Daniel Groß · Harald Lübke · John Meadows · Detlef Jantzen (eds.)

# Working at the Sharp End: From Bone and Antler to Early Mesolithic Life in Northern Europe



Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum

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Band 10

Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum aus dem Museum für Archäologie Schloss Gottorf und dem Zentrum für Baltische und Skandinavische Archäologie in der Stiftung Schleswig-Holsteinische Landesmuseen Schloss Gottorf Band 10

> Begründet von Jürgen Hoika †

Herausgegeben von Sönke Hartz und Harald Lübke

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# Contents

Vorwort der Herausgeber
Editors' Preface
Grußwort des Landesarchäologen von Mecklenburg-Vorpommern
Welcome address by the State Archaeologist of Mecklenburg-Western Pomerania
Acknowledgements
Daniel Groß, Harald Lübke, John Meadows, Detlef Jantzen and Stefan Dreibrodt Re-evaluation of the site Hohen Viecheln 1
John Meadows, Mathieu Boudin, Daniel Groß, Detlef Jantzen, Harald Lübke and Markus Wild Radiocarbon dating bone and antler artefacts from Mesolithic Hohen Viecheln (Mecklenburg-Western Pomerania, Germany)
<i>Éva David</i> The osseous technology of Hohen Viecheln: a Maglemosian idiosyncrasy?
Markus Wild An evaluation of the antler headdress evidence from Hohen Viecheln
<i>Erik Brinch Petersen</i> Nordic visits to Hohen Viecheln, Mecklenburg
Bernhard Gramsch The Mesolithic bone industries of northeast Germany and their geo-archaeological background
Sönke Hartz, Harald Lübke and Daniel Groß Early Mesolithic bone points from Schleswig-Holstein
<i>Ulrich Schmölcke</i> Early Mesolithic hunting strategies for red deer, roe deer and wild boar at Friesack 4, a three-stage Preboreal and Boreal site in Northern Germany
Lars Larsson, Arne Sjöström and Björn Nilsson Lost at the bottom of the lake. Early and Middle Mesolithic leister points found in the bog Rönneholms Mosse, southern Sweden

Sara Gummesson and Fredrik Molin
Points of bone and antler from the Late Mesolithic settlement
in Motala, eastern central Sweden
Harry K. Robson and Kenneth Ritchie
The Early Mesolithic fisheries of Southern Scandinavia
Ilga Zagorska
The Early Mesolithic bone and antler industry in Latvia, Eastern Baltic
Mikhail G. Zhilin
Early Mesolithic barbed bone points in the Volga-Oka interfluve
Olga Lozovskaya and Vladimir Lozovski†
Bone and antler projectile points from the Meso-Neolithic site
Zamostje 2, Moscow region, Russia
Svetlana Savchenko
Early Mesolithic bone projectile points of the Urals
Luc Amkreutz and Merel Spithoven
Hunting beneath the waves. Bone and antler points from
North Sea Doggerland off the Dutch coast
Barry Taylor, Nicky Milner and Chantal Conneller
Excavations at Star Carr: past and present
Ben Elliott, Barry Taylor, Becky Knight, Nicky Milner, Harry K. Robson,
Diederik Pomstra, Aimée Little and Chantal Conneller
Understanding the bone and antler assemblages from Star Carr

# Vorwort der Herausgeber

Die Schriftenreihe "Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein" wurde von dem ursprünglichen Herausgeber Jürgen Hoika vor mittlerweile 25 Jahren im Jahre 1994 begründet, um am damaligen Archäologischen Landesmuseum Schleswig (ALM) und heutigem Museum für Archäologie Schloss Gottorf (MfA) ein Publikationsorgan für die Veröffentlichung von Forschungsergebnissen zur Steinzeit Schleswig-Holsteins zu schaffen. Dabei sollte es sich zum einen um Sammelwerke mit Beiträgen von vorzugsweise auf Schloss Gottorf veranstalteten Symposien, Workshops und Tagungen mit steinzeitlicher Thematik und zum anderen um zumeist in Dissertationen zusammengestellte ausführliche Materialvorlagen handeln. Entsprechend enthielt der 1994 vorgelegte erste Band der Reihe die Beiträge zum 1. Internationalen Trichterbechersymposium, welches, von Jürgen Hoika gemeinsam mit Jutta Meurers-Balke initiiert, 1984 am Archäologischen Landesmuseum in Schleswig stattgefunden hatte. In der Folge wurden dann aber beginnend mit den Arbeiten der beiden heutigen Herausgeber nunmehr acht überwiegend am Institut für Ur- und Frühgeschichte der Christian-Albrechts-Universität zu Kiel fertiggestellte Dissertationen veröffentlicht, die ganz wesentlich mit der wissenschaftlichen Vorlage und Auswertung von Forschungsgrabungen in Schleswig-Holstein und - seit der Beteiligung des Zentrums für Baltische und Skandinavische Archäologie an der Herausgeberschaft – aus dem gesamten Ostseeraum befasst sind.

Deshalb ist es eine besondere Freude für die Herausgeber, mit dem vorliegenden Band 10 "Working at the Sharp End: From Bone and Antler to Early Mesolithic Life in Northern Europe" der Schriftenreihe "Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum" wiederum einen Sammelband mit den Beiträgen eines Workshops vorlegen zu können, der vom 14. bis 16. März 2016 auf Schloss Gottorf stattgefunden hat. Dabei handelt es sich um den Abschlussworkshop des von der Deutschen Forschungsgemeinschaft geförderten Projektes "Neubewertung von Chronologie und Stratigraphie des frühholozänen Fundplatzes Hohen Viecheln (Mecklenburg-Vorpommern) unter besonderer Berücksichtigung der diagnostischen Knochenartefakte" (DFG-Projektnummer 271652103) unter Leitung von Daniel Groß, Harald Lübke, John Meadows (alle ZBSA) und Detlef Jantzen (Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern; Landesarchäologie). Entsprechend enthält dieser Band neben dem Abschlussbericht des Forschungsprojektes insgesamt 17 Beiträge der eingeladenen Workshop-Teilnehmer, die entweder ergänzende Studien zum Fundplatz Hohen Viecheln enthalten oder sich grundsätzlich mit verwandten Themen zur Erforschung des frühholozänen Mesolithikums im nördlichen Europa befassen.

Alle Beiträge wurden nach internationalem Standard von jeweils zwei anonymen Gutachtern in einem Peer-review-Verfahren bewertet und danach den Autoren zur erneuten Überarbeitung übergeben, bevor die abschließende redaktionelle Bearbeitung der Manuskripte erfolgte. Die Textredaktion für alle Beiträge wurde von Gundula Lidke durchgeführt, Jana Elisa Freigang und Jorna Titel leisteten dabei unterstützende Arbeiten. Das Layout übernahm Daniel Groß, Titelbild und Umschlag entwarf Jürgen Schüller. Die meisten Karten und Zeichnungen wurden von den Autoren selbst bereitgestellt. In einzelnen Fällen erfolgte eine Überarbeitung durch Daniel Groß. Allen sei dafür an dieser Stelle herzlich gedankt.

Neu im Rahmen der Schriftenreihe ist, dass die Beiträge unmittelbar nach Fertigstellung und Freigabe der Autoren in einem "online-first"-Verfahren auf der Homepage des Verlages im Open Access zum freien Download bereitgestellt wurden. Für die Umsetzung dieser Forderung der Herausgeber danken wir dem Wachholtz Verlag, insbesondere Herrn Henner Wachholtz, sehr. Besonderer Dank gilt dem Vorstand des Zentrums für Baltische und Skandinavische Archäologie Schleswig, besonders dem Direktor, Claus von Carnap-Bornheim, und der Forschungsleiterin, Berit Valentin Eriksen, die die Veröffentlichung dieses Bandes durch die Bereitstellung der erforderlichen Mittel für den Druck der Arbeit maßgeblich unterstützten.

Sönke Hartz und Harald Lübke Schleswig, im Oktober 2019

# Editors' Preface

The series 'Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein' was founded by its first editor, Jürgen Hoika, in 1994, 25 years ago, in order to establish a possibilty to publish Stone Age research results from Schleswig-Holstein at the then Archaeological State Museum (Archäologisches Landesmuseum [ALM]), today's Museum for Archaeology (Museum für Archäologie, Schloss Gottorf [MfA]). Publications should, on the one hand, reflect proceedings of symposia, conferences and workshops with Stone Age topics primarily held at Gottorf Castle, on the other hand, dissertations presenting comprehensive material. According to that, the first volume, published in 1994, contained the contributions to the 1<sup>st</sup> International Funnelbeaker Symposium, which, initiated by Jürgen Hoika and Jutta Meurers-Balke, had taken place at the Archaeological State Museum in 1984. Following that, eight dissertations, mainly accomplished at the Institute for Pre- and early History at the Christian-Abrechts-University Kiel, were published, starting with those by today's editors. All these volumes contributed substantially to the scientific presentation and analysis of excavation materials from Schleswig-Holstein and – since 2012, when the Centre for Baltic and Scandinavian Archaeology (ZBSA) also became involved in editig the series – the whole of the Baltic Sea area.

Therefore the editors are especially happy to once more present conference proceedings with volume 10 of the series 'Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum': 'Working at the Sharp End: From Bone and Antler to Early Mesolithic Life in Northern Europe' collects contributions to a workshop held at Gottorf Castle on 14<sup>th</sup>–16<sup>th</sup> March, 2016. This represented the closing workshop of the DFG-funded project 'Neubewertung von Chronologie und Stratigraphie des frühholozänen Fundplatzes Hohen Viecheln (Mecklenburg-Vorpommern) unter besonderer Berücksichtigung der diagnostischen Knochenartefakte' (DFG project no. 271652103), directed by Daniel Groß, Harald Lübke, John Meadows (all ZBSA) und Detlef Jantzen (Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern; Landesarchäologie). In addition to the project's final report the volume contains 17 papers by researchers invited to participate in the workshop, representing either additional studies on material from the site Hohen Viecheln or related topics in research of the early Holocene Mesolithic in northern Europe.

Each paper was, according to international standards, peer-reviewed by two anonymous reviewers and then returned to the author for reworking before final editorial work. Copy-editing was performed by Gundula Lide, supported by Jana Elisa Freigang and Jorna Titel. Daniel Groß realised the layout; cover and cover illustration were designed by Jürgen Schüller. Most maps and figures were provided by the authors themselves, some were reworked by Daniel Groß. We express our sincere thanks to all involved!

It is a novelty for the series to have papers published online first immediately after completion and authors' approval in open access for free download on the website of Wachholtz Publishers. We would like to thank Henner Wachholtz, Wachholtz Publishers, very much for making this possible!

Special thanks are due to the board of the Centre for Baltic and Scandinavian Archaeology (ZBSA) Schleswig, particularly to the director, Claus von Carnap-Bornheim, and the head-of-research, Berit Valentin Eriksen, who substantially supported this publication by providing financial means for its printing.

Sönke Hartz and Harald Lübke Schleswig, October 2019

# Grusswort des Landesarchäologen von Mecklenburg-Vorpommern

Mit seinen großflächigen, oft noch weitgehend unberührten Niederungen und Binnengewässern bietet Mecklenburg-Vorpommern beste Voraussetzungen, um die gewässeraffinen Kulturen des Mesolithikums zu erforschen. Die Überreste ihrer Wohn- und Jagdstationen sind im feuchten Milieu hervorragend erhalten geblieben. Störungen durch Torfabbau, Begradigung von Gewässern oder Meliorationsmaßnahmen blieben im Wesentlichen auf das 19. und 20. Jahrhundert beschränkt. Sie haben zwar einen gewissen Schaden angerichtet, aber, weil sie zumindest im 20. Jahrhundert oft von aufmerksamen ehrenamtlichen Bodendenkmalpflegern beobachtet wurden, überhaupt erst zur Entdeckung vieler Fundstellen geführt.

Welche Fundstellen eingehender erforscht werden und damit das Bild einer Epoche besonders prägen, unterliegt oft dem Zufall. Hohen Viecheln rückte in den Fokus der Forschung, weil die Entdeckung mehrerer Knochenharpunen zu Beginn der 1950er Jahre auf eine günstige Konstellation traf: 1953 war aus der Vorgeschichtlichen Abteilung des Staatlichen Museums das Museum für Ur- und Frühgeschichte Schwerin entstanden, das auch für die Bodendenkmalpflege in den drei Nordbezirken der DDR zuständig war. Der ehrgeizige Direktor des Museums, Ewald Schuldt, hatte sich durch Ausgrabungen auf der Burgwallinsel Teterow einen Namen gemacht und war nun auf der Suche nach einem geeigneten Fundplatz für ein eigenes Forschungsprojekt.

Wegen der sehr guten Erhaltungsbedingungen versprach Hohen Viecheln, zusätzlich zu dem bekannten Spektrum an Steinartefakten auch ein umfangreiches Geräteinventar aus organischen Materialien bergen zu können. Die ebenfalls ausgezeichnet erhaltenen Tierknochen sollten Aufschluss über das Jagdwild geben. Hinzu kam die Aussicht, aus der Stratigraphie neue Erkenntnisse zur Chronologie und zu den Veränderungen der naturräumlichen Verhältnisse zu gewinnen. Diese Erwartungen wurden nicht enttäuscht: Hohen Viecheln entwickelte sich zu einem der bedeutendsten Plätze mesolithischer Forschung, gleichrangig mit Duvensee, und inspirierte weitere Forschungen, u. a. in Friesack und Rothenklempenow.

Hohen Viecheln gehört nach wie vor zu den legendären archäologischen Fundstellen in Mecklenburg-Vorpommern, auch wenn es aus heutiger Sicht nicht mehr so einzigartig dasteht. Dank einer intensiv betriebenen ehrenamtlichen Bodendenkmalpflege ist die Zahl der bekannten mesolithischen Fundplätze im Land deutlich gestiegen, von denen vermutlich mehrere ein ähnliches Potenzial wie Hohen Viecheln aufweisen. Verändert haben sich aber nicht nur die Verbreitungskarten, sondern auch die Möglichkeiten archäologischer Forschung. Es drängte sich deshalb geradezu auf, Hohen Viecheln noch einmal unter die Lupe zu nehmen, bisherige Erkenntnisse kritisch zu prüfen und neue hinzuzufügen. Der DFG und allen Projektpartnern gebührt herzlicher Dank dafür, dass sie das ermöglicht haben.

So wird Hohen Viecheln auch weiterhin als exemplarischer Fundplatz für das Mesolithikum in der norddeutschen Tiefebene stehen – eine hochinteressante Umbruchszeit, in der Klimawandel, Anstieg des Meeresspiegels und andere Veränderungen eine ständige Anpassung der Menschen an ihre Umwelt erzwangen.

Detlef Jantzen Schwerin, im September 2019

# Welcome address by the State Archaeologist of Mecklenburg-Western Pomerania

Mecklenburg-Western Pomerania with its large, often unspoiled lowlands and inland waters offers outstanding possibilities for research into the water-oriented cultural groups of the Mesolithic. Remains of their settlement and hunting sites are often well preserved in wet conditions. Disturbances by peat extraction, straightening of watercourses or melioration measures mainly took place during the 19<sup>th</sup> and 20<sup>th</sup> centuries. They did some damage, but – as at least during the 20<sup>th</sup> century they were often supervised by vigilant amateur archaeologists – many sites were discovered this way in the first place.

But often it is left to chance which sites can be thoroughly investigated to largely characterise the picture of a whole timespan. Hohen Viecheln became the focal point of research interest under favourable circumstances: the discovery of several bone points there at the beginning of the 1950s fell together with the establishment of the Museum of Pre- and Early History in Schwerin (out of the former Department of Prehistory at the State Museum) which was also responsible for the preservation and care of field monuments in the three northern districts of the GDR.

The ambitious museum director, Ewald Schuldt, had already gained reputation through his excavations of the Slavic ring wall island near Teterow, and he was looking for a suitable site for another research project. Due to the very good preservation conditions at the site, Hohen Viecheln promised, in addition to the spectrum of artefacts known from other places, a substantial organic inventory. The wellpreserved animal bones were expected to shed light on game species and hunting strategies. Furthermore, important results were expected concerning chronology and environmental changes. These hopes were not disappointed: Hohen Viecheln has become, alongside Duvensee, one of the most important sites for Mesolithic research, and research there has inspired further excavations, e.g. at Friesack or Rothenklempenow.

Hohen Viecheln is still one of the legendary archaeological sites in Mecklenburg-Western Pomerania, even if it no longer stands alone. Thanks to intensive voluntary archaeological surveys the number of Mesolithic sites has increased significantly; and several of these may have a potential similar to that of Hohen Viecheln. But not only distribution maps have changed during the last years, but also the possibilities of archaeological research. Therefore, the idea to have another look at Hohen Viecheln, to challenge old results and add new ones, suggested itself. I want to thank the German Research Foundation (DFG) and all project contributors for having made this possible. In this way, Hohen Viecheln will continue to be an exemplary North German Lowland site of the Mesolithic – a highly interesting time when climate change, sea-level rise and other changes enforced constant human adaptions to the environment.

Detlef Jantzen Schwerin, September 2019

# Acknowledgements

This volume of the series 'Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum' represents the proceedings of a workshop held at the Centre for Baltic and Scandinavian Archaeology (ZBSA) in Schleswig in March 2016. It is a part of the editors' project 'Neubewertung von Chronologie und Stratigraphie des frühholozänen Fundplatzes Hohen Viecheln (Mecklenburg-Vorpommern) unter besonderer Berücksichtigung der diagnostischen Knochenartefakte', funded by the German Research Foundation (DFG) under the project number 271652103.

While the project was dealing with the re-evaluation of the site Hohen Viecheln 1 for chronological and stratigraphical aspects, this volume does not only cover its final publication but comprises additional modern studies about the site by different scholars. These are furthermore embedded into the international research landscape by adjacent studies covering an area from modern day Britain in the west to the Urals in the east.

All contributions are representing the authors' point of view and respective terminologies. Therefore differences in the vocabulary may appear to the careful reader. While a homogenisation of terms and data recording is relevant for comparative studies, it was beyond the scope and means of this project. As a consequence, terminologies may differ between the contributions, as exemplified by the terms 'uniserial' and 'uni-lateral' bone points: both are characterised by barbs or notches on one lateral side. At the British site Star Carr those have ever since been named uni-serial, whereas uni-lateral is a more common term in other parts of Europe.

We, as editors, would like to thank all contributors for being part of this volume and their interesting and high-quality articles; also we are grateful for the voluntary support of all anonymous peerreviewers and their help in improving the articles. Furthermore, we thank the German Research Foundation (DFG) for funding our research and the workshop as well as the Centre for Baltic and Scandinavian Archaeology represented by its director, Claus von Carnap-Bornheim, and the head-of-research, Berit Valentin Eriksen, for support of the project and its presentation in the current form. A tremendous help in the course of making this book was Gundula Lidke who was responsible for text editing, proofreading, and correspondence with the authors and publishers. Thank you very much! Further editorial support was provided by Jana Elisa Freigang, Jorna Titel, Matthias Bolte, Isabel Sonnenschein and Jürgen Schüller. The latter is also responsible for the cover drawing. Much help and support was provided by Peter Teichert-Köster with respect to handling the finds and accessing them in the depot of the Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern; Landesarchäologie in Schwerin. Close collaboration with Mathieu Boudin of the Royal Institute for Cultural Heritage, Brussels, improved our radiocarbon measurements and the analysis of the consolidant.

We thank all people, mentioned and unmentioned here, who were involved in this book and the different research projects, who helped by further pushing the boundaries of our understanding of the cultural remains and chronologies of the past.

Daniel Groß, Harald Lübke, John Meadows, Detlef Jantzen Schleswig, October 2019

# The osseous technology of Hohen Viecheln: a Maglemosian idiosyncrasy?

#### Éva David

#### Abstract

Many wetland areas in Northern Europe have preserved relevant organic material, but the archaeological site of Hohen Viecheln (Germany) offers the exceptional preservation of part of an open-air lakeside settlement site much as it was during its long period of occupation in the Early Holocene. The analysis of production debris and artefacts discarded there amongst the refuse of consumption has provided evidence for a culturally-specific concept underlying the production of hunting/fishing gear. The major potential of this corpus of finds lies in the opportunity it presents for the comparison of the technologies employed at the site over time, and the broadening of such comparisons to contemporaneous sites that have yielded similar assemblages in neighbouring and more distant regions. On the basis of artefact morphology and fabrication techniques of artefacts made of the bones of butchered animals, Hohen Viecheln has become a key Postglacial (Early Mesolithic) site in the illumination of a unique technological tradition, the 'northern technocomplex', spanning the whole of Northern Europe west of the Baltic Sea during the Early Mesolithic, distinct from contemporary technologies of other Nordic regions, and those of eastern origin.

The northern technocomplex, which represents a technological tradition that occurred in the bone manufacture in the western part of Northern Europe from the 9th to 8th millennia cal. BC, is marked by a strong diachronic consistency in artefact form and design over a period of about two millennia. Within it, Hohen Viecheln stands out for the relative crudeness of the barbed points that were probably used as leister prongs. An analysis of this unique technological trait raises two primary areas of further inquiry: 1) the relationship between the industrial domain and that of subsistence, when a single animal species served as a primary resource in both domains, and 2) the recognition of distinct cultural groups founded on a techno-stylistic variability as observed in the form of such projectile points. It is assumed here that Hohen Viecheln belonged to (a) subgroup(s) (Duvensee/Pritzerbe) of this northern technocomplex throughout the period of its occupation, with the addition of a Maglemosian component in its more recent phase. Without offering a conclusive explanation of the origin of this apparent technological transformation, from Duvensee/Pritzerbe to Duvensee/Pritzerbe + Maglemose (autochthonous innovation, acculturation, import?), the study examines the Hohen Viecheln osseous industry in diachronic and regional context, and in comparison with contemporary assemblages from the neighbouring region of Zealand (Denmark), where the Maglemosian appears - technostylistically – as a more internally-consistent, monolithic entity. The results provide new evidence relevant to the old debate over the appropriateness of chrono-cultural seriation based solely on durable elements of material production and the implications for understanding the relationships between recognized postglacial cultural groups in this area of Northern Europe.

# 1 The archaeological context

The corpus of worked hard organic material (bone, antler, and tooth) analysed here stems from the original excavations conducted by E. Schuldt. For the study, the two Mesolithic horizons, as initially described by the archaeologist, have been considered (SCHULDT 1961b, 87–88): a more recent horizon containing a layer 'a' (peat and gyttja, or fine sediment with high organic content formed in shallow and still water according to CROTTI 1993, 278), grouped with a layer 'b', attributed to the Boreal-Atlantic transition (pollen zones VII–VIIIa); and an earlier horizon comprised solely of the sandy sedimentary unit 'c', related to the early Boreal (pollen zone VI, as identified by SCHMITZ 1961, 14–16; 36). As no radiocarbon dates were available at the time of the present study, we considered the material from the more recent horizon to be associated with the end of the Boreal chronozone, based on the distribution of the artefacts near the bottom of layer 'a', and on the pollen spectrum, which was observed in the botanical studies to be similar (in the hazel peaks) to that of Lundby-holmen II (Denmark), later attributed to the Maglemosian phase 1 (Table 1, dotted line).

It was apparently impossible to consistently separate the different concentrations observed during the excavations because of the difficulty of distinguishing unique archaeological horizons in the often disturbed or truncated sediments of the palaeo-lakeshore (SCHULDT 1961b, 89–90). There is no doubt, however, that the site was subject to multiple periodic occupations, even though no evidence of habitation structures was found in the sediments (SCHULDT 1961b, 86), which were rich in charcoal and vegetal matter, including fragments of wooden shafts of arrows, a sleeve in stump wood, and perforated pinebark disks (SCHULDT 1961b, 141–144). The faunal remains, numbering in the thousands, were unfortunately studied as a single Mesolithic unit (by GEHL et al. 1961, 40–63). The faunal inventory contains an impressive array of animal species<sup>1</sup>, specimens of which are sometimes of very large size (such as pike), and some that are rarely encountered in comparable series from contemporary Danish sites (horse, for example; see AARIS-SØRENSEN 2009). Bones of most of these species were not used in the osseous industry, which, besides, has been limited in the present study, because of the number of pieces that were not attributed to one or the other Mesolithic horizon at the time of excavation (n = 175)<sup>2</sup>.

### 2 The osseous artefact assemblage at Hohen Viecheln

The entire 'osseous' industry analysed is presented in the site monograph (SCHULDT 1961a). The material was stored, however, in the archaeological collections at two different places: Wiligrad Castle in Lübstorf near Schwerin, and the Mausoleum of Helen at Ludwigslust Palace (both Germany). Therefore, it was not possible to expect results from refittings, as such was the case with several fragments of a single engraved adze, originally associated with distinct layers 'a' and 'b' (Fig. 2E,2), which led Schuldt to attribute these two layers to a single archaeological 'horizon of barbed points' (SCHULDT 1961b, 87).

<sup>1</sup> Roe deer, red deer, red fox, aurochs, wild boar, elk, dog, brown bear, wolf, horse, beaver, hare, wild cat, otter, lynx, badger, polecat, tortoise, bird sp. (crested grebe, arctic diver, red-throated diver, cormorant, mallard, pintail, widgeon, tufted duck, goosander, breasted merganser, graylag goose, white-fronted goose, bean goose, wild swan, white-tailed eagle, black grouse, coot, common crane) and large fish (pike, perch, bream). Animal species also found in the remains of the osseous industry on the site are indicated in italics (after DAVID 1999).

<sup>2</sup> An adze (a Mesolithic antler that has been [recently re]worked with a metallic tool to socket an original lithic Mesolithic flake-axe, recorded as if the lithic material had been initially found so socketed); an unidentified tool fragment (ulna, elk); a pendant? (limb bone, roe deer); two perforated narrow hammers (antler, red deer); two blade axes/adzes (antler, red deer); three hammer-axes or socketed hammer-axes (antler, red deer); six straight points (limb bone, cervid); eleven barbed points (limb and rib bone, cervid); 18 notched points (limb bone, cervid); 35 fragments of points (limb bone, cervid); and 95 elements of production debris (limb bone and antler, cervid) (after DAVID 1999).

Table 1. Chronological setting of the Mesolithic assemblages studied according to comparisons of the pollen spectra of the sedimentological horizons that yielded the studied osseous industries: Verup-a (Andersen 1960), Lundby-holmen II (Bille Henriksen 1980, 104), Mullerup Sarauw's island (Sarauw et al. 1903), Ulkestrup II (Jørgensen 1982), Friesack 4 (Kloss 1987), Ageröd I:A-H-C (Nilsson 1967), Hohen Viecheln (Schmitz 1961), Duvensee (Bokelmann 1971) and Star Carr (Walker/ GODWIN, in Clark et al. 1954).

Regions / Chronozones	Maglemose lithic stages	Zealand	Mecklenburg / Schleswig-Holstein	Brandenburg	Scania / England
LATE BOREAL	M2	Ulkestrup I Mullerup 1			Ageröd I:A-H-C, VL
	M1	Lundby II	Ho. Viecheln, a		Ageröd I:A-H-C, UT
		Verup a	Ho. Viecheln, b		Ageröd I:A-H-C, BL
EARLY BOREAL				Friesack 4, III	
			Ho. Viecheln, c	Friesack 4, II	
			Duvensee 1 & 2		
PREBOREAL				Friesack 4, I	Star Carr



Fig. 1. List of the studied bone and antler artefacts, presented according to their distribution in the original excavations in trenches (I to XIII, after SCHULDT 1961b, 77–78); all bone projectile points (barbed, notched, straight ones) given in regular font, tools in bold, waste of production in italics.

	Species – Anatomical parts	La red auroch meta rao	arge ungulate l deer (c) elk as (h) wild bo apod. (m) rib dius (r) tibia (	es (e) par (w) (co) (t)	<b>Roe deer</b> metapod. (m)		
	Artefact types	Antler	Limb	Flat	Limb bones	TOTAL	
	straight point				1 (m)	1	
	notched point		3			3	17
	barbed point		4			4	
VTS	awl on epiphysis		1 (mc)			1	
MEN	wedge		1 (mh)			1	
DLEI	blade-axe/adze	2				2	
IMI	sleeve with a transverse hafting	1 (c)				1	
	narrow 'lissoir' or smoother	2 (c)				2	
	baton with a socketed end		1 (tw)			1	
	unidentified socketed or hammer-axe	1 (c)				1	
ASTE	waste of production	1 (e) 5 (c)	7 (mc)	1 (co)	1 (m)	15	16
$W_{I}$	waste of pendant	1 (c)				1	
	TOTAL	13	17	1	2	33	

Table 2. The bone industry of the Hohen Viecheln layer 'b', in number of pieces.

As a precaution, we decided, however, to study the assemblages from these two layers of the more recent horizon separately (DAVID 1999, 298). Ultimately, the paucity of material from layer 'b' (Table 2) and its similarities in terms of tool types and techniques with the material of the most recent layer 'a' (Table 3) led us to consider only layers 'a' and 'c' as clearly distinct for purposes of technological comparisons (DAVID 1999, 302–309).

Within each horizon, the horizontal distribution of elements of the 'osseous' (or hard material of animal origin) industry (bone, antler, and tooth) could not be reconstructed. Nonetheless, the inventorynumbers on the pieces show that the trenches rich in such elements (Fig. 1, trenches I, II, IV, V, VIII, and IX) all yielded similar assemblages: production debris, tools and objects of the same types regardless of the stratigraphic layer (though the lower horizon of trench IV was richer in these materials than were trenches I, VIII, and IX). This indicates that the two units considered here, represented by the upper layer (a) and the lower horizon (c), are theoretically comparable.

Fig. 2. Bone industry of the Hohen Viecheln upper horizon (layers 'a' and 'b'). Each scale in cm. LAYER A: A: 1 - hammer-axe, red deer stag antler (HoVi3174); 2 - blade-axe/adze, butt-end regularised by bi-lateral tangential nicking 'décorticage', elk antler (HoVi1208); 3 - narrow 'lissoir', red deer antler tine (HoVi133); 4 - chisel, red deer metatarsal (HoVi5867); B: 1-5.7 - barbed points, elk metatarsals (HoVi4385, 4, 16, 17, 20, 13); 6 - basal part of a barbed or straight point, elk metatarsal (HoVi3); 8 notched point, large-ungulate limb bone (HoVi52); 9 - notched point, roe deer metatarsal (drawing replacing HoVi3270 in a poor state of preservation); 10 - harpoon head fragment, large ungulate limb bone (HoVi3272); 11 - straight point, large ungulate metatarsal (HoVi3867); C: 1 - straight point, roe deer metapodial (HoVi105); 2.4 - notched points, large ungulates limb bones (drawing representing HoVi4429 and HoVi2690, both in a poor state of preservation); 3 - barbed point, large ungulate rib (HoVi5349); 5 - straight point, large ungulate flat bone (HoVi1205); 6-7 - straight points, large ungulates limb bones (HoVi4765; HoVi5447); 8 - straight point, large mammal jaw? (HoVi5448); 9 - basal part of a barbed or straight point, large ungulate limb bone (HoVi5610); D: 1-2 - engraved batons, unshed red deer antler, no. 1 with a transverse shaft (HoVi610) and no. 2, of a 'dague' (first-year antler), with traces of a binding system (HoVi136), both drawings after SCHULDT et al. 1961, Taf. 61-62; E: 3 unengraved adze (damaged by gnawing) with a transverse shaft, red deer radius (HoVi5485); 4 - thick wedge, aurochs metatarsal (HoVi1204, with a schematic location of the fragment, no scale); LAYER A OR B: E: 1-2 - adze with a transverse shaft, each engraved with incised lengthwise barbed lines on the upper face, and drilled with dotted lines on the other face, aurochs radius (HoVi609, drawing after SCHULDT 1961a, Taf. 113), or with fringed lines, of aurochs or elk radius (HoVi4761; 4760; 5229; 5606).



### 3 The osseous industry of the upper layer (a)

The artefacts of osseous materials of layer 'a' at Hohen Viecheln include 184 items, of which 144 are implements (identifiable tools, points, and other objects), 38 are debris of production, and two are of an undetermined nature (Table 3). The assemblage of implements is characterised by a high number of fixedly-hafted projectile points (84 %), with the remaining 16 % composed of other pieces (tools and objects), of which 82 % are heavy-duty tools (Fig. 2).

The quantity of production debris from the bones of large ungulates is lower than would be expected based on the composition of the artefact assemblage and the skeletal elements used in artefact production, suggesting that parts of the production sequence occurred probably off-site, or that there was some recovery bias during the excavations. The matrices of compact material could have been exhaustively used, but there are certain 'irreducible' elements, such as the distal *trochlea* of the metapodials of large ungulates (even in a juvenile state) that are rare or entirely absent in the production debris, notably for the aurochs. The waste products recorded were all found during the re-examination of the faunal assemblage. With regard to the large cervids, however, twenty of these distal ends from elk (*Alces alces*) and red deer (*Cervus elaphus*) remain, as removed anatomical end pieces, ambiguous in terms of provenance from a stratigraphic unit. Their inclusion in the layer would change the current unequal ratio between metacarpals, found as debris of production, and the metatarsals, poorly represented as debris but largely recognised as the main original anatomical parts used as bone blanks for implements.

As at the classic Maglemosian sites<sup>3</sup>, the other bones removed from the limbs are solely represented by the epiphyses (Fig. 3A.D) as well as numerous fragments of diaphyses that show evidence of fracture by direct hard percussion for consumption purposes (recovery of yellow marrow). This makes the metapodials the most frequently used anatomical elements in manufacture, besides antlers. Worked antlers are present in the form of numerous cortical fragments, tines and shed basal ends, which suggest that these anatomical parts were probably brought to the site and exploited as collected material for artefact production (this is particularly true for the red deer, except for two pieces made of unshed antlers). At the same time, the unshed antlers of roe deer present in the faunal assemblage were apparently not exploited for manufacture. As at the Danish sites, large ungulates – large cervids (elk and red deer, followed by roe deer) and bovids (aurochs) - were primarily exploited for the Hohen Viecheln osseous industry. Teeth of wild boar and fox provided the blanks of some elements too. Other species, including large carnivores, rodents, and birds, are represented in abundance in the faunal assemblage but absent from the osseous industry. The latter is composed of used artefacts as well as rough-outs and production debris, the surface preservation of which has allowed the recovery and identification of manufacturing techniques, technological processes and methods of manufacture (this terminology as well as the twenty-one manufacturing techniques and eleven processes used in the Early Mesolithic are defined in DAVID 2004; 2016).

#### 3.1 Barbed points

With the exception of one harpoon, the projectile points were all of the fixedly-hafted type and primarily represented (63 %, n = 41, for typologically identifiable pieces) by barbed points made of limb bones and flat bones of large ungulates. The other types of projectile points are, in equal proportion (c. a dozen examples each), straight and notched points made of the bones of large ungulates.

Thick and prominent barbs sharpened by scraping on the elongated blank of a (limb) bone of a large ungulate suggest that one fragment belonged to a harpoon head (Fig. 2B,10). The general morphology of

<sup>3</sup> The classic Maglemosian here concerns the Danish material from the Lundby-holmen and Verup-a sites, illustrating its phase 1 (M1), and then the Mullerup, Ulkestrup and Vinde Helsinge sites of phase 2 (M2), as defined by the lithic (BECKER 1953; BRINCH PETERSEN 1973; SØRENSEN 2006) and the bone industry (DAVID 1999; 2003).

Species – Anatomical parts		Large ungulates red deer (c) elk (e) aurochs (h) metapod. (m) rib (co) radius (r) scapula (s)			Roe deer metapod. (m)				
Arte	fact types	Antler	Limb	Flat	Limb bones	Ind.	TOTAL	1	
	straight point		8	1	3 (m)	1	13		
	notched point		9		2 (m)		11		
	barbed point		30	11			41		
	unidentified point from above types		54	1	1		56		
	harpoon		1				1		
LEMENTS	wedge		1 (mh)				1		
	adze with a transverse shaft		3 (1r&2re) 2 (rc)				5	144	
IMI	hammer-axe	3 (c)					3		
	blade-axe/adze	2 (e) 7 (c)					9		
	chisel		1 (mc)				1		
	narrow 'lissoir'	1 (c)					1		
	hafted ornamented baton	2 (c)					2		
STE	waste of production	21 (c)	3 (me) 7 (mc)	2 (co) 1 (s)	3 (m)		37	38	
WA	waste / rough-out socketed or hammer-axe	1 (c)					1	50	
?	unidentified waste of production or implement		1 (mc)		1 (m)		2	2	
	TOTAL	37	120	16	10	1	184		

Table 3. The bone industry of the Hohen Viecheln layer 'a', in number of pieces.

this piece suggests that it could predate the Boreal occupation(s) of the site; it is most similar to the 'Havel' points attributed to the Epipalaeolithic groups of the Ahrensburgian or the Bromme (GRAMSCH 1973; HEIDELK-SCHACHT 1984), such as the example from Venz, also in Mecklenburg-Western Pomerania (HEIDELK-SCHACHT 1984, fig. 1a). However, the recent radiocarbon date obtained from this piece (Table 4, see GRoss et al., this volume) suggests contemporaneity with one of the classic Maglemosian assemblages. On the island of Zealand (Denmark), typical harpoon heads are not found at Maglemosian settlement sites, even though dates of stray finds indicate a contemporaneity persisting until the beginning of the Atlantic phase (ANDERSEN/PETERSEN 2009). Though the faunal assemblages show a uniform regional subsistence economy with large land mammals as the primary animal resource (LEDUC 2010), this raises the question of whether different local subsistence strategies could be reflected in the osseous industry of inland sites, as certain types of projectile points may reveal different types of hunting modes (with detachable heads for harpooning sea mammals versus those with fixed heads, such as the straight, notched, and barbed points, for hunting land mammals and spearing fish, theoretically). Alternatively, it is possible that these different types of projectile points at the site correspond with different, culturally distinct groups exploiting the same location, a case illustrated for the same chronological period on Bornholm (CASATI/SØRENSEN 2006). In order to address this question a complete detailed study of the fabrication of harpoons is necessary, as the methods of barb-shaping, and blank-debitage, may reveal telling chrono-cultural patterns, when examined across the entirety of Nordic Early Holocene series (study in progress).

The barbed points made of limb bones, which account for half of the fixedly-hafted tools in the series when all types are combined (if one includes some of the basal fragments that have been left typologically unidentified in Table 3, since only the active end can be used to characterise the type), are different from their Danish correlates (Fig. 2B,1–7). Though their uni-serial barbs are restricted to the most distal tenth of the overall length, they were generally fashioned only with deep, convergent transverse-oblique double sawing. The fact that they were rarely (in only three cases; Fig. 2B,4) made deeper with the filing technique resulted in barbs that are generally rather unpronounced, and functionally more comparable to notches (that would be localised at the distal end of the point) than to true barbs. Their location at the active end of the point suggests, however, that these points can still be called barbed points rather than notched points (the attributes of which cover the point at the stem). Because these barbed points have been found in a used state (with a worn out or damaged tip, originally), we are confident that they are not bone projectile points still in the process of manufacture, that is to say not yet subjected to filing (as sawing is a preliminary step to filing in the Danish *chaîne opératoire* of fashioning: DAVID 2003, 652 fig 81.3).

The two barbed points recovered whole weigh 20 g each, with a length of 165 mm, a width of 15 mm, and an average thickness of 7 mm at the shaft. Anatomical aspects of the bone are preserved at their base or tang, and measurements taken on corresponding skeletal parts of related animal species suggest these artefacts were probably made of elk metapodials (except for the length). As they are shorter than it would be expected in this case<sup>4</sup>, they could have been broken at the point of the (first) barb and reshaped (refreshed) for (re-)use. Actually, the dimensions do not support the use of other anatomical elements

4 The length available after removal of the distal *trochlea* from the limb-bone matrices of the commonly used, very large artiodactyls in the Mesolithic would be (taken on some Danish original faunal material discarded at the classic Maglemosian sites): Red deer – femur 200 mm, tibia 250 mm, metatarsal 200 mm (maximum thickness of cortical bone 10 mm, usual average 4–5 mm, when used for straight points, after DAVID 1999, 100 tab. 8); Elk – metatarsal 270 mm (maximum thickness of cortical bone 10 mm, usual average 7–9 mm, when used for barbed points, after DAVID 1999, 103 tab. 10); Aurochs – metatarsal 140 mm.

Fig. 3. Bone industry of the Hohen Viecheln upper horizon. Each scale in cm. \* unrecorded material in the original publication: SCHULDT 1961a (drawings É. David, unless otherwise specified). LAYER A: A: Production debris in red deer bone: 1 - wedgesplinter (proximal end), grooving and nicking (distal), metatarsal diaphysis (HoVi2070); 2 - dotted perforation (proximal articular plane), total (upper face) and internal (medullar canal) grooving, metatarsal elongated splinter (HoVi2910); 3 - dotted perforation (proximal articular plane), metacarpal diaphysis (HoVi764); 5-7 - nicking and flexion break, metatarsal distal ends and (no. 7) diaphysis (HoVi5752; 5754; 2694); 9 - fragment or basal end of a barbed or straight point, metatarsal splinter (HoVi3851). Elk bone: 4 - dotted perforation (proximal articular plane), wedge-splinter (proximal side) and inverse nicking (proximal side), metatarsal diaphysis (HoVi1001). Roe deer bone: 8 - shaft-wedge-splinter(?), metatarsal (fragment of an) elongated splinter (HoVi671); 10 - flake breakage, metacarpal diaphysis (HoVi172); 11 - fragment or basal part of a straight point, metatarsal splinter (HoVi53); B: Production debris in red deer antler: 1 - rough-out of a hammer-axe or socketed hammer-axe (HoVi112); 2 - groove and splinter technique (HoVi6246); 3-20 - nicking and flexion break (3-5: basal parts [HoVi6251; HoVi5474; HoVi4436]; 6-7: crown parts [HoVi5773; HoVi5722]; 8: beam B [HoVi1195]; 9-20: tines [HoVi1198; HoVi5696; HoVi1199; HoVi1201; HoVi6084; HoVi4118; HoVi5695; HoVi6032; HoVi5698; HoVi4297; HoVi5831; HoVi4928]); LAYER B: C: 1 - thick wedge, aurochs metatarsal (HoVi5272); 2 - notched point, large ungulate limb bone (HoVi5260); 3 - hafted narrow double 'lissoir', with two adjacent active parts at the distal end, red deer antler (HoVi5226); 4 - barbed point, large ungulate limb bone (HoVi2253); 5 - awl on epiphysis, distal end of red deer metacarpal (HoVi5242); 6-7 - blade-axes/adzes, no. 7 buttend regularised by tangential nicking 'décorticage', elk or red deer antler (HoVi5350; HoVi5271); 8 - perforated narrow 'lissoir' (cross-like notch made to avoid propagation of an accidental split? made by incision (HoVi5326), red-deer 'dague' or first-year antler); D: Production debris (except no. 15: faunal remain): 1 - nicking and flexion break, elk antler (HoVi4762); 2-5 - nicking and flexion break, red deer antler (HoVi4202; HoVi5895; HoVi5896), no. 5 is of unshed stag antler (HoVi2069); 6 - worn-out pendant, of which one side has been removed by nicking, elk antler (HoVi5351); 7 - nicking and wedge-splitter, large ungulate rib diaphysis (HoVi5526); 8 - bifacial scraping and flexion break, red deer metacarpal (HoVi119); 9-10 - nicking and flexion break, red deer metatarsals (HoVi120; HoVi5326); 11-12 - nicking and flexion break, red-deer metacarpals (HoVi117; HoVi122); 13 - grooved diaphysis, the articular end of which was removed by nicking and flexion break, red deer metacarpal (HoVi5894); 14 - dotted perforation and flexion break, red deer metatarsal (HoVi118); 15 - gnawed roe deer metacarpal (HoVi5264), with typical 'punctures' made by dog teeth (Binford 1981, 44; 45); 16 - sleeve, red deer antler (HoVi6250); 17 - baton engraved by sawing (parallel notches) and incising (criss-cross lines), with a socketed end, juvenile wild-boar tibia (HoVi5367, drawing after

SCHULDT 1961a, Taf. 55); 18 – unidentified tool, hammer-axe or socketed hammer-axe, red-deer antler (HoVi230).



(aurochs metapodials, for example), or of a specific fabrication method aimed at the production of shorter blanks. The few examples of debris from the processing of metapodial end-parts indicate removal by circum-work (by detaching the diaphysis) just above the *trochlea* (Fig. 3A,5–7), which indicates an intention to keep the maximum possible length of naturally available cortical bone in the fabrication of elongated blanks, i.e. from the proximal articular end to the metaphyseal zone of the bone, at its anatomically distal end, which is also typical of the classic Maglemosian. Furthermore, there is no indication that production involved the segmentation of initially longer blanks to produce multiple shorter blanks (by snapping the splinter in several pieces, for instance).

The reduction techniques employed in the production of blanks for barbed points are the same as those of the 'Danish' method D (DAVID 2003, 625). One can detect negatives of removals from the use of the wedge-splinter technique at the basal end of the points that correspond to the stage when the bone's upper end-part was calibrated by removing flakes from and around its articular anatomical plane, seen as a striking platform. Although no such bone flake has been recorded so far (no sieving was done during the excavations, pers. comm. D. Groß), the negatives of removals located at the proximal ends, whether displayed on the worked matrices or on the barbed points, testify that the pointed end of these barbed points was always oriented towards the distal anatomical end of the metapodial during manufacture. This calibration stage occurred before splinter-blanks were pre-formed on the anatomical faces of the bone by grooving the matrix longitudinally, down into its natural cranial and caudal dividing lines. The blanks were detached by inserting a wedge, the axis of which was guided by the artificial grooves, transverse to the bone. This has left some irregular fracture planes, visible on the cortical bone towards the anatomical interior face, and adjacent to the grooves. The latter have resulted from a longitudinal grooving that was also made on the interior side of the bone, down to the medullar canal, once the blanks corresponding to either the lateral or the medial anatomical side of the metapodial were detached. The anatomical location of the artificial grooves, indicated by the specific shape of the point, in the transverse cross-sections, shows that the barbed points were made on splinter-blanks that were quartered in two such steps (from the external surface and then the medullar side) by the grooving and wedge-splitter techniques, when made of metapodials.

Large dotted perforation is clearly visible on metapodial fragments that show the enlargement of the natural foramen at the articular anatomical upper plane. As for the Maglemosian products, the random distribution of deep impact-marks, displayed all around the centre of the surface on this plane, suggests that a pointed lithic tool was used in direct percussion to enable perforation of the articular end (percussion was guided by the natural hole), so that it pre-formed the basal part of each point made from there in its thickness (Fig. 3A,2-4). At the same time, it can be noted that the wedge-splinter and dotted perforation techniques were not systematically observed on all of the early fabrication-stages (wedge-splinter alone, Fig. 3A,1; dotted perforation alone, Fig. 3A,3). One or the other of these techniques was sometimes replaced or supplemented by inverse nicking, i.e. nicking the bone inversely compared to its genuine anatomical orientation (Fig. 3A,4), performed later in the *chaîne opératoire*, following the extraction of the elongated blank (Fig. 2B,4–5). In comparison to method D, other unshaped bases of points bear evidence of new technical practices, both related and unrelated to the wedge-splinter technique: longitudinal grooving leading to fractures along the length of the blank (Fig. 2B,1), a succession of marks related to a direct (nicking) or indirect (wedge-splitter) percussion visible along one edge associated with a plane of fracture on the other edge of the blank (Fig. 2B,2), including accidental transverse fracturing of the blank (Fig. 2,B 3), impact traces of the inverse nicking technique associated with longitudinal grooving but occurring from working the bone from a different angle, as to regularise the anatomically upper end of the blank produced (Fig. 2B,4-6).

The very fact that all these traces of fabrication remain so clearly visible on the artefacts shows that aside from the imposition of the characteristic attributes (the active and basal ends, and the barbs) no

Table 4. Radiocarbon dates of material from Hohen Vieceln and Mullerup. \* illustrated material (see Figures); \*\* all bone material, É. D.'s identification; \*\*\* after TAUBER 1972; 1973, and FISCHER et al. 2007 (for the human).

Sites	Inv. Number	Lab. Codes	<sup>14</sup> C (BP)	Directly dated material **
	878 a/IV	RICH-22174	$8631 \pm 41$	barbed bone point
	2677 a/V	RICH-22645	$8728 \pm 42$	barbed bone point
	3272 a/IV *	RICH-22178	$8822\pm45$	bone harpoon head
	3273 a/IV	RICH-22169	$8941 \pm 44$	basal bone part (unid.)
	3692 a/VIII	KIA-51090 9043 ± 42		barbed bone point
Hohen Viecheln 'a'	4764 a/IX	RICH-22642	$8663\pm44$	barbed bone point
	4926 a/VIII	RICH-22650	$9278 \pm 44$	notched bone point
	5609 a/VIII	KIA-51089	$8973\pm46$	basal bone part (unid.)
	5610 a/VIII *	KIA-51087	$9205\pm43$	basal bone part (unid.)
	5610 a/VIII *	RICH-22172	$9055 \pm 44$	basal bone part (unid.)
	5611 a/VIII	RICH-22649	$8829 \pm 44$	notched bone point
Hohen Viecheln 'b'	2253 b/IV *	RICH-22178	$8822\pm45$	barbed bone point
Hohen Viecheln 'a' or 'b'	609 a-b/III *	RICH-22644	$8741 \pm 43$	adorned bone adze
	915 c/IV *	RICH-22173	8630 ± 42	antler blade
TT 1 TT 1 1 ( )	3426 c/IV	RICH-22641	$8906 \pm 49$	barbed bone point
Hohen viechem c	3743 c/VIII	RICH-22640	$9109 \pm 49$	notched bone point
	3843 c/VIII *	KIA-51093	$9349 \pm 45$	antler hammer-'lissoir'
	A18269-1 zone I/H/1	K-1609	$8720 \pm 140$	charcoal
	A18269-1b zone I/H/1	K-1609	$8610\pm140$	charcoal
	A18269-2 zone III/B-C/5	K-1610	$8500\pm140$	charcoal
Mullowee ***	A18269-3 zone IV/J/2	K-1611	$8520\pm140$	charcoal
Mullerup	A18269-4 occup. layer	K-1612	$8230 \pm 140$	hazelnut shells
	A18269-4b occup. layer	K-1612	$8440 \pm 140$	hazelnut shells
	A18269-4t occup. layer	K-1612	$8310 \pm 140$	hazelnut shells
	A18269 occup. layer	AAR-8554	$8310\pm55$	human adult left femur

sequence of shaping through abrasion techniques occurred. In contrast to comparable barbed points of the Danish record, their overall degree of transformation is therefore low, i.e. corresponding to Stordeur's class 3: 'worked [anatomy is drastically transformed] only at the extremity and [upper area of the] shaft' (STORDEUR 1978, 22). All these features, as they record a particular concept in design of the barbed points, have led us to define a new *chaîne opératoire* for the fabrication of barbed points of limb bones at Hohen Viecheln, layer 'a', designated method H.

#### 3.2 The *chaîne opératoire* of method 'H' (Hohen Viecheln)

The variety of tool-traces observed on the basal ends of these barbed points indicates that the production of elongated blanks did not strictly follow method D, as it did in the classic Maglemosian of Denmark. It seems here that inverse nicking was an important technique in the fabrication of barbed points on metapodials, without truly belonging to a distinct sequence (either the operation of calibration, or that of regularisation) in the *chaîne opératoire*. It belongs to the initial reduction sequence, in which it may replace the wedge-splinter and even the dotted perforation techniques (Fig. 4, sequence 1), perhaps even serving as the sole base-shaping technique (Fig. 4, sequence 8). It was used in combination with longitudinal grooving (Fig. 4, sequences 4–6), performed as often as not along a certain length of the piece (Fig. 2B,4).

Following removal of the distal trochlea (Fig. 4, sequence 3), and during the quartering of metapodials into several elongated blanks by splitting-and-wedging (wedge-splitter technique), the intermediate piece serving as the wedge ceased to be guided by the artificial grooves (only one of which continued all the way to the end) near the proximal end of the bone; so that the elongated blank was then transversely fractured at the anatomically proximal end, leaving either a characteristic cortical spur, when the fracture developed towards the outside of the blank (Fig. 2B,6), or, conversely, a fracture plane that evolved towards the inner part of the tang, at the point of fracture. One would have attempted to remove the cortical protuberance (Fig. 2B,4–5), at the risk of breaking the blank where the tang of the point would be (Fig. 2B,3), by inverse nicking. That is to say: deep impacts and removed planes made with a lithic tool with a cutting edge (axe/adze/'tranchet'), used in direct percussion repeated along the length of the artificial grooves (Fig. 4, sequence 8), created random, visible nick-planes and cut-marks along one of the edges of the blank (Fig. 2B,2). The cortical spur resulting from the fracture that freed the blank was thus removed by inverse nicking, which would have facilitated the thinning of the anatomically proximal end of the blank. This formatting of a piece allowed for the shaping of the point's basal end with a lithic edge used in direct percussion, a conceptual approach never observed to such an extent on typical Maglemosian material.

Method H differs from method D in the adoption of the inverse-nicking technique for the thinning of blanks, and in the use of convergent sawing, without filing, for the manufacture of the barbs (Fig. 4). In method H, inverse nicking replaces the calibration by wedge-splintering and perforation-by-nicking, which are used in method D to perform the ultimate cylindrical shape of the matrix before it is quartered (then up to eight blanks are extracted) from several grooves made longitudinally on the outer surface of the matrix. The Hohen Viecheln approach to blank-reduction apparently minimises the requisite effort in longitudinal grooving but presents the risk of shortening the blank by accidentally breaking the proximal end, and resulting in even shorter barbed points. Method H refers to an expedient, less 'so-phisticated' approach to the fabrication of barbed points of the metapodials of large ungulates at Hohen Viecheln, layer 'a'. From conception to completion, this method differs from the (Danish) method D, which produces more standardised, refined points from the same matrices.

#### 3.3 Discussion

Could the use of inverse nicking, rather than a technique of abrasion, for the shaping of the point-bases be linked to a different mode of hafting than that used for classic barbed points of the Maglemosian? This seems unlikely, as a reduction of the width and thickness of bases is sought in both cases. Stone tool economy also doesn't seem to explain the difference, as tools used to groove the metapodials are represented equally and as both methods present the risk of damage to the lithic edges employed (DAVID/JOHANSEN 1997, 21 fig. 8). The advantage may lie in efficiency, and the time gained by removing extra bone material by a series of percussions, rather than with abrasion only, that would always necessitate grooving along the entire length of the matrix. Even so, in comparison to method D, the time required for blank-production may have been just as long, because, in one out of two cases, the operation of longitudinal grooving was carried out with a similar depth, and along the entire length of the bone shaft (before the eventual additional longitudinal sawing at the point of fracture), and also because the blanks were manufactured in quarters, requiring supplementary grooving from the interior side of the metapodial blank (Fig. 4, sequence 10). The latter has not been observed in the Danish material so far, which, conversely, was always grooved from the outer surfaces of the metapodials, in anticipation of the subdivision of the bone into several extremely regular blanks.

The question remains: how do we interpret this variability in the production of barbed points of the metapodials of large ungulates between the geographical areas of the classic Maglemosian and Hohen Viecheln? While the technical potential is the same, we must keep in mind that at Hohen Viecheln the



Fig. 4. The two contemporary Maglemosian manufacturing 'D' (Danish) and 'H' (Hohen Viecheln) methods used to produce the barbed points made of metapodials from large cervids (elk, red deer) in the western part of Northern Europe c. 9200–8200 BP (8600–7200 cal. BC).

barbed points made of flat bones and straight points of limb bones were produced according to the same methods employed on Zealand (see below). Rather than a case of cultural difference, it could simply be due to a greater relative abundance of the necessary skeletal elements, probably the metapodials of large cervids, as previously suggested. We can suppose that cervids were hunted or acquired in abundance enough, perhaps stored or gathered and left over locally for a logistic purpose as a ready-to-use base material (e.g. PEDERSEN/PETERSEN 2017), and therefore these barbed points were made with less care (heavier and coarser than other types of points), because they were manufactured with a particular animal species as prey in mind in relation to a certain animal exploitation cycle (BOETHIUS 2017). Recent advances in the domain show indeed that the way in which this animal resource (large cervids) has been apprehended globally, both as a food supply and a resource for material production, may explain the technological shifts recorded in the bone industry (DAVID 2017). It would be logical to suppose that the prey for which the barbed points were conceived was the very same that provided the most important resource, and that therefore no large amount of effort would be invested in their manufacture, the local abundance or the easy availability of the product resulting in a lower quality.

But let us suppose instead that the source of raw material was not the intended prey. If these points were hafted in the same way as those of the classic Maglemosian, after Danish examples, the efficacy of the shallow barbs is in fact questionable. This may not have presented a disadvantage, though, in the context of a particular or occasional activity in which quantity was more important than quality, and in which a large number of people were participating, all of whom were perhaps not manufacturing their own points. We can also recall that points were perhaps not manufactured on-site. It follows that the time gained by limiting the investment in point-shaping could be spent in the other domains, notably the gathering of a readily available raw material (metapodials of cervids), with the knowledge that later, at another site (Hohen Viecheln), a large number of points would be quickly broken or lost. At Hohen Viecheln, the barbed points are indeed often in such a state that they could possibly have been successfully re-shaped or re-sharpened. This could have been advantageous in the case of a collective hunt, of pike for instance, examples of which reaching the size of an adult human being have been recovered at the site, requiring then a specific hunting strategy (the use of a large number of leister prongs in a limited amount of time?). Such bone prongs have been found at a contemporaneous site in association with a pike that was still partly in anatomical articulation (INDREKO 1934, 241). It is entirely possible that, rather than a factor of chronological or geographical stylistic difference, the unique crude barbed points made at Hohen Viecheln 'a' reflect a strategy of expedient manufacture of a large number of prongs for a specific economic activity in response to a local abundance of a particular prey.

In terms of understanding variation in osseous industries, the technological study conducted at Hohen Viecheln 'a' highlights the importance of the relationship between strategies of production and the prey exploited, as animal bodies are indeed the final destination of the bone prongs. Within a particular projectile point-type, could the prey species and/or the mode of prey acquisition favour certain techniques of fabrication within the technical parameters of a common approach to the fabrication of bone projectile points? The technique of inverse nicking was obviously known to populations on Zealand, though it is rarely documented at the Danish sites. Could the abundance of an osseous raw material that permitted, with the use of a particular method, expedient production of a large number of bone points with minimal investment of effort in design, have led to the exploitation of a specific species of prey or the adoption of a specific hunting strategy? Or is the opposite perhaps the case? If we can demonstrate that the modes of hunting and the prey exploited are similar at Hohen Viecheln and at the classic Maglemosian sites on Zealand, we can perhaps conclude that the manufacture of crude barbed points at the former do constitute a distinct cultural trait. On the other hand, if these points do not have an apparently similar use (different prey exploited or prey exploited differently), is it reasonable to differentiate the material culture of Hohen Viecheln from that of contemporaneous sites based solely on the presence of this one type of projectile point? Since we do not know what the exact function of these points was, and lack sufficient information on the subsistence strategy at Hohen Viecheln, we must appeal to the overall osseous assemblage at the site in our efforts to determine whether the adoption of method H in the manufacture of crude barbed points is an isolated technological response (of a socio-economic nature) or a cultural trait indicative of a 'Hohen Viecheln' (or 'Pritzerbe': CZIESLA 1999) group.

#### 3.4 Other types of bone projectile points

Though barbed points made of flat bones only account for one third of all barbed points at Hohen Viecheln 'a' (Fig. 2C,3), these elements are identical from a morphological and technical point of view to contemporary examples from Denmark. Three specimens of production debris show reduction by bilateral scraping and wedge-splitting on the scapulae and ribs of large ungulates, following the previously defined method F (on flat bone: DAVID 2003, 653 fig. 81.5), and the use of sawing and filing in the shaping of barbs. A fragment of a straight point completes the assemblage of pieces made of flat bones of large ungulates. As at the sites on Zealand, it could be a broken barb that was reshaped as a pointed tip for re-use (Fig. 2C,5).

With regard to other points made of the limb bones of large ungulates, and in contrast to the crude barbed points, straight points and notched points show a high level of technical investment. Each complete specimen weighs about 10 g, and each blank represents about one quarter of a metapodial of a large ungulate. Based on their morphology, it is likely that they were manufactured according to method D. Their bases show preparatory scraping that would have provided a better surface for adherence of an adhesive in hafting, as observed at the Danish sites. The base of some points, though, shows evidence of inverse nicking (Fig. 2C,6.9) beneath the scraping employed in shaping, suggesting the possible use of method H. Yet another point has a base with no modifications (Fig. 2B,11). This piece shows two incisions that may have been the starting points of barbs, but it was ultimately used as a straight point. The ten straight points are, in half of the cases, thin and rectilinear like those of the classic Maglemosian (Fig. 2C,7). The only complete example is 201 mm long, 10 mm wide, and 9 mm thick (with a lengthto-width ratio of 20:1, which is close to the maximum ratio of Zealand points; DAVID 1999, 100 tab. 8). One of them is concave in cross-section, suggesting the use of another skeletal element, perhaps the base of the jaw of a large ungulate (Fig. 2C,8). The others are up to twice as large (Fig. 2C,5–6.9). The nine notched points have notches that are fairly deep, fashioned by transverse sawing repeated in a row, distributed along the length of the shaft, and even the base, which is differentiated by the comparatively fresher aspect of its surface (the active part of the point shows conversely a patina or lustre) and the convergent delineation of its edges towards the end (Fig. 2B,8; 2C,4). Sometimes, notches are merely suggested (Fig. 2C,2), like those on the points from the nearby site of Duvensee (DAVID 1999, 315).

In addition to these implements, there are three straight points and two notched points made of metapodials of roe deer (Fig. 2B,9). The blanks were apparently shaped into rectilinear products, according to method E, like those used on Zealand for the manufacture of points made of roe deer metapodials (DAVID 1999, 208 fig. 65). Because the faunal assemblage contains numerous epiphyseal ends broken by flexion, it is likely that the *chaîne opératoire* employed was the same as the one documented at Lundbyholmen II, or Mullerup, with rectilinear-shaped blanks made of the cranial or caudal halves of metapodials, rather than the lateral or medial anatomical sides. A single blank of a straight point was made of a quarter of a metapodial (Fig. 2C,1). The point has been warped over time and displays a rough-out of shaping by inverse nicking at the base. These projectile points are relatively light, hardly weighing more than 5 g each. Of the pieces made of roe deer metapodials, two are complete and unbroken (one straight and one notched point); they have, on average, a length of 92 mm, width of 12 mm, and thickness of 5 mm at the mesial part. The maximum length of these items would be limited to 145 mm, based on the length of a roe deer metapodial without the distal epiphyses, as indicated by one of the blanks (Fig. 3A,11). As the complete projectile points are shorter than this, the active end must have been frequently re-sharpened by scraping. The notches, rather superficial, were made by a row of shallow, transverse saw-marks distributed more or less evenly on the side along the length of the cortical edge. The external surface (anatomically speaking) of the blanks of these points were generally scraped axially to reduce the natural relief of the longitudinal dividing lines that occur here on the metapodial in its proximal cranial and caudal anatomical faces, with the result of further thinning the final products, most notably at the basal end of each one. These pieces thus present a great technical investment in fabrication. Though straight points made of roe deer metapodials are observed in classic Maglemosian contexts (DAVID 1999, 450–457 pl. 22–29), notched points made of metapodials of large ungulates and roe deer are entirely absent (DAVID 1999, 246).

Points made of deer antler are not seen in Hohen Viecheln 'a', even though a piece of red deer antler debris was observed from which an elongated blank had been extracted (Fig. 3B,2). It possibly is indicative of method G, as identified similarly in the Zealand assemblages (DAVID 1999, 172 fig. 48).

#### 3.5 Other implemented and decorated pieces

The assemblage of 'domestic' implements' (*mobilier de fonds commun*) is comprosed of 22 pieces, mostly heavy-duty tools (n = 18), and four other pieces (two tools and two objects<sup>5</sup>).

The heavy-duty tools are mostly bevelled red deer antler pieces, hammer-axes and blade-axes/adzes (Fig. 2A,1–2), with the addition of several bone 'adzes' with transverse hafting and a single heavy-duty wedge<sup>6</sup>, made of a radius and a metapodial of aurochs (for the pieces that could be anatomically identified; Fig. 2E,3).

This assemblage is identical in its morphometric, technological, and anatomical characteristics to those of the classic Maglemosian, composed of the same tool-types (DAVID 2003, 655 fig. 81.8). In antler, the hammer-axes made of shed basal parts have been perforated transversely and obliquely by bowcoring, from both sides, and the bevelled end, used until exhaustion as in Denmark, has been obtained by a technical procedure that was commonly utilised by Mesolithic craftsmen for pre-forming cuttingedges of the antler material: groove and truncated breakage (DAVID 2006a, 85 fig. 6). The antler blades were mostly segmented from tines in a similar way (DAVID 1999, 114 fig. 16), and their butt-end was blunted by debitage and/or regularised by décorticage (BILLAMBOZ 1977, 102), i.e. the natural irregularities (pearls) of the antler surface were removed carefully by the nicking technique applied with a lithic edge used in direct percussion, as an axe/adze/'tranchet', but in a tangential motion. The heavily damaged bone tool, used as a thick wedge (Fig. 2E,4), has been manufactured in the exact same way as in the Maglemosian, with method C (DAVID 2003, 655 fig. 81.7). Because it is more complete, we were able to observe that a bone wedge from layer 'b' provides an angle for the bevel of 29°, which is in close accordance with the Danish examples (Fig. 3C,1). It is the bone 'adzes' that differ substantially from their Danish counterparts, specifically in their engraved motifs. One of them, recovered in many pieces, consists of several rows of 'fringed lines' made of short, longitudinal incisions, parallel to one another and regularly spaced (Fig. 2E,2). The whole adze with the 'barbed incision' – a motif already known from a tool of the same type from the contemporaneous Danish site of Højby (SØRENSEN 1979, fig. 1) – bears an additional non-figurative motif of 'dotted lines' made of regularly spaced small dots on its anatomically caudal side (Fig. 2E,1). Close observation of clearly visible dots shows that they are circular in form but terminate with a kind of tail, as a comma, or a 'Q'. This characteristic pattern can only result from the circular motion achieved with a bow-drill applied to the surface (with a hand-held borer, the dots would be neatly circular in surface). This technique of perforation was used, in this case, only to begin the process of

<sup>5</sup> Objects, as opposed to tools or projectile points, show no active end; they are shaped or unshaped anatomical parts, which have been worn out by use or manipulation only.

<sup>6</sup> The bone wedge was previously called 'bone adze' or 'bone adze with longitudinal hafting' (DAVID 2003, 655 fig. 81.7). However, some experimental work has shown that the edge obtained by the truncation of the aurochs metapodial was not intended to cut, as an adze would be, but to split wooden trunks longitudinally instead. The thick wedge was perforated at its opposite anatomical end, so that the hafted wooden part would stand up to the various repetitive percussions applied on this side of the bone tool, preventing damage of its upper end (DAVID et al. 2005; 2006).

decoration that formed the final motif when repeated in a line. Though these heavy-duty tools are generally made of *radii* of aurochs, and maybe elk (Fig. 2E,2), one of them was made of the radius of a red deer and was not decorated (Fig. 2E,3).

A segment of antler, obtained by nicking transversally and perforated at its basal part by the coring technique, was identified as a rough-out of a hammer-axe or socketed hammer-axe/adze (Fig. 3B,1). Its burr was removed by percussion, in order to regularise the hammer side. The socket, broken on one edge, and the shape of the stump, which retains the natural character of its genuine surface, indicate that the piece was discarded unused. Entire sleeves are absent from the assemblage of Hohen Viecheln 'a', but the type could be expressed by some removed fragments of worked antler bases left untouched amongst the remains of production, or suggested by numerous rejected tines of red deer (Fig. 3B,3–20). We must note as well that elk antler, used to make two blades, is, unlike red deer antler, entirely absent in the debitage debris.

A chisel made of a red deer metatarsal and a narrow 'lissoir' made of the tine of a red deer antler complete the assemblage of used tools abandoned in Hohen Viecheln 'a'. The chisel is made of the caudal half of the matrix and was fashioned of an elongated blank extracted by longitudinal grooving (Fig. 2A,4). A use of the artefact as an intermediate piece is indicated by typical patterns of 'retouch-like' damage at the distal edge and clear evidence of hammering (*bouchardé aspect*) at the opposite proximal anatomical end. The piece measures 150 mm in length and 20 mm in maximum thickness. The angle of the bevelled end is about 30°, an acute angle of the kind observed for example at Mullerup (DAVID 1999, 456 plate 28 no. 2). The 'lissoir' shows an active part that has become abraded, probably by means of use rather than intentional shaping. It has a plano-concave active end (the striations on the active end are very fine usewear traces, much finer in reality than can be shown in the illustration: Fig. 2A,3). The piece is 22 mm long, 12 mm wide, and weighs 112 g. The butt-end is unrefined, showing only evidence of debitage (by the nicking technique) without signs of hammering or hafting. The shaft is unworked. The active end has got this shape by use only (DAVID/SØRENSEN 2016). Such narrow 'lissoirs' are unknown in the classic Danish assemblages, though other types of this category of tools are represented (DAVID 1999, 456 pl. 28 no. 1).

Two decorated antler pieces, perforated batons (Kommandostäbe) engraved with non-figurative motifs, complete the assemblage of layer 'a'. One of them was made of the beam of an unshed red deer antler (Fig. 2D,1). There is a perforation at the basal end that was not roughed out in this case by the process of centripetal nicking that is usually observed to precede perforation by coring on comparable Mesolithic examples. The object is heavily fragmented and restored. The entire surface was worked in preparation for engraving, but no traces diagnostic of prehistoric techniques could be identified. The primary decorative motif consists of numerous longitudinal lines, each of which is in turn decorated with a series of short incisions, closely-packed and very regular, that are parallel to one another and obliqueto-perpendicular with respect to the primary longitudinal lines. This motif, which was for the most part entirely reconstructed during museum restoration of the artefact, presents a 'methodical' regularity that we have never observed on original Mesolithic pieces of art. As we have noted a technique of debitage employing a modern (metallic) tool on a piece that probably originated from the Mesolithic deposits at Hohen Viecheln (undetermined layer, see DAVID 1999, 580 pl. 130 no. 1), we prefer to remain cautious regarding an interpretation of this composition and refrain from using the object and its decoration as a comparative element. The other baton (Fig. 2D,2) was simply-made of a shed antler of a young red deer, engraved with motifs similar to those on a baton from Mullerup (DAVID 1999, 459 pl. 31 no. 1). The darker colour, lustrous surface, and undulation in lengthwise profiles indicate that the base of the object must have been wrapped with a kind of binding material for a suspension system and/or a particular use, as a kind of handle-grip.

Material constraints seem to explain why the methods applied to antler, and to aurochs or even roe deer metapodials, did not vary much from one site to another, especially as populations of the Early Mesolithic were all equipped with an array of lithic tools that were utilised more or less in the same way

(cutting, scraping, gouging, etc.) to reduce osseous materials that occurred in a specific set of natural shapes: tubular and very thin (roe deer metapodials), or extremely thick (aurochs metapodials), cylindrical with a bumpy (pearled) surface (red deer antler), or palmate in form (elk antler). In contrast, the use of method D or method H seems to reflect a choice, as the skeletal element used in both cases is the metapodial of a very large cervid (red deer, elk). The nature of this choice requires closer examination, especially in the functional analysis of barbed points. Before proceeding to such analyses, the informative potential of which may be limited on specimens that have not been restored, we consider it wise to first complete the technological analyses of the available collections.

With regard to the comparative analysis between the osseous industries of Hohen Viecheln 'a' and of the classic Maglemosian of Zealand, it seems premature at this stage to establish a distinct cultural group outside the Maglemosian of Denmark solely on the basis of the use of method H for the fabrication of barbed points of metapodials of large cervids, a large number of notched points made of the same anatomical element, and the presence of narrow 'lissoirs', while the overall osseous industry, including the non-figurative motifs, recalls without question the Maglemosian as it is manifest at the Boreal sites of Zealand, and in the same technical style of the M1 and M2 phases (DAVID 2003).

Also, before continuing in our analysis, we integrate the comparative elements identified in the study of osseous materials from horizon 'c' of Hohen Viecheln, which is, based on the stratigraphy of the site, prior to horizon 'a', attributed to the early Boreal (SCHULDT 1961b, 87). This provides an important diachronic element to the study.

### 4 The osseous industry of the lower horizon (c)

The osseous industry from horizon 'c' of Hohen Viecheln is composed of 135 artefacts, of which 91 are identifiable tools, objects, and pendants, only 22 are production debris, and an additional 22 could not be unambiguously identified as implements or production debris (Table 5).

#### 4.1 Notched points

The points are all of the fixedly-hafted type and represent 84 % of the implements (exactly as in layer 'a'). The notched points that were present but rare in the more recent assemblage of Hohen Viecheln dominate the assemblage from the lower layer, accounting for 80 % of the typologically determined projectile points. Unlike the points in layer 'a', they were not exclusively made of limb bones of large ungulates, but also of metapodials of roe deer, and even of the flat bones of large ungulates.

The uni-serial notched points are morphologically identical to those encountered in the upper layer. Nonetheless, two sub-types can be distinguished on the basis of shaping techniques: those with the notch formed by simple, transverse sawing (Fig. 5A, 1–9), and those with the notch made by convergent, transverse-oblique double sawing (Fig. 5B,1; 5C,11). Within the first sub-type, two additional variations are observed: the edge is either notched on the side of the edge (Fig. 5A,2), or on its inner face (Fig. 5A,1). One example, the stratigraphic provenance of which remains unfortunately undetermined, displays both variations simultaneously, one localised on the basal end and the other one on the distal part of a single edge (DAVID 1999, pl. 129 no. 6). The convergent double sawing type of notch has never been encountered in Zealand so far, except as a first stage in the manufacture of barbs, so that this approach for shaping the notch is identical to that used in shaping barbs (Fig. 5C,10). Even so, we maintain the term 'notch' for these (very similar) attributes because they extend invasively into the shaft, and even sometimes the base, as it is the case here. In contrast, on the barbed points used as weapons at Hohen Viecheln 'c', the barbs are entirely restricted to the active (distal) end of the point and were deepened

	Species – Anatomical parts	Larg red d metapo	<b>ge ungula</b> eer (c) elle d. (m) ul	<b>tes</b> <b>c (e)</b> Ina (u)	Roe deer metapod. (m)	Wild boar (s) fox (r) incisor (i) canine (ca)		
Arte	efact types	Antler	Limb	Flat	Limb bones	I	TOTAL	
	straight point				5 (m)		5	
	notched point		41	2	19 (m)		62	
	barbed point		11				11	
	awl with epiphysis		1 (uc)				1	91
TS	curved awl					1 (cas)	1	
IEN	hammer-axe	1 (c)					1	
MPLEM	blade-axe/adze	2 (e)					2	
	narrow 'lissoir'	2					2	
Ι	hammer-'lissoir'	1					1	
	worked cranium	1 (c)					1	
	bead					2 (is) 1 (cas) 1 (car)	4	
ASTE	waste of production	1 (e) 10 (c)	3 (me) 1 (mc)		6 (m)		21	22
Μ	tool's rough-out?	1 (c)					1	
?	unidentified nature: waste of production or implement		19		3 (m)		22	22
	TOTAL	19	76	2	33	5	135	

Table 5. The bone industry of the Hohen Viecheln layer 'c', in numbers of pieces.

by filing and/or scraping (Fig. 5B,2). It is important to maintain these typological distinctions because they prove significant in the large-scale comparative studies of implements displaying these attributes. Specifically, certain types of notched points might display closer similarities with some barbed types, in terms of manufacturing techniques, than with other points of the same (notched) typological category. This would allow further discussions of idiosyncratic patterns within a tradition of tool-making, and of relationships between diverse populations, by providing examples of different types of points from various sites that show an intriguingly similar approach to each attribute's production, regardless of functional aspects. Unfortunately, the limited amount of production debris here does not allow for a precise reconstruction of the approach to blank-production in the manufacture of these extensively-worked points (Fig. 5D, 1–8).

In contrast to the overlying layer, barbed points constitute only 14 % of the fixedly-hafted type of points in horizon 'c'. As in Hohen Viecheln 'a', the blanks were produced according to method H, and the points are only lightly worked (Fig. 5B,2.4–6). The remaining ones are straight points made of roe deer metapodials (Fig. 5B,3; 5C,12–13), with blank-production probably achieved by grooving and flake-breakage (DAVID 2004, 145 no.21). As points of the same materials in the more recent horizon, all the points made of metapodials exploit half (roe deer, facial half) or a quarter (large cervids) in cross-section of the available cortical matrix, excluding the distal *trochlea*.

#### 4.2 Other tools and ornaments

The heavy-duty tools (which account for more than 80 % of the 'domestic' tool-kit from the more recent horizon, as at the classic sites on Zealand) are represented by a single hammer-axe and two blade-axes/

adzes, accounting for 23 % of the overall implements from horizon 'c'. Typologically, they are identical to those of layer 'a' (Fig. 5C,8–9). Unlike layer 'a', however, horizon 'c' yielded absolutely no engraved bone adzes, bone wedges, or (fragments of) antler sleeves. The rest of the implements are various types of awls – made of epiphyses, or curved – and a narrow 'lissoir', as well as a hammer-'lissoir' made of an unshed antler (Fig. 5C,5–7). In addition to these tools, objects identified in the assemblage include beads (Fig. 5C,1–4) and modified red deer skulls (Fig. 5B,7), which are analogous to the well-known antler frontlets identified elsewhere in Mesolithic Europe, and show more similarities with the examples from Star Carr (LITTLE et al. 2016) and Berlin-Biesdorf (REINBACHER 1956) than with those from Bedburg-Königshoven (STREET 1991) in that their antler and pedicle have been carved and emptied by longitudinal nicking and/or scraping (DAVID 1999, 382 fig. 124). The beads are wild boar and red fox incisors and canines that have been modified for suspension by bifacial boring of the tooth root on its largest faces. Similar objects known from the classic Danish assemblages include the narrow smoother and analogous types of beads.

The labial teeth of *suidae*, used to make the curved awl (canine) and most of the beads (incisors), were not used in the other assemblages at the site. Though awls made of *ulnae* are a common component of Maglemosian (M2) assemblages, the modified red deer skull is a type unknown in the Maglemosian assemblages in Denmark. This artefact-type is only associated with slightly older, Early Preboreal contexts at sites that have preserved organic materials (CLARK 1954; MELLARS/DARK 1998; STREET 1991).

### 5 Hohen Viecheln ('a' and 'c') and the Maglemosian

If we exclude the elements that seem to be unique to the assemblages of Hohen Viecheln, that is to say the narrow 'lissoirs', the crude barbed points made of metapodials of large ungulates with method H, and the notched points made of roe deer metapodials, which are totally absent from the Danish Maglemosian, two observations can be made. Firstly, the osseous artefacts of horizon 'c' offer few elements

Fig. 5. Bone industry of the Hohen Viecheln lower horizon. Each scale in cm. \* unrecorded material in the original publication (SCHULDT 1961a); ◊ notable presence of black residue (drawings É. David, unless otherwise specified). A: 1-5 - notched points, roe deer metatarsals (1-3) and metapodials (HoVi678; HoVi490; HoVi360; HoVi29; HoVi857); 6-8 - notched points, large ungulates limb bones (HoVi30 $\diamond$ ; HoVi26 $\diamond$ ; HoVi864 $\diamond$ ); 9 – notched point, large ungulate flat bone (HoVi2898); 10 – awl on epiphysis, red deer ulna (HoVi3813); 11 - curved awl, half of a wild boar canine removed by scraping, grooving and wedgesplinter (HoVi5452); B: 1 - notched point, large ungulate limb bone (HoVi4933); 2 - barbed point, large ungulate metatarsal (HoVi21); 3 - straight point, roe deer metatarsal (HoVi39); 4-6 - basal ends of (barbed?) points, elk metatarsals (5-6) and metapodial (HoVi3279; HoVi639; HoVi7); 7 - worked red deer cranium showing two perforations made by centripetal nicking on the occipital as well as unshed stag antler worked by the nicking technique applied lengthwise (HoVi5063): a - superior view; b - inferior view (drawing after SCHULDT 1961a, Taf. 56; 58); C: 1-4 - beads, wild boar incisors, roots perforated by bifacial boring (HoVi607; HoVi609), tiny wild boar canine (HoVi6030), red fox canine (HoVi2338); 5 - (hafted) narrow 'lissoir', large cervid antler tine (HoVi131); 6 - distal fragment of a narrow 'lissoir', large cervid antler tine (HoVi1859); 7 - fragment of a hammer-'lissoir', unshed red deer antler (HoVi3843); 8 - fragment of a hammer-axe, basal part of a shed red deer antler (HoVi3828); 9 - blade-axe/adze, butt-end regularised by tangential nicking ('décorticage'), large cervid antler (drawing replacing HoVi915 in a poor state of preservation); 10 - barbed point, large ungulate limb bone (HoVi8); 11 - notched point, large ungulate limb bone (HoVi68); 12-13 - straight points, roe deer metapodials, no. 12 engraved with a row of tiny incisions on the upper side of the anatomical dividing line (HoVi1858; HoVi32); D: Production debris in roe deer bone: 1 - grooving and breakage, metatarsal elongated splinter (HoVi1901); 2 - flake breakage, metatarsal elongated splinter (HoVi1886); 3 - grooving and breakage, metapodial (fragment of an) elongated splinter (HoVi707); 4 - flexion break, distal metacarpal (HoVi2528); production debris in red deer bone and antler: 5 - grooving, nicking and flexion break, metacarpal articular ends (HoVi123); 6 wedge-splinter (proximal side), grooving, flexion break and inverse nicking (proximum), metapodial (fragment of an) elongated splinter (HoVi684); 10-16.18-20 - nicking and flexion break (HoVi130; HoVi2471; HoVi32; HoVi1154; HoVi5257; HoVi2627; HoVi5549; HoVi916; HoVi389; HoVi3898), antler tines, beam B, crown antler; 17 - nicking and scraping (at the end?) of the crown antler tine (HoVi4754); production debris in elk bone and antler: 7 - nicking and flexion break, metacarpal articular ends (HoVi3810); 8 - wedge-splinter (proximal side) and breakage, proximum metacarpal (HoVi1879); 9 - nicking and flexion break, central segment of a palmated antler (HoVi3791).



of comparison with the material from Zealand, except in the presence of the hammer-axes, blade-axes/ adzes, awls, perforated beads, and also in the use of method D in the manufacture of blanks for some projectile points. Because these elements are associated with other types, including a curved awl, some hammer-'lissoirs' and modified red deer skulls, never observed in the material of the Danish Maglemosian, we cannot justify placing the material from horizon 'c' at Hohen Viecheln into this Scandinavian scheme. Secondly, compared to the material from horizon 'c', the material from the more recent layer seems (with the exception of the harpoon head) nearly identical with the osseous industry of the Danish Maglemosian. Similarities are clear in the presence of:

- barbed points with filed barbs, produced of flat bones according to method F,
- straight points with a high degree of transformation, produced of metapodials according to method D,
- adzes with transverse hafting made of the radius of large ungulates, with engraving of the 'barbed incision' type,
- heavy-duty wedges made of aurochs metatarsals,
- sleeve with transverse hafting and a likely socketed hammer-axe,

and the ratio of:

- projectile points within the used implements,
- barbed points within the category of projectile points ,
- heavy-duty tools within the category of domestic implements,
- tools made of cervid antler within the category of heavy-duty tools.

If the characteristics typical of the osseous industry of the Maglemosian had also been identified in the assemblage from Hohen Viecheln 'c', it would have been possible from a typo-technological point of view to group these assemblages into the same cultural unit, because even though horizon 'c' is attributed to an earlier chronological phase, as stated by the original excavator, the Maglemosian suggests a tradition of manufacture, and one that evolves over time and space in an identifiable fashion (approach to the industrial production) with respect to the osseous industry. But the comparison of the osseous assemblages of the Maglemosian with the two horizons, 'a'(/'b') and 'c' , of Hohen Viecheln demonstrates clear differences that lead us to recognise a distinct cultural group geographically restricted to Zealand – called, to avoid any confusion, the Maglemosian *sensu stricto* (DAVID 2003) – chronologically attributed to a recent phase of the Boreal. First identified based on a study of the Danish lithic assemblages (BECKER 1953; PETERSEN 1973; SØRENSEN 2006), the classic Maglemosian (M1 and M2) can be just as well characterised in terms of the osseous technology, by method D, used exclusively throughout the territory of the island of Zealand to the exclusion, as employed in a systematic manner, of all others (such as method H) in the transformation of metapodials of large ungulates. This method D can now be called the Maglemosian method.

But does Hohen Viecheln really indicate the existence of another cultural entity? Following the comparative analysis of the older and the more recent assemblages at Hohen Viecheln, and the comparison of the latter with the osseous assemblages of the Maglemosian *sensu stricto* on Zealand, one can state with confidence that the presence of crude barbed points made of metapodials of large ungulates made according to method H and of notched points and narrow 'lissoirs' are features unique to Hohen Viecheln. However, the functions of individual sites and the purpose of projectile points remain unclear, and these tool-types are associated in one case with a set of tools of a Maglemosian type (horizon 'a') and in another case with an entirely different set of tools (horizon 'c'). How are we to interpret the presence, in the more recent horizon, of an osseous industry of the classic Maglemosian type in association with the set of tools unique to Hohen Viecheln? Is it the result of innovation, import, or acculturation?

The previous technological study of Maglemosian lithic assemblages (SØRENSEN 2006) did not, unfortunately, include those of Hohen Viecheln. Classic typological studies have placed the Hohen Viecheln material, solely on the basis of the lithics, in the complex known as the 'Duvensee complex', composed of

different 'cultures': 'Star Carr' in England, 'Duvensee' in Germany and Denmark, 'Melsted' in Denmark and Sweden, and 'Komornica' in Poland (KozŁowski 1973). It is evident that the Maglemosian is clearly identifiable as a regional cultural entity based on approaches to the lithic industry, but according to the authors cited above, it would extend to regions neighbouring Zealand, notably northern Germany, where other cultural entities have also been identified. The relationships between these cultural groups have not yet been explained. An interpretative model for the analysis of 'material culture' as a dynamic and interactive system might reveal instances of convergence between apparently distinct components, and show how various aspects of material production articulate at different scales (e.g. FUGLESTVEDT 2003; ZVELEBIL 2003). In the absence of such a model, it seems reasonable at present to consider that some osseous assemblages are similar to those of the Maglemosian sensu stricto, but characterised by regionally specific typo-technological components, hence: Hohen Viecheln, an idiosyncrasy of the Maglemosian? Contemporaneous osseous assemblages of the late Boreal, currently known outside of Denmark only by the material from the more recent horizon at Hohen Viecheln, seem to be characterised by the use of method D and the products that result from it, as well as by the distinctiveness of the barbed points that account for at least 70 % of the fixedly-hafted projectiles and the heavy-duty tools within the category of domestic osseous implements. With regard to these heavy-duty tools, we emphasise that the presence of antler sleeves (of the hammer and transversely-hafted types), bone wedges and engraved bone 'adzes' (with incised barb motifs), are diagnostic components of these particular outlying Maglemosian-related osseous assemblages.

Whether they represent an endemic evolution, a cultural import arriving with visitors to the site, or instances of borrowing, the osseous assemblages represented by the material of the more recent horizon at Hohen Viecheln constitute a Maglemosian composition with some regionally-specific components identified, *a priori*, by the presence of different types of points (notched points on limb bones) and the use of an alternative method of fabrication (method H for the manufacture of barbed points of metapodials), and seem to attest to the presence of a cultural entity contemporaneous to the Maglemosian of Zealand. For this reason, we consider it important to stipulate that, from the perspective of the osseous industry, the Maglemosian *sensu stricto* concerns the Danish material exclusively, and the more recent horizon at Hohen Viecheln ('a' and 'b') constitutes a Maglemosian *sensu lato*, also attributed to a late phase of the Boreal. This is asserted on the basis, presented above, that the industry of Hohen Viecheln 'a' has more in common with the Maglemosian of Zealand than with that of Hohen Viecheln 'c', a regionally specific (endogenous?) industry.

## 6 Hohen Viecheln in a regional and diachronic context

At Hohen Viecheln, the two horizons differ in proportion of notched points to barbed points: in layer 'c', 80 % of the bone points are notched, and 14 % are barbed points, while almost the opposite is true for layer 'a', which yielded 17 % notched points and 63 % barbed points. The same evolutionary shift in fixedly-hafted projectile points, by which the proportion of notched to barbed points is inversed, was also observed in the sequences at Friesack 4, from the early horizon I (late Preboreal) to the horizon III of the Early Mesolithic (early Boreal; GRAMSCH 1987), even though, at both sites, the techniques of fabrication and the nature of the two types of projectiles concerned remain identical across the horizons (DAVID 1999, 316–330). The assemblage of bone points from Hohen Viecheln 'c' has yielded barbed points, much like those from horizons II and III of Friesack 4, and a high proportion of notched points similar to those from horizon I of Friesack 4. Considering that the nature of each of these pointtypes is consistent for these two sites, it seems that the form and relative quantities of these artefacts alone can no longer be taken as an indication of a micro-regional component at Hohen Viecheln, as once supposed (CZIESLA 2006; GALINSKI 1989; KOZŁOWSKI/KOZŁOWSKI 1977; VERHART 1990). Rather, they show a more global (macro-regional) evolutionary pattern in northern Germany that is, thus far, common to the studied sites of the late Preboreal to late Boreal chronozones (Duvensee included).

The bone points of Hohen Viecheln 'c' differ from those of Friesack 4 only in the use of method H for the fabrication of blanks and the minimal degree of investment in the shaping of barbed points (though the exact method of debitage of the blanks used at Friesack 4 or Duvensee is yet unknown). All bone projectile points from the known contemporaneous sites in Northern Germany, though, are similar in the choice of skeletal elements used, in the mode of shaping attributes like notches and barbs, and, in the case of straight points and notched points, in the degree of shaping. As such, it is the relative proportion of each type within these artefact assemblages that reveals variation over time in the region. Specifically, the assemblages of the late Preboreal are characterised by a high proportion of notched points (around 80 % of bone points), almost to the exclusion of barbed points (they exist, but in small numbers and made of red deer antler: GRAMSCH 2009/2010, 48). In contrast, the assemblages of the Boreal are composed of three types of bone projectile points (straight, notched, and barbed) and are dominated by barbed points at the end of the chronozone.

The composition of the bone point industries at Hohen Viecheln and Friesack 4 has also yielded a distinct and homogeneous set of tools that do not belong to the Maglemosian sensu stricto and include notched points made of limb bones of ungulates, narrow 'lissoirs' and, in the more recent phases, unfiled barbed points. At the same time, the antler sleeves, hammer-axes/adzes, and awls made of epiphyses constitute a set of tools common to the two sites that are chronologically differentiated within the Boreal. If we exclude the awls made of epiphyses, which are poor indicators of change because they show great inter-assemblage variation in terms of the skeletal element used, the hammer tools, for the most part as common in the assemblages of Zealand as in the earlier phases of the Boreal in Germany, can no longer characterise the Maglemosian in its classical aspect by their mere presence. On this basis, and on the basis of a domestic osseous tool-kit common to all the assemblages, the osseous industry of the Maglemosian sensu lato does not seem to be substantially different from the osseous industry of Germany. Nevertheless, the industry from horizon IV of Friesack 4, which was not available for this study, is also attributed to a late phase of the Boreal in transition to the Atlantic chronozone; it could, like the recent horizon at Hohen Viecheln, be completed by a set of tools more typical of the Maglemosian on Zealand. Conversely, as suggested in the same way by Gramsch for the only assemblage from the Havelland (GRAMSCH 2011), it could conserve autochthonous characteristics indicative of an in situ evolution of elements that have been evident in the region since, at least, the late Preboreal.

The expansion of comparisons with contemporary European assemblages show technological variations in the manufacture of barbs between the points at Star Carr (filed) and at Friesack 4 (unfiled), made of identical (antler) blanks. Even so, the use of the term 'Proto-Maglemosian', employed by J. G. D. Clark (CLARK 1975) to define the osseous industry at Star Carr, cannot be justified on the sole basis of the presence of a few notched points made of limb bones of large ungulates made according to method D (as in Barmose, Denmark), or that of points with filed barbs as in the classic Maglemosian of Zealand. On the contrary, the assemblage at Star Carr presents a closer affinity to the osseous industries of Northern Germany and the Rhineland, as represented by the early Boreal and Preboreal horizons at Hohen Viecheln, Friesack 4, and Bedburg-Königshoven, on the basis of the number of common tool-types (notched bone points, barbed antler points, large bone chisels, elk antler mattocks, narrow bone 'lissoirs', and modified red deer skulls: DAVID 1999, 324). One could then label this entire ensemble Proto-Maglemosian.

In addition to the evolving nature of the projectile points with uni-serial edge-modifications, which show a trend from notches to barbs that inverts at or just after the Preboreal-Boreal transition (represented by Friesack 4-II), there is a progressive increase in the number of straight bone points toward the late Boreal. These trends indicate an evolution in (fixedly-hafted) organic projectiles in the Early Mesolithic, from the middle Preboreal to the Boreal-Atlantic transition, in the regions of Denmark, Germany, and England, even though stylistic variations within the types of points with uni-serial edge-modifications allow for distinctions to be made between the sites. It is thus possible to differentiate be-tween the notched points of the 'Friesack type', which present a notch regularly produced by convergent sawing, and those of the 'Star Carr type', on which the notches are just evoked by simple sawing, or of the 'Duvensee type', with deeper and narrower notches. We can now identify barbed points of the 'Hohen Viecheln type' made by method H and characterised by a low degree of modification that distinguishes them from points of the 'Friesack type' which show instead a higher level of investment in the manufacture of morphologically identical barbs (Figs. 6–7).

Even if we cannot yet offer an explanation for the variability and transformation in fixedly-hafted projectile points, quantities of notched and barbed points seem to vary in tandem and to display an obvious, regular evolution from the middle Preboreal to the late Boreal, regardless of the degree of shaping and style of attributes. Even if this permits us to identify certain points by geographic locality, though, we cannot define or identify cultural groups on this basis alone without identifying each and every site as its own unique cultural group, as each site has a distinct style in bone weapons. In order to attribute these variations to cultural values, it is necessary to develop a better understanding of the place of these elements in the broader socio-economic systems in which they functioned. At present, it seems that we lack both the chronological resolution and sufficient data on the modes of acquisition and exploitation of animal resources for subsistence and raw material (e.g. LEDUC 2012) to proceed in such studies for the Early Mesolithic.

### 7 Conclusion

Though we would expect to find drastic differences between the osseous industries that characterise the classic Maglemosian and this Northern European ensemble that is chronologically older (with the exception of both the more recent horizons at Hohen Viecheln and Friesack 4, contemporary with it at its early phase), it seems that method D, the use of which does not appear to be dependent on raw material, has been observed across assemblages of Northern Europe (the method S initially distinguished at Star Carr in the fabrication of notched points is actually equivalent to method D used for the straight and barbed points: DAVID 1999, 333 fig. 100). Its use appears to be primarily associated with the fabrication of different sorts of projectile points of a high degree of modification and perhaps also the debitage of blanks for bone chisels (Friesack 4, horizon II). Several artefact types that seemed to be specific to the Maglemosian *sensu stricto* have been identified within the osseous assemblage of the layers attributed to the early Boreal in this ensemble: beads, blades, awls, unsocketed and socketed hammer-axes/adzes. This suggests that, of the heavy-duty tools that characterise the Maglemosian *sensu stricto* (DAVID 2003), only bone hammers (with and without a binding system) seem to be securely representative.

Given these considerations, from an osseous technology perspective, we are led to attribute all these assemblages in Northern Europe to a single 'technocomplex' (the term is used here in its original sense: CLARKE 1968, 53). With regard to the tools that define it, this technocomplex can be identified by the shifting proportions of projectile point-types and the presence of a domestic tool-kit that evolves, without interruption, from the second half of the Preboreal (Star Carr, Friesack 4-I) to the late Boreal (Hohen Viecheln 'a') in Northern Europe, represented by Hohen Viecheln, Friesack 4, Duvensee, Star Carr (and by extension Barmose and Bedburg-Königshoven, to which one can also add the deposits at Lundby [Møller et al. 2004]). Based on the study of the osseous industry, the northern technocomplex is characterised by assemblages that share typological, technological, and anatomical characteristics and a simi-





lar trajectory of evolution (similarities in diagnostic projectile points), but show idiosyncrasies in terms of the stylistic traits within the assemblages at each site: a distinct technique for shaping the bases of barbed points (method H), the morphology of projectile point attributes, their placement along the cortical edge, their depth, the way with which the sawing technique was applied to make them (simple, convergent, facial, lateral), and the use of similar anatomical supports for other tool-types such as awls made of epiphyses, and perforated beads. In comparison with this northern ensemble, two other contemporaneous technocomplexes are in the course of being defined, as they show drastically distinct tool-types and manufacturing methods. Located in Western Europe (DAVID 2000; 2012) and the eastern regions of the Baltic to Russia, respectively (DAVID 2005; 2006b), they are perceived from contemporaneous assemblages constituted of similarly used anatomical matrices.

Is the Maglemosian *sensu stricto* a latest development in the evolution of the northern technocomplex, then seen as a Proto-Maglemosian, or an idiosyncrasy of this large ensemble, thus composing an Initial or Pre-Maglemosian? The osseous industry of Zealand



Fig. 7. Ratios of different osseous points from the Northern technocomplex.

attributed to the Preboreal (or the 'Maglemosian 0' based on the lithic industry: PETERSEN 1973) shows a similar composition to that of the northern technocomplex in the high number of notched points made of limb bones of large ungulates at Skottemarke, Mørke Enge, and Barmose. At these sites, the scarcity of production debris has prevented the identification of the Maglemosian method. Nonetheless, the degree of the points' manufacture and the morphology of the notches and their position along the point-edge, as well as the shape of the bases, show great similarities with those already described in northern Germany. In these series, though, other skeletal elements (flat bones) are used, which limits the utility of a point-by-point comparison in separating the northern technocomplex from the classic Maglemosian in its Danish form.

Consequently, the more recent horizon of Hohen Viecheln, which presents an osseous industry of 'mixed' composition, has led us to define a Maglemosian *sensu lato*, which could be the product of cultural contact (borrowing, import) between these two distinct entities, the northern technocomplex represented here by Hohen Viecheln 'a' and the Maglemosian *sensu stricto*, or of a sudden local technological evolution (traditional components + innovation). Each of these northern sites belongs to a cultural tradition that has either evolved in two distinct cultural branches before the time of layer 'a' – one in the European plain (Initial Maglemosian) and another one on Zealand (Maglemosian *sensu stricto*) that came back to Hohen Viecheln (Maglemosian *sensu lato*) after it developed in Denmark first –, or it originated from the Hohen Viecheln substrate initially. In this case, such innovation would suggest the addition of too many different (and not necessarily complementary) innovative elements at the site at once: not only the use of filing (for the shaping of barbs), and of new blanks for points (flat bones), with a suite of new

forms of tools (sleeves and several types of adzes), but also art, in the form of adzes adorned with barbed, fringed and dotted engraved lines, as an explosion of sudden yet unexplainable novelties. We therefore favour the first scenario, and see in the Maglemosian *sensu lato* the import or borrowing of a technology of Maglemosian origin in addition to the traditional local assemblage of the Hohen Viecheln site, of a Duvensee/Pritzerbe substrate origin. This is also supported by a new radiocarbon date (see GRoss et al., this volume) obtained on one of the typical Maglemosian products – the engraved bone adze found in layer 'a'/'b' at Hohen Viecheln (HoVi609) – that is in complete accordance with the dating of Mullerup (see Table 4), the site eponymous of the classic Maglemosian.

### 8 Perspectives

Eastwards, the northern technocomplex extends over the territory of Zealand, without reaching the other parts of Scandinavia towards the north (BERGSVIK/DAVID 2015) or the east (by now, the bone industry of Ageröd I:A-H-C, in Scania [Sweden], shows a mixture of Maglemosian and other series, with indications of a foreign technology of Eurasian origin, c. 7500/7300 cal. BC: David 1999, 351; DAVID/KJÄLLQUIST 2018). Because the study of the lithic industry has shown the existence of a homogeneous Maglemosian entity in this Danish territory from the Preboreal to the Atlantic, a scenario can be proposed concerning the chrono-cultural affiliation between the northern technocomplex and the early Maglemosian according to the primacy given the results of the lithic analyses over those of the osseous industry presented here. In the common traits that it shares with the northern technocomplex, the Maglemosian sensu stricto could have originated in this larger entity that spanned the whole of Northern Europe, which would thus constitute an Initial or a Pre-Maglemosian. In the area of Zealand exclusively (Maglemosian sensu stricto), the osseous industry could have taken a particular form in the late Boreal, potentially tied to a technological component that emerged further south around 8200 cal. BC. As a matter of fact, we can see a development in fixedly-hafted points toward more pronounced forms (sawing/filing on barbed points) and a partitioning of the anatomical elements used in their manufacture (straight points made of red deer material, barbed points of elk material). A broadening of the range of material sources in terms of skeletal parts is observed (flat bones, notably), presumably related to a greater demand for heavy-duty tools made of the limb bones of large ungulates (adzes, hammers), in association with particular supplementary methods of fabrication (method C, method F). Regardless of the anatomical element used, over the course of the 8th millennium cal. BC, straight points and barbed points came to replace the notched points that were everywhere the most common and abundant form in the early Boreal. These technological trends maintain a relationship with the intended purpose of the fixedly-hafted points (straight, notched, barbed) that seem to be complimentary from this period on. In Northern Europe, with the exception of the crude barbed points at Hohen Viecheln, they were all manufactured according to the Maglemosian method.

Depending on the site, we could observe that the composition of the point assemblages, related to the composition of the faunal assemblages, suggests selective hunting of several species (e.g. cervids, aurochs), whereas certain species (pike?) appear to have provided the group with a source of animal protein that was more regularly seasonally available with the warmer Boreal climate (e.g. ERIKSSON et al. 2003). It follows that, though we recognise that the northern technocomplex (Pre-Maglemosian) followed a particular evolutionary trajectory in this region, in the sense proposed by V. G. CHILDE (1931), eventually becoming the Maglemosian *sensu stricto* in the Boreal, prudence demands that we do not attribute the origins of this industry to other groups belonging to the northern technocomplex (Duvensee, etc.) in the absence of a global comparative analysis of the lithic and bone technologies and subsistence systems in this vast Northern European entity.

A unique evolutionary trajectory of hunting/fishing gear evolution on Zealand would allow us to identify areas - on the margins of this territory, notably at Hohen Viecheln 'a' -, where the association of these two types of industries (Maglemosian sensu lato) would indicate a clear zone of contact between these two neighbouring entities that show previous divergence. How can we explain what appears to be a trend in projectile point production that imposes an apparent monolithic aspect in the assemblages of Zealand (the comparison of the morphology of the basal end of the barbed points, though, could be used for identifying distinct styles for the sites that constitute the Maglemosian there), if not by invoking the increasing insularity of this region toward the Boreal/Atlantic transition? Following environmental changes, animal resources appear to have already begun to diminish in abundance, necessitating the development of an economy of subsistence based on a familiar sets of animal resources that was nonetheless reduced in variety; elk, for example, disappeared from the faunal assemblages in Denmark (AARIS-SØRENSEN 2009, 47). Because this animal had provided the majority of raw material for the osseous industry, notably leister prongs, it is understandable that certain anatomical parts – such as metapodials - became more important in the maintenance of an osseous industry which for that culture remained unchanged (e.g. OETELAAR/BEAUDOIN 2016). The later phases of the Maglemosian (M3 to 5, Maglemosian as displayed at the Sværdborg sites) testify that the material culture remained stable, although it was enriched with new forms of bone projectile points (slotted bone points: DAVID/SØRENSEN 2016), implying that strategies of provisioning material of the key animal species to maintain a consistent industrial system would have been developed in neighbouring regions beyond Zealand (Germany, Sweden).

Additionally, the geographic frontiers proposed between these different entities or technocomplexes, with regard to the osseous industries of the Early Mesolithic (DAVID 2009), do not constitute hermetically sealed spheres. To the contrary, the material from the layers at Ageröd I:A-H-C, for example, clearly demonstrates the use of the Maglemosian method associated with other components in the early phases (BL, UT), as in the other known case of a Maglemosian sensu lato. However, the grouping of the archaeological layers and trenches in archaeological horizons at this site, as at Hohen Viecheln, does not allow for a more fine-grained reading of the succession and distribution of *in situ* occupations that would permit their (re)attribution to the different components identified within the assemblages, and the identification of patterns of occupation-fluctuation, or the meeting of groups of various origins at the site over time. The recent dates obtained on the series of artefacts from Hohen Viecheln (Table 4; see GRoss et al., this volume) show, at the least, substantial overlap between the two horizons that were distinguished during excavation but are unfortunately contemporaneous according to absolute dates, regardless of the type of bone point concerned (Maglemosian, Duvensee, Pritzerbe). We therefore emphasise the importance of combined analyses of the economies and technologies related to the material at these endemic Mesolithic sites, for which the stratigraphy could have been understood at a finer scale during excavation, so that new research perspectives might be developed for the better understanding of cultural affinities between the groups that occupied Northern Europe at the beginning of the Postglacial period.

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## Appendix

Inventory list of the bone and antler industry from Hohen Viecheln (in Latin alphabet, trench number, each starting with 'HoVi' for Hohen Viecheln). \* Pieces illustrated in Figs. 2, 3 and 5. Bold: newly dated material (see Table 4 and GROSS et al., this volume).

#### LAYER a

TOOLS STRAIGHT POINTS (limb bone, large ungulate) 5447a/IX\* 3873a/IX 465a/I 3619a/VIII 4765a/IX\* 4454a/IX 4445a/IX 47a/V (metapodial, roe deer) 105a/II\* 99a/I 2685a/V (flat bone, large ungulate) 1205a/IV\* (unidentified) 5448a/IX\* NOTCHED POINTS (limb bone, large ungulate) 3867a/IX\* 4429a/IX 5611a/VIII 4358a/IX 4926a/VIII 3269a/V 6157a/F 2690a/V 52a/II\* (metapodial, roe deer) 3270a/V 46a/V BARBED POINTS (limb bone, large ungulate) (1-4 barbs, mainly 2 barbs) 4385a/IX\* 19a/? 3177a/V 463a/I 13a/?\* 100a/II 20a/III\* 1677a/IV 1678a/IV 2678a/V 2680?/V

16a/II\* 17a/IV\* 3178a/V 1a/III 2639a/V 3179a/I 4a/?\* 878a/IV 4764a/IX 45a/? 75a/I 83a/II 3854a/VIII 3874a/IX 6253a/F 2688a/V 2677a/V 464a/I 3692a/VIII (flat bones, large ungulate) 6a/II 2951a/V 2952a/V 3185a/IV 5270a/VIII 3307a/IV 5349a/IX\* 1194a/IV 3308a/IV 756a/IV 801a/II HARPOON (limb bone, large ungulate) 3272a/IV\* WEDGE (LONGITUD. SHAFT) (metatarsal, aurochs) 1204a/IV\* ADZE (TRANSVERS. SHAFT) (radius, aurochs or elk) 4761a/IX+4760a/IX+5229b/ IX+5606?/IX\* 3878a/IX (radius, red deer) 5485a/IX\* 632a/II HAMMER-AXES (antler, red deer) 3174a/V\* 113a/II 1192a/IV BLADE AXES/ADZES (antler, elk) 1208a/IV\* 4384a/IX (antler, red deer) 1730a/IV 135a/III 710a/II 1195a/IV 1202a/IV 5775a/VIII 2693a/V

CHISEL (metatarsal, red deer) 5867a/XII\* NARROW LISSOIR (tine antler, red deer) 133a/II\* HAFTED BATONS (antler, red deer) 136a/II\* 610a\* UNIDENTIFIED TOOLS (base of straight or barbed points) limb bone (elk) 5610a/VIII\* 3a/IV\* 107a/IV 74a/II 63a/II 3714a/VIII 514a/I 5612a/VIII 4383a/IX 2890a/IV 2697a/V 545a/I 3693a/VIII (red deer) 69a/II 3850a/VIII 3853a/VIII 3849a/VIII 6158a/F 6031a/F 108a/IV 88a/II 3129a/V 3023a/V 469a/I 3184a/IV 2681a/V 92a/II 60a/II 77a/IV 64a/II 5609a/VIII 3875a/IX 3852a/VIII 3872a/IX 3876a/IX 3868a/IX 3866a/IX 3870a/IX 3273a/IV 6253a/F 2689a/V 2691a/V 2906a/V 2864a/IV 2697a/V 2896a/V 3691a/VIII

468a/I 466a/I 467a/I 471a/I 234a/IV 88a/VII 45a/V flat bone, large ungulate 15a/II limb bone, roe deer 81A/I WASTE PRODUCTS Elk (metapodials) splinter 6252a/F 1001a/IV\* segment 4723a/IX Red deer (roughout of a hammer or socketed hammer-axe/adze) 112a\* (antler) splinter 6246a/X\* segment 5474a/VIII\* 4436a/IX\* 6251a/XIII\* 1195a/IV\* 5698a/VIII\* 6032a/X\* 4118a/IX\* 4297a/IX\* 6084a/X\* 5695a/VIII\* 4928a/VIII\* 1201a/IV\* 5831a/IX\* 1198a/IV\* 1199a/IV\* 5696a/VIII\* 5773a/VIII\* 5722a/VIII\* 6093a/XIII 1202a/IV (metapodial) splinter 764a/II\* 2070a/IV\* 2915a/V+2916a/V\* segment 181a/II 5752a/VIII\* 5754a/VIII\* 2694a/V\* Large ungulates (rib) 5890a/XII 1685a/IV

(scapula) 5952a/XII Roe deer (metapodial) 674a/II 172a/II 671a/II UNIDENTIFIED (waste or tool?) (metatarsal, red deer) 3851a/VIII\* (metatarsal, roe deer) 53a/II\* LAYER a or b TOOL ADZE (TRANSVERS. SHAFT) (radius, aurochs) 609a-b/III\* LAYER b TOOLS STRAIGHT POINTS (metapodials, roe deer) 5328b/VIII NOTCHED POINTS (limb bone, large ungulate) 5260b/IX\* 5366b/IX 1862b/IV BARBED POINTS (limb bone, large ungulate) 2253b/IV\* 5230b/IX 5241b/IX 3210b/V AWL ON EPIPHYSIS (metacarpal, red deer) 5242b/IX\* WEDGE (LONGITUD. SHAFT) (metatarsal, aurochs) 5272b/VIII\* BLADE AXES/ADZES (antler, large cervid) 5350b/IX\* 5271b/VIII\* SLEEVE (antler, red deer) 6250b/XIII\* NARROW 'LISSOIR' (antler, red deer) 5226b/IX\* socketed ('dague') 5326b/IX\* BATON WITH A SOCKET (tibia, wild boar) 5367b/IX\* UNIDENTIFIED TOOL hammer or socketed hammer-axe/adze 230b/II\*

WASTE PRODUCTS Elk (antler) 4762b/VIII\* (antler pendant) 5351b/IX\* Red deer (antler) 2069b/IV\* 4202b/IX\* 5896b/XII\* 5431b/XII 5895b/XII\* (metapodial) 5894b/XII\* 119b/II\* 117b/II\* 122b/II\* 118b/I\* 5326b/IX\* 120b/II\* Large ungulate (rib) 5526b/IX\* Roe deer (metacarpal) 5264b/IX\* LAYER c TOOLS STRAIGHT POINTS (metapodial, roe deer) 1858c/IV\* 9c/II 39c/II\* 12c/II 32c/III\* NOTCHED POINTS (limb bone, large ungulate) 42c/II 73c/II 35c/III 5891c/XII 1856c/V 30c/II\* 25c/1953 23c/II 4766c/IX 4769c/IX 2134c/IV 2570c/IV 34c/II 37c/II 10c/II 24c/III 58c/II 33c/II 97c/IV 104c/IV 101c/IV 861c/IV

5548c/IV

5614c/VIII 3845c/VIII 3743c/VIII 3275c/IV 3274c/IV 6092c/XIII 1857c/IV 2901c/V 3180c/V 3165c/V 3166c/V 3164c/V 546c/inf 98c/IV 4933c/VIII\* 68c/II\* 864c/IV\* 26c/?\* (flat bone, large ungulate) 2898c/V\* 3425c/IV (metapodial, roe deer) 49c/II\* 4768c/IX 36c/III\* 29c/V\* 857c/IV\* 682c/IV 681c/IV 27c/? 3265c/IV 2899c/V 2900c/V 2850c/V 3181c/V 3183c/IV 3167c/V 231c/IV 232c/IV 678c/IV\* 858c/IV BARBED POINTS (limb bone, large ungulate) (2 barbs) 21c/III\* 40c/II41c/II 85c/IV 11c/II 919c/IX 5c/II 8c/IV\* 860c/IV 2135c/IV 3426c/IV AWL ON EPIPHYSIS (ulna, red deer) 3813c/VIII\* CURVED AWL (canine, wild boar) 5452c/IX\* HAMMER-AXE

(antler, red deer) 3828c/VIII\* **BLADE AXES/ADZES** (antler, elk) 915c/IV\* 2137c/IV NARROW 'LISSOIRS' (tine antler, red deer) 131c/II\* 1859c/IV\* HAMMER-'LISSOIR' (antler, red deer) 3843c/VIII\* WORKED CRANIUM (red deer) 5063c/XII\* BEADS (incisor, wild boar) 698c/III\* 607c/III\* (canine, wild boar) 6030c/XII\* (canine, fox) 2338c/IV\* WASTE PRODUCTS Elk (metapodial) splinter 1879c/IV\* 684c/II\* segment 3810c/VIII\* (antler) segment 3791c/VIII\* Red deer (metapodial) segment 123c/III\* (bois) segment 1154c/IV\* 3898c/VIII\* 132c/I\* 916c/IX\* 5257c/IX\* 2627c/V\* 2471c/IV\* 130c/I\* 5549c/I\* 389c/II\* tool's roughout? 4754c/IX\* Roe deer (metapodial) splinter 1901c/IV\* 1886c/IV\* 5562c/IV 707c/II segment

2528c/IV\* UNIDENTIFIED (waste or tool?) (limb bone, large ungulate) 2c/II2905c/V 7c/II\* 639c/II\* 3279c/IV\* 93c/II 90c/II 94c/IV 84c/II 67c/II 72c/I 51c/II 102c/IV 80c/II 79c/II 684c/IV 683c/IV 862c/IV 3278c/IV (metapodial, roe deer) 708c/II 3677c/VIII 1209c/IV

985c/IX