Moving Beyond the Margin: A Multi-Perspective Approach to the Study of the Peripheral Neanderthal Range with a Case Study from Scandinavia

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Abstract: *The geographical margin of the Neanderthal range requires constant (re)assessment in order to distinguish between hominin adaptive constraints and research and preservation biases. Using Scandinavia as an overarching case-study area, this paper addresses this need in two parts. The first part presents a widely applicable multi-perspective approach to the study of the marginal range of Neanderthals. This four-step analytical strategy offers a methodological scaffold with multi-regional application potential. The second part presents the results of the empirical aspect of the approach, in this case, by reviewing the purported Pleistocene archaeological record of Denmark focusing on two main challenges, 1) the geological context and 2) the technological integrity of the finds. The conclusion of this review is that there are currently no secure finds or sites from Denmark that indicate a pre-Upper Paleolithic Pleistocene age or a Neanderthal affiliation. The final recommendation of the paper is that the multi-perspective approach should be applied along the margins of the currently acknowledged Neanderthal range in order to improve the baseline from which we build our assumptions.*
Keywords: *Denmark, Neanderthals, marginal landscapes, distribution, multi-perspective approach*

Über den Rand hinaus: ein multiperspektivischer Ansatz zur Erforschung der Verbreitungsgrenze von Neandertalern mit einer Fallstudie aus Skandinavien

Zusammenfassung: Nur eine ständige (Neu-)Bewertung der äußeren Ränder des Neandertaler-Verbreitungsgebietes erlaubt es den Archäologen, den überlieferten Befund als Ergebnis von Anpassungsbeschränkungen früher Menschen, von Forschungslücken oder durch Erhaltungsbedingungen verursachten Lücken zu deuten. Unter Berücksichtigung von Skandinavien als umspannendes Arbeitsgebiet für eine Fallstudie, geht der Beitrag in zwei Teilen auf diese Notwendigkeit ein. Der erste Teil präsentiert einen weithin anwendbaren multiperspektivischen Ansatz zur Erforschung des äußeren Verbreitungsgebietes von Neandertalern. Eine in vier Schritte aufgebaute Analysestrategie schafft ein methodologisches Gerüst mit dem Potential für eine multiregionale Anwendung. Schritt 1 ist eine gründliche Beurteilung des Einflusses, den forschungsgeschichtliche Aspekte auf die archäologische Überlieferung und die erkenntnistheoretischen Forschungsgrundlagen im Arbeitsgebiet haben. Schritt 2 beinhaltet eine Untersuchung des weiteren Kontextes der menschlichen Biogeographie und der Rolle des Arbeitsgebietes für die Ausbreitung von Menschen und deren Anpassung an die Umwelt. Schritt 3 besteht in einer regionalspezifischen Untersuchung der zeitlichen und räumlichen Fenster für A) Möglichkeiten zur Besiedlung in der Vergangenheit (z.B. paläoklimatische Bedingungen, Nahrungsverfügbarkeit und Zugangsmöglichkeiten) und für B) Möglichkeiten archäologischer Entdeckungen in der Gegenwart (z.B. geologische Geschichte und Aufdeckungspotential). Schritt 4 ist eine empirische Beurteilung der lokalen im Laufe der Zeit aufgestellten Behauptungen über die Auffindung pleistozäner Funde bzw. Fundstellen

(z. B. die Auffindung angeblicher Faustkeile) sowie eine strategische Durchführung systematischer und datenbasierter Surveyvorhaben an geeigneten geoarchäologischen Stellen, wie sie durch Schritt 3 identifiziert worden sind. Als solcher berücksichtigt dieser Ansatz die Hauptfaktoren, die die archäologische Überlieferung des gewählten Arbeitsgebietes beeinflussen, auf einer sowohl lokalen und regionalen als auch globalen Ebene und schafft eine neue und fundierte Basis, von welcher aus Hypothesen getestet werden können.

Im zweiten Teil des Beitrags werden die Ergebnisse zum empirischen Aspekt dieses Ansatzes vorgestellt. Dies geschieht mittels einer Bewertung der angeblichen pleistozänen archäologischen Funde in Dänemark. Dabei liegt der Schwerpunkt auf zwei wesentlichen Fragestellungen: 1) dem geologischen Kontext und 2) der technologischen Integrität der Funde. Die Schlussfolgerung aus dieser kritischen Sichtung ist es, dass es derzeit keine gesicherten Funde bzw. Fundstellen aus Dänemark gibt, denen ein vor-jungpaläolithisches pleistozänes Alter zugebilligt werden kann oder die mit Neandertalern in Zusammenhang stehen. Die abschließende Empfehlung besteht darin, den multiperspektivischen Ansatz auf alle Randgebiete entlang der anerkannten Neandertalerverbreitung anzuwenden, um festzustellen, ob das momentane Vorkommen bzw. Fehlen auf menschliches Verhalten, taphonomische Prozesse oder forschungsbezogene Phänomene zurückzuführen ist. Dadurch würde die Grundlage, auf welcher wir Hypothesen über die förderlichen oder hinderlichen Faktoren bei der Verbreitung von Neandertalern formulieren können, beachtlich verbessert.

Schlagwörter: Dänemark, Neandertaler, Randgebiete, Verbreitung, multiperspektivischer Ansatz

Introduction

Challenging assumptions

In the last decade, baseline knowledge regarding our human ancestors has repeatedly been challenged by groundbreaking findings, such as the discovery of the new Denisovan species (Reich et al. 2010), symbolic behavior attributed to Châtelperronian Neanderthals (Welker et al. 2016), the early and simultaneous presence of *Homo sapiens* in Morocco (Hublin et al. 2017), the small-bodied *Homo naledi* in South Africa more than 300,000 years ago (Berger et al. 2015), and archaic-modern human interbreeding (Kuhlwilm et al. 2016). Among other consequences, this stresses the need for the continuous re-evaluation of archaeological hypotheses and assumptions, for example, when it comes to our understanding of the adaptive and behavioral plasticity of archaic hominins, such as Neanderthals (*Homo neanderthalensis*). In order to do this, archaeologists also need to look beyond the already acknowledged, find-rich, and well-preserved archaeological sites in the interior of past population ranges in order to push boundaries (theoretically as well as practically) and explore the potential at the margins of the geographic range and test the representativeness of hominin absence. Against this background this paper presents a multi-perspective approach to test and explain the causes for the absence of evidence along the geographic range periphery, here specifically to (re-)assess the northern European dispersal boundary of Pleistocene Neanderthals.

The current archaeological record suggests that the Neanderthal range encompassed large parts of Eurasia, delimited naturally in the west, north and south by the Atlantic Ocean, the North and Baltic Sea and the Mediterranean Sea. Their range to the east extended to the inner Eurasian continent, at least to the Altai Mountains of Russia. However, it is relatively unclear how far north Neanderthals successfully ventured and to what degree climate-driven adaptive constraints made habitual colonization of high northern latitudes (un-)viable.

Based on the archaeological record, the currently accepted northern range boundary approximately follows the 55°N latitude gradient, which excludes the circumpolar region of Eurasia as well as Scandinavia and parts of the British Isles from expected

Neanderthal occupation. Prevailing arguments usually explain this demographic pattern with reference to the cold and harsh climate of the north, combined with archaic hominin adaptive constraints and high energy requirements (Finlayson 2004; Serangeli and Bolus 2008; Macdonald et al. 2009; Roebroeks et al. 2011; Cohen et al. 2012). However, these arguments are often rooted in general and large-scale (both temporally and spatially) reconstructions of northern (>55°N) paleoenvironments that are contrasted with the more consistently occupied prolific habitats of the southwestern part of the Neanderthal range, such as the Mediterranean coast.

Undoubtedly it is true that, for long periods of the Pleistocene, the northern Eurasian latitudes were generally not as hospitable as the southwestern latitudes, particularly when continental ice sheets expanded from the earth's poles during global cold phases and made large parts of the northern hemisphere completely uninhabitable. But it is necessary to consider the dichotomous north-south environmental oscillations against the longitudinal gradient as well as smaller local/regional scales in order to effectively assess the spatiotemporal occurrence of suitable environments for human occupation during warmer periods.

Such an exercise is likely to reveal a much more complex picture of the potential for human dispersal along the northern margins of their range, particularly when keeping in mind that some areas have undergone less archaeological field work (surveying as well as excavation) targeting the Pleistocene period than others. In addition, preservation of *in situ* Pleistocene deposits may be negatively correlated with the extent of the Pleistocene ice sheets as a result of soil displacement and degradation. This is important because our interpretations of past human range expansions are direct reflections of the available archaeological data, which can be biased by a wide range of factors from research history to geology, and which are often of relatively poor chronological resolution. It is therefore particularly crucial to explore the representativeness of this data along the assumed occupational peripheries, since this shapes our interpretations of behavioral and adaptive abilities in our human ancestors.

Still, one of the main challenges is *how* to effectively do this in the absence of clear-cut archaeological data. This problem is addressed below through a multi-perspective methodological template, which can be used to address this particular gap in knowledge. Its timeliness is particularly relevant when considering the several paradigm-changing discoveries made in the last decade that require us to explore novel efforts in systematically investigating and challenging baseline assumptions regarding the Neanderthal range.

Marginal landscapes

The focus of this paper is marginal landscapes at the edge of the Neanderthal world, but here specifically drawing on the Scandinavian Peninsula as a case study, and including the present-day Nordic countries Denmark, Norway, Sweden and Finland (Fig. 1). In addition to demarcating the transition between the greater European continent and the peninsular region of Scandinavia, this area represents the currently acknowledged boundary of the Neanderthal range with multiple secure sites from various time periods recognized on the continent and few, highly controversial, and/or indeterminate sites recognized in Scandinavia (some of which will be discussed in the latter part of this paper).

This setting therefore offers a suitable study area for marginal landscapes, but it should be noted that the methodological approach presented here can be extended to other regions along the periphery of the Neanderthal, or any other hominin, range.

The first part of this paper outlines the multi-perspective methodological approach to the study of marginal landscapes. The second part elaborates on one aspect of this approach, namely, the empirical evaluation for present-day Denmark.

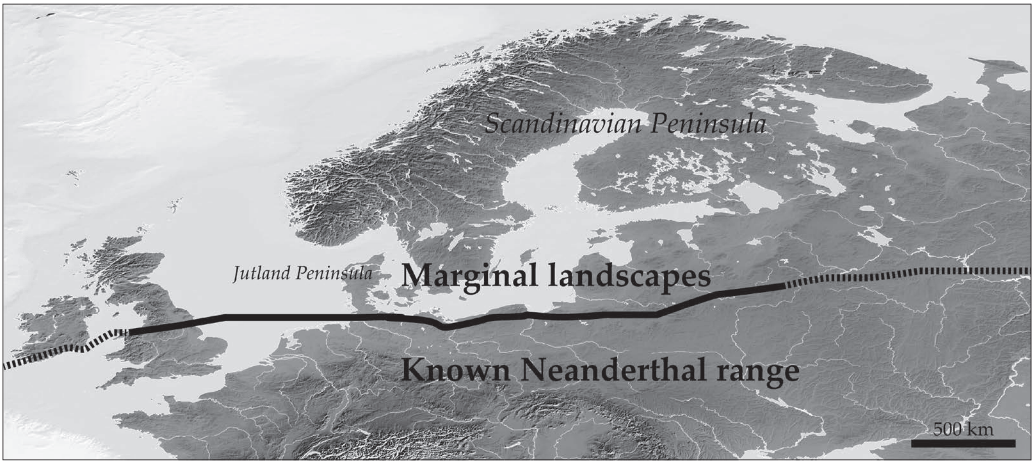

Fig. 1: *Geographical scope and the extent of the currently acknowledged Neanderthal range and marginal landscapes.*

Methodology

Outlining the multi-perspective approach

The range of explanatory hypotheses and sources of potential biases affecting archaeological interpretations of hominin expansion into peripheral regions such as Scandinavia makes it necessary to develop a rigorous and multi-perspective analytical approach to access the legitimacy of these various hypotheses. The approach is shaped by the circumstances of the current case study, but with regional-specific modifications it can be transferred directly to other geographical areas. It includes four overarching, and advisably sequential, analytical steps designed to clarify whether the current absence of archaic human evidence, in this case in Scandinavia, is a result of (lack of) hominin dispersal, and if so, why? Or a result of archaeologically biasing factors, and if so, which? The four epistemological steps and their applications are elaborated below and presented in Fig. 2. An underlying critical practice and multi-proxy proposition is pertinent to each analytical step of the approach.

Step 1: Research history

Aim

The first step is to identify the degree to which research history has influenced the archaeological agenda in the case-study area, creating a source of potential interpretative bias. This is important across all lines of archaeological research, but even more so when dealing with controversial research topics. Historical debates can continue to evoke strong emotional reactions and create, as well as discredit, groundbreaking paradigms, such as the famous case of the Piltdown man hoax (Stringer 2012). Further, paradigms can have formed on the basis of wrongful or untested information and, masked by time, regenerated as baseline knowledge. It is therefore important to scrutinize the historical roots of persistent hypotheses such as, in this case, those governing the wide held assumption that Neanderthals did not exploit Scandinavia.

Applications

A critical review of the literature is the standard and most effective way to obtain information on the epistemological baseline in a field of research. It allows unravelling sources of theories and hypotheses and their direct/indirect ties to contemporary schools of thinking. With the ever-increasing body of literature, however, this can easily become a tedious and unstructured exercise, both for the producer as well as recipient of the qualitative analysis. Faced with never ending 'big data', there is acute need for updating basic scholarly tasks and for promoting hypothesis-driven analyses even at the first level of enquiry. One way to do this is to integrate network theory in this preliminary review stage. Network theory allows studying and visualizing complex systems as graphs, allowing for intuitive and quantifiable understanding of inherent structures and relationships in the network in focus such as a research field. It specifically aids historical assessments by explicating ties and relationships between, for example, articles, authors, time and nationality. It further ensures a structural understanding of the dynamics behind paradigm formation, which allows quantitative analyses and interpretations rather than subjective and opinionated discussions of the relative influence of historical phenomena.

Step 2: Hominin biogeography

Aim

The second step is to understand the degree to which past human biogeographical behavior can explain the absence of archaeological discoveries in the case-study area. In many cases it is plausible, or at least assumed plausible (as investigated in Step 1), that absence of evidence reflects a true representation of absence of hominins. But optimally, this should be explicitly supported by and contextualized with existing knowledge on adaptive abilities, mobility patterns and subsistence strategies of the species in focus in an analogue geoenvironmental frame. These data are derived from the archaeological and fossil record at the larger scale. There is unfortunate circularity in this reasoning since the adaptive interpretations are based on, and thereby shaped by, the archaeological record under scrutiny. But this is an inherent constraint and weakness when dealing with the past and its intermittent preservation.

Applications

The archaeological record provides the main data source to investigate archaic human biogeography. This involves mapping the spatiotemporal distribution of, in this case, Neanderthals at a supra-regional/global scale, as well as identifying site function and behavioral applications at a local/singular-site scale. Drawing on biogeographical range theory, this information can then be used as proxy to unravel dynamics of dispersal at species-level and mobility at group-level, respectively, and provide a foundation to make inferences on the likelihood, and potential timing and driver, of human expansion in the case-study area.

One way to improve the explanatory power of such investigations is to include modeling approaches to explore specific parameters and possible scenarios (see Banks et al. 2008; Rodríguez et al. 2016 for examples). Agent-based modeling and/or paleo-site distribution modeling are two powerful tools for this. In the current case study, for example, paleo-species distribution modeling coupled with environmental parameters (temperature, precipitation and topography) was used to identify Neanderthal ecological preference (based on the known distribution) across the entire geographical range during the Eemian Interglacial. With this information the degree of habitat suitability in regions lacking evidence of Neanderthal occupation, such as Scandinavia, can be investigated (Benito et al. 2017; Nielsen et al. 2017).

Step 3: Windows of opportunities

Aim

The third step is to identify if and when ‘times of opportunities’ for hominin occupation occurred in the past, and if and where ‘spaces of opportunity’ for subsequent archaeological recovery occurs today. This step is therefore divided into two lines of investigation, where the aim is A) to assess if the absence of archaic humans can be explained by an unsuitable paleoclimate, inopportune paleoecology or natural boundaries in the Pleistocene landscape. This is a data-driven elaboration of the theoretical evaluation in Step 2 and is therefore complimentary. The second aim is B) to investigate the degree to which the archaeological absence can be explained by geological preservation issues. This is particularly relevant for regions with a high degree of Pleistocene landscape remodeling, like Scandinavia, where glaciotectonic and glaciofluvial dynamics have caused major chronostratigraphic displacement. This dual step is important because it helps clarify and test whether human absence is respectively due to environmental or taphonomic conditions.

Applications

Past environmental and geographical reconstruction provides the main frame to assess whether and when times of opportunity arose for human colonization. Step 3A includes reconstructing long-term changes in climate, vegetation and ecology as well as outlining the changes in land, sea and ice cover. In Scandinavia, this can be done by reviewing local pollen successions and faunal fossil remains for each Pleistocene global warm phase (interglacials and interstadials) and secondly, by reconstructing the timing and extent of marine transgressions and glacial advancement influencing terrestrial access to southern Scandinavia. This exercise is aimed at identifying which time periods offered basic conditions for human dispersal, and in extension, identify chronostratigraphic placement and depositional environment of corresponding deposits.

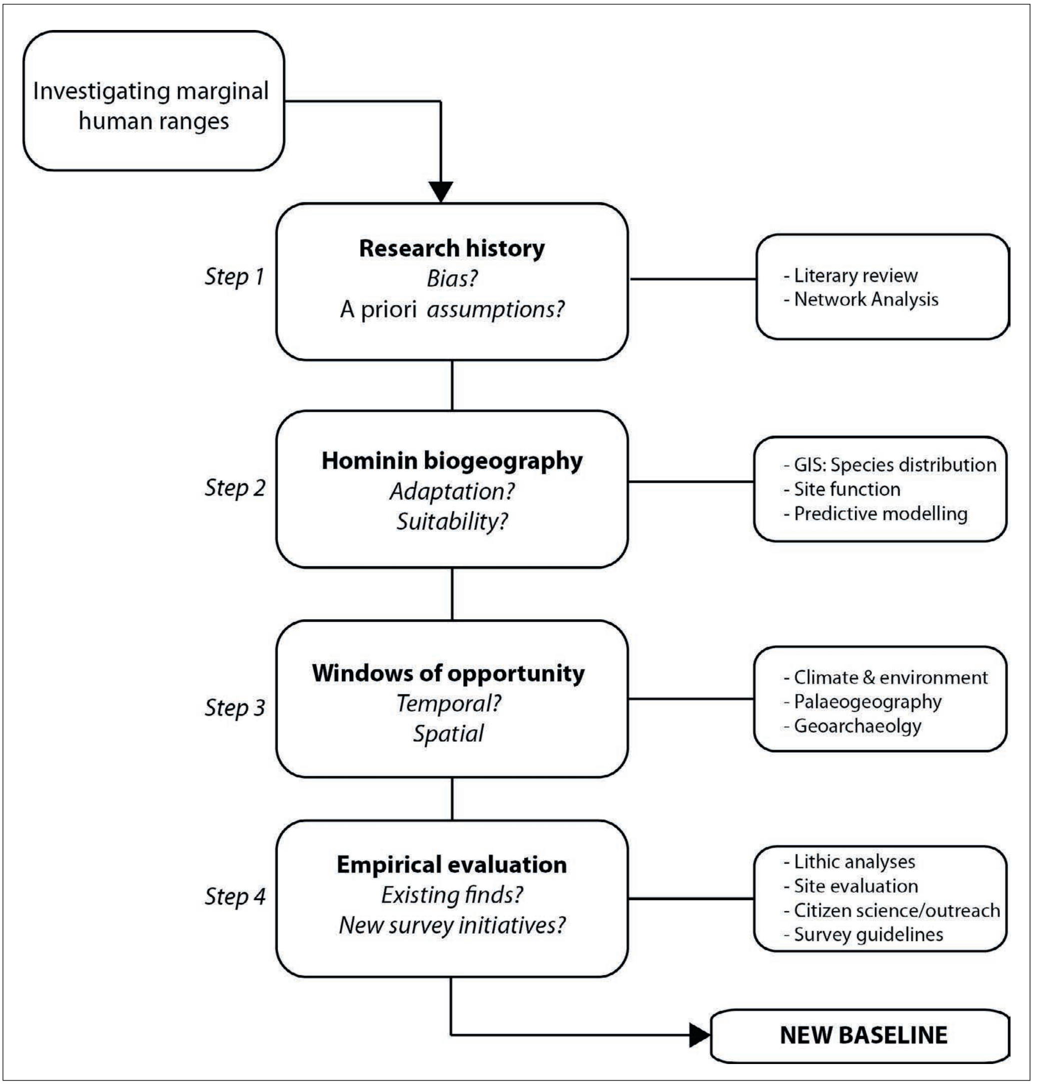

Fig. 2: *Graphical representation of the multi-perspective methodological approach.*

Step 3B consists of a systematic geochronological survey assessing the degree of preservation of relevant deposits as identified in Step 3A, as well as their potential exposure in the contemporary landscape through anthropogenic or natural erosion (e.g., beach cliffs, rivers and quarries). In Scandinavia, this can be done by triangulating information from groundwater borehole data (and their Pleistocene lacustrine deposits), reconstructed buried valleys, known interglacial paleosols, waterway erosion estimates, beach cliff profiles and aggregate activities. Due to data abundance this is best done in strategically selected areas along the expected dispersal route (here the Jutland Peninsula of Denmark). This triangulation and subsequent maps are useful for identifying areas for prospective archaeological surveys as part of Step 4B.

Step 4: Empirical evaluation

Aim

The fourth and last step is to evaluate the empirical potential of the case-study area by means of A) critical assessment of existing finds (from museums and/or private collections) and B) development of initiatives enabling new find procurement with rigorous registration procedures.

Continuous challenging of find-hiatuses is at the core of archaeological practice. The only way to securely settle fundamental debates of presence/absence is through the identification of genuine archaeological finds/sites with good contextual information. This step is therefore of the highest priority, but informed and hypothesis-driven efforts are needed in order to avoid costly and inefficient undertakings. The multi-perspective approach can therefore be seen as a scaffold enabling empirical evaluation and surveys with a greater likelihood of success. Appropriate strategies will vary greatly between different regions and local circumstances, but by building on the results obtained in Steps 1-3, endeavours can be planned from an informed foundation and executed while testing relevant hypotheses.

Applications

The first step (Step 4A) is to evaluate existing finds of purported Pleistocene age, for example, by evaluating historical claims of ‘sensational’ Neanderthal tools from Scandinavia. Most regions have historically ambiguous finds, such as lithics and geofacts, in need of reassessment that are stored in museum archives or in private collections (for discussions, see Peacock 1991; Schulz 2007; Slimak et al. 2011; Zwyns et al. 2012; Wiśniewski et al. 2014). These should be systematically and critically assessed with regard to their geoarchaeological context, typology, technology and natural surface modification. In some cases it is important also to consider their alternative status as geofacts or unfinished preforms from later prehistory, which are two significant issues pertinent to Scandinavia specifically. Additionally, the find-context (e.g., surface or stratigraphy) of each find can be evaluated against the geological reconstruction in Step 3B in order to assess whether the context matches the assumed Pleistocene origin at the specific findspot. This particular step will be a focus of this paper.

The second step (Step 4B) is to initiate and implement informed survey and outreach programs. Because of the historical absence of secure pre-Upper Paleolithic Scandinavian Pleistocene sites, there is no pre-existing archaeological practice for organized surveying targeting this time period in the study area. This is most likely a common characteristic in regions along the margins of the Neanderthal world. In order to facilitate new discoveries, there is a need for organized survey activities specifically targeting places where relevant Pleistocene deposits are likely to be readily exposed without costly excavation (as deducted from Step 3B, e.g., paleo-lakeshores exposed in active quarries or beach cliffs). Citizen science is an opportune way both to integrate and educate interested amateur archaeologists while regularly monitoring selected areas. Systematic registration and documentation are essential tools for the success of such initiatives and need to be developed within the local context.

The final objective of the methodological approach is to integrate all the results. From this informed foundation it is possible to generate a new and improved baseline from which new data-driven hypotheses can be developed and tested.

The new baseline: main results

Detailed descriptions of the analytical and methodological aspects of each of these steps are described in a number of supportive papers (as cited below). But the main results demonstrate that besides potentially being a true result of hominin absence, other factors could be responsible for the current absence of Pleistocene evidence in Scandinavia. These include the following problems identified:

- **Historical research bias** and several long research hiatuses caused by regionalized and nationalized publication strategies and polarized scientific as well as public disputes (Nielsen and Riede in press). Further, the present absence of secure evidence is not the outcome of rigorous and long-term data-driven investigations challenging the representativeness and validity of the underlying assumption that Scandinavia was not within the adaptive range of Neanderthals.
- A very **scarce archaeological signal** even if hominins were present, because utilization of extreme northern landscapes by Neanderthals requires very high mobility, ephemeral stays and seasonal discontinuity (Nielsen 2016). This means that if Neanderthals ventured into what is today considered Scandinavia, the evidence of these visits may be easily overlooked in the archaeological record because of their scarcity and paucity in the landscape. This is further supported by the Eemian habitat suitability model, which suggests that occupations at high northern latitudes (~53°N) were part of the distribution tail of the continental Neanderthal population (Benito et al. 2017).
- **Short intermittent Pleistocene timeframes** with combined paleoecological and paleogeographical conditions allowing hominins to disperse into Scandinavia. Due to this, opportune times for dispersal into southern Scandinavia were restricted to the few longer Pleistocene interstadials (e.g., MIS 9, 7 and 5c) rather than full interglacials and glacial periods (Nielsen et al. 2017). The potential of the early Weichselian Brørup Interstadial is emphasized in Scandinavia on the basis of geological preservation conditions and the wider biogeographical behavior of Neanderthals during this period.

- **Poor geological preservation conditions** and very sporadic occurrences of exposed and archaeologically relevant Pleistocene deposits in the contemporary Scandinavian landscape (see Nielsen 2016). Geologically relevant deposits are deeply buried, fragmented and/or poorly preserved. The potential for finding stratified and well-preserved archaeological sites of Pleistocene age is therefore very low from a geological perspective.

Together, these factors stress that not only were the temporal and spatial openings for Neanderthal presence at these latitudes highly constrained in the past, but that the potential for recovering evidence of such ephemeral visits are also highly restricted in present-day Scandinavia. This frame thereby also constrains and limits the archaeological exploration for these elusive finds (if they are there) to interstadial deposits, preferably stratified paleo-lake shore deposits (for preservation and chronostratigraphic reasons), exposed in the current landscape in, for example, active quarries or in erosive hills along the coast. The geographical occurrence and exposure of sediments corresponding to these criteria thereby represent primary targets for prospective reconnaissance and survey activities. Only through such rigorously data- and hypothesis-driven survey schemes can we explore the representativeness of the Neanderthal presence and/or absence along the distribution range margin.

Case Study

Neanderthal finds in Denmark? An empirical evaluation

Against this methodological background, the second part of this paper will take a closer look at the archaeological record of Denmark. This means evaluating all the finds and sites which historically have been assigned a pre-Upper Paleolithic Pleistocene age or have been tentatively associated with archaic hominin behavior (~Neanderthals). This exercise is restricted to finds from present-day Denmark (instead of all of Scandinavia) because this allows direct comparison with the data obtained as part of the geological prospection in Step 3B. The scope yields in total seven single finds and three sites/assemblages composed from a review of the literature, from a search through museum archives, and an examination of collections. These are mapped in Fig. 3 and listed in Table 1. Two more sites are known but excluded from this review (Kolding Bay and Vejstrup Ådal) because of lack of access or permission to view the material.

These finds are all controversial with regard to their purported age, which explains why they are not widely known or internationally acknowledged. The controversies are rooted in three main problems: lack of geological context, uncertainty regarding human involvement, and typological ambiguity. The first problem stems from the fact that most of the finds are surface finds or found in secondary position (Alrø, Fænø, Harebjerg, Karskov Klint, Seest, Skellerup and Villestrup). The few sites that are indeed stratified (Ejby Klint, Hollerup and Vejstrup Skov) can be contested on the basis of the excavated material, which may instead represent natural accumulations, geofacts, or younger artifacts such as Neolithic preforms, respectively. In the following, the unstratified and stratified finds are reviewed separately with a focus on resolving the main problem of each individual find group, or the geological context and the association with human behavior and/or cultural affiliation.

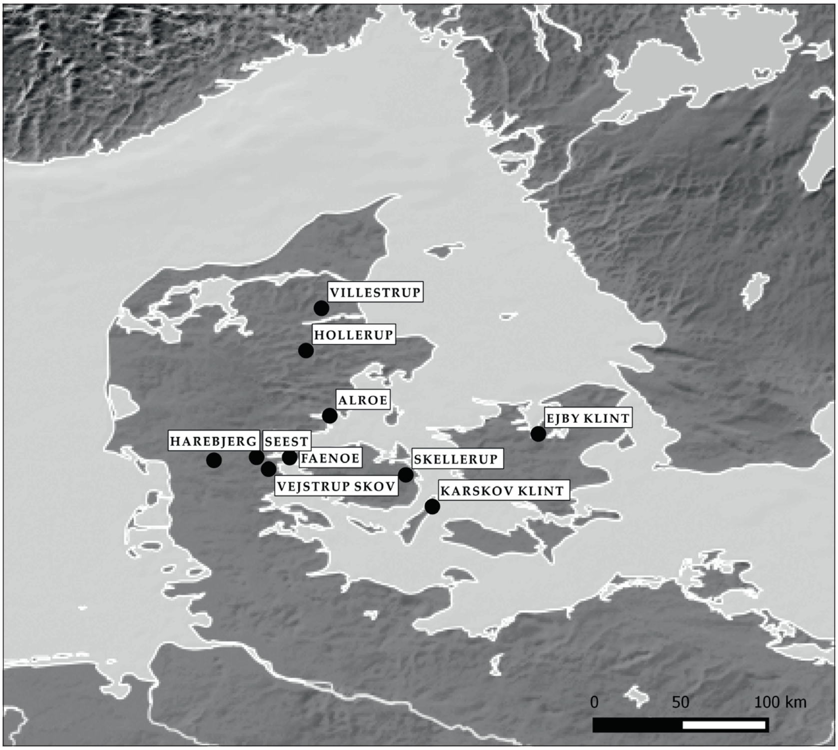

Fig. 3: *Map of archaeological sites/finds from Denmark that historically have been assigned a pre-Upper Paleolithic Pleistocene age.*

Unstratified finds: does local geology permit exposure of Pleistocene artifacts?

Most of the finds without context were found on the contemporary surface of agricultural fields (Alrø, Skellerup, Villestrup and possibly Fænø) or in a beach setting (Karskov Klint and possibly Fænø). Two finds, those of Seest and Harebjerg, were found in a secondary position in a wheelbarrow in a quarry and on the ground in a sandpit, respectively. Most of these finds resemble handaxes or fragments thereof, which is why they as undated surface finds where considered Paleolithic in the first place (Becker 1971, 1985). This is not the case for the Harebjerg and Seest finds, which resemble a flake tool and a blade, respectively. Their discovery in active mines seemingly exploiting Weichselian sand and gravel led to their general interpretation as Paleolithic tools, despite the fact that they could not be securely placed within the exposed stratigraphy.

Recent work confirms that most of these surface finds are indeed manufactured by humans and are not geofacts (Johansen and Stapert 1995/1996; Nielsen 2016). However, some uncertainties exist as to the Alrø and Harebjerg pieces and possibly also the proposed Karskov Klint biface, which is highly weathered and too eroded for a clear identification. Harebjerg is, with its hinged negative flake scar, unsystematic retouch-like edge damage and small patches of cortex, an excellent example of an incertofact common to

Name/site	Region	Type	Quantity	Find context	Finder	Year
Alrø	East Jutland	Biface, *preform?*	Single find	Surface find, agricultural field	Per Borup	1980
Ejby Klint	North Zealand	Crude flakes, *incertofacts?*	>1000 on the beach + 3 *in situ* (~geofacts)	Beach shore and cliff, excavated	Erik Madsen	1960s
Fænø	Fænø, Little Belt	Biface, *preform?*	Single find	Unknown, likely agricultural surface or beach	Gine Jacobson	1957
Harebjerg	South Jutland	Crude flake, *geofact?*	Single find	Sandpit, at 7 m depth but possibly redeposited	Dr. phil. N. Hartz	1905
Hollerup	East Jutland	Faunal remains (*Dama dama*)	MNI 8	Lacustrine, excavated	Dr. phil. N. Hartz	1897-1992
Karskov Klint	Langeland	Biface, fragment, *preform?*	Single find	Surface find, beach below cliff	Dr. Klaus Palandt	1973
Seest (Oluf Jensens quarry)	South Jutland	Blade Flake, *geofact?* Faunal remains (*Cervus elaphus*?)	2 lithics, 2 bone fragments	Quarry, glaciofluvial (blade in wheelbarrow)	Børge Svendsen, Erik Westerby	Early 1950s
Skellerup	East Funen	Biface, *leaf blade? preform?*	Single find	Surface find, agricultural field	Helge Kierkegaard	1960-1965
Vejstrup Skov	South Jutland	Crude flakes, cores	119 pieces	Fluvial, possibly re-deposited, excavated	Niels Boysen, Aage Boysen	1971-1972
Villestrup	North/East Jutland	Biface, *preform?*	Single find	Surface find, agricultural field	Elly Jensen (married Petersen)	1931

Table 1: *Tabular overview of the Danish empirical record discussed in the text. Listed in alphabetic order.*

the Danish landscape overflowing with erratic flint and stone-rich soils. Without context, pieces such as this remain difficult to classify.

Alrø appears to be artificially manipulated, but discarded at an early point and subsequently exposed to severe natural surface modification. Frost-induced splintering is the main reason it was previously considered (potentially) very old (see Fig. 5), because such damage was assumed to only be inflicted by exposure to full glaciations (note in archive file, Moesgaard Museum, Aarhus, FHM A 2747). However, this has been experimentally challenged (Lautridou et al. 1986; Sieveking and Clayton 1986) and frost cracks/splintering alone does not seem to be a secure sign of pre-Weichselian manufacture. Because the Alrø implement is both distally and proximally broken, the original artifact shape is unknown, and it is plausible that it is an unfinished or discarded preform from the Holocene rather than a finished Pleistocene handaxe.

The most convincing handaxe-like artifact is undoubtedly the piece from Villestrup (Fig. 10). But in this case, its freshness and slight asymmetry, combined with the fact that it was discovered not far from Neolithic flint-mines with specialized preform-workshops (Becker 1952), equally indicate that it is an unfinished preform, intended maybe for a sickle (Glob 1972). Some doubt has also been voiced whether it may actually be an imported find from France (Holm and Larsson 1995). Similar problems are attached to the Fænø handaxe, since it cannot be ruled out that it is a discarded preform from much more recent prehistory.

Geological frame

The primary problem with these finds is their lack of context, which is unfortunately not possible to obtain in retrospect. Also, since their typology is not diagnostic on its own, these finds cannot be dated on this basis. Instead it is possible for us to assess whether a Paleolithic tool of assumed Pleistocene age could have ended up on the surface by investigating the local geological context.

This is possible because Denmark's Quaternary history comprised multiple glaciations and several episodes of landscape remodeling (Houmark-Nielsen 1987; Larsen et al. 2009). The multiple Weichselian ice advances are responsible for the current landscape of Denmark today. They created a more hilly landscape overall in the east and a flat outwash plain in the west. The topographically more diverse eastern landscape is a product of deposition of large quantities of clay, till, sand and gravel (often thicker than 20 meters) intersected by open but relatively shallow tunnel valleys. The western outwash plain was never fully covered by the ice sheet and is a periglacial feature created by glacial meltwater. There are, however, a number of so-called hill islands (*Bakkeøer*) on this flat and sandy plain (*Jyske hede*). These hill islands are isolated patches of relict landscapes, which avoided erosion by the glacial meltwater (Sjørring and Frederiksen 1980; Høyer et al. 2013). The hill islands are archaeologically highly interesting because they not only have good soil preservation conditions (compared with the surrounding outwash plain), but they also allow, for example, for Saalian and Eemian deposits to be accessible just below the Holocene topsoil.

As a result, the chronostratigraphic placement of Pleistocene interglacial and interstadial deposits, for example, is highly variable across Denmark. In some places they are deeply buried below more than 50 meters of inorganic Weichselian moraine, greatly impeding the potential of pre-Weichselian artifacts naturally finding their way to the current surface. Conversely, in other places, Pleistocene interglacial/interstadial lakes are detected immediately below the Holocene topsoil (e.g., in the Brørup area of central Jutland), greatly improving the potential of pre-Weichselian artifacts finding their way to the current surface through either natural or anthropogenic processes.

With this the underlying reasoning, it is therefore possible to evaluate the surface find-spots by investigating whether the local circumstances speak for exposure of Pleistocene artifacts on the current surface using local geological data as a comparative proxy.

To this end, each find-spot is evaluated against a number of paleo-landscape proxies, including 1) the distribution, depth and infill of buried valleys reconstructed on the basis of borehole data, transient electromagnetic data (TEM) and seismic data (Jørgensen

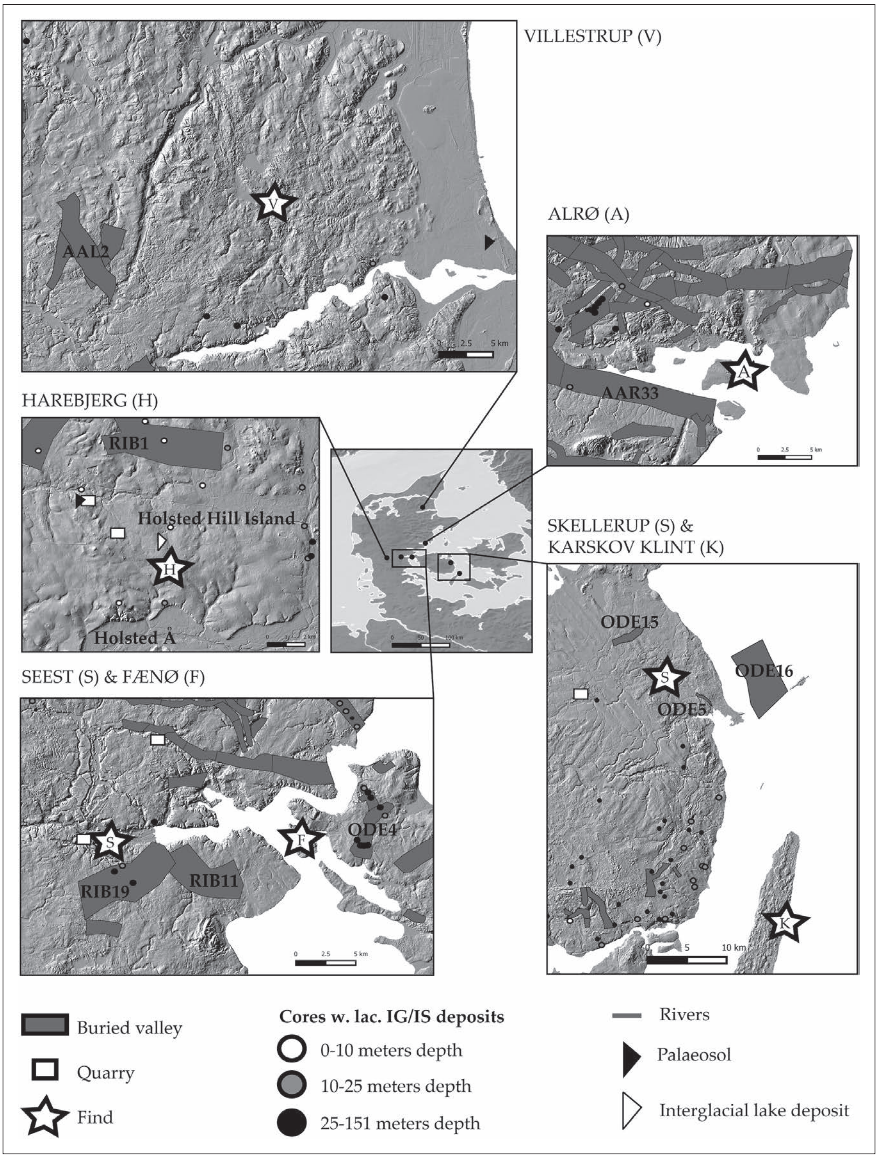

Fig. 4: *The unstratified find-spots discussed in the text mapped against the base-map showing the occurrences of paleo-landscape proxies (buried valleys, cores with lacustrine interglacial/interstadial deposits, paleosols, and interglacial lake deposits) as well as contemporary exposure proxies (quarries, rivers and coastal erosion). As Danish quarries principally do not extract soil deeper than 25 meters below current terrain (Ditlefsen et al. 2015), Pleistocene deposits at depths greater than this are extremely unlikely to ever be exposed through aggregate activities. 10 m grid Digital Terrain Model (DTM 2007), © Geodatastyrelsen. Buried valleys from Jørgensen and Sandersen (2007-2009a). Interglacial/Interstadial lacustrine observations from The National Borehole Archive (PC-Jupiter 2001). Note that only cores with interglacial/interstadial observations are shown in these maps, but the texts draw on data and descriptions from all relevant cores in the archive. This is because of core density, which would render the maps unreadable if they were all included.*

and Sandersen 2007-2009a); 2) stratigraphic descriptions and observations and depths of interglacial and interstadial lacustrine deposits extracted from the Danish National Borehole Database (PC-*Jupiter* 2001); and 3) the observations of Pleistocene deposits published in the literature and/or registered in the online repository of the Geological Survey of Denmark and Greenland (GEUS).

This is combined with a set of proxies useful for assessing the degree to which these potentially relevant Pleistocene deposits are exposed in the contemporary landscape. These include 1) the current landscape features derived from a Digital Terrain Model 10 m (DTM 2007), 2) the distribution of active quarries collected manually from satellite, aerial and field search, 3) the trajectory of modern rivers from OpenStreetMaps (MapCruzin.com) and 4) the presence of erosive coastal sections assembled from literature and field reconnaissance.

The triangulating of this data produces a base-map from which the local context of each find-spot can be assessed and discussed (see Fig. 4).

Alrø

Maximum dimensions: length 15.4 cm, width 10 cm, thickness 3.9 cm

Current position: Moesgaard Museum, Aarhus, FHM A 2747

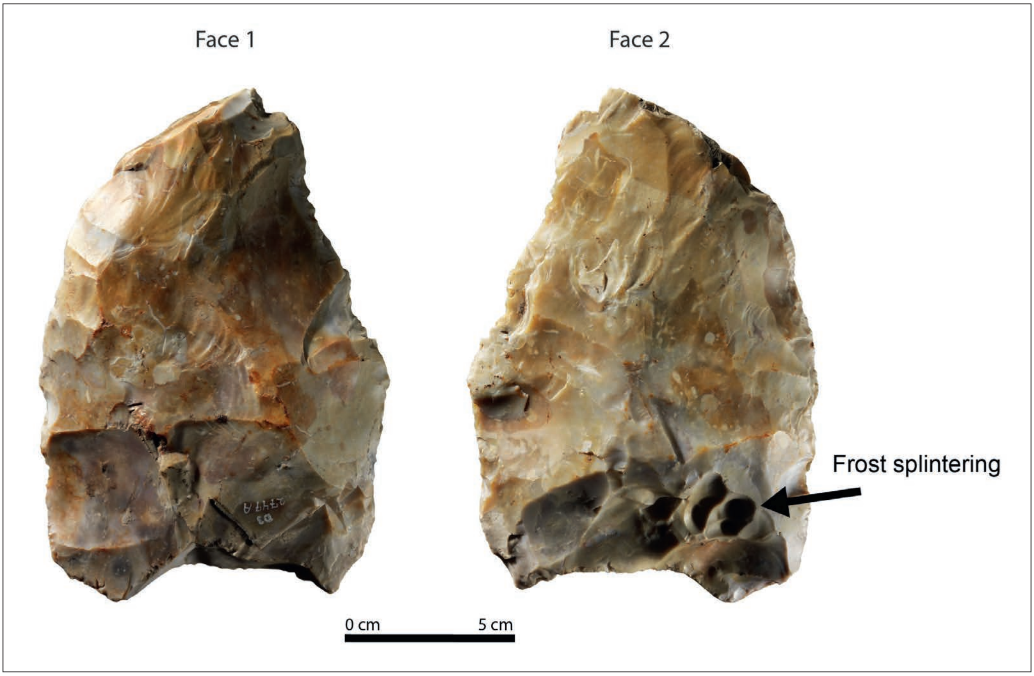

Fig. 5: *The Alrø implement. © Rógvi N. Johansen, Foto/medie afd. Moesgaard.*

Historical context

The Alrø implement (Fig. 5) has not been formally published. The object was found in the early 1980s by an archaeologist on an agricultural field facing the beach on the eastern tip of the small island of Alrø in Horsens Bay, East Jutland (Fig. 3). It was brought to Moesgaard Museum in Aarhus where it was registered (FHM A 2747) and is currently stored.

Geological context

Horsens Bay in which the island of Alrø is found has a buried valley with interglacial deposits in the southern part of the bay. This is a partly buried valley (AAR33) running in an east-west trajectory just south of Alrø (Fig. 4). The valley most likely continues west offshore into Horsens Bay. Yet, the offshore and northern valley edge is weakly documented and the bay area is disturbed by deep faults (Jørgensen and Sandersen 2007-2009b). AAR33 is c. 300 m deep and 2-3 km wide and was formed during the Elsterian Glaciation (Jørgensen and Sandersen 2007-2009a). According to the National Borehole Database, unspecified interglacial deposits have been observed 5 to 10 m below the current terrain in the valley infill. Coring on Alrø indicates that the island is covered by >20 m of Weichselian moraine sediments consisting of clay, sand and gravel (e.g., cores: DGU: 107.1534, 107.360-107.366; *PC-Jupiter* 2001). Alrø is therefore located north of the paleo-valley which, according to marine sedimentation in the infill, was a fjord during the Holsteinian Interglacial and perhaps also during the Eemian Interglacial (Jørgensen and Sandersen 2007-2009b). These combined observations underline the Pleistocene potential of the valley infill and walls, but it does not provide a reliable setting for a pre-Weichselian artifact being exposed naturally on the current surface of Alrø.

Fænø

Maximum dimensions: length 11 cm, width 7.3 cm, thickness 2.7 cm

Current position: National Museum of Denmark, Copenhagen, NM A 51117, J. No. 617-71

Historical context

The Fænø biface (Fig. 6) was found in 1957 on Fænø, an island located in Little Belt between Jutland and Funen (Fig. 3). It was collected somewhere on the island by amateur archaeologist Gine Jacobson from Middelfart, Funen (Johansen and Stapert 1995/1996). Gine Jacobson and her husband repeatedly surveyed and collected archaeological material, which they occasionally sold to private collectors. But they did not register their finds, making it impossible to verify the find history or to specify the exact find-spot. Patches of rust and the absence of severe rounding indicate that it was found on an active agricultural field rather than on the beach. In 1971 the implement was sold to private collector Eli Jepsen who was confident that the implement was a Pleistocene handaxe. This interpretation was corroborated by Archaeology Professor C. J. Becker (Becker 1971). Also, minor natural surface modification (sub-parallel scratches, oblique pressure cones and a small patch of friction) have been observed on the artifact (Johansen and Stapert 1995/1996), something which is expected on a Pleistocene artifact, but does not rule out a much younger age (Nielsen 2016). In 1982 Eli Jepsen donated the implement to the National Museum (NM A 51117, J. No. 617-71) where it is today part of the permanent exhibition (Becker 1985).

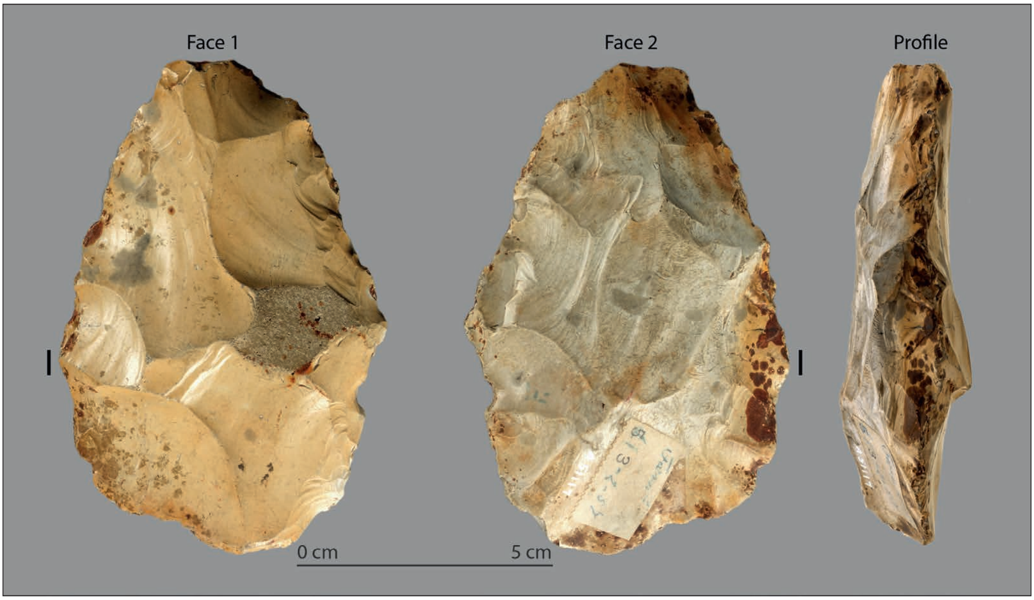

Fig. 6: *The Fænø biface. © John Lee, National Museum of Denmark.*

Geological context

The nearest buried valleys with observed lacustrine deposits are ODE4 on Funen and RIB19 and RIB11 on Jutland (Fig. 4). No buried valleys are observed on the island of Fænø, and borehole data suggest that the island is covered by c. 20-30 m of moraine clay and till deposited during the Weichselian Glaciation (DGU: 134.1442, 134.1441, 134.1461; *PC-Jupiter* 2001). In one of these boreholes (DGU: 134. 1442) the Weichselian moraine directly overlies marine Miocene deposits (PC-*Jupiter* 2001). Exposed stratigraphy in the beach cliffs on the northern tip of Fænø strongly resemble the distinct-looking Miocene marine sequence observed at Rønshoved, located directly opposite on the Jutland coast (GI 208; Gravesen et al. 2004). This suggests that the Miocene is found directly below the thick Weichselian moraine. These observations do not support exposure of pre-Weichselian artifacts on the current surface of Fænø.

Harebjerg

Maximum dimensions: length 9 cm, width 7 cm, thickness 2 cm

Current position: National Museum of Denmark, Copenhagen, NM A 35553, J. No. 323/33

Fig. 7: *The Harebjerg implement. © John Lee, National Museum of Denmark.*

Historical context

The Harebjerg implement (Fig. 7) was found in 1905 by geologist Dr. N. Hartz in a small sand and gravel pit near Harebjerg, located c. 1 km south of Brørup Station in the central part of South Jutland (Fig. 3). The implement was first mentioned in a study by Bjørn (1928) on the Paleolithic of Norway. According to Bjørn, the piece was found *in situ* at 7 m depth in gravel sediment. He categorized it as a *coup-de-poing* (small handaxe) with large simple removals on each face and retouch along the edges. Bjørn (1928) regarded it as secure evidence that humans had occupied Denmark prior to the last Ice Age and inferred that a similar scenario was likely for Norway.

Bjørn's interpretation is contradicted in the description attached to the find in the archive at the National Museum of Denmark where it is now stored (J. No. 323/33). Here it is mentioned that the discoverer could not verify that the implement was found *in situ*. Further, it is regarded more likely to have fallen into the gravel pit from the topsoil and is classified as a natural flint.

Geological context

The implement was found in the context of active extraction on the southern part of the Holsted Hill Island in central Jutland. Holsted Hill Island has a southern and a northern part, divided by the recently opened tunnel valley leading into the stream Holsted Å (Fig. 4). The buried valley system RIB1 is located on the northern part and contains relatively shallow interglacial lacustrine deposits (e.g., DGU: 123.1283 between 3-4 m depth under terrain; PC-*Jupiter* 2001).

Boreholes on the southern part of the hill island contain interglacial lacustrine peat and gyttja deposits at varying depths (between 0.8 to 22 m below current terrain). Yet none of these are in the immediate vicinity of the Harebjerg find-spot. North of the find-spot is the small town Brørup, known for several occurrences of well-studied early Weichselian lacustrine deposits (Hartz and Østrup 1899; Jessen et al. 1918). A nearby paleosol (Holsted paleosol) has tentatively been dated to the Eemian or early Weichselian (Frederiksen and Sjørring 1979).

The area in itself displays geological characteristics that allow for the possibility of finding Pleistocene material at relatively shallow depths. The uncertainty regarding whether the implement came from the actual quarry or from the topsoil is, however, a central problem, along with the fact that it is likely to be a geofact and not an intentionally modified tool.

Karskov Klint

Maximum dimensions: length 11 cm, width 7.9 cm, thickness 3.1 cm

Current position: National Museum of Denmark, Copenhagen, NM A 51111, J. No. 4621-82

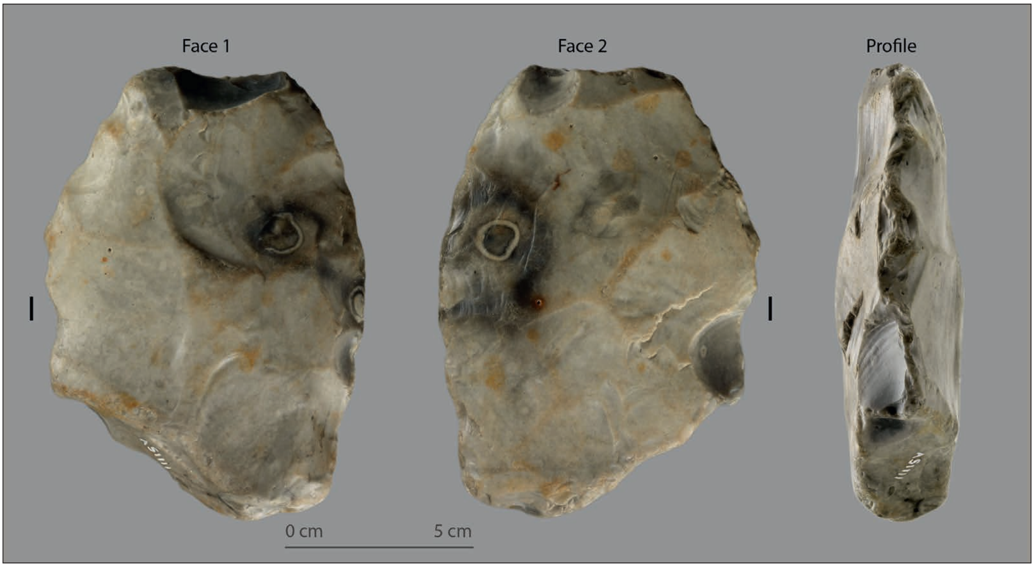

Fig. 8: *The Karskov Klint biface. © John Lee, National Museum of Denmark.*

Historical context

The Karskov Klint (Karskov Cliff) implement (Fig. 8) was found in 1973, c. 10-20 m north of Karskov Forest on the northeastern coast of the island of Langeland, Denmark, situated in the South Funen Archipelago (Fig. 3). It was discovered by archaeologist Dr. Klaus Palandt (*Niedersächsisches Landesamt für Denkmalpflege*) from Hannover, Germany, during a holiday. The artifact was allegedly described as found embedded in the sediment exposed in the coastal cliff (Grote and Jacobsen 1982). In 1979, Dr. Palandt showed it to Dr. Klaus Grote from the *Denkmalpflegeamt Landkreis Göttingen*, who suggested that it could be a weathered Pleistocene handaxe.

This led to a small investigation of the find-spot by Dr. Grote and geologist Erik Maagaard Jacobsen in 1979. Studies of the presumed find-bearing profile in the coastal cliff indicated deposition in Weichselian moraine till. This was used to reject that it was a Neolithic preform, but instead represented an Acheulian handaxe from the Saalian Glaciation or early Weichselian Glaciation (Grote and Jacobsen 1982).

Through its publication from 1982, Danish archaeologists became aware of the existence of the find. It was subsequently handed over to the National Museum of Denmark as a gift from Dr. Palandt. Here it is now on display in the permanent exhibition (Becker 1985).

Unfortunately, there are some inconsistencies in the description of the find context of the artifact. The authors of the publication explicitly state that the implement was found embedded in the moraine till in the cliff profile (Grote and Jacobsen 1982, 281, 24-26). The stratified status of the artifact is therefore an important element in their interpretation of the artifact having a pre-Weichselian origin. But in a letter from the discoverer, Dr. Palandt, to Ebbe Lomborg at the National Museum of Denmark (dated 27th February 1983), the implement is reported to have been found on the beach at the base of the cliff and that Palandt could not specify the exact stratigraphic origin: *"Der Stein lag unmittelbar am Fusse der etwa 1,5 - 2 m hohen Abbruchkante. Ich vermute, dass der Stein aus dem Kliff herausgebröckelt ist. Jedenfalls lag der Stein nicht in der Nähe der Wasserkante. Leider kann ich Ihnen also nicht sagen, in welcher Erdschicht sich der Stein befunden hat."* (Johansen and Stapert 1995/1996, 13). As noted by Johansen and Stapert (1995/1996), the erroneous idea that the piece was found in the cliff profile has unfortunately (but unknowingly) been reasserted in later publications (e.g., Holm 1986). It seems reasonable to assume that Palandt's account is correct and that it is therefore not possible to place the implement in any stratigraphic context. The piece could therefore equally have eroded from the topsoil at the top of the cliff or have washed onto the beach, implying a much more recent age.

Geological context

No buried valleys or interglacial lacustrine deposits are observed on Langeland (Fig. 4). In many places the glacial till directly overlies the pre-Quaternary substrate, which rises higher in southeast Denmark, allowing the exposure of primary flint sources on east Funen and east Zealand (Petersen 1993). For instance, in a sequence observed in two boreholes just west of the find-spot (DGU: 165.75 and 165.99), 28 m of Weichselian till directly overlies Danien bryozoan chalk (PC-*Jupiter* 2001). The complete lack of lacustrine observations on Langeland does not suggest good preservation potential for Pleistocene interglacial deposits.

Similarly, no interglacial lacustrine deposits have been registered on the remaining islands and peninsulas south of Zealand, and only 17 boreholes with interglacial layers are observed in total on Zealand (PC-*Jupiter* 2001). This points to the high degree of erosion of interglacial soils by the various glacial advances and the thick cover of Weichselian till present in eastern Denmark. This does not support a pre-Weichselian age of the Karskov Klint implement, even if it was indeed modified by humans.

Skellerup

Maximum dimensions: length 13.7 cm, width 7.2 cm, thickness 3.2 cm

Current position: National Museum of Denmark, Copenhagen, A 52220

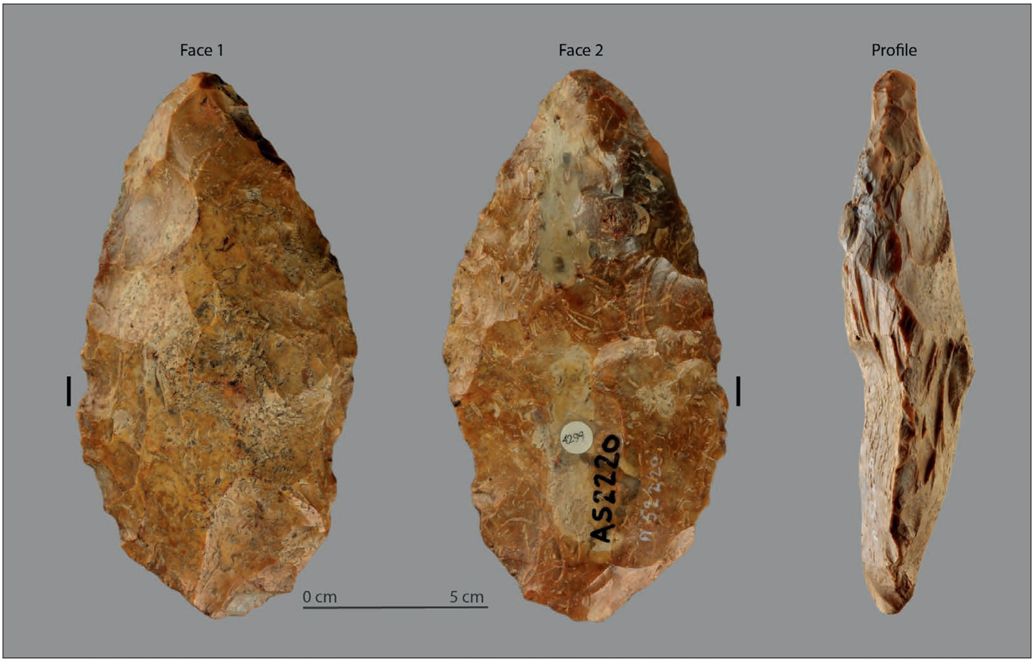

Fig. 9: *The Skellerup biface. © John Lee, National Museum of Denmark.*

Historical context

The Skellerup implement (Fig. 9) was found by amateur archaeologist Helge Kierkegaard between 1960 and 1965. At this time he was a small boy collecting flint from several localities on eastern Funen and did not register his finds (Fig. 3). The handaxe-looking implement comes from one of these localities, but the exact find-spot cannot be identified. Based on a comparison of the surface patina on the Skellerup implement and the other finds in his collection, Kierkegaard is convinced that this particular artifact was found on an agricultural field between Hjulby and Skellerup on East Funen (Johansen and Stapert 1995/1996). Neolithic artifacts have been found in the same area, and the discoverer himself never suggested that the implement was of a Pleistocene age. The implement is now on display together with the other possible Paleolithic handaxes in the permanent exhibition of the National Museum of Denmark.

Geological Context

The find area overlaps with an open valley system, formed at the end of the Weichselian Glaciation, which is draining water S-E into Nyborg Bay (Fig. 4). Three buried valleys are registered in the area (ODE16, ODE15 and ODE5). ODE16 and ODE5 are caused by tectonically induced faults in the otherwise highly raised Danien chalk (Jørgensen and Sandersen 2007-2009a). ODE15 is 1 km wide, 4 km long, facing ENE-WSW and filled mostly by moraine sediments (Jørgensen and Sandersen, 2007-2009a). No interglacial observations are made in any of these valleys. Five boreholes in the wider area indicate the presence of interglacial deposits found between 29 and 59 m below the current terrain, everywhere covered by thick moraine deposits (PC-*Jupiter* 2001).

These observations indicate that this part of Denmark is covered by more than 30 meters of inorganic Weichselian sediment, and does not suggest that pre-Weichselian deposits could be exposed by natural or anthropogenic activities on an agricultural field.

Villestrup

Maximum dimensions: length 13.1 cm, width 7.4 cm, thickness 3.1 cm

Current position: National Museum of Denmark, Copenhagen, NM A 51116 (J. No. 618-71)

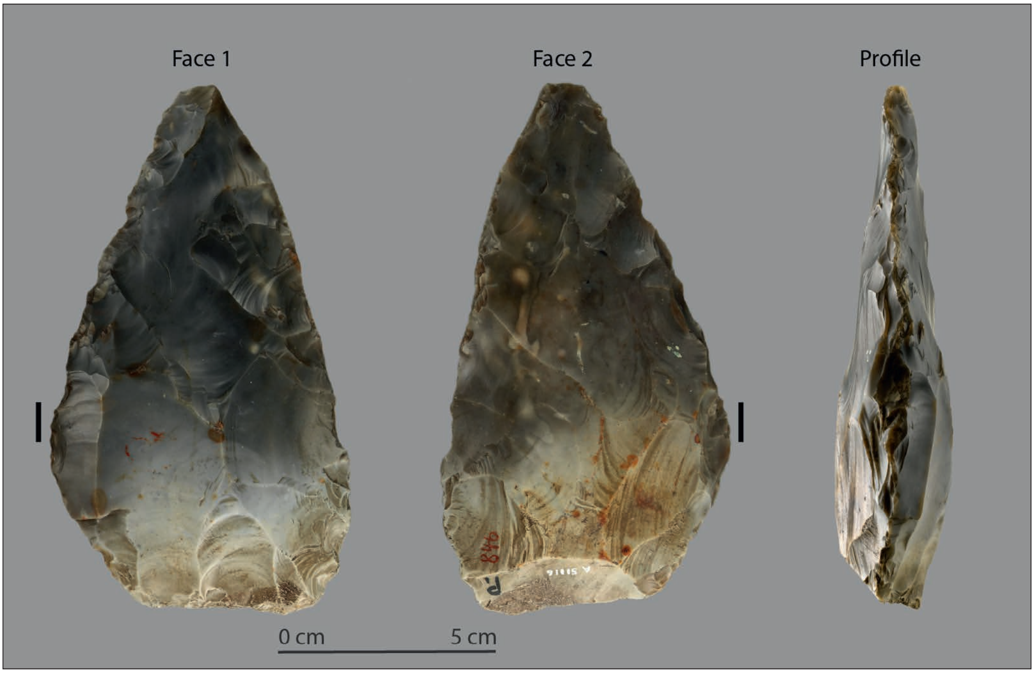

Fig. 10: *The Villestrup biface. © John Lee, National Museum of Denmark.*

Historical context

The Villestrup implement (Fig. 10) was found on a field near the town of Villestrup, located north of the Mariager Fjord in northeastern Jutland (Fig. 3). It was found in 1931 by the 13-year-old Elly Jensen while she was harvesting potatoes with her father Frederik Jensen (Jepsen 1973). Elly gave the artifact to the collection at the local Møldrup School, administered by the teacher Michael Christensen. It remained here until

1950 when archaeologist Riis-Møller visited the collection, receiving permission to borrow the artifact and bring it to Aalborg Historical Museum (Marseen 1972).

It is unknown exactly why and with whose permission, but archaeologist Riis-Møller then passed the artifact on to antique dealer and amateur archaeologist Jørn Bower. Bower later came into financial trouble and sold a large part of his collection, including the Villestrup handaxe, to private collector Consul Eli Jepsen from Herning.

While in Jepsen's possession, archaeologist Oscar Marseen succeeded in obtaining information on the find-spot from Elly's father, Frederik Jensen, who pointed it out on a map. Later, independent of her father's statement, Elly identified the same find-spot in the field (Marseen 1972; Jepsen 1973). Eli Jepsen later donated the Villestrup handaxe, together with the Fænø handaxe, to the National Museum of Denmark, where it is now part of the permanent exhibition.

Geological context

A characteristic geological feature of North Jutland is the raised Paleogene and Neogene chalk-rich seabed (Binzer and Stockmarr 1994; Knudsen and Larsen 2009). Prequaternary deposits are therefore occasionally accessible close to the current surface, which is why high-quality Cretaceous flint in primary position was actively mined here as early as the Neolithic (Petersen 1993). In more recent times, cement industries have also exploited this geological feature when mining for limestone, chalk or clay along the shores of Mariager Bay (Larsen 1999). Mariager Bay in its current form was shaped subglacially during the Weichselian Glaciation, but the basin started forming in the early Paleogene (Larsen 1999).

Only four boreholes with interglacial deposits have been observed in the vicinity of Villestrup, but at a distance of 10 to 12 km from the find-spot (Fig. 4). They suggest that the interglacial deposits are found at varying depths (between 7.5 and 39 meters below current terrain) owing to the intense structural alterations of the landscape from the pre-Quaternary onwards (PC-*Jupiter* 2001).

Because the precise find-spot is known, it is possible to evaluate the sub-stratum directly at the find-spot (DGU: 41.1174; PC-*Jupiter* 2001). Here the agricultural topsoil is immediately underlain by 42 meters of alternating gravel and sand containing two strata of moraine clay between 7-9 m and 11-13.5 m depth, respectively. This is interpreted as glacio-fluvial deposits with remnants of two glacial moraines, probably from two Weichselian ice advances (PC-*Jupiter* 2001). This is underlain directly by the raised Paleogene or Neogene seabed, which continues to the bottom of the borehole at a depth of 101 m. This does not provide a suitable frame for exposure of a pre-Weichselian artifact on the current surface at the Villestrup find-spot.

Seest

Seest blade, maximum dimensions: length 8.7 cm, width 3.5 cm, thickness 0.9 cm

Total quantity: 38 bone fragments, 26 lithic implements, six teeth or fragments of teeth, five antler fragments and two tusk fragments

Current position: Faunal remains: The National History Museum of Denmark, Zoological museum, Copenhagen. Lithic remains: National Museum of Denmark, Copenhagen, NM A 51589, A 51590/51687, A 51612, A 51615, A 51642, A 51667, A 51668, A 51686

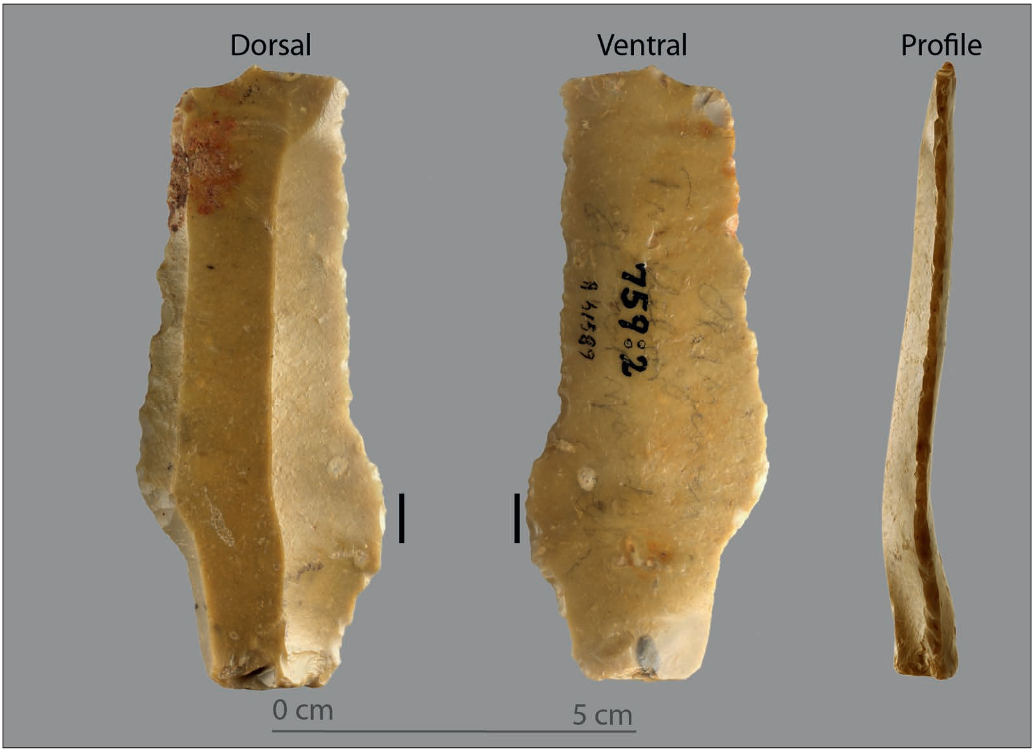

Fig. 11: *The Seest blade (759:2 and NM: A 51589). © John Lee, National Museum of Denmark.*

Historical context

The Seest blade (Fig. 11) is part of a larger assemblage containing material from ten smaller quarries in and around the small town of Seest, located southeast of the city of Kolding in southwest Jutland (Fig. 3). The material was collected and recorded by amateur archaeologist Erik Westerby between 1950 and 1960, aided by the local quarry workers (Westerby 1925-1959, 1956; Fischer 2002; Eriksen 2012).

Westerby collected in total 78 finds, including 38 bone fragments, 26 lithic implements, six teeth or fragments of teeth, five antler fragments and two tusk fragments (Westerby 1925-1959). The whereabouts are only known for 12 of these finds stored at the National Museum of Denmark and Zoological Museum in Copenhagen. This includes the Seest blade from Oluf Jepsen's quarry which is on permanent display together with the purported handaxes (Villestrup, Skellerup, Karskov Klint and Fænø) in the National Museum of Denmark in Copenhagen (Andersen 1957; Nielsen 1985; Johansen and Stapert 1995/1996).

The blade was found in a wheelbarrow by one of the quarry workers and later given to Westerby upon a visit. The stratigraphic position is therefore unknown. It was assumed that the blade came from the Weichselian soil being extracted. Westerby was therefore convinced that the Seest blade was of minimum Weichselian age, possibly made by a Neanderthal or an early modern human. He subsequently published this interpretation in a Danish newspaper (Westerby 1956).

The blade has rounded edges and a small patch of microscopic scratches which led Johansen and Stapert (1995/1996) to argue that the blade, from the point of view of natural surface modification, potentially could be Pleistocene. However, the types of natural surface modification do not, in itself, exclude a Holocene age. Also, the fact that it is a blade, a relatively common tool type in the Holocene and less so in the Pleistocene, makes it just as likely to be a tool of more recent age.

Geological context

Kolding Bay and its onshore tunnel valley extension were formed during the Weichselian Glaciation (Fig. 4). It shares characteristics with the other open tunnel valleys along the east coast of Jutland, such as Vejle tunnel valley (Gravesen et al. 2004). The quarries around the town of Seest, where the Seest blade was found, are located just south of this open tunnel valley.

Two wide buried valleys (RIB19 and RIB11) with an ENE-WSW trajectory are found southeast of the find-spot (Fig. 4). Interglacial deposits are observed at several places deep within this valley infill, i.e., freshwater gyttja at 20.6 m below terrain (DGU: 133.426), freshwater peat at 42 m below terrain (DGU: 133.81) and freshwater sand at 39.3 m below terrain (DGU: 133.435). In all these cases, the interglacial layer is overlain by thick moraine till and clay deposited during the Weichselian (PC-*Jupiter* 2001). In fact, all the interglacial deposits observed within a radius of ~20 km from the Seest blade find-spot are found below at least 10 m of moraine till and often deeper than 25 m below the current surface. In borehole DGU: 133.574 from the currently active Vranderup quarry west of the find-spot, the sequence shows an alternating glacio-fluvial deposit and moraine clay until the bottom of the core at 103 m below terrain.

The area around Seest is noticeably devoid of interglacial lacustrine deposits. Westerby himself proposed that the Pleistocene faunal remains he collected in the quarries had become embedded in the Weichselian gravel through glacial planning as the glacier moved over Eemian peat bogs of eastern Denmark (Westerby 1925-1959, 1956). This hypothesis could possibly be corroborated through blocks of peat with preserved leaves and hare-droppings found in a small quarry in Kolding (Nordmann 1944). But the age of these peat-blocks has not been further investigated. Conversely, Westerby's hypothesis is somewhat challenged by the low degree of general wear observed on the faunal remains (Holm 1984). Based on the geological data obtained here, this hypothesis can neither be confirmed nor rejected. But the Seest blade find-spot in itself does not present promising characteristics for exposure of *in situ* pre-Weichselian deposits.

Stratified finds: can human agency and/or cultural affiliation be confirmed?

The three stratified and excavated sites are Ejby Klint, Hollerup and Vejstrup Skov (Fig. 3). Hollerup contains faunal remains, whereas the two others contain lithic material. Ejby Klint and Hollerup have absolute dates placing the find layers in the Eemian Interglacial. The chronostratigraphic position of the find layer at Vejstrup Skov was initially thought to be 400,000 years old (and sensationalized in numerous national newspapers), though this date was questioned soon after it was proposed. The final site report assumes a relatively recent interpretation, in which the find layer is argued to be the result of an ongoing accumulation by the Holocene river cutting and depositing material into Saalian/Weichselian moraine sediments along the river shore (Jensen 1980).

Apart from Vejstrup Skov, the Eemian chronologies of these sites are well established, which is why the excavated material was initially thought to be the product of visiting Neanderthals. In fact, at all three sites, the chronostratigraphic investigations received more attention than the artifactual verification in the original publications (Møhl-Hansen 1955; Madsen 1965; Jensen 1980). It is interesting to note that the geological analysis of the Hollerup and Ejby Klint find-spots, following the same procedure as for the surface finds above, indeed supports their Pleistocene potential (Nielsen 2016). The geological context at Vejstrup Skov, on the other hand, does not support the Pleistocene potential of the area. This corroborates the final interpretation of the site report.

In all three cases, the smoking gun is the excavated material and whether or not it is the result of human agency, and if so, whether the material can be culturally contextualized. This will be investigated below. Unfortunately, the current whereabouts of some of the key pieces could not be ascertained despite rigorous efforts. This naturally challenges the present analyses, and their disappearance leaves many questions open. Despite this shortcoming, the analyses contribute new aspects to the empirical assessment while documenting previously unpublished information concerning site discovery and excavation.

Ejby Klint

Quantity: Eemian horizon: 3 lithics; Beach finds: >1000 lithics

Current position: Bramsnæs Lokalhistoriske Forening, Kirke Hyllinge; however, the three in situ *finds (Fig. 12) are currently lost*

Historical context

Ejby Klint is located on the eastern shore of Isefjord in north Zealand (Fig. 3) and is a c. 22.5 m high moraine hill. It is not particularly steep but rises slowly from the beach and is covered by grassy vegetation. The majority of the flint assemblage (>1000 pieces) was collected on the beach below the hill (Madsen 1963, 1965, 1968; Holm 1986). Approximately in the middle of the hill (Trench 13) three lithics were found in horizon Lok. EN-2/13 during excavation in the early 1960s led by Erik Madsen (Fig. 13). The find horizon is underlain by a moraine deposit of compact clay and overlain by a layer of aeolian sands (see inserted profile description in Fig. 13).

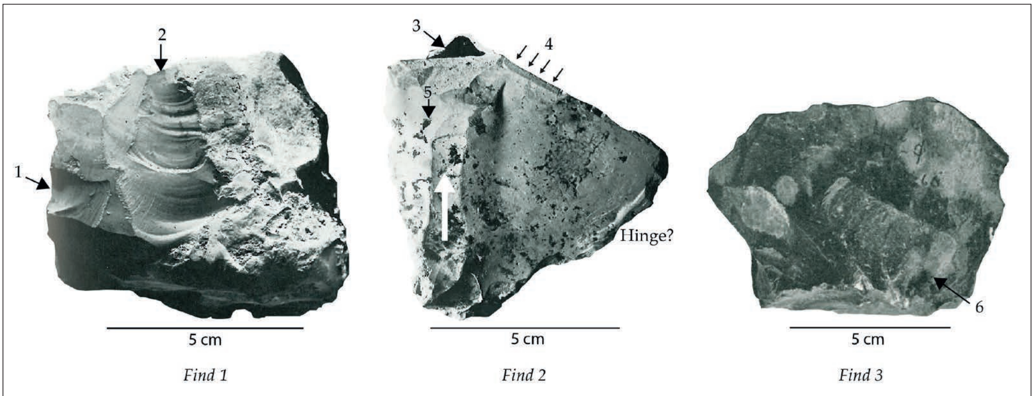

Fig. 12: *The original photographs of the three finds from the Eemian stone horizon considered Neanderthal tools by Erik Madsen. From Madsen (1968, Figure 2, 3 and 4).*

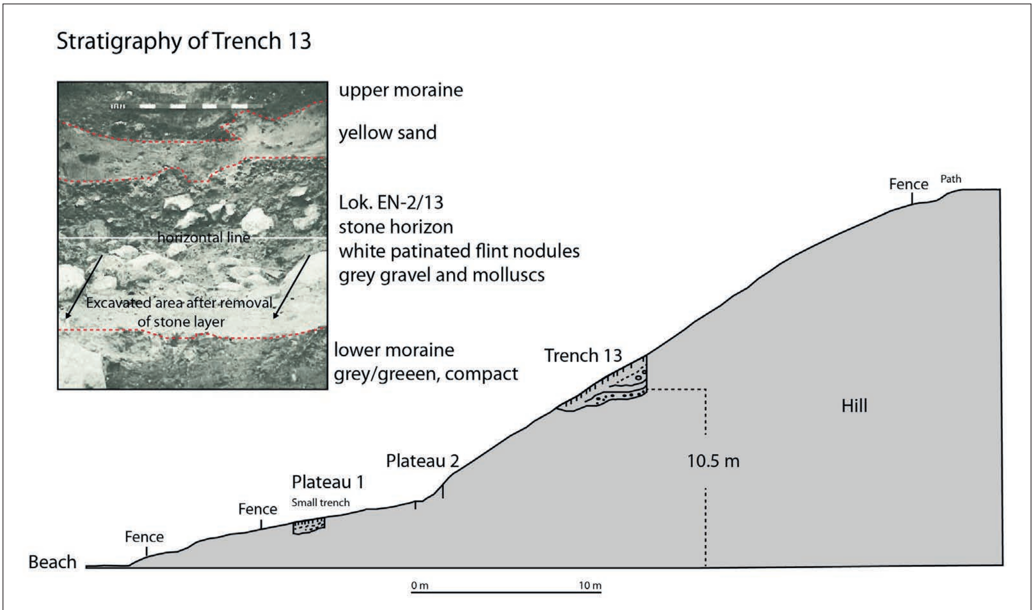

Fig. 13: *Drawing of the hill at Ejby Klint and the location of the excavation in Trench 13 containing the Eemian shoreline. Inserted photograph and description of the stratigraphy viewed in Trench 13. After Madsen (1965, Figure 1 and 2).*

The find horizon (Lok. EN-2/13) is a c. 0.5 m thick stone- and shell-rich layer. Based on molluscs species present in this layer, Madsen argued that it represented an Eemian shoreline (Madsen 1968). The three proposed artifacts were retrieved from this layer and registered with the following IDs: Lok. EN-2/13 (same as the layer name), Lok. EN-2/13A and Lok. EN-2/13D (Madsen 1963, 1965, 1968). For convenience, these three finds are here referred to as Find 1, Find 2 and Find 3, respectively. OSL-dating later confirmed the stratigraphic assignment of the find layer to the Eemian Interglacial (~121,000 ±

8000 BP) and provided age estimates of 142,000 ± 11,000 BP for the lower part of the moraine, and 40,000 ± 6000 years for the overlying aeolian sands (Schrøder 2000).

These results support Madsen's Eemian interpretation and suggest that the lower moraine is Saalian. However, it does not provide a frame for dating the beach finds. Madsen himself states that hill erosion is minimal at the find-spot because the water is shallow, the inclination of the hill is low and the layers are protected by vegetation (Madsen 1965). The proportional difference of finds on the beach and in the hill-horizon also do not support that the latter is the primary source of the former. The link between the beach finds and the hill-horizon is therefore weak, and the beach assemblage most likely represents activities taking place in younger prehistory or even historical times (the beach is a good source of erratic flint) rather than during the Eemian Interglacial. The following discussion therefore focuses on the three finds recovered from the Eemian deposit.

Artifacts or geofacts?

The central issue that needs resolving is whether the three finds from Ejby Klint are artifacts, i.e., artificially manipulated by humans, or if they are shaped by natural processes, i.e., so-called geofacts.

Unfortunately, it proved impossible to locate the three finds. Together with the much larger lithic assemblage (~1000 pieces) from the beach below Ejby Klint, the material has moved several times in the last five years due to various museum mergers. Today most of the collection is stored by the local historical association in the small town of Kirke Hyllinge (*Bramsnæs Lokalhistoriske Forening*) northeast of Ejby Klint (board member Thomas Dam Bruun, pers. comm. 11.02.2016-19.03.2016). But a search through the collection by the members of the local historical association did not reveal the three finds. It is presently unresolved where these finds are, and why and when they were separated from the remaining collection. Only the photographs and descriptions from Madsen's publications are available for study, and unfortunately, these are of relatively poor quality, with the photographs only available in black and white.

Find 1 (Lok. EN-2/13)

Maximum dimensions: length 10.5 cm, width 8.3 cm, thickness 7.5 m

Madsen (1968) categorizes this implement as a crude tool. In his description he mentions ten short flake scars with negative bulb of percussions, which, in his words, "seems intentional" (Madsen 1968: 37). Two complete removals can be clearly identified in the photograph (Fig. 12, Find 1, arrow 1 and 2). The largest of these has very pronounced heterogeneous concentric rings suggesting that the blow causing the flake to detach was of weak and irregular force consistent with natural or thermal fracture mechanics. Perpendicular to this, another possible removal is observed showing a pronounced negative bulb impression consistent with frost fracture dynamics. According to Madsen, these removals are covered by white patina and have a porcelain-like smoothness, whereas the rest of the piece has cortex and a weathered surface. Except perhaps for cortex, which is usually removed on human-made tools, these natural surface modifications match the expectations for all stones in beach environments irrespective of the piece being a geofact or artifact (Schmalz 1960; Rottländer 1975; Stapert 1976). Additionally, the large and nodule-like dimensions (= maximum thickness of 7.5 cm) of the implement correspond poorly with the expectations of a finished tool. These combined observations suggest that this is a geofact, possibly fractured naturally through contact with other stones in the active beach-shore environment.

Find 2 (Lok. EN-2/13A)

Maximum dimensions: length 7.5 cm, width 8.8 cm, thickness 3.3 cm

Madsen (1968) categorizes this implement as a flake-tool. The face Madsen considered the ventral side (the face shown in Fig. 12, Find 2) displays one elongated removal (Fig. 12, Find 2, large white arrow), whereas the dorsal side supposedly displays four removals (not depicted in any of the publications). The photograph and description are not of a quality that allows us to confirm whether this piece is a flake. Like Find 1, the piece also has a layer of white patina which can be viewed distally where the implement has broken (Fig. 12, Find 2, arrow 3). Dark patches/staining on the white surface can be observed which might be caused by algae or seaweed (Fig. 12, Find 2, arrow 5). Yet, the fact that the photos are black and white makes it difficult to verify this. It appears as if a small and defined part of the distal edge has strong local abrasion, causing the edge to be almost flattened in an oblique angle (Fig. 12, Find 2, arrows 4). Such grinding can occur between two objects of similar mineral density during slow high-pressure movements, for example in the case of solifluction. This is not consistent with Madsen's description of the find horizon showing no signs of redeposition (Madsen 1968: 35-36). Again, these combined observations suggest that the find is a geofact.

Find 3 (Lok. EN-2/13D)

Maximum dimensions: length 9.2 cm, width 6.6 cm, thickness 2.2 cm

According to Madsen (1968) this is also a flake-tool. The face shown in the photograph is described as convex, whereas the opposite side is described as concave. The convex face is most likely the one Madsen regards as the ventral side (the one shown in Fig. 12, Find 3), though this is not exactly clear from Madsen's description (Madsen 1968: 39). According to Madsen, the flint is grey and displays no coloured patina, but has patches of porcelain-like surface gloss. The ventral side (according to the above assumption) has one possible flake removal (Fig. 12, Find 3, arrow 6). One edge is argued to contain retouch; however, the location is not visible in the photograph or specified further in Madsen's description. There are no clear traces that imply human manipulation of the piece, which is therefore considered more likely to be a geofact.

It is also noticeable that this piece (Find 3) has no white patina. According to Madsen, it was found in the upper section of the find horizon, whereas the two others were found in the middle (Find 1) and lower section (Find 2) (Madsen 1968). Find 3 may therefore have been less exposed to the wet beach environment (causing the white patina) if it was deposited at the end of the interglacial as cooling led to lower sea levels. The porcelain-like surface gloss also matches the expectations for pieces exposed to aeolian sand transport typical of cold phases, corresponding to the aeolian sand cover in the stratigraphy. Therefore, if for a moment we assume that the three finds are actual artifacts, this means that they were not produced by the same people in a single event, but by at least two or even three different occupational events. In this case it is curious that so few traces of these separate events are found today, especially considering the extent of the excavation. Madsen expanded Trench 13 in both directions as well as opened several new trenches during several field seasons in the hope of making more discoveries in the same layer, but without success (Madsen 1963, 1965, 1968).

Considering Madsen's assertion and its implied importance to Neanderthal dispersal, it is also remarkable that the artifactual evaluation does not feature more in his several publications of the site. This in itself may be concerning. It is clear that locating the pieces is an important next step in ascertaining all aspects of their manufacture, but their dimensions, characteristics and the fact that they do not represent well-articulated tools do not provide the long-awaited proof that Neanderthals were knapping flints on the beach at Ejby during the Eemian Interglacial. It may also be important to note that, like today, Zealand was most likely an island during the last interglacial. Since we still lack clear evidence of Neanderthal sea-crossing abilities, these finds are too ambiguous to offer the unequivocal evidence needed to make claims of Neanderthals living at these high latitudes and possessing seafaring technology.

Hollerup

*Minimum number of individuals: eight fallow deer (*Dama dama*)*

Current position: The National History Museum of Denmark, Zoological museum, Copenhagen

Historical context

Hollerup is located southwest of the city of Randers in north-central Jutland (Fig. 3). Here, diatomaceous lake sediments from the last interglacial-glacial complex were exposed through commercial gravel and lime mining, which started in the late nineteenth century. In the Eemian lacustrine deposit, at least eight fallow deer (*Dama dama*) specimens were discovered between 1897 and 1992 (Hartz and Østrup 1899; Møhl-Hansen 1955; Björck et al. 2000). No lithics were recovered from the sequence.

The faunal remains were not recovered through controlled excavation, but the stratigraphic information was carefully recorded during extraction (Møhl-Hansen 1955; Björck et al. 2000). The finds derive from a lacustrine layer found c. 2.5 m below the terrain, and pollen studies indicate a clear affiliation with the Eemian Interglacial (Hartz and Østrup 1899; Jessen and Milthers 1928; Andersen 1966; Kronborg et al. 1990). The layer is overlain by early Weichselian sands and late Weichselian till and underlain by Saalian sand, gravel and till. Thermoluminescence dating of the find layer produced dates between 77,000 BP and 88,000 BP (Kronborg and Mejdahl 1989). Correction using shallow trap correction resulted in ages of ca. 120,000 BP, corresponding to the Eemian Interglacial (Mejdahl and Funder 1994). Additional Uranium-series dates produce ages within a wider range between 89,000 BP and 199,000 BP, not directly contradicting an Eemian age, but not narrowing the frame either (Israelson et al. 1998).

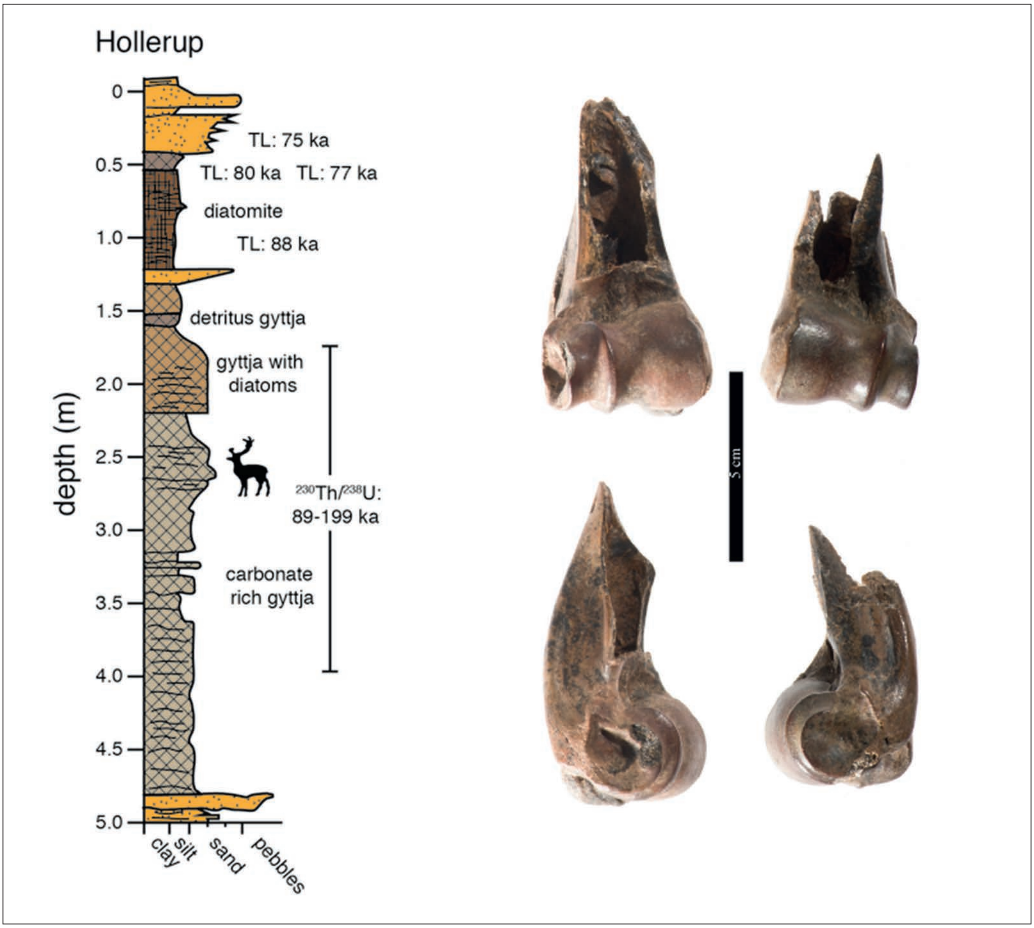

Fig. 14: Left: Stratigraphy of the Hollerup lacustrine sequence with accompanying dates. Position of the primary find layer indicated with a fallow deer. From Egeland et al. (2014, Figure 5; after Møhl-Hansen 1955). Right: Cranial (top) and lateral (bottom) views of distal humeri from Find V. From Egeland et al. (2014, Figure 19), © K. Hansen.

The association with human activities was first suggested by zoologist Ulrik Møhl-Hansen (1955) who, during a study of fallow deer specimen Find V, noticed a high degree of symmetry in the bone breakages, particularly around the epiphyseal end of the long bones. He concluded that this was the result of intentional marrow extraction, which, taking the Eemain age into consideration, implied that Neanderthals were the likely culprits. However, no distinct cut-marks were observed by Møhl-Hansen, and the site is not connected to other archaeological material. The 1955 marrow-extraction hypothesis therefore needs to be tested against experimental and archaeological data using up-to-date methods and drawing on recent research into natural bone breakage dynamics.

Marrow extraction or natural processes?

A comprehensive taphonomic (re-)analysis of the Hollerup fallow deer specimens retrievable from the original study was conducted between 2012 and 2013 and investigated whether the bones showed explicit signs for marrow extraction (Riede et al. 2012, 2013; Egeland et al. 2014). The analysis included in total 665 separate fallow deer bones from five localities, with the most complete specimen being Find V from Hollerup (Fig. 15, top row, right). Here, only the Hollerup specimens are discussed, first with regard to potential cut-marks, and second with regard to the cause of the bone breakage.

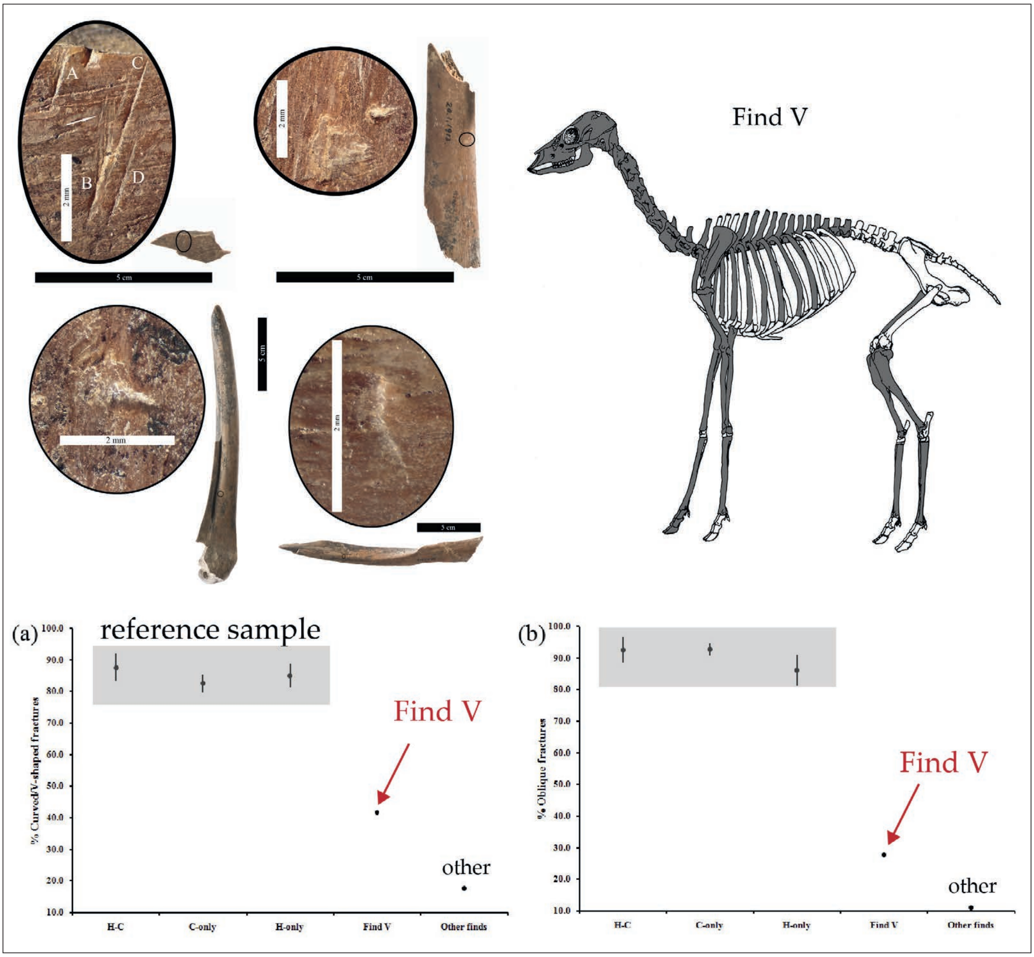

Fig. 15: *Top row, left: Four ambiguous marks observed on Find V; from Egeland et al. (2014, Figure 12-15); © M. MacNaughton. Top row, right: Preserved parts of the Find V fallow deer specimen shown in grey; from Riede et al. (2013, Figure 10). Bottom row: Percentage of a) curved/V-shaped fracture outlines and b) oblique fracture angles for three experimental scenarios of fresh-broken long bones (HC: human–carnivore, C-only: carnivore only, H-only: human only), Find V (arrows), and the other fallow deer finds combined. Bars indicate bootstrapped 95% confidence intervals. Experimental data from Marean et al. (2000, Table 2).*

Bone analysis identified four previously unrecorded but ambiguous marks on specimen Find V which could potentially represent cut-marks or percussion marks (Fig. 15, top row, left). However, their morphology and freshness also leave open the possibility that they are animal tooth marks or more recent marks made during excavation or curation of the bones. Of these, Mark 1 is the most convincing and is subdivided into four individual incisions, A, B, C and D (Fig. 15, photo, top left). Detailed studies of the individual incisions, however, revealed that these marks were made by different processes at different stages (Egeland et al. 2014). Although this does not completely rule out that a lithic tool could have made the incisions at different times, it does not correspond to the behavioral expectations for meat processing and marrow extraction. No unambiguous evidence for tool manipulation of the bones is therefore observed.

The bone-breakage pattern was investigated using comparative data from an experimentally obtained modern reference sample of freshly broken long bones (with soft hammer technique) exposed to hyenas (Marean et al. 2000, 2004). The comparison shows that the frequencies of curved/V-shaped fracture outlines (Fig. 15, bottom row [a]) and oblique fracture angles (Fig. 15, bottom row [b]) in Find V are much lower than expected from the experimental reference sample (Fig. 15, bottom row, shaded grey). This indicates that the bones of Hollerup Find V were not broken during a nutritive phase of the bone development, which is the optimal time for marrow extraction. This does not offer support to the interpretation that meat-processing behavior is responsible for the fractures, but rather that the fractures occurred after deposition.

Consequently, since the bones are not pronouncedly weathered, sediment compaction or gelifraction, or both, combined with rapid organic leaching, are the most likely causes of these fractures. Since the epiphyseal part of the long bone is weaker in comparison to other bone tissue, these are also more inclined to break as a result of such pressure (Riede et al. 2013; Egeland et al. 2014). The final conclusion of the study is therefore that the Hollerup deer do not display clear signs of anthropogenic marrow extraction.

Vejstrup Skov

Quantity: 132 lithics are listed in the original find list in the excavation report (Jensen 1980). Of these, 56 listed pieces were discarded in 1972 by Søren H. Andersen. This leaves 76 lithics, yet 119 lithics are counted in the assemblage at Moesgaard Museum in 2016. Of these, 56 pieces are registered with find ID, whereas 63 pieces are without find ID. The four finds illustrated in Holm and Larsson 1995 (1689:X3, 1689:AB94, 1689:BX3 and 1689:AB96) are not found in the collection at Moesgaard in 2016 and are possibly located elsewhere

Current position: Moesgaard Museum, Aarhus, FHM 1689, and possibly elsewhere

Historical context

Vejstrup Skov is located north of Christiansfeld in southern Jutland (Fig. 3). It was discovered in the 1960s by two local brothers, Niels and Åge Boysen. They found several concentrations of 'primitive' flake-dominated flint assemblages in and around an erosion gully formed by Weichselian meltwater. Of these, the Vejstrup Skov location provided

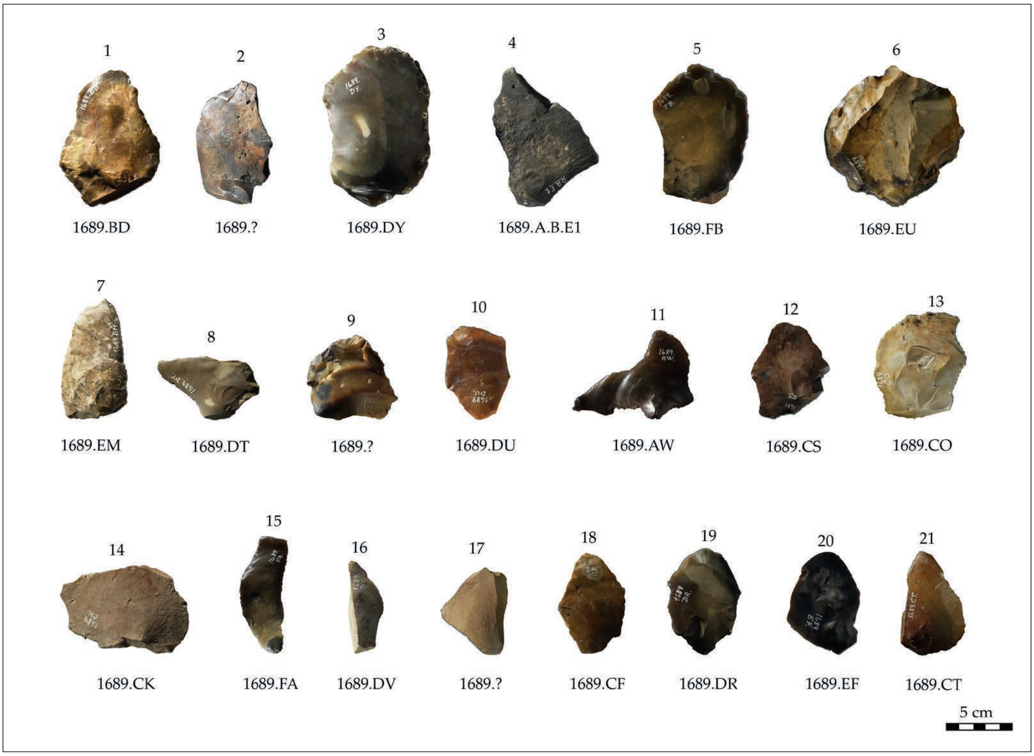

Fig. 16: *A selection of the larger implements from Vejstrup Skov, primarily ventral view of simple flakes and core trimmings. Find ID is recorded below each find (all starting with the site identifier 1689), ? denotes finds without unique ID. Notice the variation in flint types, shine, gloss and patination. © Rógvi N. Johansen, Foto/medie afd. Moesgaard.*

good circumstances for archaeological investigation, and test-trenches were opened here in 1971 (Jensen 1980; Holm and Larsson 1995). More extensive excavation took place in 1972 in collaboration between Moesgaard Museum in Aarhus and the local Museum in Haderslev.

Today, the most challenging aspect of this site is the stratigraphic interpretation, as the official understanding of the deposition scenario changed during and after excavation. The initial stratigraphic understanding was that the find horizon (layer 6, and possibly 5 and 7, Fig. 17) was deposited by freshwater during the Eemian Interglacial. This was based on the fact that it was placed between two clay-rich deposits interpreted as an underlying Saalian- and an overlying Weichselian moraine (Holm and Larsson 1995).

Later, during excavation, the age of the find layer changed to 400,000 years old. This was based on foraminiferal analysis, which purportedly found foraminifers characteristic of the Holsteinian Interglacial (stated in several Danish newspapers), but no official report from the analysis is currently available. This deep Pleistocene chronological affiliation implied that humans were here much earlier than expected and the site attracted a lot of media attention and was proclaimed a national sensation (for examples, see Nielsen 2016).

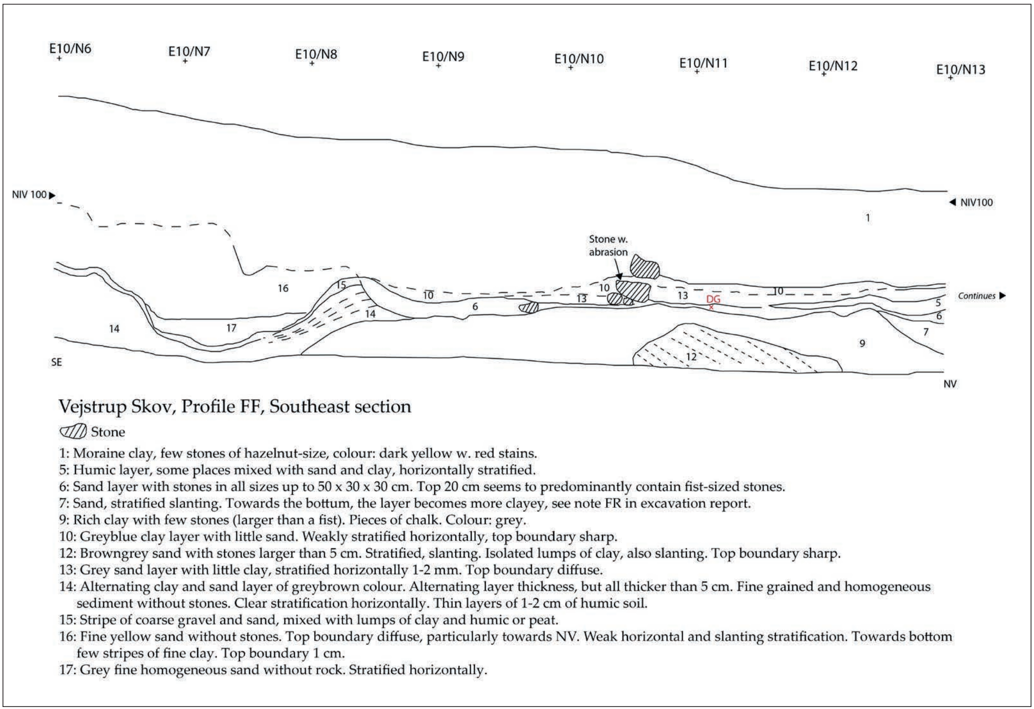

Fig. 17: *Drawing and sediment description of the southeastern part of the main profile (FF) at Vejstrup Skov. Find 1689:DG was exposed in the profile and is marked with a red cross. Digitized after the original profile drawing kept with the site report at Moesgård Museum (Jensen 1980).*

In the last stage of the excavation, however, it was observed that the find-bearing horizon inclined upwards and ceased rather abruptly in the profile, resembling a modern river shore. Further, post-excavation analysis of the artifacts stressed the heterogeneous nature of the assemblage with regard to surface patination, raw material selection and degree of rolling and weathering. This cast doubt on the notion that they were part of a single deposition event. Combined, these observations lead to an alternative, and much younger, formation scenario.

In this scenario, the Holocene river gradually eroded and cut into the intact Pleistocene moraine along the erosion gully, depositing over time much younger flint, seemingly *in situ*, between the older glacial deposits. This interpretation became the one supported in the final excavation report, although the possibility of a Pleistocene age was not completely dismissed (Jensen 1980). The site was never formally published.

Pleistocene or Holocene?

Since the assemblage, with diagnostic bulbs of percussion, shows clear signs of being worked by humans, the main question becomes whether the lithics were knapped during the Pleistocene or the Holocene. Most of the flint assemblage (n=119) is currently stored at Moesgaard Museum (FHM 1689) in Aarhus, Denmark. But a comparison between the original find-list, finds listed in previous publications, and the current assemblage does not match (see quantity description in the beginning of this section). It appears that the current collection at Moesgaard Museum is not complete, but since it is unknown where the missing finds are located today, they are excluded in the following discussion.

The remaining assemblage is dominated by simple flakes made with hard hammer percussion (Fig. 16). Formal tools and evidence of *chaîne opératoire* is restricted to a few blades, retouched flakes, debitage and core trimming flakes with cortex. Combined with the uncertain chronostratigraphy, this technically sound but typologically weak material makes clear cultural affiliation difficult.

Previously, affiliation with the Clactonian industry had been proposed based on the Holsteinian chronology, the lack of handaxes, and statements made by foreign experts (Holm 1986; Holm and Larsson 1995). However, the Holsteinian date is highly tentative and the lack of handaxes alone can equally point to a Holocene age. Further, correlations based on typological similarity between relatively undiagnostic tool types are inadequate. Not least, because foreign authorities come with a very different archaeological baseline and may not be contextually equipped to interpret contentious finds in a region such as Scandinavia.

Natural surface modification

This leaves only the natural surface modification as an indication of relative age. This is because the various combinations of natural surface modifications on a lithic surface provide information about the post-depositional history of the implement (Stapert 1976). It is a particularly useful analytical tool in previously glaciated areas, such as Scandinavia, where Pleistocene stone tools are expected to have been exposed to various natural phenomena such as frost, wind-erosion and soil movement. Since these processes leave characteristic marks on the lithic surface, they can suggest a relative deposition age in very broad terms, i.e., whether the artifact was deposited before or after a major glaciation event. However, the rate and palimpsest of natural surface modification is complex, context-dependant and nonlinear. Surface modification can also occur in more recent times, but in an active landscape such as in Scandinavia, Pleistocene artifacts are expected to have major natural surface modification depending on the depositional environment. The approach alone is therefore only supportive and should optimally be complimented with other lines of evidence.

Since Vejstrup Skov was covered by the Scandinavian Ice Shield during the several Saalian and Weichselian glacial advances, lithic artifacts from the Holsteinian or Eemian Interglacials are expected to possess some, or all, of the following features: frost damage (e.g., cracks, splintering or potlid fractures), aeolian pockmarks (sometimes called orange skin caused by sand particles and strong winds), micro- or macro-fragmentations due to soil movement and friction (e.g., natural retouch) and edge-rounding (Stapert 1976; Nielsen 2016).

A study of the surface modification using a digital USB microscope revealed a few occurrences of scratches, for example on artifact 1689.DD (Fig. 18A), as well as rounding of the edges on a number of artifacts, for example on artifact 1689.ET (Fig. 18B).

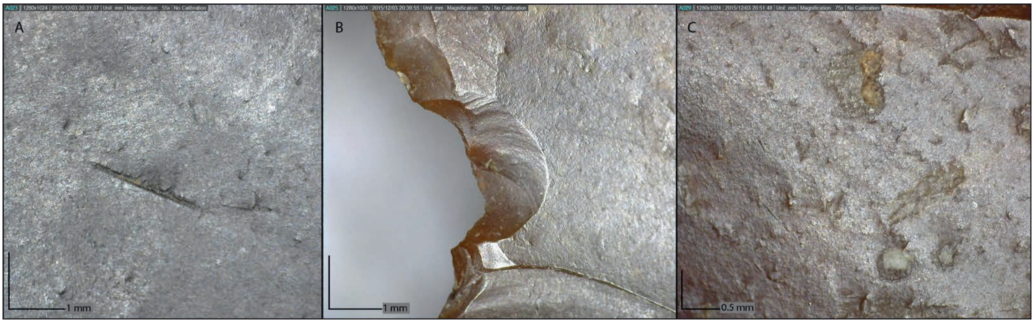

Fig. 18: *Three examples of natural surface modification observed on the lithic material from Vejstrup Skov. A: An isolated scratch on 1689.DD. B: Minor edge rounding on 1689.ET, dorsal side of blade. C: A small collection of round flat-bottomed pockmarks observed on 1689.EX.*

Potential pockmarks were only observed on one small flake fragment 1689.EX (Fig. 18C), but not at a very pronounced stage. Except for these observations, the general assemblage does not display strong modification of the surfaces besides different coloration.

Artifacts left for some time in open-air paleo-landscapes are naturally more exposed to these modification processes than artifacts embedded in protective lake sediments immediately after deposition. Since Vejstrup Skov is a low-energy fluvial site, post-depositional frost damage would be expected on artifacts if they date to either of the proposed Pleistocene interglacials. This is not the case. The observed natural surface modifications instead conform to the expectations for Holocene fluvial deposition. There is therefore little support that Neanderthals were the makers of the assemblage, and it is more likely that the finds are the remains of repeated episodes of nodule testing and flake production by humans in much more recent prehistory, i.e., during the Holocene.

Conclusion

Empirical synthesis and final remarks

The state of the Danish empirical record as reviewed above questions why the artifacts and sites were even proposed a Pleistocene/Neanderthal affiliation in the first place. The explanation may lie in an early tradition of optimistic abductive reasoning rooted in false assumptions of convergence. This means by regarding all the “Neanderthal” finds as part of the same find-category, the typologically stronger (but contextually weaker) unstratified handaxe-like implements were connected with the contextually stronger (but typologically weaker) signal from the stratified sites. The stronger aspects of these respective categories (typology and geology) were thereby traversed and used as arguments, primarily by autodidact archaeologists (Madsen 1968; Jepsen 1973), and also sometimes by professional archaeologists. An example of this is when Danish archaeologist Becker used the contextually secure Hollerup locality to support his interpretation of the typologically convincing Fænø and Villestrup handaxes (Becker 1971).

This early positivism led to a negative turn and highly critical view regarding the potential of Pleistocene archaeology in Denmark, led primarily by Danish archaeology

Professor P. V. Glob (Glob 1972). This negativism is persistent today and shapes the current and widely held assumption that there are no traces to be found in Scandinavia (either rooted in preservation concerns or notions of hominin adaptive constraints). This has created a vacuum in the study of the earliest prehistory of Scandinavia. The problem has repeatedly been pointed out by Holm (Holm 1986, 2002; Holm and Larsson 1995), but so far with little effect.

This stresses the necessity to start anew and to assess the integrity of each locality on its own terms, completely unbiased by interpretations and assumptions formed on the basis of other locales or material objects. This has been done here, and the conclusion is that there are currently no solid contenders for Neanderthal evidence in Denmark. Moving forward, there is a need for new and improved find-procurement strategies in order to rigorously investigate the Pleistocene empirical potential of southern Scandinavia on a wider scale. Such investigations should be shaped and steered by the renewed critical baseline produced through the multi-perspective approach outlined in the first part of this paper.

By encouraging and performing similar critical investigations along the geographical margins of the entire Neanderthal range, the representativeness of current Neanderthal distribution can be formally investigated. Ultimately, such endeavors have the potential to produce new finds in unexpected places, thereby pushing the boundary of currently acknowledged Neanderthal adaptive abilities as well as spatiotemporal distribution.

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