Animal Bones from Danish Single Grave Contexts

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ABSTRACT

Since the 1890s, the Danish Single Grave Culture (SGC; *c.*2850-2350 BCE) has been recognised as a distinct cultural complex with its core area centred on the sandy regions in Mid and Western Jutland, often associated with a pastoral-based economy. However, the absence of animal bone material from this area seriously constrains interpretations of prehistoric subsistence strategies and human-animal relations. This brief case study assesses the potential for future reconstructions of subsistence strategies and cultural practices pertaining to livestock in Danish SGC. By systematically re-evaluating all known and available assemblages with animal bone material from Jutland SGC contexts, supplemented by selective radiocarbon dating, we have tested the suitability for dating of the zooarchaeological remains. As a result, there are no known animal bones from the heath regions that can be securely dated to the Danish SGC. We suggest that future research should explore alternative proxies, such as parasite analyses, phytolith studies, and sedaDNA, to comply with these fundamental empirical challenges.

ARTICLE HISTORY
Received
25 May 2026;
Accepted
05 October 2026

KEYWORDS
Single Grave Culture; Neolithic; Subsistence strategies; Zooarchaeology

Introduction

The Danish Single Grave Culture (SGC; 2850-350 BCE) is defined by its single inhumation burials under low mounds and a distinctive material culture primarily in the form of stone battle axes and ceramics with cord impressions (Ebbesen 2006; Glob 1945; Hübner 2005). Early on, archaeological research recognised its close association with the expansion of pastures and heathlands, particularly within its core area in Mid and Western Jutland, characterized by sandy, nutrient-deficient soils (Glob 1945; see also Haughton and Løvschal 2023; Hübner 2005; Thorsen 1980). However, the Danish SGC extends well beyond this region, including areas further east in Denmark, particularly in its later phases (Allentoft *et al.* 2024; Egfjord *et al.* 2021; Iversen 2016; Madsen 2024; Nielsen 2024), Schleswig-Holstein and the Netherlands, as well as it being more broadly connected with the European Corded Ware Complex.

The sandy, acidic soils of the core SGC area severely limit the preservation of zooarchaeological material, as low calcium content accelerates bone decomposition. Although early excavations (*c.*1890-1950) documented the presence of animal bone material and hides in SGC burial contexts (site ID and codes in the database of *Fund og fortidsminder* 170209-1, 131203-74, 190306-141), these bones were not preserved. And to this day, only one site from Mid and Western Jutland has been claimed to contain animal bones from SGC, namely a dog found at Forsøgsgården, Esbjerg. This dog has been widely cited in publications on the SGC core area (*e.g.* Hübner 2005; 603-605; Lauenborg 1982; Siemen 2009: 468-472), and in its original publication, Lauenborg interpreted the find as a parallel to the human-dog burials known from Linköping, Sweden.

Forsøgsgården was excavated in 1981 by Esbjerg Museum as one of four burial mounds near the centre of Esbjerg. In one of the burials (Grave E), a battle axe and an amber bead dated

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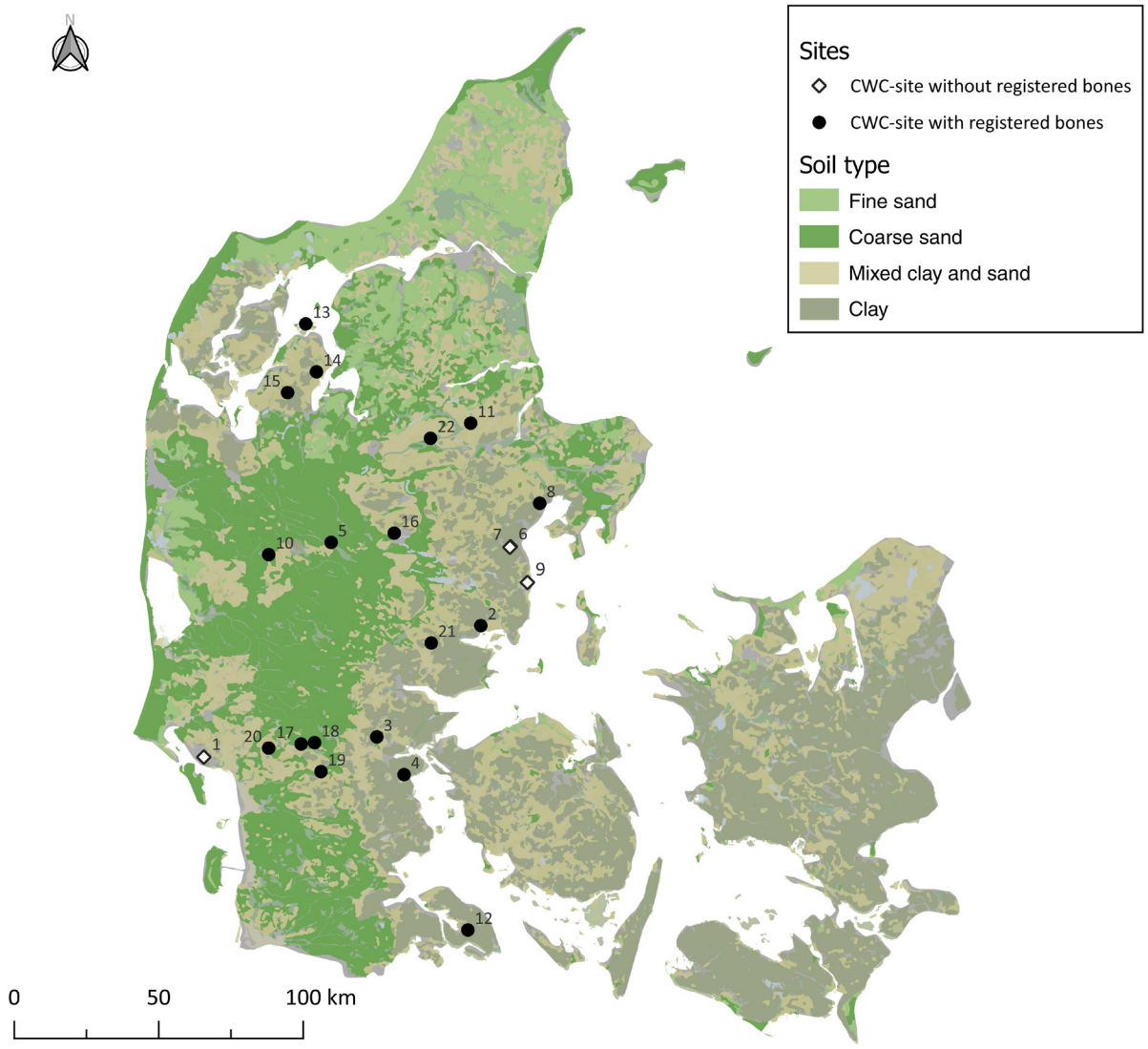


Figure 1: Map of the 22 sites of the pilot project. 1: Forsøgsgården, 2: Toftum Mose, 3: Elkærholm, 4: Binderup, 5: Holdgaardshøj, 6: Eskelund III, 7: Gaasemosen, 8: Hjelmagervej, 9: Kalvø, 10: Havnstrup, 11: Kousted Å, 12: Brovold, 13: Fur Ø, 14: Rigmandshøj, 15: Harehøj, 16: Vester Skovgård II, 17: Gjerndrup-Holsted, 18: Graungård, 19: Askov, 20: Løkkesgaard, 21: Korning Søndermark, 22: Årup.

the mound to the SGC. In the same grave, the partially preserved skeleton of *Canis familiaris* (domesticated dog) was discovered. The skull and spine were preserved, while the limbs and hindquarters were a dark, greasy layer in the soil. The skeleton was osteologically examined at the Zoological Museum and the breed was identified as Neolithic Spitz (Lauenborg 1982).

Outside the core region, there exist only two sites with preserved animal bone material in secure SGC contexts: the coastal sites of Kalvø and Gåsemosen (including Eskelund III), both located in peripheral East Jutland (Andersen 1982, 1983; Enghoff 1999, 2011; Rasmussen 2016; Rowley-Conwy 1985). Both sites contain a mixture of domesticated animals, game, fish, and birds, reflecting mixed economies and adaptations to coastal and forested environments. Whereas these sites are useful in terms of understanding key dynamics in subsistence strategies in the peripheral regions, they are less useful in understanding the economy of the core areas of the SGC relating to the rapidly expanding heathlands (*e.g.*, Haak *et al.* 2023; Løvschal *et al. forth.*).

Materials and methods

We aimed at identifying all SGC sites with preserved animal bone material (or unspecified osteological remains) from secure, dated contexts from

Western Jutland, Thy and Salling. A systematic collection and evaluation were conducted in Fund & Fortidsminder and Arkæologiske Udgravninger i Danmark. Osteological material from urns and cremation graves were excluded. On this basis, 22 sites were reviewed (see Figure 1).

Of the 22 sites, only four (Eskelund III, Gåsemosen, Kalvø, and Forsøgsgården) have yielded zoo-osteological material associated with secure SGC contexts. The remaining localities contained either unspecified or poorly preserved bone fragments. These are often represented only by burnt material in grave fill or by traces of decomposed organic matter such as hides. In several cases, references to bones in early excavation reports could not be substantiated by surviving material. Thus, apart from the four sites mentioned above, no animal remains suitable for radiocarbon analysis are currently known.

We selected three sites for further osteological analysis and radiocarbon dating, including *Gåsemosen*, Aarhus (Rasmussen 2016), *Eskelund III,* Aarhus (Rasmussen 2022), and *Forsøgsgården*, Esbjerg (Lauenborg *n.d.*; Lauenborg 1982; Siemen 2009). The aim was to assess preservation conditions, taxonomic identification, and the potential for radiocarbon dating, in order to evaluate the prospects for further analysis.

At Gåsemosen, a bone fragment of a *Bos taurus* femur was selected for radiocarbon dating, due to its stratigraphic association with SGC ceramics in the cultural layers. At Eskelund III, an antler fragment from *Cervus* (red deer) was chosen for sampling for radiocarbon analysis, due to its association with SGC ceramics found in the cultural layer within which, it was found. At Forsøgsgaarden, a diaphysis fragment of a humerus was sampled for radiocarbon dating, due to its in-situ preservation in a SGC grave.

Results

Two of the three samples yielded reliable RC dates; none of them situated the bones in the SGC. At Gåsemosen, the selected bone fragment was the diaphysis of a femur from *Bos taurus*, with the joint ends absent. Although the bone was well-preserved, the collagen content was insufficient for successful radiocarbon dating. At Eskelund III, the antler fragment was dated to 2141-1946 BC *i.e.* the Late Neolithic (see Table 1).

At Forsøgsgården, the diaphysis fragment from the dog was dated to 1634-1807 AD. The morphology of the femur and radius, particularly their compact structure, closely resembles that of small dog breeds such as Dachshunds in comparative analyses with modern specimens. These skeletal traits, combined with the context of the burial, strongly suggest that this was a pet dog, likely associated with a nearby 19th-century farm.

Discussion

The subsistence economy of the SGC and the associated nature of human-animal relations remain poorly understood. In the archaeological evidence, early phases of the SGC show no permanent house constructions, indicating seasonal settlements, while the expanding heathlands in the Mid and Western Jutland likely supported

Site	Laboratory number	Sample	Radiocarbon date	Calibrated age ranges 1 and 2 sd
Gåsemosen	SID-45112 AAR-36932	Femur, diaphysis fragment *Bos taurus*	Insufficient amount of collagen	No results
Eskelund III	SID-45113 AAR-36933	Antler, fragment *Cervus*	3667,33	2141 – 1946 calBCE
Forsøgsgården	SID-45055 AAR-36905	Humerus, diaphysis *Canis familiaris*	230,32	1687 – 1807 calCE

Table 1: Results of radio carbon analyses.

mixed herds dominated by sheep (Haughton and Løvschal 2023). In the preceding Funnel Beaker Culture, cattle played a prominent role, particularly in the stone heap graves, providing an important point of comparison for understanding changing human-animal relationships and subsistence in the SGC (Becker 1960).

Moreover, the scarcity of preserved animal bones in the Danish SGC core region should be considered in light of the fact that it forms part of the broader Corded Ware Culture (CWC) complex, which extends across much of Europe. In regions with more favourable preservation conditions, animal bones are comparatively common finds in CWC graves (*e.g.* Kyselý *et al.* 2019), suggesting that their absence in the Danish material more likely reflects a preservation bias than a genuine absence of animal deposition. Notably, the occurrence of animal bones in these graves also appears to follow age-specific patterns (Nørtoft 2022), which lends further plausibility to the assumption that comparable practices may have existed within the Danish SGC as well.

Spectacular finds from the CWC complex of combined human and animal burials and new evidence of cereal cultivation also hint at a more complex and varied subsistence economy than has traditionally been assumed for Danish contexts. This is potentially echoed in the early SGC grave at Refshøjgård, East Jutland which contained a quern stone and cereal residue (Klassen 2005). The site, however, is situated outside the heathland core area and securely dated cereal finds from the SGC more broadly remain scarce (Andreasen 2009).

However, poor preservation on the sandy soils of Mid and Western Jutland remains a key obstacle to discover new human and animal osteological remains. The failed attempt to date the *Bos taurus* femur from Gåsemosen, due to insufficient collagen, further illustrates how preservation conditions, even outside this area, constrain the potential for radiocarbon analysis.

This raises the need to develop and deploy new analytical methods to compensate for the lack of bone preservation. Below we suggest a series of steps where we see the potential for bringing this research field further. Approaches such as parasite analysis, phytolith studies, sedaDNA (sedimentary ancient DNA) and SEM (scanning electron microscopy) hold potential for advancing our understanding of the role of wild and domestic animals and subsistence strategies in the Danish SGC.

Analytical approaches to non-osteological material

Each of the following analytical methods contributes a complementary perspective on subsistence strategies and human-animal relations in the SGC: parasite and sedaDNA analyses yield direct biological evidence of species presence and interaction, whereas phytolith and SEM studies provide indirect environmental and microscopic indicators of foddering, grazing, and animal-derived material. The preservation potential of these non-osteological proxies varies considerably by material type and is not uniformly favoured by the same depositional conditions. Phytoliths, being composed of amorphous silica, are comparatively resistant to dissolution under acidic conditions, whereas their preservation is instead compromised in alkaline, calcium-rich environments (Cabanes 2020; Nawaz *et al.* 2019). In contrast to osteological material, phytoliths may therefore be expected to survive reasonably well in the sandy, acidic soils characteristic of the SGC core area. The preservation of parasite remains and sedaDNA is less straightforward to predict under these same conditions, as their survival depends more strongly on factors such as moisture, temperature, and microbial activity than on soil pH alone (Bouchet *et al.* 2003; Mitchell 2024). It therefore remains an open question whether these latter proxies would be as suitable for the sandy soils as the phytoliths.

Parasite remains preserved in soil samples can provide indirect evidence of animal husbandry and human-animal interactions (Mitchell 2024). Eggs, cysts, or larvae of gastrointestinal parasites may survive in latrine deposits, midden layers, or grave fills, even when bones are poorly preserved (Bouchet *et al.* 2003). When sampled and examined under microscopy, these remains can reveal which species were present (Søe *et al.* 2015). Systematic sampling of sediments from burial contexts in the SGC could thus expand our understanding of subsistence strategies and complement traditional zooarchaeological data.

Phytoliths, microscopic silica bodies formed in plant tissues, are often preserved in soils (Cabanes 2020). Analysing phytolith assemblages allows reconstruction of past vegetation and crop use, as well as indirect evidence of foddering practices or animal grazing areas (*e.g.*, Ball *et al.* 2016; Out *et al.* 2024). At SGC sites, systematic recovery and identification of phytoliths could clarify the environmental context of livestock and human activity. Studies from other Danish prehistoric sites (Out *et al.* 2022; Sulas *et al.* 2022) show that phytoliths can reliably indicate plant species and agricultural or pastoral practices, even in areas with poor preservation of macrobotanical remains.

SedaDNA extracted from soil samples can provide species-level identification of plants, animals, and microorganisms associated with past human activity. Broader reviews (Aldeias and Stahlschmidt 2024; Brown *et al.* 2025; Özdoğan *et al.* 2024) outline the methodological potential and limitations of sedaDNA for reconstructing past human-animal interactions. In SGC contexts, sedaDNA can in principle be recovered from midden deposits, grave fills or other organic-rich layers, allowing reconstruction of herd composition, local fauna, and even past diets. Methodological studies (*e.g.*, Slon *et al.* 2017) highlight how sedaDNA can detect species not otherwise visible through traditional zooarchaeological or microfossil analyses. It is worth noting that current genomic evidence from Denmark reflects a similar preservation bias: sampling for skeletal ancient DNA has so far been concentrated in eastern Denmark, where bone preservation is generally favourable, while comparable material from the earliest SGC phase in western Denmark remains largely absent due to poor preservation conditions (Allentoft *et al.* 2024). Although this observation pertains to skeletal DNA, rather than sedimentary DNA, it nonetheless underscores that the acidic, sandy soils of the Danish SGC core area are unlikely to offer more favourable conditions for sedaDNA recovery. Applying sedaDNA systematically across SGC sites may therefore hold potential to fill gaps in knowledge where osteological material is absent or poorly preserved, but expectations should remain cautious until preservation potential in this specific soil type has been empirically tested.

Our pilot project identified sites with possible remains of hides in SGC burials. These may appear as dark, fibrous layers or amorphous organic stains but can still preserve identifiable material. When sampled, such remains can be examined through scanning electron microscopy (SEM) combined with microscopic analysis to determine species. A study of this type from Perttulanmäki in Finland (Ahola et al. 2018) demonstrates the potential of this method. Future systematic investigation of hide remains could offer new perspectives on burial practices, animal selection, and cultural continuity, supported by parallel finds from the Corded Ware and Yamnaya cultures (Heyd 2011).

Analytical approaches to osteological material

While analyses of parasites, phytoliths, sedaDNA, and microscopic examination of hide remains provide valuable insights into subsistence strategies and animal use, other types of material preserved in burial contexts can shed light on additional aspects of human-animal relations. Burnt and fragmented osteological material, although often overlooked, offers opportunities for species identification, radiocarbon dating, and understanding ritual practices. The following sections explore these underutilized materials and the methods that can be applied to study them, highlighting their potential to expand our knowledge of animal use and cultural practices in the SGC.

Burnt animal bone material from inhumation graves may constitute an underexplored source of information. In some of the earliest publications on SGC, charcoal was identified as a recurring element in graves (Müller 1898), yet it has rarely been described in detail or subjected to systematic analysis. Fragments of burnt bone have also been recorded in several inhumation graves (Mortensen and Andersen 1987; Poulsen 2015), but these finds have largely gone unexamined. It is likely that many of these burnt fragments are of animal origin. In our dataset, burnt bone material was identified in four of the 22 reviewed sites, though in all cases the degree of fragmentation precluded morphological assessment of whether the material was human or animal in origin.

Osteological material exposed to temperatures above 650°C becomes calcined, a condition in which bioapatite recrystallizes and can potentially be radiocarbon dated despite the destruction of collagen (Chatters *et al.* 2017; Olsen *et al.* 2011). This offers a directly applicable avenue for the calcined material identified in this study, allowing at least a chronological anchoring of these finds even where species identification remains elusive. This presents an opportunity for dating cremated remains from burial contexts previously considered unsuitable for analysis. However, the high degree of fragmentation often complicates anthropological identification. Where unburnt, morphologically indeterminate fragments occur in future finds, ZooMS (Zooarchaeology by Mass Spectrometry) offers a minimal-destructive method for species identification when bones are not morphologically diagnostic (Brandt *et al.* 2018; Martisius *et al.* 2020). This technique analyses peptide sequences preserved in collagen, which are species-specific – although it is only applicable to unburnt osteological material (Fellows Yates 2013; Vitale *et al.* 2026), meaning it cannot be applied to the burnt fragments identified in the present dataset. As such, ZooMS is particularly valuable where traditional zooarchaeological methods are limited by poor preservation.

These analytical approaches demonstrate considerable potential for expanding our understanding of subsistence strategies and human-animal relations in the SGC. At the same time, it is essential to critically assess the differential preservation potential of these proxy materials, as discussed above, under the same depositional conditions that have resulted in poor preservation or complete absence of osteological remains. Consequently, the applicability of these methods will vary between sites and contexts.

Conclusion

The paucity of animal bone material from the core regions of the Danish SGC continues to limit our knowledge of human-animal relations and subsistence strategies. This is however not only an issue for the SGC, but pertains to several other time periods in Danish prehistory, where the absence of pits and depressions poses a severe preservation issue for organic material in general. The integration of alternative proxies – including parasite analysis, phytolith studies, sedaDNA, and microscopic examination of hide remains – offer significant potential to overcome preservation biases and provide a more comprehensive understanding of human-animal interactions. Therefore, future research employing systematic sampling and multi-proxy analytical frameworks is essential for reconstructing both the ecological and cultural dimensions of human-animal relations and subsistence within the SGC.

Acknowledgements

This work was supported by the Moesgaard Collaboration seed funding scheme. We are very thankful to Jacob Kveiborg, Uffe Rasmussen, Niels Nørkjær Johannsen, Pernille Bangsgaard and Kirstine Stæhr Gregersen for their valuable contributions to the work underlying this study.

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