of Tryggevælde Å. The prefix of the place name has been interpreted as meaning 'holy' and Albris has hypothesised that it has been a sacred place during the Iron Age (Albris 2025, 348-350). Of relevance here is a gilded top-disc from a shield boss and a belt buckle, but only five brooches accompany them.[45] Crop marks indicate the presence of at least one three-aisled building and large pits, but no excavation has been carried out.

*C.*5 km downstream of Tryggevælde Å is Avlebjerg where two strap-distributors from horse harnesses have been found together with 14 brooches.[46] The metal objects have mostly been retrieved in even terrain on both sides of a small brook. Whether the finds represent a burial ground or a settlement is not clear as no excavations have been carried out yet.

*C.*1.5 km to the northeast the Late Germanic Iron Age and Viking Age site of Strøby Toftegård is attracting attention because it is labelled a magnate settlement with a residence together with other farms in a village-like structure (Beck and Kildetoft Schultz 2025). It has been suggested earlier that the site had close connections to the residence and cult site at Lejre but being at a secondary level of the hierarchy of residences and settlements in East Sjælland (Ulriksen, Schultz and Mortensen 2020, 2-5). However, the first hall building at Strøby Toftegård seems to have been built in the mid-7th century, thus some decades later than the end of the period relevant to this study. Indeed, there are some metal objects dating from the period of interest namely nine gold foil figures retrieved by sieving the top soil when excavating the main building (Beck and Kildetoft Schultz 2025, 33-34). However, only a shield rivet can be related to the sphere of the warrior, and only two brooches predate AD 630.

*C.*3 km south-east of Strøby Toftegård the metal detector site of Magleby NØ holds a variety of metal objects dating from the Roman Iron Age to the Scandinavian Middle Ages among which is a mount from a horse harness.

In North-east Sjælland, the warrior related objects are present but scattered and with no relation to locations rich in metal objects or other traces of importance. The same is true regarding the Hornsherred peninsula separating Roskilde Fjord from Isefjord, except perhaps for a buckle from Selsø-Vestby interpreted as the specialized landing site related to Lejre (Ulriksen 1998, 42-78). Another buckle comes from the production site of Kirke Hyllinge-Stensgård (Ulriksen 2014, 201-202).

In the southernmost part of Sjælland, the picture more or less resembles Hornsherred with dispersed finds but with a sword pommel, a scabbard mount and a strap-distributor from a specialized landing and assembly site at Vester Egesborg (Ulriksen 2018, 175-177). Noteworthy is a die for a gold foil figure while brooches are scarce. Within a radius of 1 km from the site, there is a stray-find of a strap-distributor from a horse harness and related to a possible burial there is a buckle and a strap-mount (Ørsnes 1966, 254 and Fig. 19-20).

As is the case on Bornholm, it is possible to point at tentative 'districts' on Sjælland when mapping the metal objects combined with the 'significant' locations. These 'districts' will be discussed in more detail below.

Distribution Patterns and Topography

Between the clusters and the scattered find spots there are obviously 'empty' areas where none of the relevant objects have been found. To some extent this may be due to the geo-morphology of the islands.

Lars Jørgensen (1990, 71-76) suggested that Bornholm consists of three main landscapes offering different conditions for agriculture. Due to an uneven terrain and many rift valleys Jørgensen considered the northwest part of the island as difficult to farm and thus having a low yield. In this area there are no possible 'significant' sites and the warrior related objects are dispersed and relatively few. Northeast Bornholm with Agerbygård and Sorte Muld has heavy clay soil but more wetlands, which Jørgensen stressed as a positive economic factor. While most of the weapon burials are located here, not least along the coast, there are in this area only few stray-finds of metal objects from the warrior's equipment. The third area covers the southern part of the island. Compared to the other areas the south side is low lying and covered with a sandy moraine, which has been easier to farm than the heavier clay. In this area are Smørenge and Sandegård as well as the majority of the relevant stray-finds.

Regarding Sjælland and the adjacent islands, it is clear that the finds are connected to the fertile, generally clayish ground moraine landscape and mostly not at the more (or very) rugged dead ice terrain. This preference is stressed by the distribution of other types of metal objects dating from AD 520-630 (Figure 14). Nevertheless, there are also areas of ground moraine where the finds are absent. This may be due to areas of uninhabited Iron Age woodland, however, there are parts of arable land where brooches are present but weaponry is not. This is true regarding East Lolland and the entire island of Falster and it is not because of low intensity of metal detecting. More than 230 locations with metal objects are registered within these areas.[47]

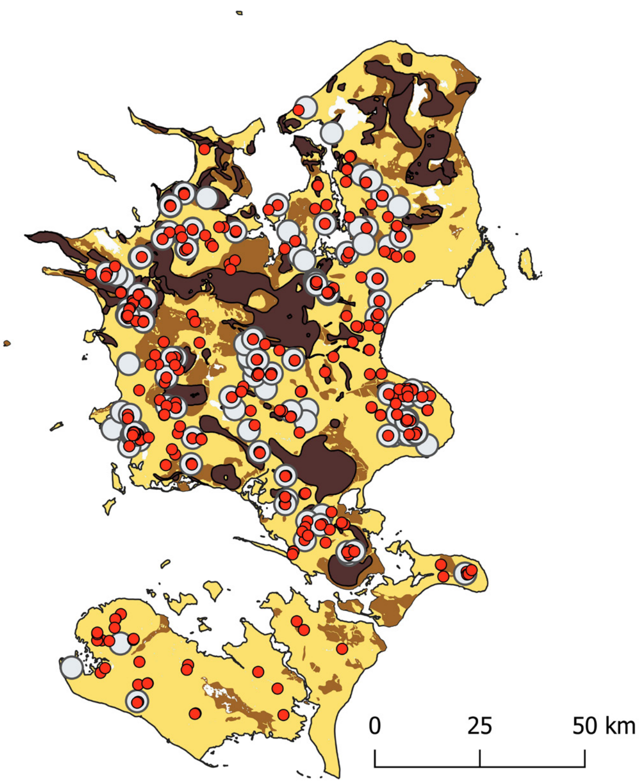

Figure 14. Distribution of sites with one or more of *c*.800 brooches on Sjælland and adjacent islands dating from AD 520-630 (red dot) and warrior related objects (grey dot) in relation to the dead ice terrain (brown) and pronounced dead ice (dark brown). Map contains data from the Danish Geodata Agency supplied by the author.

Discussion

Deducting a military organisation on the basis of weapon burials from Bornholm and stray-finds from the East Danish islands meets a major obstacle: how many warriors do the stray-finds represent?

Counting Warriors on Bornholm

Taking the 25 weapon burials from Bornholm as a starting point they obviously represent 25 warriors but, except for the sword (seax or spatha or both), in nearly all burials the furnishing is not standardized.[48]

Of the six burials from Scandinavian Phase I (AD 520/530-560/570) five had a sword, four had a lance and four had a shield, while two of the burials also had a mount from the baldric. However, only two burials contained all weapon types and they had no mounts or fittings. Splitting up the inventory of these six warrior burials into 'stray-finds' there are 21 different pieces of copper alloy, which would have a chance of being found by a metal detectorist.[49] There are copper alloy parts from weaponry in all the burials so they would all have a chance of being retrieved.

From Scandinavian Phase II (AD 560/570-610/620) there are 19 weapon burials, all but two containing a sword.[50] Five burials had a lance and five had a shield. Five burials contained mounts, strap-ends and/or buckles while four held parts of horse harnesses. Only two burials had all three weapon types and additionally they were richly furnished with mounts and buckles as well as horse harnesses. Of the 19 burials only six contained copper alloy objects, but one by one they summed up to 86 single items with a chance of being found as stray-finds.[51]

Altogether, 12 of the 25 weapon burials would have a chance of being retrieved as stray-finds in the ploughsoil.

Comparing these data with the 78 warrior-related stray-finds from Bornholm it is noticeable that the total number of stray-finds comprises only around 75% of the number of objects in the 12 burials. Moreover, comparing the weapon burials and stray-finds it is evident that the relative proportions between the different categories of warrior related equipment do not correspond. The shield and the horse harness are much more common in the burials, while mounts and swords are twice as frequent among the stray-finds.

While the number of buried warriors is clear an attempt to convert the stray-finds into an estimated number of warriors naturally poses serious questions of representativity and validity.

Thus, it is important to notice that of 86 single objects from Scandinavian Phase II burials 77 objects belong to four burials, hence representing only four warriors. These all contain several mounts, fittings, buckles and strap-ends from the baldric and the horse harness. However, leaving out these categories the sword, lance and shield are represented by 24 copper alloy objects deriving from four burials, which are also rich in mounts and the like.[52]

It is essential to stress that the different categories of objects are not equally represented in the stray-find material because the original objects have been being split-up in different numbers of fractions.

The sword is present in all but two of the burials in question but of 25 swords,[53] only seven have parts of copper alloy. Theoretically, less than one out of three swords have a chance of being found using a metal detector. In contrast, the shield is present in nine burials. Even though only five shields had parts of copper alloy they amounted to 29 individual objects. Accordingly, the chance of retrieving a part of a shield is many times higher than finding the most common weapon in the burials – the sword.

Regarding the stray-finds sword pommels as well as scabbard mounts and fittings have been found in nine instances, while lances are represented by six rivets. Most frequent are buckles, strap-ends, mounts etc. counting 51 objects, while only four parts of horse harnesses and the same number of shield rivets have been found. The latter is a significantly low number since a shield holds several rivets. Comparable in size, shape and dating, the disc brooch has been registered in more than 60 cases on Bornholm, so rivets in the ploughsoil cannot be harder to detect. It is also significant that the sword is the most frequent weapon among the stray-finds contrasting the fact that less than a third of the swords from the burials had parts of copper alloy. All things considered, the comparison between the copper alloy objects from the burials and the stray-finds show the relative figures do not correlate (Figure 15).

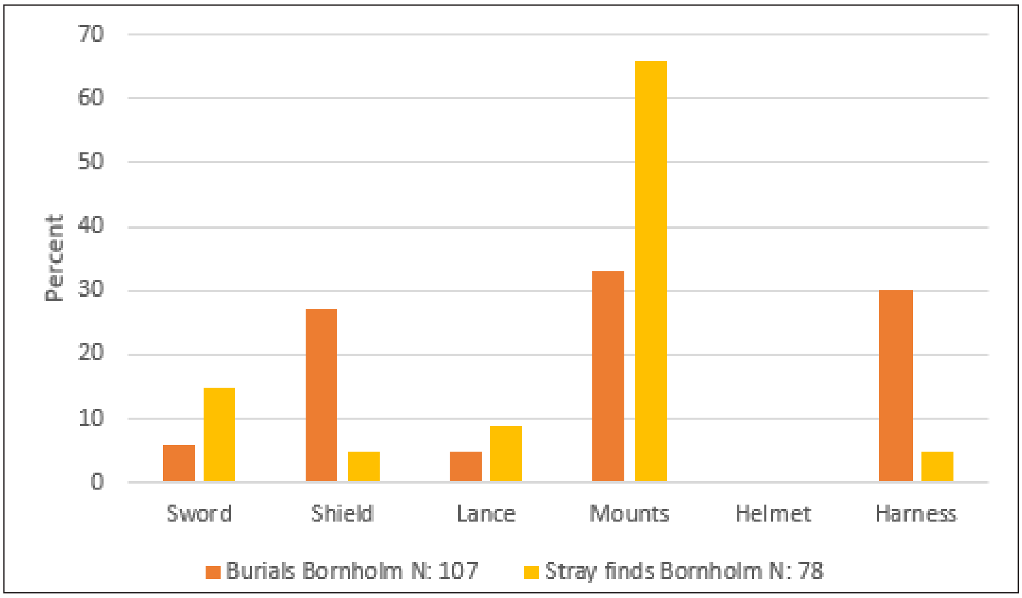

Figure 15. The relative number (percent) of the five categories of weaponry from 25 burials compared to stray-finds on Bornholm.

It is not possible to combine the stray-finds into interconnected equipment in any way, so they have to be considered individually. Consequently, the 78 warrior-related stray-finds from Bornholm hypothetically represent the same number of warriors. As mentioned earlier a little less than half of the weapon burials could possibly have been found as stray-finds as they contained objects of copper alloy. If these proportions are transferred to the stray-finds one can estimate that approximately half of the warriors are represented in the stray-find assemblage.

Following this line of speculation there may have been around 185 warriors including the 25 from the burials, a number that covers *c.* 100 years or the equivalent of *c.* three generations. According to the distribution of finds they have lived in most parts of the island and thus may reflect the farms of free men.

Considering Nørgård Jørgensen's suggestion that a sword, a lance and a shield have been a standard armament for free men with an obligation to muster when called upon is difficult to confirm. Studying the stray-finds, they do not reflect warriors armed with a standard set of weapons. Additionally, both the lance and the shield are rare despite their relatively good potential for being retrieved using a metal detector. Revisiting the data from the burials only four of 25 burials contain all three 'common' weapons. The norm is the sword found in 23 burials, sometimes (in nine burials) combined with a shield and/or occasionally (in six burials) a lance.

The assumption that 'the better-off warriors' had a horse (*cf.* Jørgensen and Nørgård Jørgensen 1997, 98) may find some support in the fact that only four pieces of horse harnesses are registered, maybe indicating a sort of elite. However, none of the harness parts originate from one of the alleged 'significant' sites of Bornholm (*cf.* above) and only one strap-distributor has been found together with other indicative objects at Store Myregård.[54]

Elite, Free Men and 'Conscripts' on Bornholm

The estimated number of warriors is not the real figure but it is clear that the archaeological record does not support a higher number at this point. The question is: hypothetically, are 185 armed men in a hierarchy of at least two levels or ranks reflecting a situation of unstable power structures fuelled by competing families between *c.*AD 550-630 (Jørgensen 1990, 88-89, 94) and forming a source for conscription (Jørgensen and Nørgård Jørgensen 1997, 109-111)?

The whereabouts of the 'competing families' may be illustrated by the simple settlement hierarchy sketched above by pointing out six locations, each holding a suite of archaeological records and objects making them stand out from the other 103 archaeological sites holding metal objects from AD 520-630.[55] It is important to note that the six locations mostly excel because of the volume and concentration of finds, not due to a higher quality of the objects. In fact, there is a remarkable uniformity in the metal objects in this study regarding the manufacturing and design displaying a mediocrity in materials and skills. Objects made of silver and gold are almost absent and so are objects manufactured in cloisonné-technique. When present they are mostly connected to the Sorte Muld complex (*cf.* Lund Hansen 2008a; 2008b; 2008c).

The uniform quality of the metal objects may reflect a rather flat social hierarchy, and so may the frequent location of the six 'significant' sites. Looking at the distribution of weaponry alone, each of the six locations sits within an area loosely defined by further sites including weaponry (*cf.* Figures 5-6). The border zones between them do not lack relevant objects entirely (except for the northern part of the island) but a pattern of separate districts is clear. This is emphasized when adding the distribution of brooches (see Figures 7-8).

The combined picture seems to reflect six locations performing some kind of centrality, each controlled by a magnate, with other armed men living in the hinterlands (see Figure 9). In theory the latter should represent the free men obligated to muster equipped with sets of standardized weaponry. However, the stray-finds do not unequivocally support the hypothesis of such an organization. The parts of sword, lance and shield are few in numbers, they are mostly concentrated at the six 'significant' locations, and the supposed sets of weapons are not present at any location.

On Bornholm, there has most likely been a leader among peers and the Sorte Muld complex is a strong candidate as his home-base. The general assumption that the Sorte Muld complex had an overarching role as the most important site of the period rests on the extraordinary rich find material, a thick culture layer covering parts of the complex, special objects like the more than 2000 gold foil figures, and traces of workshops and cult activities spanning several hundred years. It is, however, of interest that fluctuations in the number of finds shows a decrease in activity in the Late Germanic Iron Age compared to the Late Roman Iron Age and the Early Germanic Iron Age (Watt 2006, 149).

The Smørenge site also attracts attention because of the rich and varied find material of copper alloy, silver and gold, as well as warrior's equipment from the Roman Iron Age to the Viking Age. The more than 80 gold foil figures indicate an extraordinary location in the middle of the 1st millennium (Nielsen and Watt 2019, Fig. 6) and just like Sorte Muld, Smørenge covers a rather large area. It is difficult to establish whether Smørenge competed with the Sorte Muld complex or if it was subordinated, maybe at the second level in the hierarchy.

The ring-knobs, inspired by Continental practice (Steuer 1987, 219-227), have been suggested as a token of rank given by a supreme leader to trusted high ranking military sub-leaders in times and places of relative stability where ordinary weapon burials do not occur (Jørgensen and Nørgård Jørgensen 1997, 113-115). On Bornholm ring-knobs have been found at Gammel Skovgård (gilded silver), Lillevang (silver) and at the Sorte Muld complex (gold), and their presence aligns poorly with the proposition regarding their role mentioned above. However, the ring-knob of solid gold from the Sorte Muld complex resembles more ring-knobs from the Iron Age cult and residential location of Gudme, Fyn (Jørgensen and Nørgård Jørgensen 1997, Fig. 71), thus highlighting the special status of the Sorte Muld complex.

A Hierarchy of Warriors and Settlements on Sjælland

Comparing the stray-find evidence from Bornholm to Sjælland and adjacent islands it is worth noticing that the latter hold approximately three times more objects from an area 15 times larger than Bornholm. Accordingly, the density of finds is far greater on Bornholm.

Moreover, there are some discrepancies regarding the relative proportions between the categories (Figure 16). In Sjælland the shield is far more frequent and the sword and the horse harness is considerably more frequent than on Bornholm. Regarding the lances and the mounts, it is the other way around. Mounts from helmets are only identified on Sjælland in this study.

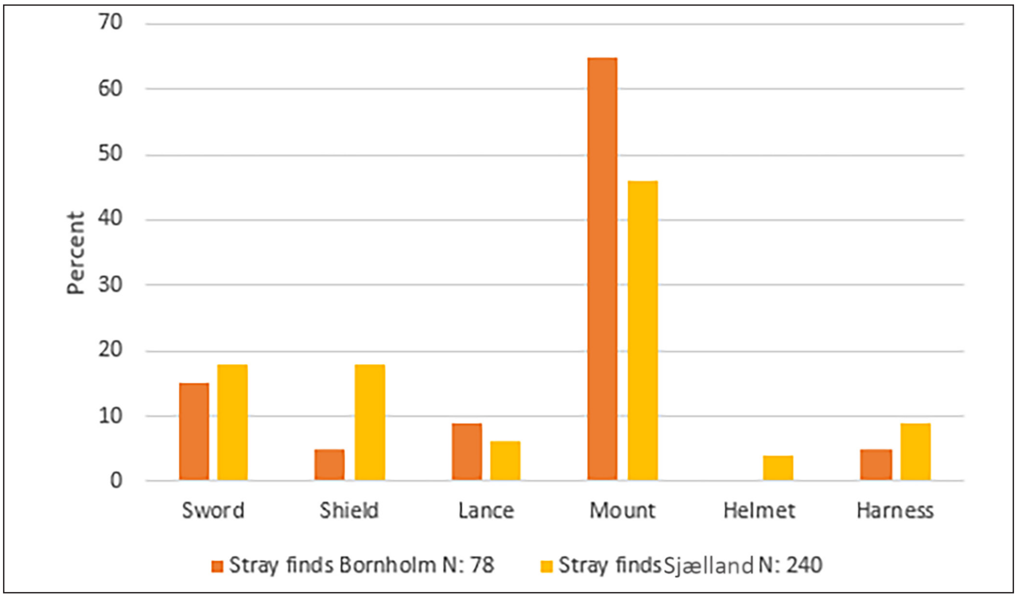

Figure 16. The relative portion of stray-finds (percent) of the six categories of weaponry from Sjælland and adjacent islands compared to the evidence of Bornholm.

Following the same line of argument as for Bornholm 240 objects related to the warrior's equipment from Sjælland and adjacent islands hypothetically represent *c*.500 individuals when adding the supposed 'missing' warriors (*cf.* above).

The distribution map supports the notion that armed men have been living in most parts of the arable areas of the islands. However, the evidence does not support the hypothesis of a standard set of weapons. Lejre, the Boeslunde complex and Hjortholm are the only locations where both sword, lance and shield are present, and they hold most of the helmet parts identified. Further, Lejre's and Boeslunde's archaeological records surpass the rest of the sites – in other words, they are significant in more ways than just on account of the weaponry.

There is a conspicuous absence of parts of shields in southern Sjælland and the islands, and the lances are concentrated in a few locations except North and South Sjælland. The pieces from horse harnesses are present in most of the clusters but as on Bornholm they are not confined to the 'significant' sites.

Inspected from a high altitude the finds do form clusters but zooming in they dissolve into more scattered patterns. Some of the suggested 'significant' locations may each have been a sort of centre of a district. This is most distinctive in West Sjælland where four areas can be separated (Marke, Bakkendrup-Tissø, Skaftelev, and the Boeslunde complex) even though some of the border zones between them are fairly blurred (Figure 17). Stubberup is a specialised landing site, most likely connected to the district of Marke. The Stevns peninsula is a confined area regarding the distribution of finds but according to the definition of 'significant' locations there are no less than three potential sites inside this rather limited area (Avlebjerg, Hjortholm and Frøslev).

For North-east Sjælland Lejre is the most important location. It has a close hinterland of settlements more or less surrounding the cult and residence site (Christensen 2015, 231-238) but noting the scattered distribution of finds of weaponry and brooches it is quite possible that Lejre's hinterland includes the territory around Roskilde Fjord. Supporting the suggested interrelation of the area as a whole is the fact that this is the only part of Late Germanic Iron Age East Denmark where pit houses are combined with rural settlements and production sites situated inland (Ulriksen 2018, 422-425). The specialized landing site of Selsø-Vestby located at a well-protected natural harbour in the middle of the Roskilde Fjord may have belonged to Lejre (Ulriksen 1998, 78).

It is tempting to include the locations in East Sjælland between the towns of Roskilde and Køge in the district of Lejre, but the settlements in that area

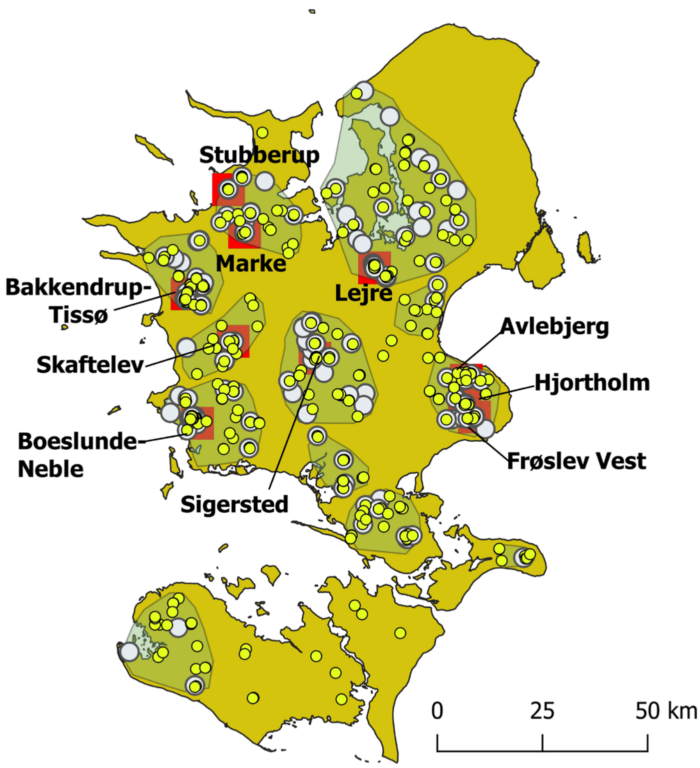

Figure 17. Tentative districts (green shading) on Sjælland based on the distribution of weaponry (grey dot) and brooches (yellow dot). Map contains data from the Danish Geodata Agency supplied by the author.

lack the rural pit houses, thus indicating that there has not been an incorporation. Only a sword pommel and a belt buckle have been found in the area and even though the fertile land holds several metal detector sites including objects from the relevant period none of them has the necessary combination of finds to candidate for 'significance' as yet.

There are clearly areas with both weaponry and brooches where 'significant' locations are absent. This is particularly obvious in Central and South Sjælland, Møn, and Lolland. Nevertheless, based on the distribution of weaponry and brooches it is possible to define tentative districts for the areas in question (Figure 17).

Ranking the 'significant' locations hierarchically depends on whether single objects, *i.e.*, stray-finds, or excavated houses etc are considered to be diagnostic. In that regard there is no doubt that the Boeslunde complex is extraordinary both in size and in the amount of warrior related objects, the number of metal objects generally, and the quality of some of these objects. Of the 148 warrior related objects from the five districts of West and Central Sjælland the Boeslunde complex alone holds 39%. Lejre covers a smaller area but has many metal objects too, and some of these of an extraordinary quality.[57] The number of warrior related objects is not as high as at Boeslunde, but excavations at Lejre have revealed a large hall building and a cultic area from the period under scrutiny here.

At the Tissø complex excavations have revealed a large hall building too and even though only the published part of the stray-finds can be included in this study it indicates a situation comparable to the Boeslunde complex and Lejre. Unfortunately, without corresponding excavations of the Boeslunde complex a qualified comparison is lacking an important dimension.

The suggested district of Lejre is unparalleled in size on Sjælland but the combination of ordinary settlements, warrior related objects and the topography surrounding the Roskilde Fjord supports it. One may argue for a similar district in West Sjælland from the Tissø complex to the Boeslunde complex, but this leaves us with two high-level 'significant' sites in the same district and the topography between them with traversing dead ice terrain and river valleys does not form a natural context either. The foundation for the Lejre district is the Roskilde Fjord unifying the coastal landscape and the importance of the fjord as the gateway to Lejre.

The evidence presented suggests that a first among peers has been connected to Lejre but having at least two magnate families more or less on the same level considering the metal objects, weaponry and – regarding the Tissø complex – a large building with an assembly hall. The other 'significant' sites and districts have been placed at a lower level of the hierarchy.

Stating this, a peculiarity is found in Southwest Sjælland at Harrested Skovvej between the Boeslunde complex, the Central Sjælland district and the district around Næstved. The area holds no relevant objects but at Harrested Skovvej a large three-aisled building with a hall has been excavated (T.H.B. Hansen 2023). The hall building is more or less similar in size and construction to the first phase of halls at Lejre and indeed they were contemporaneous during the 6th and early 7th century. However, contrasting to Lejre no metal objects from the same period have been detected neither during the excavation nor in metal detector surveys in the field surrounding this building.

The District as a Power Base

All of the districts are connected to the coastline except for Central Sjælland (see Figure 17, 'Sigersted'), which also lacks a clear 'significant' site. Even though it is easy to incorporate coastlines on islands the sizes of Bornholm and Sjælland there may very well have been obvious reasons for the suggested situation. During the 6th and 7th century sailing got ever more important to the Danes and specialized landing sites manifested themselves on the otherwise uninhabited coast (Ulriksen 1998, 2004, 9-18, 2018, 369-379). This development is evident throughout Scandinavia and, consequently, controlling the access from the sea and observing the fairways passing by has been crucial. This may explain the relatively larger amount of warrior related objects in West Sjælland compared to the rest of the island (see Figure 3). West Sjælland faces the Storebælt, which has very likely been the main fairway between the Baltic Sea and the Seven Seas, thus being more vulnerable to raids and accordingly more important military positions have had to be manned (Ulriksen 2024). This situation may also be the reason why it is the western part of Lolland that holds the warrior related equipment.

The increased traffic on the Baltic Sea may also be the reason why Bornholm holds a relatively larger portion of warrior related objects compared to Sjælland and adjacent islands given to the size of the territories. Like in West Sjælland it seems to indicate more military sub-leaders, which may have been necessary in order to maintain maritime surveillance and control the access points to the island. Due to the geology of Bornholm the coasts to the north and north-west are characterized by cliffs and rocks with a limited number of suitable landing sites and the districts of the area are all connected to potential landing sites, in the present day occupied by modern harbours. The southern part of Bornholm has a steep coast at places, but generally the number of potential landing sites is larger there and so is the number of warrior related equipment.

Getting Armed Men Together

Cosmology in 5th century South Scandinavia was evidently rooted in the Norse (or Scandinavian) mythology. Acknowledging the interpretation of the gold bracteates as depicting cosmological beings like Oðin and psychopomps or even mythological scenes (Axboe 2007; Hauck 1994; Hedeager 2004, 2011) the pantheon of the Aesir and Vanir was a part of life. Embedded in this cosmology was an ideology idealizing the warrior and making the powerful leader the offspring of a male god (Oðin or Freyr) and a female *jötunn*. Thus, possessing aspects of 'the Other World' hidden from ordinary people the leader had an outstanding status and a special charisma representing his divine nature towards his people and vice versa (Graeber and Sahlins 2017, 2; Schjødt 2003, 390-392; Sundqvist 2012, 234). In myths, legends, songs and saga texts Oðin is closely related to the leader, selectively offering his advice to warlords and kings. He is known by 170 *heiti*, *i.e.*, synonyms, and most of them are related to war, warriors, death – and poetry (Bek-Pedersen 2021,153). Oðin is the wisest god of the pantheon while also representing the raging essence of the fight and the killing. The relations between god and leader, war and death are obvious.

From the mid-6th century, the animals appearing as decorative elements on brooches and mounts – the wolf, the wild boar and the eagle – are all regarded as aggressive, fierce beings closely connected to the elite (Hedeager 2004, 2011). Human-animal interaction could mean shapeshifting, so that man could become the animal and fight fearlessly

Figure 18. Eagle-shaped mount from a shield or a saddle transformed into a brooch. Found at Hjortholm on Stevns (Photo: Jens Olsen, Museum Southeast Denmark).

and viciously (Hedeager 2004, 236; also, Pedersen 2021, 129-136). The ubiquity of the martial mentality is stressed by the fact that decorations and shapes of the warrior's equipment are mirrored in the brooches of the women. Furthermore, there are examples of a transference of specific objects from the warrior's sphere to the women's sphere. For instance, an eagle-shaped mount from a shield or saddle has been transformed into a brooch (Figure 18).

In this martial mentality, organizing and sustaining a military capacity has been crucial for any powerholding leader to maintain his position. Likewise, gathering armed men for an expeditionary force aiming at getting all participants wealthier by plundering was not difficult – it may well have been based on the willing warrior alone. However, it is quite another matter to command armed men to muster for combat of the leader's choice of reason, time and place. This demands a sense of obligation on the warriors' part.

It has been suggested that such an obligation may have been rooted in a military organization based on conscripts inspired by the Merovingian model (Jørgensen and Nørgård Jørgensen 1997, 109-110). The Merovingian military organization had a complex hierarchy of positions and the most powerful had retinues reflecting their status (Sarti 2016, 284-286). The king's retinue outshone all others as it consisted of renowned men followed by their own retinues. Initially the military organisation was based on taxation of both land and persons, a system inherited from the collapsed Roman society in the area and subsequently filtered through the Burgundians, the Visigoths and the Ostrogoths (Goffart 1982, 3-4; Drew 1991, 8). During the 6th century the taxation system gradually eroded especially regarding the taxes on landed property of the free Franks and was replaced by an obligation of military service to the king at their own expense (Goffart 2008, 183). Omitting to meet this obligation meant heavy fines. However, the free Franks were apparently eager to follow the king on military campaigns because they would have had the opportunity to plunder (Goffart 2008, 184, note 57).

Transferring these conditions to the society of the Danes in the decades around AD 600 meets the obvious question if a similar mode of taxation, obligation and judicial consequence existed or was adapted. Tax on landed property has been a matter of debate but it cannot convincingly be established in Denmark until the 11th century (for instance Poulsen 2011; Poulsen and Sindbæk 2011; Hansen 2016, 159-172, with further references). This is also the first time a military organisation based on landed property is known (Lund 1996).

Among the Danes of the 6th and early 7th century the obligation to perform military service does not seem to have been founded on a regulated tax system. Instead, it is likely that the military forces have been based on a social system of mutual obligations rooted in a code of honour closely intwined with cosmology and ideology. In other words, it was a way of life.

Even at a local level there may have been leaders with a number of property-owning free men connected to them through mutual obligations and services in terms of cultic rituals involving gifts and feasts, legal disputes, and armed conflicts. No doubt some leaders have been more important than others due to pedigree, riches, and reputation. At a higher level, leaders have had young warriors in their bread, kin and others, in other words a retinue forming a warband of professionals ready to serve (Beck, Kildetoft Schultz and Ulriksen 2025). Lower-level leaders most certainly have been connected to more important magnates. This may have been sealed by oath or by promising one's support while drinking in the leader's hall (for instance, Beowulf, v. 2633-2639, see Fulk, Bjork and Niles 2008), nevertheless mutual obligations have been the adhesive between them.

In this setting an armed man, a warrior, has not been conscripted on the basis of his property or because the male population legally obligated to muster on the orders of the supreme leader. Instead, the obligation has been based on a social code of conduct between two parties typically of different social ranks.[57] For his part, the higher-ranking leader would most likely have a similar relation to a magnate or king. Instead of degrading taxes free men offered gifts and services to the higher-ranking magnate and he gave prestigious valuables in return and included his followers in his lavish lifestyle through the ritual feasts he conducted (Härke 2000, 377, 379-383; Mauss 2001, 82-86; Poulsen 2011, 278-283; Graeber and Sahlins 2017, 15-16). When necessary, a high-ranking leader could call upon those who had obligated themselves to him and as men of honour they would appear, some of them with their own band of supporting armed men.

The number of steps in this pyramid of mutual obligations are difficult to assess. As stated above the archaeological material indicates a rather flat hierarchy, and the basic order may have been the same as known from Widukind's description of Viking Age Saxony. Here was an elite class of birth, a class of free men, a class of freed slaves and a class of unfree (*i.e.* slaves) (Widukind 1910, 30). It is likely that there have been differences inside the social groups regarding power, wealth and position enabling connections of obligation in the same way as between higher and lower ranking classes. Joining an expedition, the expected achievement would be the plundering of the riches of the defeated and an improved esteem as a warrior.

The initial questions of how, why and in what numbers warriors were summoned may find their answers in a system of mutual obligations based on a martial mentality closely connected to the cosmology of the period. The notion of warriors gathering around a leader hinges on the martial mentality and the society's terms of honour. Furthermore, plundering as an economic strategy has been vital for the system of obligations. Enabling a leader to offer rich gifts of golden rings, precious weaponry and clothes to his followers, plunder-aimed warfare was essential. This is known in other parts of Germanic Western Europe, but while the strategy of the Merovingian kings was to conquer territory too, apparently the South Scandinavians did not. Thus, there was no need for thousands of men joining an expedition – a fraction would do.

Concluding Remarks

Comparing the inventory of the Bornholmian weapon burials with the stray-finds of warrior related objects reveals some disagreements in the relative frequency between different parts of the equipment. This may be due to a specific selection of materials and symbols for the grave furnishing, while the parts retrieved as stray-finds mirror 'real life'. However, 'real life' has not been exactly the same on Bornholm compared to Sjælland and within the borders of the latter there is no normal, neither regarding presence or the relative numbers of artefacts. In other words, it is not possible to deduct a military organisation on the basis of standardized sets of weapons and a Merovingian inspired system of conscripts is not likely.

Without a law code regulating military organisation, it is probable that the warriors were connected to a leader by mutual obligations. Above, it has been possible to delimit districts, in most cases with a 'significant' site as its core (see Figures 9 and 17). These districts may have been the basic unit where people have attended the important gatherings connected to the *blót* and other ritual feasts at the magnate's residence. The magnate had the capacity to perform power and he controlled the interaction with the gods and 'the Other World'.

The districts may have formed a basic power base. They shall not be perceived as locked and top-down defined entities, but it is likely that the basic levels of mutual obligations can be found here. Combined and over time they would be the core in larger entities (Iversen 2020; Helgesson 2002; Näsman 2006; Skre 2020). The districts seem to be rooted and stable for centuries. Applying the distribution of stray-finds of weaponry and brooches dating from the second part of the 7th century do not alter the picture much and the same is true regarding weaponry dating from the 8th to 11th century.

Indeed, the number of warriors indicated by the burials and stray-finds is an estimation to say the least. Nevertheless, it is a maximum number of individuals based on the available find material. Each generation on Bornholm would have had *c*.60 warriors across the island, and *c*.170 can be counted on Sjælland and adjacent islands. Based on these individuals any thought of a defence system based on fixed positions is questionable, but certainly the number of invisible warriors may have been much larger than suggested here. This is implied by the story of the king of the Danes raiding 'Gallia' in the early 6th century. Hypothetically – but probably not realistically – this enterprise could have been accomplished by two or three ships. We do not have archaeological evidence of South Scandinavian ships from the 6th century but based on the number of oars in the *c*.200 years older Nydam-boat (Bockius 2013) and the 500 years younger small longship Skuldelev 5 (Crumlin-Pedersen 2002) even this low number of vessels would have needed a crew of at least 60-90 men. The archaeologically speaking invisible warriors must have been equipped with weapons that we cannot detect today.

Summing up on 'how', 'why' and 'in what numbers' armed men were gathered, a martial mentality permeating all of society, combined with a social code of conduct with mutual obligations between free men and leaders and between leaders of different ranks, may give an answer to all three questions.

Funding

The study has been funded by the Centre for Viking Age Studies at Museum Southeast Denmark.

Acknowledgments

For helping me with gaining access to archives and registration photographs of objects I am grateful to curator Esben Aarsleff at Museum North Sjælland, curator Céline Vacher at Kroppedal Museum, curator Anders Rasmussen at Museum Lolland-Falster, registrator René Laursen at Bornholms Museum, curator Trine Borake at Museum Vestsjælland and Head of Archaeology Julie Nielsen at ROMU in Roskilde. For reading a first draft of the manuscript I owe many thanks to archaeologist Sandie Holst.

I owe thanks to Lisbeth Zenth for revising the language.

Notes

1 A critical and reducing view on the relative number of warriors in Early Merovingian *Reihengräberfelder* is published by Doris Gutsmiedl-Schümann (2012).
2 One example, though, is Grønbæksminde near Aulum, Central Jutland (Helt 2021).
3 See Supplementary Material, Table 1.
4 There is no doubt that the stray-find material is lying out there in the fields of Skåne. Uppåkra holds many parts of weaponry for instance (Helgesson 2002) but it is characteristic that stray-find assemblages from the odd field are not integrated in publications (e.g., Helgesson 2010; Söderberg 2005).
5 See Supplementary Material, Table 1.
6 Regarding the magnate's residence of Tissø (Bulbrogård and Fugledegård) it has not been possible to include all the relevant find material in this study because the location is under publication (personal correspondence Mads Dengsø Jessen, the National Museum, Copenhagen). Only objects previously published or registered at Museum Vestsjælland are included here.
7 See Supplementary Material, Table 2.
8 Belonging to the location Smørenge is: BMR 766 Smørengegård; BMR 1469 Smørenge; BMR 1697 Smøreenge; BMR 2652 Smørengegård SV; BMR 2654 Østre Smørengegård; BMR 3479 Smørengegård S; BMR 3550 Store Smørengegård.
9 Belonging to the Sorte Muld complex are: BMR 1191 Sorte Muld; BMR 1430 Brændesgård 2/Kanonhøj; BMR 1639 Dalshøj; BMR 1653 Brændesgård omr. 1; BMR 1716 Sylten 3; BMR 1795 Biskopsenge IIIB; BMR 2149 Sylten 6; BMR 2155 Brændesgård omr. 2; BMR 2156 Brændesgård omr. 3; BMR 2280 Engegård; BMR 2508 Kanonhøj; BMR 2509 Kanonhøj Syd; BMR 2648 Nørregård; BMR 2650 Kanonhøj/Sønderhøj; BMR 3065 Dalshøj II; BMR 3141 Paradisgård; BMR 3144 Grydehøj; BMR 3185 Dalshøj III; BMR 3200 Engegård Nord; BMR 3308 Hallebrøndhøj-Frennegård; BMR 4110 Nørregård.

10 BMR 2114 Kobbegård; BMR 3792 Kobbegård II.
11 BMR 1836 Lehnsgård; BMR 3860 Lehnsgård NØ.
12 See Supplementary Material, Table 2.
13 BMR 1371 Sandegård.
14 A total of 55 objects.
15 BMR 2812 Ndr. Mulebygård; BMR 3227 Ndr. Mulebygård.
16 BMR 1569 Gammel Skovgård.
17 BMR 750 Rytterbakken.
18 BMR 2812 Ndr. Mulebygård; BMR 3227 Ndr. Mulebygård.
19 BMR 1235 Møllegård.
20 See note 16.
21 See Supplementary Material, Table 1.
22 In Krageskov near Køge a low mound was excavated by the National Museum in 1875. According to Mogens Ørsnes (1966, 254) a single-edged sword was found. A specific type or dating is not recorded.
23 The survey was initiated by the Author and carried out by an expierenced detectorist, Robert Poulsen.
24 108 objects. See Supplementary Material, Table 2.
25 110 objects. See Supplementary Material, Table 2.
26 22 objects. See Supplementary Material, Table 2.
27 AMK 1989027 Grisebjerg 1; AMK 36/89 Neble 2; MVE 3380 Grisebjerggård; MVE 3425 Maglegård; MVE 4322 Neble NØ; SVM 1321 Neble detektorfund; SMV 1449 Neble; SVM 1533 Neble SV.
28 MVE 3536 Langetofte.
29 SVM 1452 Gudum N. See Borake 2019, Appendix I, 55-71.
30 MVE 3041 Skaftelev.
31 MVE 3086 Hallelev.
32 KAM 2009-003 Skadhauges Mark; MVE 3014-1 Bakkendrup Nord. Cf. Borake 2019, Appendix I, 12-27. Further MVE 3167 Bakkendrupvej 40-42.
33 KAM 2008-011 Bulbrogård; MVE 3167 Bakkendrupvej 40-42, Lille Fuglede.
34 MVE 4205 Fugledegård. Almost certainly, this is not the true picture, which most likely will be unfolded in the coming publication of the Tissø complex. *Cf.* note 5.
35 MVE 3089 Sæbygård; MVE 3496 Jorløse; MVE 4250 Halleby Hale; Hallebygård (no museum's site registration number as yet).
36 OHM 1164 Stubberup.
37 MVE 3127 Marke.
38 ROM 615 Fredshøj; ROM 641 Mysselhøjgård; ROM 3577 Lejre By. Among the metal objects are items dating from the Roman Iron Age and the Early Germanic Iron Age, the Viking Age and the Scandinavian Middle Ages. Cf. Baastrup 2015.
39 SVM 1370 Sigersted NØ; SVM 1382 Sigersted SØ; SVM 2002-020 Sigersted Kirke Ø; SVM 1383 Sigersted S.
40 SVM 1502 Gyrstinge Nord.
41 SVM 1478 Allindemaglegård.
42 KNV 294 Frøslev Vest.
43 KNV 224 Frøslev matr. 10c.
44 KNV 1125 Hjortholm.
45 KNV 92 Hellested Nord.
46 KNV 914 Avlebjerg.
47 According to the central data base 'Finds and monuments' at the Agency for Culture and Palaces with the search terms 'Diverse anlæg og genstande' – 'Enkeltfund' – 'Detektor'.
48 See Supplementary Material, Table 1.
49 The thorn from shield-on-tongue buckles is counted separately – they are only rarely found still connected to the buckle. Shield bosses may have between four and six rivets and a top-disc, while the handle has two rivets. The lance has two rivets. The sword typically only has a pommel of copper alloy but there may be additional parts of the hilt as well as scabbard mounts of copper alloy.
50 See Supplementary Material, Table 1.
51 Regarding a burial from Nymølle grave 1 at Nexø the inventory is not described in detail (Jørgensen 1990, 143), but in his catalogue Mogens Ørsnes notes that the shield boss probably has had a top-disc (Ørsnes 1966, 246). This assumption is not taken into account here.
52 See Supplementary Material, Table 1.
53 There were two swords in three burials.
54 BMR 3542 Store Myregård ØSØ.
55 In the study there are 172 different locations from Bornholm with metal objects from the relevant period with a separate Bornholm's Museum's site registration number. They have all been assessed and due to topography and short distances between two or more site registration numbers some have been joined ending up with 109 locations.
56 Lejre holds *c.*23% of the warrior related equipment from South and East Sjælland.
57 In Anglo-Saxon England the personal bond between a warrior and his lord overruled the warrior's obligation to the King and if so, the warrior would even follow his lord into exile if he was a man of honour (Abels 1988, 16-17).

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Supplementary Material

Material see also .xlsx-attachment

Table captions:

Table 1. Inventory from weapon burials from East Denmark dating AD 520-630. The weapon definitions are from Nørgård Jørgensen 1999, while the mounts, buckles and harness parts are in accordance with Ørsnes 1966. The chronological phases relate to Nørgård Jørgensen 1999. Data from Jørgensen 1990; Jørgensen and Nørgård Jørgensen 1997; Nørgård Jørgensen 1999.

Table 2. Stray-finds of warrior related metal objects included in the survey. The table is divided in 'sword', 'lance', 'shield', 'helmet', 'mounts', 'strap ends and buckles' and 'horse harness'. The locations are listed alphabetically. In the right-hand column, the related museum is listed.

Gripping Boundaries

Animal Style Contingencies in c.AD 600-800 Scandinavia

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ABSTRACT

This article examines the role of Scandinavian animal styles in the early Viking Age. It first assesses several strands of relevant discourse in the research history. One line of argument suggests a link between early and late animal styles. That postulate serves as the article's next point of departure. By focusing on the timespan of *c.*AD 600–800, the connection between 'Gripping Beast Style', Style III/E, Style 2.5/D, and Style II is sought. Building on pioneering formulations, the styles' respective definitions are amended. The styles' iconographic contents are then explored through their respective archaeological-historical backdrops. Ontological models serve as the analysis' next consideration. It is argued that the material mainly reveals animistic and/or totemistic worldly understandings. Accordingly, the active use of, and shifts in, Scandinavian animal styles, may be related to an increasing politico-religious divide between the Nordic sphere and the rest of the continent. This could constitute one of many facets 'vikings' applied in their alienation of others, thereby justifying extreme violence.

ARTICLE HISTORY
Received
17 January 2025;
Accepted
29 July 2025

KEYWORDS
AD 550-750/800;
Animal style;
Ontology; Symbolism;
Viking Age onset.

This article surveys animal styles in *c.*AD 600-800 northwestern Europe. By highlighting the styles' contingencies, it argues that some of the shifts could reflect major socio-political transformations. Many of these likely constituted interlinked catalysts for what scholars consider the Viking Age. The topic is approached through three intertwined research questions:

1) What role does animal style play in the archaeological understanding of the early Viking Age?
2) How do 'Gripping Beast Style' and Style III relate to Style II?
3) What can these aspects reveal about the expressions' symbolic, ontological, and socio-political significance?

Preceding research related to animal style and North Sea activity in the 8th century AD is reviewed and amended to frame the paper's emphasized argument. This proposes a link between animal styles and ontology, in turn offering interlinked hypotheses of the expressions' ideological components and potential role in separating Scandinavia as a distinct politico-religious sphere. The animal styles are reviewed in reverse chronological order. They are then brought together in subsequent sections dealing with their symbolic, ideological, and ontological content. These aspects are then discussed in light of the earliest viking incursions.

Background – 'Viking Revaluations'

The scholarly construct of the Viking Age (*c.*AD 750/800-1066/1100) was already well in place before the advent of archaeology. It was largely established on the bases of Old Norse poems and sagas. Moreover, these resulted in a highly interdisciplinary field comprised of, *inter alia*, history, linguistics, philology, runology, and studies of religion. Archaeology continues to face certain challenges in this convergence. For one, many of the traditionally accepted criteria to delineate the Viking Age as a chronological period are based on non-archaeological sources. In turn, archaeologically motivated adjustment is met with some reluctance and scepticism in the grand scheme of realignment (*e.g.* Lund and Sindbæk 2022, 172-174). The period's many circumstantial and complex factors ultimately led to a rigid scholarly construct. Vikings were raiders; thus, the period is primarily defined by this activity. In turn, *The Anglo-Saxon Chronicles*' and *The Annals of Inisfallen*'s descriptions of late 8th century AD attacks by 'vikings' on insular monasteries remain pivotal to chronological endeavours and academic interpretation.

As archaeology struggled to rid itself of these traditionalist chains, Bjørn Myhre (1993) proposed several independent empirical indicators. One highlighted factor was the many imported artefacts from contexts preceding *c.*AD 800 by more than a century. This could indicate longer lasting ties between the Scandinavian and other North Sea horizons than what was typically accentuated in research. Furthermore, the emphasized contexts appeared at sites with continuity from the 7th, and 8th centuries AD, into the 11th and later. Their layouts, and dates, indicate relatively stable political cohesiveness within their respective regions. Accordingly, Myhre sought to demonstrate how all these facets could be linked to the viking phenomenon. They thus warrant inclusion in the scholarly construct of the Viking Age.

Myhre (1993, 186-188) also stressed the introduction of so-called gripping-beast elements on Viking-Age artefacts as a tangibly archaeological signifier. Typochronological studies of Viking-Age artefacts were already well established through the work of archaeologists such as Oluf Rygh (1885) and Oscar Montelius (1895; 1896; 1897). Among the most influential contributions are Jan Petersen's (1919; 1928; 1951) treatises on weaponry, jewellery, and tools. Gripping-beast elements appear on a considerable repertoire of these implements. Early results from excavations at Ribe suggested that this expression was already manufactured around the middle of the 8th century AD (*e.g.* Feveile 2002), thereby justifying chronological emendation. Perhaps there was merit to changing the Viking Age's onset from AD 800 to 750 or earlier.

Later research has since moved Ribe's gripping beast production to around the last quarter of the 8th century AD (*e.g.* Feveile and Jensen 2006; Sindbæk 2011; 2012; 2023, Fig. 1.3). Despite this, many of Myhre's observations and arguments for redressing the scholarly understanding of the beginning of the Viking Age still stand. While the author glosses over several significant aspects about animal style production and use, the overarching presentation of an increasingly active North Sea horizon with frequent contacts between the various coastal areas present an alluring backdrop (*cf. e.g.* Sindbæk 2005; 2007). This is also perceptible in the horizon's animal style developments. At an early stage, these reveal overarching affinities; however, at different intervals, they shift and move along different trajectories to form new expressions.

These considerations all serve as significant pieces in a bigger puzzle and may provide some clues about the relation between animal style production and use in the 7th-9th centuries AD. Furthermore, the outlined links may reveal some less frequently addressed aspects about the period's Norse-speaking communities in the geographical area of Scandinavia. That includes their ontological concepts, and how these may have figured into their 'viking' endeavours.

Animal Styles in Archaeology – 'Pre-Viking' and 'Viking-Age' Animal Styles

Sophus Müller (1880) and Bernhard Salin (1904) remain the great grandfathers of animal style research in Scandinavia. A lot has happened since their seminal contributions; at the same time, the perceptible divide in their framings has had an immense impact on current research. Hence, scholars tend to focus on animal styles in either ***c.*AD 400-800** (*e.g.* Arwidsson 1942a; 1942b; 1954; 1977; Haseloff 1981; Høilund Nielsen 1987; 1991; 1997; 1998; 2002; Kristoffersen 1995; 2000; 2010; Ørsnes 1966) or **800-1100** (*e.g.* Christiansson 1959; Fuglesang 1980; 1981; 1982; Gjedssø Bertelsen 1992; 1994; Graham-Campbell 2013; Klindt-Jensen and Wilson 1965; Neiß 2022; Wilson 1995; 2008; Wilson and Klindt-Jensen 1966; Skibsted Klæsøe 1999; 2002). A few exceptions include very brief accounts of transitional styles in some of the cited Viking-Age studies. Similar tendencies are present in studies focusing on early Viking-Age art (*e.g.* Shetelig 1920).

This means that bridging the gap between research on 7th-9th century AD animal styles remains challenging. Salin's (1904) criteria and descriptions for Style I (*c.*AD 475-550), II (*c.*AD 550-700), and III (*c.*AD 700-820) are quite different from those that are typical of the considerably more faceted Viking-Age style formulations. This is

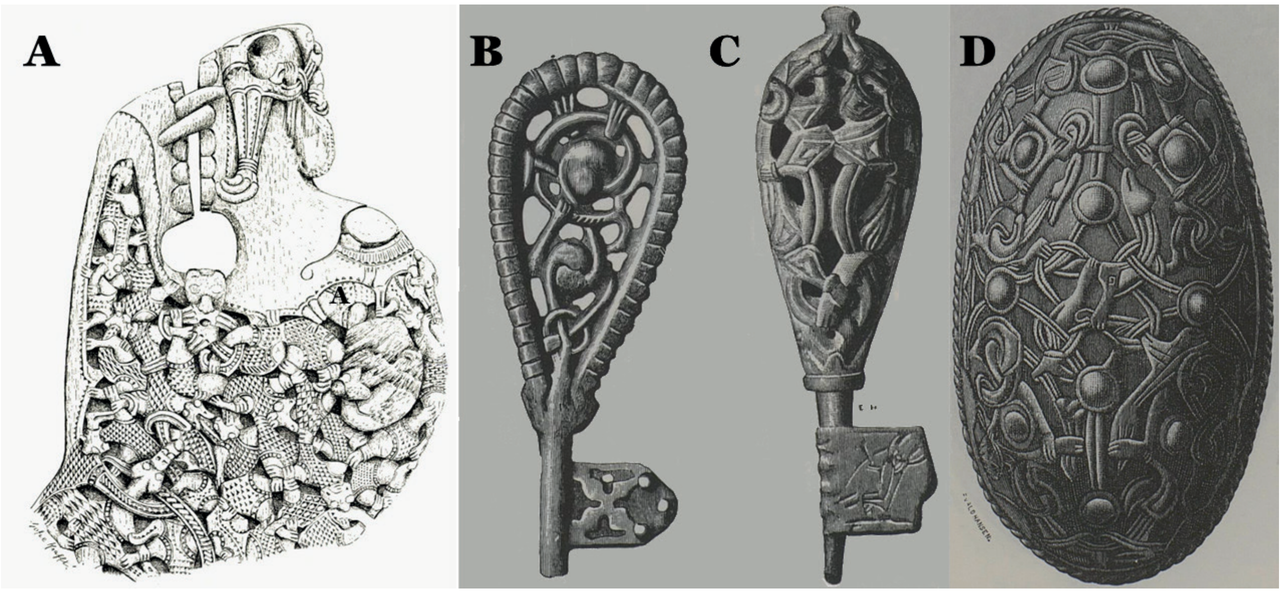

Figure 1. Gripping beast motifs on various artefacts found in Norway. A) On one of the wooden figureheads from Oseberg (after Shetelig 1920, Fig. 106). B-C) On AD 8^{th} century keys (after Rygh 1885, Figs 454-455). D) On an oval brooch (after Rygh 1885, Fig. 648).

especially true for the 'Berdal' (*e.g.* Petersen 1928, 12-22), 'Broa' (*e.g.* Salin 1922), and 'Oseberg' styles (Shetelig 1920). As Bertil Almgren (1955, 88-97) argued, these type-sites do not display different styles, but different motifs in unmistakably related styles. In turn, some of their components were eventually rebranded as 'Gripping Beast Style' (*e.g.* Marstrander 1964), but with little to no concession in current research. In other words, while most researchers working on animal styles from these periods acknowledge the expressions' joint backdrop, there are likely as many different scholarly concepts of exactly what constitutes an example of 'Oseberg' as opposed to 'Gripping Beast Style'. Often, clear definitions in animal style research are entirely absent (*e.g.* Malmer 1963, 222-223, 243-244; Karlsson 1983, 92-101).

This tangled and downright messy circumstance stems from too many cooks working with disparate criteria for the Viking-Age material. Müller (1880) addressed both early and late examples of animal styles, covering the full span of *c.*AD 400-1100. However, his concern mostly centred on the later styles' position in a bustling North Sea environment. As such, he explicated on non-Nordic influence in Nordic expressions. This opened the sluice for subjective style understandings, thereby avoiding the comparatively stricter confines of Salin's scheme.

Lotte Hedeager (*e.g.* 1999; 2000; 2004; 2011, 61-98) argues that the different animal styles' similar aesthetics and material premises could indicate a common backdrop throughout AD 400-1100. In turn, there is reason to suspect shared ontological framings and familial links. However, until each sequential link is studied more thoroughly, for example by bridging the discordant understandings of AD 7^{th}-9^{th} century animal styles, this hypothesis remains embryonic. On a related tangent, it is worth considering that stylistic shifts do not necessarily develop linearly, or in vacuums. Forms can eschew, retain, and/or develop certain features, leading to concurrent, variously diverging expressions. Some of these can be labelled hybrids, whereas others traverse entirely new terrain. It is therefore optimistic to expect complete scholarly congruence in classificatory and chronological endeavours.

'Gripping Beast Style'

The identification of gripping beasts in early Viking-Age research is not new. Neither is the attempt to frame them as an analytical group in archaeological publications (*e.g.* Marstrander 1964; Sindbæk 2011; 2012; Steuer 1994; Wamers 1999; Wilson 2001). Michaela Helmbrecht's (2004-2005) study makes up the most recent elaborate synthesis. This

Figure 2. Gripping beast in amber found at Råde in east Norway (C4033) (Photo: Eirik Irgens Johnsen - CC BY-SA 4.0 © Museum of Cultural History, Oslo).

collates 116 artefacts, with only 11 found outside Scandinavia. Ten additional artefacts later surfaced in Marquartstein, Traunstein, Germany (Helmbrecht 2008). As Helmbrecht's (2004-2005, 274-279) 11 different subcategories reveal, classifying these under a coherent 'style' warrants scrutiny. It is more accurate to refer to a recurring but diverse gripping motif. This comprises a meshwork of paws and fretwork elements, in which said paws, usually featuring three, rarely four, phalanxes, grab onto the nearest compositional element. The paws are typically placed at the end of limbs, but only sometimes attached to otherwise full-bodied zoomorphs (Figure 1). During the 9th century AD, said gripping elements are increasingly found with *en face* zoomorphic heads, traditionally linked with the Borre style. Style historically, the latter designation is therefore preferred when gripping elements are found with heads and knots of the Borre type (*cf. e.g.* Fuglesang 1982; Klindt-Jensen and Wilson 1965; Skibsted Klæsøe 1999; 2002; Wilson 1995; 2008; Wilson and Klindt-Jensen 1966).

Anton Brøgger (1916-1917) collated a conspicuous group of gripping beast figurines made in amber (Figure 2), likening these to parallels in metalwork. Analogous representations are present on keys (*e.g.* Almgren 1955), brooches (*e.g.* Jansson 1985; Petersen 1928), the Oseberg ship (Shetelig 1920), as well as miscellaneous jewellery and fittings. Moreover, the well-documented contexts of Ribe (Feveile and Jensen 2006; Philippsen et. al. 2022, Fig. 2; Sindbæk 2023, Fig. 1.3), and Oseberg (Bonde 1997; Bonde and Christensen 1993), yield the three absolute dates of *c.*AD 780-790, 820, and 834. Establishing the tail-end of 'Gripping Beast Style' is therefore unproblematic, with AD 820-834 marking the end for variants without Borre elements.

Determining its beginning is more difficult. Historically, the Lindau Gospels are afforded an unwarranted emphasis in gripping beast research (Figure 3). The variants on the oldest cover are frequently considered the motif's progenitors (e.g. Wamers 1999, 207-210). This discourse introduces a range of complex problems in intra-North-Sea art-historical discourse, with frequent reference to the Tassilo Chalice (*e.g.* Bakka 1983; Haseloff 1951; Pesch 2021; Wamers 2019). While that tangent is best circumvented here, the discussion's perplexities are neatly captured in Signe Horn Fuglesang's

Figure 3. Illustration of gripping beasts on the Lindau Gospels (Drawing: Mats Skare, based on Elbern 2000, Fig. 26.1).

Figure 4. Style 2.5/D on one of the pommels from the Salme II mass grave (Drawing: Mats Skare, based on Lõugas and Luik 2023, Pl. 71.290).

(2013) rebuttal. She simply flips the common hypothesis. Instead of gripping beasts originating on the continent, they may have developed through the frequent exchange between people in the Anglo-Saxon and Scandinavian spheres. Accordingly, the gripping beasts on the Lindau Gospels may have been produced in Scandinavia, and then gifted to a Carolingian aristocrat. They were then ultimately incorporated into its cover. Helmbrecht (2005, 214-217; 2008, 377-380) also references the Lindau Gospels. She suggests that the oldest cover was made by a continental artisan with an excellent comprehension of several fashionable coeval styles. Accordingly, its gripping beasts could be modelled after Scandinavian antecedents.

These examples demonstrate some of the many difficulties when dealing with iconographical lacunae and relative dates; the Lindau Gospels' oldest cover is only loosely dated to the mid-8th century AD (*e.g.* Elbern 2000, 331-334). Absolute dates are also absent for most other artefacts featuring gripping beasts. Private metal detecting in Denmark and Norway continually introduces new examples in these areas. However, most lack archaeologically accessible contexts. Only through subjective art historical intuition is it possible to conjecture some type of chronological sequence for the early variants. This could propose that the most idiosyncratic variants are of earlier dates than the more streamlined and analogous types. The former were thus initial pieces; the latter, such as the examples from Ribe, on the other hand, entail mass production in a sphere where gripping beasts belong to an established movement and/or trend.

Another possible line of investigation considers the links to overlapping and preceding animal styles.

Gripping Beasts in Light of Style III

Salin's (1904, 270-290) description and examples of Style III have caused some confusion. The author includes examples of the same variant for both late/early Style II/III. It is therefore unclear if and how he understood this type's differentiation. Hence, Greta Arwidsson's (1942b) endeavour to rectify this fault deserves commendation. On the one hand, she successfully conveys the deficiencies of Salin's tripartite classification; on the other, her own system to replace Salin's II-III scheme with an A-E-lettering results in similar confusion. This mainly applies to her A-C variants. Arwidsson's only elaborately developed group is D. This comprises the transitional variant mentioned above. It is most easily positioned between Style II and Style III as a sort of Style 2.5 (henceforth '2.5/D'). Its main characteristics are sleek zoomorphs, with drawn out ribbon-shaped limbs; their contour lines are emphasized, frequently in relief; a singular or

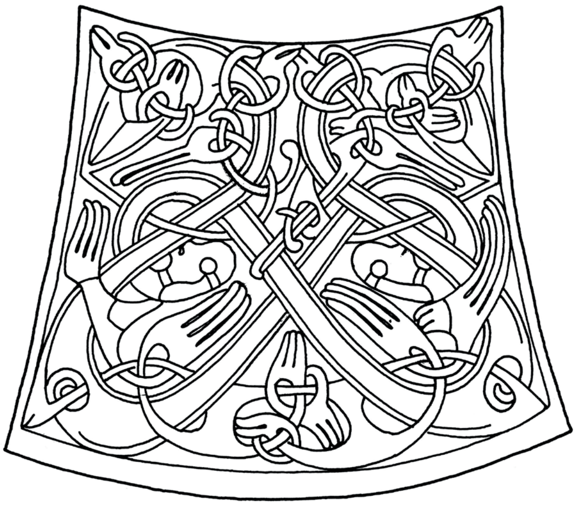

Figure 5. Style III from a disc-on-bow brooch found in Stavanger, west Norway (C488) (Drawing: Lars Tangedal - CC BY-SA 4.0 © the University Museum of Bergen).

two central longitudinal lines often run parallel between these, for a total of three or four (Figure 4). There are also variants where these central features take other forms, such as continuous rows of triangles or lozenges. The zoomorphs' heads are quite heterogeneous and often feature clamp-like maws; that type lasts into the more typical Style III variant, referred to by Arwidsson as Style E. Style 'III/E' is aptly captured by Salin's description of an increasing tendency towards busier, *horror vacui*, compositions, with more tendril-like, slithering, implements; limbs are cleaved and perforated, with various parts looping through and knotting around them. Ultimately, the style's intricacies led to what Salin describes as a misunderstanding and thereby degeneration of the zoomorphs. He also notes Style III/E's perhaps most emblematic feature: the limbs' flame-shaped extremities (Salin 1904, 284-286). Many of these feature three or four prongs (Figure 5).

When scrutinizing the position of these pronged extremities around the respective compositions, it is tempting to interpret them as gripping paws. The impression of that connection is bolstered when considering the panels of a select few disc-on-bow brooches featuring both Style III/E and 'Gripping Beast Style' (Figure 6). This also applies to some of the fittings, and box-shaped brooches, found on Gotland, Sweden (*e.g.* Helmbrecht 2004-2005, 279; Wilson 2001, 135-137).

The hypothesis presented here is thus: Gripping beasts are already present in some of the highly stylized Style III/E representations; along with another slew of influences, these develop over the course of the 8th century AD. Towards the century's latter half, artefacts are now adorned with flurries of gripping paws presented on artefacts of the above-mentioned types (Figure 1).

Animal Style Continuity and Ideology

By establishing a connection between 'Gripping Beast Style' and Style III/E, Hedeager's (1999;

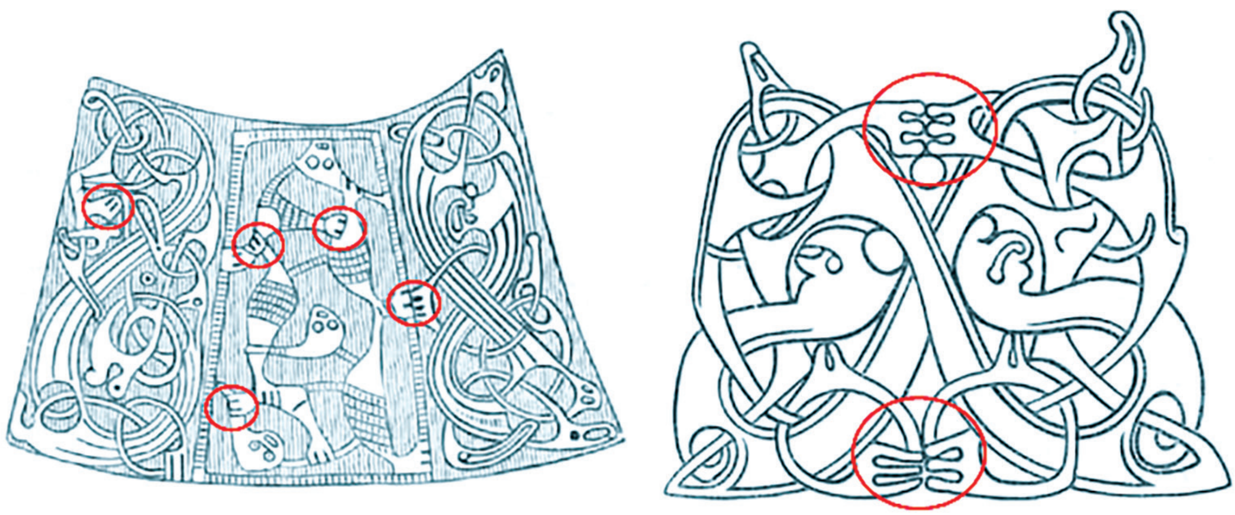

Figure 6. Side-by-side comparison of Style III and "Gripping Beast Style" phalanxes from disc-on-bow brooches found in Gotland, Sweden, and Trondheim, Norway. Left: Style III in the side panels; Gripping Beast Style in the center. Right: Style-III motif (after Salin 1904, Figs 620-621).

Figure 7. Style-II motifs from Sutton Hoo. A) Shows three classes of zoomorphs on the Sutton Hoo buckle (British Museum 1939,1010.1). Red fill = quadrupeds; green fill = serpents; blue fill = avians; most of the animals create a link by biting each other. B) A self-biting quadruped on the shield mount from Sutton Hoo (British Museum 1939,1010.94.B.1, Drawing: Mats Skare).

2000; 2004; 2011, 61-98) proposed hypothesis of a functional and/or symbolic animal style continuity serves as a convenient point of departure. If there is a link between 'Gripping Beast Style' and Style III/E, there could also be a link between Style III/E, 2.5/D, and II. At the same time, it is worth noting how the styles differ. Even though certain features are shared, others are not. Certain shifts in style and motif could therefore represent deliberate change.

The common denominator for all animal styles is that they feature zoomorphic representations and are presented on artefacts. Style II presents three clear classes of zoomorphs: quadrupeds, serpents, and avians (Figure 7; *cf. e.g.* Behrens 2023, 180-183). Ambiguity becomes increasingly more common in the subsequent styles. Quadrupeds and serpents persist, but do not follow clear conventions.

The frequency of animal style fluctuates throughout the 7th-9th centuries AD, but the type of artefact it is presented on largely remains the same. For metal implements, these are: brooches, buckles, figurines, fittings, helmets, horse tack, keys, pendants, shield bosses, spears, spurs, and swords (including sheaths). Until recently, helmets and shield bosses were only known to feature Style II (*cf. e.g.* Arwidsson 1942a; 1954; 1977; Bruce-Mitford 1978; Grieg 1924; Nerman 1969-1975; Stolpe and Arne 1912). However, a metal-detector discovery at Lejre, Denmark, unveiled a helmet brow featuring Style 2.5/D, along with parts of a crest terminal (Ljungkvist, Price and Christensen 2024, Fig. 7). For now, only one complete helmet is known from Viking-Age Scandinavia (Grieg 1947), with another few fragments (*e.g.* Christensen 2024, Fig. 1). None of these feature animal styles, but that picture may change with future discoveries. Meanwhile, keys with animal style first appear in the 8th century AD (Almgren 1955); the only known spur featuring Nordic animal style from the period was found at Rød, in Moss, Norway (C5905; Fuglesang 1981, Fig. 2.32). It is made of gold and presents profile zoomorphs along with a sculptural head. It is best described as a mixture of 9th century AD Borre and Jelling styles.

Based on the current archaeological record, animal style is numerically more present during the Viking Age than the preceding centuries. This may represent a shift in availability, with mass production perhaps granting animal-style access to further individuals; the expression could therefore be considered more egalitarian in this phase (Neiß 2022, 152). Meanwhile, Style II's considerably more uniform expression and larger spread across Europe could be linked to deliberate rulership strategies, indicating affiliation and sociopolitical significance. As Karen Høilund Nielsen (1997; 1998) suggests, Style II could therefore constitute a politico-religious insignia. This can be augmented with Hedeager's (1999, 224-225; 2011, 57-58) observation that Style II ceases in the Anglo-Saxon and continental areas once a primarily Christian faith is consolidated by the end of the 7th century AD. In this climate, Style II's potential politico-religious connotations would no longer be significant, thus leading to its demise. Meanwhile, Egon Wamers (2009) refutes Style II's possible religious undercurrents on account of its appearance on gold foil crosses, as well as some vaguely analogous Style II traits appearing on other Christian artefacts. Despite this discordance, it is worth noting Style 2.5/D and III/E's clear relation to Style II, and how these expressions are currently only known on artefacts found in the Nordic region (see below). This could indicate the animal styles' non-Christian, but politico-religious significance in this area.

Animal Style as Ontology

If the above argument is accepted, it is also necessary to make a connection between the iconography on the one hand, and its ontological significance on the other. Among others, Maria Domeij Lundborg (2004; 2006; 2009), and Michael Neiß (2022, 252-279) picked up the age-old thread suggesting a relation between the periods' *kennings* and animal style (*e.g.* Söderberg 1905, 54; Salin 1922, 194). Domeij Lundborg's titles consistently reference 'boundedness' or the act of weaving, drawing on the skaldic poem *Darraðarljóð*. Other highlighted correlating aspects are some of the written sources' emphasis on the described human and non-human agents' actions. There appears to be a semblance of symmetry between both, signifying a link. This link could thus be tacit in the animal styles' compositions, emphasising examples with interlace. Humans are thus bound to animals, and vice versa. These descriptors neatly capture the appearances and acts that many of the animal representations convey. However, instead of fixating on the direct link between *kennings* and animal styles, it seems prudent to move a few steps back to get a better look at the full picture. Accordingly, it is here suggested that the people creating and using these expressions made sense of their surroundings through analogies. In turn, *kennings* and animal style may reflect their crafters' and users' ontologies.

Here, a brief departure to Philippe Descola's (2013) four ontological models provides some useful heuristic concepts to think with. Based on ethnographic studies of societies around the world, Descola (2013, 101-121) presents the hypothesis that certain cognitive premises lay the foundation for worldly understanding (ontology). These are structured by an inner as opposed to an outer reality. When human beings perceive and process their outer realities, this is done on two levels: Through perception, and through physical navigation. Perception can be related to senses which are primarily processed internally, for example through rationale. Meanwhile, physical navigation establishes the body's outer components and how these relate to tangible matter more directly. Based on these patterns, any living agent forms *schemas*. Through identification and relation, order is structured. Conscious creatures make meaning of their environments through their senses; with these, they can relate themselves to the environment, and vice versa. Descola thus conceptualizes four possibilities of human worldly understanding. These are animism, totemism, naturalism, and analogism. Animism prescribes an ontology in which all its classes of subjects share the same interiority but have disparate physicalities (Descola 2013, 129-143); totemism, on the other hand, prescribes sameness on both fronts (Descola 2013, 144-171). Meanwhile, naturalism comprises the traditionally western doctrine of a firm dichotomy between nature and culture. This is best captured with the sentiment that both humans and animals consist of atoms, but only humans possess rationale (Descola 2013, 172-200). Analogism presupposes that all subjects are different on both counts, but that those who resemble each other most, may be

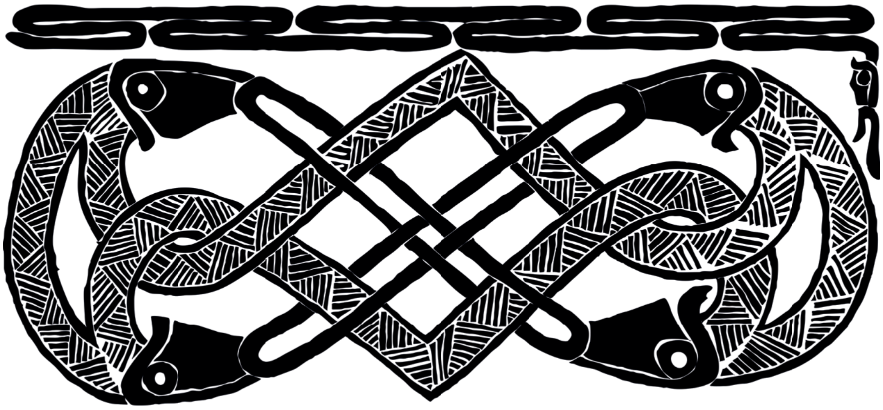

Figure 8. Reconstructed Style-II motif from Hornhausen (Drawing: Mats Skare, partially based on Hahne 1922, with corrections).

placed next to each other on a gradient scale. Accordingly, the slight differences and commonalities bridge the gaps and make up the whole (Descola 2013, 201-231).

Rather than understanding these as rigid categories, it could be useful to approach them as a spectrum. That entails how each model may be identifiable among a select group of people's worldly understandings, but that some are more present than others. Based on Old Norse sources, Simon Nygaard (2022) identifies a type of analogism in 'Chiefdom religion'. Similarly, the distinction in Old Norse vocabulary between *innangarðr* and *utmark* (in- and outfield) may indicate a type of naturalism (*e.g.* Steinsland 2005). At the same time, animism and totemism both seem more prevalent. This especially applies to the Old Norse concepts of shapeshifting and communicating with transcendental animal spirits, *fylgjur* (*e.g.* Aðalheiður Guðmundsdóttir 2007; Bryan 2021, 67-88; Hedeager 2011, 81-85; Mundal 1974). If a human being is thought capable of changing forms into a non-human animal, or communicate with non-human agents, this implies some form of shared cognizant precondition across all species.

Skipping the well-established source critical discourse related to the reliability of Old Norse sources, and how to best proceed (*e.g.* Hedeager 2011, 23-26; Meulengracht Sørensen 1991; Price 2019, 9-10; Schjødt 2020, 13-14), this opens several avenues to explore the animal styles of the 7th-9th centuries AD. The material appears to indicate an intricate connectedness between the world's various inhabitants, whether human or non-human.

Deciphering the Link and Meaning of 'Gripping Beast Style', Style III/E, and Style II

The perceived shifts in animal styles from Style II to III/E, and 'Gripping Beast Style', primarily concern the specifics of the respective variants' intertwined motifs. Style II has clear classes of zoomorphs. Its compositions generally allow the modern viewer more discernible individual elements than the later styles; at the same time, intermingling, repetitious, patterns, such as whirls, are also current (Behrens 2023, 86-107). The Hornhausen stones' Style II carvings may provide an important clue (Hahne 1922). Here, two sets of self-biting Style II heads take on the form of an infinity loop as their four maws converge in an interlocked X at the composition's centre (Figure 8). Exactly what the motif represents is difficult to assess. However, one tempting avenue of explanation may be found in the comparable Ouroboros motif. It is here worth noting that a self-biting serpent is represented on IK 327, a gold bracteate from the 5th century AD found in Lyngby, Denmark (Hauck et al. 1986, 126-127). Sigmund Oehrl (2013; 2019, 117-120) also identifies another few later parallels and variations found in northwestern Europe. The Ouroboros motif is mainly associated with alchemy and found throughout large parts of North Africa and Eurasia in Antiquity and the Medieval Period. It is generally perceived to symbolize *materia prima*, that is, the essence of things (*e.g.* Karlsson 1976, 172-175; Sheppard 1962, 84). Building on this theme, Style II and 2.5/D's menageries of intertwined beasts may signify the relation between all things, whether human or non-human. By outfitting seemingly inanimate objects with animal style, the objects are afforded life (Kristoffersen 1995). The connection between each worldly subject is thus established. Their internal and potentially external likeness constitute the weaving threads of existence.

As Style III/E is developed, its zoomorphic representations' dispositions are literally cleaved and perforated for all elements to ultimately become reintegrated. Specific classes of zoomorphs are thence sidelined for the expressions' more conspicuous subtext: the inevitable reconcilement of things. This is mirrored by the materiality of the artefacts they are found on, whether metal, stone, bone, or wood. They are all wrought from nature and adapted by humans into tools, weaponry, jewellery, and so forth.

With 'Gripping Beast Style', the zoomorphs' classes are made even more ambiguous; meanwhile, the specific action of grasping onto whatever is near and dear holds significant emphasis. The blatant focus on this action signals urgency. Sæbjørg Walaker Nordeide (2015, 214-215) likens it to the literal binding of chaos. Chaos is thus kept in check by binding the volatile forces. However, rather than the beasts representing destructive agents, they could symbolize safeguarding. The gripping makes sure that things are held together; it upholds balance. By acknowledging this status quo, the expressions' crafters perhaps paid tribute to a perceived harmony between humans and nature. If but a single grip falters, that very balance is tipped. The threat of collapse is thus always present. This invites the Ouroboros analogy presented above. In the Old Norse sources, the Midgard Serpent, *Jormundgandr*, is what keeps the balance of the earth intact, buckling it by biting its own tail. Thor's temperament and rivalry with Jormundgandr is what ultimately wrests away harmony, causing the downfall and rebirth of life (*cf.* Snorri Sturluson 2005, Ch. 34, 48; *Húsdrápa*; *Hymiskviða*; *Lilja*; *Voluspá*).

Deliberate Change

The above interpretation thereby frames 7th-9th century AD animal styles through a largely coinciding animistic/totemistic ontology. At the same time, minor and more evident shifts between the subsequent variants could signal deliberate change. Especially two circumstances can be proposed. As Style II's production continued in Christian environments, such as on Langobardic gold foil crosses (*e.g.* Roth 1973; Hübinger 1975; Terp-Schunter 2018), its potentially non-Christian connotations began to decline. In response, the non-Christian Nordic sphere decided to develop competing variants in the transitional Style 2.5/D, and eventually Style III/E. Instead of referencing Style II's tangible features, namely its clear classes of zoomorphs, the overarching premise 'reconcilement of things' was emphasized. With the subsequent 'Gripping Beast Style' this was made even more apparent; the expression now plainly conveyed the importance of gripping and connectedness. One possible rationale may have been to accentuate the expressions' encompassing significance.

In all things being interwoven, animal style would reasonably reflect several societal facets. Aesthetics and taste are two such aspects; at the same time, these are affected by less discernible elements, such as self-perception and communicated identity. Both are highly contingent on socio-political circumstances and values. This is where animal style may shed light on the earliest viking incursions.

The Beginning of the Viking Age

James Barrett's (2008) and Steven Ashby's (2015) deliberations on what incited the viking incursions present many reasonable possibilities. These are now augmented by Irene Baug and colleagues' (2019, 66-68) suggestion that Scandinavia's power constellations were too well established, and that certain outlier groups therefore sought fortune elsewhere. Neil Price (2014; 2016) and Christian Cooijmans (2020) apply the concept of hydrarchies to the types of seafaring marauders presented in the written sources of the late 8th-9th centuries AD. This model outlines how bands of independents or smaller retainers could form flexible seafaring domains to control the North Sea. They were thus able to seize and capitalize on all passing or nearby mobile goods.

Price (2020, 271-285) later aligned this model and the many written accounts of viking incursions with the excavated site at the Estonian island of Salme (Lõugas and Luik 2023). Here, 41 individuals with artefacts corresponding to those found in Upplandic Sweden were buried in two boats; their remains carried marks of violence; their grave goods largely featured weapons. Accordingly, one reasonable interpretation is that the Salme mass graves represent the outcome of a violent affair. The boats hint at a type of activity reminiscent of viking raids. Meanwhile, its *c.*AD 750 date and geographical position hint at these activities taking place earlier in the east than what the written sources report in the west.

Salme contained several sword hilts decorated in Style II and 2.5/D (Figure 4; Lõugas and Luik 2023, Pl. 67.531, 83.111, 93.412, 99.419, 111.890). Some may have been produced up to six decades before ending up as grave goods. These must constitute heirlooms. They therefore appear to have held significance as identity markers in an ambitious campaign. It is not known whether or how the Salme campaign succeeded.

Animal style likely played a similar role in the western campaigns. There is currently little archaeological evidence which can corroborate the earliest accounts, but sundry pieces of insular metalwork are found in early Scandinavian Viking-Age graves (*cf. e.g.* Heen-Pettersen 2020; Mikkelsen 2019; Wamers 1985; 1998). This material attests to some type of contact between the areas. Aina Heen-Pettersen (2019, 536-537) suggests that this commenced around the middle of the 8th century AD. If the rationale of looting and violent incursions is accepted, the insular metalwork forms a tangible contrast to the Nordic artefacts. Both are typically adorned with animal styles. However, their iconographic expressions are slightly disparate while also reflecting very different socio-religious environments. By the 8th century AD, Christianity was largely adopted throughout the geographical areas corresponding to current England, the Irish Sea, and most of Ireland (*e.g.* Heather 2022, 235-295). Much of the insular fine metalwork thus constitutes Christian, liturgical, artefacts, such as reliquaries and croziers.

In the North Sea area, *emporia* were becoming more numerous, allowing for an increase in the flow and exchange of information (*e.g.* Costambeys, Innes and MacLean 2011, 338-347; Loveluck 2013, 180-212; Sindbæk 2005, 70-78, 163-163). John Hines (1984; 1992) frames a likely scenario in which affiliations between Anglo-Saxon England and the Nordic spheres were nourished following the post-Roman settlement and into the 700s. Similarly, the exchange of iconographic conventions and motifs is noticeable throughout large parts of Europe in the same time frame (*cf. e.g.* Holmqvist 1939; Åberg 1943; 1945; 1947).

These circumstances all present a backdrop in which the Nordic region was very aware of everything happening around the North Sea area, and, quite likely, vice versa. Once Christianity began to take hold in the continental and insular regions through the 6th and 7th centuries AD, however, religious discrepancy may have motivated the reframing of socio-political and -ideological signifiers, such as animal style. This could tie into a similar dynamic as that proposed by Anders Ögren and colleagues' (2022) 'New institutional economics', with established conventions for specific groups and/or societies. The continental abandonment of Style II appears to happen around the middle or last quarter of the 7th century AD. Roughly around the same time, Style 2.5/D was introduced in the Scandinavian area. This then spurred a sequence in which Style III/E and 'Gripping Beast Style' may have served to tangibly represent a non-Christian ontology. Meanwhile, insular and continental animal styles followed new trajectories, frequently including references to Christian doctrine. Building on these circumstances, it is here suggested that the people subscribing to the expressions' respective ideological connotations ultimately found themselves in an 'us' and 'them' opposition. The subsequent viking incursions may thus reflect a situation in which this act was justified on account of actively dehumanizing the 'other'. Such behaviour is well-documented in more recent, comparable, historical events (*e.g.* Kronfeldner 2021). Not only were the affluent monasteries unguarded, but its people were made different through their diverging beliefs. The respective horizons' discrepant iconographic expressions may have served as identity markers to the point where these were actively embroiled in justifying 'viking activity'.

Conclusion

This article began by framing Bjørn Myhre's proposed revision of the onset of the Viking Age. Several animal style shifts run parallel to the incumbent North Sea turbulence of the 8th century AD. Many archaeologists and historians today recognize the domino effect of early incursions triggering increased viking activity in the subsequent centuries. At the same time, written sources of the late 8th century AD are granted an imbalanced position amidst tangible archaeological data in the scholarly construct of the Viking Age. Hesitance still reigns supreme; however, closer scrutiny of the links between Myhre's highlighted 'Gripping Beast Style' and its progenitors may reveal their ontological commonalities. The hypothesis presented here is that Style II, 2.5/D, III/E, and 'Gripping Beast Style' signify worldly understandings in which the interconnectedness between all things is emphasized. As Christianity became current in many of the non-Nordic regions employing Style II, its significance appeared to wane. Accordingly, new animal styles framing similar sentiments were developed and used in the non-Christian Nordic region. One ambition may have been to resuscitate a dying expression; another may have been to create distance to what was becoming an entirely different politico-religious horizon. In turn, some of the expressions' users understood a clear disparity between themselves and the people inhabiting these Christian societies. This served as motivation to target them for material wealth, essentially functioning as dehumanizing rationale.

While the reviewed animal styles only make up part of this convoluted backdrop, they can shed light on some of the developments transpiring in the 8th century AD. They cannot be employed to explain exactly what happened or why, but they may offer some clues about the bustling North Sea climate. To that end, they indicate several chains of related events. In other words, the events scholars typically highlight to characterise the construct of a Viking Age did not just manifest out of thin air. They were related to many interlinked processes. Myhre's expressed proposition was to marry this consideration with certain perceptible archaeological indicators. Closer scrutiny of animal styles supports this line of reasoning. At the same time, consolidated revision of the Viking Age's onset to AD 750 or 700 remains a lofty, if not impossible, ambition.

Notes

1 Thorkild Ramskou (1965) later introduced yet another style, 'F'. Mogens Ørsnes (1966) developed this and formed alternate descriptions of styles largely reflecting Arwidsson's B–E. This scheme is considerably more accessible than Arwidsson's; on the other hand, many of the styles' characteristics are too detailed to function well as broad groups.

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Trelleborg revisited

The context and distribution of artefact finds

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ABSTRACT

This study re-analyses artefact finds from the Viking Age ring fortress Trelleborg, Denmark, based on a digitisation and GIS mapping of the unpublished lists of finds and construction from the 1934-42 excavations. We assess the excavation's recovery strategy and we analyse the quality of the documentation in terms of the distribution and context of the artefacts. We show that a total of 3,267 artefacts were recorded from the excavations and that there is a clear under-representation of plain pottery, which suggests that many pottery sherds were discarded. Some iron artefacts are also likely to have been discarded. It is possible to link the majority of the finds to a feature or a find coordinate. The mapping shows that the vast majority of finds were found in pits or in the topsoil at the fortress site. The spatial distribution shows clear concentrations of finds related to textile work, antler working debris, and cooking vessels made of soapstone. We conclude that the finds reflect areas of activity at the ring fortress. However, there is no clear association between activities and specific buildings, which argues against artefacts being left behind in a sudden and unprepared destruction of the fortress.

ARTICLE HISTORY
Received
23 January 2025;
Accepted
21 August 2025

KEYWORDS
Trelleborg; Viking Age; Fortress; Artefacts; GIS; Database; Distribution maps.

Introduction

In 1934-1942, archaeologists from the National Museum of Denmark led by Poul Nørlund excavated the circular earthwork Trelleborg near Slagelse in western Zealand. This was the first discovery of the large geometric ring forts, of which five examples are known today in present-day Denmark, as well as two probable parallels in southern Sweden (Roesdahl & Sindbæk 2014; Runge and Gamble 2021). The five Danish fortresses of this type were inscribed on the UNESCO World Heritage List in 2023 (Sindbæk 2024).

The discovery of the large and meticulously planned fortress from the late Viking Age was an archaeological sensation at the time and sparked a discussion about the social and cultural development of the Viking Age in southern Scandinavia that continues to this day. At the same time, the ring fortress was the first major Viking settlement of any kind to be excavated in Denmark. The size of the complex and the remarkable number of buildings – with 16 large hall buildings arranged in four courtyards in the inner bailey and 15 similar buildings arranged radially in a semicircle in an outer bailey – has led some to consider Trelleborg to be a form of planned settlement of an urban nature, rather than just a fortress complex (Randsborg 1980, 99; Smith 2022, 123-124).

Poul Nørlund recognised that the large and varied object material from the excavation had considerable value as a reference for future archaeological finds. In his publication of the excavation in the monograph 'Trelleborg' (Nørlund 1948), he therefore made an exemplary effort for its time to present a large and representative selection of objects. Many finds were illustrated with photos and/or drawings, and their finds situation was summarised in the book's text and notes.

Since its publication, the artefacts from Trelleborg have been a valuable comparative corpus for research. This is due both to the fine presentation and the fact that the material is remarkably extensive and varied. However, the presentation was focused on the typological and chronological interest of the finds. No systematic attempt was made to interpret the context of the finds in relation to the construction of the fortress. At the same time, it is clear from the presentation that the artefacts presented are only a selection – albeit a rich selection – of all the objects found in the fortress.

When Else Roesdahl published the artefacts from the ring fortress Fyrkat – Trelleborg's counterpart near Hobro in Jutland, which was excavated in 1950-1973 – in 1977, she used a detailed mapping of objects found in that fortress to demonstrate how certain groups of finds were concentrated in different parts of the fortress area (Roesdahl 1977, 176-184). The distribution had to reflect activity zones, and also showed that many objects were left where they had been used – in an archaeological primary context (Schiffer 2010, 34-35).

In the 1980s, Roesdahl's results inspired Leif Christian Nielsen to re-analyse selected parts of the Trelleborg artefact finds in a similar way. Nielsen produced a plan of the distribution of clench nails and clench plates based on the unpublished excavation records from Nørlund's excavations. The result and discussion were presented in a paper published after Nielsen's death (Nielsen 1990, 124). In his analysis, Nielsen also argued that the ring fortress had been struck by a major fire that had completely destroyed the buildings on the fortress site area and caused extensive damage to the timber-clad ramparts.

Today, the finds from Trelleborg remain a central reference for the material culture of the Viking Age. Among the many settlements from the period that have since been investigated in southern Scandinavia, the finds from Trelleborg are still remarkably rich and varied (Sindbæk 2008). The reason for this richness is not clear. From other excavated ring fortresses – Fyrkat, Nonnebakken and Borgring – no similar amount and variety of artefacts has been recovered, despite the intensive use of sieving (Roesdahl 1977; Roesdahl et al. 2014; Runge (ed.) 2024). The finds from the excavations at Aggersborg are numerous, but most of them apparently originate from a rural settlement that was on the site before the ring fortress was built (Roesdahl et al. 2014, 364).

Nielsen's theory about the Trelleborg fire offers a possible explanation as to why so many artefacts were left behind. If the fortress was destroyed suddenly, one might expect that many items were left behind and perished in the fire. However, there are significant unknowns in this interpretation. It is not clear from Nielsen's published distribution map what was the basis for his mapping. Nielsen does not indicate whether the finds were made in a primary context or in contexts that can be assumed to represent redeposited material.

At the same time, the relative amounts of material types among the finds presented in Nørlund's publication indicate that selective collection and registration took place during the excavation. This is not mentioned in the published reports, which, as mentioned, only present a selection of the types of finds represented. What is striking, however, is the small number of pottery sherds presented. When compared with later excavations of Viking Age settlements, they suggest that only a selection of characteristic finds was recorded - in keeping with the typological interest that guided the excavations.

Tage E. Christiansen, who participated in most of the excavation at Trelleborg, recalled in 1984 that sieves had been used to harrow soil from pits, but that the topsoil above the fortress site was hardly ever examined in this way (Christiansen 1984, 84). He suspected that a large number of artefacts had been overlooked in the excavation, that the quality of the contextual information was deficient, and that the inventory from Trelleborg had to be judged on the basis of inferior data quality than, for example, the finds from Fyrkat.

Today, it is not possible to determine from the existing presentations and studies which processes Trelleborg's artefact finds reflect, or to what extent the finds were collected in a way that allows for an analysis of context and distribution. To investigate these questions, in this study we have digitised and reprocessed the original, unpublished finds lists from the excavation. Here we report the first comprehensive digital database and spatial mapping of Trelleborg's artefact finds and discuss our findings. The digital database is available at:
https://doi.org/10.5281/zenodo.14716529

The study focuses on the following questions:

- Can information in the finds lists help to determine what recovery strategy was practised during the excavations at Trelleborg in 1934-42?

- To what extent does the information in the finds list enable an understanding of the context of finds and a mapping of the distribution of artefacts?
- To what extent does the distribution of artefact finds at Trelleborg indicate if the finds were left in primary contexts or are redeposited objects?
- Could the distribution of artefact finds indicate areas of activity at the ring fortress, similar to the patterns found at Fyrkat?
- Can the context of the artefacts support or refute the theory of a sudden destruction of the fortress by fire?

In the following, we first explain the study's material and methodology, then present and discuss observations about the distribution and context of the artefacts, before finally concluding on the study's main questions.

Materials and methodology

The report materials from the excavation of Trelleborg are stored in the National Museum's report archive registered under NM I J.nr. 299/53. The artefact finds were originally registered on index cards. Finds were registered with a consecutive number preceded by a capital 'Q', e.g. Q1238.

Where there were multiple artefacts from the same context/excavation unit, they were identified with the same number. In addition, a small proportion of finds are also differentiated by a letter at the end of their Q number (such as Q 999a, Q 999b and two artefacts numbered Q 999c) to separate finds of the same type in the same context (for example two bone pins) from each other for use in the plates in Nørlund's 1948 publication. Although these letters for this separation are listed in the 'List of preserved finds', they are not written on the index cards or the objects themselves. We have noted them, however, in our work for precise identification.

This registration excluded some object groups; unprocessed animal bones that had been transferred to the Zoological Museum; human bones transferred to the collection of what is today the Panum Institute of the University of Copenhagen; finds from the pits from Stone Age and Iron Age settlements that were handed over to the National Museum's then First Department (Danish Antiquities); and finally a coin find that had been transferred to the Royal Danish Collection of Coins and Medals.

In 1948, the index cards were rewritten by T.E. Christiansen in the list 'Trelleborg-kartoteket'. In some cases, a new determination or description of the finds was made, especially some iron objects were better identified. Christiansen notes in his preface to the list that 'In Dr Nørlund's review of the finds, numerous items have been discarded' (our translation). This tells us that more artefacts were initially collected during the excavation than are currently registered. In 1953, a 'List of preserved finds' was rewritten in connection with the material's final accession at the National Museum's First Department. Along with these lists is an 'Overview of the find sites', i.e. units associated with a measured point or a feature, such as a pit. The numbers of the pits are identified with a capital 'G' to distinguish them from the artefact numbers.

Today, all lists and index cards are stored in the National Museum's archive, section for Danish Antiquity, separated so that materials specifically about the Viking Age fortress are stored in the 'Iron Age settlements' archive, while lists of finds and structures are stored under 'Stone Age settlements' in accordance with the practice that cases are registered under the earliest period represented among the finds.

The preparatory work for this study included digitising and rewriting the lists related to the Trelleborg excavations, which has enabled efficient searches for objects and find locations and forms the basis for further work on compiling a more complete list of objects. We cross-referenced the 'Trelleborg catalogue' from 1948 with the 'List of preserved finds' from 1953 and found only six differences between the two, none of which were significant for further work. Therefore, we have chosen to digitise the 'List of preserved finds', as it was made most recently, is easier to read, and represents the more complete work of Nørlund and his colleagues. We have also digitised the 'Overview of find sites', which contains a large

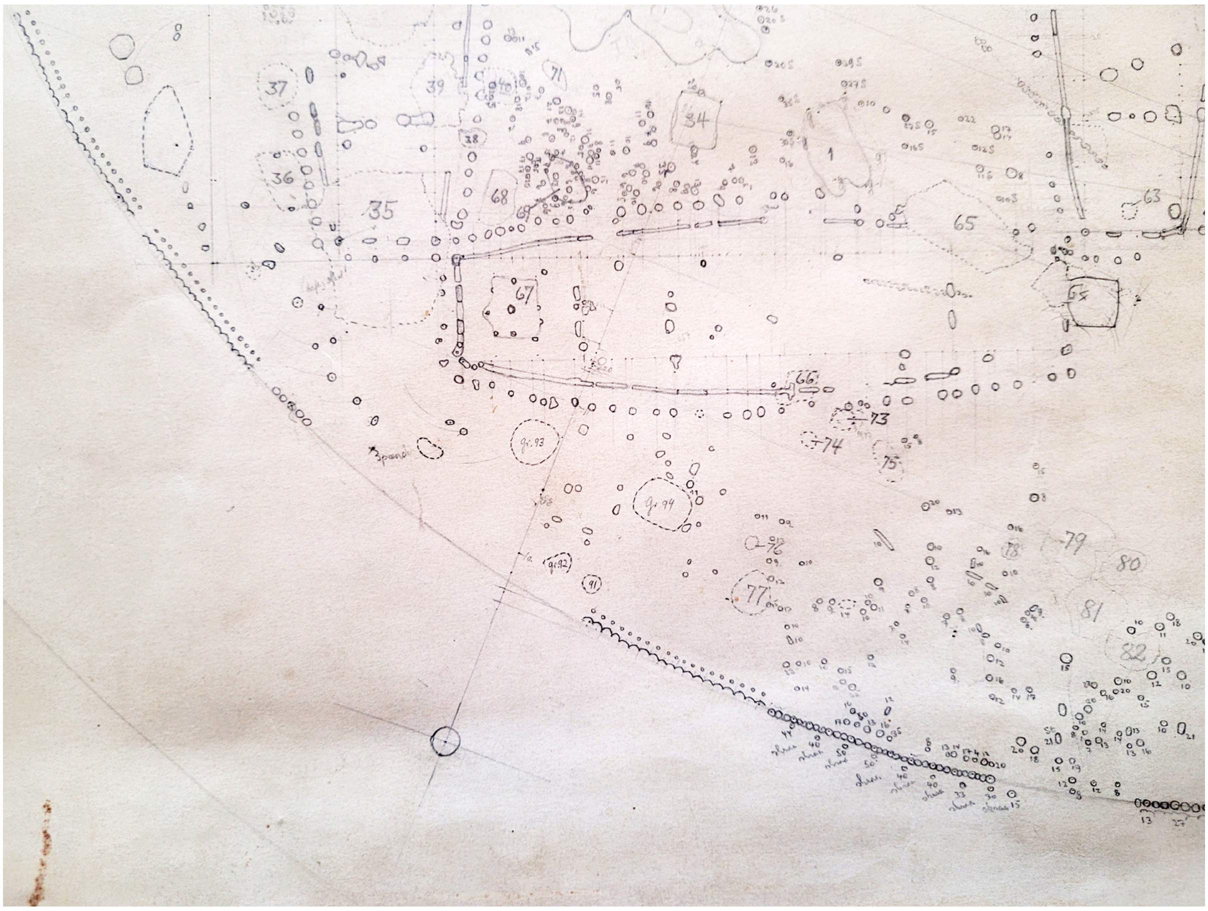

Figure 1. Detail of a draft plan of the Trelleborg excavation with a point marked by a cross and circle in the region of the rampart. This is the zero point and baseline for the main measurement system used in the excavation. The point is placed between the east and south gateway. North is to the right (Plan: The National Museum of Denmark, Topographical Archive. Photo: S. Sindbæk).

amount of handwritten underlining, notes, and later additions, parts of which are unfortunately unclear and difficult to read. In order to make the information from these lists available in a format that could be implemented in GIS programmes and for statistical analyses, the two lists were also edited into a single table. During this summarisation, we took into account that several Q-numbers are not associated with a preserved object in the list of preserved objects but are only mentioned in the overview of find locations. In addition, teeth and bones from e.g. the burial ground have their own Q-numbers and are listed in the list of find locations, but do not appear among 'preserved artefacts' because, as mentioned earlier, they have been separated out to other collections. In this way, a knife, nails or other artefacts would be listed in one list, while teeth and bones from the same grave would only be in the other. The now summarised list includes all of these items, allowing for a more accurate picture of the distribution of finds and more correct analyses of the number of items and the amount of different materials from Trelleborg.

Excavation measurement system

To get an overview of the findings from Trelleborg, we created a digital map of the site by georeferencing Nørlund's various plans according to modern maps and the Danish Elevation Model (DK-DEM, hosted by the Agency for Climate Data) based on LIDAR scans. This could be done with very high accuracy due to the many concrete posts that were placed to mark out the excavated features at Trelleborg, and which could also be identified on the elevation model and thus be used to position the plans. We could then begin to plot the known pits as polygons and mark the many finds as points on the map based on their Q-numbers and known find locations. The ETRS89/UTM-zone 32N (EPSG:25832) coordinate system was used throughout this part of the project.

In the list 'Overview of find locations', some finds are described using two numbers separated by a hyphen or written as fractions. These numbers refer to a coordinate system whose datum, axes or units of measurement were not described in the publication or the available reporting materials. From coordinates related to identifiable buildings, the approximate location and orientation of the system could be estimated. Among the archived materials was an incomplete working plan of the fortress, which indicated a line starting from a point on the south-eastern part of the rampart, marked by a cross in a circle (Figure 1). This turned out to be the baseline for the Q-list coordinates.

On the baseline, two points were marked '100' and '130' respectively, and with a digital grid and measuring tool overlaid on the georeferencing of Nørlund's map and the LIDAR map, we confirmed that they were 100 m and 130 m respectively from the system's zero point with less than one metre inaccuracy. It was also possible to confirm the baseline as the y-axis in the coordinate system from two postholes whose coordinates were given and which could also be identified independently of the coordinates, simply from their description. In this way, we can estimate that the finds are correctly located to within one metre, but in some cases, there may be doubts about more precise locations.

The previously mentioned summarised list of all pits and finds could then be supplemented with their coordinates by extracting their geographical location from QGIS in a table in which each find had x and y coordinates listed and adding this information to our table. The list of all artefacts and find locations also contains each item's Q number, material, type, its description from Nørlund's lists, year of excavation, date, and any pit the item was found in. In addition, each item in the list is equipped with a unique seven-digit number that we have added to differentiate them. The list can be implemented in a GIS programme and the objects displayed on a map according to their respective coordinates with all relevant data about the object attached.

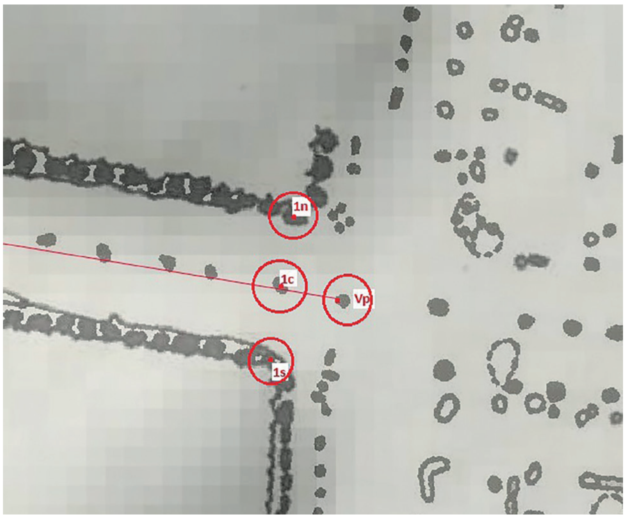

Figure 2. The reconstructed basis for the measurement system in the western gate. North is up (Graphics: M. Larsen).

Measurement system for the gates

During the excavation of Trelleborg, local measurement systems were created to record the position of finds made in the site's four gates. The system is based on postholes in the inner mouths of each gate, where postholes from the inner side of the rampart cross postholes from a planked road along the inner face of the rampart (Figure 2). Taking the western gate as an example, there is a series of 15 so-called 'centre holes' within the gate from the plank road in the longitudinal direction. These are labelled 1c to 15c ('c' for 'centre') and are counted from the inside of the fortress towards the outside, so in this case from east to west. Parallel to the row of centre holes are two rows of post holes belonging to the gate structure itself, directly adjacent to the rampart on the northern side of the centre holes and on the southern side of the centre holes respectively. Both of these rows consist of 32 posts, which, like the centre row, are numbered consecutively from the inside of the rampart to the outside, and again from east to west. They are called 1n to 32n (north side) and 1s to 32s (south side) respectively. This means that post holes 1n, 1c and 1s are aligned with each other across the length of the gate. The gate also has a measuring point called Vp ('West Gate', just as the 'East Gate' has an 'Øp'), which is the zero point of a measuring line that follows the longitudinal axis of the gate. This Vp is located in a post hole in the centre of the plank road, in the same way as the centre holes in the gate and is crossed by an imaginary line made by the holes of the planks that supported the rampart from the inside. This measuring point Vp is 1.3m east of 1c.

This system of measuring the gates has enabled an efficient and precise registration of the find locations, which, especially in the case of the west gate, are often described in terms of their proximity to the post holes and measuring point Vp. Some objects are recorded as found directly in postholes, others between two neighbouring postholes, and still others by first measuring along the length of the gate from Vp and then a short distance to the north or south of this measurement line. This system forms the basis for our digital registration of the finds relevant to the gates, which is why most of these, especially in the west gate, can be considered quite accurate. However, the system has not been used to the same extent during the excavations to record the finds in the east gate, north gate and south gate. The locations of some artefacts are described using the system's measuring points and numbering of postholes, but most find locations in these three gates are more vaguely described, such as 'F[ound] in the east side near the south end'. This should be kept in mind if one wants to investigate specific finds in these areas of the Trelleborg site.

Trelleborg's pits

During the excavations, around 220 pits and cuttings were found, of which Nørlund estimated the majority (125) to be from the Stone Age, almost half as many (approx. 45) from the Viking Age, a few (10) from the Iron Age, and the remaining are undated. These are numbered consecutively with only a few deviations; there is both a 64A (Stone Age, excavated in 1936) and a 64B (Viking Age, excavated in 1937). In addition, during the excavation, three mix-ups apparently occurred, which must have been discovered after the excavation itself, as these double occurrences were noted by hand in the 'Overview of find locations'. These are pits 31 and 184, pits 84 and 148, and pits 116 and 143 respectively. In the list of pits in the 'Overview of Find Locations', the depth, date, year of excavation and a few small comments are also listed, but these are not consistent. The year of excavation and date can be read elsewhere in the overview, but not all pit depths are noted, and from pit 138 onwards, depth is no longer noted at all.

We have digitally recorded the locations of the pits by cross-referencing two plans of Trelleborg in the publication, one of which has the pits marked in red, blue and uncoloured (Stone Age, Pre- Roman Iron Age and Viking Age respectively) and their numbers indicated, while the other is larger, of a higher resolution, and is easier to identify fixed points from. 'Overview of Find Locations' describes the locations of several pits that are not shown on the plans, but which we have added to our map based on the available information. We have given these a near-square shape, so they are visibly different from the vast majority of the pits, and their locations should not be considered nearly as precisely indicated as the rest, which on the other hand, due to Nørlund's map, must be considered to be drawn with a high degree of accuracy.

For use in our overall digital mapping of the spread of the finds, we also had to indicate the locations of the pits as points instead of their actual outline. These points indicate exactly the centre of each pit, which is why the searched objects or Q-numbers associated with them will also be shown as located directly in the centre of their pits. Since Nørlund has not indicated exactly where in the pits the individual finds were made, it would not be possible to place them with higher accuracy than this. On the other hand, it is easier to differentiate between finds from two neighbouring pits by eye.

Uncertain locations, vague descriptions, and confusing pits/objects

During further work with Nørlund's lists of artefacts and find locations, we have been aware of a number of factors that – depending on what we are investigating in a given case – can give different results. Many find locations can be determined with a high degree of precision, such as through the coordinate system and the system used in the western gate in particular, or when talking about finds in easily identifiable post holes, such as in the corners and gable rooms of the houses. Others, however, are only vaguely described, as previously mentioned, and our interpretation of the location can therefore not be as certain as for other find locations. In a few other cases, it is difficult to fully understand what Nørlund meant in his description, and our guess at such locations must therefore necessarily be an interpretation based on neighbouring finds, the order of objects in the list, and the given context. In addition, some artefacts have been found in e.g. spoil heaps, which is why their locations must also be considered approximate. On the whole, these inaccuracies are not a problem when studying the general distribution of types of artefacts in overview but must be taken into account when studying individual artefacts where, in addition to information about the object itself, one should take note of the description of the find location.

During the excavation, there have also been mix-ups and the like with a small number of artefacts, as with the pits (*cf.* above). We have taken this into account by including all such 'alternative' numbers and noting the counterpart for each instance, whereby a misunderstanding should be cleared up immediately. Again, this is not something that will have a significant impact on analyses of the items themselves or their distribution.

Results

The artefact assemblage

Poul Nørlund's presentation of the artefacts found at Trelleborg in the monograph from 1948 is, as described, intended as a presentation of the types found at the fortress in order to determine the date of the site and characterise the activities that took place at the fortress. For common find groups such as ceramics, it is not possible to determine from the book's presentations how many objects were found or recovered. It is also difficult to get an overview of the contexts in which the finds were made.

Type	Instances of finds	Number of artefacts
Ceramics	307	921
Nails	241	567
Various	267	512
Production waste	71	170
Whetstones	100	100
Beads	14	78
Pins	56	56
Loom weights	32	69
Knifes	68	68
Arrowheads	65	65
Soapstone shards	34	59
Combs	32	50
Various tools	46	49
Buckles and brooches	46	48
Fittings	38	42
Spindle whorl	40	40
Slag	12	39
Locks	11	33
Bucket staves	3	30
Keys	27	29
Handles	21	21
Hooks	18	18
Rings	14	16
Scissors	12	14
Axes	10	10
Horseshoes	9	9
Ice skates	8	8
Samples	8	8
Stone blocks	7	7
Teeth	86	7+
Grinding stones	6	6
Bowls	6	6
Shield bosses	5	6
Hinges	5	5
Equestrian Equipment	5	5
Spurs	5	5
Weights	5	5
Clubs	5	5
Chains	3	4
Fossil sea urchins	4	4
Hammers	4	4
Planks	7	4+
Gaming pieces	2	4
Brackets	4	4
Skulls	4	1+

Table 1. Number of finds by object type.

Type	Instances of finds	Number of artefacts
Wedges	3	3
Disks	3	3
Lime blocks	1	3
Drills	3	3
Lances	2	2
Weighing scales	2	2
Shoe or purse	1	2
Chisels	2	2
Anvils	2	2
Hooks	2	2
Ingots	2	2
Bells	2	2
Belemnite	1	2
Vessels	2	2
Spades	2	2
Sheet metal	1	1
Rope	1	1
Cramp	1	1
Runner	1	1
Bucket lid	1	1
Clamp	1	1
Strike-a-light	1	1
Drawknife	1	1
Tube	1	1
Plate	1	1
Pincers	1	1
Brace	1	1
Fork	1	1
Strapend	1	1
Brick	1	1
Rock	1	1
Pot	1	1
Pliers	1	1
Crucible	1	1
Weight	1	1
Felt	1	1
Roofing tile	1	1
Snail shell	1	1

Table 1 continued. Number of finds by object type.

Material	Instances of finds	Number of artefacts
Iron	831	1292
Burnt clay	387	1161
Rock	189	218
Skeleton	111	>1
Bone	110	154
Antler	69	163
Wood	64	87
Bronze	54	73
Glass	10	62
Lead	5	5
Fossil	5	6
Amber	4	4
Gold	2	6
Unknown	2	2
Horn	1	10
Leather	1	2
Silver	1	2
Soil	1	1
Lime	1	1
Seaweed	1	1
Charcoal	1	1

Table 2. Number of finds by material.

From the digitised finds lists, an overview of the most common object types (Table 1) and material types (Table 2) can be compiled. The total number of artefacts recorded in the finds lists is 3267. As already mentioned, to this should be added artefacts from the Stone Age and Iron Age, which were separated out as special collections after the excavation.

The Trelleborg assemblage is notably rich in several common find types. This applies, for example, to sherds of soapstone pots (59 pieces), whetstones (100 pieces), spindle whorls (40 pieces) and fragments of loom-weights (69 pieces). With the exception of the finds from Aggersborg, where there is a very large amount of artefact material from the rural settlement that existed on the site before the construction of the ring fortress, and Fyrkat, where an unusually intensive collection including very small fragments of soapstone and whetstones was carried out during the excavation of the ring fortress, the Trelleborg finds are among the largest known Viking Age inventories in modern Denmark.

However, the tables also show that the distribution of finds from Trelleborg is striking in several respects compared to other published Viking Age

	Ceramics	Soapstone	Whet-stones	Loom-weights	Spindle whorls	Combs	Beads	
Trelleborg	921	59	100	69	40	50	78	
Trabjerg	3415	26	27	40	10	0	3	Bender Jørgensen & Eriksen 1995
Fyrkat	304	172	238	15	12	0	9	Roesdahl 1977
Aggersborg	29500	277	153	94	128	30	23	Roesdahl et al. 2014
Sebbersund	23000	72	63	-	79	-	23	Birkedahl 2000
Ribe Post-hustorvet	19340	202	308	734	32	124	3843	Sindbæk (ed.) 2023
Ystad	1879	7	0	150	23	15	16	Strömberg 1978; 1981
Schuby	14814	8	40	227	53	0	48	Meier 2007
Gårdstånga	3167	9	28	10	11	>2	-	Söderberg & Sten 1994
Selsø Vest	3200	10	24	>100	25	8	16	Sørensen & Ulriksen 1995
Vester Egesborg	13500	>50	104	130	75	63	93	Ulriksen 2018

Table 3. Comparison of frequent artefact groups at Trelleborg and other Viking Age settlement finds.

settlement finds in Denmark (Table 3). In comparison, the number of pottery sherds among the preserved finds is relatively modest (921 pieces). At several sites with comparable finds inventories, more than ten times as much pottery has been recorded. It is also striking that no less than 338 pieces of Trelleborg pottery are rim sherds – more than a third of all pottery finds. This distribution most likely shows that the collection of pottery was highly selective.

In comparable inventories where everything has been collected, the proportion of rim sherds is, for example, 15% of the Viking Age pottery at Aggersborg and 9% of the local Viking Age pottery from Ribe/Posthustorvet (Madsen and Sindbæk 2014, 214-217; Knudsen 2023, 34). If we assume that the material at Trelleborg was similar in kind, then a total inventory of around 2,000-3,500 sherds would be needed to match the preserved number of rim sherds. It is therefore likely that the preserved finds represent less than a third of what was found.

To assess the background to the quantity and composition of Trelleborg's artefact inventory, we can compare the distribution of the most common find types in different types of context (Table 4). A large group of artefacts originate from the four gates whose floor layers were covered by the collapse of the gates. As in the pits, these were particularly well-preserved find contexts. Many artefacts have been found in the west gate of the fortress in particular. They include a large number of loom-weight fragments and production waste from antler. The excavation revealed that the west gate had been closed off to the west at some point, after which the gate room was apparently used as a living space or workshop. The many finds here are therefore linked to a specific context and activity that probably does not reflect the primary phase of use of the fortress.

Another special find context is the burial ground, which accounts for a large number of finds of nails from coffins. In addition, almost all of the excavation's finds of glass beads have come

	Topsoil		Pits		Cemetery		Gates	
Type	Units	Finds	Units	Finds	Units	Finds	Units	Finds
Whetstones	35	35	29	29	9	9	16	16
Combs	5	10	12	17	1	1	13	18
Ceramics	164	407	96	337	1	1	40	164
Soapstone	17	38	12	15	0	0	3	3
Nails	106	201	40	131	40	162	30	39
Beads	2	2	0	0	10	71	0	0
Spindle whorls	19	19	16	16	0	0	4	4
Loomweight	10	11	5	7	0	0	16	48
Others		537		403		114		164
Total		1260		955		358		456

Table 4. Comparison of frequent artefact groups at Trelleborg ring fortress by type of find context.

from the graves. A third large group of finds were made in pits and other large cuttings. The amount of finds in these features reflects the fact that soil from the pits was systematically sieved, unlike soil from the topsoil at the fortress site.

In total, 955 artefacts are registered as finds from pits, while 1260 artefacts are attributed to the fortress site area. In total, two-thirds of the inventory from Trelleborg was found in something resembling a typical situation for settlement finds, i.e. in association with the buildings' postholes, hearths or the topsoil of the fortress site

If we compare the finds from the pits with the artefacts recovered from the fortress site, they show a very similar distribution of materials and types. For both groups, the composition of materials and artefact types is similar to the pattern of the composition of more common settlement finds (see Table 3). This suggests that both the finds from the pits and from the fortress site area reflect the same activities, and thus that the spatial distribution of these artefacts may reflect activities at the fortress.

Spatial distribution of artefacts

If we first look at the distribution of the most common material groups – iron, ceramics, wood – we can get an overall impression of the preservation and excavation situation (Figure 3). The distribution shows that very few finds have been registered in the outer bailey. This is also noted by Nørlund (1948, 29), who argues that the pattern does not reflect a generally lower intensity of investigation but may be due to a lower level of activity or more short-term use of the settlement in the outer bailey. Within the inner bailey, the distribution of finds is relatively dense across all areas with the exception of the outer part of the south-west quadrant. Here, observation conditions were difficult as the fortress was built on fill layers. The excavations here were not as intensive, and a large part of this quadrant was not excavated right up to the rampart.

With the exception of the south-west quadrant, there is a tendency for more artefacts to be found in the areas closest to the rampart compared to the inner parts of the fortress site area. The documentation does not mention anything about this, but it is likely that this is at least partly due to the fact that the areas near the rampart were covered by thick layers of soil that had slipped out from the rampart, and that the previous surface layers were therefore partially intact.

Numerous finds of wood have been made in the moat, but otherwise only in a single well. Iron artefacts, especially nails and rivets, have been found more or less throughout the fortress area, and also in large numbers in the burial ground east of the fortress. Ceramics are also evenly scattered within the ring fortress but are rarely found in the burial site. There are a few large collections of pottery from the ring fortress. Most come from pits, or in places where finds from a larger area are gathered under one number. This is the case in the north gate, for example, where all finds are recorded in one collection, as opposed to, for example, the east and west gates, where most finds

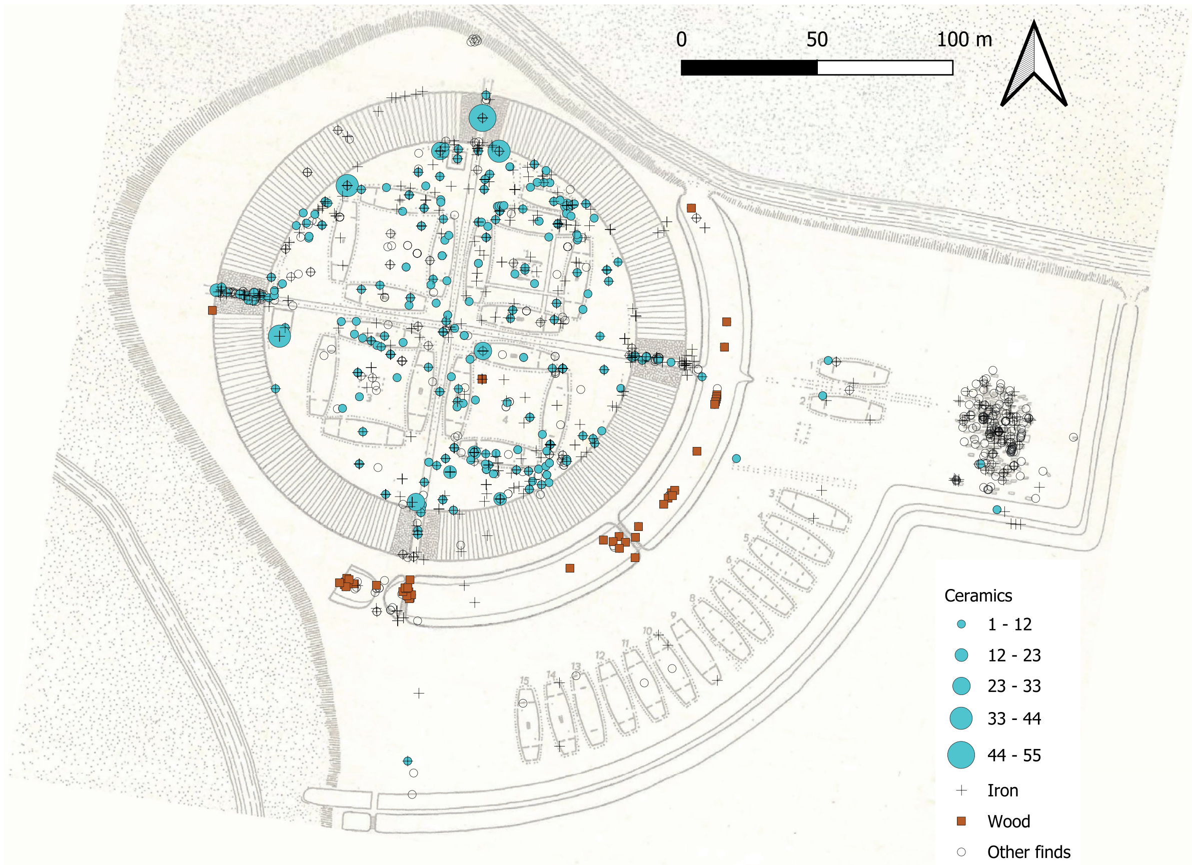

Figure 3. The distribution of artefacts found at Trelleborg divided into iron, ceramics, wood and other materials (Graphics: M. Larsen).

are recorded and measured individually. A special context is the 'Four-jar Find' Q1238, which was uncovered near the rampart east of the north gate. Here, four whole jars and sherds of several others were found together in a small area, possibly in a trench that lay right up against the inside of the rampart (Nørlund 1948 p. 16).

Looking at specific artefact types, some of them show a limited distribution pattern. Glass beads are, with two exceptions, only found at the burial site (Figure 4). Iron nails are also highly concentrated in the burial site, where they were used in coffins, but are also evenly distributed throughout the fortress area.

The relatively few finds of craft-related artefacts show no clear focus in most cases (Figure 5). An exception is the production waste of antler from combmaking, which is clearly concentrated in two areas: in the west gate and the fortress site area just north of it, and on the outer parts of the south-east quadrant of the fortress.

Textile crafts are represented by spindle whorls, which are found evenly in all four quadrants and in several gates (Figure 6). On the other hand, the distribution of loom-weights shows a clear association with the same areas as the antler-working debris, i.e. in and around the west gate and on the outer parts of the south-east quadrant. In the latter area, there are also relatively many finds of scissors and needles, which at least in some cases are linked to textile production. These distributions may suggest that weaving and other textile work was concentrated in one or more buildings in the south- east quadrant of the fortress. It cannot be clearly documented in other buildings, with the exception of spinning, which was a mobile activity.

As mentioned, the many craft-related finds from the west gate are linked to a phase when this gate was closed and used secondarily as a dwelling or workshop. This probably took place in a late or secondary phase of use, and therefore hardly reflects activities in the primary use phase of the fortress.

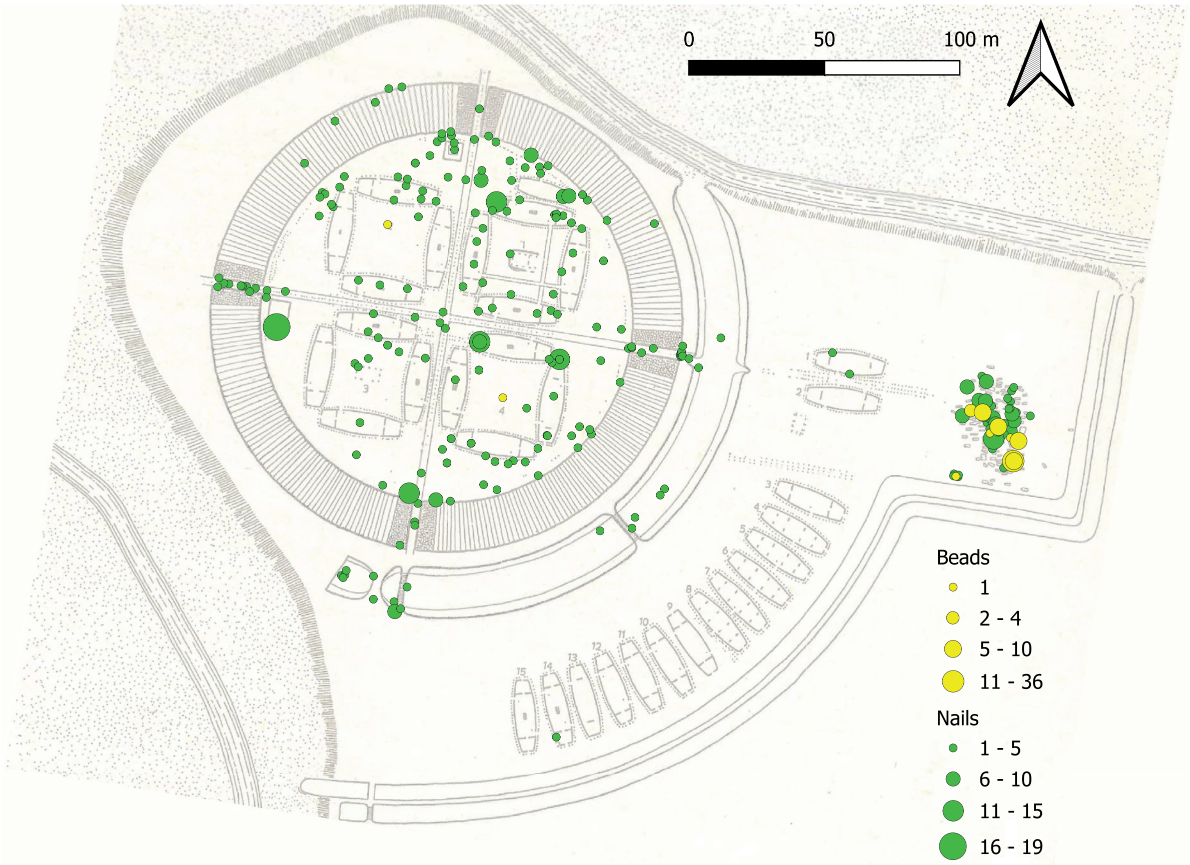

Figure 4. The distribution of glass beads and iron nails at Trelleborg (Graphics: M. Larsen).

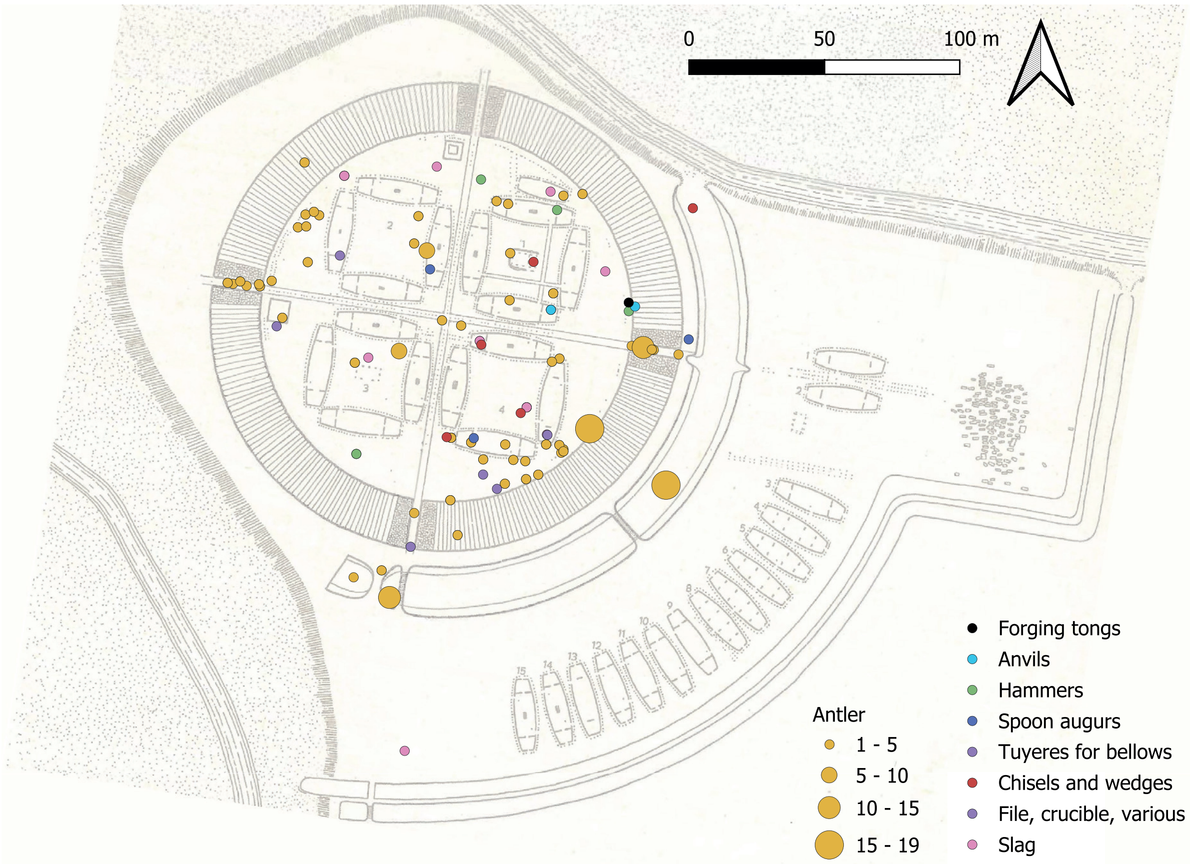

Figure 5. The distribution of artefacts related to forging, antler-working, and other crafts at Trelleborg (Graphics: M. Larsen).

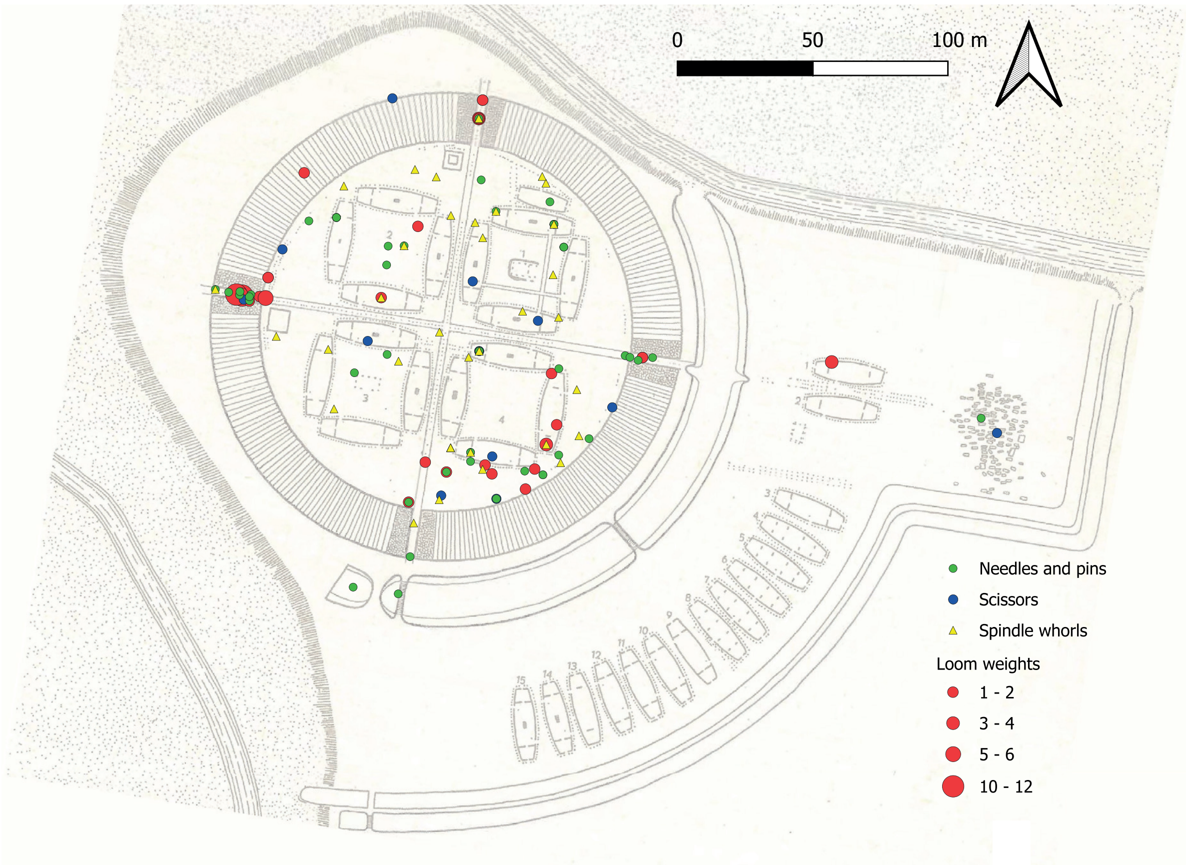

Figure 6. The distribution of textile craft artefacts at Trelleborg (Graphics: M. Larsen).

A markedly different distribution of finds is shown by sherds from soapstone vessels (Figure 7). They are mainly found in the area inside the north gate of the fortress and in and around the western-most house in the south-east quadrant. On the other hand, almost no soapstone has been found among the finds in the west gate or other areas with concentrations of craft-related finds. At Fyrkat, concentrations of soapstone sherds have been interpreted as traces of kitchen activities. The distribution of finds at Trelleborg makes a similar interpretation plausible here.

As mentioned, there is a tendency for artefact finds from the fortress site area to be concentrated in the better-preserved areas near the ramparts. Unsurprisingly, it is therefore also in these areas that we see the clearest indications of activity areas. In the inner parts of the fortress site area, the preservation is poorer, and the possibility of identifying activities is therefore slighter. This is a factor to bear in mind when assessing the overall picture of the distribution.

Discussion

The digitisation and systematic analysis of object lists and find information in the archive for the excavations at Trelleborg 1934-1942 has initially provided a clearer insight into the excavation technique and collection strategy practiced during the fieldwork. Despite earlier scepticism, we can see that the data from Trelleborg is comparable in number to the Fyrkat finds in many categories.

This is true even if we only look at the third of the material that is registered as finds from the fortress site. In other words, we have relatively precise find information on a large amount of artefacts. Based on the distribution of types and materials, we can also estimate that the collection of pottery has been highly selective, with an under-representation of undecorated body sherds. It is likely that there was a similar sorting of some other artefact groups, such as nails and rivets. For most other artefact groups, however, the relative frequency is not striking in comparison to other excavated settlements, which makes it likely that a full collection and registration of finds was attempted.

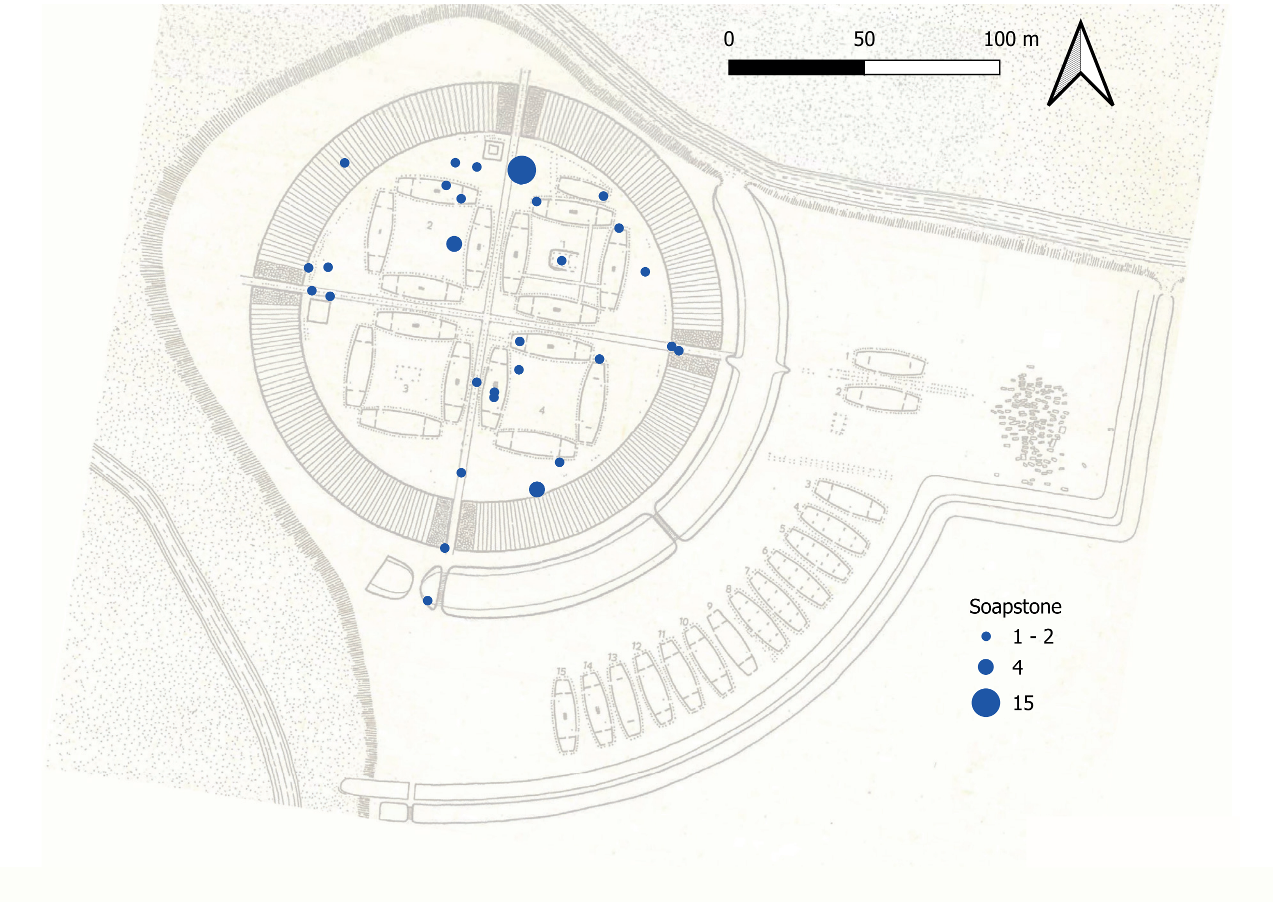

Figure 7. The distribution of soapstone shards at Trelleborg (Graphics: M. Larsen).

It proved possible to decode the information in the lists of artefacts and find conditions in the report material so that it was possible to determine the location of the vast majority of artefact finds with reasonable accuracy based on the reconstructed measurement systems: either as linked to a specific pit or other feature, or in relation to coordinates whose position can be determined with an accuracy of approximately one metre. This makes it possible to use the data to carry out an overall mapping of the distribution of artefact finds.

Based on the mapping, it is possible to show that the finds are scattered throughout the excavated area within the ramparts. The vast majority of finds were found in pits or in the topsoil of the fortress site area, while some were found concentrated in the fortress gates. In contrast, there is only a very limited amount of finds in the outer bailey area and in the burial ground, apart from the finds in the graves themselves. This suggests that the distribution of artefacts generally reflects a spatial distribution of activities in the fortress.

Within the ring fortress itself, there are clear concentrations of finds related to specific activities. This applies to craft activities such as textile work and the processing of antler, which occur mainly in the outer parts of the south-eastern block of the fortress and west of the north-western block. On the other hand, the discovery of many sherds of vessels made of soapstone in the northernmost part of the fortress can be linked to cooking. We can therefore conclude that the distribution of artefact finds at Trelleborg, as at Fyrkat, shows patterns that reflect specific areas of activity.

However, there is no clear link between activities and specific buildings. Combined with the fact that many artefacts originate from pits and other cut features, this suggests that the artefacts at Trelleborg were generally found in the spaces where they were used and lost. Artefacts found in the pits were most likely deliberately abandoned, probably disposed of as rubbish.

The finds from the topsoil of the fortress site must, in principle, be regarded as redeposited material that may have been moved spatially within the fortress area by later agricultural work.

According to the documentation, this applies to approximately half of all finds. For example, among 69 units with finds of antler 22 are related to an excavated feature with a G-number; twelve units are found in the gates and must also be from intact deposits; one find is specifically described as being found at a hearth, while the situation of 33 units is not recorded, probably indicating finds from the topsoil. Similarly, among the 32 units with finds of soapstone, twelve are related to features with a G-number, three are from the gates, while the situation for the remaining 13 is unknown. It might be tempting to exclude the 'topsoil' finds from analysis, were it not for the fact that the excavators clearly regarded most of them as related to the excavated features. Many items were found in areas covered by fill from the rampart, and were thus not affected by ploughing in the modern period. The fill removed as topsoil elsewhere in the fortress also included undisturbed deposits, as indicated by the presence of features such as stone hearths. However, in the absence of a systematic recording of depth, we cannot estimate how widely this applies to the finds. However, items like antler waste would usually not survive for long in the topsoil. It is likely, for this reason, that many of the 'topsoil' finds relate in fact to intact deposits.

The distribution also argues against the many artefact finds reflecting a sudden and unprepared destruction of the fortress. If that were the case, we might have expected a larger proportion of finds to be left within the traces of buildings. However, it is certain that at least some of the finds belong to a phase in which the primary organisation of the fortress changed. This is clearly the case for the items found in the fortress gates, especially the east and west gates, which were blocked and used as living quarters and workshops late in the life of the fortress. Unlike the finds from the fortress site area, it is likely that at least some of the gate finds can be considered to have been recorded in a primary context.

Some of the craft-related finds from the fortress site area are similar in character to the finds from the gates and may therefore possibly be linked to the same late phase of use. However, it should also be pointed out that no systematic difference has been observed in the composition of finds from the gates, the fortress site area, and the fortress pits and wells. It is unlikely that all or most of these finds originate from the late utilisation phase. They reflect at least as much the primary functional period of the fortress.

Conclusion

The digitisation and GIS mapping of the unpublished lists of finds and construction from the excavations at Trelleborg has made it possible to reassess the artefacts from the excavations. The review shows that a total of 3,267 artefacts are registered from the excavations. When comparing the range of types and materials, it can be seen that there is a clear under-representation of plain pottery. This makes it likely that many sherds have been discarded. It is likely that some iron artefacts were also discarded.

We can conclude that the area within the ring fortress – but not the outer fortress – was generally relatively rich in artefacts. This probably reflects both a relatively intensive activity and an excavation method that provided intensive opportunities for retrieval compared to many excavations today, as all soil preparation was done by hand rather than by excavator.

With the exception of the selective collection of uncharacteristic pottery sherds and possibly some iron objects, we can conclude that intensive collection was practised, and that the composition of the material does not differ systematically from other major Viking Age settlement finds, including those from the ring fortress sites of Aggersborg and Fyrkat. The artefacts reflect a broad spectrum of common activities including weapon use, food processing, crafts and household production.

Reconstructing the excavation's survey systems, we can conclude that the quality of the contextual information is good enough to carry out an overall mapping of the distribution of artefact finds at Trelleborg, which is presented here for the first time. Based on the distribution, we can show that the artefacts found at Trelleborg, as at Fyrkat, provide evidence of activity areas in the ring fortress. However, only a few artefacts appear to have been left in a primary context in the fortress buildings. This argues against the theory that the fortress was destroyed and abandoned after a sudden destruction by fire.

In this way, the analysis of the artefacts adds important new depth to the picture of the more than 80-year-old excavation, and a monument that has been a focal point in the history of archaeological exploration in Denmark and continues to be a key site for the study of the Viking Age. The results presented here exemplify the potential that still reside untapped in early excavations. The resources kept in museum archives present an increasingly valuable part of the archaeological heritage and include the prime evidence for many important sites that were explored early on. As the present study exemplifies, digitizing such materials may be an arduous task of, reconstruction, research and renewed classification. This form of study now gains attention as 'archive archaeology' across many areas (Ward 2022; Frey and Raja 2024). Much remains to be done in this field. The archives from the excavations at the Fyrkat and Aggersborg ring fortresses are a case in point, but many other archives and reports await attention.

Acknowledgements

This work was supported by the Danish National Research Foundation under the grant DNRF119 – Centre of Excellence for Urban Network Evolutions (UrbNet). The authors would like to thank Mads Dengsø Jessen, Anne-Christine Frank Larsen, Anne Pedersen and Else Rasmussen, all at the National Museum of Denmark, for help in facilitating access to the archives and for rewarding discussions. The authors have no competing interest to declare.

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