doi: 10.7485/QU60_7 Quartär 60 (2013): 137-162

Late Palaeolithic Nørre Lyngby – a northern outpost close to the west coast of Europe

Nørre Lyngby in spätpaläolithischer Zeit – ein nördlicher Außenposten nahe der Westküste Europas

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Abstract - Freshwater deposits exposed in a coastal cliff at Nørre Lyngby, NW Denmark, have yielded some of the northernmost traces of human presence in Western Europe during the Late Glacial. A rib from a reindeer bearing a cut mark has been dated to the climatically mild Allerød period. A robust projectile point of flint and an axe of reindeer antler, bearing zigzag ornamentation, are potentially of the same age. Wear marks indicate their use as a projectile tip and an axe, respectively. Botanical and faunal remains from the lake sediments indicate a colder climate and a significantly less tree-covered landscape than that seen at coeval sites further to the southeast in Denmark. The Nørre Lyngby locality is within a day's walk of the contemporary coast and a considerable number of Bromme culture activity sites and stray finds of tanged flint points of Bromme type ("Lyngby points") in the surrounding landscape suggest a significant human presence in the coastal zone of NW Europe at that time.

Zusammenfassung - *Süßwasserablagerungen in einer Steilküste bei Nørre Lyngby, Nordwest-Dänemark, haben einige der nördlichsten Spuren des Daseins von Menschen im späteiszeitlichen Westeuropa geliefert. Diese Funde spielen seit mehr als 100 Jahren eine zentrale Rolle im Studium des Spätpaläolithikums im nordeuropäischen Tiefland. Mit der vorliegenden Untersuchung wird zum ersten Mal eine gesammelte Primärstudie der drei Kulturspuren des Fundplatzes vorgestellt. Die Studie umfasst Mikrogebrauchsspurenanalysen, die wesentlich Neues über die Funktion und Datierung der Gegenstände erbrachten, sowie eine Serie von AMS-Datierungen, die zur Vorsicht bei der Datierung von konservierten Gegenständen mahnen. Eine Rentierrippe mit Schnittspur wird in die klimatisch milde Allerødzeit datiert. Eine kräftige Projektilspitze aus Feuerstein und ein Beil aus Rentiergeweih mit einem Zick-Zack-Ornament sind wahrscheinlich von gleichem Alter. Der Fundplatz befand sich innerhalb eines Tagesmarsches von der damaligen Küste. Eine beträchtliche Anzahl von Aktivitätsplätzen und Einzelfunden von Flintspitzen des Typs 'Lyngby' aus der näheren Umgebung deutet auf eine erhebliche Anwesenheit von Menschen im küstennahen Bereich Nordeuropas zur besagten Zeit. Die Studie fasst das vorhandene Wissen über die Naturverhältnisse zur Zeit der Deponierung der drei Kulturspuren am Fundplatz zusammen und unterstreicht die Bedeutung des Fundplatzes und seiner näheren Umgebung in Relation zur zukünftigen Erforschung von Nordeuropas Besiedlung und Subsistenzökonomie zur Späteiszeit.*

Keywords - Allerød period, Bromme culture, Late Glacial, projectile point, reindeer antler axe, sea level
Allerød, Bromme Kultur, Spätglazial, Geschossspitze, Rengeweihaxt, Meeresspiegel

Introduction

The archaeological renown of the Nørre Lyngby locality is due to the discovery, respectively in 1889 and 1913, of a tool of reindeer antler and a flint projectile point. Detailed studies of these artefacts were published relatively shortly after their discovery (Müller 1897; Nordmann 1915b). Since then, these objects have been almost indispensable ingredients in any review of Danish prehistory and they have been regularly referred to in academic contributions dealing with chronology and material culture in NW Europe at the end of the last ice age. This paper presents, for the first time, a comprehensive account of these two artefacts, including wear-trace analyses, which have yielded significant new information on the function and dating of the artefacts, together with a series of AMS ^{14}C dates which invite caution with

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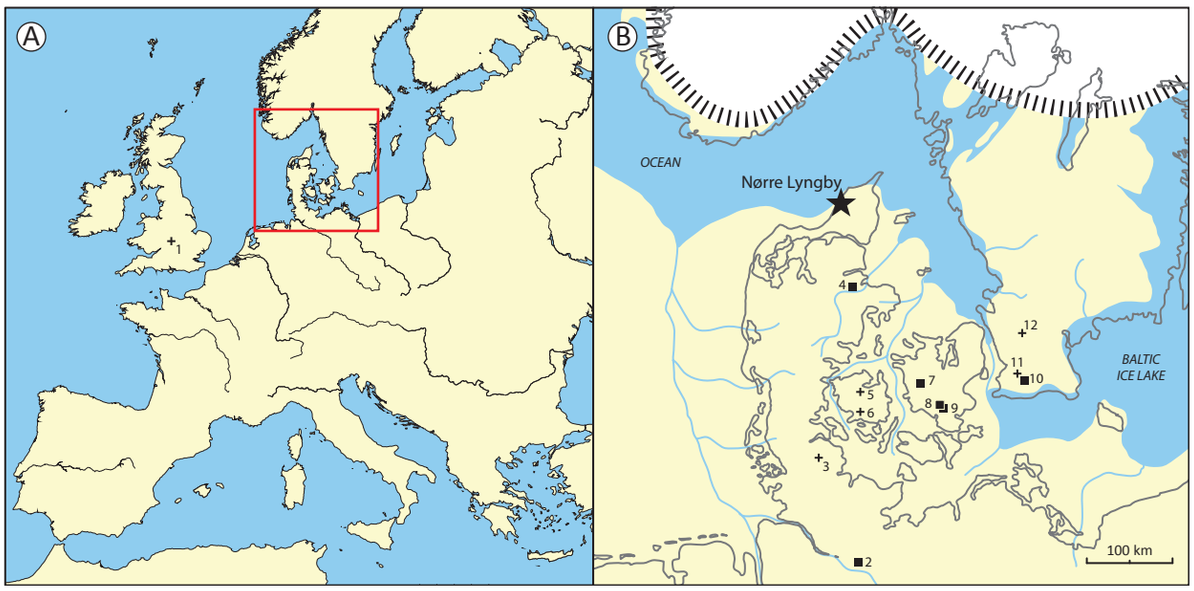

Fig. 1. The location of the Nørre Lyngby site relative to the present-day geography and the extent of land, sea and ice cap in South Scandinavia in Middle to Late Allerød times. Other Late Glacial accumulations of finds (squares) and stray finds of "Lyngby picks/axes" (crosses) mentioned in this paper are also marked on the map: Earls Barton (1), Stellmoor (2), Klappholz (3), Langå (4), Odense Kanal (5), Arreskov (6), Bromme (7), Fensmark (8), Trollesgave (9), Hässleberga (10), Bara (11), Mickelsmosse (12).

Abb. 1. *Die Lage des Fundplatzes von Nørre Lyngby im Verhältnis zur heutigen Geographie und Ausdehnung von Land, See und Eisdecke in Südskandinavien in mittlerer bis später Allerød-Zeit. Weitere in diesem Beitrag erwähnte spätglaziale Fundansammlungen (Quadrate) und Streufunde von „Lyngby Äxten" (Kreuze) sind ebenfalls eingezeichnet: Earls Barton (1), Stellmoor (2), Klappholz (3), Langå (4), Odense Kanal (5), Arreskov (6), Bromme (7), Fensmark (8), Trollesgave (9), Hässleberga (10), Bara (11), Mickelsmosse (12).*

respect to the dating of conserved artefacts. It also includes an account of an artefact found in lacustrine deposits in 1993: a reindeer rib bearing a man-made cut mark. The paper also collates and summarises the available information on natural conditions at the time when the three artefacts were deposited at the site and underlines the significance of the locality and its surroundings in relation to future research into the settlement of NW Europe and the subsistence economy of the Late Glacial.

The locality

The prehistoric lake deposits at Nørre Lyngby, Vendsyssel, in the far NW corner of Denmark, lie today on the boundary between land and sea (Fig. 1 & see Fig. 17). In the Late Glacial the area occupied a roughly similar topographical position. The people who left behind the artefacts at the site would have been able to reach the seashore in a day or less, as the distance was a maximum of 25 km (cf. below). At that time, the global sea level lay many metres below that of today such that the North European lowland extended, unbroken by the sea, from present-day England in the west to Sweden and the Baltic states in the east. With time, as the ice cap melted, this "Doggerland" (Coles 1998) and many other extensive coastal plains across the world became inundated by the sea (Fischer et al. 2011). However, specifically in the northern part of Vendsyssel, there was such significant isostatic land upheaval at the end of the last (most recent) ice age and subsequently that Late Glacial coastlines are now located above present sea level.

The North Sea coast of Vendsyssel is exposed to heavy wave action and erosion. Kilometre after kilometre, the boundary between land and sea now takes the form of a steep slope under continual degradation (Fig. 2). At Nørre Lyngby this cliff is almost 20 m high, exposing a basin 180 m wide and 15 m deep, containing freshwater deposits from the last ice age (Fig. 3).

The landscape above the approximately N-S oriented coastal cliff is characterised by the almost flat floor of the Late Glacial Yoldia Sea. However, close to the slope this lies hidden beneath massive, younger dune formations. The raised seabed, which generally (but not locally here at Nørre Lyngby) is located around 20 m a.s.l., extends many kilometres to the east. The nearest "island" of moraine deposits protrudes above the raised seabed c. 5 km to the SE.

The lake basin is the result of a local fault which runs along its northern edge. Immediately to the south of this line the clay subsoil deposits have shifted c. 30 m downwards. This took place gradually, between c. 12 500 and 11 800 ^{14}C BP (^{14}C years Before Present). Around 12 000 ^{14}C BP isostatic land upheaval brought the site above sea level, after which a lake developed in the depression (Lykke-Andersen 1992). Lacustrine deposits of Allerød date have been demonstrated

Fig. 2. The beach below the coastal cliff at Nørre Lyngby is a popular tourist destination. Few visitors discover the existence of the Late Glacial lake basin, which is exposed in the eroding cliff, because its deposits are obscured beneath collapsed dune sand. On the photograph, the basin extends from the foreground to slightly beyond the closest figures on the beach.

Abb. 2. *Der Strand unterhalb der Steilküste bei Nørre Lyngby ist ein beliebtes Ziel von Touristen. Wenige Besucher bemerken das spätglaziale Seebecken, das von der erodierenden Steilküste angeschnitten ist, da seine Ablagerungen unter herabgestürztem Dünensand verborgen liegen. Das Foto zeigt die Ausdehnung des Seebeckens vom Bildvordergrund bis kurz hinter der ersten Gruppe von Menschen am Strand.*

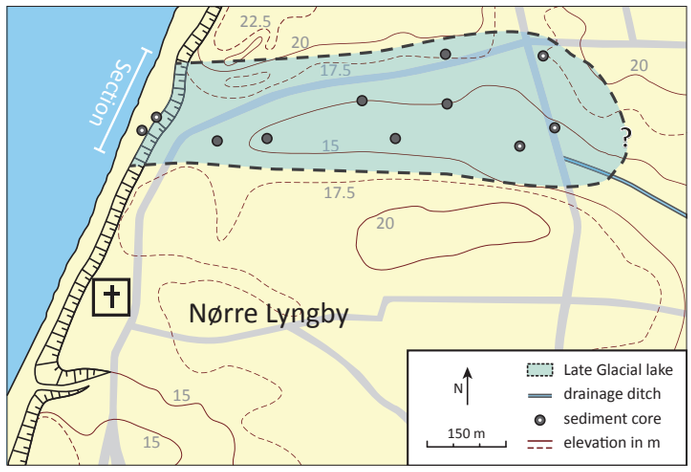

Fig. 3. The approximate extent of the Late Glacial lacustrine deposits at Nørre Lyngby. Gyttja dating from the Allerød period has been demonstrated in the boreholes marked with solid symbols. Since the discovery of the first archaeological finds in 1889 coastal erosion has moved the cliff at least 100 m to the east, and since the area was mapped in the 1970s the western quarter of the churchyard has vanished into the sea.

Abb. 3. *Die ungefähre Ausdehnung der spätglazialen limnischen Ablagerungen von Nørre Lyngby. Gyttja aus dem Allerød wurde in den mit ausgefüllten Symbolen markierten Bohrlöchern belegt. Seit der Entdeckung der ersten archäologischen Funde im Jahr 1889 ist die Steilküste bedingt durch die Küstenerosion mindestens 100 m nach Osten verlagert worden. Seit der Kartierung des Geländes in den 1970er Jahren verschwand das westliche Viertel des Friedhofs im Meer.*

through cores taken as far as 0.5 km to the E (Fig. 3). Today, the area is drained to the E (Jessen 1915), but whether the Late Glacial lake also had an outlet in that direction cannot be determined on the basis of the available data.

Research history

The freshwater basin at Nørre Lyngby, and the Late Glacial marine deposits beneath it, have been subjected to scientific attention since 1869 (e.g. Steenstrup 1879; Jessen 1899, 1931, 1936; Jessen & Nordmann 1915; Iversen 1942; Krog 1978; Bondesen & Lykke-Andersen 1977, 1978). As a result, a significant number of faunal remains have been recovered from the lacustrine deposits.

Since 1889, the site has also attracted considerable attention from archaeologists. This was the year in which a reindeer antler artefact was found below the cliff (Müller 1897). This discovery contributed to an incipient understanding of the fact that the prehistoric period of NW Europe comprised an era of reindeer hunters (Sarauw 1903: 304; Sjöberg 2005). The locality achieved greater cultural-historical significance when, in 1913 during a systematic geological investigation, a projectile point of flint was excavated at the site (Jessen & Nordmann 1915). This artefact has subsequently regularly been drawn into discussions of the cultural conditions in NW Europe during the Late Glacial. There was, accordingly, often talk of a "Lyngby culture" and points of "Lyngby type" (e.g. Schwantes 1923; Mathiassen 1948b; Taute 1968; de Sonneville-Bordes 1969; Petersen 1970; Kobusiewicz 2009).

The flint point was found in a layer later dated by pollen analysis to the Younger Dryas (Iversen 1942), and this date has subsequently been one of the few generally accepted scientific fix-points for typological-cultural developments during the Late Glacial of NW Europe. A further artefact turned up in 1993, during a quaternary palaeontological research excavation at the site (Fig. 4, cf. Fig. 5). Among the many faunal remains recovered was a reindeer rib of Allerød date bearing a man-made cut mark (Aaris-Sørensen 1995; Aaris-Sørensen & Andreasen 1997).

Artefacts from the freshwater deposits

Flint projectile point

The artefact shown in Figure 6 was made from easily-split flint that was originally dark grey in colour. Due to impregnation with iron compounds it now shimmers in a range of yellowish tones. Morphologically, the artefact can be classified as a tanged point (cf. Taute 1968) with the following dimensions:

- Length, present: 63 mm; original 64.5 ± 0.5 mm
- Width: 27 mm; tang width 12 mm
- Thickness: 10 mm; thickest on the tang
- Weight: 12.5 g.

The artefact was made from a robust blade, the sharp edges of which converge towards the tip. Part of the blade's platform remnant is preserved and this comprises a flat, man-made surface (Fig. 6: d). On the artefact's dorsal side it is apparent that the edge of the blade core was trimmed (abraded) prior to detachment of the blade. The conspicuous percussion bulb, together with clear ripples and pronounced radial fissures on the ventral surface, show that the blade was detached using a hammerstone of quartzite or similar relatively hard type of stone.

The longitudinal edges of the artefact have been retouched in three places from the ventral side. Both sides of the proximal end of the blade were modified and these retouches extend 24 and 25 mm, respectively, from the platform remnant. In addition, a minor reduction of a small projection on one of the edges was performed c. 31 mm from the platform remnant (right side on Fig. 6: c). The depth and steep angle of the retouch and the marked negative percussion-bulb scars indicate that working of the tang was done using a hammerstone.

The outer tip of the point was damaged in prehistoric times. This damage takes the form of two spalls which extend from the distal end, respectively 4 and 5 mm along the sides of the point (Fig. 7: a & b). These fracture facets have, like the rest of the artefact, been examined using high magnification metallurgical and low magnification stereoscopic microscopes. The form of the fractures suggests that they arose from use of the artefact as a projectile point, although they are not unequivocally diagnostic for this function (cf. Fischer et al. 1984; Donahue & Fischer in press; Hutchings 2011; Pargeter 2011).

The longitudinal edges show wear in the form of dense, light chipping along the dorsal and ventral sides (Fig. 8). This may derive partly from use, but is more probably the result of slight impact or applied pressure in post-depositional contexts. It could have been produced by rolling on a sandy beach, under low-energy conditions and without major impact from large stones (Burroni et al. 2002). All the surfaces of the flint point are also lightly polished and its dorsal ridges and longitudinal edges are rounded from wear (Fig. 7). These observations demonstrate that the piece was subjected to a redeposition process which, at least, involved beach rolling, but could also have included sand drift and solifluction.

Flint points with the form and manufacturing technique of the example discussed here were previously assigned to a loosely-defined archaeological find complex known as the Lyngby culture, but are now associated primarily with the archaeological find complex known as the Bromme culture (Mathiassen 1948a; Taute 1968; Andersen 1973; Clark 1975; Fischer 1985; Johansson 2003; Pedersen 2009; see also Terberger 2006; Riede et al. 2011). Consequently, artefacts such as these were formerly termed "tanged points of Lyngby type" or simply "Lyngby points" after

Fig. 4. Systematic excavation in search of faunal remains at the northern edge of the freshwater basin in 1993.

Abb. 4. *Systematische Ausgrabung auf der Suche nach tierischen Überresten am nördlichen Rand des Süßwasser-Seebeckens im Jahr 1993.*

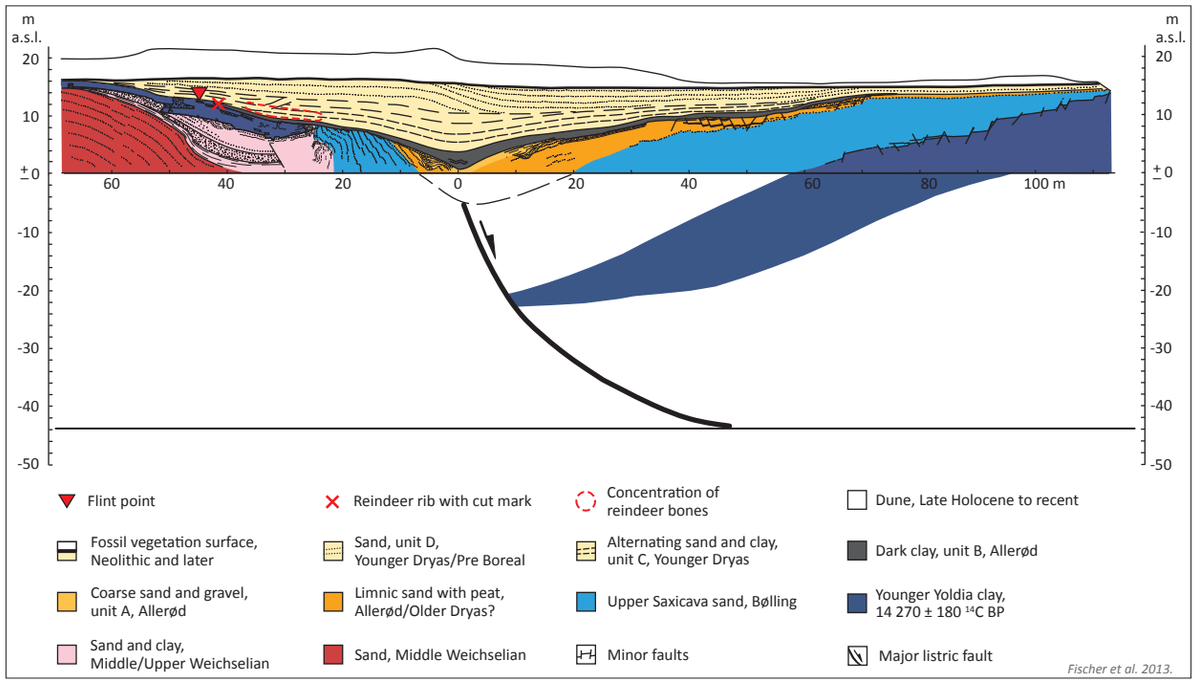

Fig. 5. Cross-section through the freshwater basin and underlying marine deposits at Nørre Lyngby, seen from the west. Based on observations at the cliff itself in 1975-1990 and seismic investigations of deposits located below sea level in 1980-1991. The approximate positions of definite and possible cultural traces have been projected on to the section. The reindeer antler axe probably also came from this northern part of the lake basin.

Abb. 5. *Querschnitt durch das Süßwasser-Seebecken und darunterliegende marine Ablagerungen bei Nørre Lyngby in Westansicht. Grundlage hierfür sind Beobachtungen an der Steilküste selbst in den Jahren 1975 – 1990 und seismische Untersuchungen der Ablagerungen unterhalb des Meeresspiegels der Jahre 1980 – 1991. Die ungefähren Positionen der gesicherten und mutmaßlichen Kulturspuren wurden in den Querschnitt projiziert. Das Beil aus Rentiergeweih kam vermutlich ebenfalls aus diesem nördlichen Teil des Seebeckens.*

Fig. 6. The flint projectile point from Nørre Lyngby, seen ventrally (a), from the side (b), face on (dorsally) (c), and from the base (d).
Abb. 6. *Die Feuerstein-Geschossspitze aus Nørre Lyngby in ventraler (a), seitlicher (b), frontaler (dorsaler) (c) und basaler (d) Ansicht.*

the site dealt with here (Mathiassen 1948b; Taute 1968), whereas they are now most commonly referred to as "Bromme points" (Petersen 1993).

Axe of reindeer antler

Figure 9 (see following double page) shows a tool made from a shed reindeer antler which measures 46 x 8 x 4 cm. Compared to many other prehistoric and recent pieces of reindeer antler it has a relatively straight beam (cf. Gripp 1943). It bears traces of working, has a range of damage arising from use and bears incised ornamentation. These man-made modifications now appear rather indistinct because the surface has been affected by wear and peeling. Some details are also obscured by conservation wax.

The protruding knobs of the burr and most of the bez tine (see Fig. 10) have been removed by shaving off of thin splinters and chopping away three large chips (Fig. 9: d). The form of the marks left behind suggests that these were produced by a tool with a straight, sharp edge – very probably a solid flint flake.

The thin end of the antler tool shows clear traces of a deliberate break (Fig. 9: k). A notch was created across the beam by chopping, perhaps followed by a little sawing. However, before the spongy interior of the antler was reached, a break was produced by a blow or by stamping. This fracture ran rather obliquely so the split surface extended 12 cm along the side of the antler (to the lower left on Fig. 9: a and to the lower right on Fig. 9: c). This oblique fracture probably removed the back tine. These working traces may derive from the use of a large flint flake like those in the Bromme culture assemblage from Fensmark (Fischer 2013: Fig. 13) and the Ahrensburg culture assemblage from Stellmoor (Rust 1943: Tafel 47: 10). The latter assemblage includes several examples of reindeer antler displaying similar working traces (Rust 1943: Tafel 49 and 69; cf. Fischer 1996: Fig. 1; Clausen 2003: Fig. 8: 1).

Part of the bez tine remains in the form of a 4 cm long projection. Two detachments on one narrow side of the projection (Fig. 9: l) show that the reduced tine was used to chop or hammer (cf. Rust 1943: Tafeln 57.1, 58.1; Clausen 2003: Fig. 8.3 & 4). On one side, remnants can be seen of a finely-polished oblique facet, relatively unaffected by surface degradation (Fig. 9: h), where it is possible to observe two types of wear (Fig. 9: i):

- Parallel superficial furrows, 0.2 - 0.4 mm in width, running parallel to the tine's longitudinal axis (perpendicular to the beam of the antler) and with a base characterised by longitudinal ridges and grooves.
- Thin scratches that arose later than the furrows. These occur over the entire oblique facet and cut each other at random orientations.

The details of these furrows and scratches are clearly visible under a stereo microscope. The first type undoubtedly represents wear arising from use as an

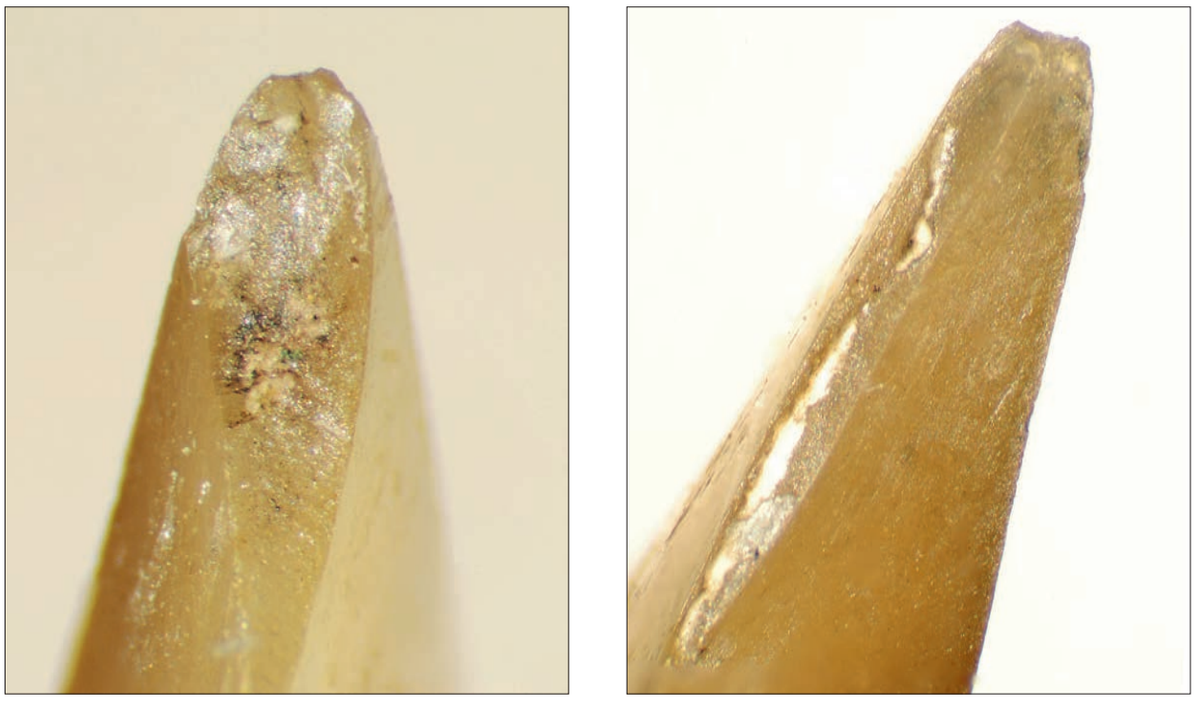

Fig. 7. Impact damage, 4 and 5 mm long, at the tip of the point, probably arising from its use as a projectile tip. The rounded edges are the result of beach rolling or a similar process before the flint point became incorporated into the sandy deposit where it was found.

Abb. 7. *Durch Aufprall entstandene Beschädigungen, 4 und 5 mm lang, im apikalen Bereich der Stielspitze, vermutlich verursacht durch ihren Gebrauch als Geschossspitze. Die Abrundung der Kanten ist bedingt durch Verrollung im Wasser oder einen ähnlichen Vorgang, bevor die Feuerstein-Geschossspitze in die sandige Ablagerung eingebettet wurde, in der sie gefunden wurde.*

axe. The second represents random damage, presumably of natural origin.

The traces of use wear and the form and orientation of the oblique facet show that the artefact functioned as an axe – i.e. it had an edge running parallel to the longitudinal axis of the shaft. Axes of reindeer antler of the same form have been found at sites such as Arreskov in Denmark (Fischer 1996) and Stellmoor in NW Germany (Rust 1943: Tafeln 59-65). The example from Nørre Lyngby was made from such a straight piece of antler that it had a reasonable balance when swung as an axe. In its present state, its point of balance lies about a third of the way between the bez tine and the base of the shaft, resulting in a relatively good "swing".

The inner, spongy part of the bez tine has disappeared, resulting in the formation of a c. 21 mm deep cavity. This is oval in cross-section, measures 17 x 8 mm just inside its opening and narrows evenly inwards. The sides of the cavity appear softly rounded without furrows or scratches of any form. It seems unlikely that the cavity results from intentional hollowing-out for the purposes of fitting a cutting tool, as has previously been suggested (e.g. Müller 1897; Rust 1943: 214-215; Salomonsson 1964; Holm 1972). It seems likely that the spongy material was lost during use and/or as a result of subsequent decay, as is evident in similar cavities in the spongy tissue of corresponding antler tools from Arreskov, Stellmoor and

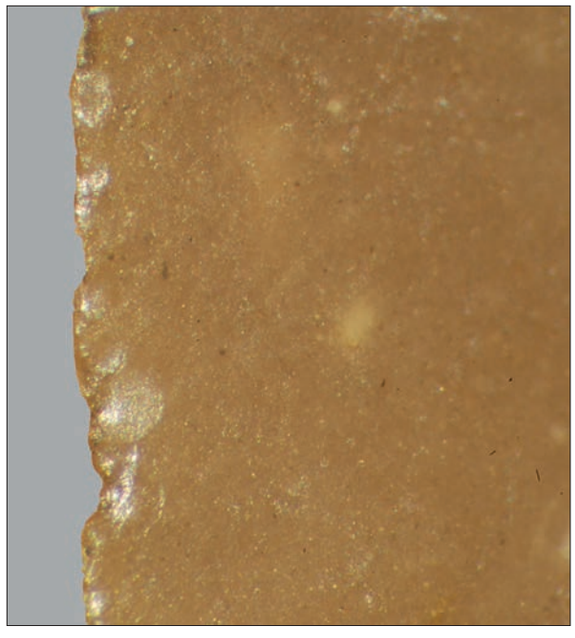

Fig. 8. Small chips along longitudinal edge of the flint point. These are characterised by point initiations and variable terminations (feather, hinge and step) and are probably the result of beach rolling.

Abb. 8. *Kleine Absplitterungen entlang der Längskante der Stielspitze. Diese sind durch punktförmige Bruchinitialisierungen und unterschiedliche Bruchendungen (ausfedernd, Angel- und Stufenbruch) gekennzeichnet und sind vermutlich durch Verrollung im Wasser verursacht worden.*

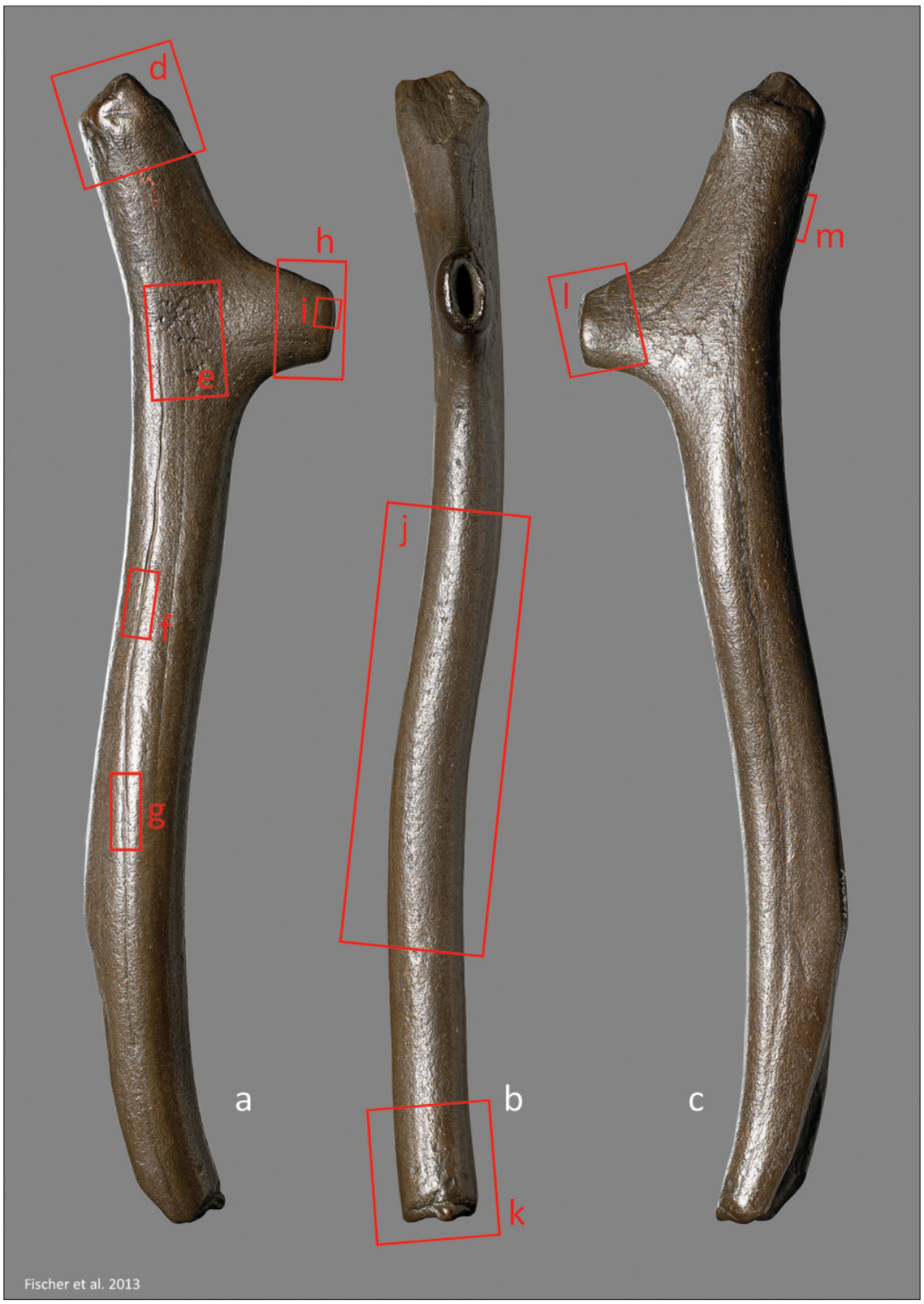

Fig. 9. Axe of reindeer antler, length 46 cm, with close-up photos of a number of working traces: Cut marks and spall facets (d), impact marks (e and m), burin furrow (f and g), remnant of an edge facet (h), microscopic, parallel furrows resulting from use (i), zigzag ornamentation (j), chipped furrow with possible saw marks at its base (k), two macroscopic fractures caused by use as a hammer or axe (l).

Abb. 9. *Beil aus Rentiergeweih, Länge 46 cm, mit Detailfotos einer Reihe von Bearbeitungsspuren: Schnittspuren und Absplitterungen (d), Schlagspuren (e und m), Stichelfurche (f und g), Überrest einer Schneidefacette (h), gebrauchsbedingte mikroskopische, parallele Rillen (i), Zickzackornament (j), angeschlagene Rille mit möglichen Sägespuren an der Basis (k), zwei makroskopische Brüche verursacht durch den Gebrauch als Hammer oder Beil (l).*

Fig. 9. legend see previous page.
Abb. 9. *Legende siehe vorige Seite.*

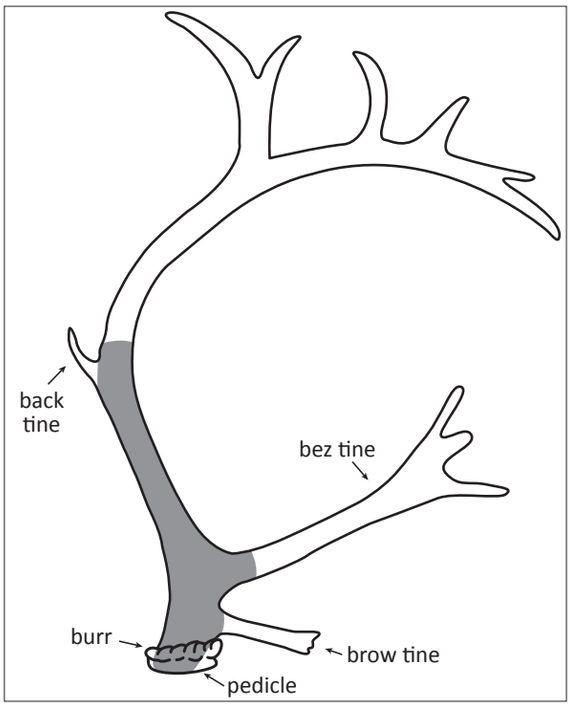

Fig. 10. Reindeer antler terminology and the position of the axe on the antler.

Abb. 10. *Terminologie des Rentiergeweihs und die Position des Beils innerhalb des Geweihs.*

Fig. 11. Reindeer rib, length 19 cm (a) with cut mark, i.e. an incised furrow (b).

Abb. 11. *Rentierrippe, Länge 19 cm (a) mit Schnittspur, d.h. einer eingeschnittenen Furche (b).*

Klappholz (Fischer 1996; cf. Rust 1943: 177; Clausen 2003).

On one broad side, in line with the bez tine, a group of impact marks is evident (Fig. 9: e; cf. Stensager 2004; Rust 1943: 176; Tromnau 1975: 76-77), and a small group of similar impactions is also apparent on the narrow side opposite this tine, 1.5-4 cm from the end of the antler (Fig. 9: m).

On the broad side with the impactions, a naturally-occurring vein-furrow has been deepened using a sharp instrument (no doubt of flint) leaving parallel scratches in the sides and base (Fig. 9: f). This groove, which is between 1 and 3 mm wide, can be followed over a distance of 272 mm. Over a short distance it divides, leading to the formation of an 8 mm long dead end (Fig. 9: g).

On the same narrow side as the bez tine there is zigzag ornamentation, running approximately parallel to the longitudinal axis of the tool (Fig. 9: j). This can be followed over a distance of 119 mm but it possibly originally continued further towards the narrow end of the antler. The decoration comprises three parallel lines which together form a belt up to 6 mm in width. It was incised using a sharp (flint) blade which has left small wedge-shaped furrows of up to 4 mm in length. At the end closest to the burr the decoration ends with two parallel incisions up to 9 mm in length.

There are several examples of similar antler tools, so-called "Lyngby picks" or "Lyngby axes", from NW Europe (e.g. Müller 1897; Sarauw 1903; Schwantes 1923; Nielsen 1946; Skaarup 1974; Schacht 1979; Clausen 2003; Stensager 2006), but examples clearly identifiable to type have only been found in a culture-specific context at the Stellmoor locality near Hamburg (Rust 1943; see also Taute 1968: 53ff). This find assemblage is incorporated within deposits dated to the Younger Dryas (Rust 1943: 37) and has been dated to c. 10 020 ^{14}C BP (Fischer & Tauber 1987). ^{14}C dates for stray finds (Fig. 15) show that the type was already in use in NW Europe in Allerød times, which means that it probably formed part of the toolkit of the Bromme culture (cf. Clausen 2003; Eriksen & David 2010; Riede & Edinborough 2012).

Deposit type	Character and genesis	Date	Stratigraphic unit (Aaris-Sørensen 1995)
Shifting sand	Shifting sand	Formed in historical times	
Old top soil	Dark brown layer with plough furrows and wheel tracks	Contains artefacts from the Neolithic, Bronze Age and Iron Age (Jessen & Nordmann 1915: 18 & 52)	
Sand	Shifting sand	Dated by pollen analysis to the Younger Dryas (Iversen 1942, 1948; Krog 1978). Terrestrial faunal remains from the lower parts of the layer (Aaris-Sørensen 1995; *Lepus timidus* (mountain hare), *Microtus gregalis* (narrow-skulled vole), *Rangifer tarandus* (reindeer)) imply a date within an unspecified part of the Late Glacial and Pre-Boreal periods (Aaris-Sørensen 2009)	D
Alternating sand and clay	Freshwater deposit possibly containing shifting sand	Dated by pollen analysis to the Younger Dryas (Iversen 1942; Krog 1978; cf. Nordmann 1936: 43-46); contains secondarily embedded reindeer bones which via ^{14}C dating are assigned to the Allerød period (Aaris-Sørensen 1995)	C
Dark clay	Freshwater deposit rich in mollusc shells and fish scales	Dated by pollen analysis to the Late Allerød period (Iversen 1942; Krog 1978); contains plant remains and bones ^{14}C dated to Late Bølling times and to the early to middle Allerød period; they must have been eroded out of an earlier deposit in the vicinity (Aaris-Sørensen 1995)	B
Coarse sand and gravel	Freshwater deposits of coarse sand and gravel, occasionally with stripes of peat	Dated by pollen analysis to the Allerød period and with secondarily incorporated terrestrial material ^{14}C dated to Late Bølling times (Iversen 1942; Krog 1978); maximum age of the sedimentation is c. 11 200 BP (Aaris-Sørensen 1995)	A
Upper Saxicava sand	Shore-near boreo-arctic marine deposit	Possibly dating from the Bølling period (Knudsen 1978; Lykke-Andersen 1987)	
Younger Yoldia clay	Arctic marine deep-water deposit	14 270 ± 180 ^{14}C BP (K-2671, uncalibrated age, implicitly reservoir corrected by c. 400 years) (Knudsen 1978; Heier-Nielsen et al. 1995; Richardt 1996)	
Lower Saxicava sand	Marine shallow-water deposit		

Fig. 12. Generalised stratigraphy of the coastal cliff at Nørre Lyngby.
Abb. 12. *Vereinfachte Stratigraphie der Steilküste von Nørre Lyngby*

Reindeer rib with cut mark

The total bone assemblage from the locality (mammals, birds, amphibians and fish, n = 432, including 32 reindeer bones) has been examined as part of a major quaternary palaeontological study (Aaris-Sørensen 1995; cf. Clark 1975: 79). In the course of this, the presence of a clearly man-made cut mark was discovered on an intact reindeer rib. The mark has a sharp-edged cross-section and its base is characterised by longitudinal, parallel ridges and grooves. Its morphology and patination, together with superimposed flecks of sediment (Fig. 11: a & b), show that the cut mark was made in prehistoric times using a stone tool (cf. Blumenschine et al. 1996). The 39 mm long furrow, which runs along the outer surface of the bone (Fig. 11: b), has parallels among bones found in refuse layers at Mesolithic and Neolithic settlements (e.g. Noe-Nygaard 1998: Plate 49.4-6). It must have been produced during skinning or butchering of the animal.

Stratigraphy and chronology

The Late Glacial freshwater sediments in the coastal cliff at Nørre Lyngby have been subjected to scientific study on repeated occasions over almost the last century and a half. The available data on the sedimentary elements, genesis and chronology are summarised in Figure 12. The lacustrine succession is initiated by coarse sand and gravel (unit A), probably deposited in shallow water, then follows dark clay (unit B), deposited in deeper water, alternating sand and clay (unit C), deposited in a lacustrine environment during episodic input of aeolian sand, and finally sand (unit D), deposited in shallow lacustrine conditions during frequent input of aeolian sand.

The freshwater deposits contain much faunal and floral material, of which several samples have been ^{14}C dated (Krog 1978; Aaris-Sørensen 1995; cf. Fig. 13). Comparison with the pollen data from the layers in question reveals that most of the large pieces of wood, bone and antler are clearly older than the formation of the sediments in which they were found (Krog 1978; Aaris-Sørensen 1995). The twig fragments are up to several centimetres in length (Bondesen & Lykke-Andersen 1978; cf. Iversen 1967: Fig. 345) and there are bone and antler fragments of several decimetres in length. Krog (1978) and Aaris-Sørensen (1995) explain this in terms of re-deposition, combined with erosion of adjacent older deposits. This explanation is supported by remarks made by Jessen (1915). He writes that "there was always a clay cliff along the

Stratigraphic unit	^{14}C years BP	Calibrated age (cal years BP, 95.4 % confidence interval)	δ^{13}C (VPDB)	% collagen	% C (bone samples)	Sample type	Lab. no.
C	11 190 ± 135	13 320-12 729	-18.3			Bone, *Rangifer tarandus*	K-6189
C	11 340 ± 120	13 444-12 926	-27.3			Wood, *Salix*	AAR-1507
C	11 370 ± 165	13 629-12 869	-17.7			Bone, *Rangifer tarandus*	K-6188
B	11 260 ± 120	13 388-12 833	-27.3			Wood, *Salix*	AAR-1508
A	11 120 ± 160	13 291-12 668	-17.1	2.8	13.0	Bone, *Rangifer tarandus*	AAR-1908
A	11 180 ± 130	13 307-12 730	-17.8	6.0	23.6	Bone, *Rangifer tarandus*	AAR-1909
A	11 190 ± 100	13 291-12 785	-18.3	7.1	25.9	Bone, *Rangifer tarandus*	AAR-1910
A	11 230 ± 150	13 383-12 739	-29.6			Wood, *Salix*	AAR-1510
A	11 570 ± 110	13 710-13 223	-17.9	9.3	23.0	Bone, *Rangifer tarandus*; with man-made cut marks (Fig. 11)	AAR-1511
A	11 590 ± 130	13 751-13 213	-29.0			Wood, *Salix*	AAR-1509

Fig. 13. ^{14}C dates for terrestrial material from the upper parts of the freshwater deposits in the Nørre Lyngby basin. After Aaris-Sørensen 1995. For the samples measured at the AMS ^{14}C Dating Centre, Aarhus University (AAR-#), the carbon yield percentage was measured as the yield of combustion of the prepared collagen to CO_2. For well-preserved bone, the typical collagen yield is greater than 2-5 % and the C yield from collagen is 20-30 %.

Abb. 13. *^{14}C-Daten für terrestrisches Material aus den oberen Bereichen der Süßwasser-Ablagerungen im Nørre Lyngby-Becken. Nach Aaris-Sørensen 1995. Für die am AMS ^{14}C-Labor der Universität Aarhus (AAR-#) untersuchten Materialproben wurde der Kohlenstoffgehalt als Ertrag aus der Verbrennung des präparierten Kollagens zu CO_2 gemessen. Für gut erhaltenen Knochen liegt der typische Kollagengehalt über 2 – 5 % und der Kohlenstoffgehalt des Kollagens bei 20 – 30 %.*

northern shore of the lake, also while the upper sand layers were deposited", and from where "pea-sized, rolled bodies of clay" were transported out into the lake sediments. With respect to the northern shore, he adds that "it appears that the clay was so saturated by the water that it was not able to bear its own weight but flowed into the lake". Aaris-Sørensen (1995) also mentions that "the bones are generally well preserved, although many of them show signs of having been slightly to strongly rolled by water".

Sand deposits in the upper part of the stratigraphic succession, presumably corresponding to units C and D, were dated by optically stimulated luminescence (Strickertsson & Murray 1999). The dates obtained of 14 300 ± 1200 years (lower sample) and 10 000 ± 700 years (upper sample) are associated with such a level of uncertainty that they merely confirm the Late Glacial age of the lake deposits.

Judging from the photo (Fig. 14) and the descriptions of the stratigraphy published by Jessen & Nordmann (1915), the flint point was either found in the upper part of Aaris-Sørensen's unit C or the lower part of unit D. Its heavily worn surface (cf. above) shows that it did not become incorporated into the deposit in question immediately after it had been used by humans. The Younger Dryas pollen date for the deposit in which the artefact was found (Iversen 1942, 1948) does not, accordingly, constitute a secure basis on which to establish the chronological position of the Bromme culture with respect to the climatic periods of the Late Glacial. The flint tip could originate from any point in time between the Late Bølling and the (Late) Younger Dryas. Considering its size, it most likely comes from the middle or late part of the Allerød period, like the similarly large and heavy faunal remains from units A - C that have been subjected to ^{14}C dating.

In typological terms, Bromme points of this large, robust size, with a partially preserved platform remnant, appear to belong to the early part of the Bromme culture (Fischer 1978; Madsen 1983; Fischer & Nielsen 1987; Johansson 2003; cf. Pedersen & Petersen 2006; Pedersen 2009; Fischer et al. 2013). No radiometric dates are available from this phase and it is therefore only possible to conclude that it is typologically earlier than the assemblages from Trollesgave and Fensmark, which are dated to the end of the Allerød period (cf. below).

The relationship of the reindeer antler axe to the stratigraphy at the site is uncertain as it was found in material that had slid out from the cliff. In this respect, the most important clue is the comment that the axe at the time it was found "... was permeated by the clay of which the cliff consists" (Svendsen 1897), and that it

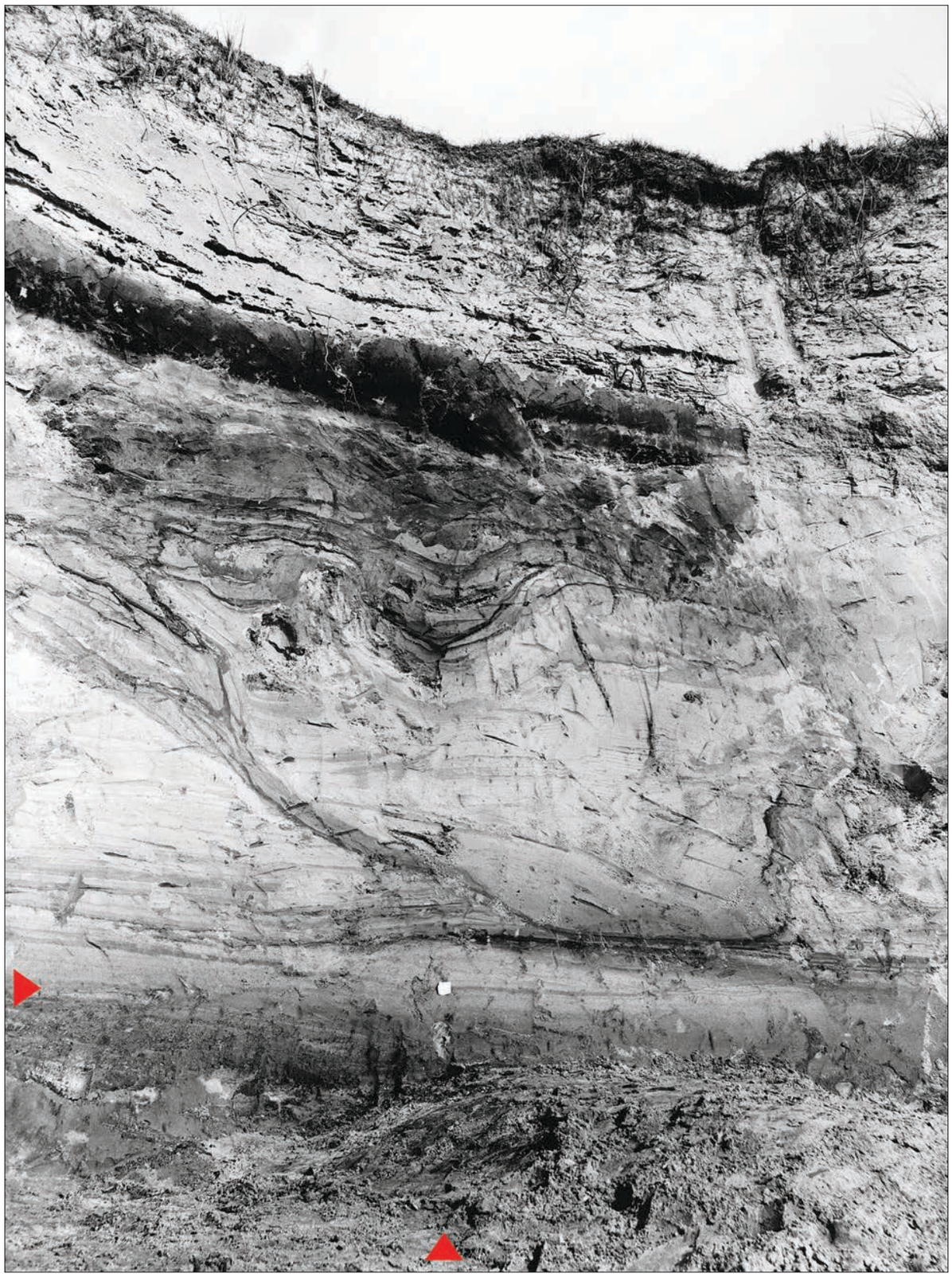

Fig. 14. Find site for the flint point marked with a square piece of paper (the arrows at the edges of the photograph mark the spot). The photo was taken by botanist and archaeologist Georg Sarauw who visited and carried out investigations at the site on repeated occasions between 1908 and 1925.

Abb. 14. *Die Fundstelle der Feuerstein-Geschossspitze ist mit einem quadratischen Blatt Papier markiert (die Pfeile an den Rändern des Fotos markieren die Stelle). Das Foto wurde vom Botaniker und Archäologen Georg Sarauw gemacht, der den Platz in den Jahren von 1908 bis 1925 wiederholt aufsuchte und Untersuchungen durchführte.*

Locality	^{14}C BP	Calibrated age (95.4 % confidence interval)	δ^{13}C (VPDB)	% col.	% C	% N	Lab. no.	Ref.	Comments – potential error sources
Scania	*< 0!!*		-21.4				OxA-2794	Larsson 1996 & pers. comm. 2012	Unknown whether the piece has been conserved; visual inspection in advance of sampling revealed no signs of conservation
Nørre Lyngby, second attempt 1	*6 573 ± 30*	7 559-7 426	-18.2	2.0	39.5	12.7	AAR-16622,1		Conserved, possibly several times with materials of significantly differing ^{14}C age; two rounds of decontamination to remove conservation materials
Nørre Lyngby, second attempt 3	*6 687 ± 35*	7 613-7 488	-17.7	2.0	39.5	12.7	AAR-16622,3		Conserved, possibly several times with materials of significantly differing ^{14}C age; two rounds of decontamination to remove conservation materials
Nørre Lyngby, second attempt 2	*8 710 ± 41*	9 886-9 546	-19.4	2.1	40.0	14.1	AAR-16622,2		Conserved, possibly several times with materials of significantly differing ^{14}C age; "ordinary" pre-treatment without decontamination to remove conservation materials
Nørre Lyngby, second attempt 4	*8 815 ± 47*	10 115-9 682	-19.7	2.1	40.0	14.1	AAR-16622,4		Conserved, possibly several times with materials of significantly differing ^{14}C age; "ordinary" pre-treatment without decontamination to remove conservation materials
Bara Mosse	*9 090 ± 90*	10 512-9 928	-20.8				OxA-2793	Larsson 1996 & pers. comm. 2012	Unknown whether the piece has been conserved; visual inspection in advance of sampling revealed no signs of conservation
Nørre Lyngby, first attempt	*9 110 ± 65*	10 486-10 182	-19.1	2.7	25.3		AAR-8919	Stensager 2004	Conserved, possibly on several occasions with materials of significantly differing ^{14}C age; one round of decontamination to remove conservation materials
Earls Barton	10 320 ± 150	12 587-11 411					OxA-803	Cook & Jacobi 1994	Type identification open to discussion
Arreskov	10 600 ± 100	12 705-12 146	-19.4	9.3	39.0	12.6	OxA-3173; Bradford ACQ293	Fischer 1996	Not conserved prior to sampling
Odense Kanal	*10 815 ± 65*	12 879-12 581	-18.6	16.3	27.3		AAR-9298	Stensager 2006	Apparently boiled in wax
Mikkelsmossen	10 980 ± 110	13 108-12 641	-19.4				OxA-2791	Larsson 1996 & pers. comm. 2012	Not conserved prior to sampling; type identification open to discussion
Klappholz	11 560 ± 110	13 698-13 205	-19.2	16.9	23.7		AAR-2785	Clausen 2003	Not conserved prior to sampling

Fig. 15. Absolute dates for reindeer antler axes from NW Europe, arranged according to ^{14}C date. The ages in italics were obtained for samples which were possibly contaminated with conservation materials. For AAR numbers ≤ 9 298, the collagen and carbon (C) yield for well-preserved bone is typically > 2 % and 20 %, respectively. For AAR numbers > 9 298, good quality bone samples have carbon and nitrogen (N) yields within the ranges 30-45 % and 10-20 %, respectively.

Abb. 15. *Absolute Datierungen von Rentiergeweihbeilen aus NW-Europa, geordnet nach ^{14}C-Alter. Die kursiv gesetzten Altersangaben ergaben sich für Materialproben, die möglicherweise mit Konservierungsmitteln kontaminiert waren. Für die AAR-Nummern ≤ 9 298 ist der Kollagen- und Kohlenstoff-(C)-Gehalt für gut erhaltenen Knochen typischerweise > 2 % bzw. 20 %. Für AAR-Nummern > 9 298 haben Knochenproben von guter Qualität C- und Stickstoff-(N)-Werte innerhalb eines Bereiches von 30 – 45 % bzw. 10 – 20 %.*

"lay in clay slurry at the foot of a high blue-clay slope facing the sea" (Sarauw 1903: 304, on the basis of information from the finder). Consequently, it was not washed ashore but must originate from the cliff. The find site is only given in very imprecise terms, clearly due to a lack of well-defined geographic fix-points. It is merely stated that the axe was found within a c. 300 m long stretch extending northwards from the middle of the freshwater basin. However, the antler could only have survived due to it being incorporated into a calcareous wetland deposit. The section of cliff in question contains no Late Glacial and post-glacial wetland deposits other than the lake basin dealt with here. If the information that the artefact was smeared in clay (Svendsen 1897) can be taken as reliable, this suggests it was incorporated into layer B which, in

Stratigraphic unit	Grain size			Microscopic investigation
	Moment mean (mm)	Moment sorting	Moment skewness	
D	0.23 Fine sand; typical of aeolian sand	0.48 Well-sorted; typical of aeolian sand	0.08 Symmetrical; most aeolian sand is finely-skewed	Mostly quartz; many rounded and sub-rounded grains, some with aeolian impact marks
C, middle	0.13 Fine sand; much finer than most aeolian sand	1.23 Poorly-sorted; less well-sorted than typical aeolian sand	3.62 Very finely-skewed; typical of aeolian sand	Mostly quartz; many angular and sub-angular grains, but also a few sub-rounded grains
C, bottom	0.09 Very fine sand; much finer than most aeolian sand	1.52 Poorly-sorted; less well-sorted than typical aeolian sand	2.75 Very finely-skewed. Typical of aeolian sand	Mostly quartz; many angular or sub-angular grains, but also a few sub-rounded grains

Fig. 16. Analytical data and evaluation of sand samples from Nørre Lyngby.

Abb. 16. *Analysedaten und Auswertung von Sandproben aus Nørre Lyngby.*

turn, indicates a date in the Allerød period (cf. Fig. 12). Alternatively, it could come from a clay stripe in stratigraphic unit C.

Scientific investigations of the basin have demonstrated that large faunal remains cluster along its northern shore (Jessen & Nordmann 1915; Aaris-Sørensen 1995). Where these have been dated, they have proved to be from the Allerød period (Fig. 13). Many of them clearly bear the effects of water rolling (Aaris-Sørensen 1995), as does the reindeer antler axe (cf. description and photos above). On the basis of the available data we therefore consider it likely that the tool originates from layer B or C in the freshwater basin, and that it is of Late Glacial age, most probably within the interval 11 600 to 11 100 ^{14}C BP (ca. 13 200 calBP), in common with the other ^{14}C-dated faunal remains from the basin. This date would also be consistent with the other dates for unconserved Lyngby axes from NW Europe (Fig. 15).

It was therefore a surprise when, some years ago, the reindeer antler axe was dated to 9 110 ± 65 ^{14}C BP (10 486 - 10 182 calBP, 95.4 % confidence interval) (Stensager 2004; cf. Petersen 2009) (Fig. 15; AAR-8919). If this date is to be believed, the artefact would be one of the absolutely latest dated reindeer remains from Southern Scandinavia (Aaris-Sørensen 2009). However, it was apparent from the cavity left by removal of the dating sample that a large proportion of the material drilled out consisted of conservation wax. Even though the sample was subjected to a pre-treatment involving chemical decontamination, it is therefore to be feared that the date was erroneous due to residual traces of conservation wax. The latter could for example be carnauba wax, produced from recent vegetable wax, which was popular in the past with conservators at Danish museums. In order to test this suspicion, a new dating sample was taken from where the tissue was more compact and where it could be assumed that the artefact's collagen content was particularly well-preserved. The sample was divided into two parts which were then subjected to different decontamination procedures and subsequently AMS dated. This resulted in four dates (Fig. 15) which are far from mutually consistent. The simplest and most obvious interpretation of these assay results is that the tool dates from c. 6 600 ^{14}C BP (app. 7 500 calBP) and that there is contamination with older material. This explanation must, however, be rejected on two counts: Firstly, because there are no wetland deposits from the relevant period (Atlantic times) at the find site. Secondly, reindeer had long since disappeared from Denmark by this time (Aaris-Sørensen 2009; cf. Liljegren 1975: 26).

Accordingly, none of the presently available ^{14}C dates for the Lyngby axe can possibly represent its actual age. The dates were presumably influenced by conservation material which could not be removed completely with the preparation methods employed. In this respect, attention is drawn to the fact that the axe could have been subjected to conservation on several occasions and that it could have been treated with materials based on both recent beeswax and fossil oils.

The dating of the reindeer rib with the cut mark to 11 570 ± 110 ^{14}C BP (Aaris-Sørensen 1995) appears unproblematic. The information received from the Zoological Museum, University of Copenhagen, (Kristian Gregersen pers. comm. 2012) is that the object was not conserved at the time of sampling. Neither do the measurements of its collagen content and percentage carbon (Fig. 13) give reason to suspect that the date is erroneous. Accordingly, this ^{14}C date bears witness to human presence by the freshwater basin during the Allerød period (cf. Fig. 19).

The natural environment at the Nørre Lyngby lake

Thanks to the many scientific analyses carried out on the freshwater deposits at the site it is possible to say a great deal about the landscape which surrounded the people of Allerød times when they spent time by the Nørre Lyngby lake. Judging from the finds of plant macro-remains, the vegetation was dominated by open-habitat species such as *Salix herbacea* (dwarf willow), *Salix polaris* (polar willow), *Dryas octopetala* (mountain avens) and *Arctostaphylus* sp. (bearberry/ alpine bearberry) (Nordmann 1915a). These are pioneer species which are found today in

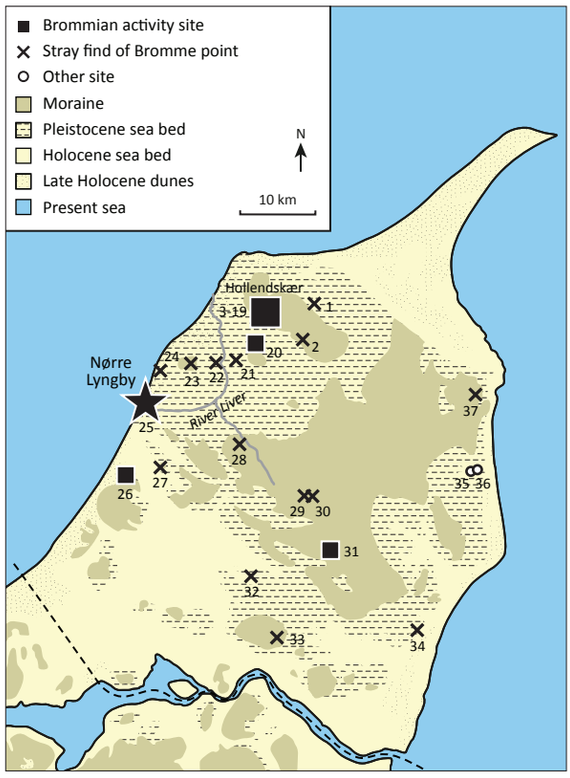

Fig. 17. Late Glacial find sites from Vendsyssel (cf. Fig. 21), shown in relation to the genesis of the surface terrain. The activity sites typically comprise one or more Bromme points together with other activity indicators such as flint debitage, scraper(s) and/or burin(s), found within an area of maximum 50 m in diameter. The two other localities are characterised by sporadic occurrences of saltwater-leached and/or beach-rolled flint flakes at locations in the landscape not reached by the sea since the last ice age.

Abb. 17. *Spätglaziale Fundplätze aus Vendsyssel (siehe Abb. 21) im Vergleich zur Genese des Terrains. Die Aktivitätsplätze enthalten typischerweise eine oder mehrere Bromme-Spitzen zusammen mit anderen Aktivitätsindikatoren wie Feuerstein-Abschlägen, Kratzer(n) und/oder Stichel(n), die in einem Areal von maximal 50 m Durchmesser gefunden wurden. Die beiden anderen Fundorte zeichnen sich durch sporadisches Auftreten von in Salzwasser ausgelaugten und/oder am Strand verrollten Feuerstein-Abschlägen an Plätzen, die seit der letzten Eiszeit nicht mehr vom Meer erreicht wurden, aus.*

Scandinavian mountain areas (Fremstad 1997). The pollen data indicate similarly that the locality, and Northern Jutland in general, was characterised by low, open vegetation (Iversen 1942; Krog 1978).

In terms of its vegetation, Vendsyssel apparently contrasted with other parts of Denmark to the south and east where birch woodland dominated the landscape, especially in the latter part of the Allerød period (Mortensen et al. 2011). The largest shrubs/small trees recorded from Nørre Lyngby are *Salix* cf. *phylicifolia* (tea-leaved willow) (Jessen 1915) together with *Hippophaë ramnoides* (sea-buckthorn) and *Juniperus communis* (common juniper) (Iversen 1942; Krog 1978). The thickest willow branches observed had a diameter of 28 mm and it is reported that many branches and twigs bore evidence of gnawing by beavers (Jessen & Nordmann 1915). One must therefore imagine stands of willow scrub at the lake margin where the local beaver population foraged, while the surrounding terrestrial areas for the most part hosted pioneer plants in the form of herbs and low shrubs. Even though no evidence has been found of tree birch, it is possible that there could have been small enclaves of birch woodland in particularly favourable and sheltered locations (cf. Mortensen et al. 2011). A mosaic-like landscape such as this would explain the distinctive fauna, for which there are no modern parallels, which Aaris-Sørensen (1995) has described on the basis of the bone assemblage recovered from the site. Today, the majority of the fauna represented in the Nørre Lyngby basin is associated either with the Boreal forest or areas of steppe (Nordmann 1915a; Aaris-Sørensen 1995).

In Allerød times people apparently experienced a somewhat cooler climate in Vendsyssel than further to the south and east within the distribution area of the Bromme culture. Temperature reconstructions based on insect remains recovered from the lake deposits give an average July temperature of between 9 and 11 °C (Coope et al. 1998). The flora, including species such as *Hippophaë ramnoides* (sea-buckthorn), *Typha latifolia* (bulrush) and *Nuphar lutea* (yellow water-lily), indicates a slightly higher average temperature, i.e. between 11 and 13 °C (Bos et al. 2006). The same is seen from the mollusc fauna, which includes *Anodonta cygnea* (swan mussel), indicating July temperatures of 13 to 14 °C (Nordmann 1915a).

The transition from the Allerød period to the Younger Dryas can be fixed, on the basis of the pollen data, to the shift between the dark clay gyttja (stratigraphic unit B) and the immediately overlying sequence of clay and sand, stratigraphic unit C (cf. Iversen 1942; Krog 1978). The change in sediment composition at this point in time must be seen as an expression of a marked change in the local natural environment. Jessen & Nordmann (1915) perceived the sand in stratigraphic units C and D as being the result of aeolian sand drift, in which case the environment at Nørre Lyngby began to become markedly less hospitable, seen from a human point of view, already early in the Younger Dryas.

Jessen and Nordmann's interpretation of the sand layers has been tested on the basis of three sand samples taken, respectively, from the base and the middle of stratigraphic unit C and from the base of unit D. The samples were subjected to particle-size analysis and microscopic examination, which led to the following conclusion (cf. Fig. 16): A large proportion of unit D comprises wind-transported (aeolian) material, and the same applies to smaller parts of unit C. The source of the aeolian sand is unknown, but it could be reworked Late Glacial marine (beach) sand blown into the lake by strong westerly winds (cf. Brauer et al. 2008).

Fig. 18. Selection of stray finds of Bromme points from Vendsyssel (cf. Fig. 21). These artefacts differ greatly in colour and surface character due to post-depositional processes such as precipitation of iron compounds (golden colour) and leaching. The skimmed-milk and "veined" appearance which characterise g and i are only seen on Late Glacial artefacts from this part of the country. Scale in cm.

Abb. 18. *Auswahl an Streufunden von Bromme-Spitzen aus Vendsyssel (siehe Abb. 21). Diese Artefakte unterscheiden sich stark in Farbe und Oberflächencharakter aufgrund von nach der Ablagerung erfolgten Prozessen wie der Ausfällung von Eisenkomponenten (goldene Farbe) und Auslaugung. Der milchige und geaderte Eindruck, der g und i kennzeichnet, wird nur auf spätglazialen Artefakten aus diesem Landesteil festgestellt. Maße in cm.*

A northern outpost on the west coast of Europe

It is not possible, on the basis of the available data, to determine whether the three artefacts from the Nørre Lyngby site result from three distinct episodes of sporadic human presence or whether they represent traces of one or more actual settlements. Nevertheless, the presence of these three definite cultural traces means that the remains of large mammals found at the locality can be seen as potentially resulting from hunting episodes or actual settlement, regardless of whether or not they show clear signs of marrow-fracturing, butchering etc. (cf. Aaris-Sørensen 1995). Attention should probably be focussed in particular on the assemblage's 32 reindeer

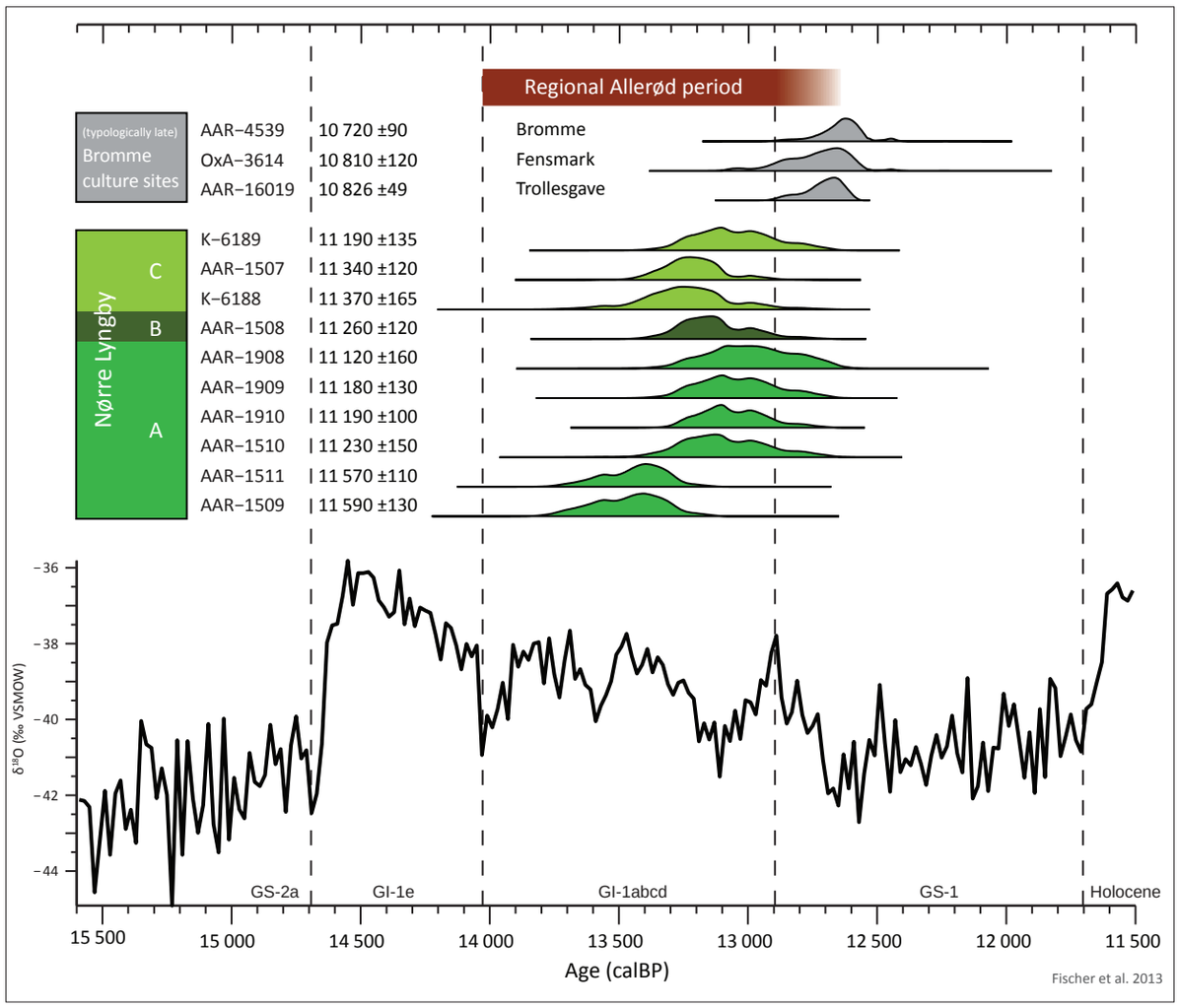

Fig. 19. Comparison of three AMS ^{14}C dates for activity sites from typologically late Bromme culture, dates for reindeer bones from Nørre Lyngby and climatic data from Greenland ice cores. The designations for the generally colder periods begin with GS (Greenland Stadial), while the names of the generally warmer periods begin with GI (Greenland Interstadial) (Björck et al. 1998; Blockley et al. 2012).

Abb. 19. *Vergleich von drei AMS ^{14}C-Daten für Aktivitätsplätze aus typologisch später Bromme-Zeit, Datierungen von Rentierknochen aus Nørre Lyngby und Klimadaten aus grönländischen Eisbohrkernen. Die Bezeichnungen der grundsätzlich kälteren Perioden beginnen mit GS (Greenland Stadial), wohingegen die Namen der grundsätzlich wärmeren Perioden mit GI beginnen (Greenland Interstadial) (Björck et al. 1998; Blockley et al. 2012).*

bones, of which four have been ^{14}C dated to within such a very narrow interval that, in statistical terms, they could be coeval (11 190 to 11 120 ^{14}C BP; see Fig. 13). It should also be noted that the reindeer bones cluster in the same general area in which the tanged point and the incised reindeer rib were found. A bone of *Ursus arctos* (brown bear), found among the faunal remains from the locality (Bondesen & Lykke-Andersen 1978), can perhaps also be considered as a consequence of the activities of hunters at the site.

An assemblage recovered from kettlehole deposits at Hässleberga in Scania can perhaps function as an interpretative model for the Nørre Lyngby finds. Digging of crayfish ponds at this Southern Swedish locality led to the collection of a few flint artefacts of Late Glacial character and a large number of faunal remains, including reindeer, wild horse and elk from Late Glacial lake deposits. Two fragments of reindeer antler show traces of deliberate working (Larsson 2012). ^{14}C dates assign the bones to the Allerød period and Younger Dryas. Three bones of reindeer and one of wild horse show cut marks which appear to be the result of skinning or butchering. The whole assemblage is interpreted as waste from hunting episodes, with the hunters taking away the skin and meat, but leaving behind the bones in a state which is difficult to distinguish from the remains of animals that died of natural causes (Larsson et al. 2002; Larsson 2008).

In any circumstances, it seems there was a great deal of human activity in the Late Glacial landscape around Nørre Lyngby (Figs. 17 & 18). Even though this area has not been particularly well surveyed for remains of Late Palaeolithic date, NW Vendsyssel is one of the parts of Denmark best represented by finds from the Bromme culture (Fischer 1985; Nilsson 1989; Eriksen 2002). They consist primarily of stray finds of

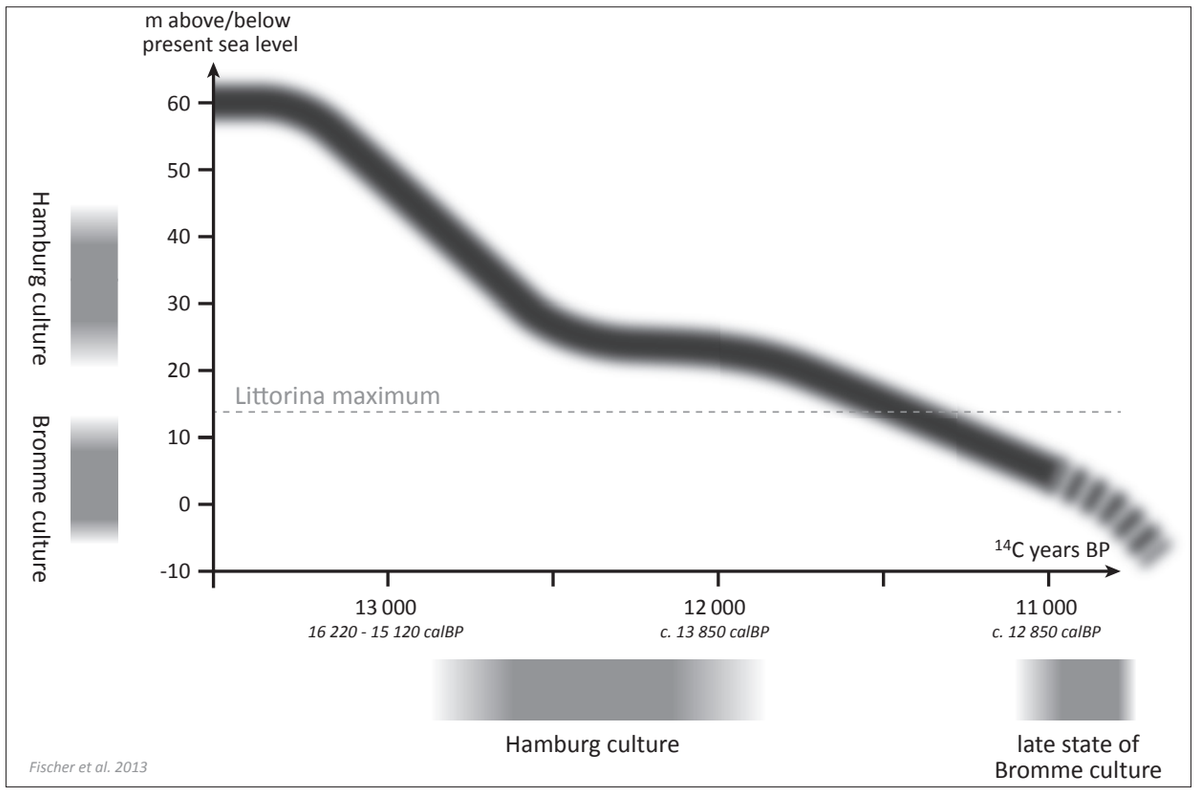

Fig. 20. Relative sea-level curve for Northern Vendsyssel on the stretch from Hirtshals to Frederikshavn.
Abb. 20. *Kurve des relativen Meeresspiegels für das nördliche Vendsyssel auf der Strecke von Hirtshals nach Frederikshavn.*

tanged points that happen to have come to the attention of the local museum. There are also several flint assemblages in which retouched flint tools are dominated by tanged points and lithic production waste is scarce or non-existent (e.g. the Stentinget, Ramsgård and Varbro sites). These sites, all located relatively high up in the landscape, appear to be special purpose camps associated with the hunting of large game (cf. Fischer 1991; Donahue & Fischer in press). Possible residential sites, similar to those at Bromme *locus classicus*, Trollesgave and Stoksbjerg Vest IV (cf. Fischer 1991; Johansson 2003; Donahue & Fischer in press) have as yet not been detected in Vendsyssel. This may, however, simply be due to a lack of dedicated survey activity in low-lying areas of the kind where Bromme culture settlements of this kind are usually found when carefully searched for (Fischer 1985, 1991, 2013).

Distinguishing Bromme culture flint artefacts from those of other Stone Age cultures is a challenging undertaking and not always achievable, even for scholars very familiar with flint artefact morphology and the lithic technology involved, as well as the leaching and bleaching that characterises Late Palaeolithic find assemblages (Fischer 1985; Petersen 2006; Pedersen 2009, 18-19). The present paper only includes those finds for which a date other than Late Palaeolithic can, in our experience, be excluded. Consequently, museum collections potentially include an even greater number of Late Palaeolithic artefacts from Vendsyssel than shown in Figure 17 and listed in Figure 21.

In Himmerland, which lies immediately to the south and which, in terms of area and archaeological research, appears to be directly comparable with Vendsyssel, the Bromme culture is only represented by two stray finds of flint points (Hansen 1984). The other Late Palaeolithic techno-complexes demonstrated in Denmark (Hamburg, Federmesser and Ahrensburg) are, on the other hand, presently not represented by definite typologically identifiable artefacts in Vendsyssel. However, sporadic finds of beach-rolled worked flint (localities 35 and 36 on Figs. 17 and 21) could suggest that the area was frequented by humans earlier in the Late Glacial. These two sites lay at the mouth of a fjord during the time of the Hamburg culture (cf. Nielsen et al. 1988), and have not been reached by the sea since then.

An important area yielding finds from the Bromme culture lies around the valley of Hollendskær. Since 1983, 15 small accumulations of finds have been located here, characterised by an extremely small amount of flint debitage, and in which Bromme points constitute a significant part of the tool inventories

Locality	Case no. and/or accession no.	Site no.	Comments	Fig. 17	Fig. 18	References
Stray finds of Bromme points						
Aså-Melholt parish	VHM 1941/96	100202		34	f	Nilsson 1989
Flade parish	VHM 1081	100303	Recorded in accession list in 1889	37	a	Nilsson 1989
Frydslund	VHM 1976/1	100611-49		21		Nilsson 1989
Jerslev	VHM 3978	100106	Recorded in accession list in 1884	29	b	Nilsson 1989
Jerslev parish	VHM 11156	100106		30	c	
Klokkerholm?	VHM 58/1990		Found in secret compartment in old wall cupboard			
Kraghede	VHM 1996/7	100119		32		
Mygdal	VHM 00384	100608-80		1		
Rubjerg Knude	VHM 00387	100609-53	A.D. Johansson RKN25	24		
Storemose	VHM 22/1996; 1996/6	120605-80		33		
Vendsyssel (?)	VHM 25/1996; 1996/10		No information on provenance, probably from Vendsyssel			
Vennebjerg parish	VHM 12	100618	Recorded in accession list in 1889	23	d	Nilsson 1989
Vennebjerg parish	VHM 81/1989	100618		22		Nilsson 1989
Vrensted parish	VHM 13339	100117		27	h	Nilsson 1989
Vrå parish	VHM 22630	100118		28	g	Nilsson 1989
Astrup parish	VHM 3487	100602		2	e	Nilsson 1989
Activity sites from the Bromme culture						
Hovbak	VHM 00382	100603-97	2 scrapers, 1 flake	3		
Højvælde	VHM 295/1987; VHM 1995/1-2	100605-41	2 robust tanged points,1 scraper	20		Nilsson 1989
Kærgård Nord	VHM 00385	100603-99	2 robust tanged points, a few flakes	4		
Kærgård Syd	VHM 00386	100603-98	5 robust tanged points, 1 scraper, a few flakes	5		
Nørre Lyngby	NM1, A16678 + A31405	401108-3	Reindeer antler axe, robust tanged point, reindeer rib with cut mark	25		Müller 1896; Jessen & Nordmann 1915; Aaris-Sørensen 1995
Ramsgård I	VHM 285/1986	100603-70		6		Nilsson 1989
Ramsgård II	VHM 286/1986	100603-71		7		Nilsson 1989
Ramsgård III	VHM 290/1986	100603-69		8		Nilsson 1989
Ramsgård IV	VHM 292/1986	100603-74		9		Nilsson 1989
Ramsgård V	VHM 453/1986	100603-72		10		Nilsson 1989
Ramsgård VI	VHM 159/1988	100603-100		11		Nilsson 1989
Ramsgård VII	VHM 160/1988	100603-101		12		Nilsson 1989
Ramsgård VIII	VHM 361/1988	100603-102		13		Nilsson 1989
Ramsgård IX	VHM 362/1988	100603-103		14		Nilsson 1989
Stentinget	VHM283/1989; 1989/55; 1999/3007-3015	100205-165	4 robust tanged points, 2 scrapers	31		
Trudslev	VHM 153/1988	100404-60	1 robust point, 2 burins	26		Nilsson 1989
Varbro I	VHM 155/1988	100603-93		15		Nilsson 1989
Varbro II	VHM 151/1988	100603-94		16		Nilsson 1989
Varbro III	VHM 157/1988	100603-95		17		Nilsson 1989
Varbro IV	VHM 158/1988	100603-75		18	i	Nilsson 1989
Varbro V	VHM 00390	100603-96	1 scraper, 1 burins, a few flakes	19		
Other localities						
Sæbygårdsvej	VHM 00383	100214-203	blade, unilaterally crested; beach-rolled and saltwater-leached	35		
Sæbygård	VHM 389/1985	100214-164	Beach-rolled flint flake, undatable; mixed with a large Mesolithic assemblage that is not beach-rolled	36		

Fig. 21. Late Palaeolithic finds from Vendsyssel. Site no. in the Danish Agency for Culture's archaeological database "Sites and Monuments" (http://www.kulturarv.dk/fundogfortidsminder/).

Abb. 21. *Spätpaläolithische Funde aus Vendsyssel. Ortsaktennummer in der archäologischen Datenbank „Fundplätze und Monumente" der dänischen Behörde für Denkmalpflege (http://www.kulturarv.dk/fundogfortidsminder/).*

(Nilsson et al. 1988; Nilsson 1989; Fischer 2012b). To date (Oct. 2012), the Late Glacial finds from these small sites include a total of 73 robust tanged points (excluding examples which have been further worked into scrapers and burins).

The absolute dates for the Bromme culture and its position relative to climatic developments have long been extremely unclear (Eriksen 1999; Pedersen 2009), but new examinations of existing finds have revealed some clues (cf. Fig. 19; see also Riede &

Edinborough 2012). The locality of Trollesgave (Fig. 1; Fischer 1990) must, on the basis of a recent series of AMS ^{14}C assays, be dated to around 10 826 ± 49 ^{14}C BP (12 871-12 590 calBP, 95,4 % confidence interval) (AAR-16019), and pollen analysis from the site has demonstrated that, in biostratigraphic terms, the deposit with cultural material *in situ* belongs to a late part of the Allerød period (Fischer et al. 2013). Typologically, the flint assemblage is seen as being from a relatively late part of the Bromme culture (Fischer 1978). There is also an AMS date of 10 810 ± 120 ^{14}C BP (13 065 - 12 543 calBP, 95,4 % confidence interval) (OxA-3614) from the Fensmark locality (Fig. 1), which is close typologically to Trollesgave (cf. Fischer 2013). Similarly, there is a date for a fragmented elk bone from a low-lying (refuse) area at the Bromme *locus classicus* of 10 720 ± 90 ^{14}C BP (12 860 - 12 431 calBP, 95,4 % confidence interval) (AAR-4539). Pollen analysis of sediment remains from the surface of the bone bear witness to a relatively mild environment at the time of deposition which, in combination with the AMS date, indicates a position in the Late Allerød period (Fischer et al. 2013). Figure 19 shows that these three AMS dates for assemblages from the Bromme culture lie in an early part of the generally cold GS-1 period. This period term, which originates from investigation of ice cores from the Greenland ice cap, cannot be regarded as being directly synonymous with the term Younger Dryas. The former term is defined on the basis of climatic indicators of presumed global character (Rasmussen et al. 2006), whereas the latter is a regional biostratigraphical term based on plant macro-remains found in lacustrine deposits in Southern Sweden and Denmark (Nathorst 1871; Hartz & Milters 1901).

It seems that the ecosystem of the Allerød period in Denmark survived the first couple of centuries of Greenland Stadial 1 (GS-1) (Mortensen et al. 2011; cf. Brauer et al. 2008). It possibly continued right up until c. 12 650 calBP, after which the Younger Dryas vegetation took over (Andersen et al. 2000). Accordingly, there is no contradiction in the three dates for the Bromme culture being assigned, in pollen-analytical terms, to the regional Allerød vegetation period while, at the same time, via ^{14}C dating, being assigned to the global climatic period GS-1.

Therefore, in summary, it can be concluded that a typologically late part of the Bromme culture existed at the end of the Allerød period, when large parts of its territory were covered by open birch woodland. Similarly, it can be concluded that the ^{14}C-dated reindeer bones from Nørre Lyngby (Fig. 13), including the rib with the cut mark, are several centuries older. In absolute years, they belong to the middle and, in particular, the later part of the GI-1 period (Fig. 19), and in terms of vegetation history they date from the middle of the Allerød period. From a typological point of view (Fischer 1978), and in the light of the above-mentioned date for the Trollesgave assemblage, it is likely that the Nørre Lyngby flint projectile point also originates from this part of the climatically relatively mild Allerød period (Fig. 19).

In terms of settlement history, the Late Palaeolithic finds from Nørre Lyngby are far from one-offs; there was a significant human presence in the Vendsyssel landscape of the time. The subsistence base would probably have included more than just reindeer. Other terrestrial species of large game, such as beaver, elk, giant deer, brown bear and polar bear, would also certainly, or very probably, have been present in the area (Aaris-Sørensen & Petersen 1984; Aaris-Sørensen 2009) and would doubtless have been hunted by humans. The human subsistence base perhaps also included marine resources in the form of shellfish, fish, seals and whales, which were apparently all present in abundance in the sea off the Vendsyssel coast of the time (Krog & Tauber 1974; Petersen 1984; Aaris-Sørensen 2009; Aaris-Sørensen et al. 2010).

The location of the marine coastline during the Bromme culture can be approximately established (Petersen 1984) (Fig. 20). At Hirtshals, just less than 25 km north of Nørre Lyngby, the sea level at that time (c. 11 000 ^{14}C BP) lay 5 - 10 m above that of today. Due to land-tilting, the contemporary coastline at Nørre Lyngby is found almost 18 m lower in the terrain (Richardt 1996).

Even though the coastline of the Bromme culture now occurs above sea level in the northernmost part of Vendsyssel, no optimistic expectations should be held with respect to demonstrating intact beach formations and possible associated coastal settlements from the period in the area. On stretches of coast directly exposed to waves from the open sea, deposits of this type will, to a very great extent, have been erased by the Littorina Sea. Around 6 400 ^{14}C BP (c. 7 200 calBP) the latter reached a level of 13 m above the present sea level in Northern Vendsyssel (on the stretch from Hirtshals to Frederikshavn; Christensen & Nielsen 2008) and about 9 m above sea level at Nørre Lyngby (Mertz 1924). The greatest chances of finding intact coastal deposits with possible Late Palaeolithic cultural remains are to be expected where there were bays and inlets in the coast, which significantly reduced wave erosion and gave the possibility of Late Glacial layers becoming sealed beneath later layers. Northern and eastern parts of Vendsyssel seem to have areas of this kind – and the same is undoubtedly true, and to an even greater extent, of areas on the present seabed further to the south and east of Denmark.

An examination of the distribution of Late Glacial finds from NW Europe reveals that the area around Nørre Lyngby plays a very special role. Despite persistent attempts through numerous decades it has not proved possible to demonstrate human presence in Norway during the time of the Bromme culture or earlier (Bjerck 1995; Eigeland 2012; Fischer 2012a). To the east, typologically secure Bromme finds presently extend to just north of Scania, southernmost Sweden

(Andersson & Knarrström 1999; Magnus Andersson, Bo Knarrström, Bengt Nordqvist and Lou Schmidt pers. comm. 2012; see however Nordqvist 2000: 182-185). To the west, no finds have yet been demonstrated of the same or greater age from Northern Scotland (Alan Saville, Torben B. Ballin, Karen Hardy, Caroline Wickham-Jones and Clive Bonsall pers. comm. 2012; cf. Ballin & Saville 2003; Saville & Ballin 2009; Ballin et al. 2010).

Accordingly, given the present picture of the find distribution, the landscape around Nørre Lyngby constitutes humanity's northernmost outpost in the Allerød period of Western Europe – bordered on the one side by the extensive reindeer and elk hunting grounds of the North European lowlands and on the other by the sea with its rich resources of shellfish, fish, seals and whales.

Conclusion and perspectives

The re-examination of the cultural remains from the freshwater basin at Nørre Lyngby has led to substantial changes in our understanding of the age and function of these familiar artefacts. The flint point is clearly redeposited and can therefore not be used as an argument for dating the Bromme culture to the climatically harsh Younger Dryas. On the contrary, the new evaluation of the accumulated data from the locality suggests that all three artefacts from the site originate from the climatically more hospitable Allerød period.

Damage to the tip of the flint point indicates that it functioned as the point of a hunting weapon. Similarly, wear traces on the antler tool indicate that it was used as a kind of axe. The incised zigzag ornamentation on this tool, together with other marks of wear and working on the piece, suggest that this represented a piece of personal property which was used over a longer period of time and which, among other functions, could have been used to dispatch wounded game. The rib with the cut mark bears witness to a successful hunt and to skinning of a reindeer. A large number of beaver-gnawed branches, a bone from a brown bear, together with abundant fish bones and shells of large freshwater mussels from the lake deposits, show that hunting reindeer was far from the only potential source of food for the people who frequented the locality in Allerød times.

At that time the landscape around the lake was virtually treeless. The remains of large mammals from Nørre Lyngby are also totally dominated by reindeer. The natural environment at the site thereby stands in stark contrast to that known from activity sites of the Bromme culture further to the south and east (Langå, Bromme and Trollesgave), where significant parts of the landscape were apparently covered by actual birch woodland and where the more woodland-adapted elk constitutes the most frequently-occurring large game species in the animal bone assemblages (Fig. 1; Degerbøl 1948; Fischer & Mortensen 1977; Madsen 1983; Mortensen et al. 2011; Fischer et al. 2013).

Traces of the human population of the Allerød period in NW Europe are generally very inconspicuous and normally occur at such low concentrations that they are difficult to demonstrate by way of traditional archaeological survey and excavation methods (cf. Fischer 2013). The famous Nørre Lyngby flint point is nevertheless joined by a considerable number of other Bromme type tanged points from Vendsyssel, many of which belong to regular find accumulations dating to the Bromme culture. These show that this area, bordering the ocean, was regularly visited by the people of the time. Apparently, Vendsyssel did not constitute a marginal element in the Late Palaeolithic settlement of the North European lowlands.

The relatively high density of stray finds and accumulations of finds from the Bromme culture in the NW part of Vendsyssel gives reason to reconsider the traditional perception of this archaeological complex as representing an inland adaptation, based on the hunting of terrestrial big game. Perhaps the day is not very far away when decisive new discoveries will be made which will add coastal settlement and exploitation of marine resources to our picture of human existence and subsistence at the end of the last ice age. Vendsyssel is an obvious place to look in this respect, as this part of the country is one of the few places in the Late Glacial human world where it is possible to find the contemporary coastline above present sea level.

Supplementary information and acknowledgements: In the Danish National Museum's Prehistoric Collection the antler axe and the flint projectile point are recorded under accession numbers A16678 and A31405, respectively. The rib with the cut mark is kept at the Natural History Museum of Denmark in Copenhagen and has accession number Z.M.K. 17/1993, 41.2/16. Ingrid Sørensen (Copenhagen), Kim Aaris-Sørensen and Kristian Gregersen (Natural History Museum of Denmark, Copenhagen), Anders Otte Stensager (Royal Library, Copenhagen), Berit V. Eriksen and Mara-Julia Weber (Zentrum für Baltische und Skandinavische Archäologie, Schleswig) and cand. phil. Torben Nilsson (Hjørring) are thanked for assistance and inspiring discussions in connection with the execution of this project. In addition amateur archaeologists Finn Grønbæk Frandsen and Otto Emil Kristensen (both of Åbyen in Vendsyssel) are thanked for qualifying information on already known find sites and for tracing several new Bromme culture localities in association with the present investigation. In addition the first author expresses his warm thanks to Vendsyssel Historiske Museum (Hjørring) and Zentrum für Baltische und Skandinavische Archäologie in der Stiftung Schleswig-Holsteinische Landesmuseen Schloss Gottorf (Schleswig) for great hospitality during research visits at these institutions. The Graphic Studio of Moesgaard Museum (Aarhus) is acknowledged for effective and competent production of the illustration graphics. Sincere thanks are also due to archaeologist, mag. art. Lisbeth Pedersen, (Kalundborg) for critical reading and constructive suggestions with respect to earlier versions of this manuscript. Finally, Dr. David Earle Robinson (Helgenæs) is thanked for swift and precise translation of the manuscript into English and for useful suggestions and comments on its content. The preparation of this manuscript was carried out under the auspices of the National Museum of

Denmark, research initiative Northern Worlds funded by the Danish Council for Independent Research (FKK ref. no. 273-08-0424).

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Figs. 6, 9 & 11. Photo Arnold Mikkelsen, National Museum of Denmark in collaboration with A. Fischer.

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Quartär

Internationales Jahrbuch zur Eiszeitalter- und Steinzeitforschung

International Yearbook for Ice Age and Stone Age Research

Band – *Volume*
60

Edited by

Werner Müller, Berit Valentin Eriksen,
Daniel Richter, Martin Street, Gerd-Christian Weniger

Verlag Marie Leidorf GmbH · Rahden/Westf.
2013

175 Seiten mit 80 Abbildungen

Manuskript-Richtlinien und weitere Informationen unter http://www.quartaer.eu
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Bibliographische Information der Deutschen Nationalbibliothek

Müller, Werner / Eriksen, Berit Valentin /
Richter, Daniel / Street, Martin / Weniger, Gerd-Christian (Eds.):
Quartär: Internationales Jahrbuch zur Eiszeitalter- und Steinzeitforschung; Band 60
International Yearbook for Ice Age and Stone Age Research; Volume 60
Rahden/Westf.: Leidorf, 2013
ISBN 978-3-86757-926-1

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie.
Detaillierte bibliographische Daten sind im Internet über http://dnb.ddb.de abrufbar.

Gedruckt auf alterungsbeständigem Papier

Verlag Marie Leidorf GmbH
Geschäftsführer: Dr. Bert Wiegel
Stellerloh 65 - D-32369 Rahden/Westf.

Tel: +49/(0)5771/ 9510-74
Fax: +49/(0)5771/ 9510-75
E-Mail: info@vml.de
Internet: http://www.vml.de

ISBN 978-3-86757-926-1
ISSN 0375-7471

Umschlagentwurf: Werner Müller, CH-Neuchâtel, unter Mitwirkung der Herausgeber
Redaktion: Werner Müller, CH-Neuchâtel, Berit Valentin Eriksen, D-Schleswig,
Daniel Richter, D-Leipzig, Martin Street, D-Neuwied und Gerd-Christian Weniger, D-Mettmann
Satz, Layout und Bildnachbearbeitung: Werner Müller, CH-Neuchâtel

Druck und Produktion: druckhaus köthen GmbH & Co. KG, D-Köthen

Inhalt - *Contents*