Late Neolithic and Early Bronze Age settlements and agro-pastoral developments in the Oslo Fjord area, southeastern Norway

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ABSTRACT

For several decades, there has been a duality in the archaeological research on the character and nature of how people became farmers in southern Norway, with scholars favouring a (swift) introduction of a comprehensive cultural package with the onset of the Late Neolithic (*c*.2350 BCE) on the one hand, and scholars favouring more long-term trajectories and internal dynamics on the other. Due to a generally more fragmented archaeological record from southeastern Norway, where there for long have been a lack of longhouses and direct empirical evidence of the introduction of farming, western Norway has been the focal point of this debate.

Through newly aggregated and different relevant data types, we aim to better the understanding of the agricultural developments and the trajectories of the early (farm-based) settlements in the Oslo Fjord area in southeastern Norway. The results of our study prove a general delay in the establishment of longhouses, which appear from 2200–2100 BCE, and a stepwise intensification in crop farming from *c*.2100 BCE, although certain regional variances were detected. Both these trajectories also contrast some of the more profound material changes evident from around 2350 BCE. We interpret this as a more gradual and adaptive farming development in this part of southern Norway, hence disfavouring the theory of the introduction of a comprehensive package with the onset of the Late Neolithic.

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Introduction

Since the 1990s, there has existed a duality in the archaeological research addressing the character and nature of how people became farmers in southern Norway. This debate has mainly had western Norway as its focal point. A reason for this, is that compared to western Norway, there has for long been a lack of evidence of Late Neolithic (LN, for details see Table 1) and Early Bronze Age (EBA) longhouses and other finds associated with a farming economy, such as cereals and bones from domesticates, as well as tilled fields, from southeastern Norway (Damlien et al. 2021, 131). The overarching aim of this paper is to better the understanding of the agricultural developments and establishment of farm-based societies in the Oslo Fjord area in southeastern Norway (Figure 1), and through this also contribute to the long-lasting and still ongoing debate on the process of how people become farmers in southern Norway.

This debate consists partly of scholars arguing for the introduction and spread of a comprehensive economic, social, and cultural package throughout southern Norway with the onset of the LN (e.g. Melheim 2012; Myhre 2002, 38-75; Prescott 2009, 200; 2020). Among the discussed changes, are the introduction of two-aisled houses and agricultural practices (e.g. Austvoll 2019, 2021; Børsheim 2003, 2004; Løken 1998; Prescott 2005; Soltvedt

Period	Late Neolithic		Early Bronze Age		
Phase	LN I	LN II	EBA I	EBA II	EBA III
BCE	2350-1950	1950-1700	1700-1500	1500-1300	1300-1100

Table 1. Chronology of the period in study (after Vandkilde 1996, From Stone to Bronze).

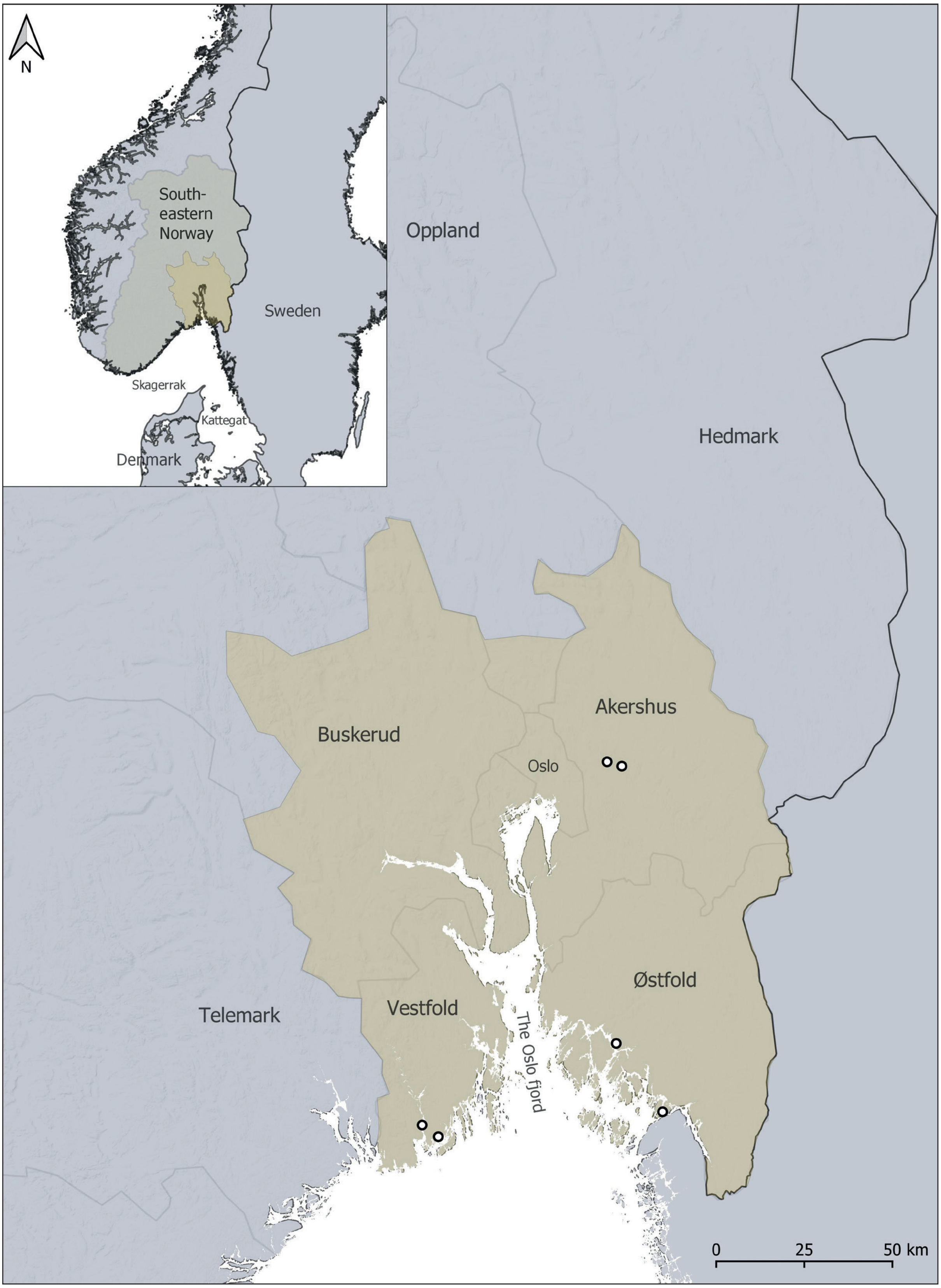

Figure 1. Map showing the Oslo Fjord area, with the different regions marked by boarders and name, and the six case sites marked in white (By A. Sand-Eriksen).

et al. 2007), as well as several new technologies and artefacts. For instance, the spread of different bifacial lithics, such as daggers, sickles and arrowheads, and metal artefacts across southern Norway (Apel 2012; Melheim and Prescott 2016; Mjærum 2012; Prescott, Sand-Eriksen, and Austvoll 2018;

Østmo 2005). These are artefacts and technologies argued to be signs of the influence of the Bell Beaker Culture (BBC) in southern Norway (Apel 2012; Glørstad 2012; Prescott 2005, 2012).

The theories of (a primary) external influence are not uncontested, however. Other scholars view the economic and cultural changes as results of internal processes as well, such as agriculture being adopted by the hunter-fisher populations earlier in the Neolithic (Bruen Olsen 1988). Such theories have later been (partly) supported by both archaeological evidence and palynological data, which, for instance, indicate that certain agricultural practices could have been performed on a small-scale basis prior to the LN in western Norway (e.g. Bergsvik et al. 2020; Hjelle, Hufthammer, and Bergsvik 2006). In lines with this latter theory, is evidence of continuous traditions of (local) lithic production and persisting subsistence practices of both hunting, fishing, and gathering across southern Norway (e.g. Nyland 2020, 71; Rundberget and Amundsen 2020, 62).

In our aim of bettering the understanding of the agricultural developments and establishment of farm-based societies in the Oslo Fjord area, we will also bring new knowledge to the outlined debate, hence reducing the knowledge gap between western and eastern Norway regarding the LN and EBA developments. We will first present results from an analysis of a larger body of radiocarbon-dated buildings dated to the LN and the EBA from all of the Oslo Fjord area (see Supplement), which will be further analysed and discussed alongside dated cereals grains (Solheim 2021a) and cultivation layers (Mjærum 2020) from the region. Thereafter, we will present three case areas of six settlement sites (see Appendix 4); two located in the region Vestfold on the western side of the fjord, two in Østfold on the eastern side and two in Akershus in the northern parts of the fjord (Figure 1). This paper is the first comprehensive analysis of the earliest farm-based settlements and their associated agro-pastoral activities in southeastern Norway.

The theoretical foundation of our inquiry relies on the concept of 'bounded rationality'. The theory was proposed by H. Simon (1955, 1959) in response to rational choice theory, which advocates how people always make optimised economic decisions. By contrast, the theory of bounded rationality argues how this is not possible due to the three limiting factors of cognitive ability, imperfect information, and time constraints. As a result, humans also make suboptimal decisions, where the mentioned limitations are overcome through satisficing. We will also draw on the concept of creolization (see e.g. Iversen 2015; Larsson 2015; Nielsen 2022), and use the combination of the concepts to move closer to the decision-making processes behind settling and becoming farmers in the Oslo Fjord area during the LN and EBA, as evident through the archaeological record.

Geography and climate

The geographical focus of this paper is the Oslo Fjord area[1], which broadly speaking consists of landscapes surrounding the 120 km long Oslo Fjord in southeastern Norway (Figure 1). Although the area of approx. 25.000 km^2 only makes up 20 % of the land coverage of southeastern Norway, large parts of this vast region consist of enormous mountain ranges, which separates it from western Norway. The geography between the mountain landscape and towards the coast, in which the Oslo Fjord area is situated, also vary. The area has large stretches of woodland and valleys, several with fertile farming areas (Puschmann 2005, 35, 43-44, 47-48; Puschmann et al. 2004), and excellent opportunities for hunting (Rundberget and Amundsen 2020, 62). The Oslo Fjord area is situated within parts of southeastern Norway referred to as lowlands, which has significant areas with drainable sandy subsoil and high mean annual temperature in a Norwegian scale, making it especially suitable for agriculture (Puschmann 2005, 19-20; Puschmann et al. 2004). Even so, the Oslo Fjord is considered as part of the boreonemoral vegetation zone, and the physical condition is thereby somewhat harsher than in the nemoral areas of southern Scandinavia (Moen 1999, 92).

The areas on and south of the terminal moraine Raet in the regions Østfold and Vestfold are highlighted as particularly suitable for early farming (Johansen 1976, 53; Østmo 1988, 123; 1993, 97-98). The southernmost parts of the area are also low-lying, particularly south of Raet, which in general do not surpass 100 m above present day sea-level. The areas further north have a divided topography alternating between small hills and flatlands and subsoils spanning from well drained sand to compact clay and unsorted moraine. In historical times, this affected land ownership and tenure, resulting in a scattered mosaic of small-scale and larger farming areas (Puschmann et al. 2004, 44, 47; see also Gjepe, 2017).

In the LN and EBA, the relative sea-level was 15-20 m higher than the present (Sørensen 2002), but the maximum distance across the fjord has nevertheless remained generally unaltered. Parts of the fjord were most likely relatively easy to cross with sufficient nautical experience or knowledge, especially compared to the argued crossing of the Skagerrak-strait (Austvoll 2021; Kvalø 2007; Østmo 2005). From the fjord, several lakes and rivers stretch inwards in all directions, effectively connecting the surrounding landscapes together. During the LN and EBA, anthropogenic effects on the area becomes more evident, indicating some degree of deforestation, most likely due to an increase in agro-pastoral activities (Mjærum, Loftsgarden, and Solheim 2022; Wieckowska-Lüth et al. 2018). Studies have indicated an overall temperature decline around 2200-2000 BCE (Hammarlund et al. 2003, 367-368), which also resulted in milder and wetter winter conditions (Nesje et al. 2001). The climatic data from the North Atlantic region are ambiguous (Bradley and Bakke 2019), but such an event could have affected subsistence and land use strategies (Blank 2021, 64; see also Gundersen 2022) and improved marine productivity (Polovodova Asteman et al. 2018, 252; see also Gundersen 2022, 365-367).

Background

The introduction of farming

The cultural and economic importance of farming has been discussed considerably in Norwegian archaeology (e.g. Bakka and Kaland 1971; Bruen Olsen 1992, 2009; Hjelle, Hufthammer, and Bergsvik 2006; Høgestøl and Prøsch-Danielsen 2006; Kaland 1986; Prescott 1996, 2005). Despite nuances, it is commonly agreed upon that crop farming was of limited economic importance before the LN in southern Norway (Bergsvik et al. 2020; Glørstad 2012; Nielsen, Persson, and Solheim 2019; Prescott 2020; Solheim 2021b). This stands in stark contrast to other areas in southern Scandinavia, where both animal husbandry and cereal cultivation were introduced around 3950-3700 BCE (Fischer 2002; Gron and Sørensen 2018; Gron et al. 2016; Sjögren 2012; Sørensen and Karg 2014). In southeastern Norway, on the other hand, only a single (secure) incidence of agricultural farming predating the LN is known (Reitan, Sundström, and Stokke 2018; Solheim 2021b).

Nevertheless, there are other components from the archaeological record that could indicate that the people inhabiting the region also knew farming prior to the LN, such as pottery and polished flint axes, as well as a low number of possible farming sites and (small scale) palynological data indicative of cereal cultivation and animal husbandry (Glørstad 2009, 2010; Glørstad and Solheim 2015; Nielsen 2021; Solheim 2012). A further example is the shift in the spread of finds in the landscape, with, for instance, Middle Neolithic (MN, 3300-2350 BCE) axes appearing more near the coast than the axes belonging to the Early Neolithic (EN, 3900-3300 BCE) did. This is by several interpreted as indicative of a de-neolithisation, where people returned back to fishing, hunting and gathering as their main subsistence strategies in the MN (Nielsen 2022, 116-117; Reitan, Sundström, and Stokke 2018, 550; see also Hinsch, 1950, 104; Østmo, 1988, 225-6). It has also been argued that during the MN, again based on the spread of artefacts, particularly axes in the southeastern mountain areas, farming practices could to a greater extent have been oriented towards pastoralism (e.g. Gundersen 2013; Hinsch 1956; Kilhavn 2013; Mikkelsen 1989; Prescott and Walderhaug 1995; Reitan 2005). Through the utilization of radiocarbon dated cereal grains from southeastern Norway, S. Solheim (2021a; 2021b) has recently demonstrated that the establishment of farming was a long-term development over several steps. He also suggests that the earliest agriculture most likely had a different form than in LN (Solheim 2021b, 10), which could explain why few archaeological traces of earlier farming are preserved or visible today (Nielsen, Persson, and Solheim 2019, 88).

Tendencies in the archaeological record

The widespread distribution of flint daggers to Norway, of which around 450[2] are known from the Oslo Fjord area (for details see Apel 2001; Scheen 1979), has been a recurring theme for researchers looking to assert and exemplify frequent contact and trade across Skagerrak from the onset of the LN (Apel 2001, 2012; Austvoll 2021; Scheen 1979; Solberg 1994; Østmo 2005, 58-61). This oversea travel, connecting southern Norway to central Scandinavia (Østmo 2005), is argued to have resulted in a swift and complete change of social life from 2350 BCE (Prescott, 2009, 200), consisting of the emergence of new settlement patterns, including two-aisled houses, farming, the introduction of bifacial technique and imported objects imitating metal artefacts, such as the abovementioned daggers, actual metal artefacts and metallurgy (Austvoll 2021; Børsheim 2003; Holberg 2000; Melheim and Prescott 2016; Mjærum 2012; Prescott and Walderhaug 1995; Østmo 2012).

Several scholars have argued that these changes were facilitated by migrations of people belonging to the BBC (Prescott 2012; Prescott, Sand-Eriksen, and Austvoll 2018). At the turn of the LN, the BBC formed broad trading networks along the European waterways and at sea (Fitzpatrick 2011; Vandkilde 2014), including the crossing of Skagerrak by boat into Norway (Melheim and Prescott 2016; Prescott 1996, 2005, 2009, 2012, 2020; Prescott and Glørstad 2012, 2015; Prescott and Walderhaug 1995; Østmo 2005, 2012). The earliest type of flint daggers (type IA) and barbed and tanged arrowheads are especially numerous along the southwest coast of Norway, interpreted as a consequence of the area's close contact to Jutland in Denmark (Austvoll 2020, 2021; Østmo 2005). Researchers advocating a longer and more gradual transition of farming, based on pollen records and MN domestic animal bones from western Norway, have argued that indigenous hunter-fisher-gatherers introduced farming to western Norway, even though they do not exclude the possibility for immigration of small groups of farmers during the MNB and LN (Bergsvik et al. 2020, 356-357; Hjelle, Hufthammer, and Bergsvik 2006, 164, with further ref.).

As in most studies on the spread of farming across Europe (for a review and discussion see e.g. Robb 2013), the above sections show that there are no clear-cut answer to whether it was the movement of farmers that led to the beginning of farming in southern Norway or if it was foragers that adopted farming. Although it is not the main purpose of this paper to address the issue of movement of 'pots or people', we will return to this inevitable question in the later discussion of our results.

Material, methods, and source criticism

The first evidence of farm-based settlement in southeastern Norway was not excavated until 2002 (Rønne 2003, 2004), and a decade later (Bruen Olsen 2013, 130) only two sites with two-aisled houses were accounted for in eastern Norway. In this paper, we present a much larger body of material. The rapid increase in the number of houses can mainly be attributed to a period of intensive archaeological activity over the last two decades, where development-led heritage management projects have generated an extensive body of high-quality data (Damlien et al. 2021; Iversen and Petersson 2017). Several sites have been 'hidden' in excavation reports, and the record of houses used in this paper is collected from reviewing reports from the Museum of Cultural History (MCH). This has resulted in a database of 60 buildings from the Oslo Fjord area, most of which are not previously published, and form part of a larger dataset from southeastern Norway currently under development. Apart from houses in the southernmost part of the region (Agder), the 60 buildings from the Oslo Fjord area make up the main part of the settlement material dated to the LN and EBA from all of southeastern Norway, and we regard the outlined trends in this paper as representative for the region.

Close to 80 % (n=47) of the buildings from the Oslo Fjord area had available information regarding the individual radiocarbon dates (see Supplement), while the remaining houses were either typologically/stratigraphically dated or had C14-data not available or retrievable, but with the dated period mentioned in the report. Dates that obviously did not have a connection with the houses, were omitted. In total, we have included 124 radiocarbon dates from the buildings in this study, which is a little low for reconstructing past events representatively (Hinz 2020; Williams 2012), as larger numbers is a more accurate indicator of robustness (Crema and Bevan 2021).

Nutshells and grains are in general seen as preferable materials for radiocarbon dating (cf. Soltvedt 2020), and used when accessible. Although likely remnants from living in and using the house, they can also be redeposited and represent earlier activities at sites (Baxter 2003, 189; Gjerpe 2008). Since wood charcoal is more commonly found at excavations in southeastern Norway, it is often used when dating the region's houses. A problem with this record is the inherent age of the dated charcoal itself, especially significant for long living species like pine and oak (Bowman 1990). To reduce this problem, botanists and archaeologists select charcoal from short-lived trees and/or young trunks and branches, as the most suitable material for dating. The dated wood charcoal might stem from the burning of the post to prevent decay, and thus represent the construction phase of the house, but can also be redeposited during the construction or later use.

To visualize the temporal distribution of the data, we provide summed probability plots (SPD). Since there is a large variation in the number of radiocarbon samples from the different sites in our study, which potentially can cause sampling bias, we have binned the data in 200-year long site phases. Several overlapping dates from one site were then counted as one if they represent a site phase of less than 200 years. The SPDs and bindings are made using the Rcarbon package (Crema and Bevan 2021) developed for R programming language (R Core Team 2020). The dates are calibrated using the IntCal 20 calibration curve (Reimer et al. 2020). We apply an exploratory approach to the SPDs, and are aware of the effects sampling biases and calibrations have on the record (Crema 2022). To mitigate these effects, we will focus on the large-scale trends and compare the house record with two other radiocarbon datasets from the Oslo Fjord area – cereals and cultivated fields. The record of dated cereals is based on a compilation of radiocarbon originally collected by S. Solheim (Solheim 2021a). We have, however, only included records from the Oslo Fjord area in our study, 514 dates altogether. The records from cultivated soils consist of 268 dates. Parts of this data is previously published (Mjærum 2020), but also here we have limited the dataset to the Oslo Fjord region and added dates from archaeological excavation reports published in 2020 and 2021.

Concerning the cultivation layers, dates of cereals are excluded from the dataset, something that makes this record fully independent from the cereal analysis. The dating of houses is based on wood charcoal (n=81), nutshells (n=4) and bone fragments (n=2), but also cereals (n=37). The house record is thereby only partly independent from the record of cereals. To test the interdependency of this record, we have also produced SPD plots of the houses without dated cereals (Appendix 1). No major differences between the plots with and without dated cereals were detected.

Results and interpretations

Of the 60 buildings, 48 are houses and 12 defined as other buildings. Of the houses, 31 are two-aisled and 17 three-aisled (Table 2). 19 of the two-aisled houses occur on the eastern side of the fjord, in the former county Østfold, while five is in Akershus towards the north, and the remaining seven in Vestfold on the western side (Figure 2). There is a total absence of three-aisled houses in Vestfold, however, this cannot be attributed to a general lack of excavations in the region since the early 2000s. There are, for instance, around 60 three-aisled houses dated to the Iron Age in the region (Gjerpe 2017, 83, Tabel 6.1).

Our detailed study of houses and associated material consists of six sites within three case areas. The first focuses on what we consider to be the first introduction of two-aisled houses south of Raet on the eastern side of the Oslo fjord. The second focuses on settlements and adaptions in the northern Oslo Fjord area, while the third case explores the more long-term development of farmyards on the western side of the fjord. The main objective is to examine the sites from a bottom-up perspective, situating them within the overarching results from our analyses and evaluations of radiocarbon datasets from the entire study area, hence testing these

Table 2. The settlement material from the Oslo Fjord area dated to the LN and EBA, sorted after type, period, and regions (most of the excavation reports use the same regions, as they were separate administrative counties in Norway until 2021)

	Period	Østfold	Akershus	Vestfold	Sum period
Two-aisled houses	LN I	3	-	1	4
	LN I-II	1	1	1	3
	LN II	3	2	-	5
	LN	2	-	-	2
	LN-EBA	5	1	3	9
	EBA I	1	1	-	2
	EBA I-II	-	-	1	1
	EBA II-III	-	-	1	1
	EBA-LBA	2	-	-	2
	EBA?	1	-	-	1
	Sum region	*19*	*5*	*7*	*31*
Three-aisled houses	EBA I	2	-	-	2
	EBA I-II	-	1	-	1
	EBA II	1	1	-	2
	EBA III	-	1	-	1
	EBA-LBA	2	1	-	3
	EBA	1	-	-	1
	BA	3	4	-	7
	Sum region	*9*	*8*	*0*	*17*
Other buildings	LN	-	1	-	1
	LN-EBA	-	2	-	2
	EBA I	1	1	-	2
	EBA I-II	-	-	1	1
	EBA II	2	-	-	2
	BA	4	-	-	4
	Sum region	*7*	*4*	*1*	*12*
	Total sum	35	17	8	60

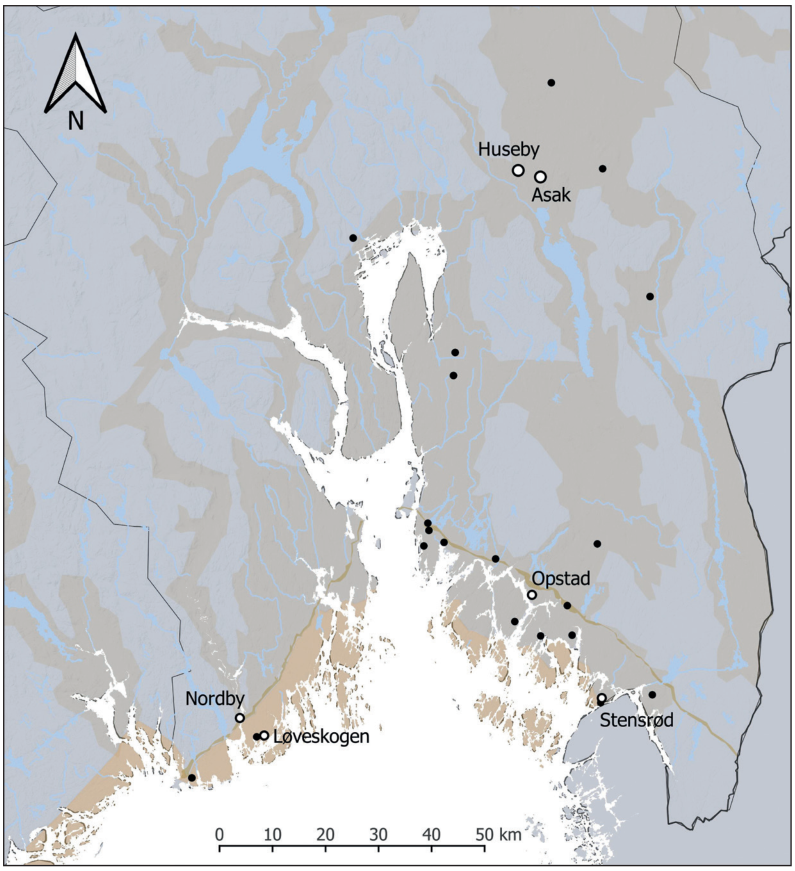

Figure 2. Map of the three case areas with the six sites marked with names, and other LN and EBA settlements sites added. Brown lines shows the terminal moraine, Raet, while light brown highlights areas favourable for agricultures. The light orange shows the coastal zone, with favourable mean annual temperatures. The sea level is raised 15 m higher than present (By A. Sand-Eriksen).

results also locally. First, we will present the results from the radiocarbon analysis of the settlements, cereals, and cultivation soils.

Results inferred from radiocarbon dates

From the settlement material, 124 radiocarbon dates ranging between 2835-2345 cal BCE (4000±110 BP, T8022) and 1020-900 cal BCE (2810±30 BP, Beta-426059) have been collected from excavation reports (Figure 3A, Supplement). The simulation shows a tail to the distribution of calibrated dates extending back to the late third millennium BCE, first rising marginally throughout the MN, before a small peak in the SPD gets visible around the onset of the LN, *c.*2350 BCE. Following this weak introductory curve is a more discernible establishment in the settlement material at around 2200 BCE. Due to source critical problems with the dated material (see above), together with tail and spreading effects of the standard error in radiocarbon dates, we regard 2200-2100 BCE as the time when two-aisled houses became common within the study area. Although the handful of previous dates in the weak introductory curve could be evidence of actual houses, they are not possible to construe form the data, nor were they noticed during excavations. The number of dates is relatively stable until the transition to the EBA, but from *c.*1700 BCE the SPD indicates a fall in the number of two-aisled houses, although occurring as late as 1300 BCE (see Case 3).

According to the SPD, three-aisled houses start to appear already in the LN (Figure 3B), which is too early. This is probably to some degree caused by source critical issues, as well as a couple of possible wrong interpretations of (partial) house plans. The second, more pronounced peak in three-aisled houses around 1600 BCE is in line with developments in southern Scandinavia (Artursson 2009; Børsheim 2003; Larsson and Brink 2013), and most likely represent the real entry of the three-aisled houses in the Oslo Fjord area, although earlier secure instances occur (see Case 2). Surprisingly, the three-aisled houses do not seem to get a real footing at this time, perhaps indicating that the building technique did not immediately replace the two-aisled. There is a continued fall in the presence of houses, resulting in a rather drastic decline in the settlement material just before 1400 BCE, followed by a period of few acknowledged houses throughout the EBA. This situation seems to have ended by an increase in the number of the three-aisled buildings from the onset of the Late Bronze Age (LBA, 1100-500 BCE).

The SPD for cereals gives us a partial picture of the outcome of actual farming in the study area (Figure 4A). No grains have been directly radiocarbon-dated to before 2200 BCE, and dates prior to 2000 BCE are few in numbers. The SPD from Østfold displays a slightly earlier introduction of cereal farming than the rest of the study area (Appendix 2), hence demonstrating certain local temporal developments. In the plot of dates from cultivated soils, there are six EN and MN radiocarbon dates (Figure 4B). Such layers commonly include charcoal fragments that predate the farming activity (Mjærum 2020, 6-10), and it is unlikely that these EN and MN dates indicate early farming. The SPD demonstrates a real onset of fossil tilled soil in the archaeological material in the study area during LN II, with an intensification from the transition to the EBA. This is particularly evident in Østfold (Appendix 3).

Summary

By combining the dataset of cereal cultivation with the settlement material, the different trajectories of the house establishments on the one hand and the beginning of cereal cultivation and cultivated soil on the other, become evident (Figure 5). Most importantly, the compilation indicates that the establishment of two-aisled houses and crop farming are not completely concurrent, with settlements preceding larger scale crop farming in the Oslo Fjord area with at least one century, perhaps more, followed by an even later entry of tilled soils in the archaeological record. We interpret this in opposition to a swift and complete change of social life at around 2350 BCE, but rather pointing to a more gradual process over several centuries. How does this fit together with archaeological records from individual settlement sites?

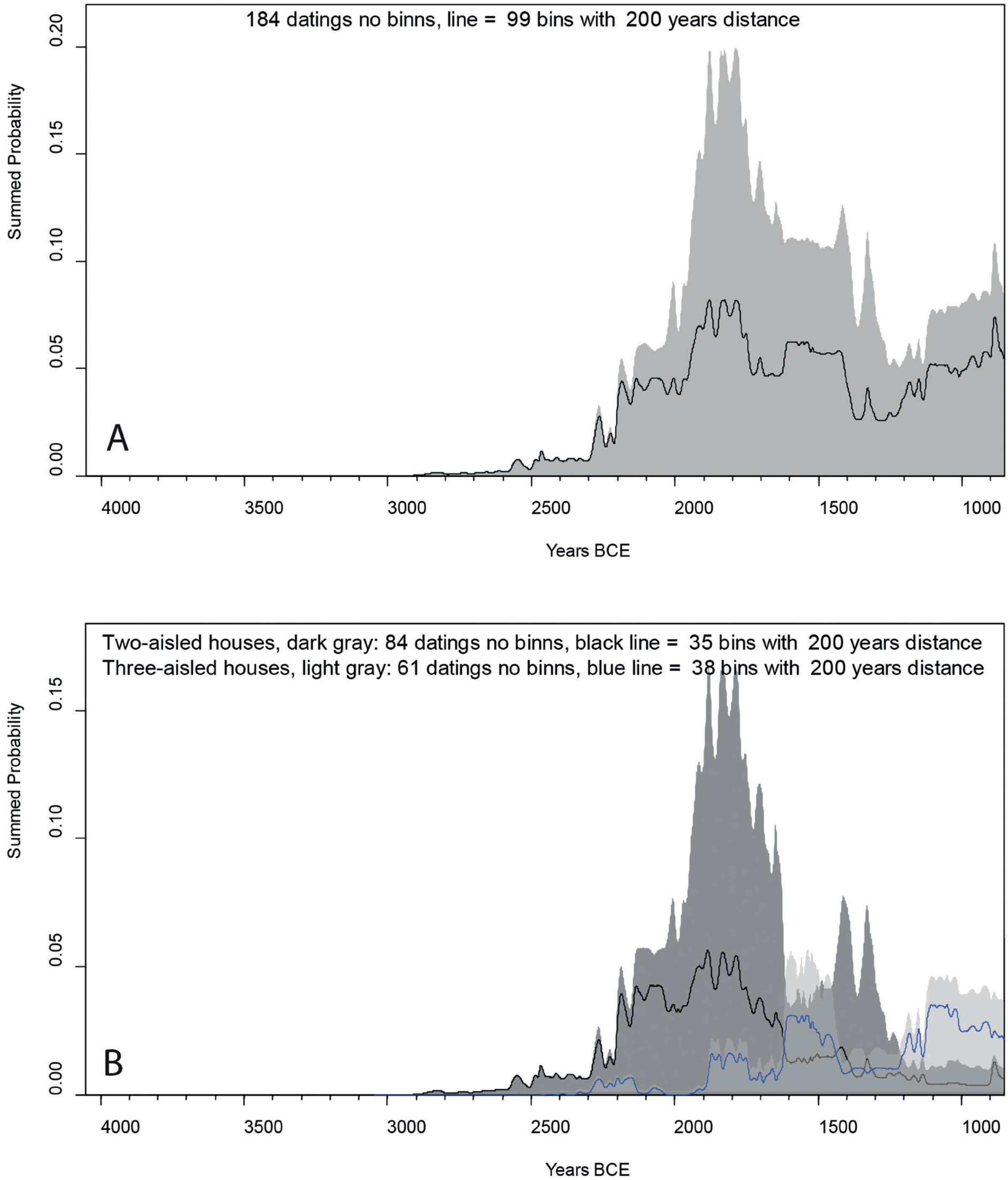

Figure 3. Summed probability distribution of dates from the houses, with and without binning.
A: The collected plot of all 184 radiocarbon dates from the settlement material from the Oslo Fjord area. LBA is included to a void a drop effect at 1100 BCE in the plots, but 124 dates are from the LN and EBA. Black line indicating the trajectory based on individual house.
B: Separated radiocarbon dates of two- and three-aisled houses in the region (By A. Mjærum).

Case studies

The case studies were partially chosen based on geographical representation within the study area (Figure 2), and partially due to some overall trends visible in the material (Table 2). For instance, close to 80 % of the total two-aisled material is found in Østfold on the eastern side of the fjord, especially in the areas south of Raet (Case 1), while a lower percentage of the three-aisled material is found in the same area (53 %). North of the fjord, the situation is the opposite (Case 2), with a higher percentage

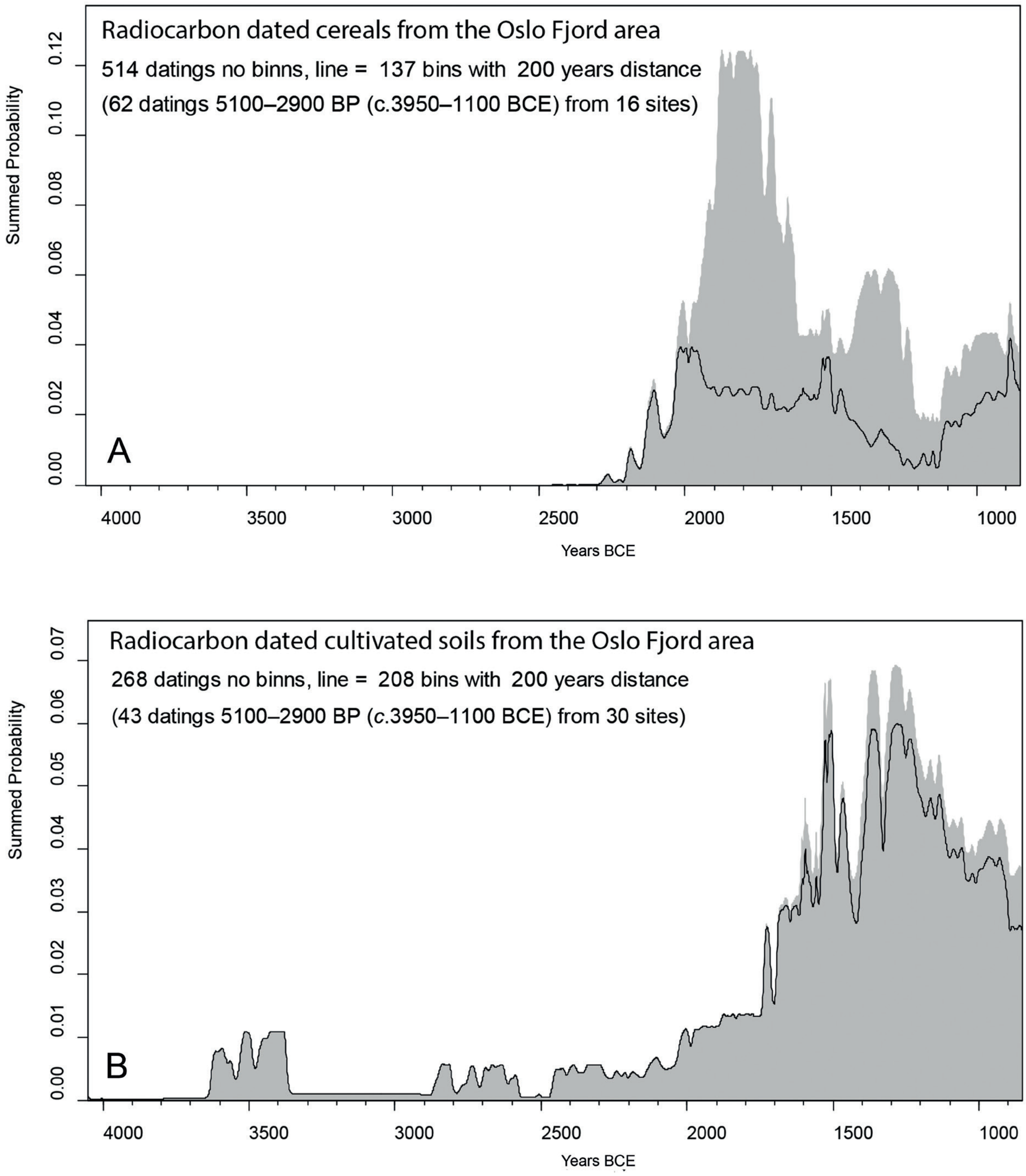

Figure 4. Summed probability distribution of A: dates from cereal and B: fossil tilled soils, with and without binning (By A. Mjærum).

of three-aisled houses than two-aisled ones. In the western part of the Oslo Fjord area (Case 3), three-aisled houses are not present in the material at all. In addition to these overall trends, we also chose the sites because they are among the best documented in the record. The following sections are rather short summaries of the sites, for further details about the settlements and the associated material found at the individual sites see Appendix 4 or the respective excavation reports referenced in Table 3.

Case 1: Eastern side of the fjord

Stensrød, Halden in Østfold

In 2002, three two-aisled houses were discovered at the site Stensrød (Rønne 2003), as the first recognition of houses dated to the LN and EBA in southeastern Norway. Two of the houses from Stensrød were complete (Figure 6), while a third close by building was only partially uncovered during excavation. The two complete houses were

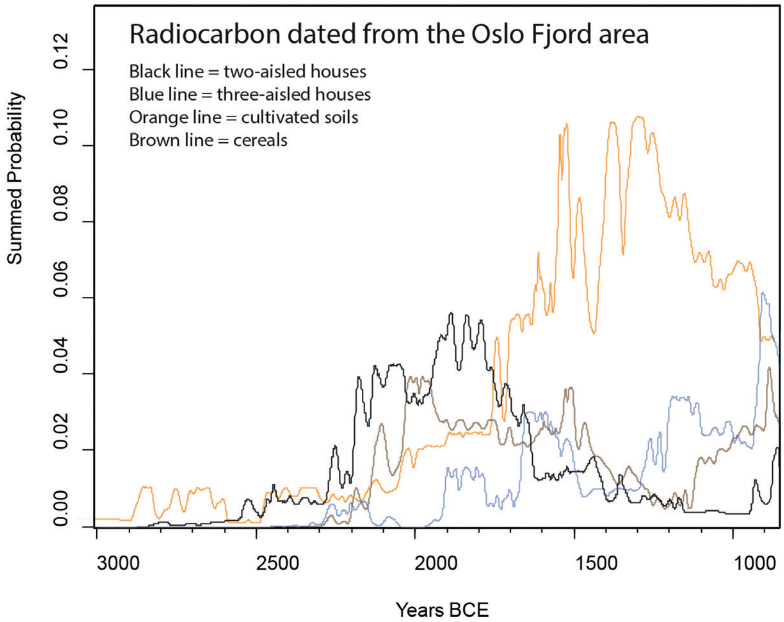

Figure 5. Compilation of the plots in figure 3B and 4. The combination effectively demonstrates the different trajectories of the establishment of longhouses to that of dated cereal and cultivated soil (By A. Sand-Eriksen)

Case	Site	Period	Estimated Absolute Dates	House types: 2-aisl.	3-aisl.	Other	Measurements: Length (meters)	Width (meters)	Cereals: Barley	Wheat	Other	Finds: Bones	Pottery	Lithics	References
1	Stensrød	LN	2285-1775 calBCE	3	-	?	19.5-24.5	5.2-5.4	x	x	-	x	x	x	Rønne, 2003
	Opstad	LN	(2200/) 1975-1695 calBCE	4		2 -	19.2-23.1	4.8-6.7	x	x	x	x	x	x	Munch Havestein, in prep
2	Huseby	LN-EBA II	1880-1425 calBCE	1-3	3?	1?	13.5-17.5	5.2	x	x	-	x	x	x	Rødsrud, 2014
	Asak	LN II	(2110/) 1945-1775 calBCE	2	-	-	11-14	-	-	-	-	-	-	-	Eggen, 2010
3	Nordby	LN-EBA II	(2280/) 1960-1450 calBCE	2	-	1	17	4.8-5	x	-	-	x	x	x	Gjerpe & Bukkemoen,2008
	Løveskogen	LN-EBA III	(2285/) 1880-1115 calBCE	2>	-	1?	15.5>	5.5-5.7	x	x	-	x	x	x	Sand-Eriksen & Mjærum,2021

Table 3. Data from the case studies after sites. Estimated Absolute Dates shows the outliers, dates outside brackets are regarded as representative for the living phase. See Appendix 4 for further details about the settlements and the associated artefacts and ecofacts found at the respective sites.

partially superimposed (see Figure 1A in Appendix 4). The smallest of the houses (for details see Table 3) was stratigraphically older than the larger house, also supported by radiocarbon dating's of the buildings. The smaller house could be dated to between 2150-2050 BCE, while the larger house was dated to around the transition between LN I and II (for details on radiocarbon dates, see Table 1 in Appendix 4 or Supplement).

The site was located in a small valley *c.*600 m from the present coastline, in an area that with a 15-20 m higher sea level would have been an island, and the location was interpreted as indicating that conditions for agro-pastoral activities were more decisive than the sea (Glørstad 2004, 69-70). The location was also noted as marginal, suggested to be due to better locations for farming already being taken (Rønne, 2004, 66). Around a dozen cereal grains were found at Stensrød, and the site can be connected to some level of arable farming and pastoralism, most likely in combination with other subsistence practices (for details see Appendix 4).

Opstad Vest, Sarpsborg in Østfold

At the site Opstad, 23 km from Stensrød, four two-aisled houses were excavated in 2019 (Munch Havstein in prep.). As at Stensrød, two of the houses at Opstad were superimposed, both had (more or less) complete ground plans uncovered during the excavation (Figure 6, also see Figure 1B in Appendix 4). Both houses are dated within LN II (for details on radiocarbon dates, see Table 1 in Appendix 4 or Supplement), while the two partial houses found at Opstad predate the two complete houses. Compared to general trends in houses elsewhere in Scandinavia (Artursson 2009, 50-51, 70), the houses from both Stensrød and Opstad are lower- to medium-sized (Table 3).

At Opstad 265 cereal grains were found in connection with the definable two-aisled houses, and

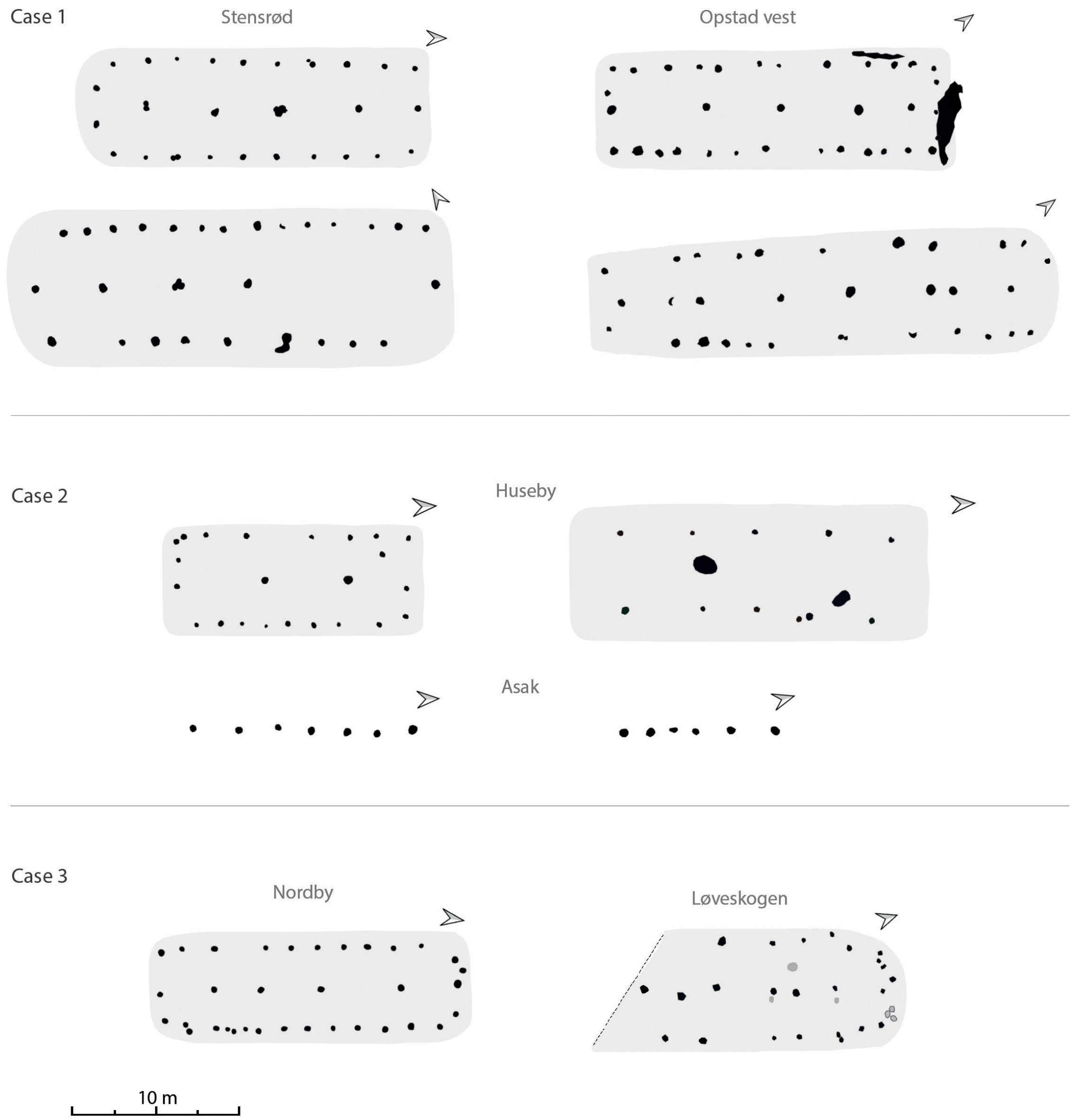

Figure 6. Ground plans of the most definable houses from the sites separated in the three cases. See Appendix 4 for more detailed depictions, including in-site relation between houses, other structures, etc. (By A. Sand-Eriksen).

this number is significantly higher than what is normally uncovered at archaeological excavations in southeastern Norway. Based on the radiocarbon dates of the cereals as well as their context in connection to the two definable houses, agricultural activity can only be connected to the later settlement phases at the site with certainty. The site was situated around 300-350 m away from the contemporary shoreline and was as such situated closer to the sea than Stensrød, and in addition, the data suggests a stronger empirical evidence of the presence of farming.

Case 2: North of the fjord

Huseby and Asak, Skedsmo in Akershus

At Huseby, remnants of four to six buildings were found during excavations in 2011 (Rødsrud 2014). Of the buildings, two are defined as two-aisled and three-aisled houses, while another two are defined as three-aisled in the excavation reports, however, there are some insecurities in the interpretations (for details see Appendix 4). We will therefore focus on the two definable houses at Huseby, and the two two-aisled houses from the nearby site Asak found during excavations in 2008 (Eggen 2010) in this paper. The two sites are located approximately

70 km north of Raet, around 20 km from the sea and 6.5 km from large lakes within the Glomma watershed, Norway's longest and largest river.

A striking feature in the house material from Case 2, is the fact that they are remarkably smaller than the LN and EBA houses found south of Raet (Figure 6; Table 3). The two-aisled houses from both sites are dated within the LN-EBA transition, making them younger than those from Case 1 (for details on radiocarbon dates see Table 3 in Appendix 4 or Supplement). The combination of younger dates and smaller sizes goes against the general architectonical trend of a gradual increase in building sizes from the LN II throughout EBA II (Artursson 2009, Fig. 2). However, it could, for instance, reflect the increased variations in the settlement material connected to increased hierarchy within the society (Brink 2013, 439). At Huseby, there is also an overall strong consolidation of arable farming, with cereals found in all buildings, and a wider variety of cereal types than at any other of the sites. There is also a remarkably low number of other finds, particularly flint (see Appendix 4).

Case 3: Western side of the fjord

Nordby, Larvik in Vestfold

During excavations in 2006, two two-aisled houses dated to the LN and a third house or building dated to the EBA I-II were found at Nordby (for details on radiocarbon dates see Table 4 in Appendix 4 or Supplement; Gjerpe and Bukkemoen 2008, 7). One of the houses had preserved wall-posts (Figure 6), and as rather similar to that from Stensrød, except smaller. A rock shelter 40 m west of the settlement was excavated simultaneously. While this included both finds and radiocarbon dates pre- and post-dating the settlement, C14-dates (3670±35BP, TUa-6692; 3120±35BP, TUa-6694) demonstrates that it could have been a working or storage place contemporary with the LN and EBA houses (Gjerpe and Bukkemoen 2008, 35). The mentioned dates were on bones from seal (*Phoca vitulina*) and beaver (*Castor fiber*), indicating a connection to water as part of their economy, further supported by its close proximity to the sea. With a 15-20 m higher sea-level, an inlet would make the distance to the contemporary shoreline no more than around 200 metres. There are also other finds demonstrating agro-pastoral and hunting activities at the site (see Appendix 4)

Løveskogen, Larvik in Vestfold

Only 5.5 km from Nordby, the site Løveskogen was excavated in 2019 (Sand-Eriksen and Mjærum 2021). At Løveskogen, two two-aisled houses and traces of a third building were uncovered. One of the houses is securely dated to the decades around 1300 BCE (for details on radiocarbon dates see Table 4 in Appendix 4 or Supplement), demonstrating that the two-aisled building technique survived much longer than expected, while the other buildings are older, based on both stratigraphical features and radiocarbon dates. The site demonstrates the persistence of a long-term farmyard, similar to Nordby, with continued settlement activity at the same places for several centuries, dating back to *c.*2000 BCE. As at Nordby, a rock shelter located relatively close to Løveskogen has previously been excavated (Østmo 1993), and could perhaps have been part of the larger farm.

In addition to the houses, a large refuse layer was found at Løveskogen, with numerous associated finds, such as 1.2 kg pottery, flint debitage, a flint dagger and a Nøklegård point, as well as several bone fragments. Although none could be securely identified, some are likely from domesticated animals (for details see Appendix 4). In addition to the bone fragments, traces of animal faeces were found in a sample from the layer, a direct evidence of animals being kept on or near the site. The local pollen diagram also showed a stronger presence of pastoralism compared to cultivation in the area (Høeg 2020, 4).

Discussion

The case studies demonstrate that the different trajectories of the establishment of houses on the one hand and the beginning of cereal cultivation and cultivated soil on the other, made visible in the SPD (Figure 5), also is detectable in the local site material. The late establishment of a full-scale agro-pastoral production in the Oslo Fjord area stands in particularly stark contrast to the more profound changes in the material culture around 2350 BCE, but there is also a pronounced delay in the onset of extensive crop farming compared to the establishment of two-aisled houses in the region, which, based on our results is at least a century. Consequently, these different trajectories demonstrate the likelihood of a more gradual farming development in the Oslo Fjord area, rather than a swift transition, which indirectly also opens the possibility of certain farming practices were introduced in the area before 2350 BCE. Moreover, the case studies also reveal a variety of settlements and economic practices in the region, evident both temporally and geographically.

The complexity of the development trajectories of the early farm-based settlements can in our opinion best be understood with the help of the concept of 'bounded rationality' (Simon 1955, 1959). The concept provides a conceptualisation of people's decision-making as 'rational behavior that is compatible with the access to information and the computational capacities that are actually possessed by organisms, including man, in the kinds of environments in which such organisms exist' (Simon 1955, 99). People exhibiting such bounded rationalities have a tendency to 'satisfice' rather than to 'optimise' given the available information in a specific environment (Foxon 2006). This also means that what would be an irrational decision strategy in one environment, can be entirely rational in another. The inertia in both crop farming and the establishment of a full-scale agro-pastoral production compared to the emergence of two-aisled houses in the Oslo Fjord area, could for the LN farmers living in, for instance, Jutland or perhaps even in southwestern Norway, be an irrational choice. In the Oslo Fjord area on the other hand, it demonstrates bounded rationalities within a given ecological structure, resulting in adaptability to environmental conditions. At Opstad, Østfold (Case 1), for instance, no large-scale agricultural activity can be connected to the first settlement phases, but then this became much more pronounced in the following phases. This does not mean that those settling there in the first phase could not have practiced farming. The low number of seeds may be caused by a low intensive cultivation, or that the processing chain for seeds deferred from later periods (see Soltvedt 2020, 31, with further ref.). However, our record indicates that the LN farming pioneers adapted in a way that was satisfactory in the given situation, and that it took generations to learn and master the local landscape affordances in regards to farming practices (cf. Robb 2013, 671). The people settling in the area could have needed to make (different) decisions based on limited or imperfect information (perhaps even ability and time).

Inherent in the above reasoning is the emergence of the two-aisled building technique as part of an expansion within the larger Scandinavian society (e.g. Kristiansen 2010), which Stensrød's similarity with LN houses from the district Vendsyssel in northern Jutland clearly exemplifies (for details see Appendix 4). This means that we see the introduction of farming happening at least partly because of migration and long-lasting contact, but do, however, not discount the possibility that foragers also learned how to grow crops. LN and EBA records of aDNA and isotopes support increased mobility of females, males and children in southwestern Sweden, especially from *c.*1950 cal. BCE (Blank et al. 2021, 64). Our architectural record, alongside the recorded artefacts, support the idea of a close contact, not only as a migration wave, but as established long-lasting relations between eastern Norway and parts of southern Scandinavia (Anthony 1990, 903-905). The inertia and variety in our findings could be a result of economic creolization between and within groups in this larger area, counterbalancing the 'bounded rationalities' and optimising the situation within the available information and environmental conditions. We will return to this concept after discussing the settlement and farming developments in the Oslo Fjord area.

Settlement developments

Since two-aisled houses first appeared in the eastern parts of Østfold (Stensrød, Case 1) bordering present-day Sweden, the processes happening around the Oslo Fjord cannot be seen isolated from this area, as mentioned above. However, the number of excavated houses is low along the northern parts of the southwestern coast of Sweden (Artursson 2009, 166), to which the Oslo Fjord area is directly connected. It has unfortunately not been possible with any direct comparison of the house structures between the areas. As previously mentioned, Stensrød do, however, show a striking similarity to LN houses from the district of Vendsyssel (see Appendix 4), situated just across the Kattegat strait (see Figure 1). Several of the houses in this area are suggested to have been built within the same template (Sarauw 2019, 164), one that Stensrød also might fit into.

Opstad, on the other hand, demonstrates a closer similarity to houses found at Limensgård on Bornholm, and House AB in particular (see Nielsen and Nielsen 2019; Nielsen 2019). A common trait in the large Limensgård houses, and in eastern Denmark and Scania in general throughout the LN (Björhem and Säfvestad 1989; Brink 2013; Nielsen 2019, 905), is the utilization of recessed supporting posts. This is not interpreted as present at Opstad in the excavation report. Since the rest of the ground plan is so similar, we see this a possible deliberate adaption of building technique within a specific environment. Such an adaption to regional conditions could also be present in the houses from Case 2, where a smaller size is a common feature compared to both Case 1 and 3. The houses from Case 2 are younger than most of the houses from the other cases, which goes against the general architectonical trend in southern Scandinavia of a gradual increase in building sizes from the LN II throughout the EBA II (Artursson 2009, Fig. 2). A possible explanation is that this reflects increased variations in the settlement material connected to an increased hierarchy within the society (Brink 2013, 439), but it could also be a deliberate adaption of the building technique in regards to environment and/or economy. Studies on houses have, for instance, noted that size is likely do decrease in colder climates, as this allows a more efficient heating, as well as within societies more reliant on pastoralism or other mobile subsistence practices compared to crop farming (Porčić 2011). Not only are the houses in Case 2 generally smaller than the houses from the other cases, the houses from both Case 1 and 3 are also quite small compared to general trends in houses elsewhere in Scandinavia (Artursson 2009, 50-51, 70). The outlined tendencies in the houses demonstrate both the potential and need for a more detailed study of the buildings from southeastern Norway.

A striking feature in the settlement material from the case studies, is the continued settlement activity at several of the sites. This is well illustrated by the site Løveskogen (Case 3), which was first settled around 2000 BCE, while the last two-aisled house was built as late as around 1300 BCE. Based on excavation data from the most excavated part of the region (Figure 7), there seems to have been broad habitual stretches of land accessible, and people could easily have moved their farms and carried out more extensive farming practices already from the LN. To continue the activity at the same places for centuries, as demonstrated in all three cases, stands out as a deliberate choice and a specific feature of the early farming settlements in the Oslo Fjord area. Compared to material components, such as daggers, houses are slow responders, however. The lifespan of a house can span anything from 20-30 years to 50-100 years, perhaps even as long as 150 years in certain cases (Artursson 2009, 34). As such, houses can potentially span multiple generations, and we must therefore exercise a certain caution when using houses to study change. Nevertheless, this caution does not affect the timing of the establishment of the houses in the Oslo Fjord area to 2200-2100 BCE and the fact that some of the settlements were inhabited for many generations, a conclusion derived from both the radiocarbon datasets and the case studies.

Farming developments

The long-lasting sedentary tendencies in our results are not in compliance with what is to be expected of slash-and-burn farming, which is argued to be the earliest method of cultivation (Fischer 2002, 350). Slash-and-burn consists of a shifting clearance technique for short-term cultivation, involving a regular moving of fields and settlements (Simonsen 2017, 279-285; Sørensen 2014, 3). This method has been criticised for requiring too much movement and larger areas than reasonably manageable for the early farmers, resulting in more long-lasting methods being suggested as alternatives (Gron and Rowley-Conwy 2017, 99), such as fixed fields managed and cultivated using hoes and digging sticks (Rowley-Conwy 2004, 93). Slash-and-burn agriculture has also been criticized

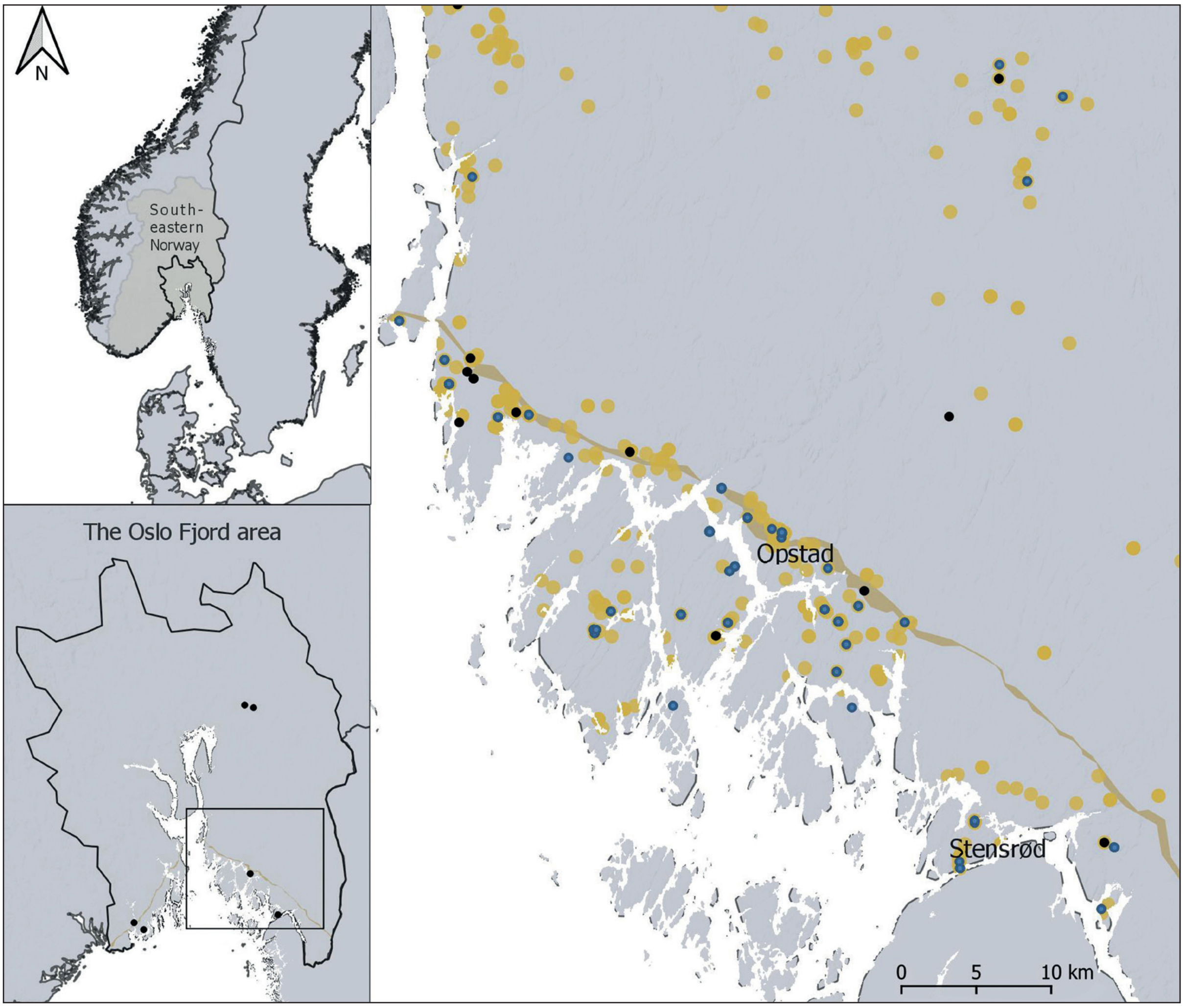

Figure 7. Map showing all archaeological excavations by MCH in the southernmost part of Østfold on the eastern side of the fjord marked in yellow. Black marks the settlement sites, while the blue indicates sites with archaeological features or structures radiocarbon dated to the LN and EBA (By A. Sand-Eriksen).

for being in direct conflict with keeping domesticated animals (Gron 2020, 322). Using livestock, such as sheep, cattle, and pigs, in the permanent field systems, would, according to P. Rowley-Conwy (1981, 91), make much more sense than slash-and-burn, as these animals would provide traction, manuring, cleaning, weeding, and even overturning the soil. Although there is still limited evidence, a recent study (Gron 2020) suggests that this could be an equally valid early farming system in Scandinavia as slash-and-burn. A recent study by R.R. Bishop and colleges (2022) have further reinforced the picture of variability in early cultivation practices across Neolithic northwestern Europe (Bishop et al. 2022, 4-9).

Based on our results, particularly the sedentary tendencies, which we believe could point towards a practice of long-lasting field systems, and delay in the establishment of full-scale agriculture, we want to suggest an existence of a subsistence practice where pastoralism was a better scenario than large scale crop agriculture for the farmers settling in the Oslo Fjord area during the LN. The traces of animal faeces found at Løveskogen (Case 3) is direct evidence that animals were being kept on or near the site. This is further supported by palynological data from the area, demonstrating a stronger presence of pastoralism compared to cultivation during the LN and EBA (Høeg 2020, 4). Except from Asak (Case 2), cereals were found at all sites, confirming that crop farming was part of their domestic economy, however. Apart from possible traces of fields and clearance at Stensrød (see Appendix 4), none of the sites yielded any tangible evidence of agricultural practices. If we consider the settlements long periods of use, this should have been more substantial than a couple of fragmented sickles (see Table 2 in Appendix 4). This could indicate that the earliest LN agriculture in the Oslo Fjord area had a different form than that suggested for other areas of southern Scandinavia from the same period, which could explain why few archaeological traces of earlier farming are preserved or visible today. Indirectly, our results also open up for farming being introduced before 2350 BCE, but perhaps not as how we intuitively imagine it to be.

Data from tilled soils suggest an intensification of farming practices towards the LN-EBA transition in the study area. This intensification coincides with the time new two-aisled houses replace old ones at several of the sites. A possible explanation for the intensification could be the necessity to invest more to maintain required levels of production in areas that had been cultivated for several generations. This process seems to appear a little earlier in Østfold compared to other parts of the Oslo Fjord area (Appendix 3), something which may be explained by the overall close connection to present-day Sweden, as discussed above, but also the area's overall suitable environmental conditions for agriculture, which could have eased an adaption of south Scandinavian farming practices.

Optimising through creolization?

Based on our results of an inertia in crop farming, which we see due to the existence of bounded rationalities, we have suggested an existence of a farming practice where pastoralism was a better scenario for the early farmers settling in the Oslo Fjord area. Moreover, the evidence of hunting, fishing, and gathering in the archaeological record from the case studies also indicates how this pastoralism existed in combination with other practices, also including (lower levels of) crop cultivation. We suggest that economic creolization could be a suitable term for the economic practices taking place in the Oslo Fjord area in the LN and EBA. This differs from a mixed or multiple economic practice by how it is adapted to local circumstances, and becomes a result of the interchange and ongoing dynamic between two (or more) groups (Eriksen 2007, 156, 171-172). This would explain the heterogeneity or variety of settlements and economic practices in the region made visible in the case studies, which blurs the otherwise proposed homogeneous cultural expression of the LN in southern Norway. Similar heterogeneity, or a blurred economic situation, has been applied to the cultural diversity in the MN material assemblage from southern Scandinavia (e.g. Iversen 2015).

Although the bounded rationalities, could have asserted itself when migrating farmers were faced with new environmental conditions, and directly resulting in an inertia in crop farming compared to the emergence of two-aisled longhouses, economic creolization could also be a way of optimising this circumstance. This implies that the economic expressions of the Oslo Fjord area to a larger degree were dependent on availability rather than cultural preference. Within this, the migrating farmers would have needed to familiarize themselves with local possibilities and restraints, challenges that may have been reinforced by the possible temperature decline *c.*2200 BCE (cf. Hammarlund et al. 2003, 367-368). During the time of transition, local inhabitants could have been more active agents than passive recipients in the Oslo Fjord area during the LN and EBA (also see Nyland 2020).

Concluding remarks

The study has used radiocarbon-dated buildings, cereals, and cultivated soils to address the establishment of farming in the Oslo Fjord area. This has demonstrated a delay in the onset of crop farming compared to the establishment of houses in the region, which also contrasts the more profound changes in the material culture around 2350 BCE. Overall, the study demonstrates the likelihood of a more gradual and adaptive farming development in the Oslo Fjord area in the LN and EBA, which in the earliest parts seems to be more oriented towards pastoralism, while the presence of agriculture grows throughout the EBA. We have suggested an understanding of the agricultural developments in the Oslo Fjord area from the onset of the LN as results of an economic creolization, where migrating farmers adapted to local circumstances, both in terms of landscape, environment and to/with those already inhabiting the area.

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Notes

1) The Oslo Fjord area is a commonly used term, but not a pre-defined area. Our definition is the coastal region and adjoining lowlands around the fjord and is based on historical landscape divisions and modern administrative borders.
2) Retrieved from the museum database Unimus in April 2022. From all of southeastern Norway the number is 661, all are, however, not listed by type in the database. The latest number of daggers with ascribed types are 445 from eastern Norway, which is approximately half of that from western Norway (see Apel, 2001, Table 9.2).

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Supplementary

Supplements see .xlsx- and .pdf-attachment