Impulses of agro-pastoralism in the 4th and 3rd millennia BC on the south-western coastal rim of Norway

Mari Høgestøl and Lisbeth Prøsch-Danielsen

A review of the available archaeological and palaeoecological evidence from the coastal heathlands of south-western Norway was compiled to reveal the processes of neolithisation proceeding from the Early Neolithic towards the generally accepted breakthrough in the Late Neolithic, 2500/2350 cal. BC. South-western Norway then became part of the Scandinavian, and thus the European, agricultural complex. Three phases of forest clearance are recorded — from 4000–3600 cal. BC, 2500–2200 cal. BC and 1900–1400 cal. BC. Deforestation was intentional and followed a regional pattern linked to the geology and topography of the land. In the first period (4000–2500 cal. BC), forage from broad-leaved trees was important, while cereal cultivation was scarcely recorded. Agro-Neolithic (here referring to agriculturally-related Neolithic) artefacts and eco-facts belonging to the Funnel Beaker and Battle Axe culture are rare, but pervasive. They must primarily be considered to be status indicators with a ritual function; the hunter-gatherer economy still dominated. The breakthrough in agro-pastoral production in the Late Neolithic was complex and the result of interactions between several variables, i.e. a) deforestation resulting from agriculture being practised for nearly 1500 years b) experience with small-scale agriculture through generations and c) intensified exchange systems with other South Scandinavian regions. From 2500/2350 cal. BC onwards, two distinct environmental courses are noticeable in all pollen diagrams from the study area, indicating expansion in pastoralism, either towards heath or towards grassland and permanent fields.

Keywords: south-western Norway, archaeology, pollen analysis, neolithisation, agro-pastoralism, clearance phases

Introduction

Although agriculture was introduced to various parts of Europe in different periods, the theoretical and scientific approaches relating to this event are often similar. Discussions concerning the processes leading to the final consolidation of agriculture in the different Nordic countries run parallel. This is despite the fact that there is a time lag of about 1500 years between this consolidation in southern Scandinavian (the transition at Late Mesolithic (LM)/Early Neolithic (EN)) and parts of Norway (the transition at Middle Neolithic Period II (MN II)/Early Late Neolithic (ELN)) (Petersson 1999; Prescott 1996; 2005). In our opinion, the course of events and the causes behind this defining transition can hardly be the same, independent of time and place. We have thus chosen to examine one particular area, namely south-western Norway (Fig. 1).

It is generally accepted that agro-pastoralism gained its final foothold in south-western Norway by the MN II/ELN transition. From this time onwards, the area became an integral part of the southern Scandinavian culture in which agriculture was economically fundamental. This is reflected by finds of, for example, two-aisled houses, specific artefacts and carbonised cereals. The same pattern has been uncovered over large parts of Norway, even in the most remote areas (Prescott 1995).

Mari Høgestøl (corresponding author) and Lisbeth Prøsch-Danielsen, Museum of Archaeology, Stavanger, P.O. Box 478, N-4002 Stavanger, Norway; e-mail: mho@ark.museum.no; lisbeth@ark.museum.no
Received November 2004; revised manuscript accepted October 2005.

Published by Maney
DOI 10.1179/174963106x97034

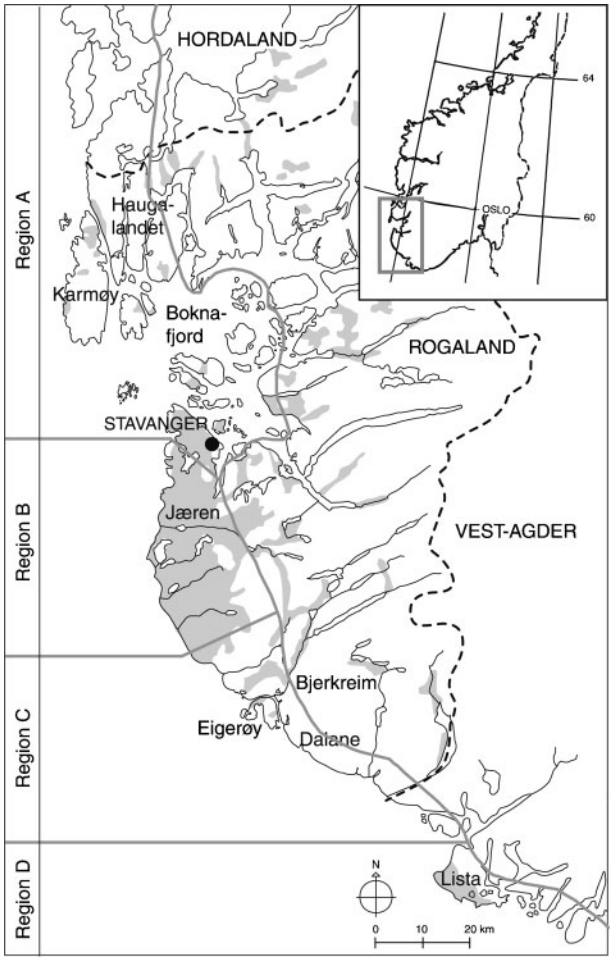


Figure 1 **The south-western part of Norway showing the eastern limit of the coastal heath (solid line). The area is further divided into four regions (A–D). The distribution of till and Quaternary deposits is shown in grey (from Prøsch-Danielsen and Simonsen 2000a; 2000b)**

The archaeological record from the periods preceding the Late Neolithic (LN) differs in general from that of southern Scandinavia, perhaps with the exception of the Oslo Fjord area (i.e. Østmo 1988). Nevertheless, a few artefacts and eco-facts indicating agricultural activities have been found, although the quantity of relevant finds is too limited to justify classifying these societies as 'agricultural'.

Numbers of anthropogenic indicators in the pollen diagrams from the area also increase subsequent to the MN II/ELN transition. Although processes operating in the ELN are not readily comparable to those active before that time, pollen analytical data indicate a course of events leading up to the MN II/ELN transition that encompasses deforestation in certain regions beginning as early as the EN. The pollen evidence thus indicates some degree of animal husbandry. Scattered episodes of cereal cultivation are also recorded before the transition to the ELN.

It would seem that different disciplines generate dissimilar narratives and explanations concerning events leading up to the MN II/ELN transition. Does this arise from an uncritical application of pollen data (Welinder 1988; Prescott 1996; Persson 1999) or may it be that our conception of the artefacts an agricultural society is thought to leave behind is too rigid? There is certainly dissatisfaction with de-contextualised (theoretically, chronologically and environmentally) blanket explanations, and we believe that high resolution, cross-disciplinary studies can help to identify some of the complexities of this long-term prehistoric process.

The aim of this paper is to formulate ideas and present new data on the course of events leading to the agro-pastoral breakthrough in the ELN through a combination of different approaches. This should provide a better starting point for a discussion of the existence or, more precisely, the variable impact of ecological, cultural and economic determinants for the rapid spread of agriculture around the MN II/ELN transition.

Study area and environmental setting

We have focused on the south-western part of Norway, primarily the coastal lowland heath belt. The number of ancient monuments and antiquities found here is among the greatest in Norway. The belt is restricted to areas with a pronounced oceanic climate, characterised by a mild, humid conditions limited inland by the January mean 0°C isotherm (Moen 1999). There is, in a Norwegian context, a rather long growing season of 210 to 220 days. The area comprises four natural geographical regions, separated primarily on the basis of their topography and geology (Fig. 1) (Prøsch-Danielsen and Simonsen 2000a; 2000b). These are:

A. Karmøy, Haugalandet and Boknafjord region, the 'Strandflaten' region with upland
B. Jæren, low-lying part and coastal upland region
C. Dalane region
D. Lista coastal region

Their characterising features include:

1. presence of archipelagos (region A and D)
2. nature of the bedrock, i.e. Pre-Cambrian (region C and D) or Caledonian orogenic complex (region A and B)
3. presence of thick Quaternary deposits (region B and D) (further details in Prøsch-Danielsen and Simonsen 2000a).

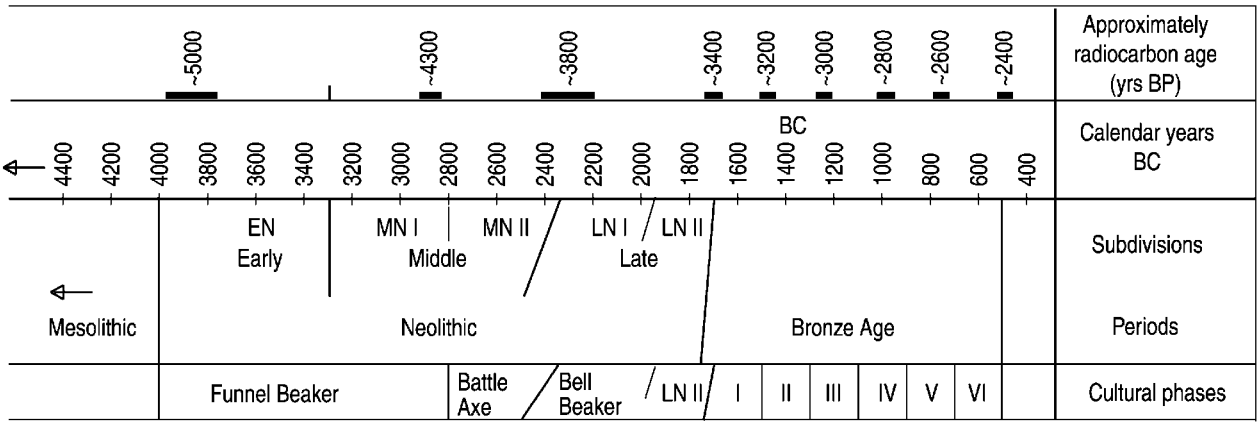


Figure 2 Overview of the chronology of the Neolithic and Bronze Age in south-western Norway — presented in uncalibrated ^{14}C-years BP and calibrated calendar years BC

Both the Jæren (B) and the Lista regions (D) are generally regarded as being among the most favourable, modern and highly efficient farmlands in Norway today. Dalane (C), on the other hand, is a mountainous area dominated by anorthosite, poor in plant nutrients. Region A constitutes a complex, varied landscape, favouring a mixed economy.

Although the study area is geographically restricted, it is varied in terms of nature and landscape type. These preconditions provide us with a good starting point for examining the role that ecological, geological and topographical conditions may have had on the evolution of agriculture.

Chronology and radiocarbon dates

The chronological subdivision of the Neolithic follows Nærøy (1987; 1993). The chronology for western Norway is based on local artefact assemblages, with data compiled primarily from Hordaland County. This is correlated with the southern Scandinavian chronology proposed by Fischer and Kristiansen (2002). The Bronze Age (BA) chronology follows Vandkilde *et al.* (1996) (Fig. 2).

Conventional radiocarbon dates were produced by the Radiological Dating Laboratory in Trondheim, Norway (T-..). AMS dates obtained for the oldest carbonised cereal grains from Rogaland were produced by the Svedberg Laboratory at the University of Uppsala, Sweden (TUa-..) and by Beta Analytical Inc. Florida, USA (*β*-..). The results, mentioned either in the text or in Table 1, are expressed in conventional uncalibrated ^{14}C years BP and calibrated according to Stuiver *et al.* (1998), OxCal 3·9

Table 1 The oldest radiocarbon-dated carbonised cereals from Rogaland. All cereals identified by Eli-Christine Soltvedt, Museum of Archaeology, Stavanger

Region	Site	Archaeological context	Cereal species	Lab. ref.	Age uncal. BP (T½ 5570)	Age cal. BC 2 sigma	References
A		pit	*Hordeum vulgare* L.	TUa-2988	3805±75	2470–2030	
		culture layer	*Hordeum vulgare*	TUa-2862	3690±60	2280–1880	
	Austbø	culture layer	*Hordeum vulgare*	TUa-2861	3610±75	2200–1740	Sandvik 2003
		culture layer	*Triticum sp.*	TUa-3417	3595±60	2140–1750	
		culture layer	*Hordeum vulgare* + *Triticum* sp.	TUa-3419	3540±55	2030–1690	
	Voll 27	two-aisled house	*Hordeum vulgare* var. *Nudum* L.	TUa-2601	3560±55	2040–1740	Soltvedt 1995
	Voll 59	culture layer	*Triticum dicoccum* L.	TUa-2600	3500±60	1980–1680	Soltvedt 1995
B	Håbakken	below stone fence A152	Unident. cerealia + charcoal	TUa-1838	3710±65	2300–1910	Soltvedt 1997; Juhl 2002
		two-aisled house II:19	Unident. cerealia	TUa-1846	3670±55	2280–1880	
	Jåttå	two-aisled house II:5	Unident. cerealia	TUa-1790	3610±150	2500–1600	Hemdorff *et al.* pers. comm.
		two-aisled house II:27	*Triticum* sp.	TUa-1847	3515±50	1960–1690	
	Soma	culture layer	*Hordeum vulgare* var. *nudum*	ß-118741	3640±40	2140–1880	
				ß-118740	3590±40	2120–1770	
				TUa-1453	3580±85	2200–1650	

(Bronk Ramsey 2003) expressed with a 95·4% confidence interval.

Historical account

Archaeological review

Traditionally, there have been two separate fields of interest within scientific research on the EN and MN periods: one has focused on the economies of hunting-gathering, while the other has been preoccupied with the introduction of agriculture, based on 'agro-Neolithic' artefacts. This trend can also be observed outside our study area.

In south-western Norway, there is a rich archaeological record from the Neolithic relating to hunting and fishing. However, no complete survey of Stone Age finds from regions A-C has been compiled since 1920 (Gjessing 1920). In the case of region D, no survey work whatsoever has been carried out. A few studies deal with particular sites (Bang-Andersen 1981; Skjølsvold 1977), placing these sites within a larger cultural context. Several excavation and archaeological project reports have been published (Ballin and Jensen 1995; Skjølsvold 1980a; 1980b; Juhl 2001), as well as some briefer articles (Bang-Andersen 1970; 1973).

The archaeological evidence indicates roots extending back into the Mesolithic. Most sites are located along the coast, but a few have also been found inland, principally along rivers and on the shores of lakes. Contrary to the situation further north in western Norway that indicates some degree of sedentary settlement, occupation of the sites in south-western Norway was probably seasonal.

Some groups of artefacts, such as boat axes, imported flint axes, as well as domestic and imported ceramics, have been described (Hinsch 1956; Skjølsvold 1977; Berg 1986; Glørstad 1996; Amundsen 2000). These artefacts have been traditionally regarded as indicators of an agricultural economy, though not necessarily at the place where they were found.

Regarding scientific analysis, the LN was for a long time a neglected period, both in the south-western part of Norway and Norway in general. More recently, however, it has become increasingly subject to attention. A number of studies on groups of materials, as well as the social, ideological and economic conditions, have been published (Scheen 1979; Berg 1986; Solberg 1993; Prescott and Walderhaug 1995; Prescott 1996; Holberg 2000). In the course of the last 15 years, completely new structures and building traditions have uncovered in our study area; namely two-aisled houses. Ten certain examples, and a few less clear structures, with obvious parallels to the South Scandinavian material have so far been excavated (Høgestøl 1995; Løken *et al*. 1996; Børsheim 2005).

Even though 'agro-Neolithic' artefacts from the EN and MN periods may not in themselves prove the existence of animal husbandry and arable agriculture, they do constitute material elements of an agricultural society, and at least indicate interaction with such societies. It may therefore be useful to investigate the geographical distribution of these artefacts, compare the results of this with those from palynological and archaeobotanical studies, and assess differences between the EN/MN patterns and those of the LN.

Palaeoecological review

The initial pollen studies on the origin and management of the coastal heathland in Hordaland, further north on the west coast (Kaland 1979; 1986), led to a breakthrough in understanding early pastoralism in this part of Norway. Kaland's studies, based on peaty soil profiles, led to 'an abrupt local deforestation model', where a heath stage immediately followed deforestation by burning. Kaland demonstrated that the coastal heathlands were anthropogenic in origin, maintained through continual grazing and burning, and not, as postulated in previous explanations, the result of severe climatic deterioration.

> *"From the very beginning the heath was regularly burnt and used as grazing area for the livestock. The deforestation of the coast was regionally a gradual process which continued for more than 3000 years" (Kaland 1986, 19).*

The oldest heaths were formed at the MN I/MN II transition, i.e. dated by radiocarbon to 4310 ± 60 uncal. BP, 3100–2700 cal. BC. Kaland (1986) also stressed that

> *"the population in the heath district always combined farming with fishing and sea hunting for whales, seals and birds" (Kaland 1986, 22).*

Although the heathlands were established in the MN, the two main periods of rapid heath expansion have been shown to be comparatively late in Hordaland; within the Pre-Roman Iron Age (300 BC–AD 1) and within the Viking Age and Medieval period (AD 900–1100).

Insight into the environmental changes occurring in the coastal heathlands further south in the 4th and 3rd millennia BC has increased considerably due to extensive palaeoecological research in the last 15 years. In the 1990s, pollen data from 58 localities

were compiled, providing a descriptive, chronological, ecological and cultural framework for describing and interpreting the deforestation process (Prøsch-Danielsen 1996; Prøsch-Danielsen and Simonsen 2000a; 2000b). Additionally, new data have been generated by measuring magnetic susceptibility (MSc) parameters to soil sections (Prøsch-Danielsen and Sandgren 2003).

In contrast to Kaland's 'abrupt model', data from the various pollen diagrams in our study area indicate variable patterns in the vegetation history, ranging from abrupt deforestation to a gradual to stepwise process. These different patterns can be explained by variation in the size of the pollen catchment areas; i.e. either local, extra-local or regional pollen source areas. It is also worth noting that developments lead in one of two directions; primarily towards heathland (region A-C) but also towards grassland and permanent infields (region D). Compared to the pioneer studies in Hordaland, we also see that the process of deforestation and heath establishment occurred earlier. Deforestation seems to have been metachronous, resulting in a regional mosaic lasting more than 3600 years. Three pronounced clearance phases have been identified in the Neolithic and Early Bronze Age (EBA) (Fig. 3):

1. 4000–3600 cal. BC (Mesolithic/Early Neolithic transition)
2. 2500–2200 cal. BC (Middle Neolithic II/ Early Late Neolithic transition)
3. 1900–1400 cal. BC (Late Neolithic to Bronze Age period II).

As far as the expansion of heathland is concerned, events corresponding to clearance phases 1 and 2 can be identified, but the dramatic transformations seem to occur as of Bronze Age period V (900–700 cal. BC). With this in mind, the clearance phases reflect the introduction and early practising of animal husbandry, and thus the agricultural history of this region.

In Rogaland (especially in region A and B), sampling for macroscopic plant remains has been an integral part of every archaeological investigation since 1975 (Soltvedt 1995; 2000; Bakkevig *et al*. 2002). This systematic sampling has provided an invaluable source of data for the understanding of the agro-pastoral economy during the Neolithic. The development of cereal cultivation, based on evidence from plant remains recovered from archaeological sites, shows two main phases; small-scaled cereal cultivation 2500–2200 cal. BC followed by the major breakthrough around 2200/2000 cal. BC.

The archaeological and environmental archaeological evidence

EN/MN I (Funnel Beaker culture, 4000/3800–2800 cal. BC)

The number of 'agro-Neolithic' artefacts dating from around 4000–2800 BC is modest. For example, there are approximately 20 flint axes from the EN/MN (Fig. 4). Two of these were recovered from a LN votive deposit, indicating that they had been deposited more than 1500 years later than their typological date, the rest are without primary context (Berg 1986; Amundsen 2000). A few faceted axes have also been found (Hinsch 1955).

Recently, there has been a discussion concerning the age of Norwegian (and indeed Scandinavian) decorated ceramics. Until recently it was assumed, on typological grounds, that these date back to MN II (Skjølsvold 1977; Bang-Andersen 1981). Recent AMS-dating of carbonised organic material encrusting the ceramics suggests that this particular type mainly originates from the EN and the MN I (Glørstad 1996; Amundsen 2000). However, as the number of dates and chemical analyses has increased, serious inconsistencies have become apparent in the Scandinavian data and these AMS dates are now used with caution. The relatively few localities with ceramics, six in all, are distributed along the entire coast. They are all dwelling sites and the archaeological inventories are indicative of hunting.

The ecofacts recovered include a bone from a domesticated ox (*Bos domesticus* L.) (Hufthammer 2000). This is dated to 4405 ± 65 uncal. BP, 3340–2890 cal. BC and is from the Stangelandshelleren rock shelter in region B. Numerous bones of various species of birds, wild boar, red deer, sheep and goat were also found. The archaeological artefacts indicate that the shelter was in use for a long period of time, extending up into the Iron Age.

In short, ceramics and hunter-gatherer related artefacts come from dwelling sites, whereas the axes are stray finds. The find-sites for the ceramics and the bone (Fig. 5) are scattered across regions A-C, while the axes were mainly found in region B.

Pollen data suggest a contrasting pattern in which the first period of forest clearance started in the time interval 4000/3600 cal. BC in region A and D (Fig. 3). The forest clearance indicates an active use of land for grazing. The impact of the grazing developed gradually and extended over a period of 2300 years in region A. In region D the initial impact was greater and seems to have been concentrated in the Early and Middle Neolithic.

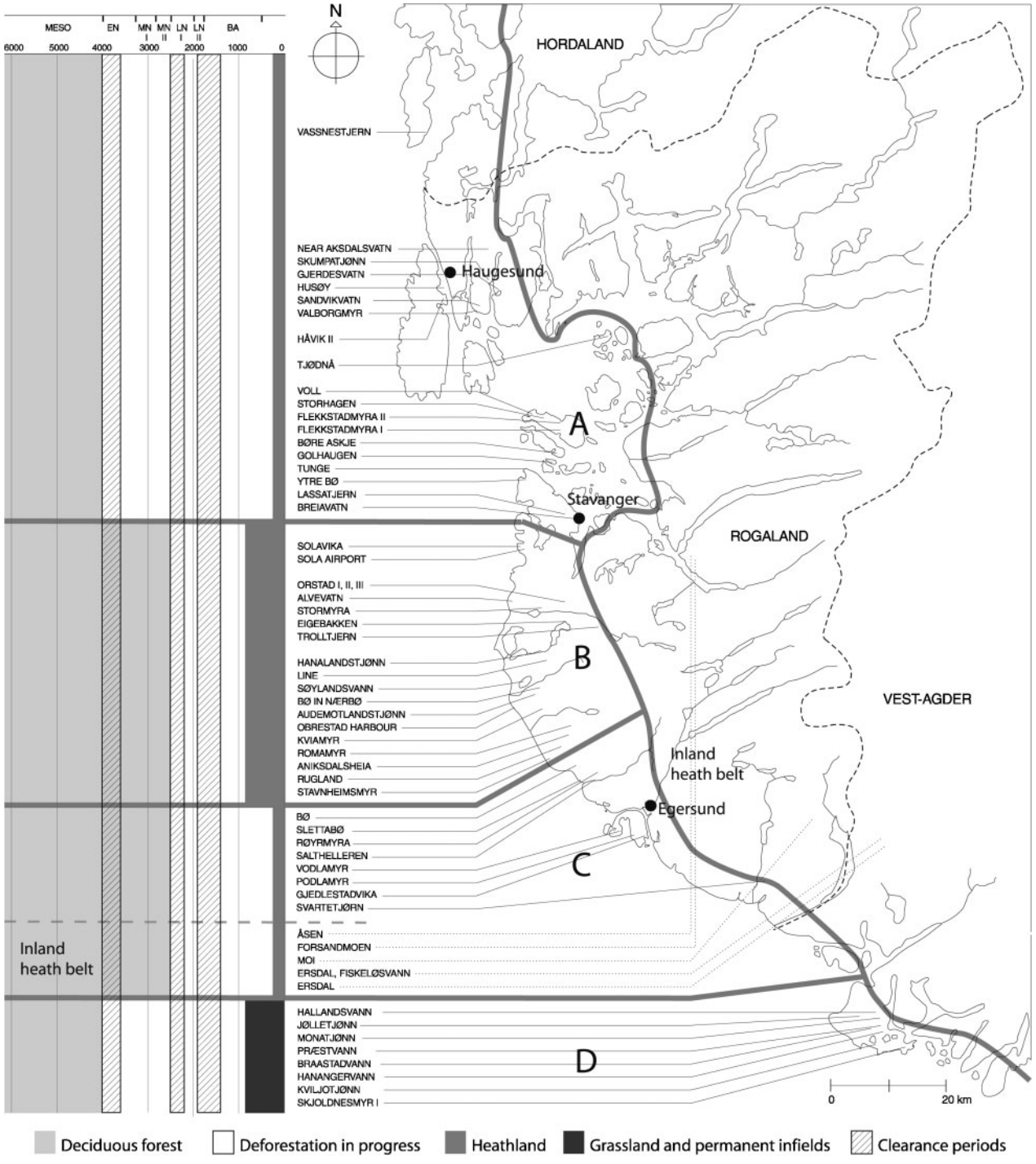


Figure 3 The dates of the inferred deforestation and final establishment of heathland or grassland and permanent infields for regions A–D and also the inland heath belt. Clearance phases (1–3) are hatched (after Prøsch-Danielsen and Simonsen 2000b)

During the deforestation process, some localities in region A show a semi-stationary stage in which elm (*Ulmus*), ash (*Fraxinus*), lime (*Tilia*) and, in part, hazel (*Corylus*) were favoured. This stage may reflect farming practises primarily based on cattle, where foraging for fodder from broadleaved trees was important (Simonsen and Prøsch-Danielsen 2005). Only a single find of Cerealia pollen has so far been recorded from this region, in Lake Lassetjern with a date estimated to 5300 BP (app. 4000 cal. BC) (Fægri 1944; Prøsch-Danielsen and Simonsen 2000a).

In region D (at Lista), covariance between broad-leaved and open-field species is not pronounced. A short-lived peak of broad-leaved trees after the first

Figure 4 A flint axe and part of a flint axe from the EN in Rogaland, south-western Norway. Photo: Terje Tveit, AmS

appearance of ribwort plantain (*Plantago lanceolata* L.), indicative of pastures, could reflect harvesting of leaf fodder. But it may also be a consequence of

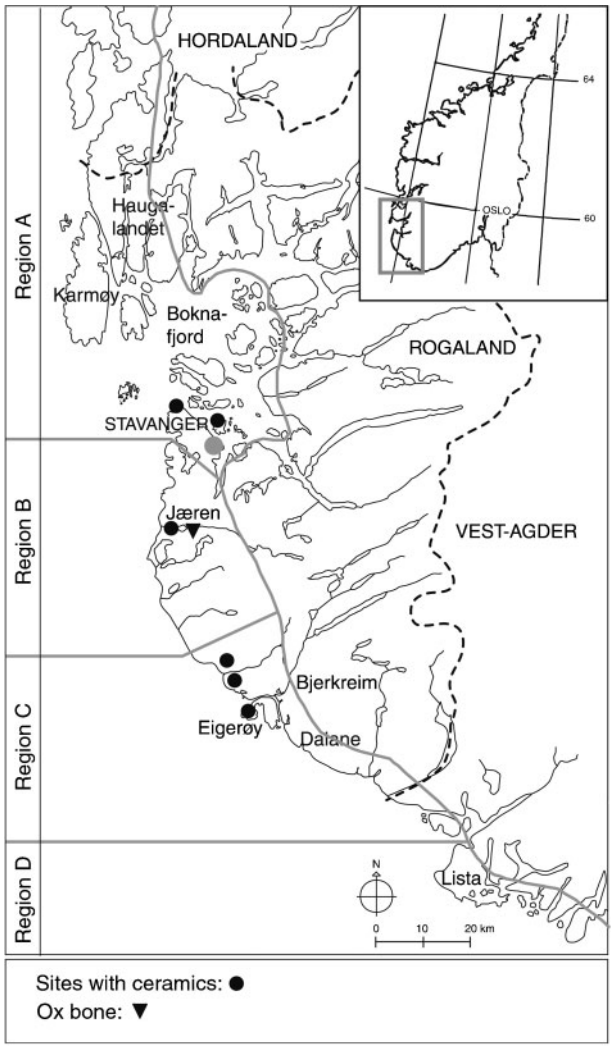


Figure 5 Sites with ceramics and ox bone in regions A-D of south-west Norway during the EN/MN II

Figure 6 Boat axe from MN II found in region B. Photo: Åge Pedersen, AmS

human forest clearance producing better conditions, especially for lime (*Tilia*) and the light-demanding oak (*Quercus*). Human impact was intensive in this time interval and large-scaled forest clearance followed, indicating continued agricultural expansion. Grasslands were established and maintained by high grazing pressure (Simonsen and Prøsch-Danielsen 2005). The earliest recorded occurrences of Cerealia pollen in the Lista region are from 5685 ± 125 uncal. BP, 4850–4250 cal. BC and to 5240 ± 60 uncal. BP, 4250–3950 cal. BC in Lake Braastadvatn and Lake Kviljotjønn respectively (Prøsch-Danielsen 1996; 1997).

MN II (Battle Axe Culture, 2800–2500/2350 cal. BC)

In Hordaland, further north (Hjelle *et al.* in press), large dwelling sites with numerous artefacts were abandoned by the transition to MN II, and the sites thereafter became fewer and smaller. In contrast, the habitation pattern is more continuous in our study area, both in terms of geography and distribution.

During MN II, the number of flint axes increased. Approximately 130 axes have been found (Berg 1986; Amundsen 2000), coinciding with the closing down of local stone quarries (Alsaker 1987). The majority of the flint axes originate from the Swedish/Norwegian Battle Axe Culture, while some can be traced back to the Jutlandic Single Grave Culture. Most are 'stray' finds, but like the axes from the preceding periods, some of these were uncovered in votive/hoard finds together with LN artefacts, indicative of a significant gap between production and deposition. Characteristically, some of these axes were worn and reworked (Berg 1986). This indicates that these objects were valued and used over a very long period of time, and 'hand-to-hand' exchanges through time probably took place. Approximately 20 boat axes have been found (Fig. 6). Some of these seem to be

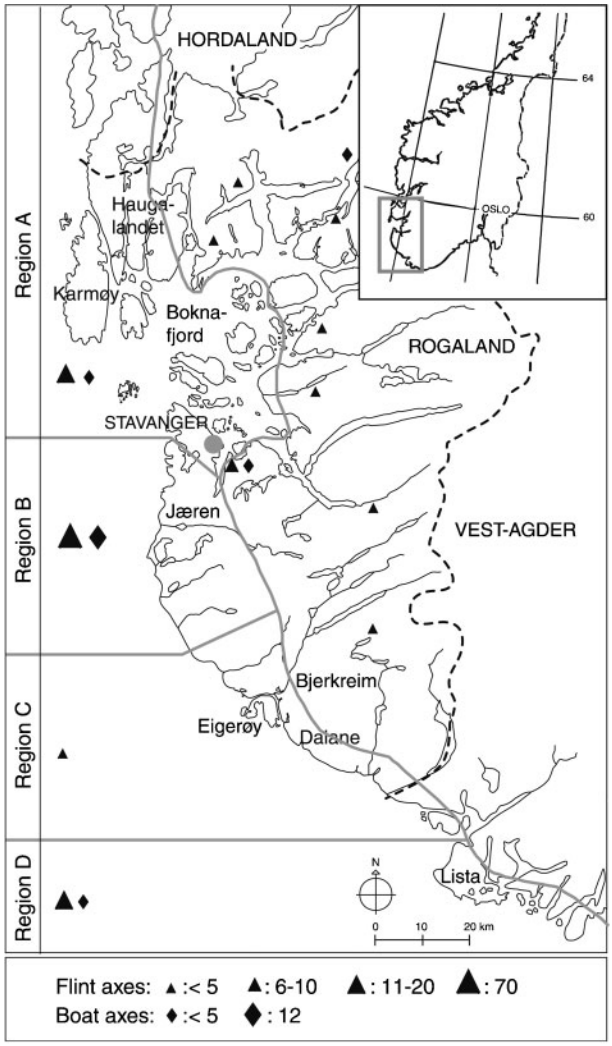


Figure 7 Distribution of flint axes and boat axes in regions A–D during MN II. Artefacts plotted and numbered east of the coastal heath section according to the present administrative boundaries

Figure 8 Bell Beaker arrowheads found in region B. Photo: Terje Tveit, AmS

copies, and most were found in region B. As in the preceding period, impulses from the north can be identified, for example, a number of slate points with roots extending back to the EN/MN I have been found in the study area, especially in region B.

Assuming that the AMS dates are correct, the decorated ceramics seem to have gone out of use by the transition to MN II, while the dissemination of axes seems to have increased. Both flint axes and boat axes are strongly concentrated in region B, and in terms of relative geographic scale, also in region D. There are, however, scattered finds in the other regions (Fig. 7).

Processes leading to deforestation were continuously active in region A during this time interval. Heathlands only developed at exposed localities far beyond the limits of the later agricultural areas. An unequivocal agro-pastoral production can only be demonstrated at one pollen site, Håvik II at Karmøy (region A). Here there is a rise in cultural indicators from 4305 ± 80 uncal. BP, 3350–2600 cal. BC (Prøsch-Danielsen and Simonsen 2000a). This coincides with the transition to MN II. Subsequently, the pollen curves for ribwort plantain (*Plantago lanceolata*) and comparable cereal (Cerealia) values are continuous up to the present day.

The introduction of an agrarian economy with elements of animal husbandry, introduced slightly before 4300 BP (3000–2900 cal. BC) in region B, has also been explored by combining pollen studies with independent methods (magnetic susceptibility (MSc) and carbon analysis) likely to record human impact on the landscape (Prøsch-Danielsen and Sandgren 2003). At this time this lowland region was still densely forested with mixed oak woodland. It was conceivably exploited by migrating groups that left few and sketchy traces in the pollen record.

LN I (Bell Beaker Culture, 2500/2350–2000/1950 cal. BC)

During the Late Neolithic, there was a pronounced change in the material culture; a completely new artefact inventory was introduced. The influence of the Bell Beaker culture is particularly evident via bifacial daggers and arrowheads (Fig. 8), but amber buttons and beads have also been found, in addition to the northernmost examples of Bell Beaker ceramics in Europe. Flint was traded from Denmark, both as finished and semi-finished artefacts (Skjølsvold 1977; Myhre 1979; Scheen 1979; Holberg 2000).

Compared to MN II, the dominant lines of communication and interaction had now shifted from the north and east, to the south and Jutland. Southern Norway became incorporated into the

Nordic cultural sphere. As shown in Fig. 9, there are concentrations of dagger finds especially in region B, but also in region A, and a little less in regions C and D. The same distribution pattern applies to Late Neolithic axes (Fig. 9) and chisels. New categories of finds include votive objects, also predominantly within region B. A few burials have also been found (Berg 1986). In the LN and Early Bronze Age (EBA), periods I and II, it also seems to be a concentration of finds of flint sickles, shaft-hole axes and spoon-shaped scrapers in region B (Solberg 1993).

The transition to LN I corresponds in time to the second pronounced forest clearance phase; from then on virtually the entire landscape had been opened up (Fig. 3). The first massive forest clearance was detected in region B and environmental stability was not encountered again before heathland was well established in 900–700 BC. However, as in region A, some tree species were favoured and spared in this intermediate stage and show covariance with open-field species indicative of the gathering of cattle fodder from broad-leaved trees (Simonsen and Prøsch-Danielsen 2005).

From the very beginning of the second clearance phase, two distinct environmental courses can be identified in all pollen diagrams in the study area; leading either towards heathland (region A–C) or grassland and permanent fields (region D) (Prøsch-Danielsen 1996; Prøsch-Danielsen and Simonsen 2000a; 2000b). Cereal cultivation in region D is well documented through pollen analysis. Unfortunately, this unequivocal cereal cultivation has no parallel documentation in the form of plant macrofossils. Pollen from cereals and weeds is virtually absent in the material from regions A–C in the LN. Exceptions to this are Håvik II at Karmøy (region A), mentioned above, and a single find of barley pollen (*Hordeum* sp.) dated to 3855 ± 40 uncal. BP, 2460–2200 cal. BC in Kvåletjønna (region B) (Solem 2005). In addition, carbonised cereals have been recorded from four sampling sites in region A and B (Fig. 10, Table 1). None of these finds can be related to archaeological structures or features such as postholes, but have been sampled from 'open' settlement sites, culture layers and Late Neolithic fields.

Late Neolithic culture, phase II (LN/EBA, 2000/1950–1750/1700 cal. BC)

After the first two-aisled house was identified in Rogaland in 1990 (Mydland 1995), a further nine houses, as well as some more sketchy structures, have been reported (Høgestøl 1995; Børsheim 2005) (Fig. 11a and b). These houses are dated to the LN

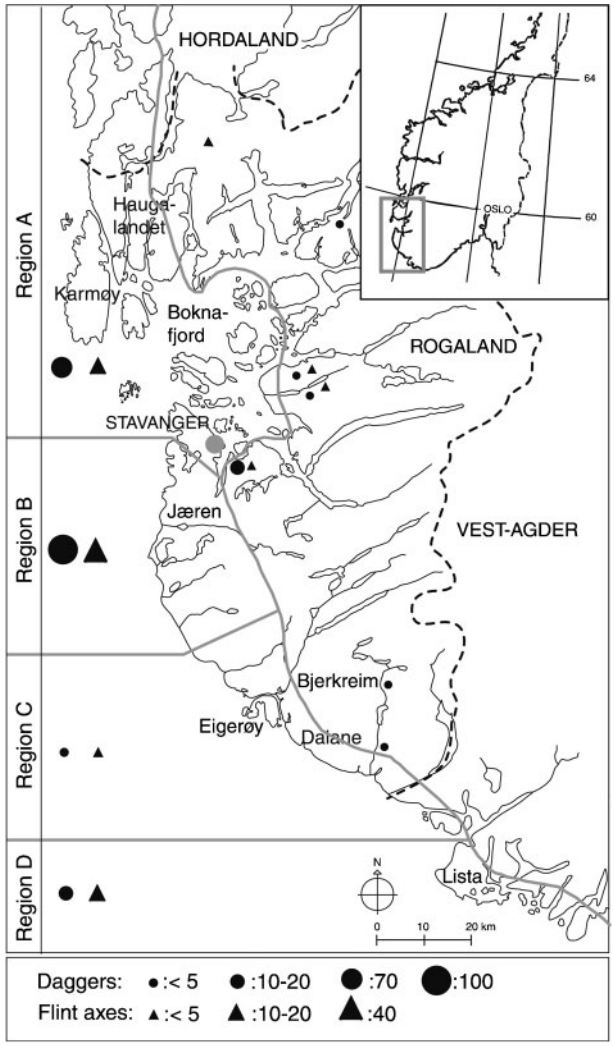


Figure 9 Distribution of daggers (type IA-C, IX) and flint axes in regions A-D during the LN. Artefacts are plotted numbered east of the coastal heath section according to the present administrative boundaries

II, extending into the EBA I. All the houses are located in region A and B, but this is most likely due to the fact that major archaeological excavations were conducted here recently. Even if future excavations should uncover older houses, it is still an interesting fact that these two-aisled houses correspond in time to the third pronounced clearance phase recorded by pollen analyses (Fig. 3).

Pollen diagrams from all localities demonstrate significant, anthropogenically induced change around the LN/EBA transition, although in region C there are no clear signs of distinct clearance phases. The events are asynchronous with both early and late human impact being traceable.

The majority of the finds of charred cereals are now primarily from postholes forming the foundations of prehistoric house. These finds can thus be

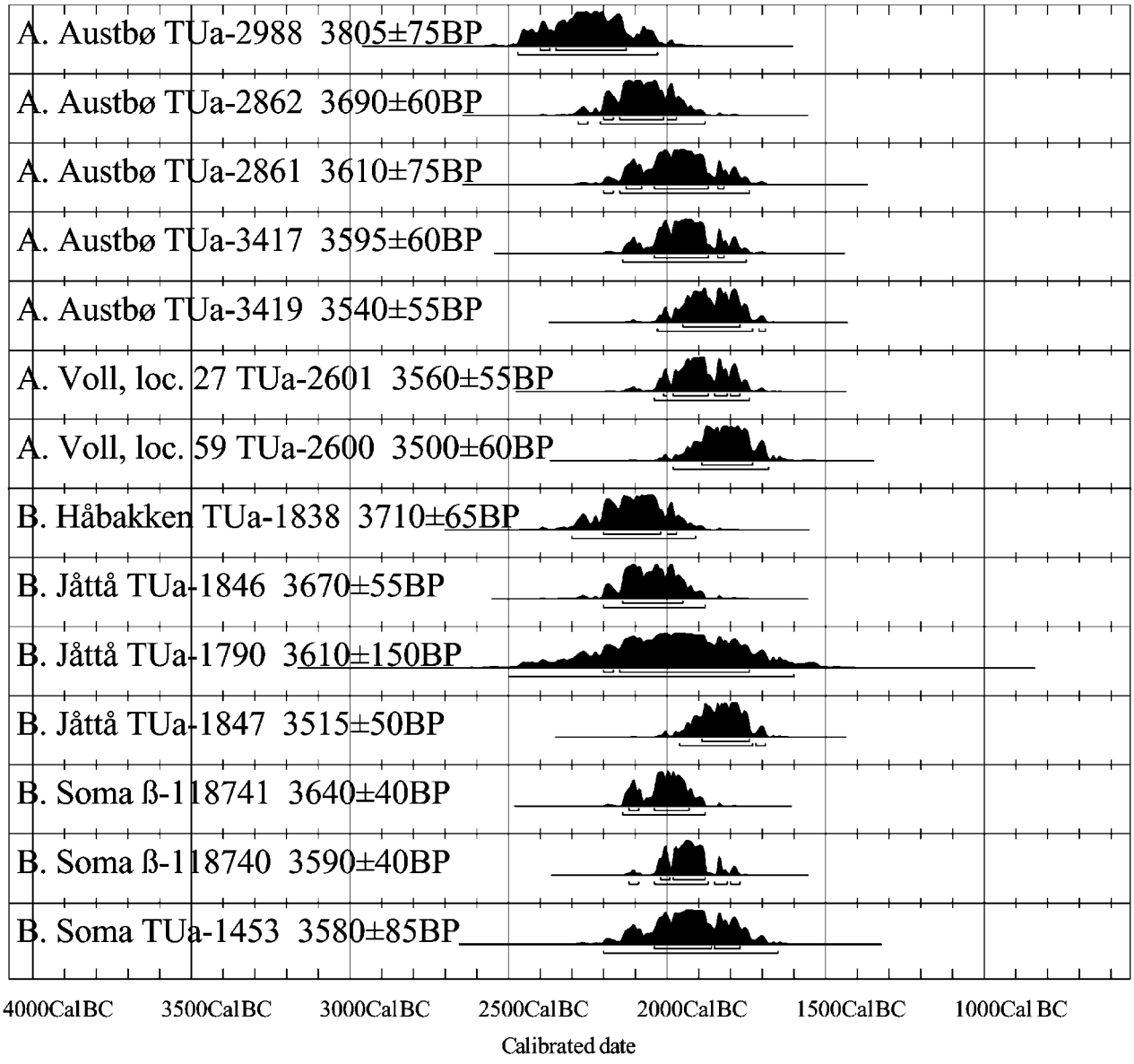


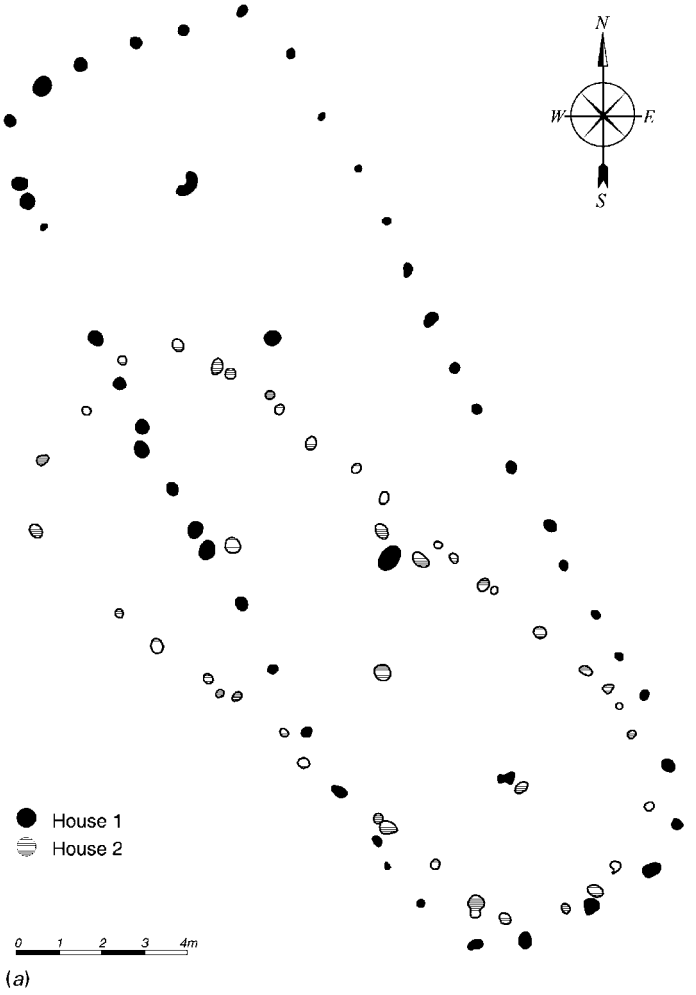
Figure 10 Probability distribution for radiocarbon dates for the oldest finds of carbonised cereal from Rogaland. Calibrated according to Stuiver *et al.* (1998), OxCal v3·9 (Bronk Ramsey 2003)

directly associated with the two-aisled houses and later, also with the three-aisled houses of permanent settlements (Soltvedt 1995; 2000). The oldest finds have been documented from a two-aisled house at Jåttå (Bakkevig *et al*. 2002; Hemdorff pers. comm.). Otherwise, cereals are associated with the oldest field-clearance cairns (Prøsch-Danielsen 1999; Juhl 2002). It would seem that the archaeological, pollen-analytical and archaeobotanical evidence from this time is indicative of an entirely new 'cultural package' and new practices.

Discussion and conclusions

Our study has shown that we have not uncovered one simple evolutionary process, but rather a historical development that includes several processes, each based on the local environment, conditions and traditions, in addition to external factors.

Both archaeology and pollen analysis have generated unequivocal data demonstrating the escalation of agricultural activities from 2500/2200 cal. BC, i.e. the LMNII/ELNI in south-western Norway. At this time, there was a clear break with earlier traditions, i.e. new artefact inventories appeared. Trade and interaction with the rest of southern Scandinavian was intensified and became regular. In addition it seems to have been organised within a much tighter institutional framework. The older lines of communication, to the north and the east, virtually disappeared. From the ELN



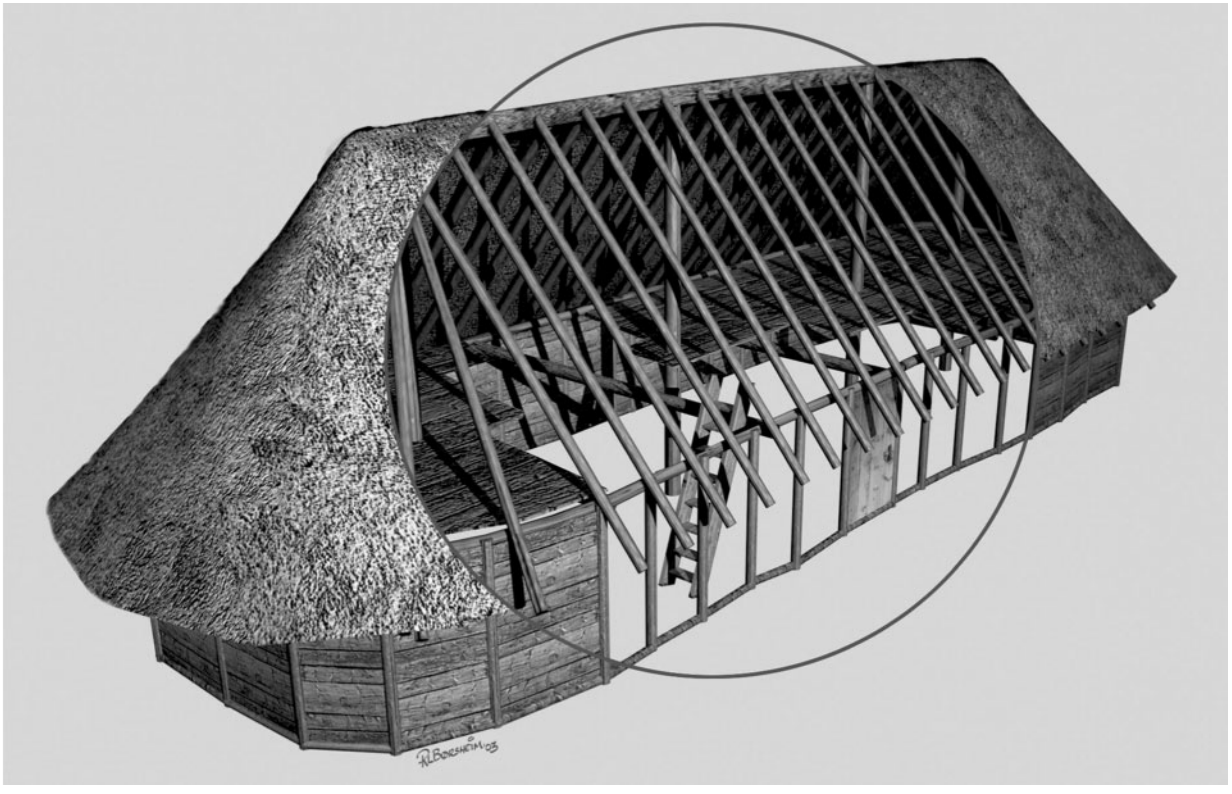


Figure 11 (*a*) **Plan of the two-aisled houses found at Kvåle, region B (after Børsheim 2005);** (*b*) **Reconstruction drawing of house 1 at Kvåle, region B. Drawing: Ragnar Børsheim**

onwards, two distinct environmental courses can be identified; moving either towards heathland (region A–C) or towards grassland and permanent fields (cereal cultivation) (region D). These two courses were consolidated in the Bronze Age, and remained unchanged from the LBA up until World War II. Furthermore, the development of cereal cultivation had two main phases; starting with small-scale cereal cultivation, documented by carbonised cereals from 2500–2200 cal. BC, followed by a major breakthrough from 2200/2000 cal. BC, which coincided with the building of the first recorded two-aisled houses, i.e. permanent agrarian settlements.

In the EN/MN-phase, fishing, hunting and gathering were still the most important factors in the subsistence economy and therefore determined settlement patterns. However, the archaeological and palaeocological data provide evidence of the gradually increasing, but still small-scaled influence exerted by agriculture in the EN/MN. This is most clearly evident in the pollen data, which indicate that deforestation was the result of planned and systematic human endeavours aimed at improving the quality of grazing land. The results of a multivariate PCA-analysis of 30 pollen diagrams from this area demonstrate that the changes in vegetation types in region A-C and D respectively, are indicative of deliberate choices built on previous experience (Simonsen and Prøsch-Danielsen 2005). This study of the processes of deforestation from 4000 to 2200 cal. BC shows that pollen from arboreal species such as ash (*Fraxinus*), lime (*Tilia*), elm (*Ulmus*) and, to a lesser degree, hazel (*Corylus*), are correlated with anthropochorous pollen types indicative of pasture. In other words, these tree species were very probably favoured because of their value as fodder. Furthermore, scattered traces of cereal pollen were found in regions A and D. These early dates, going back to the Late Mesolithic, are still controversial and they should be viewed as tentative due to critical concerns regarding their source. However, they may reasonably be explained by possible limited cereal cultivation at this early stage, a situation with counterparts in nearby western Jutland (Odgaard 1989; 1994), in eastern Norway and in the Kristiansand area (Hafsten 1956; 1958; 1992; Danielsen 1970; Høeg 1982a; 1982b; Østmo 1988). This situation is also encountered within some groups of artefacts found in region D. In the EN and MN I they are associated with artefact groups from the Kristiansand area further east. From the MN II, these artefacts become orientated towards south-western Norway (Amundsen 2000).

Having examined the evidence from 4000–2500 cal. BC, region by region, it is possible to argue a degree of correlation between the limited archaeological material and the more extensive environmental data, especially in the regions A, C and D. The long process of deforestation in region A is evidence of a gradual clearance of the landscape due to, and for the purposes of, grazing. The archaeological record does not show any evidence of pronounced peaks, rather an even distribution of 'agro-Neolithic' artefacts over time until the MN II/ELN. The number of finds in region C is small for all time periods, and the pollen diagrams show no distinct forest clearance phases. In region D, the deforestation process also begins at the transition to the EN, and there are also early, if sparse, indications of cereal cultivation. Here, human impact on the vegetation is rather intensive in the Early and Middle Neolithic, and the finds from all periods, considering the geographic size, are relatively numerous, compared with the areas both east and west of region D.

With the possible exception of the final century of MN II, the most apparent divergence revealed by the data from the different source categories is found in region B, where the degree of continuity in imported finds and the number of high status objects is greatest. These finds and objects date from the EN into the LN, whereas the pollen and magnetic susceptibility studies show only scattered traces of animal husbandry prior to the ELN. The earliest forest clearance in this region was abrupt and rather late, approximately 2500 cal. BC (documented by pollen analysis). In contrast to the other regions, this region has a uniform low-lying landscape with no significant topographical barriers. The reasons for the rather weak and late evidence for human impact provided by the pollen data have recently been discussed (Prøsch-Danielsen and Simonsen 2000a; 2000b; Prøsch-Danielsen and Sandgren 2003). One explanation might be that this homogeneous region was densely forested, making the anthrophochorous pollen types difficult to detect, as they 'disappear' and are swamped by the great multitude of arboreal pollen. Another explanation might be that there was a double-peaked Tapes transgression (rise in sea-level) (Prøsch-Danielsen and Bondevik 2003), where the second event had a maximum at around 4000 cal. BC. The latter would have induced large-scale environmental change, particularly in a low-lying coastal area, at the most sensitive time for early

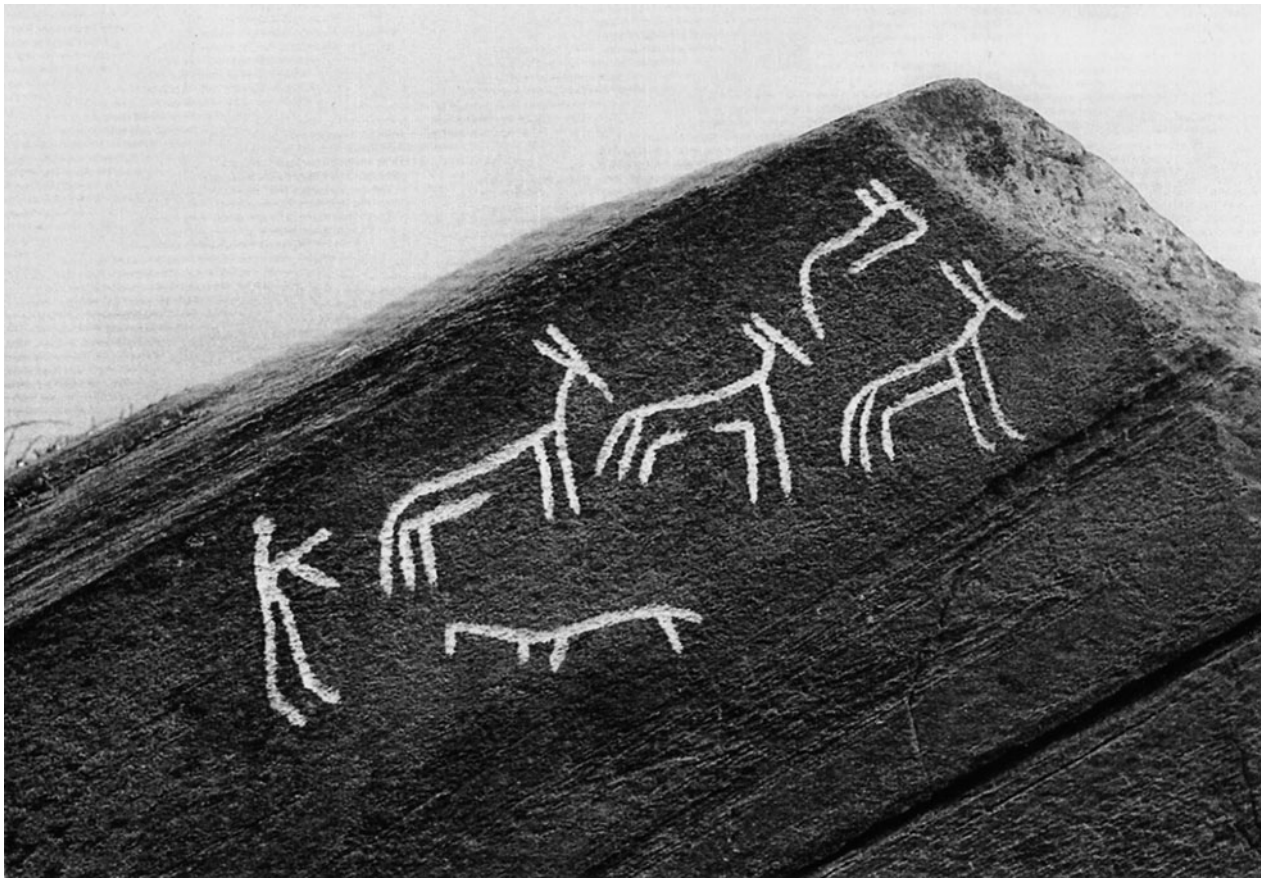


Figure 12 **A Bronze Age rock carving from Dysjaland, Rogaland. A scene showing a herdsman with his dog and livestock. Photo: Åge Pedersen, AmS**

agrarian activity. Large areas were flooded, creating wetlands and recreating highly favourable conditions for hunting waterfowl, fish and seals. The natural conditions were similar to those of the Late Mesolithic and conceivably supported a productive hunter-gatherer population that generated a surplus. This could be used to obtain imported goods, symbols of some kind of agriculture affiliation of which there is, after all, some evidence (*cf.* bones of domesticated ox and the results of the magnetic susceptibility analysis). Or perhaps, as the copying of the boat axes may indicate, people wished to signal the ideology and culture they aspired to be associated with (Berg 1993).

Even if the few 'agro-Neolithic' artefacts and ecofacts of the EN and the MN periods are not pervasive in themselves, they acquire increased significance when compared with the results of the environmental investigations. They become symbols of a pressure towards agriculture within the traditional hunter-gatherer economy and at the same time signals of a new affiliation. The limited finds that may be associated with authentic Neolithic cultures cannot be mechanically interpreted as indicators of agricultural practices, or trade in agricultural commodities. The increased number of flint axes and the use of status symbols in the MN II are, for example, not reflected in a new deforestation phase indicating changes or renewed agricultural activities; i.e. changes in the everyday activities of the agrarian population. Economic activities, new artefacts and new ideas do not always occur in a one-to-one relationship and have therefore to be examined carefully.

As mentioned earlier, there was a slow, but systematic, process towards a final breakthrough for agriculture in the LN I. Why was this process so drawn out? The most obvious answer is that there was no need — culturally or economically — to adopt a mode of agro-pastoral production. Moreover, becoming a farmer can take time, entailing adaptation to cultural and natural environments and conditions. A number of researchers have interpreted the occurrences of ceramics, cereal and

animal husbandry (i.e. Prescott 1996, 84) as evidence of the ritual consumption of food and alcohol. Together with imported goods, these initial traces of agriculture must be understood in terms of their being symbols of status and the rituals in which they were involved.

The imported goods are interpreted as evidence of exchanges or gifts (Jennbert 1984; Fischer and Kristiansen 2002; Klassen 2004). It is worth noting that some of the axes from the EN and MN have been profoundly altered, unlike axes from the LN (Berg 1986). They were perhaps heavily used, or used for a very long time after being made and up until the time they reached their final recipient. Rituals, status and gift exchanges are plausible explanations for the integration of agriculture into a hunter-gatherer economy.

Our research has shown that social and cultural influences must have been the major driving forces behind the process leading to the LN, but that ecological conditions decided the rate of this process. By this we imply that the historical process leading up to deforestation can be tied in to the ecological conditions within each region. Furthermore, rituals and intoxicating substances from the Funnel Beaker and the Battle Axe cultures were incorporated, together with a wish to signal a new affiliation, but not the complete 'cultural and ideological package' of an agricultural Neolithic society. Economic aspects played a minor role. The continuous use of dwelling sites indicates that the available resources remained stable during the whole period leading up to the LN.

Why did a breakthrough happen at the LN? Firstly, land had been cleared, the process of deforestation had come a long way and there were years of experience with low-scale agriculture to build on; the environmental conditions had become conducive to agriculture. Skills and knowledge were built up through several generations. But it is at the same time difficult to understand such an overall environmental change without accepting the introduction of a new cultural and ideological package (Prescott 2005). Together with the facts mentioned above, many factors worked together. Interaction with centres in Jutland, as demonstrated by the flint trade with Denmark, was established, with area B being the place where imports arrived and from where exchanges with the rest of Western Norway took place (Solberg 1993). At the same time, pastoralism in its true sense, had gained a greater momentum. Pastoralism is, by the logic of its economical dynamics and ideological connotations, expansive (Prescott and Walderhaug 1995).

With the exception of Lista, region D, where cereal cultivation achieved some importance in combination with animal husbandry, the preference for pastoral farming in the coastal heath region is evident in these data. A common approach seems to have been adopted by farmers within the Scandinavian and West European heathlands; cereal cultivation was subordinate to husbandry. This is, perhaps, expressed artistically by the agrarian Bronze Age rock-carvings in the study area (Fig. 12). There is not a single engraving showing the characteristic portrayal of procession, scenes of ploughing and fertility, motives which are attributed to the 'agrarian rock art tradition' elsewhere in Eastern and Central Norway.

Acknowledgements

We wish to thank Arne Johan Nærøy, Christopher Prescott and Astri Irene Sivertsen for linguistic advice, suggestions and constructive comments on the manuscript. The authors are also indebted to Tove Solheim Andersen for drawing the figures.

References

Alsaker, S. 1987. *Bømlo. Steinalderens Råstoffsentrum på Sørvestlandet* (Bømlo. The Centre of Raw Material in the Stone Age, in Southwest Norway) (Arkeologiske Avhandlinger fra Historisk Museum, Universitetet i Bergen 4). Bergen: Historical Museum, University of Bergen.

Amundsen, Ø. M. 2000. *Neolitikum i Agder og Telemark. En Komparativ Analyse av Keramikk og Flintøkser* (The Neolithic in the Counties of Agder and Telemark. A Comparative Study of Ceramics and Flint Axes). Unpublished M.A. thesis. Department of Archaeology, History of Art and Conservation, University of Oslo.

Bakkevig, S., Griffin, K., Prøsch-Danielsen, L., Sandvik, P. U., Simonsen, A., Soltvedt, E.-C. and Virnovskaia, T. 2002. Archaeobotany in Norway: investigations and methodological advances at the Museum of Archaeology, Stavanger. *Archaeology and Environment* **15**, 23–48.

Ballin, T. B. and Jensen, O. L. 1995. *Farsundprosjektet. Stenaldersbopladser på Lista* (The Farsund Project. Stone Age sites at Lista) (Varia 29). Oslo: Universitetes Oldsaksamling (in Danish with English summary).

Bang-Andersen, S. 1970. Steinalderboplassene langs Håelvas nedre del (Stone Age sites near the outlet of the river Hå). *Frá Haug ok Heiðni* **3**, 61–77.

Bang-Andersen, S. 1973. Steinalderboplassene ved Storamos og Holmavatnet på Høg-Jæren (Stone Age sites at the lakes Storamos and Holmavatnet, Jæren upland region). *Frá Haug ok Heiðni* **3**, 35–50.

Bang-Andersen, S. 1981. *En Fangstboplass på Eigerøya — Boplassbruk og Miljøtilpasning i Sørvestnorsk Yngre Steinalder* (A Hunting/gathering Site at Eigerøya — Habitation Activities and Environmental Adaption during the Neolithic Period in Southwest Norway) (AmS-Skrifter 6). Stavanger: Museum of Archaeology (in Norwegian with English summary).

Berg, E. 1986. *De Neolittiske Flintøksene i Vest-Norge. Typologisk/kronologisk Inndeling* (The Neolithic Flint Axes in Western Norway. A Typological/Chronological Classification). Unpublished M.A. thesis, Historical Museum, University of Bergen.

Berg, E. 1993. Symbolic aspects of selected groups of Neolithic axes/adzes in Western Norway. *Universitetets Oldsaksamling Årbok* **1991/1992**, 69–85.

Bronk Ramsey 2003: *OxCal 13.9* (A computer program for radiocarbon age calibration based on atmospheric data from Stuiver *et al.* 1998).

Børsheim, R. 2005. Toskipede hus i neolitikum og eldste bronsealder (Two-aisled houses in the Neolithic and oldest Bronze Age), pp. 109–21 in Høgestøl, M., Selsing, L., Løken, T., Nærøy, A. J. and Prøsch-Danielsen, L. (eds.), *Construction Traces and Building Tradition. Mechanical Topsoil Stripping — Methods, Interpretations and Management* (AmS-Varia 43). Stavanger: Museum of Archaeology, Stavanger.

Danielsen, A. 1970. Pollen-analytical late Quaternary studies in the Ra district of Østfold, southeast Norway. *Universitetet i Bergen Årbok* **1970** (Naturvitenskapelig Serie) **14**, 1–146.

Fischer, A. and Kristiansen, K. (eds.), *The Neolithisation of Denmark. 150 Years of Debate*. Sheffield: J. R. Collis publications.

Fægri, K. 1944. On the introduction of agriculture in western Norway. *Geologiska Föreningens i Stockholm Förhandlingar* **66**, 449–62.

Gjessing, H. 1920. *Rogalands Stenalder* (The Stone Age in Rogaland) (Stavanger Museum Skrifter 2). Stavanger: Stavanger Museum.

Glørstad, H. 1996. *Neolittiske Smuler. Små Teoretiske og Praktiske Bidrag til Debatten om Neolittisk Keramikk og Kronologi i Sør-Norge* (Neolithic Crumbs. Small Theoretical and Practical Contributions to the Debate about Neolithic Ceramics and Chronology in South-Norway) (Varia 33). Oslo: Universitetets Oldsaksamling.

Hafsten, U. 1956. Pollen-analytic investigations on the late Quaternary development in the inner Oslofjord area. *Universitetet i Bergen Årbok* **1956** (Naturvitenskapelig Serie) **8**, 1–161.

Hafsten, U. 1958. Jordbrukskulturens historie i Oslo og Mjøstrakten belyst ved pollenanalytiske undersøkelser (The history of agriculture in the Oslo- and the Mjøsa region as shown by palynological studies). *Viking* **21**, 51–74.

Hafsten, U. 1992. Vegetation, climate and agricultural history on the extreme south coast of Norway. *Norsk Geografisk Tidsskrift* **46**, 1–17.

Hinsch, E. 1955. Traktbegerkultur — Megalitkultur. En studie av Øst-Norges eldste, neolitiske gruppe (Funnel Beaker Culture — Megalith Culture. A study of the oldest Neolithic group in eastern Norway). *Universitetets Oldsaksamling Årbok* **1951–1953**, 10–177.

Hinsch, E. 1956. Yngre steinalders stridsøkskultur i Norge (The material from the neolithic Battle-axe culture in Norway). *Universitetet i Bergen Årbok* **1954** (Historisk-Antikvarisk Serie) **1**, 1–237.

Hjelle, K., Hufthammer, A. K. and Bergsvik, K. A. 2006. Hesitating hunters. The introduction of agriculture in western Norway. *Environmental Archaeology* **11.2**.

Holberg, E. 2000. *Klokkebegerkulturens Symboler. Senneolitikum i Rogaland og Nordland sør for Polarsirkelen* (Symbols Belonging to the Bell Beaker Culture. The Late Neolithic Period in Rogaland and in Nordland, South of the Polar Circle). Unpublished M.A. thesis, Archaeological Institute, University of Bergen.

Hufthammer, A. K. 2000. Bestemmelser av Bein fra Ni Lokaliteter i Rogaland (Identifications of Bones from Nine Localities in Rogaland). Unpublished Report, Museum of Zoology, University of Bergen.

Høeg, H. I. 1982a. Vegetational development from about 12,000 to 6,000 years B.P. in the counties of Agder and Telemark, South Norway. *Norsk Geografisk Tidsskrift* **36**, 211–24.

Høeg, H. I. 1982b. Introduksjon av jordbruk i Øst-Norge (The introduction of agriculture in East-Norway), pp. 143–51 in Sjøvold, T. (ed.), *Introduksjonen av Jordbruk i Norden* (The Introduction of Agriculture in the Nordic Countries). Oslo-Bergen-Tromsø: Universitetsforlaget.

Høgestøl, M. 1995. *Arkeologiske Undersøkelser i Rennesøy Kommune, Rogaland, Sørvest-Norge* (Archaeological Investigations in the Municipality of Rennesøy, Rogaland, Southwestern-Norway) (AmS-Varia 23). Stavanger: Museum of Archaeology.

Jennbert, K. 1984. *Den Produktiva Gåvan. Tradition och Innovation i Sydskandinavien för omkring 5300 År sedan* (The Fertile Gift. Tradition and Innovation in Southern Scandinavia some 5,300 Years Ago) (Acta Archaeologica Lundensia, series in 4, no. 16). Lund: CWK Gleerup.

Juhl, K. 2001. *Austbø på Hundvåg Gennem 10 000 år. Arkæologiske undersøgelser i Stavanger Kommune 1987–1990 Rogaland, Syd-Vest Norge*. (Austbø on Hundvåg. Archaeological Investigations in the Municipality of Stavanger 1987–1990, Rogaland, South-West Norway) (AmS-Varia 22). Stavanger: Museum of Archaeology (in Danish with English summary).

Juhl, K. 2002. Theoretical and methodological aspects of investigating stone built structures of ancient farms and field systems. *Archaeology and Environment* **15**, 111–31.

Kaland, P. E. 1979. Landskapsutvikling og bosettingshistorie i Nordhordalands lyngheiområde (Landscape development and settlement history in the coastal heath section in Nordhordaland), pp. 41–70 in Fladby, R. and Sandnes, J. (eds.), *På Leiting etter den Eldste Gården* (Searching for the Oldest Farm). Oslo: Universitetsforlaget.

Kaland, P. E. 1986. The origin and management of Norwegian coastal heaths as reflected by pollen analysis, pp. 19–36 in Behre, K. E. (ed.), *Anthropogenic Indicators in Pollen Diagrams.* Rotterdam: A. A. Balkema.

Klassen, L. 2004. *Jade und Kupfer* (Jutland Archaeological Society 47). Århus: Aarhus University Press.

Løken, T., Pilø, L. and Hemdorff, O. 1996. *Maskinell Flateavdekking og Utgravning av Forhistoriske Jordbruksboplasser — en Metodisk Innføring* (Mechanical Topsoil Stripping and Excavation of Prehistoric Agricultural Sites on Cultivated Land — a Methodological Guide) (AmS-Varia 26). Stavanger: Museum of Archaeology.

Moen, A. 1999. *National Atlas of Norway. Vegetation*. Hønefoss: Norwegian Mapping Authority.

Mydland, L. 1995. Lok. 27, Rennesøy. De arkeologiske undersøkelsene (Locality 27 at the island Rennesøy. The archaeological excavations), pp. 125–31 in Høgestøl, M. (ed.) *Arkeologiske Undersøkelser i Rennesøy Kommune, Rogaland, Sørvest-Norge* (Archaeological Investigations in the Municipality of Rennesøy, Rogaland, Southwestern Norway) (AmS-Varia 23). Stavanger: Museum of Archaeology, Stavanger.

Myhre, B. 1979. Spor etter klokkebegerkulturen i Rogaland (Traces of the Bell Beaker Culture in Rogaland). *Frá Haug ok Heiðni* **4**, 298–303.

Nærøy, A. J. 1987. *Redskapstradisjon i Hordaland fra 5500 til 4000 før Nåtid — en Lokalkronologisk Studie* (Tools used in Hordaland from 5500 to 4000 BP — a Local Chronological Study). Unpublished M.A. thesis, Historical Museum, University of Bergen.

Nærøy, A. J. 1993. Chronological and technological changes in western Norway 6000–3800 BP. *Acta Archaeologica* **63**, 77–95.

Odgaard, B. V. 1989. Cultural landscape development through 5500 years at lake Skånsø, northwestern Jutland, as reflected in a regional pollen diagram. *Journal of Danish Archaeology* **8**, 200–10.

Odgaard, B. V. 1994. The Holocene vegetation history of northern West Jutland, Denmark. *Opera Botanica* **123**, 1–171.

Persson, P. 1999. *Neolitikums Början: Undersökningar Kring Jordbrukets Introduktion i Nordeuropa* (The Beginning of Neolithic: Studies of the Introduction of Agriculture in Northern Europe) (Gotarc Series B, Gothenburg Archaeological Thesis 11). Gøteborg: University of Gøteborg.

Petersson, H. 1999. Where did all the farmers come from? *Journal of Danish Archaeology* **13**, 179–90.

Prescott, C. 1995. Aspects of early pastoralism in Sogn, Norway. *Acta Archaeologica* **66**, 163–89.

Prescott, C. 1996. Was there really a Neolithic in Norway. *Antiquity* **70**, 77–87.

Prescott, C. 2005. Settlement and economy in the Late Neolithic and Bronze Age of southern Norway: some points and premises, pp. 127–36 in Høgestøl, M., Selsing, L., Løken, T., Nærøy, A. J. and Prøsch-Danielsen, L. (eds.), *Construction Traces and Building Tradition. Mechanical Topsoil Stripping — Methods, Interpretations and Management* (AmS-Varia 43). Stavanger: Museum of Archaeology, Stavanger.

Prescott, C. and Walderhaug, E. 1995. The last Frontier? Processes of Indo-Europeanization in Northern Europe: the Norwegian Case. *The Journal of Indo-European Studies* **23** (3/4), 257–78.

Prøsch-Danielsen, L. 1996. Vegetation history and human impact during the last 1500 years at Lista, the southernmost part of Norway. Based primarily on Professor Ulf Hafsten's material and diary from 1955–1957. *Norsk Geografisk Tidsskrift* **50**, 1–18.

Prøsch-Danielsen, L. 1997. New light on the Holocene shore displacement curve on Lista, the southernmost part of Norway. Based primarily on Professor Ulf Hafstens material from 1955–57 and 1966. *Norsk Geografisk Tidsskrift* **51**, 83–101.

Prøsch-Danielsen, L. 1999. Rydningsrøysa som pollenfelle og kilde til norsk jordbrukshistorie — innsamlingspolitikken i Rogaland (The clearance cairn as pollen trap and a source of Norwegian farming history — the sampling policy in Rogaland), pp. 355–70 in Selsing, L. and Lillehammer, G. (eds.), *Museumslandskap* (Museum Landscape) (AmS-Rapport 12B). Stavanger: Museum of Archaeology.

Prøsch-Danielsen, L. and Bondevik, S. 2003. *Tsunamis, Real Transgressions or Stormy Episodes?* (AmS-Oppdragsrapport 1). Stavanger: Museum of Archaeology.

Prøsch-Danielsen, L. and Sandgren, P. 2003. The use of pollen, magnetic and carbon analyses in identifying agricultural activity and soil erosion from the Neolithic to the Iron Age — a study of two lake sediment cores from Jæren, southwestern Norway. *Environmental Archaeology* **8**, 33–50.

Prøsch-Danielsen, L. and Simonsen, A. 2000a. *The Deforestation Patterns and the Establishment of the Coastal Heathland of Southwestern Norway* (AmS-Skrifter 15). Stavanger: Museum of Archaeology.

Prøsch-Danielsen, L. and Simonsen, A. 2000b. Palaeoecological investigations towards the reconstruction of the history of forest clearances and coastal heathlands in southwestern Norway. *Vegetation History and Archaeobotany* **9**, 189–204.

Sandvik, P. 2003. Kornet på Hundvåg (The cereals from Hundvåg). *Frá Haug ok Heiðni* **4**, 20–2.

Scheen, R. 1979. *De Norske Flintdolkene* (The Norwegian Flint Daggers). Unpublished M.A. thesis, Universitetets Oldsaksamling, University of Oslo.

Simonsen, A. and Prøsch-Danielsen, L. 2005. *Tidlig Jordbrukspåvirkning innen Kystlyngheibeltet i Sørvest-Norge. Økosystemer i Endring.* (The Impact of Early Farming on Forest Ecosystems within the Coastal Heathland of Southwestern Norway. Changing Coastal Ecosystems) (AmS-Varia 44). Stavanger: Museum of Archaeology.

Skjølsvold, A. 1977. *Slettabøboplassen. Et Bidrag til Diskusjonen om Forholdet mellom Fangst- og Bondesamfunnet i Yngre Steinalder og Bronsealder* (The Slettabø site. A Contribution to the Problem of Inter-relations between the Hunters and the Farmers during the Neolithic- and the Bronze Age) (AmS-Skrifter 2). Stavanger: Museum of Archaeology (in Norwegian with English summary).

Skjølsvold, A. 1980a. *Boplassen på Nygård i Ogna* (The Nygård Site — a Neolithic Dwelling Place in Rogaland, SW-Norway) (AmS-Varia 6). Stavanger: Museum of Archaeology (in Norwegian with English summary).

Skjølsvold, A. 1980b. *Boplassen på Holeheia i Klepp* (The Holeheia Site — a Neolithic Dwelling Place in Rogaland, SW-Norway) (AmS-Varia 7). Stavanger: Museum of Archaeology (in Norwegian with English summary).

Solberg, B. 1993. Western Norway in the Late Neolithic and Early Bronze Age. Can loose finds contribute to our understanding of demography and social stratification? *Arkeologiske Skrifter fra Historisk Museum, Universitetet i Bergen* **7**, 118–38.

Solem, T. 2005. *Kvåle-Prosjektet: Vegetasjonshistorisk Undersøkelse av Lonartjønna på Gården Norheim gnr. 19, Time Kommue, Rogaland* (The Kvåle Project: Studies on Vegetation History in the Small Tarn Lonartjønna at Norheim 19, Time Municipality, Rogaland) (AmS-Oppdragsrapport 2005/16). Stavanger: Museum of Archaeology.

Soltvedt, E.-C. 1995. Makrofossiler (forkullete frø og frukter), lok. 27 og 59, Voll. (Macrofossils (carbonised seeds and fruits), loc. 27 and 59 at Voll). pp. 131–132 and 137–140 in Høgestøl, M. (ed.), *Arkeologiske Undersøkelser i Rennesøy Kommune, Rogaland, Sørvest-Norge* (Archaeological Investigations in the Municipality of Rennesøy, Rogaland, Southwestern Norway) (AmS-Varia 23). Stavanger: Museum of Archaeology.

Soltvedt, E.-C. 1997. Makrofossilanalyse av Prøver fra Håbakken, Time Kommune, Rogaland (Macrofossil Analyses of Samples from Håbakken, the Municipality of Time, Rogaland). Archived report. Stavanger: Museum of Archaeology.

Soltvedt, E.-C. 2000. Carbonised cereal from three Late Neolithic and two Early Bronze Age sites in western Norway. *Environmental Archaeology* **5**, 49–62.

Stuiver, M., Reimer, P. J., Bard, E., Beck, W., Burr, G. S., Hughen, K. A., Kromer, B., McCormac, G., van der Plicht, H. and Spurk, M. 1998. INTCAL98 radiocarbon age calibration, 24,000–0 cal. BP. *Radiocarbon* **40** (3), 1041–83.

Vandkilde, H., Rahbek, U. and Rasmussen, K. L. 1996. Radiocarbon dating and the chronology of Bronze Age Southern Scandinavia. *Acta Archaeologica* **67**, 183–98.

Welinder, S. 1988. Comments on Göransson, H. Neolithic man and the forest environment around Alvastra pile dwelling. *Norwegian Archaeological Review* **21** (2), 129–30.

Østmo, E. 1988. *Etableringen av Jordbrukskultur i Østfold i Steinalderen* (The Establishment of Agriculture in the Municipality of Østfold in the Neolithic) (Universitetets Oldsaksamlings Skrifter 10). Oslo: University of Oslo (in Norwegian with English summary).