A Study of the Mesolithic Handle Core Technology in Schleswig-Holstein

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Abstract – In this paper, flint materials from three sites in Schleswig-Holstein are studied to investigate the local expression of the lithic technology known as the handle core concept. This technology was implemented in Scandinavia and parts of continental Europe during the Mesolithic. Handle cores are for example found in northern Germany but few technological studies have focused on these materials and little is known about how the local expression of the technology compares to other parts of northern Europe. The present study acts as a local case study that, when included in a larger setting, could approach subjects such as transmission of knowledge, social interaction and mobility in landscapes. The study includes the systematic recording of 3735 flint artefacts that, through descriptive statistics and analysis, describes the preparation of the cores and the production of blades. The results are then compared to other studies from Scandinavia. The results show that the handle core technology in Schleswig-Holstein largely corresponds to the already established picture of the handle core concept in Scandinavia, and is especially similar to handle cores found in southern Scandinavia. This indicates that southern Scandinavia and northern Germany were a part of the same social and cultural sphere during the Mesolithic.

Key words – archaeology; mesolithic; technology; flint; lithic; Maglemose; Kongemose; handle core

Titel – Eine Studie zur Handgriffkerntechnologie in Schleswig-Holstein

Zusammenfassung – Dieser Beitrag befasst sich mit drei Fundplätzen aus Schleswig-Holstein, die flinttechnologisch untersucht werden, um die lokale Ausprägung des so genannten „handle core concept" zu bewerten. Dieses Konzept ist sowohl aus Skandinavien als auch Kontinentaleuropa als ein lithisches Abbaukonzept während des Mesolithikums bekannt. Handle cores (früher auch: „Handgriffschaber" genannt) sind zwar aus Norddeutschland bekannt, aber nur wenige technologische Studien haben sich mit diesem Material auseinandergesetzt, weshalb wenig über ihre lokalen Ausprägungen und deren Verhältnis zu Fundkomplexen in anderen Teilen Europas bekannt ist. Die vorliegende Untersuchung ist eine lokale Fallstudie, die – eingebettet in eine umfassende Betrachtung – dazu beitragen kann, Wissenstransfer, soziale Interaktion und Mobilität in der Landschaft während des Mesolithikums zu ergründen. Für diese Studie wurden 3.735 Flintartefakte systematisch aufgenommen, die unter Verwendung deskriptiver Statistiken und Analysen in Bezug auf Kernpräparation und Klingenproduktion untersucht werden. Anschließend erfolgt ein Vergleich mit Studien aus Skandinavien. Die Ergebnisse zeigen, dass die Handle-Core-Technologie in Schleswig-Holstein zu großen Teilen mit dem etablierten Bild des Konzeptes in Skandinavien korrespondiert, hierbei besonders mit Südskandinavien. Dies weist darauf hin, dass Südskandinavien und Norddeutschland Teil einer gemeinsamen sozialen und kulturellen Sphäre während des Mesolithikums waren.

Schlüsselwörter – Archäologie; Mesolithikum; Technologie; Flint; Stein; Maglemose; Kongemose; Handgriffkern

Introduction and background

Research focused on Middle- and Late Mesolithic societies of Scandinavia and adjacent areas is often centred on the handle core technology. This technology can be described as the combined knowledge and know-how of a type of microblade production, used for inserts and/or microliths (Olofsson, 2002). The traditional handle core, often described as a microblade core with an oblong platform and distal keel, is considered a *"lead artefact"* (*Leittyp*) of the Middle- and Late Mesolithic periods. This lithic technology was once considered to be the remnants of the first people entering the Scandinavian peninsula after the Weichsel glaciation (Olofsson, 2002). However, this notion has been challenged by more recent research that suggests that another lithic concept, characterised by the production of pressure produced blades from conical or sub-conical cores, was introduced prior to the development or introduction of the handle core concept (Sørensen et al., 2013). Even though the handle core technology may not be the remnants of the first repeopling after deglaciation, this lithic technology was used during a large part of the Mesolithic and existed over a widespread area. It is therefore an important and well-suited study object for understanding large-scale processes and subjects such as mobility, contacts between people and transmission of knowledge.

Research on handle cores has to a large extent been centred around Swedish and Danish handle core finds (Ballin, 2016; Larsson, 1978; Olofsson, 1995; 2003; Sørensen, 2006; 2012; Øland Frandsen, 2015), even though handle cores are known to exist in southern Norway as well as in several parts of northern continental Europe, such as northern Germany, Poland and in Lithuania (Ballin, 2016; Hartz et al., 2010; Olofsson, 1995: 124; 2002; Ostrauskas, 2002). There is some discussion about possible handle core finds from Finland

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and northern Norway, but a clear consensus of whether the technology exists in these areas is not established (Ballin, 1999, 208; Knutsson, 1993; Olofsson, 2002). Perhaps this discussion can be seen, at least to some extent, as a result of inconsistency in how the core is defined.

The areas outside of Sweden and Denmark have been researched to a much smaller degree and little is known about the technological characteristics of the handle core concept in these areas (Gerken, 2001, 42-43; Gramsch, 1973, 27; Mahlstedt, 2012, 59-62). Schleswig-Holstein in northern Germany is one area, in which handle cores exist (Schwabedissen, 1944; Schwantes, 1939, 110-111), but they have not been technologically studied and contextualised on a larger spatial scale.

Handle core definitions

The handle cores from Denmark and Sweden have been described and defined in many ways, often based on their morphological traits. The cores are described as having an oblong shape with blade reduction from one- or two of their shorter sides. They have also been described as "handle-shaped". The handle core blades are said to be short, thin, with distal curvature and trimming of the platform (Bille Henriksen, 1976, 15, 17; Friis Johansen, 1919, 156; Mathiassen, 1948, 16; Westerby, 1927, 53). Handle cores have also been defined via certain metric rules such as having a length – width ratio of 2:1. Similarly, microblades are sometimes defined as blades that are less than 10 mm wide (Lannerbro, 1976, 53-56).

The definition of a handle core has also been related to technological attributes, which illustrate the choices made by the flint knapper in the preparation and exploitation of the core (Callahan, 1985; Øland Frandsen, 2015). By extension, this also takes into account the dynamic morphology of the handle core throughout its preparation, exploitation and final discarding, i.e. the *chaîne opératoire*. The first to do this was Larsson (1978, 55) who described the handle core as a core which was exploited for detachment of microblades on one end of the core. Furthermore, Larsson describes the shaping of the core and considers the changing morphology of it as a result of continuing exploitation. He furthermore suggests that the knapper seems to strengthen the platform edge through trimming. The reason for the initially longer shape of the core and the placement of the blade negatives on one side (the front) is technologically explained by Knutsson (1980) as a result of wanting an effective way of producing many blades of similar character by keeping a constant reduction radius. Since the core is reduced from front to back, the length and width of the blades can remain the same, as opposed to a conical core which has to be rejuvenated through the detachment of core tablets, which furthermore reduces the length of the core as production is progressing (ibid.). By using technological attributes instead of, for example, metric ones as a base for defining the handle core technology, the definition in itself becomes relevant for understanding the choices made by the flint knapper. Variations within this technological concept in different parts of Northern Europe can therefore contribute to the understanding of the people that implemented it.

Variations within the handle core concept in Northern Europe

Large amounts of work have been put into describing handle cores and handle core blades from different parts of Scandinavia, which has resulted in a lot of literature on the subject (e.g. Larsson, 1978; Olofsson 1995; 2003; Sørensen, 2006; Vang Petersen, 1984; Øland Frandsen, 2015).

Handle core finds from Scandinavia indicate that the shaping and preparation of the cores were done in a similar manner in the southern and northern parts of the area. However, a few differences were observed in a study by Olofsson (1995, 108-109). One observed difference is the size of the cores, with larger cores in southern Scandinavia (ibid., tab. 11). In southern Scandinavia mean measurements for handle core lengths vary between 61 and 71 mm (compared to 44 mm in north). For core width the difference is between 26 and 27 mm (compared to 23 mm for north) and for core height between 33 and 43 (compared to 24 mm for north). But the representability of this comparison is doubtful, as Olofsson (ibid.; 2002) himself states, since the core assemblage used for this comparison consists of 85 cores from only three sites (compared to 125 cores from all over northern Sweden) and might therefore not be representative for all of southern Scandinavia. A second difference in the core material from these areas is the size of the front angle, which is larger in the south than in northern Sweden. Especially in Denmark there seems to be a trend of cores having a larger angle than 90 degrees, while in the north it is more common to have an angle smaller than 90 degrees (Olofsson, 1995, 109-110). Still it is important to note that the sizes of the two compared samples are uneven, consisting of 8 cores from the Vedbaek site and 184 cores from all over northern

Sweden. A third difference between these two areas relates to the microliths made from handle core blades. In northern Sweden the worked microblades are almost completely absent and it seems instead that the microblades themselves were used without further shaping. In southern Scandinavia microliths appear in abundance (Olofsson, 1995, 110). A fourth difference can be seen in the choice of raw material. In southern Scandinavia flint is dominantly used, while in the northern parts of Sweden a larger variety of different local raw materials are used (Olofsson, 2002).

Besides the general differences between southern and northern Scandinavia mentioned above some technological trends have been found in the handle core materials from different areas in Scandinavia. In Olofsson's (1995, 50-51) study of handle cores from northern Sweden he describes that the shaping of the cores to a large extent (69 % of the cores) is done by flake detachment from both platform and keel, while the rest seem to be shaped from the platform only. He further observes that cores sometimes have cortex covering one complete side of the core (ibid., 15). The cores have one or two blade detachment sides and a majority of the handle cores included in his study contain core side trimming, 51 % show signs of trimming on both sides of the core. The reason for this trimming has been debated and it might be traces of the core being fixed in a holding device during blade detachment (ibid., 15, 50-51) or a result of softening the sharp edges of the core for hand held detachment (Callahan, 1985, 32). Furthermore, the blades seem to have been detached from the core using either indirect soft technique or pressure technique (ibid., 50-51). However, it should be noted that in Olofsson's (1995) study, handle cores were not separated from keeled scrapers (for discussions on the subject of handle cores and keeled scrapers c.f. sources in Olofsson, 1995).

Handle cores from the southern and eastern parts of Norway have been described as similar to the northern Swedish ones when it comes to the use of local raw materials and the size of the cores (Olofsson, 1995, 113-116).

Larsson (1978, 55) describes handle cores from Scania, from the early Atlantic site Ageröd I:B. These cores are described as oblong and often having cortex remains on one of the long sides. The cores are shaped from both platform and keel, sometimes with flake negatives perpendicular to the long axis. Larsson goes on to discuss *"retouch"* located at right angles to the platform which he explains as being the result of unsuccessful pressure knapping and not as results of striking or wear, as had been previously suggested. Based on these traces he argues for the use of indirect technique, or what he found more likely, pressure technique for the detachment of the blades (ibid.).

Sørensen (2006) describes handle cores and blades from Zealand, eastern Denmark, from the site Mosegården III Nord. Here he includes the handle core concept (concept 7) in a larger technocomplex called *"Technocomplex 4"*. He describes the handle cores as elongated single platform cores from which blade detachment was done by means of pressure technique from one or two sides of the core. The handle core blades are described as shorter and thinner than an earlier microblade concept (concept 5), with a length as short as 40 mm. Blades are narrow, thin, regular, with percussion bulb and lip as well as with a lens-shaped butt. Butt interior angles are c. 90-100 degrees and blades are prepared by slight abrasion (ibid.).

Ballin (2016) has described handle cores from Jutland, western Denmark, an area formally thought to lack handle cores completely. He describes the cores as elongated with detachment front(s) on one or two of the short ends and with plain or faceted platforms. The cores also have keels on the opposite side of the platform. The cores were rejuvenated when the front core angle became too blunt for further blade detachment. This was done by either a front detachment flake or by flaking of the platform, creating a core tablet/rejuvenation flake (ibid.). Other characteristics of these cores include trimming of the core front and often large portions of remaining cortex on the cores. On several of the handle cores described by Ballin (2016) cortex remains on at least one full side and some recorded cores have cortex where a keel is normally found. Blades are described as often having curved distal ends.

Øland Frandsen (2015) has studied handle cores from 15 sites from both sides of the Øresund in order to investigate any chronological or regional differences between these areas. In his study Øland Frandsen (2015) defined four different technologies relating to the handle cores: 1) Handle cores with rejuvenation from the platform, 2) Handle cores with rejuvenation of the platform, 3) Handle cores with intentionally low fronts, 4) Microblades on a flake (Øland Frandsen, 2015). He furthermore concluded that there seem to be temporal differences between some of these technologies. One example comes from his technology 3, which exists on both sides of Øresund, but only during the Vedbæk phase (late Kongemose period). Another example is that technology 2 seems to only have existed east of Øresund until the Vedbæk phase when it seems to have existed on both sides (ibid.). The different ways of shaping and rejuvenating the handle cores are demonstrated by the names of the technologies. Øland Frandsen (2015, 40-41) describes the handle core shaping process starting with the use of flint nodules that have an advantageous shape, reducing the nodule with flakes on all sides before creating a platform. Trimming and flaking of the sides of the core, from platform and keel, is then used to create a keel shape. Then blades are detached by pressure knapping and core fronts are rejuvenated according to the technologies described. The handle cores included in this study often have a large portion of remaining cortex, sometimes as much as a full core side (Øland Frandsen, 2015, catalogue).

Chronology and distribution

It has been suggested that the handle core technology was introduced in northern Sweden sometime around 7500-6300 cal. BC[1] (Olofsson, 2002; c.f. comprehensive review in Olofsson, 2003). The oldest radiocarbon ages used to establish this chronology come from Garaselet, located in Västerbotten, northern Sweden. On this site the handle core technology was dated to around 7500-6200 cal. BC. However, when the stratigraphy of the site was analysed by Knutsson (1993) it became obvious that the radiocarbon sample came from a different layer than the handle core finds (Knutsson, 1993; 2004) and should therefore not be used for dating the handle core technology. The oldest radiocarbon date from northern Sweden, besides the Garaselet site, comes from Högland, Lappland, and dates to 7026-6372 cal. BC (7715±115 uncal. BP in Melander, 1981; Olofsson, 2002). However, the radiocarbon date and the handle core finds can again not certainty be attributed to the same context (Olofsson, 2002). This type of discrepancy between a handle core find and a radiocarbon sample used to date the find is recurrent on several other handle core sites in the area (Olofsson, 2002).

In the central and southern parts of Scandinavia the technology has been said to be in use from the early Atlantic chronozone, around 7000-6500 to around 5700-5400 cal. BC, and is considered a characteristic feature of both Late Maglemose and the following Kongemose technocomplexes (Ballin, 2016; Jensen, 2001, 58; Hartz et al., 2010; Sørensen, 2006). It has also been argued that the handle core technology is introduced in northern Germany at around the same time as in southern Scandinavia (c.f. Bokelmann, 1991, 91-92; Hartz et al., 2010), though this is difficult to support with C^{14}-dates since few sites in Schleswig-Holstein and Mecklenburg-Vorpommern, relating to the relevant time period, are AMS dated (Hartz et al., 2010). The varying accounts for the introduction of this technology together with the low number of AMS-dated sites from northern Germany create issues in establishing a chronology for these finds. One of the dated sites, containing handle core finds in a distinct find layer, has been dated to between 6400 and 6000 cal. BC, placing it at the transition between Middle and Late Mesolithic (Lübke et al., 2011). The use of handle core technology is suggested to end in southern Scandinavia at the end of the Kongemose technocomplex around 5400 cal. BC (Ballin, 2016; Jensen, 2001, 58).

Objectives and research questions

Many comparative studies focused on the handle core technology have been conducted throughout Sweden and Denmark (see above). These studies have led to valuable knowledge that can be used for comparing raw material use, core preparation, blade production etc. during the Mesolithic around the Baltic sea. In extension, this can be used to approach subjects such as mobility patterns, contacts between people and transmission of knowledge. But few technological studies have been done on the handle core materials from the southern parts of the Baltic region, which is the research area focused on in the present study. The research questions are:

1. What is the local expression of the handle core concept in Schleswig-Holstein? How were the cores shaped and prepared and how were the blades produced?
2. How does the handle core concept in Schleswig-Holstein compare to the established picture of the handle core technology in Scandinavia?

Method and material

By studying the technological process of lithic tool production, the choices and actions of the knapper can be observed as well, as is the general idea behind the *chaîne opératoire* approach (Dobres, 2010; Inizan et al., 1999; Lemonnier, 1976; Leroi-Gourhan, 1964; Pelegrin, 1990; Pelegrin et al., 1988; Schlanger, 1994). With this theoretical backdrop, lithic analysis can be used to understand mobility, contacts and transmission of knowledge.

For this article three Mesolithic flint assemblages from Schleswig-Holstein were systematically studied to investigate the local expression of the handle core concept. In accordance with the research questions, I have specifically focused on the preparation and shaping of the core as well as the production of the blades.

Three Mesolithic sites in Schleswig-Holstein were chosen for analysis (see **Fig. 1**; **Fig. 2**), based on material availability and chronological relevance. It is worth noting that the Dreggers site contains a higher number of finds than the Owschlag sites, which creates an overrepresentation of the Dreggers site in this study.

The selection of cores and blades for recording was based on the definitions for respective artefact type. Cores were selected if they showed traces of blade detachment, i.e. had remains of blade negatives with a length-width ratio of 2:1 as well as indications that blades were detached as a part of a serial production. Additionally, handle cores were defined as such when blade reduction was made from one (or two opposing) clearly limited reduction fronts. Blades were selected fitting the same description as the mentioned blade negatives. Blades of all sizes were recorded in the same manner; no (metric or typological) separation was made between smaller and larger blades in order to avoid constructed groupings within the material.

The attributes chosen for the recording scheme are listed in **Fig. 3** (see supplementary material for full database (suppl. 1a) and attribute morphologies (suppl. 1b)). In addition to the attributes listed below, general information such as find ID, find no., site, raw material, thermal influence, weathering, cortex remains, basic artefact type and secondary artefact type was recorded for each find.

The attributes included in the recording scheme were chosen based on their relevance for

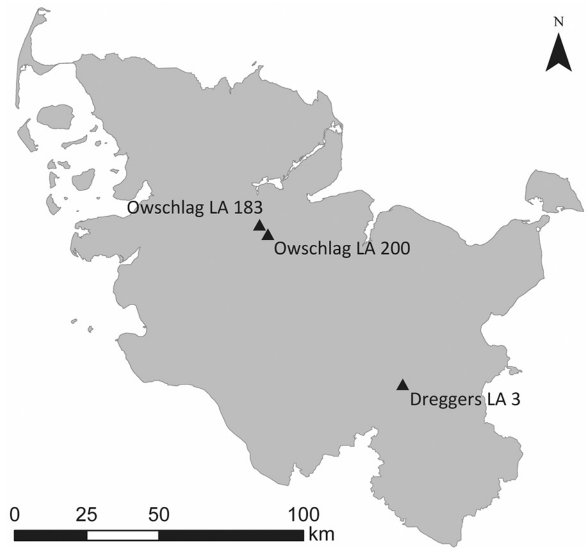

Fig. 1 Map of Schleswig-Holstein displaying the locations of the three sites included in the study; Owschlag LA 183, Owschlag LA 200 and Dreggers LA 3 (© EuroGeographics for the administrative boundaries).

the research questions as well as their statistical significance as defined by Damlien (2015). In this study, Damlien investigated the relationships between several technological blade attributes and the knapping techniques used to detach blades. The significance and strength of the relationships were then measured. Combinations of several blade attributes were identified and their predictive efficiency for blade detachment technique was analysed. The results showed that the combination of *regularity*, *interior platform angle* and *conus formation* provides a good predictive value for blade detachment in a larger population of blades

Site	Type of excavation, year	Archaeologist	Time period, C^{14}-dates	Number of cores (incl. handle cores)	Number of blades	Total number of recorded finds
Owschlag LA 183	Partial excavation, 1970	Kühl, J.	Late Mesolithic	12 (3)	228	240
Owschlag LA 200	Partial excavation, 1984	Clausen, I.	Late Mesolithic-early Neolithic, 5215-4565 cal. B.C (charcoal, KI-2351)	1 (0)	91	92
Dreggers LA 3	1960-1980, surface collection	Nierling, P.	Late Mesolithic	155 (54)	3248	3403
All sites				**168 (57)**	**3567**	**3735**

Fig. 2 Site information. Including type of excavation, year of excavation, excavating archaeologist, time period, any C^{14}-dates and recorded number of cores and blades (Bokelmann, 1971; Clausen, 1994; P. Nierling, in personal communication with S. Hartz, November 21, 2012).

Core attributes		Blade attributes
Length	Length	Blade retouch
Width	Width	Ventral/dorsal retouch
Thickness/height	Thickness/height	Retouch location vertical
Fragmentation	Fragmentation	Retouch location lateral
Core type	Blade curvature	Visible use wear
Blade reduction	Ventral ripples	Use wear location vertical
Blade negatives width	Regularity	Use wear location lateral
Blade negatives length	Blade termination	
Faceting of platform	Conus formation	
Platform preparation	Butt preservation	
Front angle	Butt morphology	
Core body shaping vertical	Butt preparation	
Core body shaping lateral	Butt interior angle	
Core side retouch	Lip formation	

Fig. 3 Recorded attributes of cores and blades.

(ibid.). These attributes are therefore used as *"predictors"* of knapping techniques in this study. The remaining attributes relating to blade production and core shaping were chosen in an effort to describe the handle core concept in this region and to be used for comparative studies. A selection of photos of handle cores can be found in the supplementary material (suppl. 4).

The finds were collectively analysed and no separation between sites were made, due to varying amounts of materials from each site, which made comparisons between them difficult. Finds were statistically analysed using the program *R studio* (Version 1.0.153). A cluster analysis, including length, width and thickness of blades, was also done in order to visualize any groupings of different sizes within the material. A special focus was also put on the three predictors noted by Damlien (2015) as a way of investigating the knapping techniques used for blades of different sizes. This was done in an effort to observe any differences in knapping techniques used for handle core blades, which are often smaller in size (often called *"microblades"*), and for blades that were larger in size.

Results

Attributes and attribute morphologies, connected to handle core shaping and preparation observed for this study are displayed in **Fig. 4**. The number of recorded handle cores is 57. For each attribute, the number does not always add up to 57, simply because there are some indeterminable (indet.) cores for the category in question. Percentages were not added since the low number of cores is likely to create a sense of overrepresentation when displayed as percentages. The recorded handle cores from Schleswig-Holstein indicate that shaping was commonly done from both platform and keel (45/55) as well as from the back of the core (22/50). The high number of cores with shaping from the back of the core might be due to the standard manner of blade reduction from these cores. It is done from the front and thus removes any shaping negatives on the front end. Because of this it can be assumed that the cores were shaped from the front as well as from the back.

Blades are generally detached from one of the core's shorter sides (51/53), and the core's frontal platform edge is often trimmed (35/53). Core front angles are generally around 80 or 90 degrees (22/47) and the core platforms tend to be plain (46/54) rather than faceted. Core side trimming is common on one (18/48) and on two sides (19/48) and the blade negative widths are generally lower than 10 mm (48/50). The amount of remaining cortex on the cores is often small with a majority of cores having no cortex (25/57) or less than ¼ (23/57). The cores that do have larger areas of remaining cortex often still exhibit the shape of the natural flint nodule, indicating that cores were often shaped to a minimum when the nodule had an advantageous shape. In order to compare core sizes, complete cores were measured (**Fig. 5**).

All attributes, and attribute morphologies, recorded for blade production in this study are displayed in **Fig. 6**. The number of recorded blades is by far greater than the cores (n=3.567). For each attribute the number does not always add up to the total number of blades, simply because there are some indeterminable (indet.) blades for the category in question. Percentages were also added to the table in an effort to handle the large number of blades. The blades can often be described as regular (61,8 %) with slight curvature (51,6 %) and slight (49,8 %) or no ventral ripples (44,6 %). The blade butts are often large and oval (39,5 %), smooth (78,2 %) and tend to lack any kind of conus formation (90,8 %). Blades often have a slight lip (71,9 %) and trimming of the platform edge (79,6 %). Interior butt angles vary a

Attribute	Attribute morphologies	Number of finds
Vertical core shaping	from platform and keel	45
	from platform	8
	from keel	2
Total		**55**
Lateral core shaping	from back	22
	no lateral shaping	14
	from front	8
	from front and back	6
Total		**50**
Blade detachment sides	one side	51
	two sides	2
Total		**53**
Platform preparation	trimming	35
	no platform preparation	7
	trimming on front and platform	7
	trimming and abrasion	2
	trimming on platform	2
Total		**53**
Front angle	80	11
	90	11
	85	7
	100	5
	70	4
	95	3
	105	3
	75	2
	115	1
Total		**47**
Faceting	plain platform	46
	partial faceting	6
	complete faceting	2
Total		**54**
Side trimming	on two sides	19
	on one side	18
	no side trimming	11
Total		**48**
Cortex	no cortex	25
	less than 25%	23
	between 25% and 50%	7
	between 50% and 75%	2
Total		**57**
Blade negative width	less than 10 mm	48
	between 10,1–15 mm	2
Total		**50**

Fig. 4 Recorded numbers of core attribute morphologies.

Handle core measurements	Min - max	Mean	SD
Length	27,2-83,3	51,1	13,63901
Width	16,5-42,6	26,6	5,939087
Height	27,7-62,1	43,5	7,939835

Fig. 5 Min., max. and mean measurements for length, width and height (in mm) of recorded complete handle cores (n=50).

lot and a clear trend cannot be distinguished. One observation that can be made is that very few blades have angles larger than 90 degrees (9,5 %).

A cluster analysis including the length, width and thickness of all complete blades (n=600) was made in order to see any groupings of blade sizes within the material. A *scree plot* was used to establish an appropriate number of clusters. Each combination of metrics was subsequently plotted in scatterplots, using 2, 3 and 4 clusters without any visible groupings within the material (see supplementary material, suppl. 2).

Even though no groupings of different sizes of blades could be seen through the cluster analysis, the attribute morphologies that relate to knapping technique were still tested with regard to different sizes of blades. The three attributes noted as predictors of knapping technique (Damlien, 2015) were chosen for this comparison (see supplementary material, suppl. 3). The result of the analysis indicates that blades of different sizes share similar attribute morphologies. The comparison of regularity between wider and narrower blades shows that there are more regular blades than irregular blades but there is no significant difference in width between these groups. The high number of regular blades within the material further indicates the use of direct soft/indirect and/or pressure technique for detachment (Damlien, 2015; Pelegrin, 2012; Sørensen, 2006; 2013).

The comparison of different conus formations gave little information since a large majority of the blades lack any sort of conus formation. The low representation of any type of conus formation among the blades, however, indicates that indirect and/or pressure technique was primarily used (Sørensen, 2013).

The interior platform angles varied among the different blade widths and no clear trends were visible among these groups. This result indicates that a large number of the larger and smaller blades are produced using the same knapping technique. The knapping technique can very likely be described as either indirect technique, pressure technique or a combination of the two.

Attribute	Attribute morphologies	Number of finds	Percent
Blade regularity	regular	2186	61,80%
	irregular	1322	37,30%
	extremely regular	32	0,90%
Total		**3540**	**100%**
Conus formation	no conus formation	1607	90,80%
	ring crack on butt	98	5,50%
	ring crack and ventral fissures	45	2,50%
	detached bulb	20	1,10%
Total		**1770**	**100%**
Blade interior angle	smaller than 71 degrees	348	21,80%
	78-82 degrees	346	21,70%
	90 degrees	266	16,70%
	72-77 degrees	242	15,20%
	83-89 degrees	242	15,20%
	larger than 90 degrees	152	9,50%
Total		**1596**	**100%**
Blade curvature	slight curvature	1553	51,60%
	straight blades	1158	38,40%
	prominent curvature	154	5,10%
	distal curvature	147	4,90%
Total		**3012**	**100%**
Ventral ripples	visible ventral ripples	1750	49,80%
	no ventral ripples	1569	44,60%
	pronounced ventral ripples	196	5,60%
Total		**3515**	**100%**
Butt morphologies	large oval butt	668	39,50%
	thick large butt	299	17,70%
	small butt	274	16,20%
	thin oval butt	209	12,40%
	small thick butt	167	9,90%
	punctiform butt	74	4,40%
Total		**1691**	**100%**
Lip formation	preserved lip	1262	71,90%
	no lip	473	27,00%
	pronounced lip	18	1,00%
	removed by preparation	1	0,10%
Total		**1754**	**100%**
Butt preservation	smooth platform	1311	78,20%
	facetted platform	208	12,40%
	broken platform	142	8,50%
	platform w cortex	14	0,80%
	polished platform	1	0,10%
Total		**1676**	**100%**
Butt preparation	trimming	1585	79,60%
	abrasion	157	7,90%
	no preparation	153	7,70%
	trimming and abrasion	95	4,80%
Total		**1990**	**100%**

Fig. 6 Recorded numbers of blade attribute morphologies.

Discussion – Handle cores in Schleswig-Holstein compared to Scandinavia

In Olofsson's (1995, 108-109) comparisons of handle cores, and handle core blades, from northern and southern Scandinavia he mentions four differences between them: the size, the front angle, the use of microliths and the use of raw material. When compared to the handle cores from Schleswig-Holstein both differences and similarities exists. First of all, it appears that handle cores from northern Germany show many similarities to the southern Scandinavian cores, especially when comparing core sizes. The mean measurements for width and height of the cores from Schleswig-Holstein closely match the recorded core sizes from southern Scandinavia. The cores from Schleswig-Holstein are also slightly shorter, perhaps as a result of being more extensively exploited. However, it should be noted that this comparison is based on 50 handle cores from Schleswig-Holstein only, in comparison to 85 from southern Scandinavia and 125 from northern Scandinavia (Olofsson, 1995). It is possible that this is a result of availability, quality or property of different raw materials.

When it comes to the core front angle, most of the Schleswig-Holstein cores have angles around 80-90 degrees. This, according to Olofsson (1995, 109-110), indicates more of a similarity to the northern Swedish cores. However, the observations by Olofsson (ibid.) from southern Scandinavia are represented by 8 cores only from one site in Zealand, and can therefore not be seen as a significant difference between these areas. However, Sørensen (2006) also described handle cores from southern Scandinavia as having core fronts at angles between 90-100 degrees. The angles measured from the blades, however, indicate smaller angles (Fig. 6), which could be a more relevant result since cores tend to show only the last stage of detachment. Perhaps differences in core front angle could be attributed to regional differences, chronological differences or use of different raw materials.

The recorded handle cores from Schleswig-Holstein are all made from flint materials, following the same trend as the south Scandinavian cores. Most probably this is a result of raw material availability in the different areas. Flint is abundant in southern Scandinavia while other local raw materials are commonly used in the northern parts.

Besides these general trends, the technological attributes recorded in the northern Swedish handle cores (Olofsson, 1995, 50-51) show great similarity regarding the shaping of the core with the cores from southern Scandinavia (Ballin, 2016; Larsson, 1978, 55; Sørensen, 2006; Øland Frandsen, 2015) as well as with the cores from Schleswig-Holstein. The similarities are numerous and will be discussed in the following. The handle cores from Schleswig-Holstein are shaped from all directions, just as the cores from northern Sweden (Olofsson, 1995, 50-51), Scania (Larsson, 1978, 55) as well as Denmark (Øland Frandsen, 2015, 41).

The handle cores from the study area commonly have one blade detachment side/core front, though two fronts also occur. This is similar to other areas of Scandinavia (Ballin, 2016; Larsson, 1978, 56; Olofsson, 1995, 15-17; Sørensen, 2006; Øland Frandsen, 2015, catalogue).

Trimming of the core's frontal platform edge appears to be the most common way of preparing the core before blade detachment. But there are many cores in the studied material that show no sign of preparation at all, which may be a result of the knapper not preparing a core that is to be discarded. The blades, however, regularly show signs of trimming and thus indicate that frontal platform edge preparation was commonly done. Trimming of the core front has also been observed on handle cores from Jutland in Denmark (Ballin, 2016) and in Scania (Larsson, 1978, 55). Sørensen (2006) has described the blades from handle cores as being usually prepared through abrasion. It is unclear whether the definitions of abrasion and platform edge preparation were the same for all researchers when the analyses were performed and if not, it must be questioned if this attribute should be used for this comparative study.

Handle cores are often described and visualised with plain platforms (c.f. Larsson, 1978; Olofsson, 1995; Sørensen, 2006). However, Øland Frandsen (2015) mentions and displays cores with rejuvenation of the platform, thus being a type of faceting. Faceting is also shown on illustrations in Ballin (2016). It becomes clear that this attribute seems to vary in different areas of Scandinavia. The handle cores from Schleswig-Holstein are to a large degree plain but a small amount of faceting does occur, perhaps relating to a trend visible on the handle cores from Denmark.

Core side trimming/retouch is observed on handle cores from northern Sweden (Olofsson, 1995, 50-51), from Zealand and Scania (Øland Frandsen, 2015) as well as from Schleswig-Holstein. What this side trimming was used for is still debated (Callahan, 1985; Olofsson, 1995, 15).

The notion of keeping a large portion of the cortex, preserving the natural shape of the flint nodule intact, has been observed on cores from Jutland (Ballin, 2016), Zealand/Scania (Øland Frandsen, 2015) as well as in northern Germany (see present study; Lübke, 2000, fig. 37; Lübke et al., 2011, fig. 3.6). This could be a trend in areas where flint is naturally occurring and abundant. In these areas it is also common to see cores with a full side of cortex kept throughout the blade production phase. This has also been observed on cores from northern Sweden (Olofsson, 1995, 15), though there are few recorded examples of this to be found. It is not clear if this observation regards cores made of flint or of other raw materials found in northern Sweden.

The blades recorded for this study come from different types of blade cores with varying sizes. No groupings, based on metrics or blade morphology, were observed among the blades of this study. When handle core blades are discussed they are generally described as thin, regular, short and narrow blades, often with distal curvature (Callahan, 1985; Ballin, 2016; Sørensen, 2006). The recorded blades from Schleswig-Holstein are to a large degree regular, but they generally show an even and slight curvature rather than a distal one, though the definitions of distal curvature (as with many other qualitative attributes) may not be strictly objective but rather a result of interpretation by the archaeologist who is recording. When it comes to length, width and thickness of the blades from the study area, scatterplots were used to visualise any existing groups of narrower and wider blades within the materials. The width was used instead of the length since many of the blades were fragmented. However, no groupings or clusters could be observed. Therefore, the blades from handle cores cannot be defined by their size in the analysed material. Even though, the height of the recorded handle cores suggest that most handle core blades should vary between 27,7-62,1 mm. However, these measurements should not be considered as measurements to be used for defining handle core blades in general.

It should be noted that the majority of the handle cores and blades included in this study were found on one site, Dreggers LA 3. The Owschlag sites contributed with a smaller number of finds which means that the lithics from Dreggers, which are overrepresented in the present study, might not be representative for how this technology was used in the whole of Schleswig-Holstein.

As already touched upon, it can be problematic to record and compare lithics using qualitative attributes since the interpretation of the attribute is made by different archaeologists, carrying different ideas about how the attribute can/should be described and defined. Can such interpretations really be objective and comparable? Being aware of the risk of subjectivity is crucial when studying qualitative attributes, but in my opinion there is a need for further method development on this subject.

When it comes to understanding the handle core (or any other) technology on a large spatial scale, technological comparisons between areas are important as a way of studying trends that could aid in understanding mobility, contacts and cultural transmission during the Mesolithic. However, a great problem lies in the lack of chronology for these finds. Without the chronological aspect it becomes impossible to understand such trends in their spatio-temporal contexts, which is a huge part of the understanding of how the Mesolithic people implemented and spread this technological concept and exchanged knowledge.

Conclusions

The results of the present study indicate that handle core technology in Schleswig-Holstein resembles the technology in southern Scandinavia to a large degree. This suggests that northern Germany and southern Scandinavia were a part of the same cultural sphere, with contacts and mobility taking place in the area during the Middle and Late Mesolithic. Even though the handle core concept has the same general characteristics all over Scandinavia, certain aspects such as raw material availability and usage have been different in the areas surrounding the southern Baltic Sea. This study has to be seen in context with other studies to bring clarity into larger issues relating to how people moved in the landscape and how social contacts, knowledge and transmission between people during the Mesolithic happened. Establishing an over-regional chronology needs to be the next step in understanding these subjects. The handle core technology would be useful as a target for comparative studies due to its long-lived and widespread occurrence in northern Europe.

Notes

[1] The radiocarbon dates from Olofsson (2002; 2003) are calibrated using OxCal 4.3 (Bronk Ramsey, 2017). IntCal 13 atmospheric curve (Reimer et al., 2013).

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Supplemental material/open data

This paper is enriched by supplemental material: (1a) data base, (1b) data base description, (2) table with clusters, (3) table with predictors, (4) table with photographs of four handle cores.

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Sandra Söderlind attained her Master's degree in Archaeology in the spring of 2016 from Uppsala University (Sweden). Afterwards she was working as an antiquarian at the Swedish History museum in Stockholm, where she recorded lithics from the Neolithic Alvastra Pile Dwelling site. Actually she is a PhD candidate at the Graduate School Human Development in Landscapes (GSHDL) at Kiel University. This article, however, is a result of independent research.

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