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The expansion of agrarian societies towards the north – new evidence for agriculture during the Mesolithic/Neolithic transition in Southern Scandinavia

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ABSTRACT

Radiocarbon dates on new evidence of agriculture in Southern Scandinavia document the introduction of domesticated animals and cereal cultivation during the period 4000–3700 cal BC. The speed of the expansion was so rapid that smaller groups of pioneering farmers from Central Europe must have been involved in this process. These farmers cleared the forest and settled on inland sites. For reasons of poor preservation conditions for organic finds, bioarchaeological evidence from these inland sites is rare. However, the small amounts of available evidence clearly points to a dominating agrarian subsistence supplemented by hunting and fishing. Furthermore, the distribution of archaeological stray finds, such as pointed butted flint axes, is in certain cases located around easy accessible inland flint mines, where pioneering farmers settled on easily-workable arable soils.

Evidence from contemporaneous coastal and lake shore sites show, on the other hand, a slow and gradual process of change towards agrarian subsistence, thus supporting the availability model. Our results support the theory of cultural dualism, assuming the migration of smaller groups of farmers from Central Europe. The transition towards an agrarian way of life probably happened during a complex and continuous process of migration, integration and gradual assimilation between pioneering farmers and local hunter–gatherers.

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1. Introduction

The transition process from hunters and gatherers to farmers has been the subject of debate for more than a century in Southern Scandinavia, including Northern Germany, Denmark and Southern and Western Sweden (Fischer and Kristiansen, 2002) (Fig. 1). The entrenched discussion concentrates on two hypotheses: whether agriculture was introduced rapidly by migrating agrarian societies (Becker, 1948; Lichardus, 1976; Skoglund et al., 2012: 466ff) or whether gradual adaptation by indigenous populations occurred (Zvelebil and Rowley-Conwy, 1984; Price, 2000; Fischer, 2002: 341ff; Andersen, 2008: 73; Melchior et al., 2010: 6). Many researchers now tend to favour a gradual transition towards agriculture over the introduction of the entire Neolithic package, based on data that originate from coastal or lake shore settlements, thus neglecting important evidence from inland sites located on easily-workable arable soils. The objective of this study is to present some newly discovered evidence of agriculture from several transitional coastal and inland sites, and to discuss whether these represent a gradual introduction of agriculture during the Late Ertebølle period (4500–4000 cal BC), a swift application of the entire package during the Early Neolithic I period (4000–3500 cal BC), or both.

2. Material and methods

Archaeological material from kitchen middens and sites located close to larger lakes has so far formed the basic information for research on the neolithisation process. All these sites were more easily detectable and have excellent preservation conditions for organic material and artifacts, whereas the inland sites are more difficult to find and have only poorly preserved organic finds (Fig. 2). The empirical data from these inland sites, normally located on easily-workable arable soils at least 1 km from the coast, is absent in discussions of the introduction of agriculture (Fig. 3). However, during the last twenty years a series of rescue and research excavations of sites dated to the Late Ertebølle – Early Neolithic transition has resulted in new agrarian evidence from both coastal and especially from a few important inland sites (Hartz and Lübke, 2004;

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Cultural epoch	cal BC
Late Ertebølle	4500-4000
Early Neolithic I	4000-3500
Early Neolithic II	3500-3300
Middle Neolithic I-II	3300-3000

Fig. 1. Chronology of the Mesolithic/Neolithic transition in Southern Scandinavia.

Price and Gebauer, 2005; Fischer and Gotfredsen, 2006: 38; Rosenberg, 2006; Andersen, 2008: 67; Hallgren, 2008; Hirsch et al., 2008:11ff; Skousen, 2008; Terberger et al., 2009; Hadevik and Steinke, 2009; Nielsen, 2009; Rudebeck, 2010: 85ff; Mischka, 2011: 742ff). This article focuses on agrarian evidence from these sites, including plough marks, cereals, pollen evidence, bone material from domesticated animals, and archaeological finds, such as stone querns and pointed butted flint axes, to gain new knowledge of the neolithisation process in Southern Scandinavia. Methodological problems are taken into consideration and will also be discussed.

2.1. ^{14}C dates, methodological restrictions

The presented ^{14}C dates were directly made on charred cereals and bones from domesticated animals. All dates were calibrated with the OxCal v4.1.7 program and given in "calibrated years before Christ" (cal BC), with a two standard deviation range. When comparing ^{14}C dates from different regions of Southern Scandinavia, we have to consider that two wiggles have been observed on the ^{14}C curve. The first one is located from 4200 to 4050 cal BC and the second one from 3950 to 3790 cal BC, thus limiting the time resolution (Reimer et al., 2009). The chronology could become narrower if several ^{14}C dates are made on charcoal from closed Early Neolithic contexts and subjected to a Bayesian analysis (Buck et al., 1996; Bayliss et al., 2007; Whittle, 2007: 377ff).

2.2. Records for cereal cultivation

Plough marks are one of the most significant forms of evidence for agriculture in prehistoric times (Fries, 1995). Furrows were found beneath numerous Neolithic grave mounds, giving them

Fig. 2. Map of Southern Scandinavia with sites dated to Late Ertebølle and Late Ertebølle/Early Neolithic I. 1. Østenkær, 2. Aggersund, 3. Ertebølle, 4. Lollikhuse, 5. Smakkerup Huse, 6. Wangels LA 505, 7. Rosenhof LA 58 and 83, 8. Siggeneben-Süd, 9. Baabe, 10. Krabbesholm II, 11. Åle, 12. Visborg, 13. Egsminde, 14. Bjørnsholm, 15. Ringkloster, 16. Norsminde, 17. Sølager, 18. Åkonge, 19. Øgårde, 20. Bodal A, 21. Nøddekonge, 22. Vejkonge, 23. Kildegård, 24. Klintesø, 25. Snævret Hegn, 26. Maglemosegård, 27. Löddesborg, 28. Vik and 29. Stora Förvar.

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Fig. 3. Map of Southern Scandinavia with sites dated to Early Neolithic I, Early Neolithic II and Middle Neolithic. 30. Kærup, 31. Lisbjerg Skole, 32. Barkær, 33. Højensvej høj 7, 34. Kildevang, 35. Stengade, 36. Muldbjerg I, 37. Knoglebo, 38. Skolæstbo, 39. Jordløse Mose, 40. Øgårde SV, 41. Holmene, 42. Ullerødgård, 43. Sigersted III, 44. Havnelev, 45. Dragsholm, 46. Snoldelev Mose, 47. Borremose, 48. Store Valby, 49. Sejrø, 50. Stevns, 51. Vallensgård I, 52. Limensgård, 53. Almhov, 54. Mossby, 55. Fosie 11D, 56. Svågertorp industriomr. A, 57. Bunkeflostrand 15:1, 58. Lunnebjär, 59. Lockarp, 60. Fosie 11A, 61. Vintriediket, 62. Hindbygården, 63. Petersborg 6, 64. Hyllie vattentorn, 65. Svågertorp 8B-C, 66. Bunkeflostrand 3:1, 67. Hyllie 165:79, 68. Frederiksberg 13E, 69. Hyllie 155:91, 70. Värby, 71. Södra Sallerup, 72. Björkesåkra 6:1, 73. Sturup 1:88, 74. Sturup 1:107, 75. Oxie 7, 76. Hässleberga 24:1, 77. Svenstorp 2:1, 78. Vestra Kärrstorp, 79. Önsvala 5:1, 80. Skumpaberget, 81. Trössla, 82. Lisseläng 2, 83. Skogsmossen, 84. Stensborg, 85. Hjulberga, 86. Lässmyran 1, 87. Nyskottet, 88. Tjugestatorp, 89. Kallmossen, 90. Anneberg, 91. Fågelbacken, 92. Frotorp, 93. Mogetorp, 94. Toltorp, 95. Brokvarn, 96. Sittesta, 97. Östra Vrå, 98. Karleby 10, 99. Karleby 59, 100. Karleby 194, 101. Gökhem 4 and 31, 102. Laholm 197, 103. Veddige 128, 104. Skee 1616, 105. Karleby Logården A, 106. Karleby Logården B, 107. Lillegården Karleby, 108. Ostorf, 109. Fuchsberg, 110. Borremose, 111. Toftum, 112. Sarup, 113. Saxtorp SU9, 114. Hunneberget, 115. Signalbakken, 116. Lønt, 117. Troldebjerg, 118. Lyø, 119. Storelyng VI, 120. Sørbylille, 121. Fannerup, 122. Blandebjerg, 123. Flintbek LA 3, 124. Grottan, 125. Rastorf LA 6 and 126. Oldenburg-Dannau LA 77.

a probable *terminus ante quem* (Thrane, 1989). Until now, no ^{14}C dates of Neolithic plough marks have been produced in Southern Scandinavia (Beck, 2009: 7ff; Mischka, 2011: 745ff). Other evidence for agriculture is the form of archaeobotanical material that can be recovered either by analysing soil samples or by studying plant impressions in pottery. The most abundant cereals recorded for the Early Neolithic in Southern Scandinavia are emmer (*Triticum dicoccum*), einkorn (*Triticum monococcum*), naked barley (*Hordeum vulgare/nudum*), bread wheat (*Triticum aestivum/compactum*), and possibly spelt (*Triticum spelta*) (Robinson, 2003; Gustafsson, 2004; Hallgren, 2008: 118; Andreasen, 2009: 34; Larsson and Broström, 2011: 197; Kirleis et al., 2012). Hulled wheat species need to be roasted in order to remove their glumes, which might explain why these species are often overrepresented in the archaeobotanical record (Hillman, 1981: 123ff). Cereal grains do not necessarily indicate cultivation of crops as they could have been imported. Threshing waste is, on the other hand, a more secure proof for on-site processing (Skousen, 2008: 124; Westphal, 2009: 89ff). Cereal impressions in ceramics are difficult to quantify, as wheat often seems to be overrepresented because it is easier to identify (Engelmark, 1992: 369).

Cereal cultivation could also be revealed by pollen analysis, but the investigations in Southern Scandinavia lack absolute dating (Aaby, 1985, 1986; Odgaard, 1994; Andersen, 1995; Robinson, 2003; Regnell and Sjögren, 2006: 120ff). The profiles are mostly taken from smaller lakes or bogs, thus showing the environmental change on a very local scale, whereas pollen diagrams taken from larger lakes reflect changes within the landscape covering a radius of 5–10 km. Cereal pollen evidence is rarely detected because wheat and barley are being self-pollinated species, which means that the pollen does not spread over long distances. The pollen stays within the ears, until the cereal is threshed. These observations are confirmed by experiments showing a very low dispersion of wheat pollen only 10 m away from the crop field (1.4%), and rather high values (26.6%) at the actual threshing place (Diot, 1992). Additional evidence for agriculture is given by pollen analysis in buried soils underneath long barrows dated between 3800 and 3500 cal BC (Andersen and Rasmussen, 1993: 153ff).

2.3. Faunal assemblages

As noted above, coastal, lake shore and inland sites show different preservation conditions for organic material. This fact needs to be considered when comparing the assemblages with each other. The problems with the faunal assemblages are of a taphonomic, taxonomic and stratigraphic character.

The counting method used for bone material varies between the different sites thus influencing the results: using the NISP (number of identified specimens) instead of EMNI (estimated minimum number of individuals) can lead to an overrepresentation of the calculated animals (Marshall and Pilgram, 1993; Lyman, 1994: 102ff). Both methods were applied at a number of Late Mesolithic and Early Neolithic faunal assemblages in Southern Scandinavia (Fig. 4, Table S1). Nevertheless, both methods show a rather low frequency of domesticated animals in general. Very few faunal assemblages were investigated by using EMNI, which forces us to work with NISP. This is particularly problematic when dealing with burnt bones, as at the sites of Mählardalen and Bergslagen in Sweden (Hallgren, 2008: 124f). At most sites only the percentage of the identified mammal bones is given, thus excluding the unidentified bones, as well as the fish and bird bones.

The taxonomic problems occur during the identification of bones of domesticated animals. It can in certain cases be challenging, as in the case with bones from smaller individuals of aurochs (*Bos primigenius*) and domesticated cattle (*Bos taurus*) (Hartz and Lübke, 2004; Noe-Nygaard et al., 2005; Price and Noe-Nygaard, 2009: 205ff). It is important to mention that aurochs and domestic cattle lived contemporaneously in Northern Germany and Jutland, and became extinct on the Danish islands during the early Atlantic period (7200–6000 cal BC) and middle Atlantic in Southern Sweden (6000–5000 cal BC) (Aaris Sørensen, 1998; Noe-Nygaard et al., 2005). The large amount of domesticated cattle in the sites of Wangels (Fig. 2, nr. 6) and Siggeneben-Süd (Fig. 2, nr. 8) need to be interpreted more critically, because some of them might be small individuals of aurochs (Heinrich, 1999: 45) (Fig. 12). Furthermore, the separation of domesticated pigs (*Sus domesticus*) from wild boar (*Sus scrofa*) is as well problematic. The determination is often based on the fact, that domesticated pigs are smaller than wild boars, which is reflected in the measurements of the length and anteriour breadth of the M_3 (Magnell, 2005). For this reason, we have placed wild boar and domesticated pigs together in a separate category within the faunal assemblages, as is done with the bone finds of sheep (*Ovis aries*) and goat (*Capra hircus*). Generally sheep and goat bones tend to be underrepresented, due to a higher degree of fragmentation, thus making it harder to distinguish them from other bovidae species.

Moreover, many faunal assemblages are retrieved from sites with complex stratigraphies, and where it is difficult to separate layers dated to the Late Mesolithic from the Early Neolithic ones (Jennbert, 1984; Fischer, 2002: 341ff; Hartz and Lübke, 2004: 119ff; Price and Gebauer, 2005).

2.4. Archaeological records

Pointed butted flint axes were used for clearing the forest, and quern stones for grain processing. By investigating the ^{14}C dates of the archaeological contexts, in which these artifacts were found, it is possible to date their introduction to Southern Scandinavia. The distribution of the pointed butted flint axes is shown (Fig. 16), and their typology is tested with ^{14}C dates. The pointed butted axes were, based on typological characteristics, divided into three distinct types (Fig. 5). The majority was detected as stray finds in various parishes.

3. Definitions and theories regarding the introduction of farming

In the discussion of the neolithisation process in Southern Scandinavia different definitions of hunter–gatherers and farmers are used, and no consensus has been reached yet (Becker, 1948; Troels-Smith, 1954: 5ff; Jennbert, 1984; Larsson, 1984; Nielsen, 1984: 96ff; Madsen, 1987: 229ff; Fischer, 2002: 343ff; Skak-Nielsen, 2003: 1ff; Klassen, 2004; Johansen, 2006: 201; Hartz et al., 2007: 567ff; Larsson, 2007: 595ff; Andersen, 2008: 67ff; Hallgren, 2008; Brinch Petersen and Egeberg, 2009: 447ff; Schülke, 2009: 217ff; Rowley-Conwy, 2011: 431ff; Price and Bar-Yosef, 2011: 163ff). The presence of bones from domesticated animals has often been interpreted as a distinct feature for a farming society, regardless of the fact, that the faunal material is generally dominated by remains of wild animals (Fischer, 2002; Price and Gebauer, 2005). Nevertheless, the limited number of domesticated animals

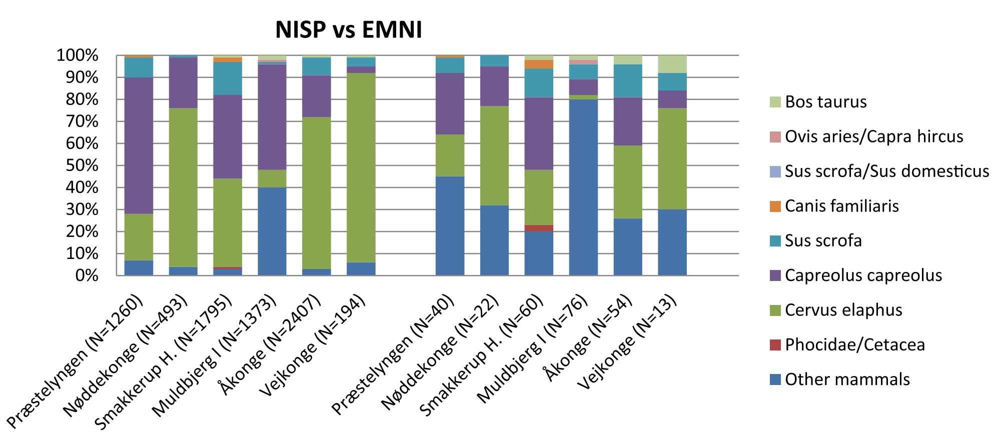

Fig. 4. Faunal assemblages investigated by using the NISP (number of identified specimens) and EMNI (estimated minimum number of individuals) methods, based on data from Table S1 (Noe-Nygaard, 1995: 76ff; Gotfredsen, 1998: 95; Hede, 2005: 94).

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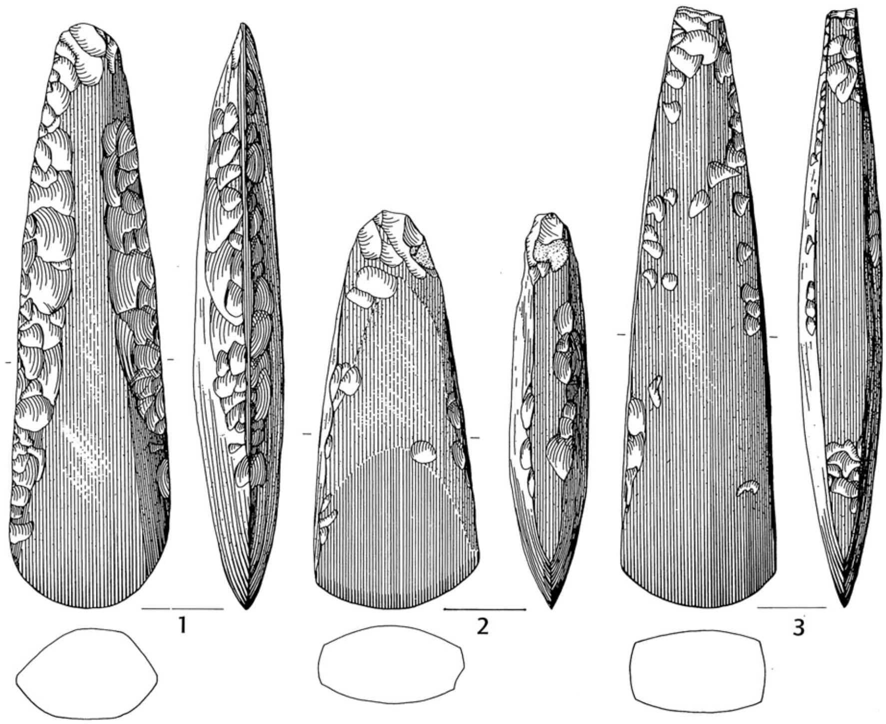

Fig. 5. Drawing of pointed butted flint axes of type 1, 2 and 3. Type 1 has an oval cross section. Type 2 has a three-sided cross-section. Type 3 has a four-sided cross section. After: Nielsen, 1977: 66.

could suggest the beginning of herding activities at the transitional coastal sites. Hunting, gathering and fishing is practised by both hunter–gatherer and farmers, of course. What separates farmers from hunter–gatherers in a transitional context is crop cultivation and managing husbandry all year round. Firstly, cultivation requires a whole new set of techniques, including slash and burn activities for opening the landscape, preparing fields, sowing and growing crops, grain processing and storing seeds. Secondly, keeping domesticated animals all year round requires storage of winter fodder (Troels-Smith, 1984; Haas and Rasmussen, 1993). We consider that Late Mesolithic or Early Neolithic hunter–gatherers kept a small number of domesticated animals for meat reserves and/or prestige reasons (Louwe Kooijmans, 2009).

Two main theories have until now dominated in the discussion of the neolithisation process in Southern Scandinavia: migration of Central European farmers to Northern Europe or the gradual transition of the indigenous hunter–gatherers (Becker, 1948; Troels-Smith, 1954: 5ff; Lichardus, 1976; Fischer, 2002; Price and Gebauer, 2005). Many reserachers have accepted the availability model of the transition from hunting to farming, proposed by Zvelebil and Rowley-Conwy (1984: 107ff). The model seems to be valid, when applied to the archaeological evidence from the numerous coastal or lake shore sites in Southern Scandinavia (Andersen, 2008: 73; Fischer and Gotfredsen, 2006: 35ff); however, the evidence from the few inland sites shows a different picture.

4. Results

4.1. Evidence for cereal cultivation and harvesting

Radiocarbon dates made directly from charred cereal grains of emmer, einkorn, bread wheat and naked barley from Early Neolithic sites in Southern Scandinavia show the synchronous introduction of these cultivars within 300 years (4000–3700 cal BC) in the entire region of Southern Scandinavia, stretching up to Bohuslän in Western Sweden, and Uppland in Middle Sweden (Fig. 6, Table S2).

The archaeobotanical assemblages originate mainly from Early Neolithic inland sites. Generally, the number of identified cereal grains is very low, with the exception of the material from Stensborg (Fig. 3, nr. 84) (Inline Supplementry Fig. S1, Table S3), where more than 3000 grains were identified (Larsson and Broström, 2011: 197). Larger botanical assemblages are also reported from several pits at the site of Almhov (Fig. 3, nr. 53), the grains (and chaff) are dominated by emmer and bread wheat (Gustafsson, 2004; Rudebeck, 2010: 156). Recent botanical studies from Early Neolithic sites in Northern Germany show that naked barley and emmer are the dominant corn species, thus showing possible regional differences in the cultivation of cereals (Kirleis et al., 2012: 224ff). Generally it is difficult to interpret any patterns and trends within the different individual assemblages from the Early Neolithic I period (Inline Supplementry Fig. S1, Table S3). The emmer from the site of Stensborg is overrepresented, when adding up the assemblages, because this is the largest assemblage in Southern Scandinavia. If we exclude the Stensborg material in our calculation, the assemblages consist of 873 identified charred grains, dominated by emmer and bread wheat. However, the 346 identified grain impressions from pottery from mainly Early Neolithic inland sites show a more equal distribution of the cereal species with a dominance of naked barley and einkorn (Inline supplementry Fig. S2, Fig. 7, Table S4). A few grain impressions are of cardinal importance, as they were found in Late Ertebølle potsherds from the coastal sites of Löddesborg (Fig. 2, nr. 27) and Vik (Fig. 2, nr. 28) in Scania (Jennbert, 1984). Unfortunately, the sites contain intermixed layers of Late Ertebølle and Early Funnel beaker ceramics which both have the same coarse tempering and thickness (Koch, 1987, 107ff). Currently, there is no additional archaeological evidence supporting any kind of cereal cultivation during the Late Mesolithic in Southern Scandinavia.

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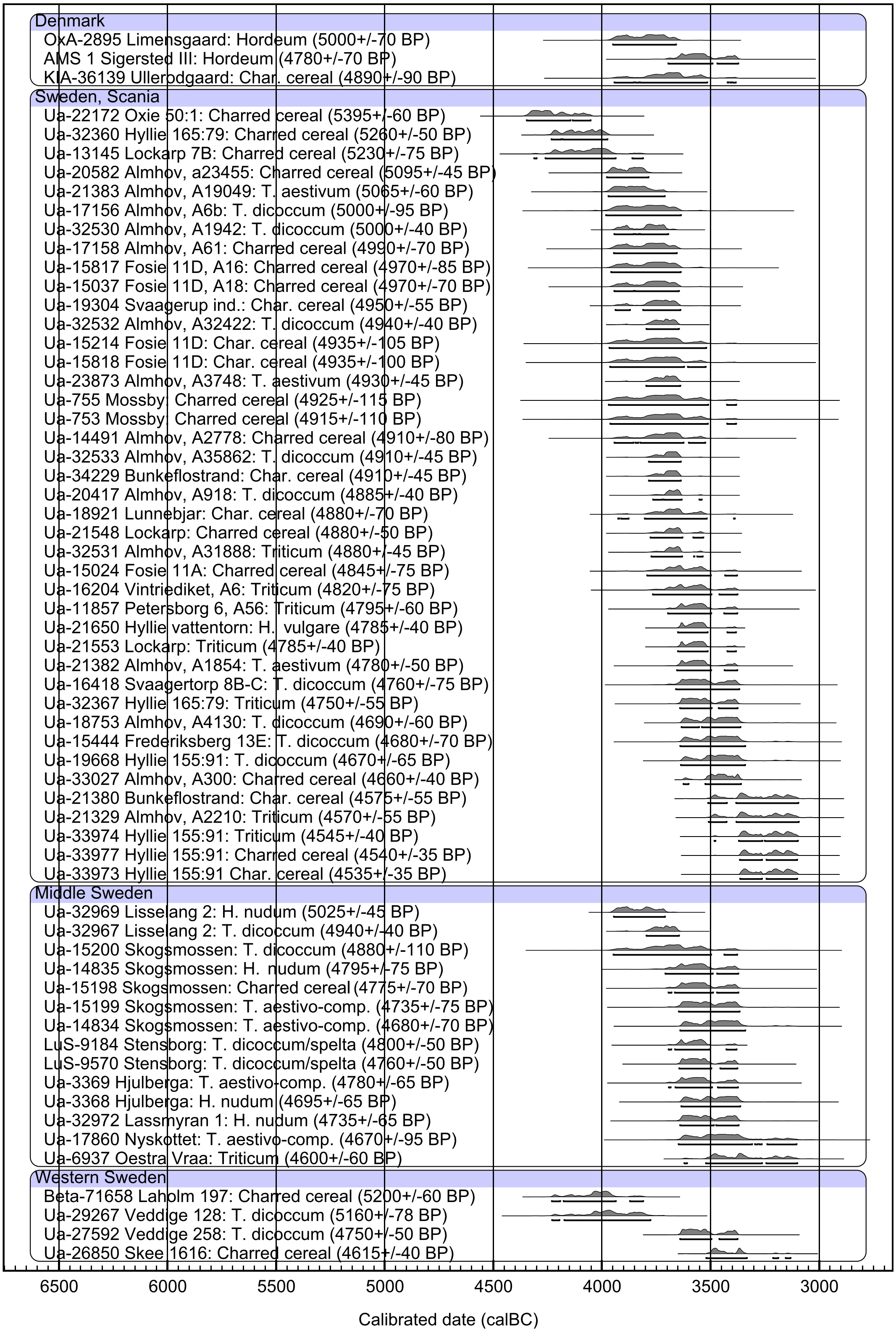

Fig. 6. [14]C dates of charred cereal grains from Early Neolithic in Southern Scandinavia based on data from Table S1: Limensgård (Fischer, 2002), Sigersted III (Koch, 1998), Ullerødgård (Esben Aarsleff, pers. Commun.), sites from Scania (Larsson, 1992: 74; Hadevik, 2009: 82ff; Rudebeck, 2010: 112ff), sites from Middle Sweden (Hallgren, 2008; Larsson and Broström, 2011: 197) and sites from Western Sweden (Svensson, 2010; Johansson et al., 2011; Ryberg, 2006; Westergaard, 2008).

Inline Supplementary Fig. S1 can be found online at http://dx.doi.org/10.1016/j.jas.2012.08.042.

Supplementary Fig. S2 can be found online at http://dx.doi.org/10.1016/j.jas.2012.08.042.

Threshing waste from emmer wheat was used as tempering material in clay discs found in several pits dated to the Early Neolithic, as for example at Lisbjerg Skole near Århus (Fig. 3, nr. 31, Skousen, 2008: 124). Hazelnut shells from the pits (A-2087, A-2092

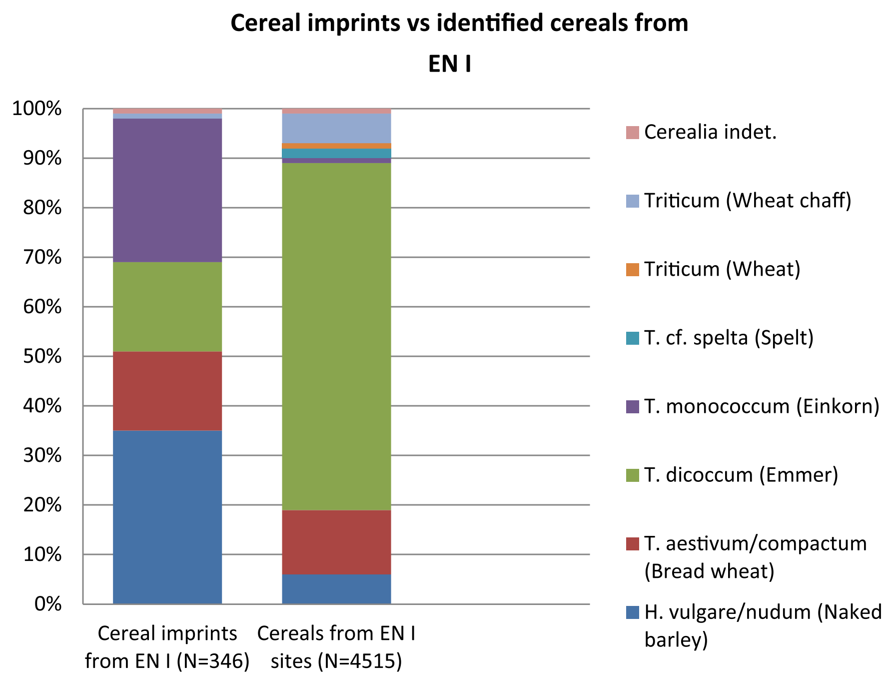

Fig. 7. Comparison of charred cereals and imprints of cereals in pottery from the Early Neolithic I based on data from Tables S3 and S4 (Mathiassen, 1940; Helbæk, 1954; Hjelmqvist, 1976; Jørgensen, 1976, 1981; Jennbert, 1984; Larsson, 1984; Andersen, 1991; Nielsen, 1984, 1994; Robinson, 1996, 1999, 2003; Gustafsson, 2004; Hallgren, 2008; Skousen, 2008; Rudebeck, 2010; Larsson and Broström, 2011).

and A2165) date to 5190 ± 90 BP (4251–3785 cal BC. AAR-8542) and to 4975 ± 55 BP (3942–3651 cal BC. AAR-9225). Straw remains and chaff imprints are also found in clay discs from the Early Neolithic site of Store Valby (Fig. 3, nr. 48), Becker, 1954: 134ff; Helbæk, 1954: 198ff). Additional evidence for crop processing is recorded from a few Early Neolithic inland sites all over Southern Scandinavia, such as Limensgård (Fig. 3, nr. 52) and Stensborg (Fig. 8, Table S5), Rastorf LA 6 (Fig. 3, nr. 125) and Oldenburg-Dannau LA 77 (Fig. 3, nr. 126) (Robinson, 2003: 145ff; Larsson and Broström, 2011: 197; Kirleis et al., 2012: 226ff) (Fig. 8, Table S5). Generally, evidence for cereal grains and crop processing is almost exclusively related to Early Neolithic inland sites (Figs. S1, S2, Table S3, S4), in contrast to the numerous coastal or lake shore sites, where clear evidence for cultivation activities seems to be missing. Only very few impressions of cereal grains in ceramics are documented from the kitchen midden at Bjørnsholm (Fig. 2, nr. 14), Norsminde (Fig. 2, nr. 16), and the lake shore site Muldbjerg I (Fig. 3, nr. 36), whereas actual grains of naked barley, bread wheat and emmer are recorded in the Early Neolithic layers of the Visborg kitchen midden (Fig. 3, nr. 12) (Helbæk, 1954: 198ff; Robinson, 1999; Andersen, 2008). Currently no threshing waste has been observed on any coastal or lake shore site. The strongest evidence of crop processing is reported from the long barrow located near the Bjørnsholm kitchen midden, where pollen of cereals was found (Andersen, 1992: 59ff). The area surrounding Bjørnsholm is one of those places that is located near sandy and easily-workable arable soils.

Crop processing activities can also be revealed by the presence of quern stones, mostly known from Early Neolithic inland sites all over Southern Scandinavia from the beginning of the 4th millennium BC onwards (Hallgren, 2008, 211; Nielsen, 2009: 14; Rudebeck, 2010: 112; Ravn, 2012: 145) (Fig. 8, Table S5). Plough marks below the long barrow of Højensvej 7 (Fig. 3, nr. 33) near Egense on the island of Funen covered an area of 85 square metres (Beck, 2009: 7ff; Beck, in press). Some of the plough marks were cut by a pit, which was dated by a burnt hazelnut shell to 4900 ± 40 BP (3770–3637 cal BC. POZ-28068), thus proving a very early date (Fig. 8), currently the earliest from Northern Europe. Plough marks were also detected below the long barrow of Flintbek LA 3 in Schleswig-Holstein (Fig. 3, nr. 123). These plough marks were, based on stratigraphic observations, assigned to the forth building phase of the long barrow (Mischka, 2011: 745f). Charcoal found in grave E was dated to 4794 ± 30 BP (3646–3522 cal BC) and 4539 ± 30 BP (3365–3104 cal BC) (Fig. 8). Plough marks of more limited extent were detected below a number of long barrows in Jutland and Funen. Notice should definitely be taken of this clear evidence for agricultural activity in future excavations (Jørgensen, 1977: 7ff; Fischer, 1980: 23ff; Ebbesen, 1992: 96; Andersen, 2009). The cultivation of large fields using an ard, in order to get maximum yield out of the soil, was obviously a technique, already being applied from the beginning of the Early Neolithic in Southern Scandinavia. Moreover, use-wear traces on sickles from Early Neolithic sites indicate cereal harvesting activities (Juel Jensen, 1994).

4.2. Evidence of domesticated animals

Domesticated dogs (*Canis familiaris*) are currently the only clear evidence for the presence of domesticated animals in Late Ertebølle contexts (Fig. 12, Table S8) (Rowley-Conwy, in press).

Bones of domesticated cattle are recorded all over Southern Scandinavia for the time period 4000–3700 BC, more or less synchronic with the evidence for cereal cultivation (Fig. 9, Table S6). Molecular genetic analysis can now prove that the presumed domesticated cattle from Rosenhof LA 58 and 83 (Fig. 2, nr. 7), dated to 4700 cal BC, were small aurochsen (Hartz and Lübke, 2004; Noe-Nygaard et al., 2005). This might also be the case for the records of domesticated cattle from Hindbygården in Scania (Fig. 3, nr. 62) 5570 ± 110 BP (4702–4173 cal BC. Ua-1575) (Hadevik, 2009: 82ff). Another early cattle find, one tooth from Lollikhuse (Fig. 2, nr. 4), is dated to 5890 ± 55 BP (4929–4612 cal BC. AAR-7410-2). The find is probably a 'souvenir' showing contact with farming societies in

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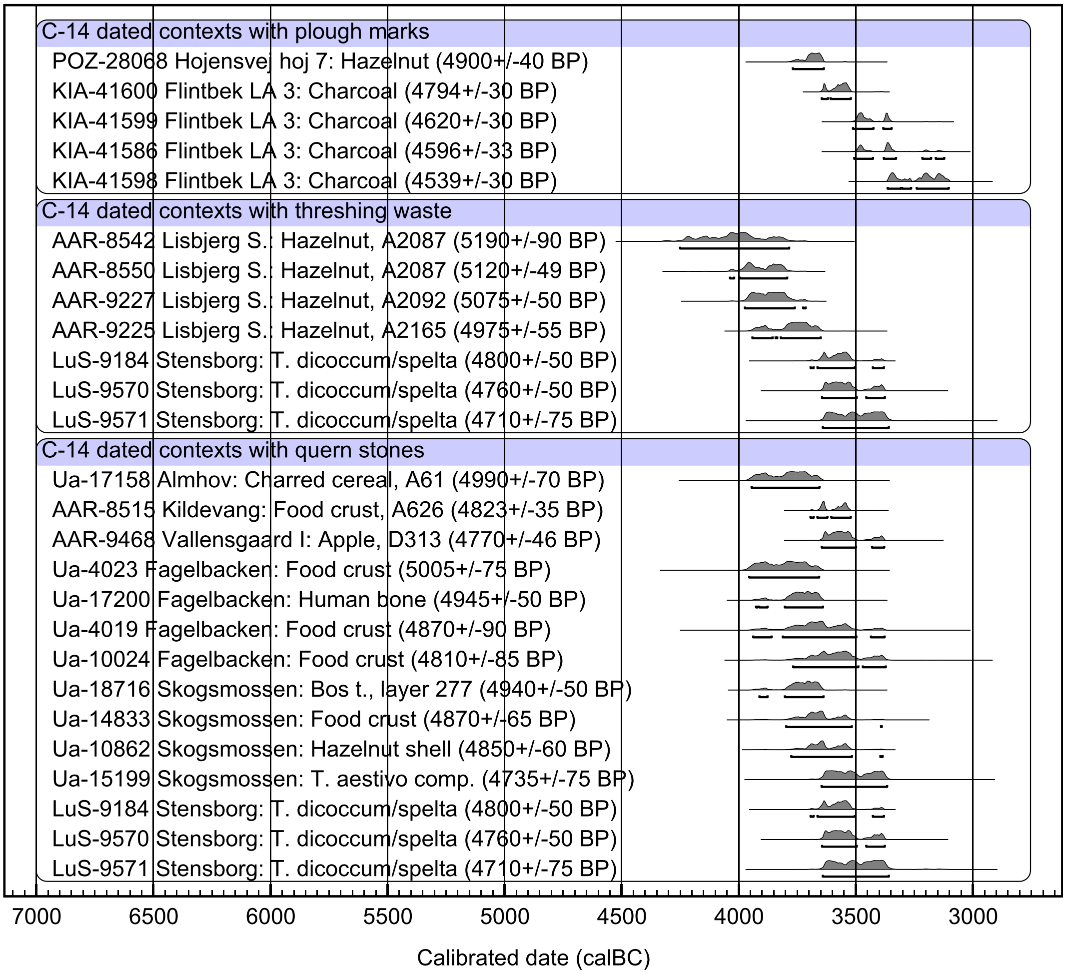

Fig. 8. ^{14}C dates of agrarian evidences from archaeological contexts based on data from Table S5 (Hallgren, 2008; Skousen, 2008; Beck, 2009; Nielsen, 2009; Rudebeck, 2010; Larsson and Broström, 2011; Mischka, 2011; Ravn, 2012).

Central Europe (Sørensen, 2005: 305). Early cattle bones from Smakkerup Huse (Fig. 2, nr. 5) support the idea that Ertebølle hunter and gatherers had access to domesticated animals (Price and Gebauer, 2005). These bones derive from stratified refuse layers that are dated to 5059 ± 68 BP (3981–3701 cal BC. AAR-3316) and 5060 ± 61 BP (3968–3711 cal BC. AAR-3317). It has to be mentioned that the site was eroded during the Subboreal period, and it cannot be ruled out, that the cattle bones could belong to an Early Funnel Beaker occupation. This means that the evidence for domestic cattle dated to clear Late Ertebølle contexts is very weak. The fact that some Late Ertebølle hunter–gatherer might have kept a few cows does not allow us to define them as farmers. Although we could be dealing with a transitional phase during the Late Ertebølle and Early Neolithic with herding activities of cows, sheep and goats.

Evidence of sheep and goat from Jutland, Zealand and Gotland is dated to 4000–3700 cal BC, in contrast to Northern Germany, where they appear at least one century earlier, and to Western Sweden, where they date to a few centuries later (Fig. 10, Table S7). More direct ^{14}C dates on sheep and goat bones in Southern Scandinavia are currently being undertaken. The few dates available suggest that sheep and goat were introduced as part of the Neolithic package together with cereals and cattle (Price and Noe-Nygaard, 2009: 206ff).

Domesticated pigs were probably also a part of this package (Fig. 11, Table S7). Recently some probable domesticated pigs were found in a pit from the Early Neolithic site of Almhov in Scania, dated to 4960 ± 50 BP (3937–3645 cal BC. Ua-22166) (Rudebeck, 2010, 112ff). Other possible domesticated pigs were identified in many Early Neolithic contexts (Fig. 13, Table S8). Especially the measurements of length and breath of the *calcaneus* (heel bone) from wild boar and domestic indicate the presence of a few probable domesticated pigs in the transitional site of Åkonge (Fig. 3, nr. 18) (Gotfredsen, 1998: 98). However, the identification of domesticated pigs causes problems due to possible interbreeding with wild boars during the Mesolithic and Neolithic transition in Southern Scandinavia. The problem could be resolved by future DNA analysis. Presently there is no secure archaeological evidence of domesticated pig earlier than 3700 cal BC in Southern Scandinavia, which has to do with the lack of direct ^{14}C dates and problems with identification.

The coastal and lake shore sites dated to the Mesolithic/Neolithic transition and Early Neolithic I, are characterized by their low number of identified bones of domesticated animals (Fig. 12, Table S8). The result is interpreted as a clear evidence for a continuation of the hunter–gatherer lifestyle at these sites, where the faunal remains are showing all year round habitation (Bratlund, 1993: 101; Noe-Nygaard, 1995: 76; Lekberg, 1997; Gotfredsen, 1998; Segerberg, 1999; Enghoff, 2011) (Fig. 13, Table S8). A different picture emerges, when investigating the faunal assemblages from the inland sites located on easily-workable arable soils. Here the percentage of domesticated animals is higher, thus

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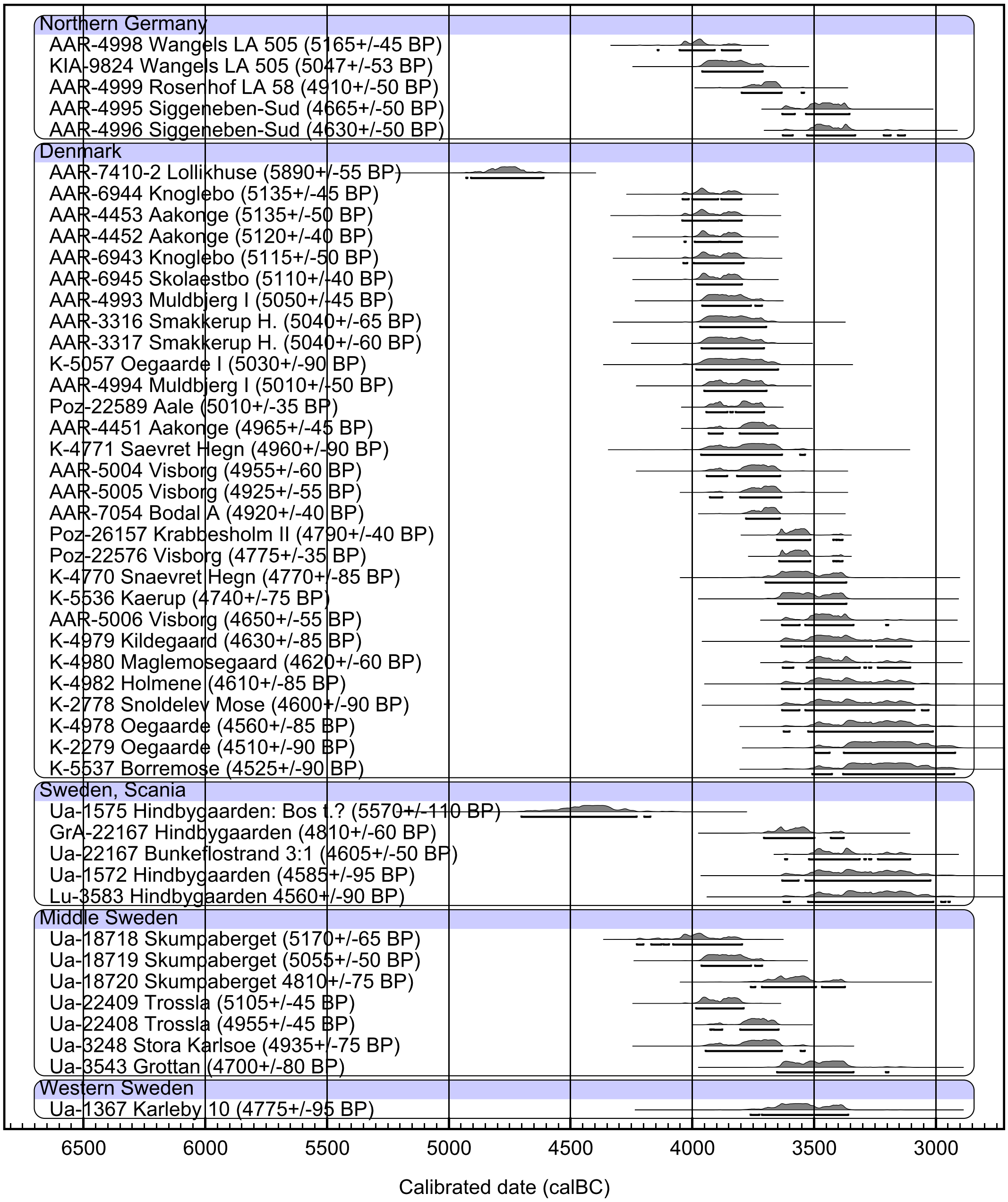

Fig. 9. [14]C dates of domesticated cattle from Late Ertebølle Culture and Early Neolithic in Southern Scandinavia based on data from Table S6 (Lindqvist and Possnert, 1997; Koch, 1998; Heinemeier and Rud, 1999, 2000; Persson, 1999; Heinemeier, 2002; Hartz and Lübke, 2004; Noe-Nygaard et al., 2005; Price and Gebauer, 2005; Sørensen, 2005; Hallgren, 2008; Hadevik, 2009; Enghoff, 2011).

supporting the interpretation that agrarian subsistence was more important at these sites (Fig. 13, Table S8). Currently no systematic investigations have been made on the faunal indicators of seasonality on any of these sites (Nielsen, 1984: 110; Koch, 1998: 244; Sjögren, 2003: 129; Hallgren, 2008; Welinder et al., 2009: 142). During Early Neolithic II and Middle Neolithic I–II, there is a more equal distribution of domesticated animals across the inland and coastal/lake shore sites although there are coastal sites like Sølager (Fig. 2, nr. 17), where domesticated animals are rare (Fig. 14, Table S8) or dominant as observed on the site Grottan (Fig. 3, nr. 124), thus showing different economic strategies. At the beginning of the middle Neolithic, a few sites still show a low number of identified bones of domesticated animals, such as the lake site Storelyng VI (Fig. 3, nr. 119). Red and roe deer are the dominant species, characterizing the sites as specialized hunting camps (Skaarup, 1973; Koch, 2003: 209ff). Generally the faunal indicators of seasonality on the Early Neolithic II and Middle Neolithic I–II hunting sites and agrarian inland sites contains evidences of a habitation during spring, summer and autumn, whereas the winter months have been more difficult to identify (Madsen et al., 1900: 135; Troels-Smith, 1954: 23; Nobis, 1962: 18; Skaarup, 1973; Møhl, 1975: 210; Madsen, 1978: 177; Johansson, 1979: 82; Andersen, 1981; Rowley-Conwy, 1984; Nyegaard, 1985: 447ff; Koch, 1998: 246; Nilsson, 2003: 294; Magnell, 2007: 51ff; Skousen, 2008: 155; Enghoff, 2011).

4.3. Pointed butted flint axes as evidence for the expansion of agrarian societies

The distribution of pointed butted axes reflects the early expansion of agrarian sites all the way up to the Stockholm area

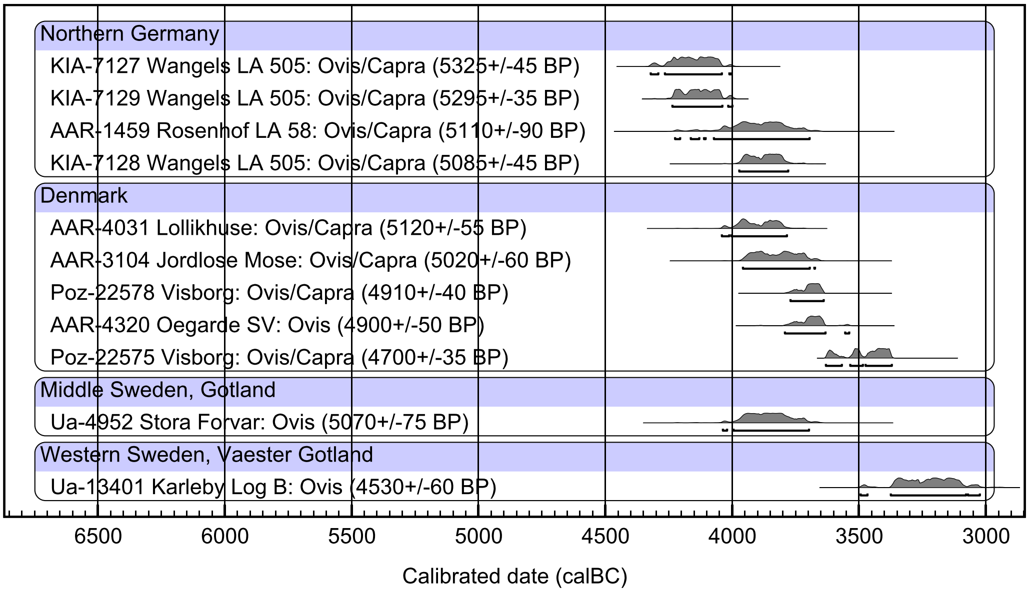

Fig. 10. [14]C dates of sheep and goat from Early Neolithic in Southern Scandinavia based on data from Table S7 (Lindqvist and Possnert, 1997; Heinemeier and Rud, 1998, 1999; Hartz and Lübke, 2004; Enghoff, 2011; Sjögren, in press.).

(Hallgren, 2008). Their typology and placement within the Early Neolithic I period is supported by several [14]C dates from settlement contexts. Generally there is an overlap between three axe types, but the [14]C dates supports the typology originally proposed by Nielsen (1977) (Fig. 15, Table S9), supported by the fact, that flint axe depositions of type 1 have never been found together with type 3, whereas type 2 can be associated with type 3 and thin butted axes (Karsten, 1994). Moreover, the axes are rather densely distributed at inland habitation sites in certain regions with easily-workable arable soils, for example the Fallbygden area, the inner part of Scania, Bornholm, and the northern parts of Funen and Jutland (Fig. 16). The pointed butted flint axes from Southern Norway are probably also connected to the Early Neolithic agrarian expansion (Henningsmoen, 1980; Østmo, 1988; Prøsch-Danielsen, 1996; Glørstad, 2010, 275). A large and systematic production and distribution of these axes, is revealed by numerous concentrations of pointed butted axes close to the flint mines on Stevns (Fig. 3, nr. 50) in Eastern Zealand, and Södra Sallerup (Fig. 3, nr. 71) in Scania (Mathiassen, 1934: 18ff; Olausson et al., 1980: 183ff). The few [14]C dates of charcoal found in the mines at Södra Sallerup suggest systematic flint mining activities from 4000 cal BC onwards (Olausson et al., 1980, 183). Deep mining after flint is a characteristic feature of the Central European Michelsberg Culture (4400–3500 cal BC) (Bostyn and Lanchon, 1992; Collet et al., 2004: 151ff; Grooth et al., 2011: 77ff), we therefore presume that this technical knowhow was introduced to Southern Scandinavia by migrating farmers from Central Europe.

5. Discussion

Our results suggest the appearance of a complete agrarian technology and a quick expansion of farming activities in the whole area of Southern Scandinavia around 4000 cal BC. The speed of the expansion was so rapid that pioneering farmers from Central European must have been involved, because the agrarian evidences supports the introduction of an entire Neolithic package. The reason for the expansion could be a combination of population pressure, and climate change to drier conditions giving better environments for crop growing in the Northern European plains (Leuschner et al., 2002: 703; Gronenborn, 2007: 71; Shennan, 2009,

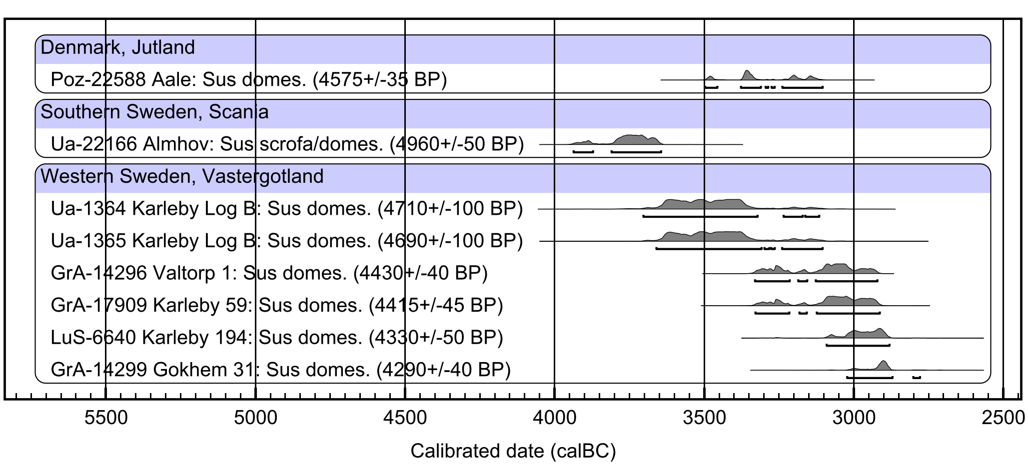

Fig. 11. [14]C dates of domesticated pig/wild boar from Late Ertebølle and Early Neolithic in Southern Scandinavia based on data from Table S7 (Hadevik, 2009; Enghoff, 2011; Sjögren, in press.).

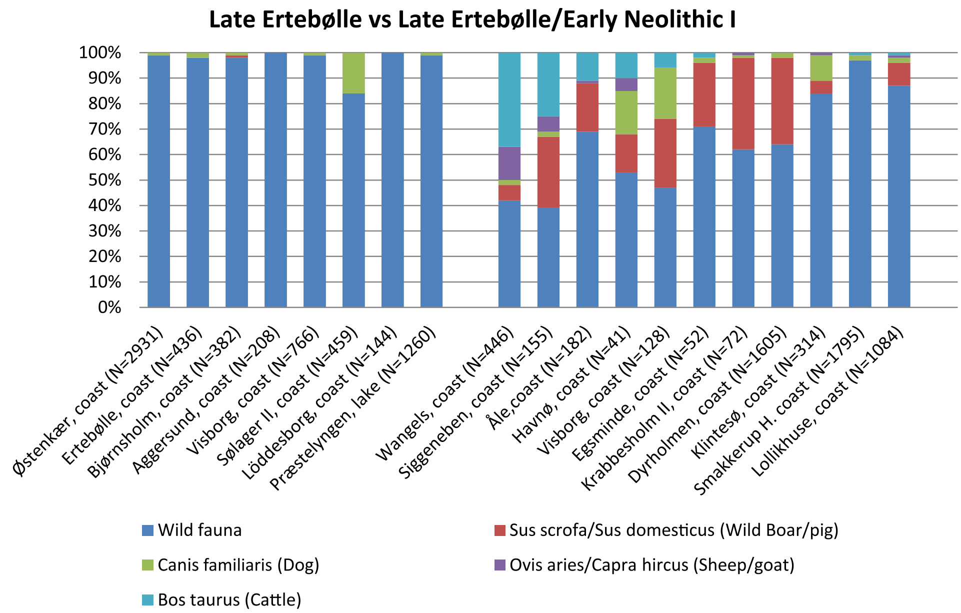

Fig. 12. Faunal assemblages from coastal and lake shore sites dated to Late Ertebølle and the earliest phase of Early Neolithic in Southern Scandinavia based on data from Table S8 (Madsen et al., 1900; Skaarup, 1973; Hallström, 1984; Bratlund, 1993; Noe-Nygaard, 1995; Heinrich, 1999; Hede, 2005; Enghoff, 2011).

339ff; Müller, 2011). Here, natural resources for agricultural activities were previously unexploited.

Another reason for the expansion could be relatively easy access to the best flint mines in Southern Scandinavia. A huge number of the Early Neolithic I inland sites are located on easily-workable arable soils and in close proximity to these mines (Fig. 16).

These pioneering farmers probably consisted of smaller groups. Recently Klassen (2004) and Rowley-Conwy (2011) suggested that they expanded to the north by leap-frog, punctuated or sporadic immigration (Moore, 2001: 395ff). A similar model has been presented by Zilhao (2001: 14180ff), explaining a rapid Neolithic expansion in the Mediterranian. The expansion towards Scandinavia happened so fast and covered areas over land and sea, that boats must have been used as indicated by very early Neolithic agrarian habitations on the islands of Bornholm and Gotland (Lindqvist and Possnert, 1997: 73f; Casati and Sørensen, 2006: 39; Nielsen, 2009: 9ff).

During the Early Neolithic period an agrarian way of life was practised on inland sites contemporaneously with hunting and fishing activities which took place on sites near the coast, in fjords or by larger inland lakes. Are we dealing with commuting farmers or with a cultural dualism? The few evidences for the presence of cows, sheep and goats at the coastal or lake sites could be interpreted as initial herding activities by communities that still live as hunter/gatherer/fishers. This interpretation finds support in historical records from South Africa, where hunter–gatherers quickly adopted herding of especially sheep through contact and information exchange with neighbouring farmers, and not

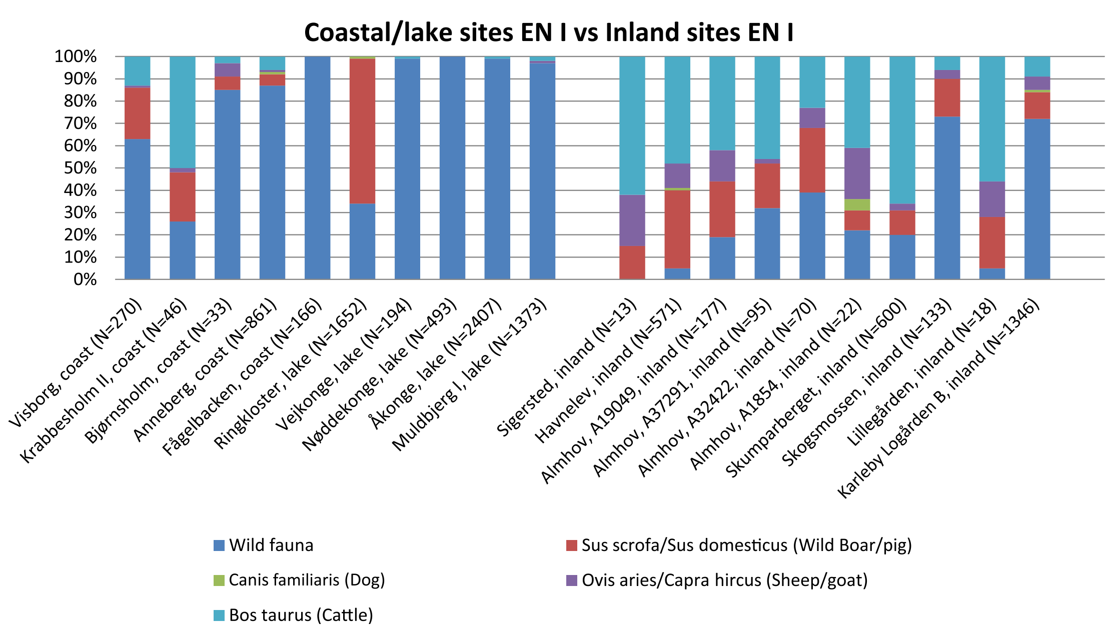

Fig. 13. Faunal assemblages from coastal, lake shore and inland sites dated to the earliest phase of Early Neolithic in Southern Scandinavia based on data from Table S8 (Nielsen, 1984; Bratlund, 1993; Noe-Nygaard, 1995; Lekberg, 1997; Gotfredsen, 1998; Koch, 1998; Segerberg, 1999; Sjögren, 2003; Hallgren, 2008; Welinder et al., 2009; Enghoff, 2011).

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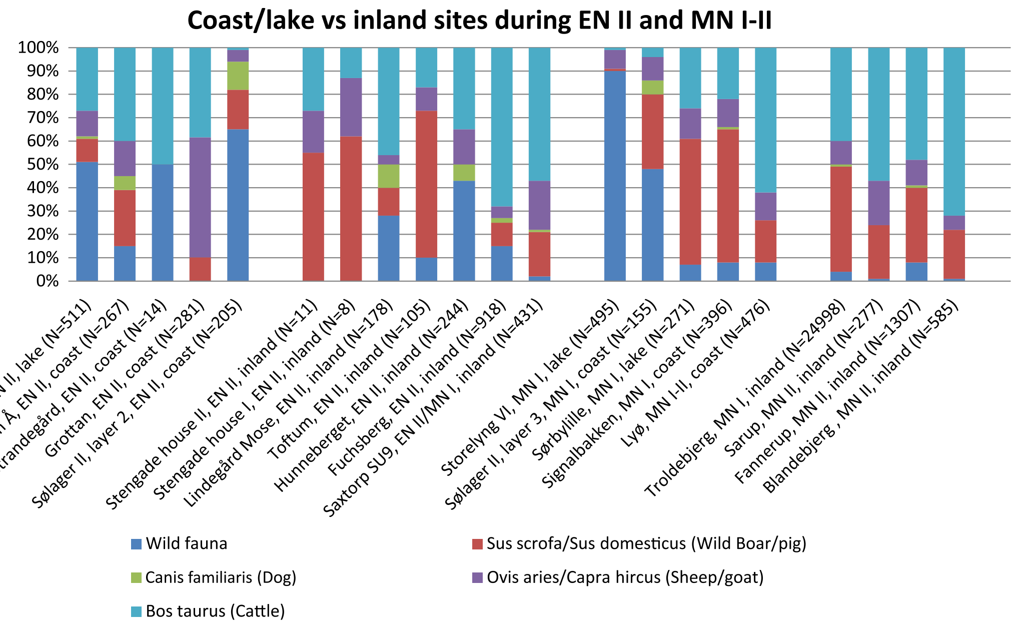

Fig. 14. Faunal assemblages from coastal, lake shore and inland sites from Early Neolithic II and Middle Neolithic I–II based on data from Table S8 (Madsen et al., 1900; Troels-Smith, 1954; Nobis, 1962; Skaarup, 1973; Møhl, 1975; Madsen, 1978; Johansson, 1979; Andersen, 1981; Rowley-Conwy, 1984; Nyegaard, 1985; Lindqvist and Possnert, 1997; Koch, 1998; Nilsson, 2003; Magnell, 2007; Skousen, 2008; Enghoff, 2011).

necessarily through the integration with farming communities (Xavier et al., 2008: 1ff). However, if hunter–gatherers started to keep domesticated animals all year round, they would have needed to collect huge amounts of winter fodder, thus changing their economic strategy and their way of life. The complexity of agricultural technologies and their application require a long-term experience in order to succeed (Lüning, 2000: 174; Ehrmann et al., 2009: 44ff; Schier, 2009: 15ff).

If these Late Mesolithic/Early Neolithic hunter–gatherers wanted to succeed as farmers, they had to integrate into the agrarian

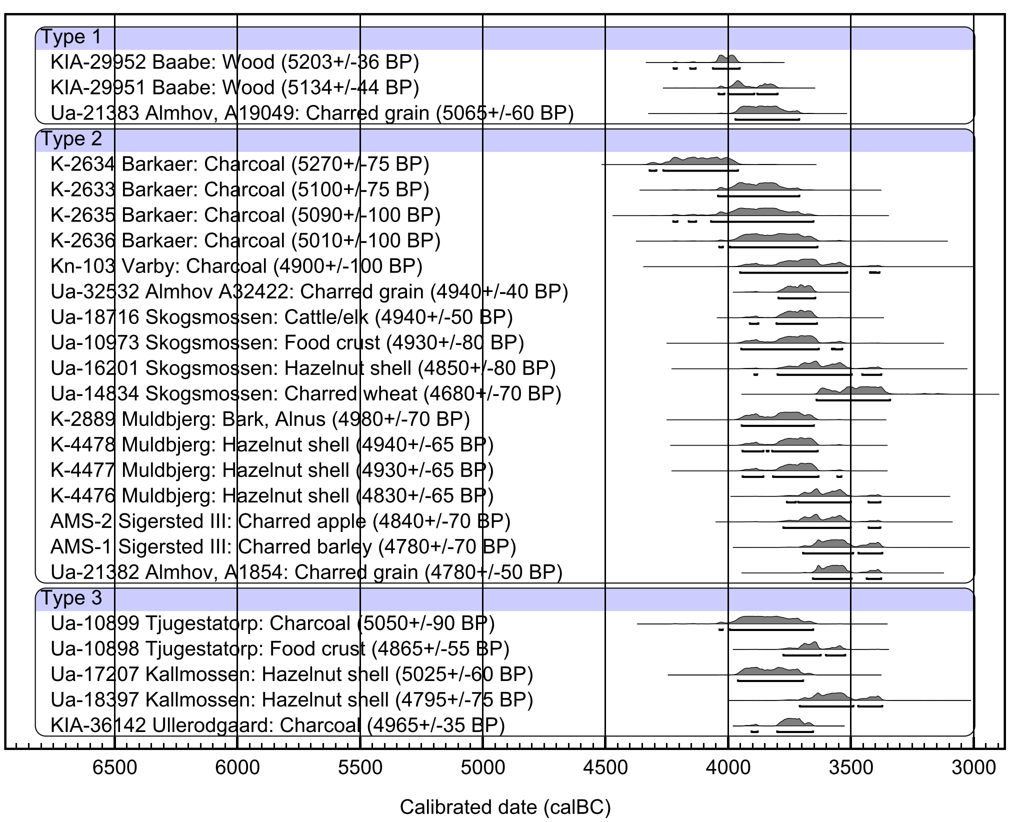

Fig. 15. ^{14}C dates of Early Neolithic contexts containing pointed butted flint axes based on data from Table S9 (Troels-Smith, 1957; Salomonsson, 1970; Liversage, 1992; Koch, 1998; Stafford, 1999; Hallgren, 2008; Hirsch et al., 2008; Rudebeck, 2010; Esben Aarsleff personal commun.).

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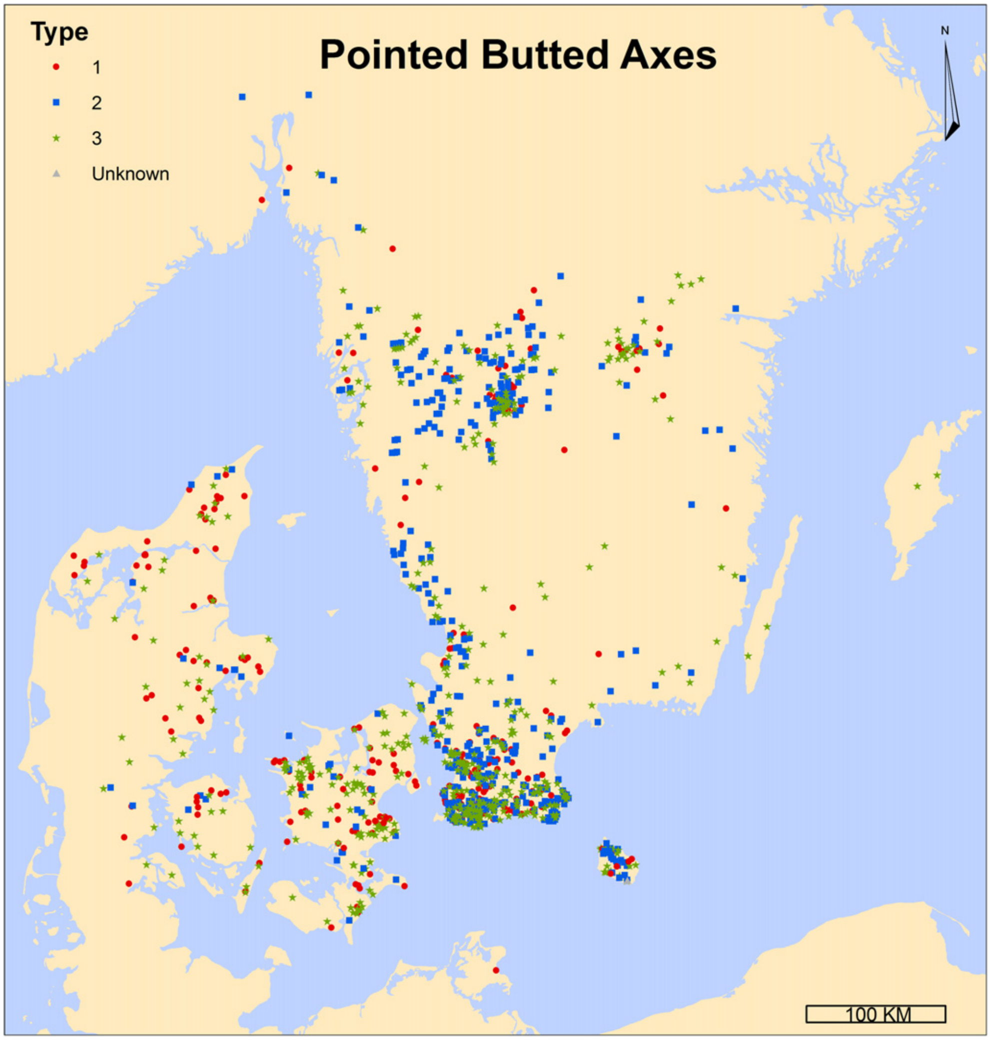

Fig. 16. Distribution of pointed butted flint axes based on data from Denmark (Brønsted, 1938, 130ff), Scania (Hernek, 1988, 216ff), Bohuslän, Dalsland, Halland and Vester Götland (Blomqvist, 1990), Bornholm (Nielsen, 2009, 16ff), Middle parts of Sweden (Hallgren, 2008), Southern Norway (Østmo, 1986, 190ff) and Stockholm's Historiska Museum.

societies. Recently, Kind (2010: 457) has proposed, that the transition towards agriculture is determined by an intensified social interaction between local hunter–gatherers and pioneering farmers, characterized as the 'managers of neolithisation'.

Proof of cultural dualism would be the actual record of cereal cultivation at a site which, on every other kind of evidence, was used by hunter–gatherers. The Bjørnsholm kitchen midden (Fig. 2, nr. 14) could be one of these sites, because pollen of barley and wheat was found under the neighbouring long barrow (Andersen and Johansen, 1992: 38ff; Andersen, 1992: 59ff). Visborg could be another example, as a burnt layer under the kitchen midden indicates the possible use of the slash and burn method (Andersen, 2008: 69ff) that was probably also applied to seashore vegetation (Karg and Harild, 2009). A clear example of cultural dualism is the extraordinary find of the Dragsholm man (Fig. 3, nr. 45), who was buried in a kitchen midden and equipped as a warrior. He could be a typical representative of a 'manager of neolithisation' (Brinch Petersen, 2008: 33ff).

A way of documenting cultural dualism is by applying molecular genetic analysis to human bones. The burial site of Ostorf (Fig. 3, nr. 108) in Northern Germany was originally interpreted as a hunter–gatherer enclave surrounded by agrarian societies, because the individuals had a high intake of aquatic resources (Lübke et al., 2009: 130ff; Schulting, 2011: 21). However, three burials contained bodies with Palaeolithic/Mesolithic haplogroups U5 and U5a, while four other burials contained Neolithic haplogroups J, K and T2e (Bramanti et al., 2009: 139). The individuals at Ostorf illustrate a rare example of hunter–gatherers and possible farmers who might have lived together.

6. Conclusions and perspectives

The hypothesis regarding cultural dualism should be confirmed by ^{14}C dates, stable isotope and molecular genetic analysis. If the DNA influx from pioneering farmers consists of Palaeolithic/Mesolithic haplogroups (D and U4 and U5) representing Central European hunter–gatherers who became farmers, then it will be difficult to detect any differences (Bramanti et al., 2009: 137ff). However, Skoglund et al. (2012: 466ff) was able to extract mtDNA from a female skeleton found in the passage grave Gök 4 in Sweden (Fig. 3, nr. 101). The woman was ^{14}C dated to 4341 $\pm$ 44 BP (3090–2889 cal BC. AAR-10235) and carying haplogroup H, which is currently observed in the Mediterranean area. Furthermore the strontium isotope analyses indicate that she was born in a distance less than 100 km away from the passage grave. The result was interpreted as a large scale migration of Neolithic farmers from

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Southern Europe and creation of retreats with very little integration between migrating farmers and local hunter–gatherers. However, the presence of the Palaeolithic/Mesolithic haplogroup U5 in Denmark during the early Bronze Age, indicates that it is unlikely, that there occurs an abrupt replacement of the Mesolithic hunter–gatherer population with a new Neolithic population in Southern Scandinavia (Melchior et al., 2010: 6). Currently the genetic analysis are pointing in two opposite directions.

Stable isotope analysis on human and animal bones is another method to prove the subsistence economy of populations (Tauber, 1981; Fischer et al., 2007: 2125ff). Marine values of δ13C and δ15N were extracted from Mesolithic hunter–gatherers, while most of the Early Neolithic samples, except one from Sejrø (Fig. 3, nr. 49), showed non-marine values. Human bones from the Early Neolithic coastal/kitchen midden sites have not yet been analyzed. The abrupt shift in δ13C values could be interpreted as a deliberately deselection of marine food as a ressource (Milner et al., 2004: 9ff; Brinch Petersen and Egeberg, 2009: 563). However, this does not necessarily mean that farmers moved away from the coastal areas, as Funnel Beaker hunting stations are documented for the Early and Middle Neolithic periods (Skaarup, 1973; Eriksson et al., 2008), but it could reflect a possible decline of marine resources.

The agrarian expansion during the Early Neolithic in Southern Scandinavia can, with the help of absolute datings of cereal remains and bones of domestic animals, be characterized as a quick process lasting only a few centuries between 4000 and 3700 cal BC. We conclude that small groups of already experienced farmers migrated by using boats as means of transportation. The reason for the expansion is still uncertain, but a combination of growing population pressure in Middle Neolithic cultures in Central Europe, favourable climatic conditions, and easy accessible flint resources could have motivated some farmers to move north. They brought with them the knowhow of agrarian technology, new material culture and ideology. The question of what happened to the local hunter–gatherers is still open for discussion: maybe they became farmers within one or two generations? This could explain the synchronism of inland and coastal sites, where both agrarian and natural food resources were exploited. Another possibility could be a cultural dualism of pioneering farmers living in inland sites and hunter–gatherers living at the coast and lake shores until the end of the Early Neolithic I period. According to this hypothesis, the local hunter–gatherers would have quickly adopted the new material culture and husbandry, but we observe in many cases a continuous hunter–gatherer lifestyle. Evidence for cultural dualism is recorded at a few hunter–gatherer sites. Both explanations are possible, but currently the archaeological evidences tend to favour a cultural dualism during the earliest part of the Early Neolithic. The transition towards an agrarian way of life in Scandinavia can be interpreted as a complex and continuous process of migration, integration and gradual assimilation of neighbouring farmers and hunter–gatherers.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jas.2012.08.042.

References

Aaby, B., 1985. Norddjurslands landskabsudvikling gennem 7000 år. Belyst ved pollenanalyse og bestemmelse af støvindhold i højmosetørv. Antikvariske Studier 7, 60–83.
Aaby, B., 1986. Mennesket og naturen på Abkæregnen gennem 6000 år – resultater af et forskningsprojekt. Sønderjysk Månedskrift 9, 277–290.
Aaris Sørensen, K., 1998. Danmarks Forhistoriske Dyreverden, third ed. Gyldendal.
Andersen, S.H., Johansen, E., 1992. An Early Neolithic grave at Bjørnsholm, north Jutland. Journal of Danish Archaeology 9, 38–58.
Andersen, S. Th, Rasmussen, P., 1993. Early and Middle Neolithic agriculture in Denmark: pollen spectra from soils in burial mounds of the Funnel Beaker Culture. Journal of European Archaeology 1, 153–180.
Andersen, H.H., 1981. Sarup. Befæstede neolitiske anlæg og deres baggrund. Kuml, 63–103 (1980).
Andersen, S.H., 1991. Norsminde. Journal of Danish Archaeology 8, 13–40 (1989).
Andersen, S. Th, 1992. Pollenspectra from two Early Neolithic lugged jars in the long barrow at Bjørnsholm, Denmark. Journal of Danish Archaeology 9, 59–63.
Andersen, S, Th, 1995. History of vegetation and agriculture at Hassing Huse Mose, Thy, northwest Denmark, since the Ice Age. Journal of Danish Archaeology 11, 57–79.
Andersen, S.H., 2008. The Mesolithic – Neolithic transition in Western Denmark seen from a kitchen midden perspective. A survey. In: Fokkens, H., Coles, B.J., Van Gijn, A.L., Kleijne, J.P., Ponjee, H.H., Slappendel, C.G. (Eds.), Between Foraging and Farming. Analecta Prehistorica Leidensia 40. Faculty of Archaeology, Leiden, pp. 67–74.
Andersen, H.H., 2009. Sarupområdet på Sydvestfyn i slutningen af 4. Årtusinde f.Kr. In: Schülke, A. (Ed.), Plads og rum i tragtbægerkulturen. Nordiske Fortidsminder Serie C, bind 6. Det Kongelige Nordiske Oldskiftselskab, Copenhagen, pp. 25–44.
Andreasen, M.H., 2009. Agerbruget i enkeltgravskultur, senneolitikum og ældre bronzealder i Jylland – belyst ud fra plantemakrofossiler. Kuml, 9–55 (2009).
Bayliss, A., Bronk-Ramsey, C., Van der Plicht, J., Whittle, A., 2007. Bradshaw and bayes: towards a timetable for the Neolithic. Cambridge Archaeological Journal 17, 1–28.
Beck, M.R., 2009. Lå Danmarks første pløjemark ved Egense? Svendborgs Museums Årbog, 7–16.
Beck, M.R. Højensvej høj 7 – en tidligneolitisk langhøj med flere faser ved Egense, Svendborg. Aarbøger for Nordisk Oldkyndighed og Historie, in press.
Becker, J., 1948. Mosefundne Lerkar fra yngre Stenalder. Studier over Tragtbægerkulturen i Danmark. Aarbøger for Nordisk Oldkyndighed og Historie, 5–318 (1947).
Becker, C.J., 1954. Stenalderbebyggelsen ved Store Valby i Vestsjælland. Problemer omkring tragtbægerkulturens ældste og yngste fase. Aarbøger for Nordisk Oldkyndighed og Historie, 127–197 (1954).
Blomqvist, L., 1990. Neolitisk Atlas över Västra Götland. Falköping.
Bostyn, F., Lanchon, Y., 1992. Jablines. Le Haut Château (Seine-et-Marne). Un miniére de silex au Néolithique. Documents d'Archéologie Francaise, Paris.
Bramanti, B., Thomas, M.G., Haak, W., Unterlaender, M., Jores, P., Tambets, K., Antanaitis-Jacobs, I., Haidle, M.N., Jankauskas, R., Kind, C.J., Lüth, F., Terberger, T., Hiller, J., Matsumura, S., Forster, P., Burger, J., 2009. Genetic Discontinuity Between Local Hunter-Gatherers and Central Europe's First Farmers. Science 326, 137–140.
Bratlund, B., 1993. The bone remains of mammals and birds from the Bjørnsholm Shell-Mound. Journal of Danish Archaeology 10, 97–104.
Brinch Petersen, E., Egeberg, T., 2009. Between Dragsholm I and II. In: Larsson, L., Lüth, F., Terberger, T. (Eds.), Innovation and Continuity – Non Megalithic Mortuary Practices in the Baltic. New Methods and Research into the Development of Stone Age Society. Bericht der Römisch-Germanischen Kommission, vol. 88. Philipp von Zabern, Mainz, pp. 447–467.
Brinch Petersen, E., 2008. Warriors of the Neolithic TRB-culture. In: Sulgostowska, Z., Tomaszewski, A.J. (Eds.), Man Millenia Environment. Studies in honour of Roman Schild, Warsaw, pp. 33–38.
Brønsted, J., 1938. Danmarks Oldtid. Bind 1, first ed. Copenhagen.
Buck, C.E., Cavanagh, W.G., Litton, C.D., 1996. Bayesian Approach to Interpreting Archaeological Data. Wiley, Chichester.
Casati, C., Sørensen, L., 2006. Bornholm i ældre stenalder. Status over kulturel udvikling og kontakter. Kuml, 9–58 (2006).
Collet, H., Collette, O., Woodbury, M., 2004. Indices d'extraction et de taille du silex datant du Néolithique recent dans la Carriére CBR à Harmignies. Note préliminaire. Notae Praehistoricae 24, 151–158.
Diot, M.-F., 1992. Études palynologiques de blés sauvages et domestiques issus de cultures expérimentales. In: Anderson, P.C. (Ed.), Préhistoire de l'agriculture: nouvelles approaches expérimentales et ethnographiques. Monographie du CRA no 6. CNRS, Paris.
Ebbesen, K., 1992. Simple, tidligneolitiske grave. Aarbøger for Nordisk Oldkyndighed og Historie 1992, 47–102.
Ehrmann, O., Rösch, M., Schier, W., 2009. Experimentelle Rekonstruktion eines jungneolitischen Wald-Feldbaus mit Feuereinsatz – ein multidisziplinäres

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Forschungsprojekt zur Wirtschaftsarchäologie und Landschaftsökologie. Prähistorische Zeitschrift Band 84, 44–72.
Engelmark, R., 1992. A review of the farming economy in South Scania based on botanical evidence. In: Larsson, L., Callmer, J., Stjernquist, B. (Eds.), The Archaeology of the Cultural Landscape – Field Work and Research in a South Swedish Rural Region. Acta Archaeological Lundensia, Serie 4, Nr. 19. Almqvist and Wiksell International, Stockholm, pp. 369–374.
Enghoff, I.B., 2011. Regionality and Biotope Exploitation in Danish Ertebølle and Ajoining Periods. In: Scientia Danica, Series B. Biologica, vol. 1. The Royal Danish Academy of Science and Letters, Copenhagen.
Eriksson, G., Linderholm, A., Fornander, E., Kanstrup, M., Schoultz, P., Olofsson, H., Lidén, K., 2008. Same island, different diet: cultural evolution of food practice on Öland, Sweden, from the Mesolithic to the Roman Period. Journal of Anthropological Archaeology 27 (4), 520–543.
Fischer, A., Gotfredsen, A.B., 2006. Da landbruget kom til Nordvestsjælland – tidligt tamkvæg i Åmosen. Historisk samfund 1906–2006. Årbog for kulturhistorien i Nordvestsjælland 2005–2006, 35–54.
Fischer, A., Kristiansen, K., 2002. Food for Feasting. The Neolithisation of Denmark – 150 years of Debate. J. R. Collis Publications, Sheffield.
Fischer, A., Olsen, J., Richards, M., Heinemeier, J., Sveinbjörnsdottir, Bennike, P., 2007. Coast-inland mobility and diet in the Danish Mesolithic and Neolithic: evidence from stable isotope values of humans and dogs. Journal of Archaeological Science 34, 2125–2150.
Fischer, C., 1980. Brendkroggården. En langhøj/langdysse ved Salten i Midtjylland. Antikvariske Studier 4, 23–30.
Fischer, A., 2002. Food for Feasting? An evaluation of explanations of the neolithisation of Denmark and southern Sweden. In: Fischer, A., Kristiansen, K. (Eds.), Food for Feasting. The Neolithisation of Denmark - 150 years of Debate. J. R. Collis Publications, Sheffield, pp. 341–393.
Fries, J., 1995. Vor- und frühgeschichtliche Agrartechnik auf den Britischen Inseln und dem Kontinent. Eine vergleichende Studie. Diss. München 1995. Internat. Arch. 26. Espelkamp.
Glørstad, H., 2010. The Structure and History of the Late Mesolithic Societies in the Oslo Fjord Area 6300–3800 BC. Bricoleur Press, Göteborg.
Gotfredsen, A.B., 1998. En rekonstruktion af palæomiljøet omkring tre senmesolitiske bopladser i Store Åmose, Vestsjælland – baseret på pattedyr- og fugleknogler. Geologisk Tidsskrift 2, 93–104.
Gronenborn, D., 2007. Beyond the models: 'Neolithisation' in central Europe. In: Whittle, A., Cumnings, V. (Eds.), GOING OVER, The Mesolithic-Neolithic Transition in North-west Europe. Oxford University Press, pp. 73–98.
Grooth, M.E. Th, Lauwerier, R.C.G.M., Schegget, M.E., 2011. New C-14 dates from the Neolithic flint mines at Rijckholt-St. Geertruid, the Netherlands. In: Capote, M., Consuegra, S., Diaz del Rio, P., Terradas, X. (Eds.), Proceedings of the 2nd International Conference of the UISPP Commission on Flint Mining in Pre- and Protohistoric Times (Madrid, 14-17 October 2009). BAR International Series 2260, pp. 77–89.
Gustafsson, S., 2004. Växtmakrofossilanalys av förkolnade växtrester från delområde 1 och Bunkeflostrand 3:1 inom Citytunnelprojektet. Malmö Kulturmiljö. Malmö Museer, Arkeologienheten, Malmö Stad.
Haas, J.N., Rasmussen, P., 1993. Zur Geschichte der Schneitel- und Laubfutterwirtschaft in der Schweiz - Eine alte Landwirtschaftspraxis kurz vor dem Aussterben. In: Brombacher, C., Jacomet, S., Haas, J.N. (Eds.), Festschrift Zoller. Cramer, Berlin-Stuttgart. Dissertationes Botanicae, vol. 196, pp. 469–489.
Hadevik, C., Steinke, M., 2009. Spåren i marken - tematisk rapportering av Citytunnelprojektet. In: Rapport nr. 48. Malmö Museer, Arkeologienheten, Malmö Stad.
Hadevik, C., 2009. Trattbägerkulturen i Malmöområdet. En sammenställing med fokus på byggnader, gravar och rituelle gropar. In: Hadevik, C., Steineke, M. (Eds.), Spåren i marken – tematisk rapportering från Citytunnelprojektet. Rapport nr. 48. Malmö Museer, Arkeologienheten, Malmö Stad, pp. 13–90.
Hallgren, F., 2008. Identitet i Praktik. Lokala, regionala och överregionala sociala sammanhang inom nordlig trattbägerkultur. In: Coast to Coast Book 17. Uppsala University.
Hallström, A., 1984. Benfynd från Löddesborgsboplatsen. In: Jennbert, K. (Ed.), Den Produktiva Gåvan. Tradition och innovation i Sydskandinavien för omkring 5300 år sedan. Acta Archaeologica Lundensia, Serie 4^{o} 16. Rudolf Habelt, Bonn, pp. 182–200.
Hartz, S., Lübke, H., 2004. Zur chronostratigraphischen Gliederung der Ertebølle-Kultur und frühesten Trichterbecherkultur in der südlichen Mecklenburger Bucht. In: Bodendenkmalpflege in Mecklenburg-Vorpommeren. Jahrbuch, vol. 52, pp. 119–143 (2004).
Hartz, S., Lübke, H., Terberger, T., 2007. From fish and seal to sheep and cattle: new research into the process of neolithisation in northern Germany. In: Whittle, A., Cumnings, V. (Eds.), GOING OVER, The Mesolithic-Neolithic Transition in North-west Europe. Oxford University Press, pp. 567–594.
Hede, S.U., 2005. The finds: mammel, bird and amphibian bones. In: Price, T.D., Gebauer, A.B. (Eds.), Smakkerup Huse. A Late Mesolithic Coastal Site in North-west Zealand, Denmark. Århus University Press, Århus, pp. 91–102.
Heinemeier, J., Rud, N., 1998. Danske arkæologiske AMS C-14 dateringer, Århus 1997. Arkæologiske Udgravninger i Danmark 1997. Det Arkæologiske Nævn, Copenhagen, pp. 282–292.
Heinemeier, J., Rud, N., 1999. Danske arkæologiske AMS C-14 dateringer, Århus 1998. Arkæologiske Udgravninger i Danmark 1998. Det Arkæologiske Nævn, Copenhagen, pp. 327–345.
Heinemeier, J., Rud, N., 2000. Danske arkæologiske AMS C-14 dateringer, Århus 1999. Arkæologiske Udgravninger i Danmark 2000. Det Arkæologiske Nævn, Copenhagen, pp. 296–313.
Heinemeier, J., 2002. AMS C-14 dateringer, Århus 2001. Arkæologiske udgravninger i Danmark 2001. Det Arkæologiske Nævn, Copenhagen, pp. 263–292.
Heinrich, D., 1999. Die Tierknochen des frühneolithischen Wohnplatzes Wangels LA 505. Ein Vorbericht. Offa 54 (55), 43–48.
Helbæk, H., 1954. Kornavl i Store Valby. Aarbøger for Nordisk Oldkyndighed og Historie, 198–204 (1954).
Henningsmoen, K., 1980. Trekk fra floraen i Vestfold. In: Møller, V. (Ed.), Bygd og by i Norge, Vestfold. Gyldendal Norsk Forlag, Oslo, pp. 163–175.
Hernek, R., 1988. Den spetsnackiga yxan av flinta. Fornvännen 83, 216–223.
Hillman, G., 1981. Reconstructing crop husbandry practices from charred remains of crops. In: Mercer, R. (Ed.), Farming Practice in British Prehistory. Edinburgh University Press, Edinburgh, pp. 123–162.
Hirsch, K., Klooss, S., Klooss, R., 2008. Der endmesolithisch-neolithische Küstensiedlungsplatz bei Baabe im Südosten der Insel Rügen. In: Bodendenkmalpflege in Mecklenburg- Vorpommeren. Jahrbuch 2007, vol. 55, pp. 11–51.
Hjelmqvist, G., 1976. Getreidearten und andere Nutzpflanzen aus der frühneolithischen Zeit von Langeland. In: Skaarup, J. (Ed.), Stengade. Ein langeländischer Wohnplatz mit Hausresten aus der frühneolithischen Zeit. Langelands Museum, Rudkøbing, pp. 211–219.
Jennbert, K., 1984. Den Produktiva Gåvan. Tradition och innovation i Sydskandinavien för omkring 5300 år sedan. In: Acta Archaeologica Lundensia, Serie 4^{o} 16. Rudolf Habelt, Bonn.
Johansen, K.L., 2006. Settlement and land use at the Mesolithic-Neolithic transition in southern Scandinavia. Journal of Danish Archaeology 14, 201–223.
Johansson, G., Westergaard, B., Artelius, T., Nieminen, J., 2011. Arkeologiska undersökningar. Boplatser och gravar vid Viskan i Veddige. Fem fornlämningar undersökta för riksväg 41. Halland, Veddige socken, Vabränna 1:5, 10:5, 3:39 och 3:33; Kullagård 1:13 och Järlöv. 7:3, RAÄ 323, 322, 128b, 320 och 321. UV Rapport 2011:26. Riksantikvarieämbetet, Stockholm.
Johansson, F., 1979. Die Knochenfunde von Säugetieren und Vögeln von Bistoft LA 11. In: Johansson, L. (Ed.), Socio-ekonomiska strukturer i tidligt neolitikum och deras förutsättningar. Akademisk avhandling. Institutionen för arkeologi, Göteborgs universitet, pp. 98–111.
Jørgensen, G., 1976. Et kornfund fra Sarup. Bidrag til belysning af tragtbægerkulturens agerbrug. Kuml, 47–64 (1976).
Jørgensen, E., 1977. Brændende dysser. Skalk 5, 7–13.
Jørgensen, G., 1981. Korn fra Sarup. Med nogle bemærkninger om agerbruget i yngre stenalder i Danmark. Kuml, 221–231 (1981).
Juel Jensen, H., 1994. Flint Tools and Plant Working – Hidden Traces of Stone Age Technology. Århus University Press.
Karg, S., Harild, J., 2009. Makrofossilanalyse af gytjeprøver fra Ronæs Skov. In: Andersen, S.H. (Ed.), Ronæs Skov: marinarkæologiske undersøgelser af en kystboplads fra Ertebølletid. Jysk Arkæologisk Selskabs skrifter, Århus, pp. 231–233.
Karsten, P., 1994. Att kasta yxan i sjön. In: Acta Archaeologica Lundensia, Series in 8^{o}, No. 23. Almqvist and Wiksell International, Stockholm.
Kind, C.-J., 2010. Diversity at the transition – a view from the Mesolithic. In: Gronenborn, D., Petrasch, J. (Eds.), Die Neolithisierung Mitteleuropas – the Spread of the Neolithic to Central Europe, International Symposium, Mainz 24 June – 26 June 2005. Verlag des Römisch-Germanischen Zentralmuseums, Mainz, pp. 449–460.
Kirleis, W., Klooß, S., Kroll, H., Müller, J., 2012. Crop growing and gathering in the northern German Neolithic: a review supplemented by first new results. Vegetation History and Archaeobotany, 221–242. http://dx.doi.org/10.1007/s00334-011-0328-9.
Klassen, L., 2004. Jade und Kupfer Untersuchungen zum Neolithisierungsprozess im westlichen Ostseeraum unter besonderer Berücksichtigung der Kulturentwicklung Europas 5500–3500 BC. Jysk Arkæologisk Selskabs Skrifter, Århus.
Koch, E., 1987. Ertebølle and funnel beaker pots as tools. Acta Archaeologica 57, 107–120.
Koch, E., 1998. Neolithic bog pots from Zealand, Møn, Lolland and Falster. Nordiske Fortidsminder serie B 16. Copenhagen.
Koch, E., 2003. Stenalderbønder på sommerjagt – bopladsen Storelyng VI I Åmosen. Nationalmuseets Arbejdsmark, 209–229.
Larsson, L., Broström, S.G., 2011. Meeting for transformation. A locality for ritual activities during the early Neolithic funnel beaker culture in central Sweden. Current Swedish Archaeology 19, 183–201.
Larsson, M., 1984. Tidigneolitikum i Sydvästskåne. Kronologi och bosätningsmönster. In: Acta Archaeologica Lundensia, Series in 4^{0}, Nr. 17. Rudolf Habelt, Bonn.
Larsson, M., 1992. The early and middle Neolithic funnel beaker culture in the Ystad area (Southern Scania): economic and social change, 3100–2300 BC. In: Larsson, L., Callmer, J., Stjernquist, B. (Eds.), The Archaeology of the Cultural Landscape. Acta Archaeologica Lundensia, Series in 4^{0}, Nr.19. Almqvist and Wiksell International, Stockholm, pp. 17–90.
Larsson, L., 2007. Mistrust traditions, consider innovation? The Mesolithic-Neolithic transition in southern Scandinavia. In: Whittle, A., Cumnings, V. (Eds.), GOING OVER, The Mesolithic-Neolithic Transition in North-west Europe. Oxford University Press, pp. 595–616.
Lekberg, P., 1997. Fågelbacken: ett fornlämningskomplex i östra Västmanland. Del. 1. Lämningar från tidligneolitikum, mellanneolitikum och järnålder undersökta

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1993. Riksantikvarieämbetet 73, 147 och 158. In: Archaeological Report. Arkeologikonsult AB, Upplands Väsby.
Leuschner, H.H., Sass-Klassen, U., Jansma, E., Baille, M.G.L., Spurk, M., 2002. Subfossil European bog oaks: population dynamics and long-term growth depressions as indicators of changes in the Holocene hydro-regime and climate. The Holocene 12, 695–706.
Lichardus, J., 1976. Rössen-Gatersleben-Baalberg. In: Ein Beitrag zur Chronologie des Mitteldeutschen Neolithikums und zur Entstehung der Trichterbecher Kulturen. Saarbrückener Beiträge zur Altertumskunde, Band 17. Rudolf Habelt Verlag, Bonn.
Lindqvist, C., Possnert, G., 1997. The subsistence economy and diet at Jakobs/Ajvide and Stora Förvar, Eksta Parish and other prehistoric dwelling and burial sites on Gotland in long-term perspective. In: Burenhult, G. (Ed.), Remote Sensing. Theses and Papers in North-European Archaeology 13:a, vol. I.. Department of archaeology, Stockholm University, Hässleholm, pp. 29–90.
Liversage, D., 1992. Barkær, Longbarrows and Settlements. In: Arkæologiske Studier, vol. IX. Akademisk Forlag, København.
Louwe Kooijmans, L.P., 2009. The agency factor in the process of Neolithisation – a Dutch case study. Journal of Archaeology in the Low Countries 1, 27–54.
Lübke, H., Lüth, F., Terberger, T., 2009. Fishers or farmers? The archaeology of the Ostorf cemetery and related Neolithic finds in the light of new data. In: Larsson, L., Lüth, F., Terberger, T. (Eds.), Innovation and Continuity Non-Megalithic Mortuary Practices in the Baltic. New Methods and Research into the Development of Stone Age Society. International Workshop Schwerin 24–26 March 2006, Bericht der Römisch-Germanischen Kommission 88. Phillip von Zabern, Mainz, pp. 307–338.
Lüning, J., 2000. Steinzeitliche Bauern in Deutschland. In: Die Landwirtschaft im Neolithikum. Universitätsforschungen zur prähistorischen Archäologie, Band 58. Rudolf Habelt GmbH, Bonn.
Lyman, R.L., 1994. Vertebrate Taphonomy. Cambridge University Press, Cambridge.
Madsen, A.P., Müller, S., Neergaard, C., Petersen, C.G.J., Rostrup, E., Steenstrup, K.J.V., Winge, H., 1900. Affaldsdynger fra Stenalderen i Danmark. Copenhagen.
Madsen, T., 1978. Toftum ved Horsens. Et befæstet anlæg tilhørende tragtbægerkulturen. Kuml, 161–184 (1977).
Madsen, T., 1987. Where did all the Hunters go? An assessment of an epoch-making episode in Danish prehistory. Journal of Danish Archaeology 5, 229–239 (1986).
Magnell, O., 2005. Tracking Wild Boar and Hunters. Osteology of Wild Boar in Mesolithic South Scandinavia. In: Studies in Osteology I. Acta Archaeologica Lundensia Series in 8º No 51. Almqvist and Wiksell International, Stockholm, pp. 1–151.
Magnell, O., 2007. Djuren och människan – kustslättens mötesplatser. In: Andersen, M. (Ed.), Kustslättens mötesplatser. Riksantikvarieämbetet, Stockholm, pp. 51–86.
Marshall, F., Pilgram, T., 1993. NISP vs. MNI in quantification of body-part representation. American Antiquity 58, 261–269.
Mathiassen, T., 1934. Flinthandel i stenalderen. Nationalmuseet Arbejdsmark, pp. 18–22.
Mathiassen, T., 1940. Havnelev – Strandegård. Aarbøger for Nordisk Oldkyndighed og Historie, 1–55.
Melchior, L., Lynnerup, N., Siegismund, H.R., Kivisild, T., Dissing, J., July 2010. Genetic diversity among Ancient Nordic populations. PLoS ONE 5 (Issue 7), 1–9.
Milner, N., Craig, O.E., Bailey, G.N., Pedersen, K., Andersen, S.H., 2004. Something fishy in the Neolithic? A re-evaluation of stable isotope analysis of the Mesolithic coastal populations. Antiquity 78, 9–22.
Mischka, D., 2011. The Neolithic burial sequence at Flintbek LA 3, north Germany, and its cart tracks: a precise chronology. Antiquity 85, 742–758.
Møhl, U., 1975. Die ältesten Haustierspuren in Dänemark. Knochenfunde aus dem frühen Neolitikum auf Langeland. In: Skaarup, J. (Ed.), Stengade. Ein langeländischer Wohnplatz mit Hausresten aus der frühneolithischen Zeit. Langelands Museum, Rudkøbing, pp. 207–210.
Moore, J.H., 2001. Evaluating five models of human colonization. American Anthropologist 103 (2), 395–408.
Müller, J., 2011. Megaliths and Funnel Beakers: Societies in Change 4100–2700 BC. (Kroon-Vordaacht 13). Amsterdams Archaeologisch Centrum van der Universiteit, Amsterdam.
Nielsen, P.O., 1977. Die Flintbeile der Frühen Trichterbecherkultur in Dänemark. Acta Archaeologica 48, 61–138.
Nielsen, P.O., 1984. De første bønder. Nye fund fra den tidligste Tragtbægerkultur ved Sigersted. Aarbøger for Nordisk Oldkyndighed og Historie, 96–126 (1984).
Nielsen, P.O., 1994. Sigersted und Havnelev. Zwei Siedlungen der frühen Trichterbecherkultur auf Seeland. In: Hoika, J. (Ed.), Beiträge zur frühneolithischen Trichterbecherkultur im westlichen Ostseegebiet. 1. Internationale Trichterbechersymposium in Schleswig vom 4. bis 7. März 1985. Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein 1. Neumünster, Verein zur Förderung des Archäologischen Landesmuseums, Schleswig, pp. 289–324.
Nielsen, P.O., 2009. Den tidligneolitiske bosættelse på Bornholm. In: Schülke, A. (Ed.), Plads og Rum i Tragtbægerkulturen. Nordiske Fortidsminder Serie C, Copenhagen, pp. 9–24.
Nilsson, L., 2003. Ett källsprång i Saxtorp. In: Svenson, M. (Ed.), Det Neolitiska Rummet. Skånske spår – arkeologi längs Västkustbanen. Riksantikvarieämbetet, Stockholm, pp. 282–295.
Nobis, G., 1962. Die Tierreste prähistorischer Siedlungen aus dem Satrupholmer Moor (Schleswig-Holstein). Zeitschrift für Tierzüchtung und Züchtungsbiologie 77, 16–30.
Noe-Nygaard, N., Price, T.D., Hede, S.U., 2005. Diet of aurochs and early cattle in southern Scandinavia: evidence from ^{15}N and ^{13}C stable isotopes. Journal of Archaeological Science 32, 855–871.
Noe-Nygaard, N., 1995. Ecological, sedimentary and geochemical evolution of the late-glacial to postglacial Åmose lacustine basin, Denmark. Fossil and Strata 37. Oslo.
Nyegaard, G., 1985. Faunalevn fra yngre stenalder på øerne syd for Fyn. In: Skaarup, J. (Ed.), Yngre stenalder på øerne syd for Fyn. Langelands Museum, Rudkøbing, pp. 426–466.
Odgaard, B.V., 1994. The Holocene vegetation history of northern west Jutland, Denmark. Opera Botanica 123.
Olausson, D., Rudebeck, E., Säfvestad, U., 1980. Die südschwedischen Feuersteingruben – Ergebnisse und Probleme. In: Weisberger, G. (Ed.), 5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit. Ausstellung im Deutschen Bergbau-Museum Bochum vom 24. Oktober 1980 bis 31. Januar 1981. Bochum, pp. 183–204.
Østmo, E., 1986. New observations on the funnel beaker culture in Norway. Acta Archaeologica 55, 190–198.
Østmo, E., 1988. Etableringen av jordbrukskultur i Østfold i steinalderen. Universitetets Oldsaksamlings Skrifter. Ny rekke Nr. 10. Oslo.
Persson, P., 1999. Neolitikums början. Undersökningar kring jordbrukets introduktion i Nordeuropa. In: Coast to Coast Book 1. Göteborg and Uppsala University.
Price, T.D., Bar-Yosef, O., 2011. The origins of agriculture: new data, new ideas: an introduction to supplement 4. Current Anthropology 52, 163–174.
Price, T.D., Gebauer, A.B., 2005. Smakkerup Huse: a Late Mesolithic Coastal Site in Northwest Zealand, Denmark. Århus University Press, Århus.
Price, T.D., Noe-Nygaard, N., 2009. Early domestic cattle in southern Scandinavia. In: Finlay, N., McCartan, S., Milner, N., Wickham-Jones, C. (Eds.), From Bann Flakes to Bushmills. Oxbow Press, Oxford, pp. 198–210.
Price, T.D., 2000. The introduction of farming in Northern Europe. In: Price, T.D. (Ed.), Europe's First Farmers. Cambridge University Press, Cambridge, pp. 260–300.
Prøsch-Danielsen, L., 1996. Vegetation history and human impact during the last 11500 years at Lista, the southernmost part of Norway: based primarily on professor Ulf Hafstens material and diary from 1955–1957. Norsk Geografisk Tidsskritt 50 (2), 85–99.
Ravn, M., 2012. The Early Neolithic Volling site of Kildevang – its chronology and intra-spatial organisation. In: Hartz, S., Lüth, F., Terberger, T. (Eds.), Frühe Keramik im Ostseeraum – Datierung und Sozialer Kontext. Internationaler Workshop in Schleswig vom 20. bis 21. Oktober 2006. Bericht der Römisch-Germanischen Kommission 89. Philipp Von Zabern, Mainz, pp. 135–163.
Regnell, M., Sjögren, K.G., 2006. Introduction and development of agriculture. In: Sjögren, K.G. (Ed.), Ecology and Economy in Stone Age and Bronze Age Scania. National Heritage Board, pp. 106–169.
Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J., Weyhenmeyer, C.E., 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon 51 (4), 1111–1150.
Robinson, D.E., 1996. Analyse af forkullet korn og kornaftryk fra det neolitiske anlæg (MNAI/II) ved Lønt, Starup sogn, Sønderjylland. In: NNU Report Nr. 21. Natural Science Research Unit. The National Museum, Copenhagen.
Robinson, D.E., 1999. Arkæobotanisk analyse af materiale fra Visborg (FHM 3933; NNU j.nr. A7641) – en tidligneolitisk køkkenmødding. Unpublished Report. Natural Science Research Unit, The National Museum, Copenhagen.
Robinson, D.E., 2003. Neolithic and Bronze Age agriculture in southern Scandinavia – recent archaeobotanical evidence from Denmark. Environmental Archaeology 8, 145–165.
Rosenberg, A., 2006. Beretning for Ullerødgård. Beretning over den arkæologiske forundersøgelse og udgravning på matr. 3x med flere. Ullerød By, Tjæreby. (NFHA 2424). Excavation rapport from Folkemuseet in Hillerød. http://www.folkemuseet.dk/Bygherre/A2424_net.pdf.
Rowley-Conwy, P., 1984. Mellemneolitisk Økonomi i Danmark og Sydengland. Kuml, 77–111.
Rowley-Conwy, P., 2011. Westward Ho! The spread of agriculture from central Europe to the Atlantic. Current Anthropology 52, 431–451.
Rowley-Conwy, P. North of the Frontier: early domestic animals in northern Europe. In: Colledge, S., Conolly, J., Dobney, K., Manning, K., Shennan, S. (Eds.). The Origins and Spread of Domestic Animals in Southwest Asia and Europe. Left Coast Press, Walnut Creek, California, in press.
Rudebeck, E., 2010. I trästoderna skugga - monumentala möten i neolitiseringens tid. In: Nilsson, B., Rudebeck, E. (Eds.), Arkeologiska och förhistoriska världar. Fält, erfarenheter och stenåldersplatser i sydvästra Skåne. Malmö Museer, Arkeologienheten, Malmö, pp. 83–251.
Ryberg, E., 2006. Arkeologisk undersökning. Vägen till Veddige. Huslämningar och annat från neolitikum och skiftet bronsålder/järnålder. In: Halland, Veddige socken, Veddige 33:3. UV Väst Rapport 2006:5. Riksantikvarieämbetet, Stockholm.
Salomonsson, B., 1970. Die Värby-Funde. Ein Beitrag zur Kenntnis der ältesten Trichterbecherkultur in Schonen. Acta Archaeologica 41, 55–95.
Schier, W., 2009. Extensiver Brandfeldbau und die Ausbreitung der neolitischen Wirtschaftsweise in Mitteleuropa und Südskandinavien am Ende des 5. Jahrtausends v. Chr. Prähistorische Zeitschrift 84, 15–43.

Schülke, A., 2009. The social use of space during the early Neolithic in northwest Zealand. In: Glørsted, H., Prescott, C. (Eds.), Neolithisation as if History Mattered. Bricoleur Press, Göteborg, pp. 217–256.
Schulting, R., 2011. Mesolithic-Neolithic transitions: an isotopic tour through Europe. In: Pinhasi, R., Stock, J.T. (Eds.), Human Bioarchaeology of the Transition to Agriculture. John Wiley and Sons, Ltd, pp. 17–41.
Segerberg, A., 1999. Bälinge mossar. Kustbor i Uppland under yngre stenålder. In: Aun 26. Institutionen för arkeologi och antik historia. Uppsala universitet.
Shennan, S., 2009. Evolutionary demography and the population history of the European early neolithic. Human Biology 81, 339–355.
Sjögren, K.G., 2003. "Mångfalldige uhrminnes grafvar…" Megalitgravar och samhälle I Västsverige. Gotarc Series B. Gothenburg Archaeological Theses No. 27. Coast to Coast Books No. 9. Gothenburg University.
Sjögren, K.G. Neolitisering i Västsverige. En översikt over källäget. In: Kaul, F., Sørensen, L. (Eds.). Agrarsamfundenes ekspansion i Norden – Netværksmøde i Nordlige Verdener. The National Museum, Copenhagen, in press.
Skaarup, J., 1973. Hesselø – Sølager. Jagdstationen der südskandinavischen Trichterbecherkultur. In: Arkæologiske Studier, vol. 1. Akademisk Forlag, Copenhagen.
Skak-Nielsen, N.V., 2003. Hvordan kom bondebruget til Sydskandinavien? Fornvännen 98, 1–12.
Skoglund, P., Malmström, H., Raghavan, M., Storå, J., Hall, P., Willerslev, E., Gilbert, T.P., Götherström, A., Jacobsson, M., 2012. Origins and genetic legacy of Neolithic farmers and hunter-gatherers in Europe. Science 336, 466–469.
Skousen, H., 2008. Arkæologi i lange baner. In: Undersøgelser forud for anlæggelsen af motorvejen nord om Århus. Moesgård Museum, Forlaget Moesgård, Højbjerg.
Sørensen, S.A., 2005. Fra jæger til bonde. In: Bunte, C., Berglund, B.E., Larsson, L. (Eds.), Arkeologi och Naturvetenskap. Gyldenstiernska Krabberup Stiftelsens Symposium Nr. 6. Lund, pp. 298–309.
Stafford, M., 1999. From Forager to Farmer in Flint: a Lithic Analysis of the Prehistoric Transition to Agriculture in Southern Scandinavia. Århus University Press, Århus.
Svensson, M., 2010. What Time Is It? In Situ 2009–2010, pp. 7–26.
Tauber, H., 1981. ^{13}C evidence for dietary habits of prehistoric man in Denmark. Nature 292, 332–333.
Terberger, T., Hartz, S., Kabacinski, J., 2009. Late hunter-gatherer and early farmer contacts in the southern Baltic – a discussion. In: Glørsted, H., Prescott, C. (Eds.), Neolithisation as if History Mattered. Bricoleur Press, Göteborg, pp. 257–298.
Thrane, H., 1989. Danish plough marks from the Neolithic and Bronze Age. Journal of Danish Archaeology 8, 111–125.
Troels-Smith, J., 1954. Ertebøllekultur – bondekultur: Resultater af de sidste 10 års undersøgelser i Åmosen. In: Aarbøger for Nordisk Oldkyndighed og Historie 1953, pp. 5–62.
Troels-Smith, J., 1957. Muldbjerg-bopladsen. Som den så ud for 4500 år siden. In: De første spor af agerbrug i Danmark. Naturens Verden, pp. 1–33.
Troels-Smith, J., 1984. Stall-feeding and field manuring in Switzerland about 6000 years ago. Tools and Tillage 5 (1), 13–25.
Welinder, S., Hadevik, C., Gidlöf, K., Rudebeck, E., 2009. Grismönster i gropkaos – en korrespondensanalys av djurben i tidligneolitiska gropar. In: Hadevik, C., Steinke, M. (Eds.), Spåren i marken – tematisk rapportering av Citytunnelprojektet. Rapport nr. 48. Malmö Museer. arkeologienheten, Malmö Stad, pp. 137–156.
Westergaard, B., 2008. Arkeologisk undersökning. Trattbägare i O-bygd. Arkeologiska undersökningar längs E6 i Bohuslän, delen Lugnet-Skee. Bohuslän, Skee socken, Neanberg 1:14 och S:a Slön 2:4, Skee 1616. In: UV Väst Rapport 2008: 40. UV Väst, Riksantikvarieämbetet, Stockholm.
Westphal, J., 2009. Vidnesbyrd om organiseringen af tragtbægerkulturens landskab i pollenprøver fra megalitgrave. In: Schülke, A. (Ed.), Plads og rum i trægtbægerkulturen. Nordiske Fortidsminder Serie C, Copenhagen, pp. 89–104.
Whittle, A., 2007. The temporality of transformation: dating the early development of the southern British Neolithic. In: Whittle, A., Cumnings, V. (Eds.), GOING OVER, The Mesolithic-Neolithic Transition in North-west Europe. Oxford University Press, pp. 377–398.
Xavier, F., Aymar, F., Sadr, K., 2008. Trends and traps in the reconstruction of early herding societies in southern Africa. In: Sadr, K., Aymar, F., Xavier, F. (Eds.), Khoekhoe and the Origins of Herding in Southern Africa. Southern African Humanities, vol. 20, pp. 1–6.
Zilhao, J., 2001. Radiocarbon evidence for maritime pioneer colonization at the origins of farming in west Mediterranean Europe. PNAS 98 (24), 14180–14185.
Zvelebil, M., Rowley-Conwy, P., 1984. Transition to farming in northern Europe: a hunter-gatherer perspective. Norwegian Archaeological Review 17, 104–128.

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