The chronological framework of the Hamburgian in the light of old and new ^{14}C dates

Der chronologische Rahmen der Hamburger Kultur angesichts alter und neuer ^{14}C-Daten

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Abstract - The relationship of the classic Hamburgian and the Havelte Group has been a matter of discussion for some decades. In order to evaluate the hypothesis that they are chronologically distinct a radiocarbon data set comprising almost 100 dates, including a number of so far unpublished ones, was examined regarding its validity. Based on this edited ^{14}C record of classic Hamburgian and Havelte Group sites a chronological differentiation can indeed be postulated. The transitional period between the two groups can be located within the earliest part of the Lateglacial Interstadial and is possibly connected with the spread of denser, shrub vegetation. Furthermore the calibrated ^{14}C dates indicate that the development of the classic Hamburgian and its northward expansion should be placed before the beginning of the Lateglacial Interstadial into the late Pleniglacial steppe.

Zusammenfassung - *Das Verhältnis der klassischen Hamburger Kultur und der Havelte Gruppe wird seit Jahrzehnten diskutiert. Um die Hypothese einer chronologischen Unterscheidung zu prüfen, wurde eine Radiokarbon-Datenbank von annährend 100 Daten einschließlich einiger bisher unveröffentlichter Daten auf ihre Verlässlichkeit untersucht. Kriterien, die dabei beachtet wurden, sind sowohl technischer als auch archäologischer Art, wie z.B. der Kohlenstoffgehalt, das Risiko von Verunreinigungen und der Zusammenhang mit den zu datierenden menschlichen Hinterlassenschaften. Basierend auf dieser geprüften ^{14}C-Datenbank wird eine chronologische Differenzierung bekräftigt, denn die Daten von Fundplätzen der klassischen Hamburger Kultur sind regelhaft älter als ca. 12 300 BP_{14C} (die Schreibweise BP_{14C} wird im folgenden für unkalibrierte Radiokarbon-Daten verwendet, um Missverständnissen vorzubeugen, die durch unterschiedliche Konventionen entstehen könnten). Die der Havelte Gruppe zugeordneten Datierungen sind fast alle jünger als dieses Datum. Die Übergangsperiode zwischen beiden Gruppen kann in den frühesten Abschnitt des spätglazialen Interstadials gestellt werden und ist möglicherweise mit der Ausbreitung einer dichteren Strauch-Vegetation verbunden. Gleichzeitig spiegeln die radiokarbon-datierten Fundstellen annährend die geographische Verteilung insbesondere der Havelte Gruppe wider, die im Osten der nordeuropäischen Tiefebene bisher nicht vertreten ist. Außerdem deuten die kalibrierten ^{14}C-Daten darauf hin, dass die Entwicklung und Expansion der klassischen Hamburger Kultur nach Norden noch vor dem Beginn des spätglazialen Interstadials, innerhalb der späten pleniglazialen Steppe anzusiedeln ist.*

Keywords - Lateglacial, North European Plain, classic Hamburgian, Havelte Group, radiocarbon dating, environmental forcing
Spätglazial, nordeuropäische Tiefebene, klassische Hamburger Kultur, Havelte Gruppe, Radiokarbon-Datierung, ökologische Steuerung

Introduction

Lateglacial archaeological studies of northern Europe generally associate the expansion of man onto the North European Plain with the Hamburgian and the early parts of the Lateglacial Interstadial (Greenland Interstadials [GI] -1e and -1d; Fig. 1). Within the Hamburgian, the relationship between the classic phase and the Havelte Group has been a matter of discussion for some decades (Schwabedissen 1937; Bohmers 1947; Tromnau 1975; Stapert 1982; Hartz 1987; Burdukiewicz 1986, 1989; Terberger 1996; Clausen 1998b; Terberger et al. 2004). With regard to the artefact record, the only typological difference between the two groups lies in the different form of their lithic points: While shouldered points are characteristic for the classic Hamburgian, tanged points

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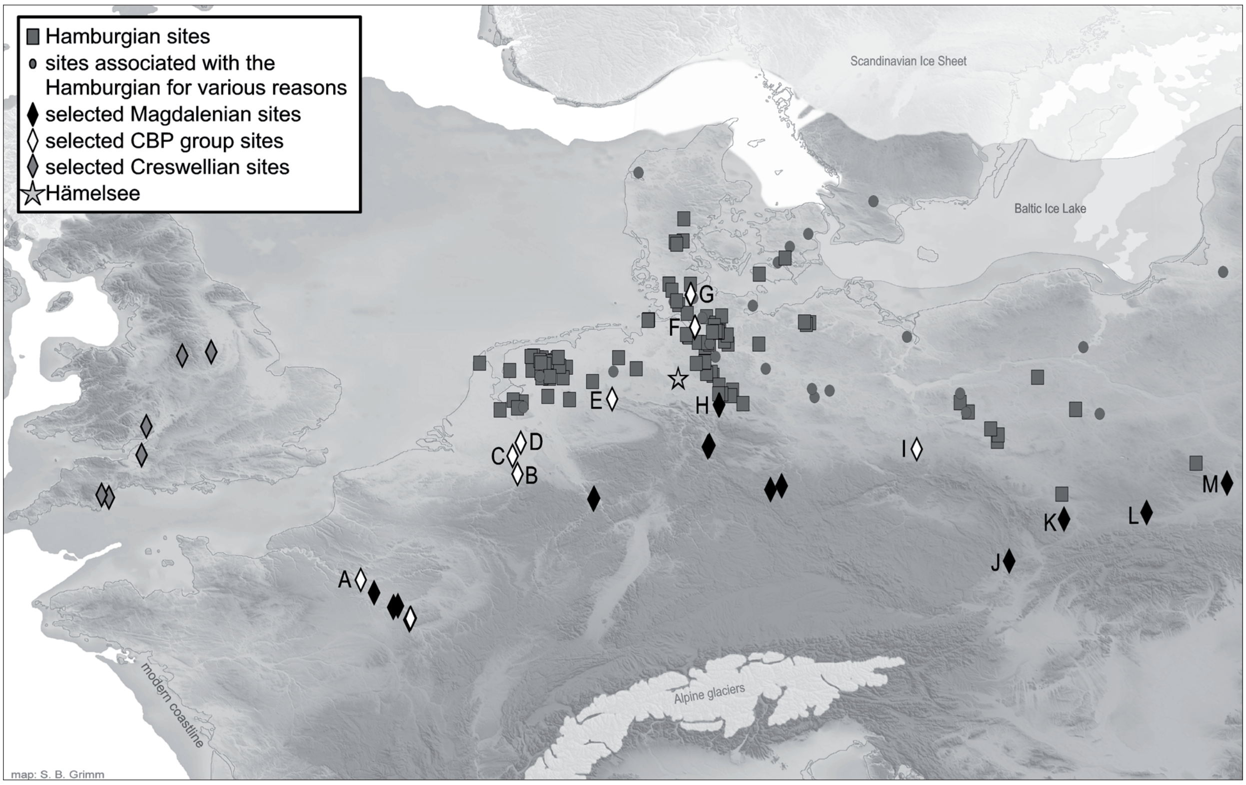

Fig. 1. Distribution of the Hamburgian and sites associated with the Hamburgian in early Lateglacial north-western Europe (sea level, Baltic Ice lake and ice sheet are approximately interpolated for GI-1e and GI-1d; Weaver et al. 2003; Björck 1995; Ivy-Ochs et al. 2005; Lundqvist & Wohlfarth 2001; Boulton et al. 2001; Clark et al. 2004). CBP and Magdalenian sites labelled: A – Le Closeau, B – Rekem, C – Budel, D - Milheeze-Hogeloop, E – Westerkappeln, F – Klein-Nordende, G - Alt Duvenstedt, H – Gadenstedt, I - Reichwalde, J - Pekárna Cave, K - Dzierżysław 35, L - Maszycka Cave, M - Wilczyce.

Abb. 1. *Verbreitung der Hamburger Kultur und weiterer Fundstellen, die der Hamburger Kultur im Allgemeinen zugeordnet werden, im frühen spätglazialen Nordwesteuropa (Meeresspiegel, Baltischer Eissee und die Eisschilde sind für die Zeit von GI-1e und GI-1d annähernd interpoliert; Weaver et al. 2003; Björck 1995; Ivy-Ochs et al. 2005; Lundqvist & Wohlfarth 2001; Boulton et al. 2001; Clark et al. 2004). Gekennzeichnete CBP- und Magdalenién-Fundstellen: A – Le Closeau, B – Rekem, C – Budel, D - Milheeze-Hogeloop, E – Westerkappeln, F – Klein-Nordende, G - Alt Duvenstedt, H – Gadenstedt, I - Reichwalde, J - Pekárna Höhle, K - Dzierżysław 35, L - Maszycka Höhle, M - Wilczyce.*

dominate in the Havelte Group. The explanation of this typological variation has ranged from functional to regional to chronological differences. Until the discovery of Lateglacial material in a kettle hole at Slotseng (southern Jutland, Denmark) there was no known Havelte Group site with preserved faunal material. In the case of the classic Hamburgian sites the representation of fauna was only slightly better, with material mainly coming from sites excavated in the 1930s to 1950s in the Ahrensburg tunnel valley, to the north-east of Hamburg (Bratlund 1996a). Reindeer (*Rangifer tarandus*) was the main game at all these sites, often accompanied by hare (*Lepus* sp.). While most of the classic Hamburgian faunal assemblages are the result of hunting episodes in autumn (Bratlund 1996a), the seasonal indicators among the Slotseng material vary from spring to early winter (Aaris-Sørensen et al. 2007) which would not rule out a hunting season comparable to that of the classic Hamburgian. In the early 1990s very fragmented faunal material discovered at the site of Mirkowice in Poland gave a somewhat different picture, with hare (*Lepus* sp.), pike (*Esox lucius*) and cyprynid fish the main species identified (Kabaciński et al. 1999). However, whether this reflects a different local economy, seasonal variation or is simply a result of preservation and excavation techniques remains to be examined. Nevertheless, the northern German classic Hamburgian and the Danish Havelte Group evidence shows that, at least in these regions, different prey species or hunting seasons do not seem to be the reason for the different shape of the projectile points.

An obvious difference is that classic Hamburgian sites are found in most areas of the North European Plain from the Netherlands to western Poland – potentially Hamburgian sites east of Poland have recently been discussed critically (Bobrowski & Sobkowiak-Tabaka 2007) – while Havelte Group sites are distributed on the north-western Plain (Fig. 2). Hence, overlapping areas are found to date only in the Netherlands, southern Denmark and northern Germany. In the latter region, the stratigraphy of Ahrenshöft LA 73 (Clausen 1998a) rather suggested a chronological difference between the two groups, since a Havelte assemblage there lay well above a more classic Hamburgian inventory. This stratigraphical evidence is supplemented by the results of

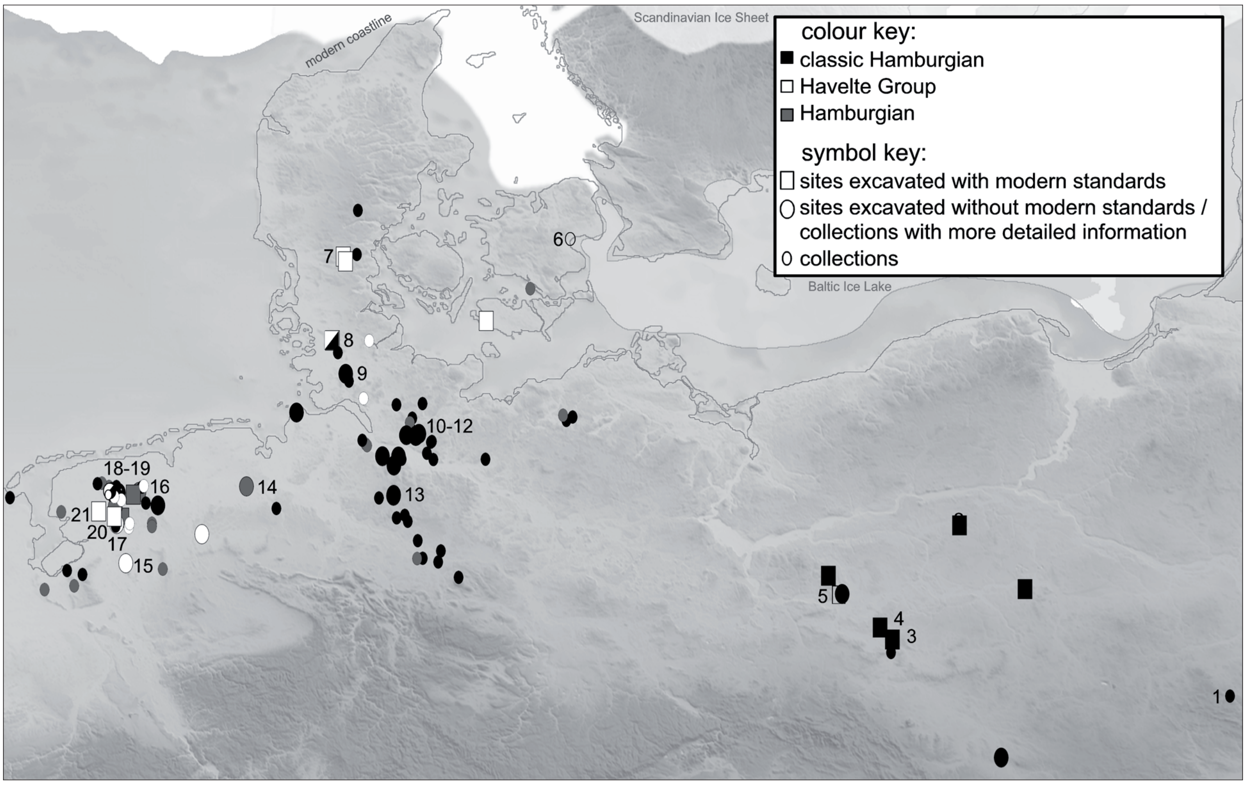

Fig. 2. Distribution of classic Hamburgian and Havelte Group sites in the Lateglacial North European Plain (map basics see Fig. 1). Hamburgian sites labelled: 1 – Nowy Młyn, 2 – Mirkowice, 3 – Olbrachcice, 4 – Siedlnica, 5 – Wojnowo, 6 – off Solrød Strand (not proofed Hamburgian origin, hence without colour), 7 – Slotseng, 8 – Ahrenshöft, 9 – Schalkholz, 10 – Stellmoor, 11 – Meiendorf, 12 – Poggenwisch, 13 – Deimern, 14 – Querenstede, 15 – Luttenberg, 16 - Donderen, 17 – Havelte Holtingerzand, 18 – Duurswoude, 19– Elsloo-Tronde, 20 – Vledder, 21 - Oldeholtwolde.

Abb. 2. *Lage der Fundplätze der klassischen Hamburger Kultur und der Havelte Gruppe (Kartengrundlagen s. Abb. 1). Nummerierte Fundstellen der Hamburger Kultur: 1 – Nowy Młyn, 2 – Mirkowice, 3 – Olbrachcice, 4 – Siedlnica, 5 – Wojnowo, 6 – bei Solrød Strand (keine sichere Zurordnung zur Hamburger Kultur, daher farblos), 7 – Slotseng, 8 – Ahrenshöft, 9 – Schalkholz, 10 – Stellmoor, 11 – Meiendorf, 12 – Poggenwisch,13– Deimern, 14 – Querenstede, 15 – Luttenberg, 16 – Donderen, 17 – Havelte Holtingerzand, 18 – Duurswoude, 19– Elsloo-Tronde, 20 – Vledder, 21 - Oldeholtwolde.*

pollen analysis, showing that the Havelte horizon is contemporary with the *Hippophaë* maximum, which is well known to characterize mid-/ late-GI-1e in pollen profiles from northern Germany and Scandinavia whereas the classic horizon precedes this maximum (Usinger 1998). Nonetheless, even the excavator counts this single stratigraphy as inconclusive evidence (I. Clausen pers. comm.) and the position of the two assemblages is not unambiguous in all areas of the site (see below) so that debate continues (Terberger 2006).

Recently several ^{14}C dates for the classic Hamburgian sites of Meiendorf, Poggenwisch and Stellmoor resulting from measurements at the Cologne radiocarbon laboratory in 1980 were made available to the authors. This provided a starting point to review the extant ^{14}C database for classic Hamburgian and Havelte Group sites and examine whether a more reliable chronological division can be established. While preparing this article the authors also received permission to include AMS dates from the Slotseng site which probably date the Havelte Group occupations there. In the interim these dates have also been published elsewhere (Aaris-Sørensen et al. 2007), but with slight differences to the information the authors received from the AMS laboratory in Århus. It soon became obvious that additional dates might be helpful, especially from Poggenwisch, and one of the authors (MJW) arranged further dating of humanly modified material from that site, the results of which are presented here for the first time. In the following, the convention BP_{14C} is used for uncalibrated radiocarbon dates in order to avoid any confusion with other usages.

Methodological review

Including the nine dates from Slotseng, the four hitherto unpublished Cologne dates and the three new Poggenwisch dates, almost 100 radiocarbon dates are associated with classic Hamburgian and Havelte Group sites (Appendix, Tab. 1). However, in view of the need for critical evaluation of the ^{14}C record (e.g. Pettitt et al. 2003), many dates must be disqualified for various reasons.

While dates obtained earlier by conventional (β-) counting are generally acceptable, unless from sometimes problematic bulked samples (see below), they normally exhibit large standard deviations. By contrast, recently measured AMS dates on sometimes very small amounts of material may run the risk of not fulfilling the general, often neglected prerequisite of the sample providing a sufficient amount of datable carbon (≥ 1.4 mg C, Wohlfarth et al. 1998; > 1-wt% collagen/ 10 mg pre-treatment yield, Higham et al. 2006). Regrettably, information on this aspect is hardly ever given in publications. However, in one of our cases supplementary data shows that the carbon value for KIA-3606 is too low to produce a reliable date (P. M. Grootes written comm.). In fact, many laboratories have only been measuring the carbon content and also the $\delta^{13}C$ value of samples since a few years although the value of this information has been recognized as helpful in interpretation for over 50 years (e. g. Rubin & Suess 1956). Because many of the dates discussed here were obtained beforehand, these evaluation factors unfortunately have to remain open in many cases. Nowadays many laboratories routinely give this background information and explicitly point to these problems within their report if necessary. Consequently, the authors strongly recommend that this supplementary information should be discussed more frequently in archaeological publications.

A priori exclusion of dates made on specific materials is not necessary except in the case of dates obtained on sediment samples such as gyttja (Appendix, Tab. 1, 23-25, 28, 39). These must be rejected due to general problems of complex biogeochemical formation processes in sediments (Hiller et al. 2003) and, in the case of gyttja, due to uncertain contamination by the "hard water effect" (e.g. Barendsen et al. 1957, 911). This contamination e.g. by ground water could also affect dates obtained on bone or antler (Münnich 1957, 194), which initially led to a general scepticism of archaeologists concerning dates received from these materials but which also motivated laboratories to further refine their pretreatment protocols (see Higham et al. 2006).

In view of the fact that lack of pre-treatment is a major source of erroneous dating, the dates W-271 and Y-158 are excluded, as is W-264 which was only washed superficially, and will not be considered further. The pre-treatment procedure for W-261 is unknown (Lanting & Plicht 1996) and the result can therefore only be accepted with caution.

Due to its better pre-treatment H-38-121A is selected from a dating series of the Heidelberg laboratory (Appendix, Tab. 1, 42). It is also preferred to the dates measured from the same sample at the laboratories of Washington (Appendix, Tab. 1, 44) and Yale (Appendix, Tab. 1, 46; Barendsen et al. 1957, 919) because the standards of the Heidelberg laboratory seem the most rigorous for the time (the dates are about 50 years old). These involved not only dissolving the samples in acid as the two US laboratories used to do (Rubin & Suess 1956; Barendsen et al. 1957), but also applying a purification process by dialysis (Münnich 1957).

In the early days of the radiocarbon method, dating the different fractions of a sample was one way to ascertain potential contamination. Especially in the case of German sites excavated during the first half of the 20th century, there are therefore often multiple published dates obtained from a single sample (see above, e.g. there are at most 7 samples from Meiendorf, but 11 dates are referenced in the literature). Of this group, the dates on collagen or the organic fraction are chosen as the most plausible; the others (Appendix, Tab. 1, 20, 48-49, 59) are not considered further. In two cases modern re-dating (Appendix, Tab. 1, 31, 20) of material (Appendix, Tab. 1, 27, 19) has been carried out. Usually we would prefer the modern dates for their better precision and pre-treatment standards, but OxA-2562 is not included since it represents the humic acid fraction (see also Appendix, Tab. 1, 59).

Another source of error for dating bone material is burning. The "burnt bone project" of the Groningen laboratory revealed that while Holocene calcined bones gave apparently reliable results, those from Lateglacial contexts frequently gave erroneous dates (Lanting et al. 2002). Therefore, although some of these dates, including one from Mirkowice (Appendix, Tab. 1, 78), might be plausible, they should all be excluded. Two additional dates from sites in Poland belong to this group (Appendix, Tab. 1, 77, 75). Consequently, for the Polish sites, there is only one date that can be accepted as reliable; this is the one from Olbrachcice 8 (Appendix, Tab. 1, 76), which is given in three different versions in the literature. Here the one provided by the laboratory is chosen (Kanwiszer & Trzeciak 1984).

In order to complete the list of potential sources of error specific for certain types of materials it should be mentioned that AMS dates made on macrofossil samples stored too long in a wet state may provide excessively young results due to fungal or micro-organism-contamination (Wohlfarth et al. 1998).

In general, a large series of dates (Appendix, Tab. 1, 1-5, 9-18, 21-22, 57, 79-80) obtained on charcoal recovered from sandy environments appears too young. This can be explained by both technical reasons (infiltration) and/or on archaeological-contextual grounds.

Archaeological-contextual evaluation

It is clearly impossible to judge accurately the significance of samples lacking a direct association with cultural remains due to human activity merely because they relate to the same stratigraphic context, since this may represent an appreciable period of time. This proviso would apply to the following dates: Appendix, Tab. 1, 74, 81-98. A particularly problematic group is formed by dates for the Dutch site of Oldeholtwolde

(Appendix, Tab. 1, 1-5) which will be discussed in more detail (see below).

Independent of sample type, the association of a sample with the human activity to be dated must be demonstrated. In particular, specimens with human modifications can provide such proof (Appendix, Tab. 1, 33, 63-64, 68, 70, 72-73), although antlers with attached cranial bone can probably be accepted as an indication of human presence since carnivore activities or other taphonomic factors would contribute to a rather different preservation pattern.

Nevertheless, disturbances may be caused not only by natural events (Appendix, Tab. 1, 57; see also Charles 1996), but also by recurrent human activity at the same site. In the case of GrN-11262 from the site of Poggenwisch, while it is established that the dated sample comes from a layer above the Hamburgian one, it can neither be proven that it belongs to the upper horizon recognized by A. Rust during the excavation (Rust 1943) nor that it has been recovered from its original stratigraphic position (Lanting & Plicht 1996). Consequently, and especially on sites with multiple archaeological events, the risk of mistaken cultural assignment has to be considered as source of error (Appendix, Tab. 1, 10, 75, 77, 79-80). This may occur at any stage between excavation and dating (e.g. Appendix, Tab. 1, 56, 50; see Lanting & Plicht 1996). In this category of error also belongs the unintentional substitution of samples, as may possibly have been the case at Oldeholtwolde (see Lanting & Plicht 1996; Appendix, Tab. 1, 8, 3). If the ages obtained for these samples are exchanged the dates from the hearth would form a homogeneous group, but they are not in agreement with a stratigraphical position within Younger Coversands I (GI-1d; Johansen & Stapert 2004).

In some cases cultural association is uncertain because samples originate from sites lacking either diagnostic artefacts in general (Appendix, Tab. 1, 26, 29-33) or characteristic projectile points in particular

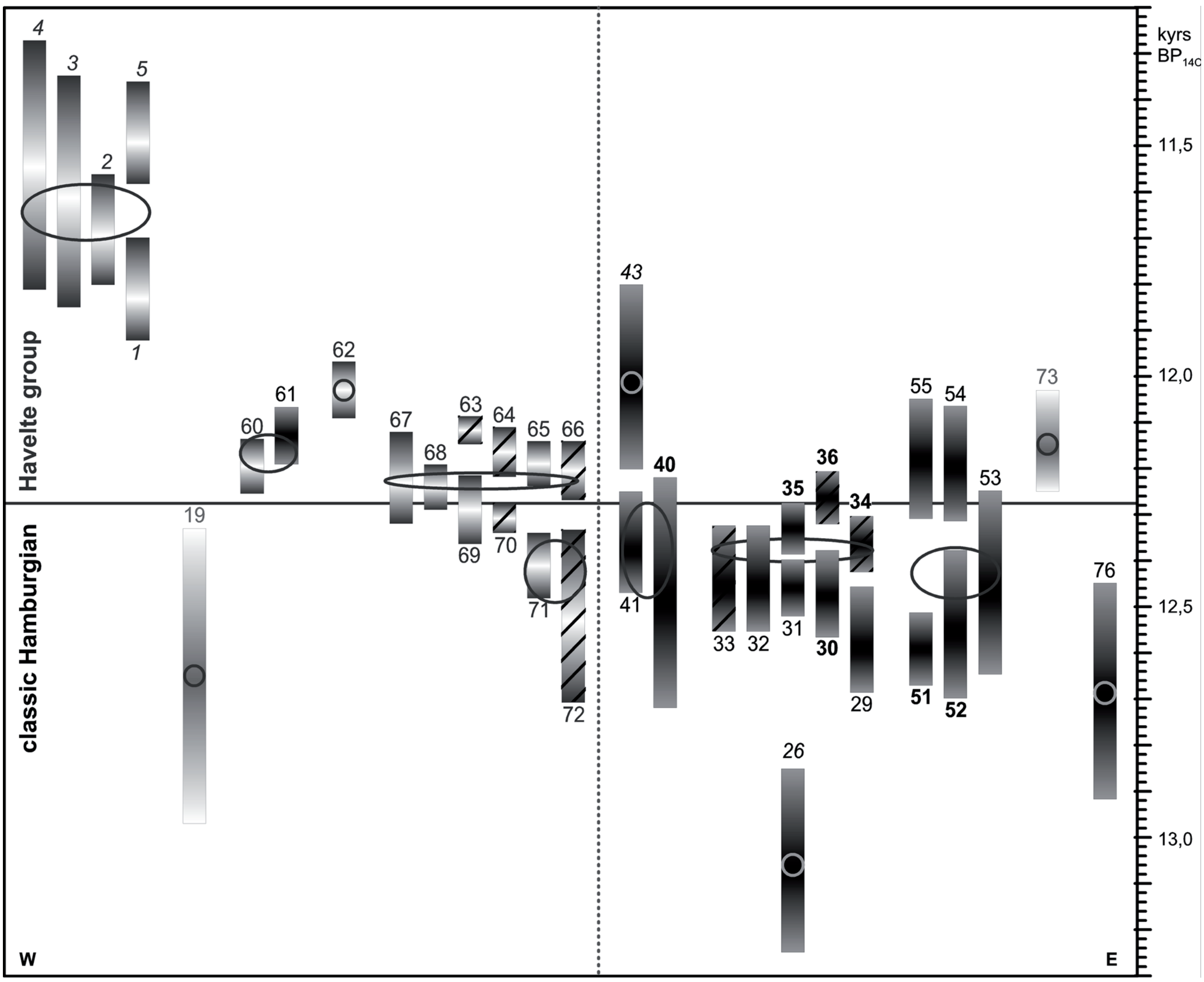

Fig. 3. Methodologically accepted ^{14}C dates displayed after geographic range (W-E) and chronological distribution. For the numbers given see Appendix, Tab. 1. Given with circles is the weighted mean of the dates within a site. Black centre – classic Hamburgian; white centre – Havelte Group; grey centre – undiagnostic association.

Abb. 3. *Methodisch akzeptierte ^{14}C-Daten dargestellt nach ihrer geographischen Lage (W-O) und chronologischen Verteilung. Bezüglich der angegebenen Nummern siehe Appendix, Tab. 1. Durch die Kreise ist das gewichtete Mittel der Daten innerhalb eines Fundplatzes dargestellt. Schwarze Mitte – klassische Hamburger Kultur; weiße Mitte – Havelte Group; graue Mitte – undiagnostischer Zusammenhang.*

(Appendix, Tab. 1, 19-20, 63-73). Such dates may be perfectly accurate but must be discussed critically for the question of their specific archaeological context. The dated fragment of reindeer antler from the submerged bog-site "off Solrød Strand" (Petersen & Johansen 1993; also referred to as Køge Bugt 1, see Aaris-Sørensen et al. 2007) shows traces of the groove and splinter technique, which is typical of the Hamburgian though not restricted to it, but was brought up from the seabed together with lithic artefacts attributed to the Bromme and the Ertebølle cultures. Hence, its cultural attribution must stay open. A second example is the Querenstede assemblage, which lacks diagnostic points (Zoller 1963). Thus, dates from these sites cannot help to solve the question of the chronological position of the classic Hamburgian and Havelte Group and are not further considered in this respect. A slightly different problem is the attribution of dates on material recovered from kettle holes with an undetermined duration of accumulation to adjacent archaeological sites (Meiendorf, Stellmoor, Poggenwisch, Slotseng).

Site context

In order to avoid drawing conclusions from overvalued single dates the acceptable 36 results associated with diagnostic sites should optimally be grouped statistically (limit: 2 σ). To do this it is first necessary to consider critically their relationship to site context and other possible dates from the same site in order to exclude archaeologically invalid dates and identify outlying results (Figs. 3 & 4). The latter then have to be interpreted with regard to their significance of the site formation.

Oldeholtwolde

This site was found within Younger Coversands I (attributed to GI-1d; Geel et al. 1989; Hoek 1997) and is assigned to the Havelte Group by D. Stapert (1986). J. Holm (1996) has considerable doubts about this attribution with regard to the projectile points. Although the authors follow the assessment of the excavator, it should be emphasised that a certain variability of points exists within Hamburgian inventories (see below).

Five dated charcoal samples (Appendix, Tab. 1, 1-5) were obtained from within a hearth and one of these was from underneath a protecting stone slab, theoretically ruling out a direct contamination from overlying layers (Appendix, Tab. 1, 4; Johansen & Stapert 2004). Statistically, the results form a homogeneous group with a weighted mean of 11 650 ± 65 BP_{14C} (Johansen & Stapert 2004) which falls outside the relatively dense cluster produced by other (rare) Havelte Group dates (Fig. 3). While the four older Oldeholtwolde dates are statistically reconcilable with the single result from Ahrenshöft LA 58 D (which is next oldest Havelte Group result, Figs. 3 & 4), the youngest date from Oldeholtwolde is statistically incompatible with the latter. Although this might suggest that the charcoal sample is intrusive, since neither the dated species (*Salix* sp.) nor the $\delta^{13}C$ value indicate this, there is no valid reason to exclude the youngest result from the Oldeholtwolde group. However, this would imply that the accumulation of the Younger Coversand I recorded in the stratigraphy of Oldeholtwolde would have lasted longer than accepted so far or that its attribution to GI-1d (Hoek 1997) is erroneous. The radiometric dates for Oldeholtwolde have been questioned (e.g. Hartz 1987, note 7; Clausen 1998a, 13, who both prefer to trust the stratigraphical context) although a potentially late Havelte survival in the region has also been considered as plausible (Burdukiewicz 1987, 164).

The apparently very young age for a Havelte Group site at Oldeholtwolde is also surprising in the light of the earliest dating of Curve-Backed Point (CBP) Groups in parts of Europe. The authors include in these groups assemblages with bipointes as well as Federmesser which, following the evidence from Le Closeau (Bodu & Valentin 1997), they regard as successive developments. However, trustworthy dates older than 11 500 BP_{14C} are so far only known for the CBP Groups from areas distant to the Dutch Hamburgian sites, such as the Paris Basin (e. g. Le Closeau: Bodu et al. 2006), northern Germany (Alt Duvenstedt LA 120b: Kaiser & Clausen 2005) and south-eastern Germany (Reichwalde: Vollbrecht 2005). Although the latter excavator considers the ^{14}C dates sceptically, the dating of the site to before 11 500 BP_{14C} is trustworthy. On the other hand, the few dates for Dutch sites and the surrounding region which can be confidently attributed to the CBP Groups do not seem to commence before c. 11 500 BP_{14C} (e.g. Rekem: OxA-942; Lanting & Plicht 1996). A date from Milheeze-Hogeloop (GrN-16509) was taken on gyttja and another date from Budel II (GrN-1675) is of uncertain association; which is also the case for a date from Westerkappeln C (KI-271). These dates should therefore be regarded as unreliable (see Lanting & Plicht 1996). A late survival of Havelte Group traditions on the Dutch lowlands until well into the Lateglacial Interstadial cannot therefore be fully ruled out a priori. Anticipating the calibrated date set (Fig. 5, see below) the Oldeholtwolde stratigraphical evidence becomes more important, because, if compared to the Greenland ice-core chronology (Rasmussen et al. 2006), the calibrated dates may even fall within GI-$1c_1$, which represents the early Allerød in continental sequences (Litt et al. 2001). In the Netherlands this period is commonly associated with the Usselo soil formation (Geel et al. 1989, Hoek 1997), which at Oldeholtwolde is located in the section well above the artefact layer (Johansen & Stapert 2004).

As long as there are no other undisputed comparable young dates from a Havelte Group site the authors prefer to rely on the stratigraphy and suspect that there might be a thus far unrecognized methodological problem with the Oldeholtwolde results and that the radiocarbon dates should be ignored in the discussion of a classic Hamburgian – Havelte Group succession.

Ahrenshöft LA 58 D

The most plausible date for the Havelte Group is the single result from Ahrenshöft LA 58 D (Appendix, Tab. 1, 62). Following S. Hartz's work on artefacts collected from different sites alongside a Lateglacial lake in the older moraine area near Ahrenshöft, Schleswig-Holstein (Hartz 1987) different archaeological investigations were carried out in the area during the 1990s including the excavation of Ahrenshöft LA 58 D and Ahrenshöft LA 73 (Clausen 1998a). At the former only a single archaeological layer, clearly attributed to the Havelte Group by four certain Havelte points, was present, and dated material from a hearth here delivered the youngest Havelte date accepted by the authors (Figs. 3 & 4). From approximately the same time there exist a few dates for early CBP assemblages from different regions in Europe (see above; Bodu & Valentin 1997; Bokelmann et al. 1983; Hedges et al. 1998). A relatively recent chronological position for Ahrenshöft LA 58 D seems to be supported by the lithic artefacts, among which occur a supposed curve-backed point and scrapers resembling those of the Wehlen type (Clausen 1998a), elements which could be interpreted as reflecting influences from early CBP Groups. However, the so-called curve-backed point from Ahrenshöft LA 58 D could equally be a broken Havelte point. The broken base shows one retouch negative on the otherwise unretouched edge, which could hint at a tanged base. This suggestion may be reinforced by the finds from Klein-Nordende A, recovered in a Lateglacial soil located stratigraphically above a layer with a weighted mean age of 12 010 ± 75 BP_{14C} (Bokelmann et al. 1983). One of the three curve-backed points here is slightly tanged and, in its elongated form, reminiscent of a Havelte point. Might this be a result of technical exchange between the Havelte Group and CBP Groups expanding from the south? The other two curve-backed points clearly have basal retouch similar to that known on British penknife points (Campbell 1977).

Ahrenshöft LA 73

At Ahrenshöft LA 73 two lithic assemblages are clearly stratified one above the other. Although the two acceptable ^{14}C dates (Appendix, Tab. 1, 60-61) from the site appear inverted relative to their stratigraphic position, they are statistically identical with a weighted mean of 12 165 ± 42 BP_{14C} (Fig. 3).

On the basis of results from the (still unpublished) extension of the excavation I. Clausen assigns the lower horizon (II) to the classic Hamburgian (Kerbspitzen-horizont) and the upper one (I) to the Havelte Group (Clausen 1998a, 45). While this interpretation clearly applies to the published Havelte Group assemblage in the upper horizon of the southern part of the site, the upper assemblage from the northern area shows an unambiguous combination of both shouldered and Havelte points (Clausen 1998a, Tab. 1; fig. 15.1-9). The excavator suggests this might be due to cryoturbation and admixture with material derived from the lower horizon (Clausen 1998a, 42), even though the diagnostic points from the lower horizon (II) across the entire site comprise only two classic shouldered points and three points of Havelte type (Clausen 1998a, Tab. 1). In addition, even the single illustrated "shouldered point" (Clausen 1998a, fig. 17.3) is doubtful in the view of the authors. Since Clausen states that in the problematic northern part of the site only artefacts from stratigraphically ascertained positions are attributed to the lower horizon (Clausen 1998a, 42) one must question where exactly the assumed admixture of the upper assemblage in this area originates. Furthermore, the lower horizon, which clearly contains both types of points, is considered as a closed unit (Clausen 1998a, 39). Radiocarbon dating is unable to distinguish the two layers at Ahrenshöft LA 73 (Fig. 4) and the apparent combination of tanged and shouldered points in both horizons also suggests that the two episodes of human activity were not separated by any great length of time.

Slotseng

The Slotseng material derives partly from the fill of a kettle hole and partly from four further late Palaeo-

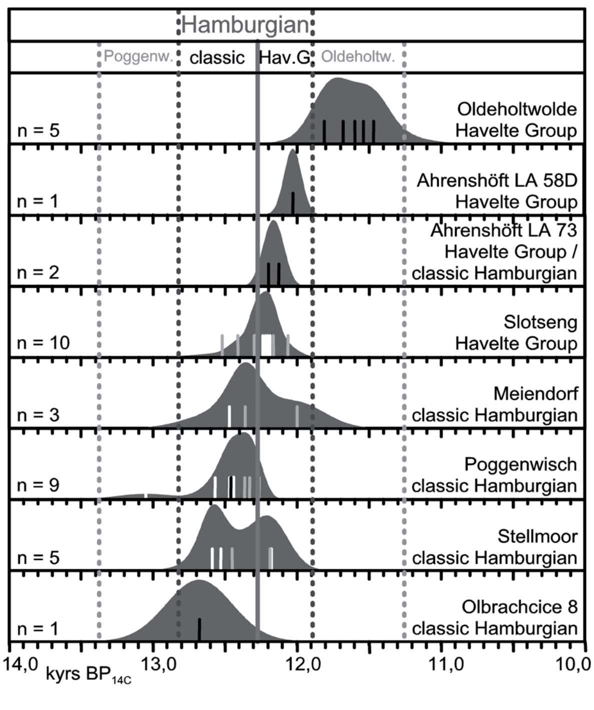

Fig. 4. Uncalibrated ^{14}C dates per site context. Black line – charcoal sample; white line – bone sample; grey line – antler sample. For dates used: see Appendix, Tab. 1.

***Abb. 4.** Unkalibrierte ^{14}C-Daten nach Fundkontext. Schwarze Linien – Holzkohle; weiße Linien – Knochen; graue Linien – Geweih. Zu den verwendeten Daten: siehe Appendix, Tab. 1.*

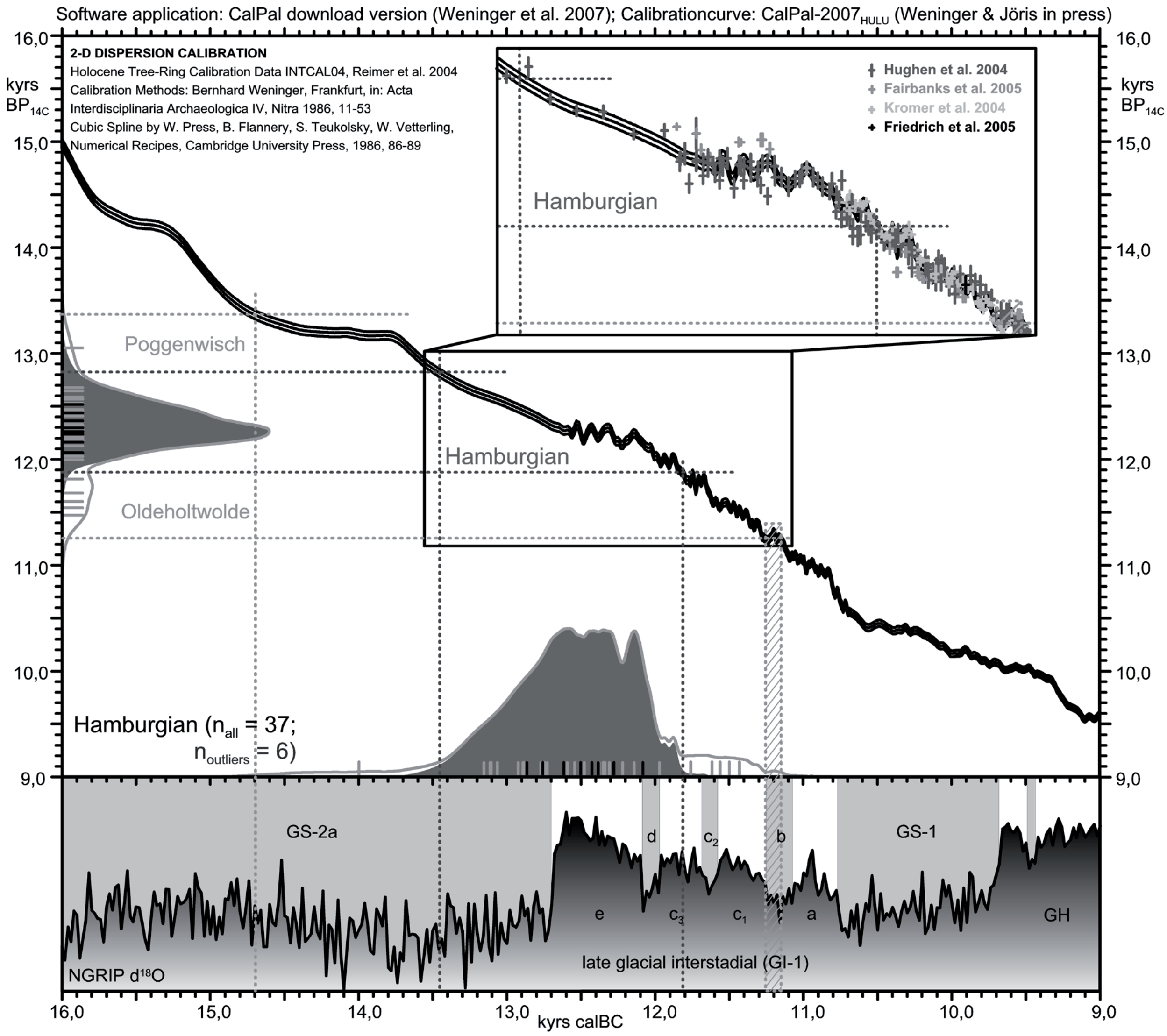

Fig. 5. Calibration of ^{14}C dates of the Hamburgian. For dates used: see Appendix, Tab. 1. Dark grey background – most certain dating of the Hamburgian. Black lines – dates from samples with human modification, grey lines – dates from samples without human modification. For the regions adjacent to the North Atlantic the δ^{18}O curves from Greenland ice-cores are generally accepted as best climate proxies. Consequently the calibrated Hamburgian dates are here correlated with the δ^{18}O curve based on NGRIP cores, the annual layers of which have been largely counted and, at least in the Holocene period, double checked with other Greenland ice-cores, resulting in the best available ice-core chronology at the moment (GICC05; Vinther et al. 2006, Rasmussen et al. 2006, Andersen et al. 2006, Svensson et al. 2006). Grey background – cold periods.

Abb. 5. *Kalibration der ^{14}C-Daten der Hamburger Kultur. Zu den verwendeten Daten: siehe Appendix, Tab. 1. Dunkelgrauer Hintergrund – wahrscheinlichste Datierung der Hamburger Kultur. Schwarze Linien – Daten von Proben mit menschlicher Modifikation, graue Linien – Daten von Proben ohne menschliche Modifikation. Für die an den Nordatlantik angrenzenden Regionen werden δ^{18}O-Kurven der grönländischen Eiskerne üblicherweise als beste Wiedergabe des Klimas angesehen. Folglich werden hier die kalibrierten Datierungen der Hamburger Kultur mit der δ^{18}O-Kurve von NGRIP korreliert, die in weiten Teilen nach Jahresschichten ausgezählt und zumindest für das Holozän mit Ergebnissen weiterer Eiskerne überprüft wurde, woraus sich die zur Zeit beste Eiskern-Chronologie ergibt (GICC05; Vinther et al. 2006, Rasmussen et al. 2006, Andersen et al. 2006, Svensson et al. 2006). Grauer Hintergrund – Kälteperioden.*

lithic concentrations approximately 70 m uphill; two have lithic material attributable to the Havelte Group and two have artefacts of later CBP Groups (Federmessergruppen). The latter are commonly associated with the Allerød or late GI-1 (c_1-a), but the oldest dates associated with early CBP Groups (Klein-Nordende CR) in the north are even older: KI-2124: 12 035 ± 110 BP$_{14C}$, wood sample *Hippophaë* and KI-2152: 11 990 ± 100 BP$_{14C}$, wood sample *Hippophaë* (Bokelmann et al. 1983, see above). The ten radiocarbon dates from the Slotseng site (Appendix, Tab. 1, 63-72) were taken on material from the kettle hole.

The first results of environmental studies carried out in the kettle hole suggested that the cultural layer belongs to GI-1e (Holm 1996). While a tool resembling a Zinken found in 2001 (Holm 2003) would correspond well with the attribution of this cultural layer to the Hamburgian, the piece is not undoubtedly determined and, even if it were, could not be taken as evidence that all remains from the kettle hole belong to this tradition. A piece of flint found in a reindeer vertebra (Holm 2003) cannot be certainly identified as of Hamburgian origin (cf. Holm 1996), however this bone was dated to 12 240 ± 50 BP$_{14C}$ (Appendix,

Tab. 1, 68), making a Havelte Group cultural attribution most plausible. The date does not contradict the typo-chronological attribution given by the mentioned potential Zinken. A further seven dates from the kettle hole (Appendix, Tab. 1, 60-64, 66-67), three samples of which show human modification (Appendix, Tab. 1, 60-61, 67), provide the best statistical fit with the first date and these eight results form a group with a weighted mean of 12 224 ± 20 BP_{14C} (Fig. 3).

A previously published date (Appendix, Tab. 1, 72) for a worked fragment of reindeer antler from the kettle hole also suggests an age consistent with GI-1e, but is appreciably older and statistically fits together with the next oldest date (Appendix, Tab. 1, 71) from the Slotseng series (weighted mean: 12 423 ± 66 BP_{14C}, Fig. 3) to date an event approximately 200 ^{14}C years older than that shown by the younger group. That the ten dates from the kettle hole could represent at least two events is not surprising in view of the archaeological evidence for at least two different Havelte Group concentrations in the vicinity and the wide seasonal range (Mid-March to Mid-December) shown by the faunal material (Aaris-Sørensen et al. 2007).

Since the older Slotseng date group is incompatible with the dates for the Havelte Group occupations at Ahrenshöft, I. Clausen argues that the older Slotseng results do not represent a Havelte Group occupation and that classic Hamburgian groups were already present in Jutland at this time (Clausen 1998a, 43). In order to explain the contradiction between the older radiocarbon age and the apparently Havelte Group context of the adjacent settlements Slotseng a and c J. Holm proposed non-chronological reasons for differences between the classic Hamburgian and Havelte Group, e.g. regional, ethnic or functional ones (Holm 1996). However, he also considers the possibility of an undiscovered classic Hamburgian site lying close to the kettle hole. This would not necessarily contrast with the view represented by B. Bratlund (1996b) who allows that classic Hamburgian groups made incursions into more northern territories although the step-wise northward extension of the total settlement area was only possible due to climatic change.

From a climatological and environmental point of view, an early northern human presence would already have been possible from the beginning of GI-1e. By this time the ice sheet had retreated far into Sweden (Boulton et al. 2001; Lundqvist & Wohlfarth 2001), with the freshly uncovered region rapidly developing a tundra vegetation with a shrub component (Hammarlund & Lemdahl 1994; Ising 1998). In consequence, Slotseng lay at least 250 km from the ice sheet, and pollen profiles from the region surrounding the site confirm shrub tundra vegetation for the area (Kolstrup & Buchardt 1982; Usinger 1985, 1998; Bennike et al. 2004). This suggests ecological conditions similar to those at other classic Hamburgian sites, which is further supported by the most recent palynological analysis from the Slotseng kettle hole (M. Mortensen pers. comm.).

Stellmoor

At Stellmoor the comparatively small classic Hamburgian lithic inventory (n=198) was found exclusively in the kettle hole from which the organic material for the six radiocarbon dates (Appendix, Tab. 1, 51-56) also originates. One of the four projectile points in this lithic assemblage is worth discussing. A. Rust already noticed that this piece (Rust 1943, pl. 22.4) differs from the shouldered points known from Meiendorf in its low width and pronounced thickness (Rust 1943, 127, 148). A further difference consists in the shortness of the bilateral, ventral basal retouch compared both to the overall length and to the extent of the retouch at the tip. The latter forms a steep angle with the unretouched edge. Together with the elongated shape mentioned by A. Rust, these features have led to the hypothesis that this point belongs to the Havelte type (I. Clausen pers. comm.). In consequence, a twofold occupation of the site by groups of both classic and Havelte character seems to be possible. Up to now, available reliable radiocarbon dates (Appendix, Tab. 1, 54-55; Fischer & Tauber 1986) have indicated a rather young chronological position, comparable to the Havelte Group dates discussed so far (Fig. 3). The date W-261 was thus considered too old, with uncertain pre-treatment procedures suggested as the reason. However, integrating the new Cologne dates (Appendix, Tab. 1, 51-52) sheds a new light on this date (Figs. 3 and 4), suggesting that, like other German dates in this laboratory series it was not just pre-treated but also tested for its $\delta^{13}C$ value (Rubin & Suess 1956) and can be accepted as valid. Neither the antler of W-261 nor the bulked samples from Cologne were specifically examined for traces of human modification, while the Copenhagen dates are certainly without human traces and therefore potentially less significant for the discussion of the dating of human presence. It now certainly seems possible that the available radiocarbon dating results indeed support the archaeological suggestion of Havelte Group activity following a classic Hamburgian occupation at Stellmoor. Nevertheless, since all five relevant dates are statistically coherent (weighted mean: 12 428 ± 54 BP_{14C}), it can equally not be ruled out that the comparatively small Stellmoor assemblage represents only a single event of human activity, accordingly a classic Hamburgian one with Havelte group affinity. For this reason, an archaeological re-examination, especially of the point mentioned above and its relationship to the other Hamburgian material from the kettle hole is considered advisable.

Meiendorf

The dates from Meiendorf (Appendix, Tab. 1, 39-50) originate from samples recovered from a kettle hole at a distance of 25 m from the actual classic Hamburgian site (Rust 1937). Their association with the site is suggested by organic tools lying beside the bones and antlers and by impact and cutmarks on the bones (Grønnow 1987; Bratlund 1990) which demonstrate the anthropogenic nature of the kettle hole assemblage. Attribution to the classic Hamburgian culture is confirmed by characteristic lithic artefacts, such as Zinken and one shouldered point. In Meiendorf only one occupation phase seems to be represented (Figs. 3 & 4). Of the eleven dates given in the literature for Meiendorf only K-4329 passes critical review and, since this sample was an antler piece with attached cranial bone, might even suggest a deposition by humans.

The very young Meiendorf date H-38-121A was taken on antler in the late 1950s without ensuring presence of human modification. Because of the large standard deviation it might be statistically identical to K-4329 and an unpublished bulked bone sample (Appendix, Tab. 1, 40) which would give a weighted mean of 12 301 ± 90 BP_{14C}. However, by comparison with all other classic Hamburgian dates (Figs. 3 - 5; see below), it appears more appropriate to consider H-38-121A as an outlier and not as dating the classic Hamburgian occupation. H-38-121A would also fit statistically with the Oldeholtwolde dates although seen in the typological context the two sites have nothing in common.

Poggenwisch

Here, as at Meiendorf, the general connection between the dated samples (Appendix, Tab. 1, 23-38) from the kettle hole and human activity at the settlement site is established by the presence of bone tools and cutmarked reindeer bone and antler (Rust 1958). Eight dates cluster in a group around 12 375 ± 25 BP_{14C} (Fig. 3), and the authors consider this to represent the most plausible age of the classic Hamburgian occupation at Poggenwisch, especially since three of these dates (Appendix, Tab. 1, 33, 34, 36) show traces of human modification.

An older date from Poggenwisch (Appendix, Tab. 1, 26, Münnich 1957) was measured almost 50 years ago and, compared with modern standards of pre-treatment methodology (Higham et al. 2006), even the good preparation standards for organic fractions of the Heidelberg institute were probably not able to eliminate all contaminating elements of the dated bones. In addition to these technical concerns a direct association of this sample with human presence is not confirmed and the date might relate to an event unconnected with human activity.

Olbrachcice 8 & Mirkowice 33

Apart from the oldest (rejected) Poggenwisch result, a date on charcoal from a hearth at the site Olbrachcice 8 (Appendix, Tab. 1, 76) is the earliest result for the classic Hamburgian (Figs. 3 & 4). Unfortunately little further information on the material is available in the literature. Moreover the date has a large standard deviation minimizing the precision of this result and thus allowing very different conclusions. Further dates for the Hamburgian from this site would be desirable to evaluate the significance of this single available date.

A further 15 dates (Appendix, Tab. 1, 81-95) taken from the area surrounding the site of Mirkowice 33 (see above; Appendix, Tab. 1) range from 16 550 to about 3 380 BP_{14C} and will not be considered further in this paper due to their uncertain connection with or demonstrable irrelevance for the classic Hamburgian site. Another date from Mirkowice 33 on calcined bone (Appendix, Tab. 1, 78) could correspond to an older age, considering that dating results on calcined bones generally seem to yield too young results (Lanting et al. 2002, 35).

Seen together with the date from Olbrachcice 8 this may indicate a rather early classic Hamburgian presence in the eastern settlement area and might reflect the observation that classic Hamburgian sites are rare to the west whereas (probably younger) Havelte Group concentrations are more common there (see below).

Clustering of accepted dates

Apart from the disregarded Oldeholtwolde dates and the oldest, problematic Poggenwisch result (Appendix, Tab. 1, 26) all dates come from within a time frame of almost 1 100 ^{14}C years (12 900 – 11 840 BP_{14C}; Figs. 3 - 5). During this time-span sites with a classic Hamburgian inventory generally provided older dates than sites associated with Havelte Group assemblages (Figs. 3 - 5).

Exceptions are provided by a few outlying dates; these are the youngest Meiendorf date (Appendix, Tab. 1, 43), the date from the lower horizon at Ahrenshöft LA 73 (Appendix, Tab. 1, 61) and the two oldest Slotseng dates (Appendix, Tab. 1, 71-72). If all the „classic Hamburgian“ outliers with an uncertain classic Hamburgian association (see above) are excluded, the weighted means for classic Hamburgian sites form a statistically homogeneous group with a common weighted mean of c. 12 390 ± 25 BP_{14C}, which agrees perfectly with the two old dates from Slotseng and may lend further support to the hypothesis of a so far undetected classic Hamburgian presence in the vicinity of the Slotseng kettle hole. The remaining dates from Slotseng form a dense cluster with both dates from Ahrenshöft LA 73 (Appendix, Tab. 1, 60-61) around 12 200 ± 20 BP_{14C}. This cluster represents most of the dates associated with the Havelte Group, but also shows that a chronological overlap of the two archaeological groups still persists. This can not only be traced statistically but also, as described above, recognized in the artefact record of e.g. Ahrenshöft LA 73 or perhaps Stellmoor. Only the date from Ahrenshöft LA 58 D (Appendix, Tab. 1, 62) is slightly younger than the other Havelte Group results. At this site, this rather young position within the Havelte Group is also suggested by the archaeological material, which perhaps already shows first influences of CBP Group techniques (see above).

The accepted dates and their significance for models of Lateglacial human expansion

Apart from showing a basic chronological differentiation the sites yielding valid ^{14}C dates can also be separated on the basis of their longitude (Fig. 3); those giving dates for the older group are tendentially found to the east, while sites with dates for the younger group lie relatively far to the west. This can be explained by the general distribution of the Havelte Group sites in the north-western region of the North European Plain (Fig. 2) while the classic Hamburgian has a wider distribution, although perhaps not reaching as far north as the Havelte Group sites. This pattern may indicate that representatives of the classic Hamburgian expanded onto the North European Plain from a southern to south-eastern territory, possibly following major river valleys (Fig. 2), and that the Havelte Group only developed among the groups subsequently living in the north-west.

The hypothesis that the classic Hamburgian was developed by representatives of the late Magdalenian entering the North European Plain from the south-east (regions of Central/Eastern Germany, Moravia

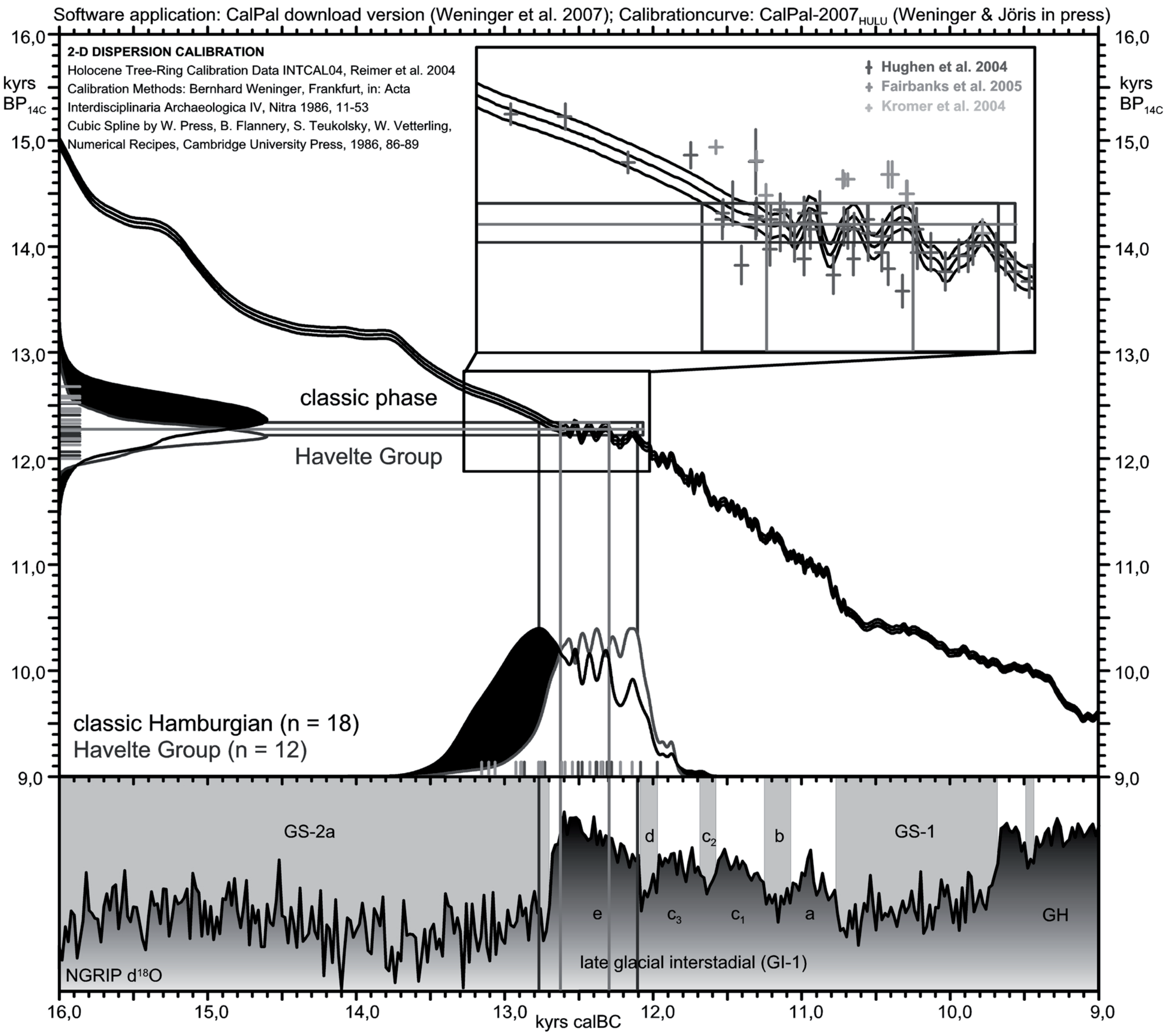

Fig. 6. Calibration of ¹⁴C dates of the archaeological groups in question. Black background and light grey lines – classic Hamburgian; white background and dark grey lines – Havelte Group. For dates used: see Appendix, Tab. 1. Correlated with the δ¹⁸O curve from NGRIP after GICC05 (see Fig. 5).

Abb. 6. *Kalibration der ¹⁴C-Daten nach den hier besprochenen, archäologischen Einheiten. Schwarze Füllung und hellgraue Linien – klassische Hamburger Kultur; weiße Füllung und dunkelgraue Linien – Havelte Gruppe. Zu den verwendeten Daten: siehe Appendix, Tab. 1. Korreliert mit der δ¹⁸O-Kurve von NGRIP nach GICC05 (siehe Abb. 5).*

and Poland: Fig. 1) was already postulated by A. Rust (1937, 139). This interpretation was based on a comparison of Hamburgian lithic material with Magdalenian assemblages e.g. from the Pekárna cave (see Valoch 2003) but also on stylistic associations (Rust 1937, 143) which were subsequently rejected (Bohmers 1961; Burdukiewicz 1989) and instead seen in relationship with Magdalenian ornaments from the Pyrenees (e.g. Bosinski 1978). All recent analyses recognize that elements of the lithic and organic inventories are common to both the Hamburgian and the Magdalenian.

Comparison of the reindeer-based economies of the Hamburgian with those of the Paris Basin Magdalenian, as well as the discovery of French Magdalenian sites yielding more than usual numbers of lithic shouldered or angle-backed points emphasized a western starting point for the Hamburgian (e.g. Burdukiewicz 1989) in preference to an eastern origin. However, this picture is not confirmed by the ^{14}C record and fails to take into account the presence of shouldered or angle-backed points in German Magdalenian assemblages (Feustel 1979, 882 ff). Arguments for a western European origin of the Hamburgian on the basis of faunal analysis can also be reviewed. Faunal analysis of sites at the Seine-Yonne-confluence conducted in the 1990s (Bridault & Bemilli 1999; Bignon 2003) has led to a reappraisal of the faunal record of the Lateglacial Paris Basin. A re-evaluation of the importance of the various prey species recognizes horse as a stable and year-round available resource at some sites (e.g. Bridault et al. 2003). This is a similar picture to that at Central Rhineland and Thuringian Basin Magdalenian sites (Fig. 1) at which horse (*Equus* sp.) is the main subsistence resource (e.g. Street et al. 2006; Feustel 1979) and reindeer plays a subsidiary role, often being predominantly represented by antler as a raw material. Until recently the only Magdalenian material known from Poland was that from the Maszycka Cave, which is dated considerably earlier than the Lateglacial (Kozłowski et al. 1995), and only now have younger Magdalenian sites with some determinable bone material been recovered (Wilczyce: Bratlund 2002; Dzierżysław 35: Ginter et al. 2005). At the former site, which was possibly inhabited during the winter season, horse and rhino dominate the fauna and only projectile points and a shed fragment of reindeer antler are present (Bratlund 2002, 106 f.). On the basis of this assembled information it can be postulated that late Magdalenian hunting economy along the southern upland periphery of the North European Plain was based on the exploitation of both horse and reindeer, with seasonal and cyclical factors influencing the faunal composition at any one site.

B. Bratlund proposes a similar model for the Hamburgian hunting economy based on her analyses of the Ahrensburg tunnel valley sites (1996a). The presence of a few horse remains in the reindeer-dominated Hamburgian faunal assemblage at Meiendorf is here interpreted as representing imported provisions from animals hunted elsewhere (Bratlund 1996a, 38).

Seen against the background of these studies the dominance of reindeer in the few known Hamburgian faunal assemblages cannot be explained as causally related to a particular regional facies of the Magdalenian, but is determined simply by seasonal availability of a major prey resource. The indications for universally similar Magdalenian hunting patterns as far to the east as Poland mean that a particular similarity of the Hamburgian faunal assemblages with those of the Paris Basin Magdalenian cannot be upheld and an origin in the south-east cannot be excluded on the basis of the fauna. The chronological division of the radiocarbon dates for the Hamburgian into an older and a younger group (Fig. 6) in combination with the geographical distribution of the considered sites (Figs. 2 & 3) is more compatible with an origin to the south-east of the North European Plain.

The conclusions for the chronological relationship of the classic Hamburgian and Havelte Group drawn from the radiocarbon database (Fig. 6) are further supported by the Ahrenshöft evidence. The palynological stratigraphy from the more convincing southern part of the site correlates the Havelte Group assemblage with the *Hippophaë* Maximum while the classic Hamburgian lies well below this (Usinger 1998, 68). The *Hippophaë* Maximum is also found in pollen diagrams at other sites. H. Usinger and other workers (e.g. Klerk 2004) suggest that, in the case of pollen analyses of sites in the Ahrensburg tunnel valley, *Hippophaë* may have been confused with *Helianthemum* (indicating a rather cold period) so that the classic Hamburgian horizons would in fact be situated well before GI-1d. Havelte sites, on the other hand, are frequently associated with deposits attributed by litho-stratigraphy to GI-1d (e.g. Holm & Rieck 1992). This evidence provides additional support for a chronological differentiation between the two groups and, furthermore, allows them to be correlated with the environmental developments of the earliest part of the Lateglacial Interstadial.

For northern Germany J. Merkt and H. Müller (1999) were able to construct a pollen succession mainly based on varved sequences, but unfortunately this is poor for the beginning of the Lateglacial Interstadial and earlier. Nevertheless, the Hämelsee 9 core (Merkt & Müller 1999) shows most of the GI-1e (Meiendorf) section of the pollen sequence (Fig. 7).

To compare radiocarbon dates with this sequence they first need to be calibrated (e.g. Weninger & Jöris 2004). In the following the CalPal-2007$_{\text{Hulu}}$ curve (Weninger & Jöris in press) is used, which the authors accept to be the best available curve at the moment. Even after a critical selection of results and with the intention to calibrate within only a narrow time frame, it emerges that most of the period of interest falls

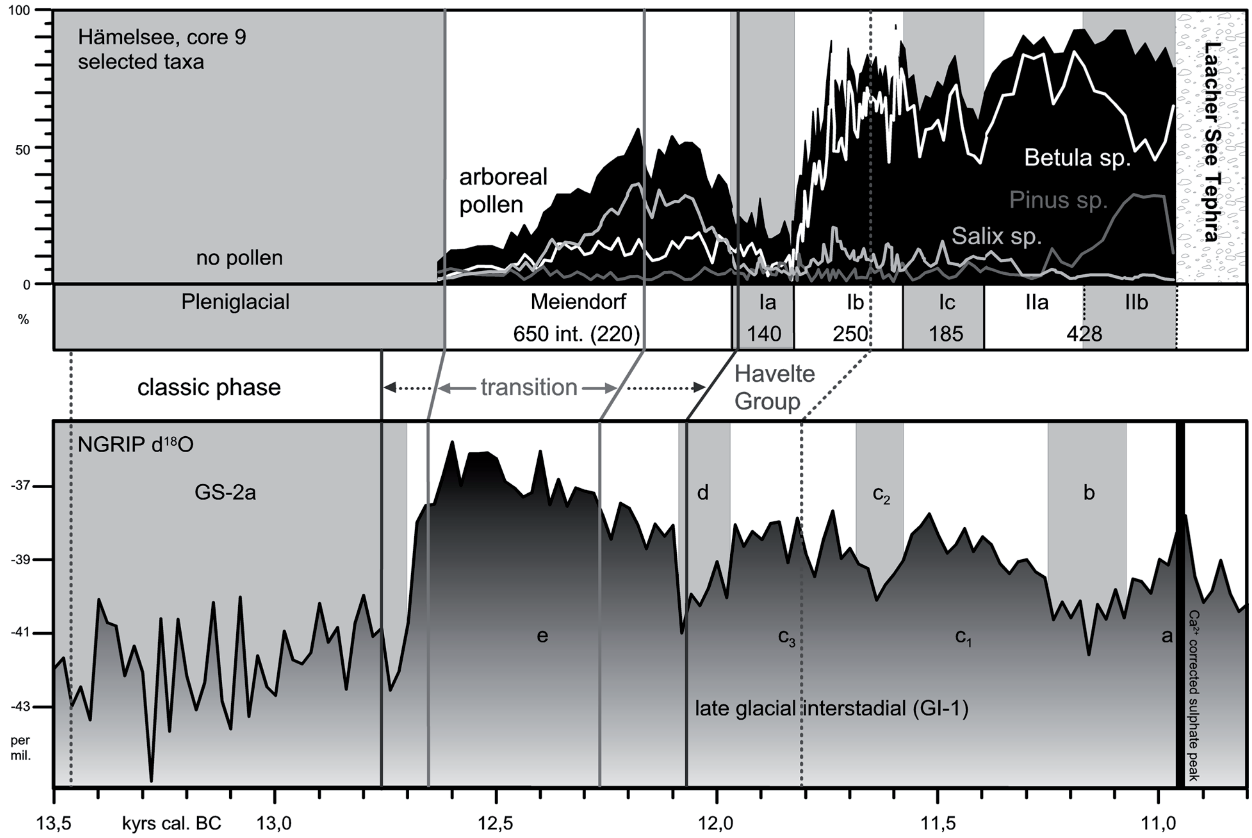

Fig. 7. Vegetation development as displayed in Hämelsee, core 9 (Merkt & Müller 1999). The chronology is following Merkt & Müller (1999, Fig. 3), with the annual layers given in Hämelsee, core 6 for the Allerød sequence (IIa/ IIb) and then following the varve chronology from Meerfelder Maar, only duration of the Bølling (Ib) is according to the varve counts from Wollingster See (85 km north of Hämelsee, see Merkt & Müller 1999, 45). Actual duration in varve-years is given per Unit; in the Meiendorf sequence of the Meerfelder Maar only 220 varves are present, but the duration is interpolated to 650 years (Litt & Stebich 1999). Units named after Merkt & Müller 1999, Figs. 4 & 11. The dating of the Laacher See Volcano eruption is according to Baales et al. 2002. The Hämelsee sequence is on this point correlated to the $\delta^{18}O$ curve from NGRIP after GICC05 (see Fig. 5, cf. Mortensen et al. 2005). Lines indicate calibrated age of the Hamburgian and the transition between the classic phase and the Havelte Group according to Figs. 5-6.

Abb. 7. *Vegetationsentwicklung wie sie sich am Hämelsee, Kern 9 darstellt (Merkt & Müller 1999). Die Chronologie folgt Merkt & Müller (1999, Fig. 3), wonach die Jahreslagen vom Hämelsee, Kern 6 für den Abschnitt des Allerøds (IIa/ IIb) stammen und in der Folge die Warvenchronologie des Meerfelder Maars verwendet wird, nur für die Dauer des Bøllings (Ib) werden die Warvenzählungen des Wollingster See (85 km nördlich des Hämelsee) herangezogen (siehe Merkt & Müller 1999, 45). Die jeweilige Dauer der Abschnitte ist in Warvenjahren angegeben; für das Meiendorf sind im Meerfelder Maar nur 220 Warven vorhanden, jedoch wird die Gesamtdauer auf 650 Jahre interpoliert (Litt & Stebich 1999). Die Benennung der Abschnitte erfolgt nach Merkt & Müller 1999, Figs. 4 & 11. Die Datierung des Laacher See Vulkanausbruchs ist nach Baales et al. 2002. Die Hämelsee Abfolge ist an diesem Punkt mit der $\delta^{18}O$-Kurve von NGRIP nach GICC05 (siehe Abb. 5, vgl. Mortensen et al. 2005) korreliert. Die Linien geben das kalibrierte Alter der Hamburger Kultur, sowie die Übergangsphase von der klassischen Phase zur Havelte Gruppe an wie es aus den Abb. 5-6 folgt.*

exactly into a very uneven period in the calibration curve (late Pleniglacial/early Lateglacial plateau), making calibration extremely difficult. Accordingly, the interesting episodes can only be defined within quite broad windows rather than divided by exact borderlines (Figs. 5 & 6).

Until now, although models for the human reoccupation of north-western Europe after the Last Glacial Maximum have now accepted that Magdalenian populations already moved into the Central European upland area during the late Pleniglacial, they have predicted that human expansion into the North European Plain first took place with the onset of the Lateglacial Interstadial (e.g. Housley et al. 1997). If the uncertain date from Poggenwisch (Appendix, Tab. 1, 26) is discarded, the oldest date for the classic Hamburgian so far is the one from Olbrachcice 8 (Appendix, Tab. 1, 76). Together with the Querenstede date it suggests that the Hamburgian may in fact have developed before the onset of the Lateglacial Interstadial (c. 12 330 BP_{14C}; see Figs. 5 - 7). These are only single charcoal dates from two sites, making a conclusive evaluation of their validity and discussion of their significance problematic. But they lead to the fact that the older group of dates comprising classic Hamburgian dates and the two oldest dates from Slotseng generally delivered calibrated ages before 12 700 cal. BC. This corresponds to the very beginning of GI-1e (Fig. 5), when the environment had just started to change as a reaction to significantly higher temperature and increased precipitation (Fig. 7). In the light of these results it seems that the first appearance of the classic Hamburgian is contemporary with the Paris Basin late Magdalenian (cf. Valentin & Pigeot

2000) and with the early British Creswellian (Barton et al. 2003), at a time when northern Europe ecologically still presented a homogeneous steppe landscape with horse and reindeer herds as the main prey species (Bratlund 1996a).

The calibrated ages for the transition between the classic Hamburgian and the Havelte Group and for the end of the Havelte Group show interesting correlations with the succession of tree and shrub pollen (AP) from the Hämelsee profile (Fig. 7). The phase of overlap between the youngest calibrated radiocarbon dates for the classic Hamburgian and the oldest ones for the Havelte Group seems to coincide with a rise in *Salix* sp. pollen and with it the overall AP rise within GI-1e. It is difficult to confirm this phenomenon using the lithostratigraphical position of the Havelte Group, since these industries are routinely found in coversand deposits assigned to GI-1d. Equally, it must be considered that the intensity of the GI-1e oscillation might not everywhere have allowed the formation of a deposit distinct from GI-1d. Possibly the two horizons at Ahrenshöft LA 73, both located within sediments attributed by H. Usinger (1998) to GI-1e (Meiendorf) and characterized by a mixture of classic shouldered points and Havelte points could represent an example of the transition between the two facies. The lower assemblage (II) also coincides with high values (32%) for pollen of *Salix* sp. (Usinger 1998, 68). The latest palynological results on the find layer in the kettle hole at Slotseng (M. Mortensen pers. comm.) also indicate a position at the end of GI-1e.

The youngest calibrated dates for sites of the Havelte Group fall at the end of GI-1d when the AP ascends markedly again due to a significant rise in *Betula* sp. pollen, a phase interpreted as representing early light forestation. In this case, lithostratigraphy confirms this pattern universally since no Havelte Group sites are found within sediments assigned to GI-1c or younger.

At present it is not possible to correlate these environmental changes with a change in the use of projectile weapons. Various studies on spearthrower and spear on the one hand and bow and arrow on the other hand have shown that size and weight of projectile points cannot in all cases be used for their differentiation as spear or arrow points (e.g. Plisson & Geneste 1989). Equally, it is not possible to distinguish between the two projectile types on the basis of fracture patterns (e.g. Fischer et al. 1984). Furthermore, the asymmetry of classic Hamburgian points has been contrasted with the symmetry of Havelte points (e.g. Beckhoff 1967). While this could affect the diameter and thus the nature of the shaft, it should not be forgotten that the manner of hafting also plays an important role in this respect. The authors therefore want to stress Cattelain's (1997) conclusion drawn from a wide range of ethnographic examples, namely that "Hunting strategies are also very similar for the two types of weapons." (Cattelain 1997, 231), and that the choice of strategy is influenced more by the environment, the prey species and the "purpose of the hunt" (Cattelain 1997, 231) rather than by the actual weapon.

In imagining the consequences of the afforestation process on these three factors, the changing environment can be looked at as providing material resources as well as the setting of a hunt. Denser vegetation with a higher component of trees brings the advantage that wood is available in greater quantities and more easily as raw material for bows, arrows and spears. This could lead to a less restrictive use of these implements. At the same time, flint sources may become more difficult of access, however, despite a general decline in the quality of flint working with the appearance of CBP Groups on the North European Plain, the type and quality of the raw material used (Baltic flint) remain unaltered (e.g. Hartz 1987; Madsen 1996). In a denser landscape prey is less visible but the hunter can also more easily hide, and precision of weapon delivery (accurate aim) might become correspondingly more important.

With regard to the prey species, the faunal record shows that these change from predominantly open landscape ones, such as horse and reindeer, to those living more in woodland, such as elk and red deer (Bokelmann et al. 1983; Bratlund 1996). Additionally, game animals show different social behaviour, e.g. changing herd size, depending on species and season, which may also influence hunting strategy.

Finally, the purpose of the hunt is difficult to evaluate, as this varies from season to season and from species to species. However, if one accepts that large herd hunting is less possible in forested landscapes, one can propose that the former organisation of large autumn hunts in order to get a meat reserve for the winter becomes impractical and may be replaced by strategies striking a balance between obtaining enough meat for the moment and killing as few animals as possible in order to maintain a critical herd size and thus preserve a stable resource.

It therefore appears very plausible that the combination of changes brought on by increasing forestation may well have affected subsistence strategies to such an extent that they needed to be transformed profoundly or even collapsed. The traces of this development may be reflected in the archaeological record by something as elementary as the changing form of projectile points.

The authors therefore suggest that the representatives of the Hamburgian were able to adapt to the increased shrubland component in the landscape and a wider variety of new vegetation resources at the onset of GI-1e by minimal changes to their behaviour (e.g. the technical adaptation leading to the Havelte-Group facies). By contrast, they were unable to adapt as easily to subsequent developments and the universally woodland conditions from GI-1c signalled the end of their way of living.

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Site	Archaeological material	No.	Lab.no.	^{14}C date (in BP_{14C})	Material (Species)	$\delta^{13}C$	Comment	used in Fig(s).	References
Oldeholtwolde, hearth, NL	Havelte	1	OxA-2558	11,810± 110	charcoal (*Salix* sp.)	-25.3		4, 5, 6	Hedges et al. 1992
		2	OxA-2561	11,680 ± 120	charcoal (*Salix* sp.)	-23.5		4, 5, 6	Hedges et al. 1992
		3	GrN-13083	11,600 ± 250	charcoal (*Salix* sp.)		possibly ***exchanged*** with GrN-12280; hearth?	4, 5, 6	Lanting & Plicht 1996
		4	GrN-10274	11,540 ± 270	charcoal (*Salix* sp.)	-25		4, 5, 6	Lanting & Plicht 1996
		5	OxA-2559	11,470 ± 110	charcoal (*Salix* sp.)	-24.6		4, 5, 6	Hedges et al. 1992
Oldeholtwolde, NL	t.a.q. for Havelte	6	***GrN-11264***	***11,340 ± 100***	charcoal	-28.1	***Allerød peat***		Johansen & Stapert 2004
		7	***OxA-2560***	***11,300 ± 110***	charcoal (*Pinus* sp.)	-25.5	***Usselo soil***		Hedges et al. 1992
		8	***GrN-12280***	***11,080 ± 280***	charcoal (*Salix* sp.)		***Usselo soil? possibly exchanged*** with GrN-13083		Lanting & Plicht 1996
Vledder, NL	Havelte / **mesolitic**?	9	***GrA-10938***	***6,150 ± 60***	charcoal (*Betula* sp.)	-25	***uncertain association***		Niekus 2006
Elsloo-Tronde, hearth, NL	classic / **mesolithic**?	10	***GrN-4869***	***7,790 ± 95***	charcoal (*Pinus* sp.)	-25	possible ***mesolithic hearth***		Lanting & Plicht 1996
Duurswoude 2, NL	Havelte	11	***GrN-1565***	***11,090 ± 90***	charcoal		***uncertain association***		Lanting & Plicht 1996
Havelte-Holtingerzand, NL	Havelte / **mesolithic**?	12	***GrA-25780***	***6,020 ± 50***	charcoal	-26.4	***uncertain association***		Niekus 2006
		13	***GrA-25778***	***5,900 ± 50***	charcoal	-26	***uncertain association***		Niekus 2006
Luttenberg, NL	Havelte	14	***GrN-7942***	***7,750 ± 70***	charcoal	-26.2	***uncertain association***		Lanting & Plicht 1996
		15	***GrN-8081***	***4,090 ± 60***	charcoal	-25.9	***uncertain association***		Lanting & Plicht 1996
Donderen, NL	Hamburgian (classic?)	16	***GrN-206***	***7,630 ± 140***	charcoal		***uncertain association***		Lanting & Plicht 1996
		17	***GrN-216***	***7,365 ± 40***	charcoal		***uncertain association***		Lanting & Plicht 1996
		18	***GrN-152***	***6,950 ± 160***	charcoal		***uncertain association***		Lanting & Plicht 1996
Querenstede, hearth, D	Hamburgian	19	KN-2707	12,650 ± 320	charcoal		same as OxA-2562	4, 6	Lanting & Plicht 1996
		20	***OxA-2562***	***11,840 ± 110***	charcoal ***humic acid***	-24.4	same as KN-2707		Hedges et al. 1992
Deimern 41 or 44, D	classic	21	***GrN-4653***	***8,160 ± 60***	charcoal		***uncertain association***		Lanting & Plicht 1996
Deimern 42, D	classic	22	***GrN-10269***	***6,595 ± 45***	charcoal	-24.7	***uncertain association***		Lanting & Plicht 1996
Poggenwisch, D	classic	23	***H-32-118a***	***17,100 ± 560***	calcareous ***gyttja***, calcareous fraction		identic with H-32-118c & H-32-60		Münnich 1957; Fischer & Tauber 1986
		24	***H-32-60***	***15,700 ± 350***	calcareous ***gyttja***, residue fr. H-32-118a/ c		identic with H-32-118a & H-32-118c		Münnich 1957; Rust 1958
		25	***W-93***	***15,150 ± 350***	calcareous ***gyttja***				Suess 1954; Fischer & Tauber 1986
		26	H-31-67	13,050± 200	bone organic fraction			4, 5, 6	Münnich 1957; Fischer & Tauber 1986
		27	***H-136-116***	***12,980 ± 370***	wood (twigs)		***same as GrN-11254***		Münnich 1957; Rust 1958

Appendix, Tab. 1. All ^{14}C dates from classic Hamburgian and Havelte Group sites. Boldface no. – unpublished dates. Grey dates – problematic dates (see text); boldface & italic dates – excluded dates and main reason for exclusion.

Appendix, Tab. 1. *Alle ^{14}C-Daten von Fundstellen der klassischen Hamburger Kultur und der Havelte Gruppe. Fette Nr. – unpublizierte Daten. Graue Daten – problematische Daten (s. Text); fette & kursive Daten – ausgeschlossene Daten und Hauptgrund des Ausschlusses.*

		28	***H-32-118c***	***12,850 ± 500***	calcareous **gyttja**, organic fraction		identic with H-32-118a & H-32-60		Münnich 1957; Rust 1958
		29	K-4332	12,570 ± 115	bone collagen (*Rangifer tarandus*)	-18.6		4, 5, 6, 7	Fischer & Tauber 1986
		30	KN-2754	12,470 ± 95	bone (bulked sample)			4, 5, 6, 7	kind permission B. Weninger
		31	GrN-11254	12,460 ± 60	wood	-28.6	same as H-136-116	4, 5, 6, 7	Lanting & Plicht 1996
		32	K-4331	12,440 ± 115	bone collagen (*Rangifer tarandus*)	-18.8		4, 5, 6, 7	Fischer & Tauber 1986
		33	K-4577	12,440 ± 115	bone collagen (*Rangifer tarandus*)	-17.4	humanly modified	4, 5, 6, 7	Fischer & Tauber 1986
		34	KIA-32926	12,365 ± 60	antler (*Rangifer tarandus*)	-20.4	humanly modified, 3.8 mg C	4, 5, 6, 7	
		35	KIA-32927	12,330 ± 55	antler (*Rangifer tarandus*)	-21.3	antler with attached bone, 4.2 mg C	4, 5, 6, 7	
		36	KIA-32925	12,265 ± 55	antler (*Rangifer tarandus*)	-21.6	humanly modified, 4.0 mg C	4, 5, 6, 7	
		37	***W-271***	***11,750 ± 200***	antler, bulked sample (*Rangifer tarandus*)		***without pre-treatment***		Rubin & Suess 1956; Rust 1958; Lanting & Plicht 1996
	uncertain	38	***GrN-11262***	***11,250 ± 50***	antler (*Rangifer tarandus*)	-19.1	***upper horizon?***		Lanting & Plicht 1996
Meiendorf, D	classic	39	***W-172***	***15,750 ± 800***	calcareous **gyttja**, organic fraction				Rubin & Suess 1955; Rust 1958
		40	KN-2220	12,470 ± 250	bone (bulked sample)			4, 5, 6, 7	kind permission B. Weninger
		41	K-4329	12,360 ± 110	antler collagen (*Rangifer tarandus*)	-18.3	antler with attached bone	4, 5, 6, 7	Fischer & Tauber 1986
		42	***H-38-121B***	***12,300 ± 300***	antler organic fraction (*Rangifer tarandus*)		***without pre-treatment***; identic with H-38-121A & H-38-121C; **same as samples W-281 & Y-158.2**		Münnich 1957; Rust 1958
		43	H-38-121A	12,000 ± 200	antler organic fraction (*Rangifer tarandus*)		identic with H-38-121B & H-38-121C; ***same as samples W-281 & Y-158.2***	4, 5, 6	Münnich 1957; Rust 1958
		44	***W-281***	***11,870 ± 200***	antler ***carbonate fraction*** (bulked sample, *Rangifer tarandus*)		**same as samples H-38-121 & Y-158.2**		Rubin & Suess 1956; Rust 1958
		45	***W-264***	***11,790 ± 200***	antler collagen (bulked sample, *Rangifer tarandus*)	-22	***washed only superficially***		Rubin & Suess 1956; Rust 1958

Appendix, Tab. 1. *(continued)*

Appendix, Tab. 1. (Fortsetzung)

		46	***Y-158.2***	***10,760 ± 250***	antler organic fraction (*Rangifer tarandus*)		identic with Y-158 & Y-158.1; ***same as samples H-38-121 & W-281***		Barendsen et al. 1957; Lanting & Plicht 1996
		47	***Y-158***	***9,540 ± 130***	antler collagen (*Rangifer tarandus*)		identic with Y-158.1 & Y-158.2, ***wrong attribution?***		Barendsen et al. 1957; Lanting & Plicht 1996
		48	***Y-158.1***	***7,060 ± 400***	antler ***carbonate fraction*** (*Rangifer tarandus*)		identic with Y-158 & Y-158.2		Barendsen et al. 1957; Lanting & Plicht 1996
		49	***H-38-121C***	***6,150 ± 500***	antler ***carbonate fraction*** (*Rangifer tarandus*)		identic with H-38-121A & H-38-121B; same as samples **W-281 & Y-158.2**		Münnich 1957; Fischer & Tauber 1986
Meiendorf?/ Stellmoor, D	classic/**Ahrens-burgian**	50	***K-4330***	***10,110 ± 85***	bone collagen (*Rangifer tarandus*)	-18.3	humanly modified; ***wrongly labelled***		Fischer & Tauber 1986
Stellmoor, D	classic	**51**	KN-2223	12,590 ± 80	bone (bulked sample)			4, 5, 6, 7	kind permission B. Weninger
		52	KN-2224	12,530 ± 160	bone/ antler (bulked sample)			4, 5, 6, 7	kind permission B. Weninger
		53	W-261	12,450 ± 200	antler (*Rangifer tarandus*)		unknown pre-treatment	4, 5, 6, 7	Rubin & Suess 1956; Rust 1958; Lanting & Plicht 1996
		54	K-4261	12,190 ± 125	antler collagen (*Rangifer tarandus*)	-18.6		4, 5, 6, 7	Fischer & Tauber 1986
		55	K-4328	12,180 ± 130	bone collagen (*Rangifer tarandus*)	-18		4, 5, 6, 7	Fischer & Tauber 1986
	Ahrens-burgian?	56	***K-4327***	***10,130 ± 105***	antler collagen (*Rangifer tarandus*)	-17.7	antler with attached bone; ***wrongly attributed***		Fischer & Tauber 1986
Schalkholz, D	classic	57	***KI-406***	***7,530 ± 190***	charcoal (*Pinus* sp./ ***Quercus*** sp.)		***admixture?***		Lanting & Plicht 1996
Ahrenshöft LA 73, upper layer, South, D	Havelte	58	***KIA-3606***	***12,550 + 1,170/ - 1,020***	charcoal (*Salix* / *Populus*)		***only 0,58 mg C***		Clausen 1998 (written comm. P. M. Grootes)
		59	***KIA-3606(a)***	***11,750 ± 60***	charcoal ***humic acid*** (*Salix* / *Populus*)				Clausen 1998
		60	KIA-3605	12,200 ± 60	charcoal (*Pinus* sp.)			4, 5, 6, 7	Clausen 1998
Ahrenshöft LA 73, lower layer, North, hearth A, D	classic	61	KIA-3833	12,130 ± 60	charcoal (*Salix* / *Populus*)			4, 5, 6, 7	Clausen 1998

Appendix, Tab. 1. *(continued)*
Appendix, Tab. 1. (Fortsetzung)

Ahrenshöft LA 58 D, hearth, D	Havelte	62	AAR-2784	12,030 ± 60	charcoal	-25.7		4, 5, 6, 7	Clausen 1998
Slotseng, DK	Havelte / Federmesser-gruppen?	63	AAR-8161	12,065 ± 80	antler (*Rangifer tarandus*)	-19.7	humanly modified	4, 5, 6, 7	kind permission J. Holm
		64	AAR-8158	12,165 ± 55	antler/ bone (*Rangifer tarandus*)	-19	humanly modified	4, 5, 6, 7	kind permission J. Holm
		65	AAR-8164	12,190 ± 50	bone (*Rangifer tarandus*)	-18.6		4, 5, 6, 7	kind permission J. Holm
		66	AAR-8163	12,205 ± 65	bone (*Rangifer tarandus*)	-19.5		4, 5, 6, 7	kind permission J. Holm
		67	AAR-8162	12,220 ± 100	antler (*Rangifer tarandus*)	-18.9		4, 5, 6, 7	kind permission J. Holm
		68	AAR-8160	12,240 ± 50	bone (*Rangifer tarandus*)	-19	with embedded stone tip	4, 5, 6, 7	kind permission J. Holm
		69	AAR-8165	12,290 ± 75	bone (*Rangifer tarandus*)	-19.4		4, 5, 6, 7	kind permission J. Holm
		70	AAR-8157	12,299 ± 41	antler (*Rangifer tarandus*)	-19.1	humanly modified; in Aaris-Sørensen et al. 2007 different version for AAR-8157.1 given	4, 5, 6, 7	kind permission J. Holm
		71	AAR-8159	12,410 ± 70	antler (*Rangifer tarandus*)	-19.6		4, 5, 6, 7	kind permission J. Holm
		72	AAR-906	12,520 ± 190	antler/ bone (*Rangifer tarandus*)	-18.6	humanly modified	4, 5, 6, 7	Holm & Rieck 1992; Holm 1993
Solrød Strand, DK	uncertain	73	AAR-1036	12,140 ± 110	antler (*Rangifer tarandus*)		humanly modified	4	Fischer 1996
Wojnowo 2, PL	classic/ tanged point complex	74	***Gd-2577***	***12,540 ± 120***	charcoal		***no association***		Burdukiewicz 1999; Kobusiewicz 1999
Siedlnica 17a, PL	classic / **mesolithic**?	75	***GrA-15832***	***8,450 ± 60***	bone		***calcined***		Lanting et al. 2002
Olbrachcice 8, PL	classic	76	Lod-111	12,680 ± 230	charcoal		two additional versions in Burdukiewicz 1981/ 1986	4, 5, 6, 7	Kanwiszer & Trzeciak 1984
	classic / **mesolithic**?	77	***GrA-15831***	***8,190 ± 60***	bone	-35.4	***calcined***		Lanting et al. 2002
Mirkowice 33, conc. I, PL	classic	78	***GrA-17715***	***12,290 ± 70***	bone		***calcined***		Lanting et al. 2002
	classic / **neolithic**?	79	***Gd-9885***	***6,900 ± 200***	charcoal		***uncertain association***		Lanting et al. 2002
		80	***Gd-9875***	***6,810 ± 430***	charcoal		***uncertain association***		Lanting et al. 2002
		81	***UtC-8492***	***165 ± 32***	tooth collagen (*Equus* sp.)		***uncertain association***		Kabaciński & Schild 2005
Mirkowice 33, PL	t. a. q. for classic	82	***Gd-9666***	***3,380 ± 210***	wood branch		***stratigraphic association only***		Kabaciński & Schild 2005
		83	***Gd-9652***	***8,020 ± 150***	wood twigs		***stratigraphic association only***		Kabaciński & Schild 2005
		84	***UtC-8617***	***10,210 ± 120***	leaf (*Salix* cf. *polaris*)		***stratigraphic association only***		Kabaciński & Schild 2005
		85	***UtC-8598***	***10,930 ± 80***	seed (*Hippophaë rhamnoides*)		***stratigraphic association only***		Kabaciński & Schild 2005

Appendix, Tab. 1. *(continued)*

Appendix, Tab. 1. (Fortsetzung)

		86	*UtC-8619*	*11,010 ± 100*	seed (*Hippophaë rhamnoides*)		*stratigraphic association only*		Kabaciński & Schild 2005
		87	*UtC-8618*	*11,820 ± 200*	charcoal		*stratigraphic association only*		Kabaciński & Schild 2005
		88	*Gd-10892*	*11,850 ± 180*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		89	*Gd-12124*	*11,950 ± 110*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		90	*Gd-7851*	*12,160 ± 80*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		91	*Utc-8493*	*12,260 ± 70*	charcoal		*stratigraphic association only*		Kabaciński & Schild 2005
		92	*Gd-10885*	*12,400 ± 230*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		93	*Gd-10544*	*12,870 ± 190*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		94	*Gd-10872*	*13,110 ± 200*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
		95	*Gd-10876*	*16,550 ± 320*	wood branch		*stratigraphic association only*		Kabaciński & Schild 2005
Nowy Młyn/ Rydno, PL	uncertain	96	*Bln-2037*	*11,970 ± 125*	charcoal		*chronological association*		Schild & Królik 1981
		97	*Gd-724*	*11,940 ± 300*	charcoal		*chronological association*		Schild & Królik 1981
		98	*Gd-725*	*12,290 ± 210*	charcoal		*chronological association*		Schild & Królik 1981

Appendix, Tab. 1. *(continued)*
Appendix, Tab. 1. (Fortsetzung)

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