jungsteinSITE Journal of Neolithic Archaeology

27 December 2017
doi 10.12766/jna.2017.4

Early Neolithic Human Bog Finds from Falbygden, Western Sweden: New Isotopic, Osteological and Histological Investigations

Karl-Göran Sjögren, Torbjörn Ahlström, Malou Blank, T. Douglas Price, Karin Margarita Frei, Hege Ingjerd Hollund

Abstract

Two recently dated finds of human bones in wetlands from the area of Falbygden in Western Sweden are described in detail and set in a wider context of depositional practices in the Southern Scandinavian Early Neolithic. Both finds, the "Hallonflickan/Raspberry girl" and the girl from Härlingstorp, are 15–20 years of age. In the case of Hallonflickan, it is probable that the girl was bound and possibly intentionally drowned in shallow water. The histological analysis indicates that she was deposited in water at or very shortly after her death and has since been undisturbed.

Hallonflickan is also unusual in that her Strontium (Sr) isotope ratio indicates that the girl was born far away, probably in Scania in Southern Sweden. Whether other finds of this kind were also long distance movers is not known.

The Falbygden finds have clear parallels in Denmark and in Southern Sweden from the same period. The Danish material indicates that a particular segment of the population was treated in this way, primarily young individuals of around 15 to 20 years of age. Some of them show signs of disease or deformation, many have signs of trauma, and a couple have been found with cords around their necks, suggesting violent deaths. In a number of cases, they were found in pairs.

Direct bone datings show that this practice was established at the same time as agriculture and that the Funnel Beaker culture (TRB) was introduced in Scandinavia, around 4000 BC, and continued until ca. 3000 BC after which it disappeared for ca. 1000 years. The deposition of humans in wetlands is paralleled by the deposition of animals, pottery and stone tools, and we suggest that these form parts of a complex of ritual practices established over a large area at the time of the earliest Scandinavian agriculture.

Introduction

In this paper, we will describe two finds of human bones from Falbygden that have recently been ^{14}C dated to the Early Neolithic. The two finds are so-called bog finds, and consist of two females. One is the so-called Hallonflickan ("the Raspberry girl") and the other is the girl from Härlingstorp. At present, these are the earliest Neolithic individuals known from Western Sweden. They are therefore of considerable interest in relation to the Neolithization of the region and because they seem to follow a practice of ritual deposition in wetlands otherwise best known from Southern Scandinavia.

Article history:
Received March 2017
Reviewed November 2017
Published 27 December 2017

Keywords: Falbygden, Sweden, Early Neolithic, Funnel Beaker culture, bog finds, wetland depositions, isotopes

Cite as: *Karl-Göran Sjögren, Torbjörn Ahlström, Malou Blank, T. Douglas Price, Karin Margarita Frei, Hege Ingjerd Hollund: Early Neolithic Human Bog Finds from Falbygden, Western Sweden: New Isotopic, Osteological and Histological Investigations JNA 19, 2017, 97–126 [doi 10.12766/jna.2017.4]*

Authors' addresses:
Karl-Göran Sjögren, Department of Historical Studies, Gothenburg University, Box 200, Gothenburg, Sweden.
Torbjörn Ahlström, Department of Archaeology and Ancient History, Lund University.
Malou Blank, Department of Historical Studies, Gothenburg University, Box 200, Gothenburg, Sweden.
T. Douglas Price, Laboratory for Archaeological Chemistry, University of Wisconsin-Madison, USA.
Karin M. Frei, Environmental Archaeology and Materials Science, National Museum of Denmark, Copenhagen, Denmark.
Hege Ingjerd Hollund, The Museum of Archaeology, Stavanger University, Stavanger, Norway.

Acknowledgements
Research for this paper was funded by the Swedish Research Council (Vetenskapsrådet) within the project "Neolithic Lifeways". For comments and suggestions, we thank Tony Axelsson, Christina Fredengren, Peter Jankavs, Per Persson, and an anonymous reviewer. We also thank Leif Arvidsson for making us aware of the Härlingstorp skull, and Claes von Heideken, Härlingstorp, for giving us access to the find.

Falbygden is a ca. 30 x 40 km large area of Cambro-Silurian sedimentary bedrock, well-known for its concentration of at least 255 megalithic tombs from the Middle Neolithic period, built ca. 3300–3000 cal BC. In the last decades, several investigations have focused on these graves and aspects of the society associated with them, so that this period may be regarded as comparatively well studied (Persson/Sjögren 2001; Sjögren 2003; Ahlström 2009; Axelsson 2010).

For the preceding Early Neolithic (EN), ca. 4000–3300 BC, the situation is very different. Rescue-driven fieldwork has concentrated on the west coast in the provinces of Bohuslän and Halland, where a number of Early Neolithic settlement sites have been excavated (Sjögren 2003; 2013). Dates on carbonized cereals in this area document cultivation from shortly after 4000 BC, along with finds of EN TRB materials (Sjögren 2013). Faunal remains are limited to scatters of burnt bones, enabling the determination of domesticated species and wild fauna in some cases. No quantitative evaluation is possible, however.

Inland areas, such as Falbygden, have been much less subject to rescue excavations. Pollen evidence suggests the practice of cultivation and husbandry in these areas (Fries 1958), but the archaeological material is largely limited to finds of axes, in most cases without any contextual information.

Wetland finds in Western Sweden

Due to its calcareous bedrock, Falbygden is one of the areas in Sweden where human and animal bones are often preserved. Finds from wetlands were recorded in particular during the period 1920 – 1950, when peat cutting was a common activity, and local antiquarians were actively registering such finds. Finds of human and animal bones are now stored at the natural history museum in Gothenburg, as well as in the Falbygden museum in the town of Falköping. Other finds are scattered in various places such as at the Natural History Museum in Lund and the Statens Historiska Museum in Stockholm (SHM).

There are a number of finds of human bones in these museums, some of which have recently been subjected to ^{14}C dating. The human bone finds in the museums are, however, only a fraction of the number of skulls and other bones actually found over the years. There are several reliable accounts of skulls or skeletons found in wetlands, which have since been lost or misplaced. For example, 3–4 skeletons were found ca. 1915 during peat cutting in a small bog in Slöta parish[1]. The skeletons were placed by the side of the trench, but their fate is unknown. From Lake Hornborga, there are several accounts of human crania and other bones found on the lake bottom in periods of low water. A particularly interesting account describes the find of a cranium, a femur and some animal bones associated with a stone concentration on the lake bottom in 1934, during a period of low water. The site was well documented, and the human bones were sent to SHM in Stockholm[2], while the animal bones were sent to Lund. Unfortunately, none of the bones can now be found, and only the documentation remains in the museum archive in Stockholm.

Based on the description, we may suspect that this is a find from the Mesolithic period, perhaps similar to the recently excavated site at Motala Kanaljorden (Eriksson et al. 2016).

More well-documented finds come from several prehistoric periods. Two Mesolithic wetland finds are known from Hanaskede not far from Härlingstorp and from Bredgården some 35 km to the south of Falbygden (Vretemark 1996; Borrman et al. 1996). From the Neolithic, in addition to the two finds discussed here, a Late Neolith-

[1] Slöta raä no 70.
[2] SHM 20559.

ic skull was found at Nossamaden, some 35 km to the west of Falbygden (Hellgren 2007). There are no remains from the Bronze Age, but three finds belong to the Early Iron Age[3] (Fig. 1).

In addition to the human bone finds, there is also a considerable number of finds of animal bones. Counting only finds of larger mammals (reindeer, red deer, cattle, aurochs, elk, etc.), around 50 sites are known from Falbygden.

In the coastal area, the only known Neolithic find is that from Rolfsåker in Northern Halland (Sarauw/Alin 1923). This is the complete skeleton of a male, found during the digging of a canal in 1920. The skeleton was lying in the bottom part of a layer of clay gyttja, above an oyster shell layer. The position was not documented *in situ*, but canal workers reported that it had been lying on the left side, with its face downwards. Beside his head, a Neolithic stone axe of unusual type was found, and in the same layer there were also a few animal bones (red deer, cattle and beaver). Flint artefacts dating to the Mesolithic were found in the shell layer and in the underlying sand layer. The bones were examined by Carl Magnus Fürst, who concluded that they belonged to a male, ca. 25–30 years of age, of short but sturdy build (Sarauw/Alin 1923; Lindälv 1968). The man had suffered sharp force trauma on his left ulna and his right tibia, presumably from a stone axe. Pollen analyses of gyttja and clay samples indicated an environment of mixed oak forest and the absence of spruce and beech (Erdtman 1921).

In 1992, a small excavation was made by Nordqvist in order to test the hypothesis of a burial (Nordqvist 1999). Two direct ^{14}C dates have been made. A conventional date on the left humerus yielded a date of 3516–2925 cal BC (4530±100 uncal BP, St-2488; Lindälv 1968) and an AMS date resulted in 3329–2916 BC (4430±70 uncal BP, Ua-7836) with the AMS δ13C value of -20.87 ‰ (Nordqvist 1999). More recently, a red deer humerus from the gyttja layer was dated to 3264–2895 cal BC (4370±45 uncal BP, GrA-17911, previously unpublished). Light stable isotopes in collagen were measured by Liden et al. (2004, see appendix).

A renewed osteological and odontological study was undertaken around 2000 by Leif Jonsson and Helene Borrman (Borrman 2004; Jonsson et al. 2002). This confirmed earlier sex determinations, and showed his dental health to be good, while the age estimate was reduced to ca. 20–25 years.

The original interpretation was that the man had drowned after being attacked in a boat (Sarauw/Alin 1923; Lindälv 1968). Another view has been proposed by several authors (Oldeberg 1952; Moberg 1960; Nordqvist 1999; Jonsson et al. 2002), who suggested that it was a burial connected to a settlement on the nearby small island. This is, however, difficult to reconcile with existing shoreline displacement curves, according to which the sea level at that time was at least 10 m above present, i.e. about 4 m higher than the level of the skeleton (Påsse 1987). A third possible interpretation could therefore be that we are dealing with a wetland deposit/sacrifice similar to the other finds discussed here.

Hallonflickan (the Raspberry girl)

This skeleton was discovered in May 1943 during peat digging in the Rogestorp bog, Luttra parish[4], part of a large bog complex called Mönarps mosse. A preliminary report was published by Axel Bagge (1947) and a more detailed account by Gejvall et al. (1952). The find was also discussed by Ahlström/Sten (1995) and by Jankavs (2011) in connection with a facial reconstruction (Fig. 3 and 4).

[3] The Iron Age finds are from Gökhem Bergsgården (FM 1903, 2872), Gökhem Rogestorp Nedergården (GNM coll an 7381-82) and Grolanda raä 97 (SLM rapport 1995). A further probable Early Iron Age find is from Myren, Bohus Malmön, Bohuslän (GAM 47394).

[4] Luttra raä 29, SHM 23163.

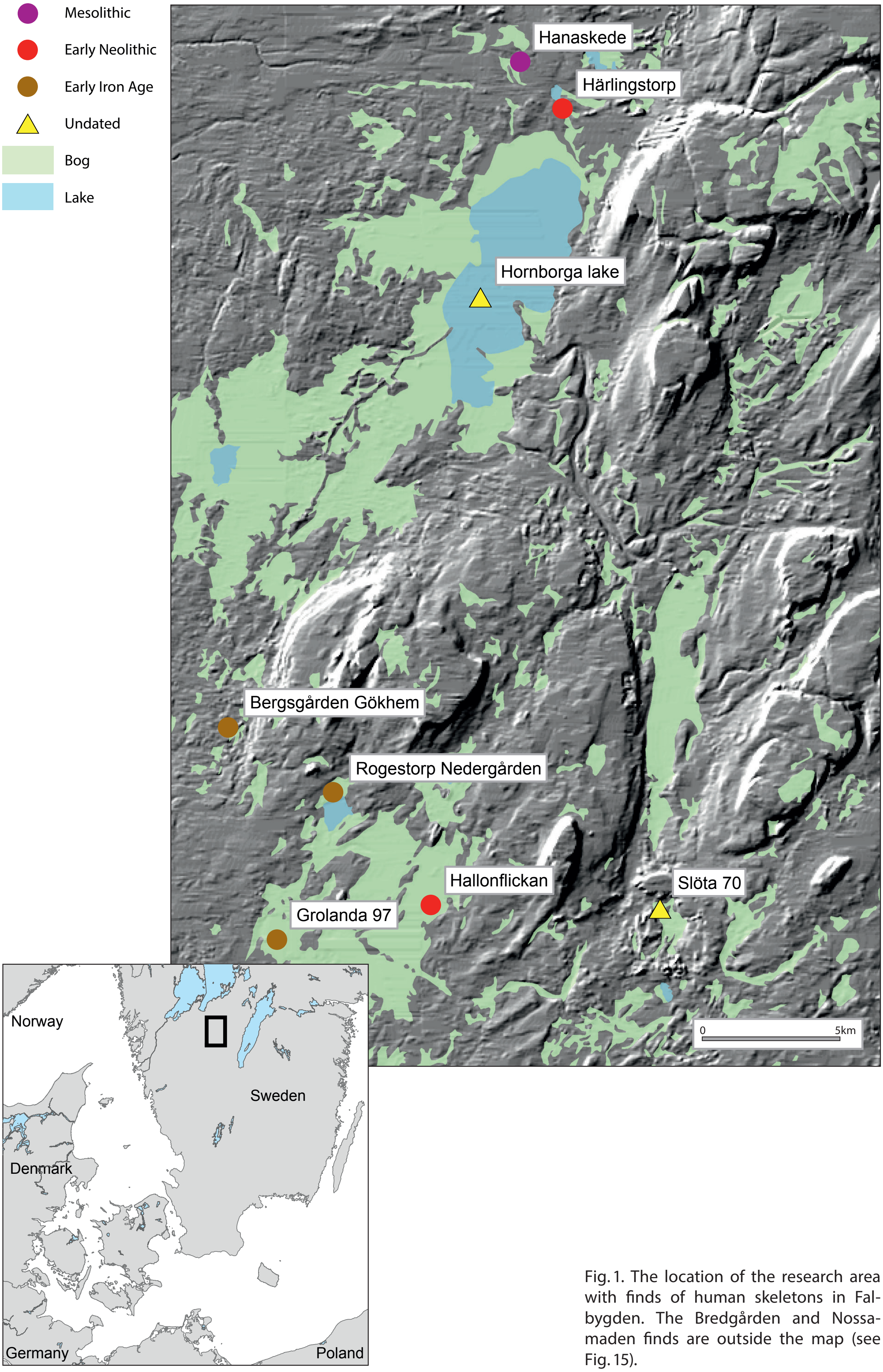


Fig. 1. The location of the research area with finds of human skeletons in Falbygden. The Bredgården and Nossamaden finds are outside the map (see Fig. 15).

When found, only the skull and a few other bones were collected, then the work was halted and the archaeologist and geologist Karl-Esaias Sahlström was called in for inspection, together with the local antiquarian Hilding Svensson. They documented the stratigraphy, took pollen samples and extracted the remaining skeleton and surrounding peat as a block for later excavation indoors, together with a few loose bones found in the peat trench. The block was transported to Statens Historiska Museum in Stockholm and was excavated later the same year by the osteologist Elias Dahr. During this excavation, a concentration of raspberry seeds in the stomach region was noted, assumed to be part of her last meal. She was therefore assumed to have died in late summer.

The stratigraphy of the find spot was determined as ca. 1.15 m of marsh peat, underlain by chalk gyttja containing freshwater molluscs. The position of the skull could be seen in the trench wall, ca. 1.2 m below the surface, corresponding to the lowermost part of the peat. The environment at the time of deposition was suggested to have been a chalk marsh with stands of sedge (*Cladium mariscus*), some shallow open water between the sedge tufts, and a seasonally fluctuating water level (Gejvall et al. 1952).

In the same peat trench, a flint blade arrowhead of MN type had been found three years earlier. The location of this arrowhead was ca. 6 m to the north of the skeleton, some 1.2 m deep in the peat.

Dating

Several attempts have been made to date this skeleton. A dating to the Middle Neolithic (the "passage grave period") was suggested by Gejvall et al. (1952) on the basis of pollen analysis and by Bagge (1947) by association with the blade arrowhead.

Three ^{14}C dates have been measured on bone collagen from the skeleton (Tab. 1, Fig. 2). A first ^{14}C dating was made at the Natural History Museum in Stockholm in 1969 with the conventional method (Oldeberg 1976). It is unclear which bones were used, but the ribs mentioned by Sahlström are now missing so this is a possibility. In 1994, an accelerator dating was done in Uppsala on the left humerus (Ahlström/Sten 1995). Finally, a second accelerator dating was undertaken in Belfast in 2015 on a sample from the left femur.

The two first dates agree, while the Belfast date is considerably older. This difference may be due to different analytical methods (conventional vs. accelerator), but more likely to developments in pre-treatment and collagen extraction protocols. Collagen extraction at the Stockholm lab consisted only of acid treatment and washing in distilled water (Sellstedt et al. 1966). A similar method was used in the Uppsala lab (dating certificates from Uppsala). The Belfast lab employs more recent methods with a series of acid and base cleaning steps including ultrafiltration. Furthermore, they measure the C/N ratio and the $\delta^{13}C$ and the $\delta^{15}N$ values, which are important parameters to monitor collagen quality and sea/freshwater reservoir effects. We therefore assume that the Stockholm and Uppsala dates are affected by remnant contaminants, such as humic acids, and we regard the Belfast date as more reliable.

Calibration of this date provides the range of 3928–3651 cal BC (95 %), corresponding to the early or middle part of the Early Neolithic. A low $\delta^{15}N$ value suggests low freshwater fish consumption and thus also a marginal impact from the freshwater reservoir effect. This re-dating indicates that the Raspberry girl is some 700 years older than previously assumed, and she is at present the earliest known Neolithic human from Western Sweden.

Tab. 1. The ^{14}C datings and light stable isotope values from Hallonflickan.

Labno	cal BC, 2 s	uncal BP	δ13Cams	δ13Cdiet	δ15Ndiet	C/N	Sample
St-2861	3354-2697	4350±100	–	–	–	Not measured	unknown
Ua-3962	3328-2881	4360±65	-20.48	–	–	Not measured	Left humerus
UBA-30518	3928-3651	4964±42	–	-20.6	8.4	3.24	Left femur

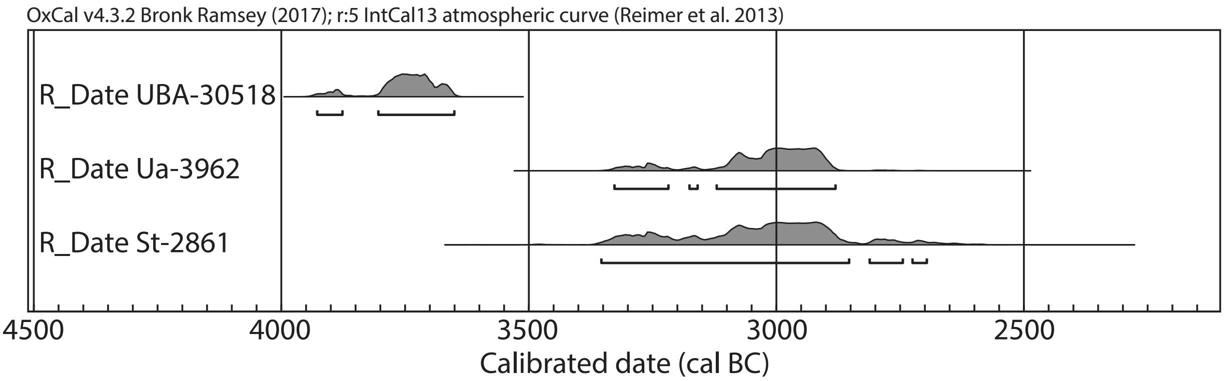


Fig. 2. Calibration plot of the dates from Hallonflickan.

Anthropology

Elias Dahr, the first anthropologist to analyse the skeletal remains from the Rogestorp bog, assessed the skeleton as a young female (Bagge 1947). However, it was Gejvall, Hjortsjö and Sahlström (Gejvall et al. 1952) who produced a proper anthropological investigation and description of the skeleton. Ahlström/Sten (1995) added an x-ray of the maxillary third molar. The sexual assessment of the skeleton has been constant through the years. The skeleton is gracile, with diminutive secondary sexual characters of the skull, suggesting a female (Fig. 3). With respect to the pelvis, the right ilium has a broad incisura ischiadica major, with a double arc composé suggesting a female. The left ilium is not so well preserved, but a broad incisura ischiadica major is present. Thus, apart from the gracile cranium, we also have evidence for an assessment of a female based on the pelvis.

While the sexual assessment of the skeleton is seemingly straightforward, the aging is not. Gejvall and Hjortsjö assessed the skeleton as an adult, 20–25 years of age, based on epiphyseal fusion, eruption of third molars (the lower third molar being erupted and the upper third molar in the process of eruption), and synostosis of endocranial sutures. In fact, with respect to the attrition of the teeth and the eruption of the third molars, they even suggested an age of 25–30 years. Ages for epiphyseal fusion were based on Ruckensteiner's (1931) roentgenological assessment of the skeleton, claiming fusion of the epiphysis much later than modern synthesis based on osteology (see below). One adult feature of the skeleton, the fusion of the synchondrosis sphenooccipitalis, was not commented upon by them.

It is the opinion of the present author (TA) that the age estimate provided by Gejvall et al. (1952) was too high. Some epiphyses that could be documented are fused (Tab. 2), and others are unfused. With respect to the unfused epiphyses, the granular appearance of the subchondral bone is evident, with no signs of osseous bridges connecting the epiphysis with the diaphysis. Thus, complete fusion is not at hand for several of the epiphyses. Furthermore, the utility of the synchondrosis sphenooccipitalis has been questioned. A meta-analysis published by Krishan/Kanchan (2013) questions whether the

Fig. 3. Hallonflickan, photo of cranium (photo by Gunnar Creutz).

fusion of this site can be used for aging at all, as it has been showed to vary considerably. Ahlström/Sten (1995) provided an x-ray of the erupting third molars of the maxillae and demonstrated that the root was not fully developed. Thus, weighing the age indicators present, it is apparent that the skeleton belongs to the age category 15–20 years, and probably the later span of this age category, 18–19 years, given the eruption of the third molars.

Histology

Changes in the bone material after death (bone diagenesis) reflect post-mortem events such as funerary treatments and fluctuations in the burial conditions. Some of these changes can be observed and assessed in histological thin-sections. As such, post-mortem histories can be partially reconstructed by so-called histotaphonomy (Turner-Walker/Jans 2008; Booth 2016; Hollund et al. 2012; 2013). A transversal bone section taken from the mid-shaft of the left femur was prepared for histological characterization of diagenetic alterations. The thin-section was studied in normal and polarized transmitted light. Alterations observable at a microscopic scale include bioerosion, inclusions, infiltrations (staining), microcracks and birefringence. Birefringence is an optical property of bone reflecting preservation of the bone protein (Jans 2005; Grupe/Dreser-Werringloer 1993; Hedges et al. 1995).

The results of the diagenetic characterization of the Hallonflickan bone are summarised in Tab. 3. The microstructure of the bone is well-preserved with no bioerosion and displays the typical birefringence of fresh bone when viewed in polarized light, i.e., alternating light and dark bands (Fig. 5). The birefringence is normal in most parts of the section, but reduced in a dark orange-brown stained band along the surface suggesting some loss of protein in this area. When viewed in normal light, the bone displays a light orange-brown stain across the whole depth, probably due to infiltration by humic factors, iron and/or manganese compounds.

Many of the vascular canals are filled with framboidal pyrite (FeS_2) and it seems that many bone cell cavities (osteocyte lacunae) and

Fig. 4. Facial reconstruction of Hallonflickan by Oscar Nilsson (after Jankavs 2011).

Tab. 2. Fusion of epiphyses in the skeleton of Hallonflickan. Female fusion age estimates after Cunningham et al. (2003) and Krogman/Iscan (1986).

Bone and side	Epiphysis fused	Epiphysis unfused
Fibula, unsided		Proximal (12-17 yrs) Distal (12-15 yrs)
Left femur	Trochanter major (14-16 yrs)	Caput femoris (12-16 yrs) Distal (14-18 yrs)
Right femur	Trochanter major (14-16 yrs)	Caput femoris (12-16 yrs) Distal (14-18 yrs)
Right pelvis	Ischiadicum (16-18 yrs)	Crista iliaca (20-23 yrs)
Left radius		Distal (14-17 yrs)
Right radius	Capiut radii (11,5-13 yrs)	Distal (14-17 yrs)
Left ulna		Distal (15-17 yrs)
Right ulna		Distal (15-17 yrs)
Right humerus	Distal (11-15 yrs)	Caput (13-17 yrs)

their small inter-connected canals (canaliculi) are filled with massive pyrite (Fig. 6).

Framboidal pyrite is an environmental indicator as its formation requires anoxic conditions, the presence of anaerobic sulphate-reducing bacteria (SRB), organic matter for the bacteria to metabolise, ferrous iron and sulphur (Wilkin/Barnes 1996; Wilkin et al. 1996). Framboidal pyrite is designated as such due to its structure resembling raspberries, providing a second meaning to the unofficial name of this skeletal find. Although sulphur levels are much lower in terrestrial sediments as compared with marine sediments, SRBs and pyrite also occur in terrestrial contexts including inland freshwater bogs and peatlands. When exposed to atmospheric oxygen and high relative humidity, pyrite will oxidize to produce iron, sulphate and acid, causing dissolution of the bone (Turner-Walker 1998).

Thus, the presence of pyrite and the absence of bioerosion suggests that the body of Hallonflickan has been kept in a stable, reducing and anoxic environment since relatively shortly after her death and until her discovery. It furthermore suggests that the skeleton was located below the water level and was not affected by water level fluctuations to any great extent.

Infiltration by humic factors and metal ions with bactericidal effects may have further protected the bone from bioerosion (Van Klinken/Hedges 1995; Nicholson 1998). Some microcracking was ob-

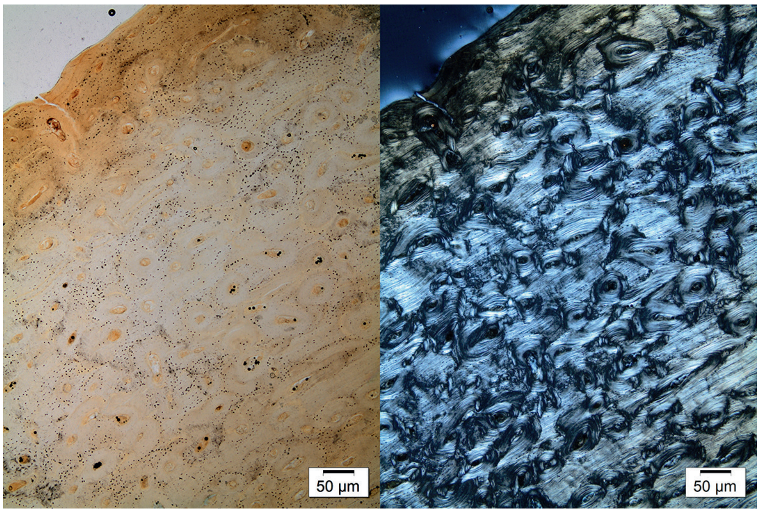


Fig. 5. Overview of the sample, normal (left) and polarized (right) light (photo by Hege Ingjerd Hollund).

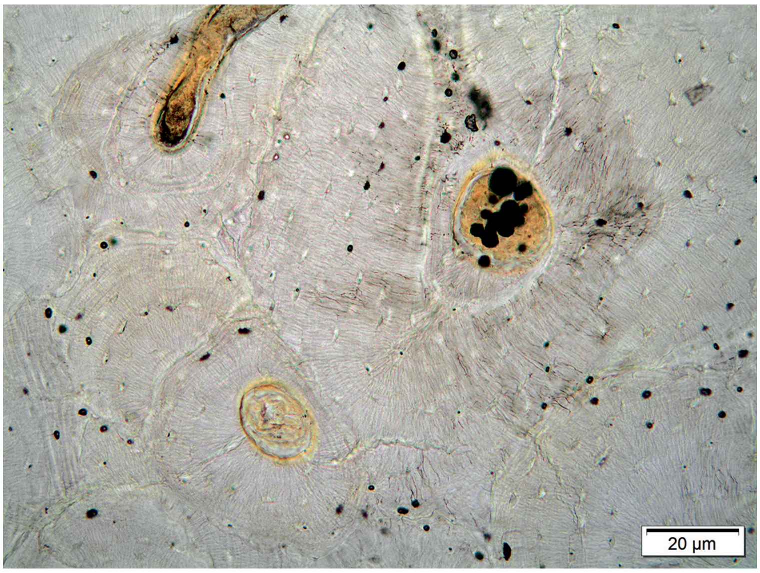


Fig. 6. Detail, pyrite (photo by Hege Ingjerd Hollund).

served. This is probably the result of precipitation of mineral compounds within the bone and/or the drying out of the bone after discovery (Van Der Sluis et al. 2014).

There is no visible extensive bone dissolution, which can be observed as the loss of microstructural features such as bone lamellae (Garland 1993). Decalcification is typical of European bog body finds and rapid decalcification has been observed after experimental burial of bone samples. Decalcification was then connected to the presence of sphagnum moss (Turner-Walker/Peacock 2008). Thus, the lack of sphagnum moss may explain the absence of extensive demineralisation in the case of Hallonflickan. In addition, the presence of calcium carbonate in the chalk marsh and underlying gyttja probably had a positive effect on its preservation. Most of the diagenetic features observed are thus factors of the special chalk marsh environment leading to well-preserved, but stained bone with pyrite inclusions.

Tab. 3. Summary of the results of the histological study. OHI = Oxford histological index, 5 is perfectly preserved (no bioerosion), 0 is completely bioeroded (Hedges et al. 1995; Millard 2001). BI = Birefringence index, 1 is normal, 0.5 is reduced and 0 is none. CI = cracking index, the average percentage of osteons (a bone anatomic structural unit) affected by microcracks divided by the total number of osteons assessed in five microscopic fields of view with magnification x100 (Jans 2005).

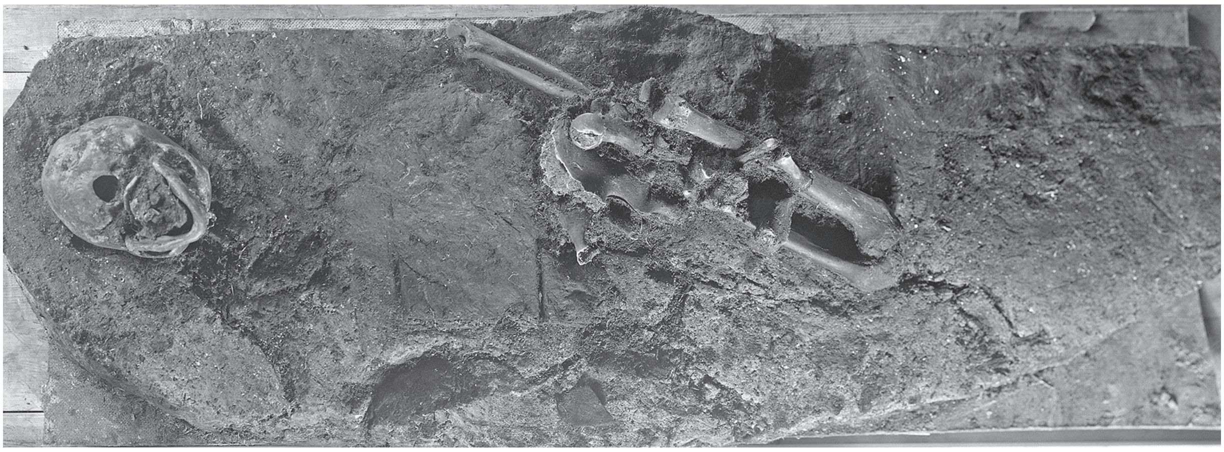
OHI	BI	CI	Infiltrations	Inclusions
5	1	20%	Brown and orange staining across the whole depth	Framboidal pyrite Massive pyrite Unknown orange material

Body position

Already during the excavation in May 1943, Sahlström noted that foot bones occurred on top of the femurs. He also remarks that the imprint from the skull indicated that it had been placed with the forehead down. The skeleton was oriented N-S with the head towards the north (Gejvall et al. 1952). According to a sketch plan made in the field by Sahlström, the skull was lying some 40–50 cm to the north of the pelvis bones, and the leg bones and foot bones further to the south of these. The bones were thus found in a reasonably intact position, suggesting limited disarticulation and little dispersion due to waves or currents.

The osteologist Elias Dahr, who conducted the investigation of the peat block, concluded that the Hallonflickan girl had been lying on her stomach, and he noted that the lower legs were extremely flexed (Fig. 7). It was therefore suggested that the feet had been tied up against the back of the femurs. Both lower arms were found below the pelvis. Whether the arms had also been tied could not be established, although this remains a possibility. No remains of rope or clothing were noted, although this may be suggested based on the integrity of the body.

Figure 8 shows an interpretation of how the body may have been positioned. Axel Bagge, who assisted at this investigation, suggested that she had been bound and sacrificed or executed (Bagge 1947). Similar suggestions were made by Ahlström/Sten (1995) who also noted similarities with Early Neolithic Danish finds.



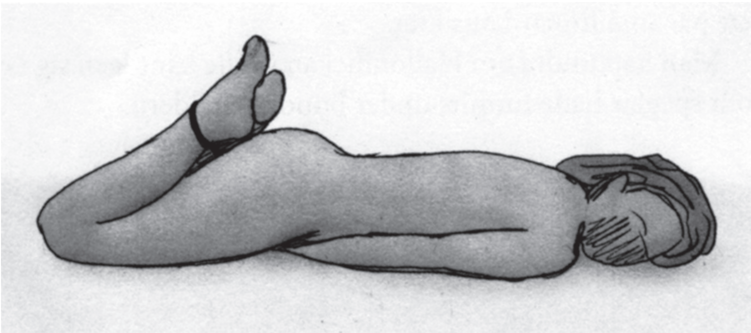


Fig. 7. Position of leg and hip bones in the peat block. Part of the pelvis is visible, with the right femur and tibia above it, and a few foot bones. The lower right arm bones are below the pelvis. The skull has been placed back in its position (photo from the excavation of the peat block 1943, Statens Historiska Museum).

Fig. 8. Reconstruction of the body position (drawing by Gunnar Creutz, after Jankavs 2011).

The Härlingstorp Girl

This find consists only of a calvarium, i.e., a cranium without the mandible (Fig. 9). The cranium was found during cleaning of a canal leading from Lake Vingsjön towards Lake Hornborga around 1980. It was not spotted *in situ* but was noted later, lying among the materials cleared out by machine from the canal. Later investigation of these dumps produced no further bones or artefacts, and the canal was too deep for further excavation. It is therefore not clear whether the find is an isolated skull or if postcranial bones were also present.

The stratigraphic position is also unclear. At the site, at least 2 m of peat overlie sediments of chalk gyttja. Due to the different colouring of part of the skull, it can be suggested that it was originally lying on the border between these two layers.

After the discovery, the find was reported to Västergötlands Museum in Skara and sent for osteological analysis to Elisabeth Iregren at Statens Historiska Museum, Stockholm (Iregren 1982). In 1986, it was returned to the landowner, in whose possession it still remains. In 2016, we sampled it for dating, isotope and DNA analysis.

In the same bog, two finds of axes are also known[5]. One is a thin-butted flint axe, of unknown subtype, but possibly contemporaneous to the skull. The other is a Late Neolithic shafthole axe. The exact find locations for these axes are not known. Only 500 m to the east, a pollen series was analysed by Magnus Fries in the 1950s (Fries 1958). Although not well dated, the diagram suggests cultivation and pastures in the surrounding area just after the elm decline. In the same canal but probably somewhat further south, a cattle cranium was found in the early 1900's (Munthe 1905).

[5] Norra Lundby raä 59:1–2.

Anthropology

The cranium was examined osteologically by Iregren (1982), who determined it as female, ca. 20–25 years of age. As there are no post-cranial bones present, aging as well as sexing can be only tentative (cf. the Raspberry girl). Secondary sexual characters of the skull are diminutive suggesting female sex. However, dental attrition for the Härlingstorp specimen is not as advanced as it is for the Raspberry girl. Furthermore, the crypt of the third maxillary molar is present and widened, suggesting that the third molar was in the process of erupting at the time of death, but not fully erupted. In comparison with the Raspberry girl, which is more complete, we suggest an age that is similar, i.e., 15–20 years old, since an age estimate of 20–25 years may be too high.

Interproximal initial caries are present on the upper left molar. Otherwise, no signs of disease or trauma can be seen.

Fig. 9. Photo of the Härlingstorp cranium (photo by K.-G. Sjögren).

Dating

A fragment of the skull was found loose inside it and sent for dating to the Oxford laboratory. The resulting date was 4730±33 uncal BP (OxA-33832). This dates the cranium to the later part of the Early Neolithic, 3635–3377 cal BC (95 %, Fig. 10). The rather low $\delta^{15}N$ value (see below) suggests low consumption of freshwater fish and consequently that any freshwater reservoir effect on the date is only marginal. It is thus some 100–200 years younger than the Raspberry girl and 100–300 years earlier than the onset of megalith building in the area.

Early Neolithic Diet

Collagen $\delta^{13}C$ and $\delta^{15}N$ values have been measured on the left femur from Hallonflickan and the cranial fragment from Härlingstorp (Tab. 4). These are relatively slow remodelling bones, and the isotope ratios should represent a weighted average over an extended period before the time of death, perhaps mainly covering the teen years for both individuals. In addition, $\delta^{13}C$ in enamel carbonate was measured on a lower left M1 tooth from Hallonflickan. Enamel $\delta^{13}C$ is relevant to diet, and reflects the entire diet (in this case in early child-

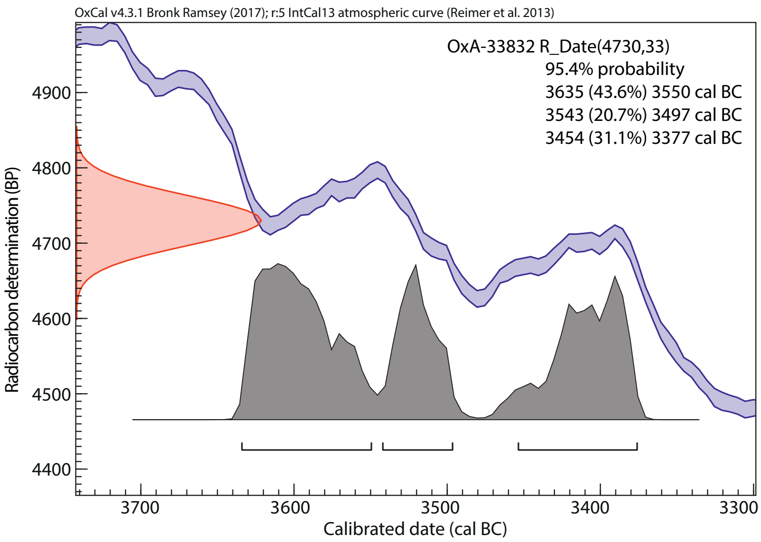


Fig. 10. Calibration of the ^{14}C date from Härlingstorp.

hood), in contrast to collagen values which are mainly influenced by protein intake.

A comparison with values from Middle Neolithic adult bone samples from the passage grave at Frälsegården (Sjögren/Price 2013; Sjögren 2015; 2017) shows that the two early Neolithic women have considerably lower δ^{15}N values than most of the Frälsegården population (Tab. 4, Fig. 11). In fact, the value from Hallonflickan is the lowest measured so far from the west Swedish TRB. The δ^{13}C collagen values, in contrast, do not seem to deviate significantly from those at Frälsegården. The δ^{13}C enamel value in Hallonflickan is slightly higher than the mean value at Frälsegården, suggesting a somewhat higher mean δ^{13}C value in her childhood diet.

As these two individuals were found in special contexts, we cannot be sure that they are representative of the Early Neolithic population in the area, or in other words if this difference is due to a chronological change or to dietary distinctions within society.

Taking a larger dataset into account, it seems that these two individuals do in fact conform to a larger Southern Scandinavian trend (Fig. 12). EN I bog finds in Sweden and Denmark (before 4700 uncal BP) all have d^{15}N values lower than 10 ‰, while individuals from EN II-early MN (later than 4700 uncal BP) have values at 10–12 ‰, i.e. values similar to those in humans from megalithic tombs (Sjögren 2017). A similar shift is also visible in δ^{13}C values, which are slightly higher in individuals dated after 4700 uncal BP. This trend needs to be confirmed by values from dry land contexts, however.

Tab. 4. Dietary isotope values for Hallonflickan and Härlingstorp, and mean and standard deviation for Frälsegården tooth and adult bone samples (N=42 for collagen, N=27 for enamel).

	Labno	δ13C coll	δ15N coll	δ13C enamel	C/N	Element
Hallonflickan	UBA-30518	-20.6	8.4	–	3.24	Femur
Hallonflickan	F6994	–	–	-13.5	–	M1 tooth
Härlingstorp	OxA-33832	-21.8	9.1	–	3.2	Cranium
Frälsegården		-21.03±0.3	10.3±0.7	-14.4±0.6		

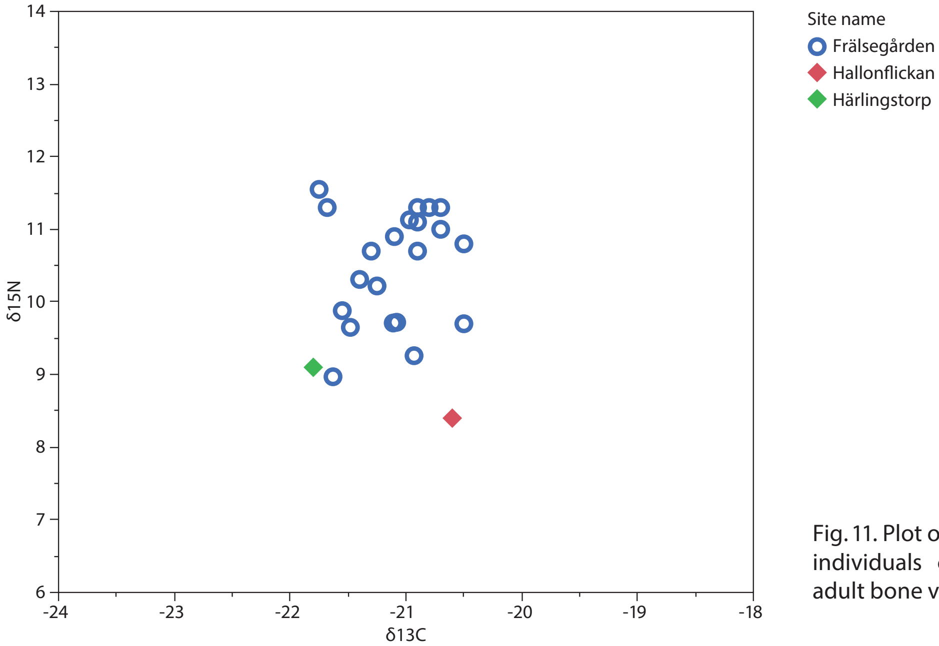


Fig. 11. Plot of δ^{13}C and δ^{15}N in the two EN individuals compared to Frälsegården adult bone values.

Such differences could result from the consumption of proteins from a lower trophic level in the EN I than in the EN II and Middle Neolithic, in other words a higher proportion of plant vs. animal protein in the diet. A high plant contribution would be consistent with the occurrence of caries in a tooth of the Härlingstorp girl. The shift could also be explained by a higher contribution of milk products or, in some areas, of marine foods in the later phase.

We must bear in mind, however, that dietary baseline values from Early Neolithic plants and animals in the area are not yet available. In theory, differences in human isotope values may be caused by underlying changes in baseline values rather than changes in human diet. Recently, a series of measurements on Middle Neolithic cereals and domesticated animals from Falbygden has been made. Estimates of human diet based on these data suggest a high proportion of plant food in the Middle Neolithic, with some variation between individuals (Sjögren 2017).

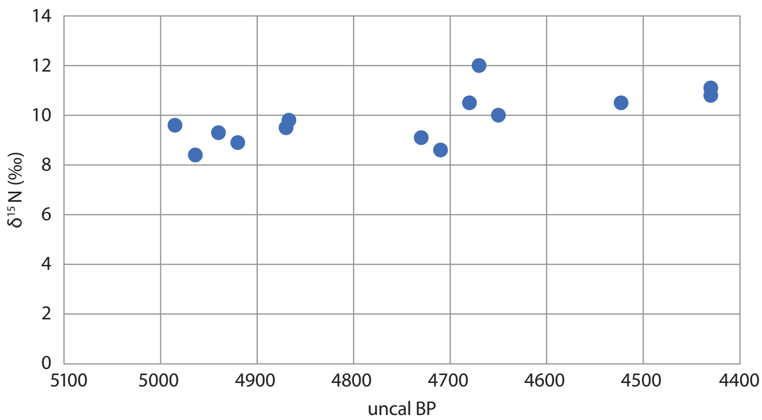


Fig. 12. $\delta^{15}N$ values in EN and MN individuals found in Swedish and Danish wetlands. Data from appendix.

Assuming that baseline isotope levels were similar in the Early Neolithic implies a rather extreme diet for these two individuals, with plants contributing ca. 80 % of the calories. We could, however, make other assumptions, for instance that the impact of manuring or other agricultural practices on $\delta^{15}N$ levels was less marked in the Early Neolithic. In this case, the EN diet was not necessarily very different from the MN one, but still probably strongly dependent on plant foods.

The case is further complicated when we realize that the Hallonflickan female spent her early years in another area, likely in Scania (see below). From the Scanian EN site of Almhov near Malmö, we do in fact have some carbon and nitrogen isotope measurements on cattle bone (Gron/Rowley-Conwy 2016). These values are similar to those in Middle Neolithic cattle from Falbygden, which may argue for an actual change in diet. Since we do not know her precise origin, nor at which point in life she moved to Falbygden, attempts to quantify her diet remain problematic.

Provenience

Strontium (Sr) and oxygen (O) isotopes were measured on enamel from the lower left first molar (M1) from Hallonflickan. Sr and O isotopes are often used to estimate mobility. The enamel of the M1 tooth is formed in early childhood, normally at the age of 0–3 years (Avery 1994; Manjunatha/Soni 2014). The Sr isotope ratios in this tooth therefore reflect the composition of Sr in the environment during early childhood, largely dependent on local geology.

The ^{87}Sr/^{86}Sr value for the M1 tooth was 0.7116 and the δ^{18}O value -4.4‰ (vPDB, carbonate value). This Sr isotope ratio is highly unusual in Western Swedish contexts. Sr isotope ratios in the Falbygden passage graves are usually in the range of 0.714-0.716, considerably higher than the Hallonflickan value (Fig. 13). Only in some Late Neolithic gallery graves do we find a few individuals with such low values (Blank/Knipper in press). Very few individuals have been analyzed outside the Cambro-Silurian areas, but the Late Neolithic individual from Nossamaden on gneiss bedrock had an ^{87}Sr/^{86}Sr value of ca. 0.722 (Sjögren et al. 2009).

In recent years, an extensive series of Sr isotope analyses has been made on small animals, water samples, etc., in order to establish the natural background variation in the area (Sjögren et al. 2009; Sjögren/Price 2012; Blank unpublished data). These analyses show a clear division between Cambro-Silurian areas with values at ca. 0.713-0.716, and Precambrian areas with generally even higher values.

It is therefore unlikely that the Hallonflickan individual was born in Falbygden, or in the surrounding areas of Precambrian rock in Western Sweden; her origin must be sought further away. Since Eastern Sweden and most of the Southern Swedish uplands are characterized by high Sr isotope ratios, these areas are also unlikely. At the same time, her Sr isotope ratio is too high to fit most areas of Denmark (Frei/Frei 2011; Frei/Price 2011). The remaining possible areas of origin are, on the one hand, Scania in the south of Sweden and, on the other hand, a narrow strip along the Swedish west coast, in Bohuslän and Halland. Both of these areas are known to exhibit values at 0.710-0.712 (Price et al. 2015; Arcini et al. 2016, CONTACT project unpublished data). On the basis of Sr data, it is not possible to distinguish between these two possibilities.

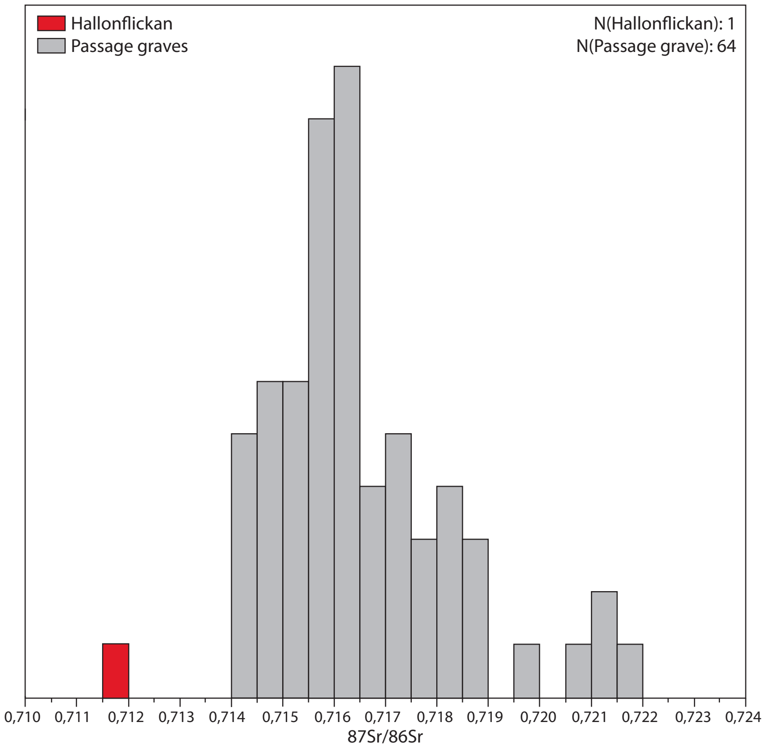


Fig. 13. ^{87}Sr/^{86}Sr in Hallonflickan (red) compared to Middle Neolithic individuals from passage graves in Falbygden (Sjögren et al. 2009 and unpublished data).

Oxygen isotope ratios are basically dependent on climate and vary with factors such as temperature, distance from oceans, and elevation. In many areas, for instance the North European plains, variation exists on a very large scale, whereas more small-scale variation may occur in upland or mountain areas, or regions close to large water bodies. Climate changes through prehistory also make interpretations difficult, as comparative data are rarely at hand for the period of interest. Instead, interpretations based on modern data are often used, which must be considered a rather risky method.

Oxygen isotopes in Western Sweden have been discussed by Sjögren and Price (2012) for cattle, and a series of human values from Frälsegården is also at hand. A comparison of the oxygen isotope value from Hallonflickan with data from the Frälsegården passage grave (Fig. 14) shows that Hallonflickan falls well within the range for Frälsegården, in contrast to the clear difference in Sr.

Data from Scania are sparser, but six humans from the period 4700–4000 uncal BP have been analysed within the Rise project (unpublished data). The Sr ratio of Hallonflickan shows a reasonable agreement with this group, although slightly higher. This is not necessarily significant since the six analysed individuals from Scania hardly cover the whole variation in that region. The oxygen isotope values largely overlap with those from Falbygden and cannot be used to discriminate between the two regions.

Looking at modern data for Swedish precipitation (Burgman et al. 1987), two geographical trends can be recognized. Close to the west coast in Halland and Bohuslän, values are about 2 ‰ higher than inland. Towards the north, values decrease, although rather slowly. This also means that there are large areas with low variability; most Southern Swedish inland areas have values similar to those in Falbygden. Even if these specific numbers are not directly translatable to a prehistoric situation, we may assume that similar geographic trends were operating in the Neolithic.

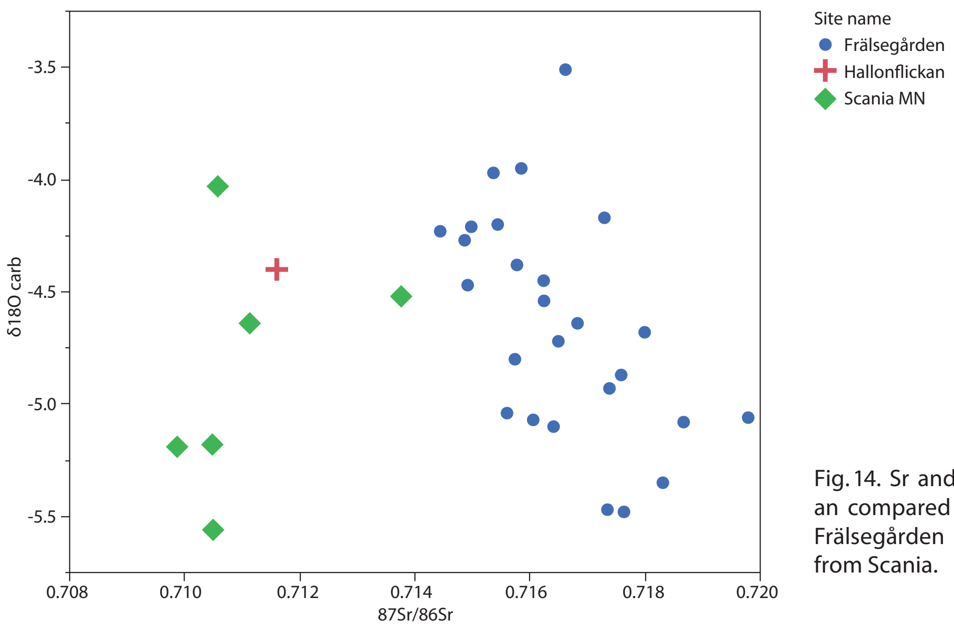


Fig. 14. Sr and O isotopes in Hallonflickan compared to MN A individuals from Frälsegården and to EN-MN individuals from Scania.

If this is true, we could perhaps expect higher $\delta^{18}O$ values along the west coast than those of the analysed individuals from Frälsegården in figure 13. Together with the Sr isotope data, this could speak in favour of an origin in inland parts of Scania. In view of the rather high variability in the Frälsegården oxygen values, this suggestion should be taken with some caution, however.

Archaeologically, an Early Neolithic connection between Falbygden and Scania makes sense, for instance, in view of the concentration of point butted flint axes, most probably produced in Scania, that can be found in Falbygden (Sørensen 2014). In the Middle Neolithic, the similarities between Scania and Falbygden are clear, for instance in pottery (Persson/Sjögren 2001).

Neolithic human bog finds in other parts of Scandinavia

Bog deposition of human bodies or body parts occurs throughout Denmark and Southern Sweden (Karsten 1994; Koch 1998; Bennike 1999). From Denmark, around 560 finds of human remains in bogs have been recorded (Ravn 2010). Most of these are undated. In recent years, the chronology of depositing human bodies in Scandinavian wetlands has been clarified by ^{14}C dating, showing them to stretch all through prehistory, starting in the Early Mesolithic and continuing into historic times. However, peaks seem to occur in the Early Neolithic and Early Iron Age periods.

Bennike (1999) quotes 35 Neolithic skeletons found in Danish bogs, but the number is likely higher. Her studies of the EN Danish material indicate that a very particular segment of the population was treated in this way. Most of these persons were quite young, ca. 16–20 years old, and some of them show signs of trauma or disease. In a few cases, the remains of a cord were found around the neck (Bennike/Ebbesen 1985; 1987; Bennike et al. 1986). Furthermore, several of the skeletons were found in pairs. The suggestion is that these people suffered violent deaths, most likely in sacrificial ceremonies, although other explanations cannot be ruled out.

Another category of wetland finds involves disarticulated human bones, often in connection with other finds such as animal bones, pottery or flint axes. Such finds have been made, for instance, at Gammellung, close to the classic Troldebjerg site, and at Myrebjerg mose, also on Langeland. These finds have not been studied in detail, but skulls and long bones seem to figure prominently, and the age distribution seems not to be as restricted when compared to the complete skeletons (Skaarup 1985).

Scanian finds of human and animal bones in wetlands were actively recorded and documented in the early 1900s by a team of geologists and archaeologists forming the "peat bog commission". Their findings were published yearly in the journal Ymer. The older Scanian finds have been surveyed by Liljegren (1975) and Karsten (1994). Liljegren lists 41 find sites, many of which are undated or have now been lost. Four of these are suggested to be Mesolithic, one Early Neolithic, two Bronze Age, and four from the Iron Age. Some of these were subsequently redated[6], however. Karsten (1994) suggests that 13 finds were probably Neolithic, only three of which had been dated by ^{14}C.

A few sites merit more detailed description. At Sandåkra, Skurup parish, a series of animal and human bones were found during road construction in 1970 (Skurup raä 7, Blumbergs et al. 1974; Karsten 1994, no. 757). The human bones belong to at least two persons, one of whom was a ca. 25–30 years old female. This woman had healed fractures on both the radius and the clavicula. Furthermore, she had raspberry seeds between her teeth. Dating of the left femur yielded the result 3712–3122 cal BC (4750±100 uncal BP, St-3771). Since this is an early date with a conventional method, it should be taken with some reservation. The other person was only represented by two bones, a left radius and ulna, presumably also from a woman. More bones were reported to have been found earlier, but these were not recovered. The animal bones originated from wolf, pig, capercaillie and turtle. Dating of the turtle bones provided results similar to the

[6] For the Mesolithic finds, see Sjögren/Ahlström 2017.

human bone. A deposition of 10 thin- and pointed-butt flint axes was found in 1899 in the same bog (Karsten 1994 no. 749).

In the small bog Näbbe mosse in Östra Vemmerlöv parish in Southeastern Scania, several Neolithic finds were made during the 1940s, including thin- and pointed-butt axes, EN TRB pottery and bones (Stjernquist 1981; Strömberg 1990; Karsten 1994 no. 1123). In 1948, the skeleton of a ca. 19–25 years old female was found during peat digging. It was dated to 3934–3538 (4920±60 uncal BP, $\delta^{13}C$ -20.8, Lu-1828).

More recently, three sites in Southwestern Scania, Saxtorp, Hindbygården and Lindängelund, have been subject to detailed investigations in connection with construction work. At Saxtorp, a small bog and a nearby EN TRB settlement were excavated in 1998 (Nilsson/Nilsson 2003). Eight find-bearing layers were encountered, the richest ones from the Early Neolithic and the Bronze Age. In the Neolithic layer, covering ca. 350 m^2, finds of flint, pottery, wood, animal and human bones were made, concentrated in a limited area in the southern part of the bog. The human bones (39 fragments) were predominantly from crania or long bones and belong to 3–5 individuals. One individual is determined as a young adult female, one as a juvenile/adult female, and one only as a juvenile/adult person. Cut marks were identified on a clavicula. All three were dated to the EN TRB period. A recent aDNA analysis on individual 3 showed genetic similarity to Central European Early Neolithic individuals, as well as to Middle Neolithic TRB individuals from Sweden (Mittnik et al. 2017). The animal bones were dominated by cattle, sheep/goat and pigs, with minor occurrences of other species. A pig and a sheep bone were dated to the EN/MN, i.e., slightly later than the human bones, while a horse tooth and a cattle bone were dated to the Bronze Age.

The site of Hindbygården in Malmö, investigated in 1989, presents a rather similar picture (Nilsson 1996, Berggren 2007; 2010). This is a small bog, ca. 40x20 m, which was excavated almost completely. Peat formation and some deposition of artefacts already started in the Mesolithic, but finds were mainly encountered in a lower EN/MN layer and an upper LN/BA layer. Large numbers (ca. 9500 fragments) of animal bones were found, mostly from domestic species such as cattle, pigs and sheep/goat. A series of 22 dates from these materials suggests that deposition started in the EN and continued into the Bronze Age. A total of 45 human bones were also found, most of them in the upper find layer. Dates on five human bones from this layer indicate that they were deposited during the LN and EBA (Berggren 2010). The bones belong to at least three individuals. Sex could not be determined, but the ages range from juveniles to young adults. Two humerus fragments show cut marks and several bones have tooth marks from animals, as well as signs of weathering.

At Lindängelund in the outskirts of Malmö, a small carr adjacent to an early MN settlement was excavated (Strömberg et al. 2014). In the carr, 14 human cranial fragments from at least two people were found together with animal bones, mainly cattle, pig and sheep/goat. One human mandible bore cut marks. The bones could not be dated, unfortunately, but are supposed to be early MN A (Boethius 2009).

In other parts of Sweden, bog finds have not been recorded or researched systematically until very recently, and preservation in most areas is poor. A recent survey suggested there were at least 80 Swedish wetland sites with human bone finds, most of which are undated or poorly dated (Fredengren 2011). Finds from Eastern Middle Sweden have so far only produced dates to the Bronze Age or later (Fredengren 2015).

A possible Neolithic find was made in 1955 in Hell Carr (SW Helveteskärr) in Östergötland (Lindahl 1971). It consisted of a cranium and a few vertebrae from a ca. 40-year-old male. On the cranium were two lesions, one healed and one not healed. A pollen dating and a ^{14}C date on gyttja, made in Stockholm in 1956, suggested that the deposit was from the Late Neolithic (Östlund 1957). Both dates must be taken with caution, but assignment to the Neolithic period is reasonable.

A particular and probably rather different kind of site is the Alvastra pile dwelling, also in Östergötland. On this Middle Neolithic wooden platform situated in a spring mire, disarticulated human bones from some 40 individuals were found, including a cranium with cutmarks. From preliminary publications, it is suggested that these are all males or boys (Browall 2011; 2016).

In Alva myr on Gotland, human bones have been dated to the early Middle Neolithic. The bones were weathered and show bite marks from animals, and have probably been redeposited from a dry land site at an unknown point in time (Bergerbrant et al. 2013).

Further north, the skull of a young adult male was found in 1991 at Ölsund, Forsa parish, Hälsingland. The skull had been dug up from a bog during the digging of a ditch. ^{14}C dating suggests an MN B date (appendix, Hallgren 1996). Despite a coastal location, d^{13}C suggested a mainly terrestrial protein intake. It was not accompanied by any artefacts, but an association with the Battle Axe culture is possible. Genetic evidence places it on the border between Corded Ware and Late Neolithic individuals (Mittnik et al. 2017).

The location of Swedish Neolithic bog finds is shown in figure 15. As it now seems, the practice of human bog deposition is most strongly represented in areas where the TRB culture is best developed and in particular areas with a strong presence of megalithic tombs, such as Denmark, Southern and Western Sweden. In Eastern Sweden, where the TRB culture was more short-lived and the construction of megalithic tombs is only weakly represented, the deposition of humans in bogs is also less clearly documented.

Discussion

In Bennike's terms, the Danish EN bog finds constituted "a strange group of people" (Bennike 1999). Most of them were young adults or juveniles, although there are also a few older individuals and at least one child (see appendix). Some of them show signs of disease, deformities or even invalidity and in a number of cases there are indications of unnatural deaths.

In many respects, the Swedish cases conform to this pattern, as far as can be judged. Most of them died at young adult age, only a couple of Late Neolithic individuals deviate by being older. One difference from Denmark is the dominance of women in the Swedish material. Only one of the seven Swedish individuals from the EN-early MN is male, while five are females and one is undetermined. This disparity is not as pronounced in the Danish material. Signs of disease have not been identified in the Swedish individuals, although modern osteological investigations are lacking for some of them. The question regarding the causes of death is in most cases difficult to answer, but indications of binding or unhealed trauma have been noted. In three cases from Scania with disarticulated bones, cut marks were also noted on some of the bones. As in Denmark, it may be possible to divide the bog finds into two categories, one with depositions of whole bodies and one with disarticulated bodies together with artefacts and animal bones, and with activities representing a longer time period.

To this list of "strange" characteristics, we can now add the fact that the Hallonflickan female was also unusual in that she was born and

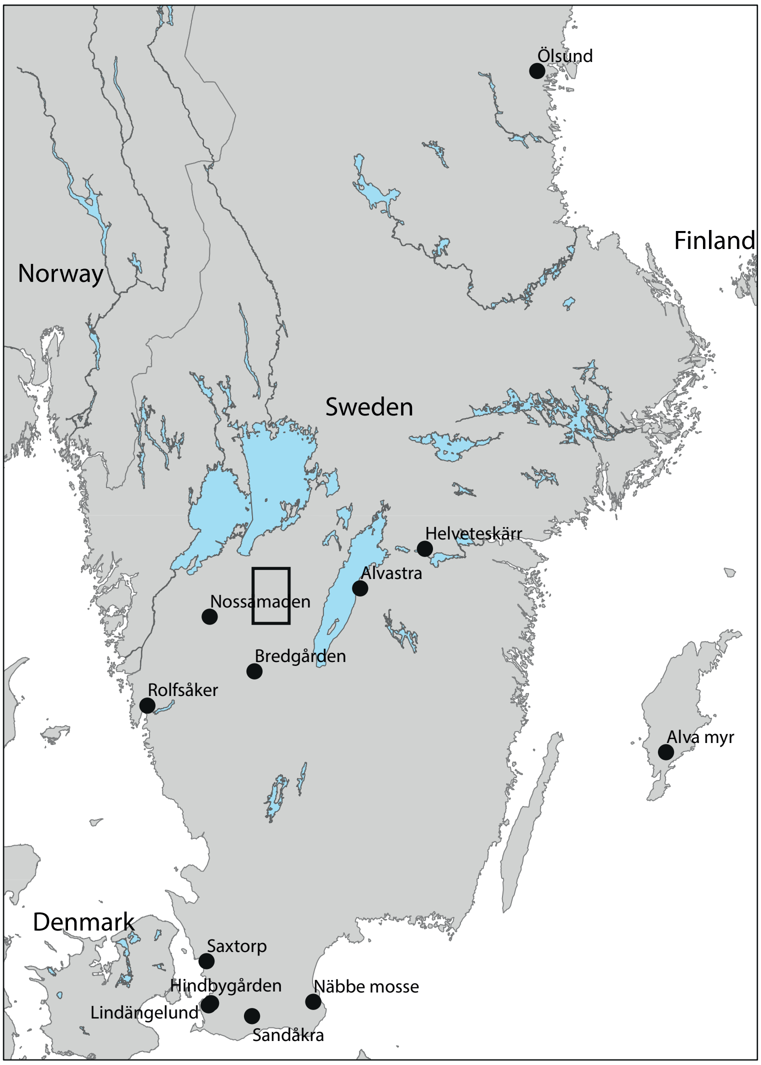


Fig. 15. Swedish bog finds of human bones mentioned in the text. The rectangle indicates the Falbygden area.

lived her earliest years far away from Falbygden, probably in Scania. At what point in life she moved to Falbygden cannot be determined. So far, she is the only long distance migrant identified from the west Swedish TRB. Whether this also applies to the Härlingstorp girl, and perhaps even to other cases from Scania and Denmark, will be determined in forthcoming analyses.

Available direct dates on human wetland finds from Sweden and Denmark are listed in the appendix. Only finds dated to 5100–3500 uncal BP have been included. A calibration plot is shown in figure 16. Note that no correction has been carried out for reservoir effects. The plot gives a striking and consistent picture. Human wetland finds occur throughout the period 4000–3000 BC, over a region covering Denmark, Scania and Western Sweden. The view of Rech (1979), who considered them to be confined to the Danish Islands, can therefore not be upheld. The oldest Swedish date, the one from Hallonflickan, is comparable with the earliest dates from Denmark and Scania. Apparently, this practice was established very rapidly over a large area, concurrently with the introduction of a new material culture (TRB), cultivation and husbandry.

The wetland finds then continue with a rather even frequency throughout the Early Neolithic. A few finds may be dated to the earliest phase of the MN, but the practice seems to disappear around ca. 3000 BC or more probably in the centuries just before this time. As with the beginning, the end of this sequence seems contemporaneous over a large area. After this time, there is a ca. 1000-year gap

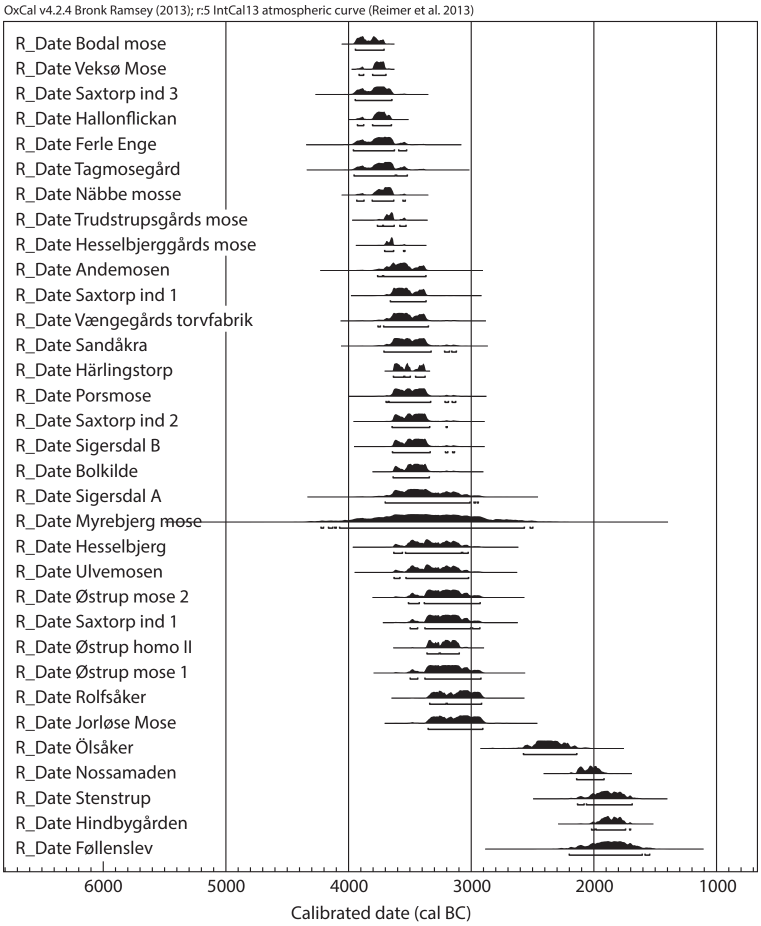


Fig. 16. Calibration plot of Swedish and Danish human bog finds dated to the Neolithic (5100–3500 uncal BP). Data from appendix.

with no wetland deposits, the only exception being the MN B find from Hälsingland, much further north. Wetland depositions start to appear again around 2000 BC and probably continue into the Bronze Age, although this has not been investigated here.

From the eastern parts of Sweden, no such finds are known yet. The find from Alva myr on Gotland must be considered as problematic. Since TRB settlement is well established in these regions during the EN, human wetland finds would be expected to occur. It is possible that the lack of finds is due to poor preservation and less intensive research, but it is also possible that this practice never became established in Eastern Sweden. Only further research and dating programmes can answer this question.

The relation to Mesolithic depositions is at present unclear, as little systematic study has been carried out on Mesolithic wetland finds. In Sweden, the few dated Mesolithic wetland finds (Bredgården, Hanaskede, Motala Kanaljorden and possibly Store mosse in Scania (Sjögren/Ahlström 2017) are considerably earlier than the Mesolithic/Neolithic transition. Dated Mesolithic humans from Denmark cover the entire period, although with a lower frequency in the 7000–6000 BC range (cf. dates in Fischer et al. 2007). However, most of these are not wetland finds. At present, we can only hypothesize that the sharp rise in wetland deposits at the beginning of the Early Neolithic represents the introduction of a new practice, connected with a different set of ideas than in the Mesolithic.

The most common interpretation of the human bog finds suggests that they are sacrificial in nature, perhaps related to fertility rites, although suggestions of accidents, punishments or victims of conflict have also been made in some cases (Becker 1947; Rech 1979; Bennike/Ebbesen 1985; 1987). For the finds with disarticulated bones together with animal bones, interpretations indicating food offerings and even cannibalism have been made (Becker 1947; Skaarup 1985; Bennike/Ebbesen 1987).

The deposition of human bodies is only one of a number of activities performed at lakes, marshes, wells, and streams. Deposits of pottery, flint and stone axes, animal bodies or body parts, etc. are well-known from both the Mesolithic and the Neolithic. The intensity of such finds seems to rise at the beginning of the EN and reaches a peak in the late EN-early MN A, after which the frequency diminishes strongly. However, in contrast to the human bog finds they do not disappear completely (Becker 1947; Degerbøl/Fredskild 1970; Rech 1979; Karsten 1994; Bennike/Ebbesen 1987; Koch 1998). Geographically, wetland finds of axes and pottery extend all across the TRB area, up to Eastern Middle Sweden, thus covering a larger area than the known finds of human and animal bones.

The deposition of humans can be usefully compared to the deposition of cattle in bogs, cattle perhaps being an animal of particular significance in TRB society. As for humans, cattle finds range from almost complete animals to disarticulated bones, and skull trauma indicating slaughter is often observed (Degerbøl/Fredskild 1970). A series of datings of Danish cattle finds has been published (Koch 1998; Noe-Nygaard et al. 2005). At least 22 sites with cattle bone finds have been recorded from Scanian bogs (Liljegren 1975) of which none was ^{14}C dated. For this region, only a series of cattle datings from the Hindbygården bog are available (Berggren 2007). For regions north of Scania, bog finds of cattle are known, for instance from Falbygden, but they have not been systematized or dated.

The available dates are plotted in figure 17. The datings show a notable similarity with those from humans, covering the span ca. 4000–3000 BC and decreasing thereafter, although not so sharply as the human depositions. This chronological parallelism between different categories could be interpreted as a sign that they form parts of an interconnected set of ritual practices.

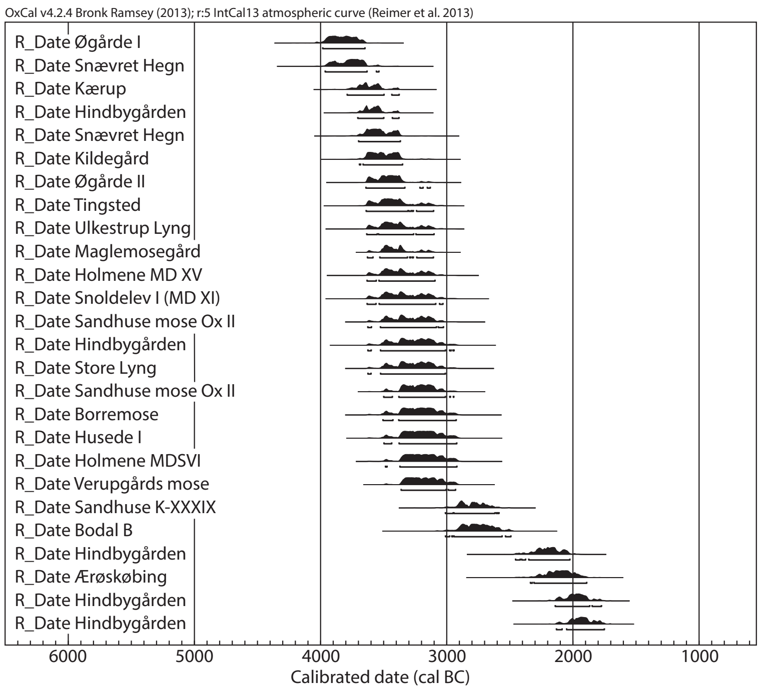


Fig. 17. Calibration plot of Danish and Swedish bog finds of cattle skeletons or cattle bones dated to the Neolithic (5100–3500 uncal BP). Data from appendix.

Concluding remarks

The evidence presented here gives us new insights into the circumstances surrounding the death of a young girl in Falbygden during the Early Neolithic. Although the cause of death cannot be demonstrated, histological investigation suggests that she was deposited in shallow water at or very shortly after her death, and has remained undisturbed since then. As indicated by the body position, she was probably bound and perhaps wrapped in skin or textile. An interpretation of death at the hands of others, perhaps by drowning, is therefore likely, although the possibility of a water burial cannot be dismissed. Comparison with other Southern Scandinavian finds of a similar nature would argue for the former possibility.

Even if all wetland finds are not necessarily explained by a single model, there are sufficient similarities between them to support the concept that there was a particular set of ideas behind this practice. The wide geographic distribution and the parallel chronological development, in particular the disappearance of wetland finds during a 1000-year period, strongly argue against explanations of a more random nature, such as loss, accident, drowning, small-scale conflicts, etc. Instead, the idea of sacrifices and rites behind these finds gains strength. In all likelihood, this would have formed an important part of the ideology adhered to by the earliest farmers in Scandinavia, and seems to have spread over a large area just as quickly as cultivation and husbandry.

The indications of an isotopic shift at the EN I/EN II transition, with higher $\delta^{15}N$ and $\delta^{13}C$ values, is interesting in light of the ongoing discussion on changes in subsistence and cultivation practices during the EN. Recently, Kirleis and Fischer (2014) suggested a change in crops at ca. 3750 BC, from a system including free-threshing wheat to assemblages dominated by emmer and naked barley. By the later EN, the probably ox-drawn ard seems to have come into widespread use, allowing an expansion of cultivated land (Beck 2013; Sørensen 2014). It is possible, but debated, that this accompanied a change from shifting cultivation to the use of stable plots. Alternatively, the change could have represented a shift from small-scale, intensive garden agriculture to a more extensive form of cultivation, as suggested by Kirleis and Fischer (2014). An increased importance of cultivation in subsistence is also suggested.

It is also the later EN that sees the start of megalithic monument building on a large scale, as well as large enclosure sites, although earth and timber monuments were already constructed in the EN I.

How the isotopic shift relates to these wider developments will have to be addressed by future research. At present, we lack sufficient isotopic baselines for both plants and animals to be able to be very precise in interpreting human diet, particularly in the Early Neolithic. Studies of Early and Middle Neolithic cultivation practices, including the importance of manuring, will demand the integration of different kinds of data, such as weed and crop composition, with the isotopic data from cereals.

References

Ahlström 2009: T. Ahlström, Underjordiska dödsriken: humanosteologiska studier av neolitiska kollektivgravar. Kust till kust-böcker 18. Institutionen för historiska studier, Gothenburg University (Gothenburg 2009).

Ahlström/Sten 1995: T. Ahlström/S. Sten, Hallonflickan. Forntid på Falbygden, 1995, 22–25.

Avery 1994: D.R. Avery, Oral Development and Histology (New York 1994).

Arcini et al. 2016: C. Arcini/T.D. Price/M. Cinthio/L. Drenzel/M. Andersson/B. Persson/H. Menander/M. Vretemark/A. Kjellström/R. Hedvall/G. Tagesson, Living conditions in times of plague. In: P. Lagerås (ed.), Environment, Society and the Black Death. An interdisciplinary approach to the late-medieval crisis in Sweden (Oxford 2016) 104–140.

Axelsson 2010: T. Axelsson, Landskap - visuella & rumsliga relationer i Falbygdens neolitikum. Kust till kust-böcker 19. Institutionen för historiska studier, Gothenburg University (Gothenburg 2010).

Bagge 1947: A. Bagge, Ett märkligt skelettfynd från gånggriftstiden. Fornvännen, 1947, 248–249.

Beck 2013: M.R. Beck, Højensvej høj 7 – en tidligneolitisk langhøj med flere faser ved Egense, Svendborg. Aarbøger for Nordisk Oldkyndighed og Historie 2011–2012, 2013, 33–118.

Becker 1947: C.J. Becker, Mosefundne lerkar fra yngre Stenalder. Aarbøger for Nordisk Oldkyndighed og Historie, 1947, 1–318.

Bennike 1999: P. Bennike, The early Neolithic bog finds: a strange group of people. In: J.B. Coles/J. Coles/M.S. Jørgensen (eds.), Bog Bodies, Sacred Sites and Wetland Archaeology. WARP Occasional paper 12 (Exeter 1999) 27–32.

Bennike/Ebbesen 1985: P. Bennike/K. Ebbesen, Stenstrupmanden. Fra Holbaek Amt, 1985, 28–39.

Bennike/Ebbesen 1987: P. Bennike/K. Ebbesen, The Bog Find from Sigersdal. Human Sacrifice in the Early Neolithic. Journal of Danish Archaeology 5, 1987, 85–115.

Bennike et al. 1986: P. Bennike/K. Ebbesen/L. Bender Jörgensen, Early neolithic skeletons from the Bolkilde bog, Denmark. Antiquity 60/230, 1986, 99–208.

Bergerbrant et al. 2013: S. Bergerbrant/C. Fredengren/P. Molnar/C. Löfqvist, Violent Death and Wetlands: Skeletal Remains from Gotland. In: S. Bergerbrant/S. Sabatini (eds.), Counterpoint: Essays in Archaeology and Heritage Studies in Honour of Professor Kristian Kristiansen. BAR International Series 2508 (Oxford 2013) 199–206.

Berggren 2007: Å. Berggren, Till och från ett kärr. Den arkeologiska undersökningen av Hindbygården. Malmöfynd nr 17 (Malmö 2007).

Berggren 2010: Å. Berggren, Med kärret som källa: Om begreppen offer och ritual inom arkeologin (Malmö 2010).

Blank/Knipper in press: M. Blank/C. Knipper, Neolithic mobility in western Sweden: interpretations of strontium isotope ratios of the megalithic population in Falbygden. In: C. Gibson/C. Frieman/K. Cleary (eds.), Making Journeys. Archaeologies of Mobility (Oxford in press).

Blumbergs et al. 1974: Z. Blumbergs/N.-G. Gejvall/C. Varenius, Subboreal Faunal remains from a peat-bog in Sandåkra village, in the parish of Skurup, Scania, S. Sweden. OSSA 1, 1974, 24–37.

Boethius 2009: A. Boethius, Lindängelund – en osteologisk analys om offer och gropar. Reports in osteology 2009:1. Institutionen för Arkeologi och Antikens historia, Lunds Universitet (Lund 2009).

Booth 2016: T.J. Booth, An Investigation into the Relationship Between Funerary Treatment and Bacterial Bioerosion in European Archaeological Human Bone. Archaeometry 58/3, 2016, 484–499.

Borrman 2004: H. Borrman, Odontologisk undersökning av Rolfsåkersmannen. ANL rapport 2004 (Gothenburg 2004).

Borrman et al. 1996: H. Borrman/E.U. Engström/V. Alexandersen/L. Jonsson/A.-L. Gerdin/G.E. Carlsson, Dental conditions and temporo-mandibular joints in an early mesolithic bog man. Swedish Dental Journal 20, 1996, 1–14.

Browall 2011: H. Browall, Alvastra pålbyggnad. 1909–1930 års undersökningar. KVHAA Handlingar, Antikvariska serien 48 (Stockholm 2011).

Browall 2016: H. Browall, Alvastra pålbyggnad. 1976–1980 års utgrävningar. Västra schaktet. KVHAA Handlingar, Antikvariska serien 52 (Stockholm 2016).

Burgman et al. 1987: J.O. Burgman/B. Calles/F. Westman, Conclusions from a ten year study of oxygen-18 in precipitation and runoff in Sweden. Isotope techniques in water resources development. IAEA, Vienna (Vienna 1987) 579–590.

Cunningham et al. 2003: C. Cunningham/L. Scheuer/S. Black, Developmental juvenile osteology (London 2003).

Degerbøl/Fredskild 1970: M. Degerbøl/B. Fredskild, The Urus (Bos Primigenius Bojanus) and Neolithic Domesticated Cattle (Bos Taurus Domesticus Linné) in Denmark. Det Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter 17/1 (Copenhagen 1970).

Erdtman 1921: G.E. Erdtman, Pollenanalytische Untersuchungen von Torfmooren und marinen Sedimenten in Südwest-Schweden. Arkiv för botanik 17, No. 10 (Uppsala 1921).

Eriksson et al. 2016: G. Eriksson/K.M. Frei/R. Howcroft/S. Gummesson/F. Molin/K. Lidén/R. Frei/F. Hallgren, Diet and mobility among Mesolithic hunter-gatherers in Motala (Sweden) - The isotope perspective. Journal of Archaeological Science: Reports, 2016. http://dx.doi.org/10.1016/j.jasrep. 2016.05.052.

Frei/Frei 2011: K.M. Frei/R. Frei, The geographic distribution of strontium isotopes in Danish surface waters – A base for provenance studies in archaeology, hydrology and agriculture. Applied Geochemistry 26, 2011, 326–340.

Frei/Price 2011: K.M. Frei/T.D. Price, Strontium isotopes and human mobility in prehistoric Denmark. Archaeological and Anthropological Sciences 4/2, 2011, 103–114.

Fredengren 2011: C. Fredengren, Where wandering water gushes – the Depositional landscape of the Mälaren valley in the late Bronze Age and the earliest Iron Age of Scandinavia. Journal of Wetland Archaeology 10, 2011, 109–135.

Fredengren 2015: C. Fredengren, Water politics. Wet deposition of human and animal remains in Uppland, Sweden. Fornvännen 111, 2015, 161–183.

Fries 1958: M. Fries, Vegetationsutveckling och odlingshistoria i Varnhemstrakten. Acta Phytogeographica Suecica 39 (Uppsala 1958).

Garland 1993: A.N. Garland, An introduction to the histology of exhumed mineralized tissue. In: G. Grupe/A.N. Garland (eds.), Histology of Ancient Human Bone: Methods and Diagnosis. Proceedings of the Paleohistology Workshop held from 3–5 October 1990 at Göttingen (Berlin/Heidelberg 1993) 1–16.

Gejvall et al. 1952: N.-G. Gejvall/C.H. Hjortsjö/K.-E. Sahlström, Stenålderskvinnan från Luttra i svensk antropologisk belysning. In: Arkeologiska forskningar och fynd. Svenska arkeologiska samfundets hyllningsskrift till H M Konungen 11 nov 1952 (Stockholm 1952).

Gron/Rowley-Conwy 2016: K. Gron/P. Rowley-Conwy, Herbivore diets and the anthropogenic environment of early farming in southern Scandinavia. The Holocene, 2016, 1–12. doi: 10.1177/0959683616652705.

Grupe/Dreser-Werringloer 1993: G. Grupe/U. Dreser-Werringloer, Decomposition phenomena in thin-sections of excavated human bones. In: G. Grupe/A.N. Garland (eds.), Histology of Ancient Human Bone: Methods and Diagnosis. Proceedings of the Paleohistology Workshop held from 3–5 October 1990 at Göttingen (Berlin/Heidelberg 1993).

Hallgren 1996: F. Hallgren, En mellanneolitisk skalle från Hälsingland. Fjölnir 15/1, 1996, 5–10.

Hedges et al. 1995: R.E.M. Hedges/A.R. Millard/A.W.G. Pike, Measurements and relationships of diagenetic alteration of bone from three archaeological sites. Journal of Archaeological Science 22, 1995, 201–209.

Hellgren 2007: M. Hellgren, Arkeologisk efterundersökning längs del av Nossan i Södra Härene socken, Vårgårda kommun, Västergötland. Lödöse Museum Rapport 2007:35 (Lödöse 2007).

Hollund et al. 2012: H.I. Hollund/M.M.E. Jans/M.J. Collins/H. Kars/I. Joosten/S.M. Kars, What happened here? Bone histology as a tool in decoding the postmortem histories of archaeological bone from Castricum, The Netherlands. International Journal of Osteoarchaeology 22/5, 2012, 537–548.

Hollund et al. 2013: H.I. Hollund/N. Arts/M.M.E. Jans/H. Kars, Are Teeth Better? Histological Characterization of Diagenesis in Archaeological Bone – Tooth Pairs and a Discussion of the Consequences for Archaeometric Sample Selection and Analyses. International Journal of Osteoarchaeology 25/6, 2013, 901–911.

Iregren 1982: E. Iregren, Kalvarium från Vg, N:a Vings socken, Härlingstorp. Unpublished manuscript, Archive of Västergötlands Museum, Skara.

Jankavs 2011: P. Jankavs, Att ge forntiden ett ansikte. Falbygden, 2011, 75–83.

Jans 2005: M.M.E. Jans, Histological characterisation of diagenetic alteration of archaeological bone. Amsterdam, Department for Geo- and Bioarchaeology (Amsterdam 2005).

Jonsson et al. 2002: L. Jonsson/B. Hall/B. Thilander/H. Borrman, The skeleton of a Neolithic farmer. A Forensic Case from the Stone Age. Poster at Odontologiska Riksstämman (Stockholm 2002).

Karsten 1994: P. Karsten, Att kasta yxan i sjön. En studie över rituell tradition och förändring utifrån skånska neolitiska offerfynd. Acta Arch Lundensia, Ser. in 80, No. 23 (Lund 1994).

Kirleis/Fischer 2014: W. Kirleis/E. Fischer, Neolithic cultivation of tetraploid free threshing wheat in Denmark and Northern Germany: implications for crop diversity and societal dynamics of the Funnel Beaker Culture. Vegetation History and Archaeobotany 23 (Suppl 1), 2014, S81–S96. doi: 10.1007/s00334-014-0440-8.

Koch 1998: E. Koch, Neolithic bog pots from Zealand, Møn, Lolland and Falster. Nordiske fortidsminder. Serie B - in quarto, 16. København: Det Kongelige Nordiske Oldskriftselskab (Copenhagen 1998).

Krishan/Kanchan 2013: K. Krishan/T. Kanchan, Evaluation of spheno-occipital synchondrosis: A review of literature and considerations from forensic anthropologic point of view. Journal of Forensic Dental Sciences 5/2, 2013, 72–76.

Krogman/Iscan 1986: M. Krogman/M.Y. Iscan, The Human Skeleton in Forensic Medicine (Springfield 1986).

Liden et al. 2004: K. Liden/G. Eriksson/B. Nordqvist/A. Götherström/E. Bendixen, The wet and the wild followed by the dry and the tame - or did they occur at the same time? Diet in Mesolithic–Neolithic southern Sweden. Antiquity 78/299, 2004, 23–33.

Liljegren 1975: R. Liljegren, Subfossila vertebratfynd från Skåne. University of Lund, Department of Quaternary Geology, Report 8 (Lund 1975).

Lindälv 1968: E. Lindälv, Fornfynd och fornminnen i norra Halland. (Lund 1968 [2]).

Lindahl 1971: A. Lindahl, Ond, bråd död vid Helveteskärr. Östergötland 1971. Meddelanden från Östergötlands och Linköpings Stads Museum, 1971.

Manjunatha/Soni 2014: B.S. Manjunatha/N.K. Soni, Estimation of age from development and eruption of teeth. Journal of Forensic Dental Science 6, 2014, 73–76.

Millard 2001: A.R. Millard, The deterioration of bone. In: D.R. Brothwell/A.M. Pollard (eds.), Handbook of Archaeological Sciences (New York 2001).

Mittnik et al. 2017: A. Mittnik/C.-C. Wang/S. Pfrengle/M. Daubaras/G. Zarina/F. Hallgren/R. Allmäe/V. Khartanovich/V. Moiseyev/A. Furtwängler/A. Andrades Valtueña/M. Feldman/C. Economou/M. Oinonen/A. Vasks/M. Tõrv/O. Balanovsky/D. Reich/R. Jankauskas/W. Haak/S. Schiffels/J. Krause, The Genetic History of Northern Europe. BioRxiv preprint, 2017. doi: http://dx.doi.org/10.1101/113241.

Moberg 1960: C.-A. Moberg, En gåtfull död (för 4000 år sedan?). Fynd, 1960, 12–13.

Munthe 1905: H. Munthe, Beskrivning till kartbladet Skövde. SGU Ser. Aa No. 121 (Stockholm 1905).

Nicholson 1998: R.A. Nicholson, Bone degradation in a compost heap. Journal of Archaeological Science 25, 1998, 393–403.

Nilsson 1996: L. Nilsson, The Bones from Hindby Votive Fen. Delicate Problems of Interpretation. Lund Archaeological Review 1, 1996, 65–74.

Nilsson/Nilsson 2003: M.-L. Nilsson/L. Nilsson, Ett källsprång i Saxtorp. In: M. Svensson (ed.), I det Neolitiska rummet. Skånska spår – arkeologi längs Västkustbanan (Lund 2003).

Noe-Nygaard et al. 2005: N. Noe-Nygaard/ T.D. Price/S.U. Hede, Diet of aurochs and early cattle in southern Scandinavia: evidence from 15N and 13 C stable isotopes. Journal of Archaeological Science 32, 2005, 855–871.

Nordqvist 1999: B. Nordqvist, Fyndplatsen för Rolfsåkersmannen. Vind och vatten. Arkeologiska undersökningar i Bohuslän och Halland. UV Väst rapport 1998:14 (Kungsbacka 1999).

Östlund 1957: H.G. Östlund, Stockholm Natural Radiocarbon Measurements I. Science 126, 1957, 493–497.

Oldeberg 1952: A. Oldeberg, Studien über die schwedische Bootaxtkultur. Kungl. Vitterhets-, historie- och antikvitetsakademien, Monografier 37 (Stockholm 1952).

Oldeberg 1976: A. Oldeberg, Die ältere Metallzeit in Schweden II. Kungl. Vitterhets-, historie- och antikvitetsakademien, Monografier 53 (Stockholm 1976).

Persson/Sjögren 2001: P. Persson/K.-G. Sjögren, Falbygdens gånggrifter. Undersökningar 1985 till 1998. GOTARC Ser. C, No. 34. Institutionen för Arkeologi, Gothenburg University (Gothenburg 2001).

Price et al. 2015: T.D. Price/D. Meiggs/M.-J. Weber/A. Pike-Tay, The migration of Late Pleistocene reindeer: isotopic evidence from northern Europe. Archaeological and Anthropological Science, 2015. doi: 10.1007/s12520-015-0290-z.

Påsse 1987: T. Påsse, Shore displacement during the Late Weichselian and Holocene in the Sandsjöbacka area, SW Sweden. Geologiska Föreningens i Stockholm Förhandlingar 109/3, 1987, 197–210. doi: 10.1080/11035898709453771.

Ravn 2010: M. Ravn, Burials in Bogs. Bronze and Early Iron Age Bog Bodies from Denmark. Acta Archaeologica 81, 2010, 112–123.

Rech 1979: M. Rech, Studien zu Depotfunden der Trichterbecher- und Einzelgrabkultur des Nordens. Offa-Bücher 39 (Neumünster 1979).

Ruckensteiner 1931: E. Ruckensteiner, Die normale Entwicklung des Knochensystems im Röntgenbild. Radiologische Praktika 15 (Leipzig 1931).

Sarauw/Alin 1923: G. Sarauw/J. Alin, Götaälvsområdets fornminnen. Göteborgs Jubileumspublikationer 3 (Gothenburg 1923).

Sellstedt et al. 1966: H. Sellstedt/L. Engstrand/N.-G. Gejvall, New Application of Radiocarbon Dating to Collagen Residue in Bones. Nature 212, 1966, 572–574.

Sjögren 2003: K.-G. Sjögren, "Mångfalldige uhrgamle grafvar…". Megaliter och samhälle i Västsverige. GOTARC Ser. B, No. 27. Institutionen för Arkeologi, Gothenburg University (Gothenburg 2003).

Sjögren 2013: K.-G. Sjögren, Neolitisering i Västsverige. En översikt över källäget. In: F. Kaul/L. Sörensen (eds.), Agrarsamfundenes expansion i nord. Symposium på Tanums Hällristningsmuseum, Underslös, Bohuslän, 25.–29. maj 2011. Nordlige verdener, Nationalmuseet København (Copenhagen 2013) 73–86.

Sjögren 2015: K.-G. Sjögren, News from Frälsegården. Aspects on Neolithic burial practices. In: K. Brink/S. Hydén/K. Jennbert/L. Larsson/D. Olausson (eds.), Neolithic Diversities. Perspectives from a Conference in Lund, Sweden. Acta Archaeologica Lundensia, Series in 8o, No. 65 (Lund 2015) 200–210.

Sjögren 2017: K.-G. Sjögren, Modeling Middle Neolithic Funnel Beaker Diet on Falbygden, Sweden. Journal of Archaeological Science: Reports 12, 2017, 295–306.

Sjögren/Ahlström 2017: K.-G. Sjögren/T. Ahlström, Early Mesolithic Burials from Bohuslän, western Sweden. In: J.M. Grünberg/B. Gramsch/L. Larsson/J. Orschiedt/H. Meller (eds.), Mesolithic burials – Rites, symbols and social organisation of early postglacial communities. International Conference in Halle (Saale), Germany, 18th–21st September 2013 (Langenweissbach 2017) 125–144.

Sjögren/Price 2012: K.-G. Sjögren/T.D. Price, A complex Neolithic economy. Isotope evidence for the circulation of cattle and sheep in the TRB of western Sweden. Journal of Archaeological Science 40, 2012, 690–704.

Sjögren/Price 2013: K.-G. Sjögren/T.D. Price, Vegetarians or meat eaters? Enamel δ13C and Neolithic diet at the Frälsegården passage tomb, central Sweden. In: S. Bergerbrant/S. Sabatini, (eds.): Counterpoint: Essays in Archaeology and Heritage Studies in Honour of Professor Kristian Kristiansen (Oxford 2013) 43–52.

Sjögren et al. 2009: K.-G. Sjögren/T.D. Price/T. Ahlström, Megaliths and mobility in south-western Sweden. Investigating relations between a local society and its neighbours using strontium isotopes. Journal of Anthropological Archaeology 28, 2009, 85–101.

Skaarup 1985: J. Skaarup, Yngre stenalder på øerne syd for Fyn. Meddelelser fra Langelands Museum (Rudkøbing 1985).

Stjernqvist 1981: B. Stjernqvist, Näbbe mosse. A mysterious Stone Age lake. Striae 14, 1981, 35–40.

Strömberg et al. 2014: B. Strömberg/A. Carlie/A. Lagergren/K. Schmidt Sabo, Lockarp 24:1, 42:1 och 43:1, Lindängelund 4. Skåne, Malmö stad och kommun, Bunkeflo och Lockarp socknar, fornlämning Bunkeflo 76, 144, 146–148 och Lockarp 50. Arkeologisk undersökning 2008 & 2009. UV Rapport 2014:83 (Lund 2014).

Strömberg 1990: M. Strömberg, Stenålder i Näbbe mosse. Österlen, 1990, 71–76.

Sørensen 2014: L. Sørensen, From hunter to farmer in Northern Europe. Migration and adaptation during the Neolithic and Bronze Age. Acta Archaeologica supplementa (Copenhagen 2014).

Turner-Walker 1998: G. Turner-Walker, The West Runton fossil elephant: a pre-conservation evaluation of its condition, chemistry and burial environment. The Conservator 22, 1998, 26–30.

Turner-Walker/Jans 2008: G. Turner-Walker/M. Jans, Reconstructing taphonomic histories using histological analysis. Palaeogeography, Palaeoclimatology, Palaeoecology 266, 2008, 227–235.

Turner-Walker/Peacock 2008: G. Turner-Walker/E.E. Peacock, Preliminary results of bone diagenesis in Scandinavian bogs. Palaeogeography, Palaeoclimatology, Palaeoecology 266, 2008, 151–159.

Van Der Sluis et al. 2014: L.G. Van Der Sluis/H.I. Hollund/M. Buckley/ P.G.B. De Louw/K.F. Rijsdijk/H. Kars, Combining histology, stable isotope analysis and ZooMS collagen fingerprinting to investigate the taphonomic history and dietary behaviour of extinct giant tortoises from the Mare aux Songes deposit on Mauritius. Palaeogeography, Palaeoclimatology, Palaeoecology 416, 2014, 80–91.

Van Klinken/Hedges 1995: G.J. Van Klinken/R.E.M. Hedges, Experiments on collagen-humic interactions: Speed of humic uptake, and effects of diverse chemical treatments. Journal of Archaeological Science 22, 1995, 263–270.

Vretemark 1996: M. Vretemark, Kraniet från Hanaskede – vår äldste skaraborgare. Västergötlands Fornminnesförenings Tidskrift 1995–96, 1996, 212–214.

Wilkin/Barnes 1996: R.T. Wilkin/H.L. Barnes, Pyrite formation by reactions of iron monosulfides with dissolved inorganic and organic sulfur species. Geochimica et Cosmochimica Acta 60, 1996, 4167–4179.

Wilkin et al. 1996: R.T. Wilkin/H.L. Barnes/S.L. Brantley, The size distribution of framboidal pyrite in modern sediments: An indicator of redox conditions. Geochimica et Cosmochimica Acta 60, 1996, 3897–3912.

Appendix Tab. 1. Dated human finds in bogs, Denmark.

Country	Site	Dat BP	Sta	cal BC (95.4%)	Labno	Sex	Age	Element	Side	δ13C VPDB (‰)	δ15N AIR (‰)	C/N	Comment	Ref
Denmark	Bodal mose	5025	40	3945-3711	AAR-5360		adult	Femur		-20,8				AUD 1999
Denmark	Veksø Mose	4985	27	3915-3696	Poz-17006+17030/ BCH198: 13a+b	F	30–40	Femur	sin.	-20,5	9,6	3,3	dental disease	Koch 1998 no 38, Fischer et al. 2007, cf. AUD 1994
Sweden	Saxtorp ind 3	4975	75	3946-3647	Ua-9808		juv/ adult	Cranium					ind 3	Nilsson, Nilsson 2003
Sweden	Hallonflickan	4964	42	3928-3651	UBA-30518	F	18-20	Femur	sin	-20,6	8,4	3,2	probably tied up	This study
Denmark	Ferle Enge	4940	95	3961-3527	K-6299/BCH199: 16+44	F	25–35	Tibia	sin.	-22,6	9,3	3,4		AUD 1994, Koch 1998 no 13, Fischer et al. 2007
Denmark	Tagmosegård	4920	95	3956-3522	K-6297/BCH199: 49		7–8	Femur	dxt.	-22,4	8,9	3,3		AUD 1994, Koch 1998 no 9, Fischer et al. 2007
Sweden	Näbbe mosse	4920	60	3934-3538	Lu-1828	F	adult			-20,8				Stjernqvist 1981
Denmark	Trudstrupsgårds mose	4870	45	3765-3532	AAR-6881	M	45-50	pelvis		-20,7	9,5	3,3	with embedded arrowhead	AUD 2001, Fischer et al. 2007
Denmark	Hesselbjerggårds mose	4867	32	3706-3541	AAR-7310		adult	Frontale		-20,5	9,8	3,2		Fischer et al. 2007
Denmark	Andemosen	4800	90	3764-3370	K-3579	M	17-18			-19,6			trauma on cranium	Skaarup 1985:64, Sellevold m.fl. 1984:19
Sweden	Saxtorp ind 1	4760	75	3660-3369	Ua-9810	F	20-30	Cranium					ind 1	Nilsson, Nilsson 2003
Denmark	Vængegårds torvfabrik	4760	95	3761-3350	K-6300	F	adult			-20,2			small female	AUD 1994, Koch 1998 no 167
Sweden	Sandåkra	4730	100	3712-3122	St-3771	F	25-30						two women plus animal bones and artefacts	Blumbergs mfl i Ossa 1974/1
Sweden	Härlingstorp	4730	33	3635-3377	OxA-33832	F	20-25	Cranium		-21,8	9,1	3,2		This study
Denmark	Porsmose	4710	90	3695-3127	K-3748/Hg24297	M	35–40	costae		-20,4	8,6	3,1	two arroheads embedded in the skeleton	Fischer et al. 2007
Sweden	Saxtorp ind 2	4690	75	3646-3196	Ua-9809	F	juv/ adult	Cranium					ind 2	Nilsson, Nilsson 2003
Denmark	Sigersdal B	4680	75	3643-3137	K-3745/BCH198: 87+23	F	16	Costae + pes		-19,2	10,5	3,3	invalid	Bennike, Ebbesen 1987, Koch 1998 no 37, Fischer et al. 2007
Denmark	Bolkilde	4670	65	3637-3342	K-4593/T4	M	>30	Femur	dxt.	-19,7	12	3,2	cord around the neck	Bennike et al. 1986, Fischer et al. 2007

Appendix Tab. 1. Continued. Dated human finds in bogs, Denmark.

Country	Site	Dat BP	Sta	cal BC (95.4%)	Labno	Sex	Age	Element	Side	δ^{13}C VPDB (‰)	δ^{15}N AIR (‰)	C/N	Comment	Ref
Denmark	Sigersdal A	4650	140	3702-2943	K-3744/BCH198: 8a+b	F	18–20	Costae		-20,4	10	3,3	cord around the neck	Bennike, Ebbesen 1987, Koch 1998 no 37, Fischer et al. 2007
Denmark	Myrebjerg mose	4640	320	4225-2498	K-3702	F	adult	Femur					At least 5 persons, with animal bones	Skaarup 1985:76, Bennike, Ebbesen 1987
Denmark	Hesselbjerg	4590	95	3632-3025	K-6298	F	25-40			-20,1			arthritis in right hand, with child cranium, 10-16 y	AUD 1994, Koch 1998 no 1
Denmark	Ulvemosen	4580	90	3630-3022	K-6306		14-16	Femur		-20,1			with bones from 8 other persons	AUD 1994, Koch 1998 no 216
Denmark	Hove å	4578	28	3496-3118	OxA30684			Cranium		-19,6	10,3	3,2	MNI 4	AUD 1994
Denmark	Øgårde boat III	4570	60	3516-3091	K-3746	M?	adult			-20,1	9,2	3,2	possible boat burial	Koch 1998 no 98, Fischer et al. 2007
Denmark	Østrup mose 2	4530	90	3512-2928	K-5741	M	young adult	fibula	dxt.	-20,7			skeleton 2, with fire making kit	AUD 1991, Koch 1998 no 167
Sweden	Saxtorp ind 1	4520	80	3498-2930	Ua-9811	F	20-30	Cranium					ind 1	Nilsson, Nilsson 2003
Denmark	Østrup homo II	4523	37	3361-3098	AAR-10248/ BCH198: 34a+b		35–45	Femur	sin.	-19,4	10,5	3,3		Fischer et al. 2007
Denmark	Østrup mose 1	4510	90	3498-2921	K-5742	F	young adult	Femur		-19,5			skeleton 1, young woman and swan	AUD 1991, Koch 1998 no 167
Sweden	Rolfsåker	4430	70	3329-2916	Ua-7836	M	20-25	phalanx		-20,1	11,1	3,5	Trauma on tibia and possibly on ulna	Sarauw, Alin 1923, Nordqvist 1999, Liden et al. 2004
Denmark	Jorløse Mose	4430	90	3352-2906	K-6302/BCH199: 17+45	M	30–40	Tibia	sin.	-20,5	10,8	3,5	trauma on cranium	AUD 1994, Koch 1998 no 203, Fischer et al. 2007
Sweden	Ölsund	3890	80	2575-2140	Ua-2138	M	young adult	Cranium						Forsa raä 416, Hallgren 1996
Denmark	Salpetermosen	3751	29	2281-2039	OxA-30484	M	25-35	tooth		-20,7	10,4	3,2		Koch 1998 no 19, dating previously not published
Sweden	Nossamaden	3655	40	2141-1918	Ua-24864	F	35-40	Cranium		-20,7				Hellgren 2007, Sjögren et al. 2009
Denmark	Stenstrup	3550	80	2134-1688	K-4424	M	ca 40						cord around the neck	Bennike, Ebbesen 1985
Sweden	Hindbygården	3535	50	2019-1701	LuS-7874			Femur					disarticulated	Berggren 2010
Denmark	Føllenslev	3530	120	2201-1546	K-3747/BCH198: 46a+b	M	adult	Femur	sin	-20,7	9,4	3,3	cord around the neck, lesions on ulnae and mandibula	Bennike, Ebbesen 1987, Koch 1998 no 80, Fischer et al. 2007

Appendix Tab. 2. Dated Cattle finds in bogs, Denmark.

Labno	Site	uncal BP	sd	Reference
K-5057	Øgårde I	5030	90	Koch 1998, Price, Noe-Nygaard 2009
K-4771	Snævret Hegn	4960	90	Koch 1998, Price, Noe-Nygaard 2009
K-5536	Kærup	4840	75	Koch 1998, Price, Noe-Nygaard 2009
Gr-22167	Hindbygården	4810	60	Berggren 2007
K-4770	Snaevret Hegn	4770	85	Koch 1998, Price, Noe-Nygaard 2009
K-4979	Kildegård	4730	85	Koch 1998, Price, Noe-Nygaard 2009
	Øgårde II	4675	75	Price, Noe-Nygaard 2009
	Tingsted	4650	90	Price, Noe-Nygaard 2009
	Ulkestrup Lyng	4630	85	Price, Noe-Nygaard 2009
K-4980	Maglemosegård	4620	60	Koch 1998, Price, Noe-Nygaard 2009
K-4982	Holmene MD XV	4610	85	Tauber 1988, Koch 1998
K-2778	Snoldelev I (MD XI)	4600	90	Koch 1998, Price, Noe-Nygaard 2009
	Sandhuse mose Ox II	4580	80	Price, Noe-Nygaard 2009
Lu-3583	Hindbygården	4560	90	Berggren 2007
K-4978	Store Lyng	4560	85	Koch 1998, Price & Noe-Nygaard 2009
	Sandhuse mose Ox II	4530	70	Noe-Nygaard et al 2005
K-5537	Borremose	4525	90	Koch 1998
K-2779	Husede I	4510	90	Koch 1998, Price, Noe-Nygaard 2009
K-4981	Holmene MDSVI	4490	85	Tauber 1988, Koch 1998
	Verupgårds mose	4480	70	Price, Noe-Nygaard 2009
	Sandhuse K-XXXIX	4230	70	Price, Noe-Nygaard 2009
K-3723	Bodal B	4190	90	Koch 1998, Price, Noe-Nygaard 2009
Gr-22163	Hindbygården	3770	60	Berggren 2007
	Ærøskøbing	3705	75	Price, Noe-Nygaard 2009
Gr-22148	Hindbygården	3610	60	Berggren 2007
Lu-3409	Hindbygården	3580	60	Berggren 2007

Imprint

ISSN 2197-649X

Layout draft: Holger Dieterich, Ines Reese
Technical edition: Susanne Beyer
Language revision: Eileen Küçükkaraca

Published by the Institute of Prehistoric and Protohistoric Archaeology, Kiel University;