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Modified Bone and Shell

Contact, Circulation, Exchange

Proceedings of the Modified Bone & Shell UISPP Commission Conference (2-3 March 2017, University of Trnava)

Edited by

Éva David and Erik Hnrčiarik

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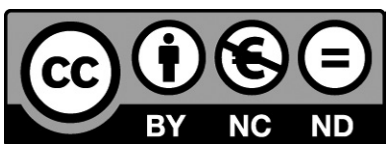

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INDUSTRIE DE L'OS PRÉHISTORIQUE — XV

CONTACT, CIRCULATION, EXCHANGE

PROCEEDINGS OF THE MODIFIED BONE & SHELL UISPP COMMISSION CONFERENCE

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Mesolithic bone spearhead with lithic insets from Veretye (Russia).
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Figure 1. Conference group at the Faculty of Philosophy and Arts of the Universitas Tyrnaviensis, Trnava. Photograph credit, Erik Hnrčiarik/The University of Trnava.

FOREWORD

The Modified Bone & Shell Commission of the International Union of Prehistoric and Protohistoric Sciences (UISPP) represents scientists promoting archaeological sciences for understanding human past and its cultural diversity through approaches from bone artefacts. Initially, publications of the Commission (see list of published issues below) consisted mainly of proposing typological grouping of bone artefacts to archaeologists for bone tool identifications and chrono-cultural classifications. Its research interests have broadened and now emphasize all potentials of bone artefacts in material studies.

The papers included in this volume constituting issue XV were presented at the last workshop of the Commission on "contact, circulation, exchange in past societies: approaches from bone artefacts", held from March 2 to March 3, 2017, at the University of Trnava in the Slovak Republic (Fig. 1). Organized jointly with Erik Hnrčiarik (University of Trnava), the workshop brought together 25 archaeologists and archaeozoologists of 13 countries and 3 continents. The collection of contributions reflects the diversity of actual approaches from the bone, ivory, antler and shell artefacts studies and are covering a wide variety of chronological periods from the Upper Palaeolithic to the Middle Ages, and geographical regions from Alaska to Asia, including central Europe and the near East.

On behalf of the UISPP and as the president of the Commission, I would like to thank Erik Hnrčiarik and the University of Trnava for hosting the Modified Bone & Shell UISPP Commission and for their full support and assistance during the workshop in providing us with the best working conditions. I am also grateful to the many members, proofreaders internal to the Commission, and the invited external reviewers for their volunteer effort in evaluating the submitted papers: Erika Gal, Hemmamuthé Goudiaby, Zlatko Kovancaliev, Pierre Magniez, Monica Mărgărit, Jean-Marc Pétillon and Francesca Romagnoli; English, Béatrice Cameron, and French revisions, Lucienne Filippi.

Éva David
President of the Modified Bone & Shell UISPP Commission
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This issue

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Used abbreviations in this volume

AD — Anno Domini (after Christ)
BC — Before Christ
BP — Before Present (1950 AD)
calBC — calibrated radiocarbon date BC*
calBP — calibrated radiocarbon date BP*
ka — kilo (1000) years

* Calibration 95.4% confidence with OxCal program version 4.4.2[130] (Bronk Ramsey, 2009) using IntCal20 atmospheric curve (Reimer *et al*., 2020).

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to Jean Guilaine,
to Michèle Julien,
with gratitude for their esteem

PART I — RESEARCH PAPERS

THE CIRCULATION OF ORNAMENTS IN AURIGNACIAN CONTEXTS

Claire Heckel
Sibylle Wolf

Abstract: *We present here a brief comparison of the Early Upper Palaeolithic ornamental assemblages in the Swabian Jura and Aquitaine regions followed by a discussion of the implications that they have for issues of cultural contact, contexts of circulation, and networks of exchange in the Early Upper Palaeolithic and beyond. Among artefacts made of hard animal materials, personal ornaments are particularly relevant to issues of contact, circulation, and exchange. The assemblages of shell and ivory beads from the Aurignacian of Aquitaine and the ivory beads of the Swabian Aurignacian present a number of insights and challenges related to these issues among early populations of Homo sapiens in these regions. The small, standardized ivory beads found in each of these regions, though different in morphology, present strikingly similar approaches to manufacture that raise challenging questions about the origins of these practices in the Aurignacian. Recent evidence from the close examination of these assemblages and their contexts of production and use also suggest very different patterns related to their circulation: while the ivory beads in Aquitaine circulated briefly in a wide regional network of exchange, counterparts in the Swabian Jura seem to have had a longer period of use in a more restricted geographic range. These similarities and differences in ornament use among Aurignacian societies that were broadly contemporary indicate that the mechanisms that drove investment in personal ornaments were complex and variable, even within the Early Upper Palaeolithic of Europe.*

Palaeolithic, Ivory, Shell, Beads, Ornaments, Swabian Jura, Aquitaine, Networks

INTRODUCTION

During the Early Upper Palaeolithic in Eurasia, there is evidence for remarkable intensification in a number of activities with precedents in earlier periods in Africa and the Near East (production of personal ornaments and osseous artefacts), as well as the apparent emergence of other phenomena (figurative representations of humans and animals in three-dimensional figures as well as paintings and engravings). Since the late twentieth century, it has been recognized that the mosaic emergence and subsidence of such behaviors are the result of a suite of complexly interrelated mechanisms, rather than a sudden cognitive or behavioral "leap." A close examination of ornament assemblages reveals that even within the Aurignacian, investment in personal ornaments was far from uniform and universal. Examining variations in personal adornment across time and space *within* the Aurignacian is crucial for understanding "the broader social, technological, and ideational contexts and processes that made complex representational systems possible, desirable, and useful." (White, 1992:538).

In the title of this paper, we have chosen the plural term "Aurignacian contexts" for a few reasons. Firstly, it is clear that in spite of a common set of general tools and technological approaches, manifestations of the Aurignacian vary in many important aspects across time and space, and that examples of the Aurignacian must be considered as they exist in different regions and at different times before meaningful cross-regional comparisons are made. Secondly, within each Aurignacian context, there are many other sub-contexts to be considered. Though many questions remain about the human behaviors in the Aurignacian, we attempt here to concisely situate the Aurignacian ornaments of Aquitaine and the Swabian Jura (Fig. 1) in their broader chronological, geographic, economic, technological, and symbolic contexts, based on the evidence currently available. We demonstrate that though they are very similar types of objects, they circulated in very different contexts.

Figure 1. Map of primary sites discussed in Aquitaine and the Swabian Jura.

Personal Ornaments and Mobility

Personal ornaments can be a particularly informative class of artefacts with regard to circulation and mobility. The mere presence/absence of ornaments at archaeological sites, however, does not tell us very much about patterns of behavior. Different types of ornament require different levels of economic and technological investment, which in turn have different implications for the function of beads. One of us (Heckel, 2016) has elsewhere made the distinction between *low-modification* ornaments and *high-modification* ornaments. The former are natural objects (often shells, teeth) that have not been extensively modified apart from preparation for suspension, while the latter are shaped from materials (ivory, soapstone, lignite, amber, etc.) in ways that transform them substantially. Though clear preferences are often shown for particular shells and teeth in ornament assemblages (when compared to natural ranges of abundance), barring any social proscriptions low-modification ornaments can be made quickly and with relative ease by most individuals. High-modification ornaments often involve complex production sequences and highly standardized manufactured shapes that require comparatively high levels of technical skill and economic investment. In the case of high-modifications Aurignacian beads from sites in Aquitaine, morphometric and statistical analyses (Heckel, 2016 & 2018) have shown that these objects are in many respects as standardized as "specialist-produced" beads and artefacts from later contexts. Both the level of skill required and the complex sequences of production suggest a level of investment in the production of high-modification beads that far exceeds those involved in the production of low-modification beads.

The availability of raw materials and the likely modes of their acquisition is another important factor to consider in evaluating the place of ornaments in prehistoric societies and economies and the conclusions that can be drawn from the presence of specific ornaments at specific sites. Both low-modification and high-modification ornaments can be made on locally available materials or exotic materials. In this instance, the term "exotic" is used for both rare materials and materials acquired at a distance; in both cases, a relatively high level of investment is required in acquisition. Of course, many factors such as subsistence economies, patterns of mobility and landscape-use, and broader strategies of raw-material procurement and use, but a general model based on technological investment and acquisition-cost groups

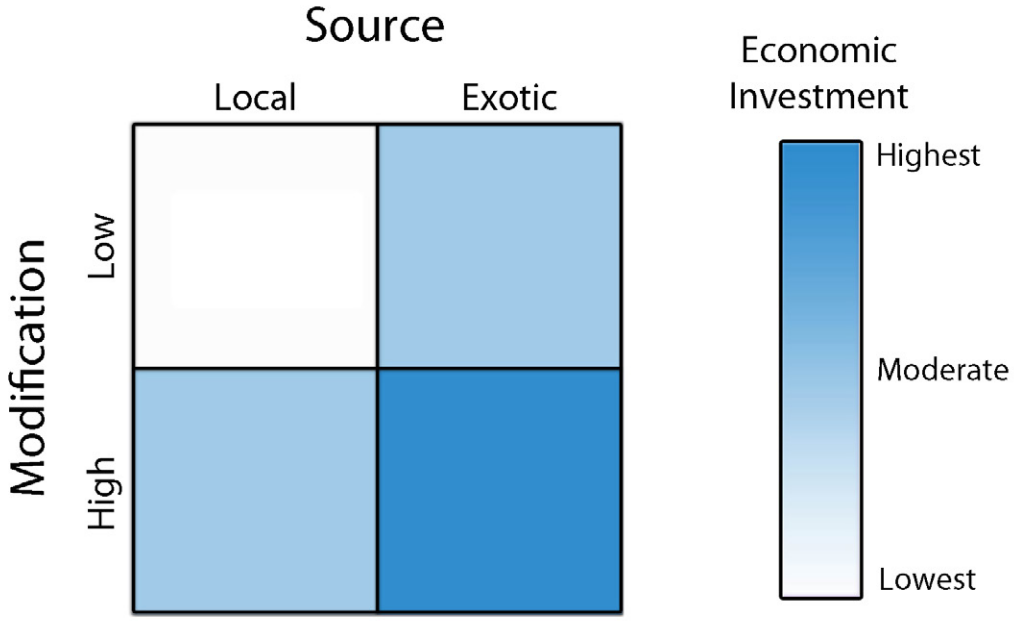


Figure 2. A schematic representation of the four primary types of beads in the Upper Palaeolithic, according to the levels of economic and technical investment they represent as discussed in text

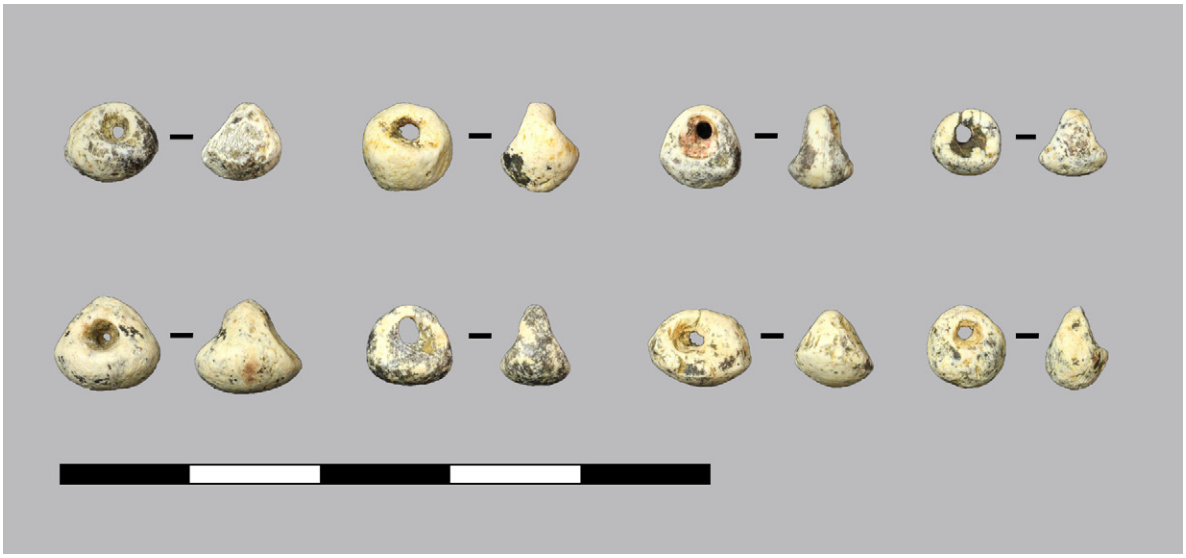
ornaments into four different types that evidence varying levels of economic investment in artefacts of adornment (Fig. 2):

1. Low-modification ornaments on local materials, a low level of technological investment, low acquisition-cost (ex: a perforated *Littorina* shell at a coastal site);
2. Low-modification ornaments on exotic raw materials (ex: a perforated *Littorina* shell 300 km from the nearest coast);
3. High-modification ornaments on local raw materials (ex: a talc bead in an area close to recognized talc sources);
4. High-modification ornaments on exotic raw materials (ex: a talc bead far from any known talc sources).

Prior to the Aurignacian[1], the vast majority of personal ornaments were low-modification ornaments on locally available materials (*Nassarius sp.* shells) (*e.g.* McBrearty/Brooks, 2000; D'Errico *et al.*, 2005; Vanhaeren *et al.*, 2006). This pattern actually holds true for much of the Aurignacian as well: with the exception of a few sites in geographically limited areas, assemblages of unambiguously Aurignacian ornaments are small (≤6) and composed almost exclusively of low-modification ornaments on locally abundant raw materials (Heckel, in press). A small number of sites in Aquitaine, the Swabian Jura, and Belgium (Kozlowski/Otte, 2000) stand out as exceptions, with large numbers of ornaments, both high-modification and low-modification, from sources both local and distant. As we will demonstrate here, these objects circulated in very different contexts of mobility and circulation in the Aurignacian.

AURIGNACIAN ORNAMENTS IN AQUITAINE AND THE SWABIAN JURA

Aquitaine and the Swabian Jura are among the few regions in which substantial numbers of ornaments have been recovered from Aurignacian contexts, and in each of these regions, a distinct type of ivory bead predominates. In Aquitaine, it is the French variant of the basket-shaped bead (*perle en forme de panier*); in the Swabian Jura, it is the double-perforated bead (*doppelt durchlochte Perle*) that dominates, though several other, less frequent, types have been defined (Wolf, 2015; Wolf/Heckel, 2018). These beads are very different in their final forms (Fig. 3 & 4), but share a broadly similar production sequence beginning with elongated ivory preforms cut in segments, then individually shaped into beads (Fig. 5).



Examples of ivory basket-shaped beads of the French style Aurignacian deposits at the site of Brassempouy (Landes, France). Scale subdivision in cm. Photos, Cl. Heckel.

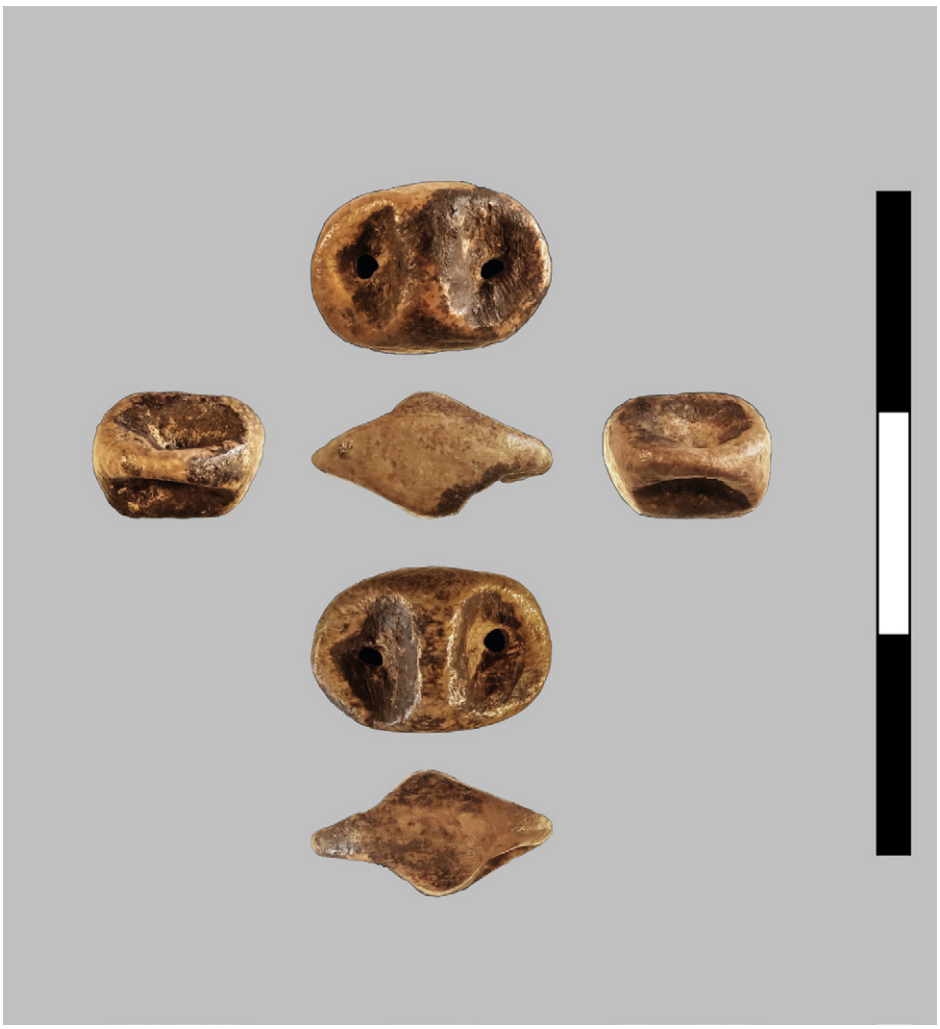


Figure 4. Double - perforated beads from Vogelherd Cave, Inv.nr. VH 43/67_82.1, all views (Swabian Jura). Scale subdivision in cm. Photos, S. Wolf.

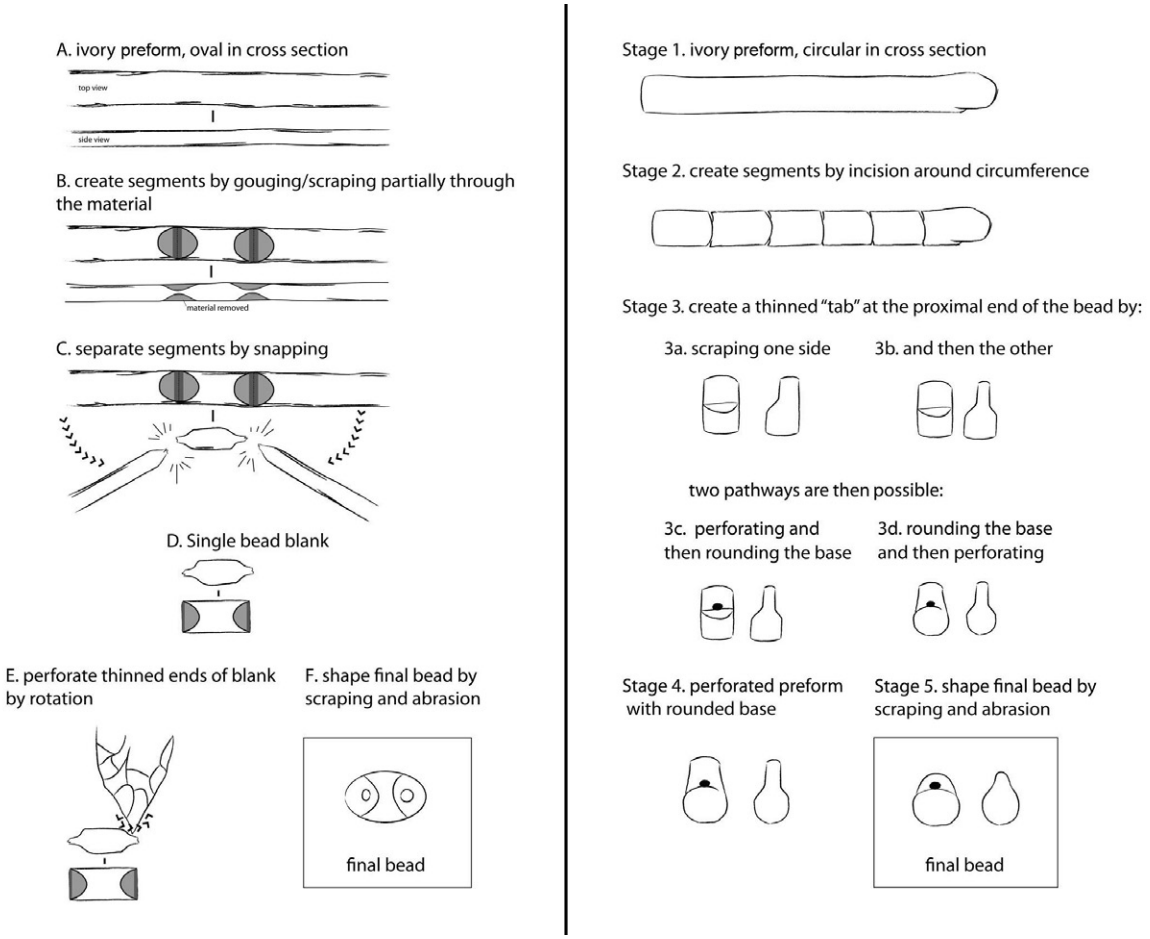


Figure 5. Schematic illustration of the production sequences for (left) double-perforated beads (Swabian Jura) and (right) French basket-shaped beads (Aquitaine). Both sequences begin with an elongated ivory preform that is cut in segments individually shaped into beads. Variations on this basic production scheme have occurred in both regions. Redrawn by Cl. Heckel after Hahn (1992) and White (1992) respectively.

Given the density of sites that have yielded Aurignacian deposits in Aquitaine, this discussion is limited to sites at which more than ten ornaments can be securely attributed to the Aurignacian: Abri Castanet, Abri Blanchard, and Abri de La Souquette in the Castel-Merle *vallon* (Dordogne), Grotte des Hyènes at Brassempouy (Landes), and Grotte d'Isturitz (Pyrénées-Atlantiques). With the exception of these sites, most of the Aurignacian assemblages in Aquitaine have yielded only small (fewer than a dozen) assemblages of low-modification ornaments on local raw materials, many of which have questionable Aurignacian association (see Heckel, in press). In the Swabian Jura, several caves have Aurignacian assemblages that include ornaments: Hohle Fels, Geißenklösterle, and Sirgenstein (Ach Valley), and Vogelherd, Hohlenstein-Stadel, and Bockstein-Törle (Lone Valley). Among these, only Hohle Fels and Vogelherd have yielded large numbers of Aurignacian ornaments (Tabl. 1).

Issues of preservation and recovery bias must be considered in any archaeological discussion but they are especially significant with regard to objects such as beads that are frequently less than one centimeter in largest dimension. It is only with meticulous water-screening of archaeological sediments that such artefacts are systematically recovered, and the methods of excavation must be considered when assessing the presence/absence of particular ornament types in Aurignacian assemblages. Conditions of excavation and recovery should be explicitly addressed in any discussion of ornament assemblages, especially those that hinge on inter-site and inter-assemblage comparison. Sites in this paper that have benefitted

Site	Known Excavations	References	Ornaments
France			
Abri Blanchard	Castanet (1909), Didon/Castanet (1910-1911), White (2011-2012)	Didon, 1911; White, 1989	134 beads and 50 bead-production stages in ivory and talc
Abri Castanet	Peyrony/Castanet (1911-1913; 1924-1925) White/Pelegrin (1995-1998), White (2005-2011)	Peyrony, 1935; White, 1989; White *et al*., 2012	278 beads and bead-production stages in ivory and talc
Abri de la Souquette	Landesque (1902-1903), Hauser (1910), Castanet*(1919-?), Roussot (1980-1982)	Roussot , 1982; White, 1989	434 beads and bead-production stages in ivory and talc
Brassempouy	Dubalen (1880-1881), Laporterie/Dufour (1891-1892), Piette/Laporterie (1894-1897), Delporte/Buisson (1981-1994); Buisson (1995-1996); Henry-Gambier/Bon (1997-2002)	Dubalen, 1881; Piette & Laporterie, 1897; Delporte, 1985; Henry-Gambier *et al*., 2004	96 beads and bead-production stages in ivory and talc
Isturitz	Passemard (1913-1922); R./S. de Saint-Périer (1928-1959, discontinuous); Normand/Turc (1995-1998); Normand (1999-	Passemard, 1944; R. & S. de Saint-Périer de Poilloüe, 1952; Normand, 2005; Normand *et al*.,	69 beads and bead-production stages in ivory and talc
Germany			
Geißenklösterle	Hahn (1974-1983, 1986-1993); Conard (2001-2002)	Hahn, 1988; Conard & Malina, 2002 & 2003	15 beads and bead-production stages in ivory
Hohle Fels	Fraas (1870/71); Matschak/Riek (1958-1960); Hahn (1977-1979, 1987-1996); Conard (1997-ongoing)	*eg.* Conard, 2002 & 2009; Wolf, 2015	217 beads and bead-production stages in ivory
Vogelherd	Riek (1931); Conard (2005-2012)	Riek, 1934; *e.g*. Conard *et al*., 2007 & 2010; Kind, 2013; Wolf, 2015	345 beads and bead-production stages in ivory

Table 1. Excavation histories and key publications of the sites discussed here.

from thorough excavations methods such as piece-plotting and water-screening are: in France, Abri Castanet, Grotte des Hyènes (Brassempouy), Isturitz; and in Germany, Hohle Fels, and Geißenklösterle.

Though Abri Castanet, Abri Blanchard, and Abri de La Souquette were excavated at the turn of the twentieth century, amateur excavator Marcel Castanet was assiduous in his efforts to recover beads and traces of bead-production by screening sediments in the winter that he and others had excavated in the summer. He recovered hundreds of examples of basket-shaped beads along with perforated teeth and shells. At Vogelherd Cave, the enormous volume of sediment removed from the cave over twelve weeks in 1931 (Riek, 1934) have been recently re-excavated and meticulously sieved and sorted from 2006 to 2016. The analysis is ongoing. In these cases, some ornaments are typologically exclusive to the Aurignacian, and can be securely attributed to the Aurignacian occupations at the site. Other ornaments, such as perforated shells and teeth, are common throughout the Upper Palaeolithic and may derive from deposits overlying the Aurignacian at this site, although it is not very likely (Schürch *et al*., 2021 & 2023).

Aquitaine short-term expansion of regional networks

The Aurignacian record in Aquitaine includes the Protoaurignacian, the Early Aurignacian, and the Recent Aurignacian. Within this sequence, a drastic intensification of investment in personal ornaments appears in the Early Aurignacian, along with a suite of related phenomena (Heckel, 2021):

1. Increased intensity of occupation at the site and regional scale;
2. Regular long-distance circulation of lithic raw materials;
3. Highly regimented and standardized system of osseous tool production with procurement of raw materials outside of subsistence activities;
4. Other forms of symbolic material culture, such as engravings and paintings on cave walls and limestone blocks and musical instruments.

Though the low precision of radiocarbon dating in the Early Aurignacian (Appendix) makes precise inter-site chronologies difficult to establish, there is ever-increasing evidence that the Early Aurignacian as defined by these characteristics was a relatively short-lived phenomenon (Fig. 6). During this time, the large assemblages of Aurignacian ornaments in Aquitaine (including but not limited to basket-shaped ivory and soapstone beads) circulated in regional networks of mobility and exchange that covered a territory of several thousand square kilometers.

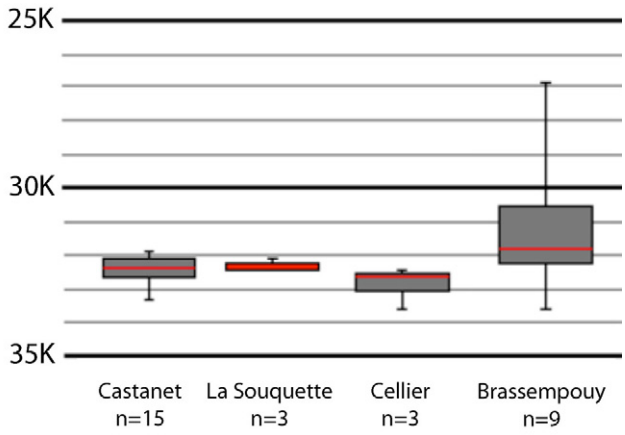


Figure 6. Boxplots of uncalibrated radiocarbon dates (in ka) from Early Aurignacian deposits in Aquitaine, showing relative contemporaneity (see Appendix 1 for details).

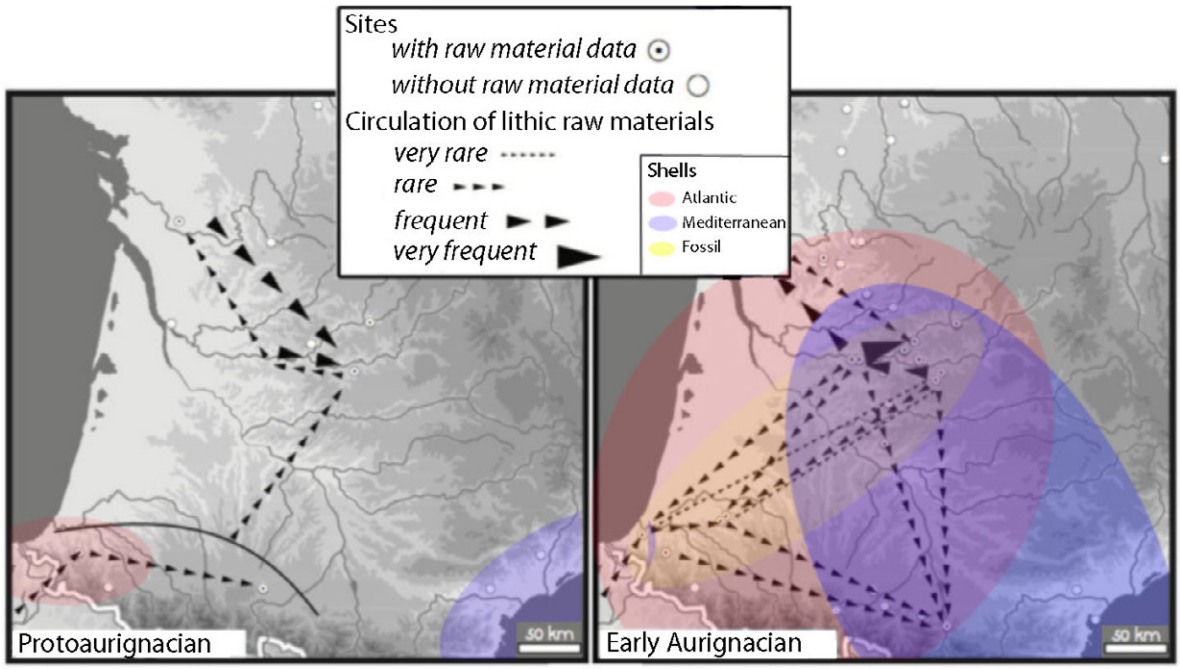


Figure 7. Patterns of lithic raw material circulation (arrows) and shell circulation (red, yellow, and blue circles) in the Protoaurignacian and Early Aurignacian of the core study area. Modified from Soulier (2013), with areas of shell distribution added.

In southwestern France, though some questions remain regarding the precise relationship between the Protoaurignacian and the Early Aurignacian, several differences can be seen that are directly relevant to the issues of adornment and mobility (see Anderson *et al*., 2015). The initial *Homo sapiens* expansion into southwestern France is represented by the Protoaurignacian, which is also characterized by high levels of mobility, approaches to technology and subsistence that favor flexibility and adaptability, and a generalized and opportunistic exploitation of osseous materials (Tejero, 2014). Long-distance (>130 km and even up to 200-300 km) transport of raw materials is documented, but rare. Though ornaments are relatively abundant at some sites, they are almost exclusively low-modification ornaments on local raw materials (Heckel, 2020 & 2021).

In comparison, the Early Aurignacian record in the same region shows greater intensity of occupation both in terms of the number of sites and the duration (or repetition) of occupation and greater evidence for longer-term seasonal occupation of sites built around

the exploitation of specific prey species (notably reindeer). There is a long tradition of studying the mobility and economies of Palaeolithic populations through the movement and use of lithic raw materials and many of these studies have focused on the Aurignacian of southwestern France (Blades, 1999a/b & 2001; Bon, 2002; Féblot-Augustins, 1993; Geneste, 1991; Morala, 1990). There is a general and pronounced expansion in the movement of lithic raw materials and of shells (Taborin, 1993), the latter exclusively for use as objects of adornment (Fig. 7). Among the stone materials that circulated from near the Pyrenees is talc for the manufacture of beads. Dordogne and specifically the sites in the Castel-Merle complex appear to be central locations in this network, which extends in a limited sense to the north of Dordogne, but primarily connects sites in the foothills of the Pyrenees to sites along the Garonne and Dordogne Rivers and their tributaries. This area of circulation is bounded to the south by the Pyrenees, to the west by the Atlantic, and to the east by the Massif Central. It is within this economic and social network that Early Aurignacian ornaments in Aquitaine circulated, and their manufacture at inland sites could have been a technological solution to the scarcity of shells at the inland sites. The standardized morphology of basket-shaped beads and differences in the distribution of production debris support a model of centralized production of basket-shaped beads at the Castel-Merle site complex (Heckel, 2016 & 2018). Within this system of circulation, clear local patterns of preference can be seen in the use of animal teeth, with the species used at Isturitz differing from those "preferred" at Brassempouy for example, though both have yielded basket-shaped beads likely to have come from Dordogne and shells from the Atlantic Coast (White, 2007).

The sheer number of shells at the inland sites is also striking and indicative of the circulation of ornaments in substantial numbers (Fig. 8). For instance, the Protoaurignacian and Early Aurignacian assemblages at the coastal site of Riparo Mochi, renowned for its ornamental assemblages, yielded 52 and 37 ornamental shells, respectively (Stiner, 1999). The Early Aurignacian layers at Abri Castanet and Abri Blanchard have yielded 93 and 60 ornamental shells, respectively (White, 1989). These patterns require further examination, but hint at a complex system of representation in which the production and use of beads was subject to both local variations and substantial exchange at the regional scale.

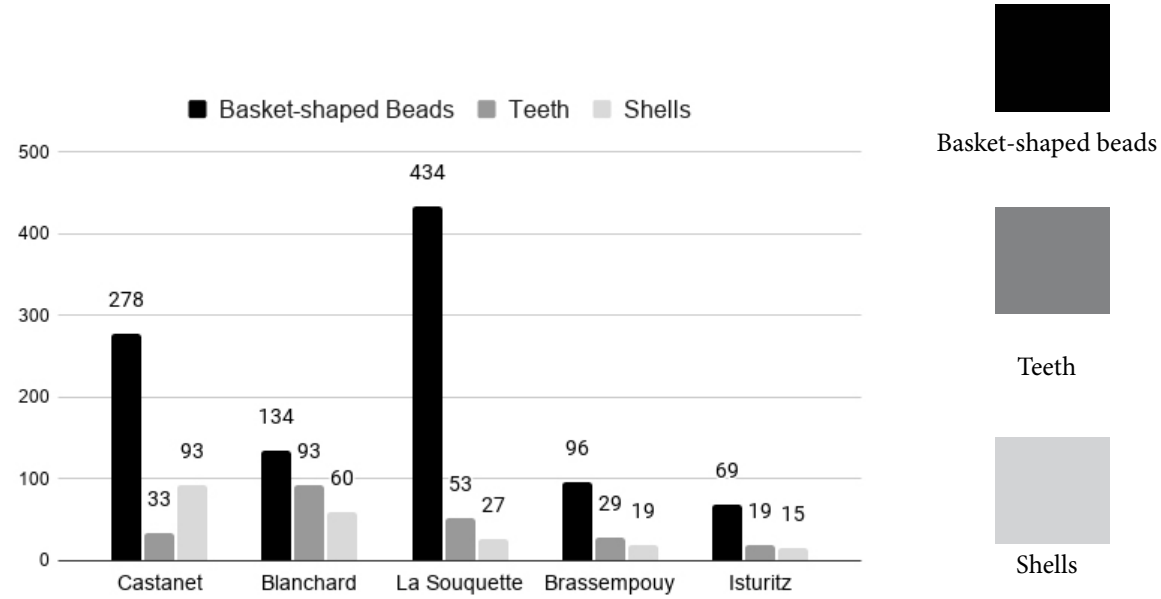


Figure 8. Overall quantities in number of pieces (NR=1401) from Early Aurignacian deposits in Aquitaine. Teeth and shells from La Souquette are not definitively associated with the Early Aurignacian (White, 1992 & 2007; Heckel, in press).

The production of basket-shaped beads also occurred within a specific technological context. Early Aurignacian approaches to osseous industry in southwestern France is defined by the procurement of certain materials (antler and ivory) outside of subsistence practices, and the systematic use of specific materials to specific ends: ribs and long bones for hide-working tools, antler for projectile points, ivory for beads (Liolios, 1999 & 2006; Tartar *et al*., 2006; Tejero, 2014). A similar logic can be seen in the production of split-based antler points and ivory beads: cylindrical preforms are produced from ivory or antler beams by circumincision and rough-outs are shaped by scraping with stone tools; final forms are regularized by grinding and abrasion. When framed in this technological system, the production of high-modification beads is an innovation with a clear basis in broader approaches to production organization and the exploitation of osseous materials.

The Swabian Jura: long-term local traditions

At sites in the Swabian Jura that have both Middle Palaeolithic and Aurignacian deposits, there is a clear occupational hiatus between the Middle Palaeolithic and the Aurignacian indicated by layers that are archaeologically nearly sterile. By currently available dates, the earliest Aurignacian assemblages of the Swabian Jura are roughly contemporaneous with Protoaurignacian occupations in southwestern France (Higham *et al*., 2012; Szmidt *et al*., 2010). In contrast to the record in France, though, there seems to be greater continuity over a longer period of time in the Aurignacian of the Swabian Jura, and this includes the symbolic material culture. The production of ivory beads, especially the dominant double-perforated bead, seems to begin earlier and last longer than production of the ivory and talc basket-shaped beads in France. As in Aquitaine, though, bead-production in the Swabian Jura occurs within a system of:

1. Increased intensity of occupation at the site and regional scale, compared to preceding periods;
2. Highly developed system of osseous tool production with procurement of raw materials outside of subsistence activities;
3. Other forms of symbolic material culture, such as ivory figurines and musical instruments.

There is little evidence, though, for sustained long-distance contacts and circulation. Indeed, both the sculptures and the ornaments of the Ach and Lone Valleys seem to indicate a shared set of traditions (and likely of ideologies) that existed in the region for perhaps several thousands of years (Conard, 2009; Conard/Bolus, 2003 & 2008; Dutkiewicz *et al*., 2018; Wolf *et al*., 2013).

Because of the issues of chronological resolution for the Aurignacian period, it is difficult to establish inter-site patterns of habitation that can be compared at a fine scale. However, the quantity of archaeological materials in the Aurignacian deposits in these valleys indicates both intensive occupation and intensive exploitation of ivory during occupation (Wolf, 2015). The thickness of the Aurignacian deposits and the ranges of the radiocarbon dates (Fig. 9), especially the recent AMS dates for Geißenklösterle Cave both support a model of extended occupation of the Lone and Ach Valleys and of relative cultural stability in terms of symbolic material culture, in both ivory beads and the animal and human figurines that show similarities in both subject matter and execution. Regarding change over time, classically Aurignacian osseous artefacts like split-based points, as well as the double-perforated beads, are present in the earliest phase, represented by the Lower Aurignacian of Geißenklösterle (Conard/Bolus, 2006; Kitagawa/Conard, 2020; Wolf, 2015).

Indeed, beads in general are scarce at Geißenklösterle, with 3 ivory beads in the Lower Aurignacian layers and 10 double-perforated beads in ivory in the Upper Aurignacian layers. At Hohle Fels Cave, which thus far provides the most extensively documented stratigraphic sequence, Aurignacian layers IV and V indicate more intensive ivory working and more intensive occupation in general than later Aurignacian layers, and all elements of the Swabian

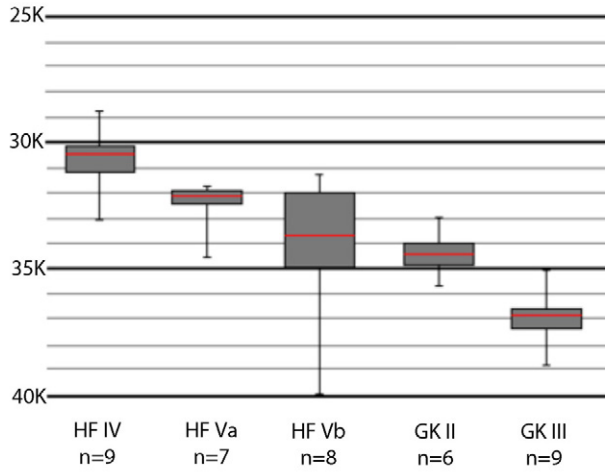


Figure 9. Uncalibrated dates for Aurignacian levels (in ka) in the Swabian Jura (HV-Hohle Fels, GK-Geißenklösterle) that show extended sequences of occupation (see Appendix 2 for details).

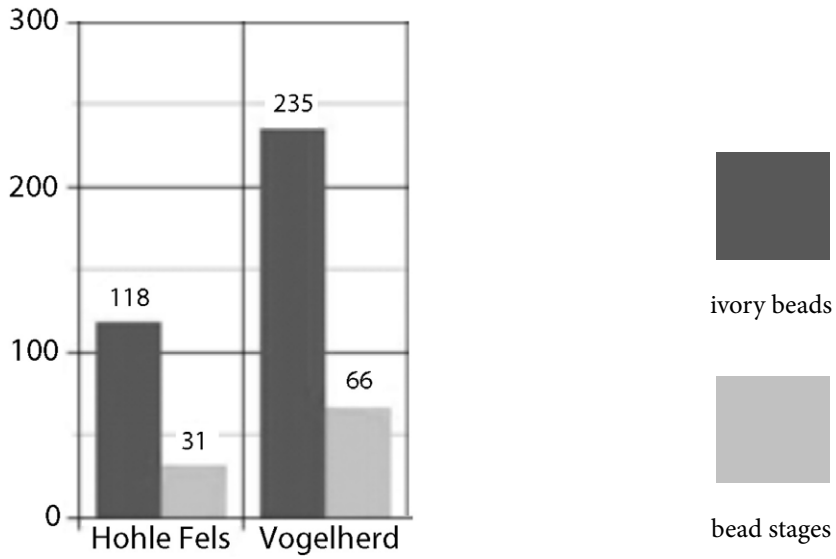


Figure 10. Overall quantities in number of defined bead types (NR=450) at Hohle Fels and Vogelherd. Ongoing recovery at Vogelherd and Hohle Fels may increase these numbers.

Aurignacian ivory industry (beads, flute fragments, figurines) are present from the basal Aurignacian Layer V (Wolf, 2015). By far the largest assemblages of Aurignacian beads have come from Hohle Fels in the Ach Valley and Vogelherd in the Lone Valley (Fig. 10). There are differences that can be seen in the approach to producing beads at Vogelherd and Hohle Fels that could be due to chronology or spatial difference (two different groups). Because the beads and bead stages from Vogelherd have only recently been recovered from the water-screening of Riek's backdirt, analyses are ongoing. And, while these subtle differences may indicate changes over time or differences in technique between two sub-groups, the overall pattern of shared local conventions over a long period of time holds true.

In the Swabian Jura, the longest proven distance to a source of raw material is the Alzeyer area, which is about 300 km away. Fossil *Glycymeris* shells come from there and were brought to Vogelherd Cave (Schürch *et al.*, 2021 & 2023). The lithic raw material circulation provides some evidence of long-distance mobility or contacts as well (*e.g.* Burkert/Floss, 2005; Floss/Kieselbach, 2004; Çep 2013; Herkert *et al.*, 2015). An example is the presence

of the "Plattenhornstein" stone at Vogelherd Cave, for which the closest known source is in Bavaria, 130 km away. Generally, though, 80%-90% of the lithic material is the local "Jurahornstein," with sources around 3-5 km from the sites (Çep, 2013). This does not mean that the Aurignacians of the Swabian Jura were not mobile, but that their mobility was probably more limited geographically, with less contact with groups living further away. It is possible that the territory of the two valleys was frequented by the same group of people or by several closely related groups who used the caves as alternate occupations. It is also conceivable that several small groups inhabited the caves in the Ach and Lone Valleys at the same time and they shared a similar material culture and frequent contacts. In terms of ornaments, there are no shell ornaments known in the Aurignacian assemblages, though some do exist in the Gravettian layers. Ornaments are abundant but are produced with few exceptions on ivory, which was apparently locally available in large quantities from the surroundings.

The Swabian Aurignacian also has a highly developed osseous industry, with bone and antler artefacts that are produced through complex, multi-stage processes (Wolf *et al*., 2016). Within this osseous industry, ivory is much more widely used than in the Aurignacian of southwestern France. This is a phenomenon that may be related to the relative abundance of ivory in the Swabian Jura when compared to the Aquitaine Basin (Heckel *et al*., 2015) where Aurignacian sites have traditionally provided large pieces of ivory recovered as type-fossils (*fossiles directeurs*) of the classic Early Aurignacian (*e.g.* David *et al*., 2014:Appendix). Ivory appears to be the "preferred" material for the osseous tools in the Aurignacian of Hohle Fels (Wolf, 2015). Antler is the used material for split-based points, probably for reasons of mechanical properties, but massive-based projectile points occur in bone, antler, and ivory (Wolf *et al*., 2016). The detailed study of osseous industry at Vogelherd is under way based on new materials from water-screening.

CONLUSIONS: ORNAMENTS AND MOBILITY IN THE AURIGNACIAN

This contextualized approach to Aurignacian ornaments underscores "how little chance there is of understanding the material culture of any society by studying just a few artefacts, or, worse, by studying artefacts of just a single type" (Lemonnier, 1992:9). High-modification ornaments seem to emerge at inland sites with sophisticated osseous industries and relatively high technical investment in symbolic material culture (either paintings/engravings or sculptures). They are products of populations that were comparatively dense and not highly mobile, and also occur with highly developed osseous industries. Current evidence suggests that both the rock shelters of Dordogne and the caves of the Lone and Ach valleys were occupied during colder seasons, and the exceptional density of archaeological materials at these sites indicate both intensive occupation and intensive technical activities.

In the context of the Early Aurignacian of Aquitaine, ornaments were part of a regional expansion in exchange and mobility that is evidenced by the circulation of shells from the coasts toward the interior, and the circulation of ivory beads in the opposite sense. These are the same patterns supported by the well-documented circulation of lithic raw materials. As the chronological sequence of the area becomes more and more refined, there is increasing evidence that the Early Aurignacian and these networks of exchange were part of a relatively short-lived phenomenon of intensified occupation defined by sustained regional networks of mobility and exchange. In the Swabian Jura, beads and figurines in ivory appear almost with the onset of the Aurignacian and last with great continuity through most of the Swabian Aurignacian. In fact, it is the elements of symbolic material culture that display the most continuity over time, while greater variation is seen in the morphology of tools like ivory points (Wolf 2015; Wolf *et al*., 2016). These observations are supported by data on lithic raw materials in indicating stable and consistent occupation of the region by a group or groups who shared aesthetic conventions that were probably based in shared identities and ideologies.

New evidence on Aurignacian economies, seasonality, mobility, and chronology is constantly emerging, and models for the mobility and behaviors of these populations will evolve along with the quality and quantity of our data. At present, we have been able to identify some important similarities and differences in two of the key contexts of Aurignacian ornament production and use. We have also highlighted that, although ornaments can be highly useful in reconstructing patterns of mobility and circulation, specific types of ornaments do not indicate specific patterns of mobility, which must be constructed with reference to larger archaeological contexts and multiple lines of data.

NOTE

[1] It should be noted that the production of higher-modification ornaments predates the Aurignacian, with examples of ostrich eggshell beads known from Africa as early as 50,000 BP (Miller/Willoughby, 2014).

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RÉSUMÉ

LA CIRCULATION DES PARURES DANS LES CONTEXTES AURIGNACIENS

*Nous présentons ici une brève comparaison des assemblages de parures du Paléolithique supérieur ancien provenant des régions du Jura souabe et d'Aquitaine, suivie d'une discussion sur les implications que ces ornements suggèrent pour traiter des questions de contacts culturels, de contextes de circulation et de réseaux d'échange au Paléolithique supérieur ancien et plus récent. Parmi les objets fabriqués en matières dures d'origine animale, les ornements personnels sont particulièrement signifiants pour traiter des questions de contact, de circulation et d'échange. Les perles en coquillage et en ivoire en Aquitaine et celles en ivoire du Jura souabe permettent d'évoquer un certain nombre d'idées et de défis liés à ces problématiques à partir des assemblages laissés par les premières populations d'*Homo sapiens *qui ont occupé ces régions à l'Aurignacien. Bien que de morphologies différentes, les petites perles d'ivoire standardisées retrouvées dans chacune de ces aires géographiques présentent*

des schémas de fabrication étonnamment similaires qui soulèvent la délicate question de l'origine de cette différentiation technique dans l'Aurignacien. De l'examen attentif de ces assemblages et de leurs contextes de production et d'utilisation, des indices suggèrent ici qu'une distinction des modalités de circulation de ces parures fait écho à la divergence déjà reconnue des schémas de production : alors que les perles « en panier » auraient circulé brièvement au sein d'un réseau d'échange plutôt étendu à l'échelle de toute l'Aquitaine, leurs semblables « à double perforation » dans le Jura souabe auraient, quant à elles, fait l'objet d'une utilisation sur une durée beaucoup longue mais cependant restreinte à cette zone géographique moins vaste. Ces similitudes et différences dans l'utilisation des ornements par les sociétés aurignaciennes dont les assemblages semblent contemporains indiquent des mécanismes, tels qu'impliqués ainsi dans des réalisations d'ornements personnels différents, à la fois complexes et variables dès le début du Paléolithique supérieur en Europe.

Sites/Layers	Dates (BP)	Lab. codes	References
Castanet	32350±450	OxA-21558	White et al. 2012
Castanet	33250±500	OxA-21559	White et al. 2012
Castanet	32800±450	OxA-21560	White et al. 2012
Castanet	32050±450	OxA-21561	White et al. 2012
Castanet	32550±450	OxA-21562	White et al. 2012
Castanet	32600±450	OxA-21563	White et al. 2012
Castanet	32950±500	OxA-21564	White et al. 2012
Castanet	32550±600	OxA-21566	White et al. 2012
Castanet	32900±500	OxA-21639	White et al. 2012
Castanet	31900±450	OxA-21640	White et al. 2012
Castanet	31950±450	OXA-21641	White et al. 2012
Castanet	32500±450	OxA-21642	White et al. 2012
Castanet	32200±450	OxA-21643	White et al. 2012
Castanet	32350±450	OxA-21644	White et al. 2012
Castanet	32000±450	OxA-21645	White et al. 2012
La Souquette	32400±550	OxA-X2627-47	O'Hara et al., 2015
La Souquette	32400±500	OxA-32198	O'Hara et al., 2015
La Souquette	32150±450	OxA-32199	O'Hara et al., 2015
Cellier	32650±500	OxA-32201	White et al. 2018
Cellier	32450±450	OxA-32203	White et al. 2018
Cellier	33600±550	OxA-32204	White et al. 2018
Brassempouy	30600±200	GIF-9658	Henry-Gambier et al., 2004
Brassempouy	31280±550	GIF-8568	Henry-Gambier et al., 2004
Brassempouy	32190±620	GIF-8174	Henry-Gambier et al., 2004
Brassempouy	31690±780	GIF-8569	Henry-Gambier et al., 2004
Brassempouy	31960±160	GIF/LSM-11305	Henry-Gambier et al., 2004
Brassempouy	26870±500	GIF-9032	Henry-Gambier et al., 2004
Brassempouy	30100±400	GIF-9031	Henry-Gambier et al., 2004
Brassempouy	32410±240	GifA-98105	Henry-Gambier et al., 2004
Brassempouy	33600±240	GIF/LSM-11304	Henry-Gambier et al., 2004

Appendix 1. Uncalibrated radiocarbon dates discussed in the text for French sites.

Sites/Layers	Dates (BP)	Lab. codes	References
Hohle Fels IV	28750±750	OxA-4980	Conard 2009
Hohle Fels IV	30040±210	KIA-32057	Conard 2009
Hohle Fels IV	30110±215	KIA-32060	Conard 2009
Hohle Fels IV	30420±220	KIA-32058	Conard 2009
Hohle Fels IV	30640±245	KIA-32059	Conard 2009
Hohle Fels IV	31100±600	OxA-4600	Conard 2009
Hohle Fels IV	31160±1400	KIA-18879	Conard 2009
Hohle Fels IV	32470±275	KIA-16037	Conard 2009
Hohle Fels IV	33090±255	KIA-16036	Conard 2009
Hohle Fels Va	31750±260	KIA-35464	Conard 2009
Hohle Fels Va	32030±275	KIA-35463	Conard 2009
Hohle Fels Va	32090±345	KIA-35462	Conard 2009
Hohle Fels Va	32370±275	KIA-35460	Conard 2009
Hohle Fels Va	32550±295	KIA-35459	Conard 2009
Hohle Fels Va	31760±200	OxA-19783	Conard 2009
Hohle Fels Va	34570±260	OxA-19859	Conard 2009
Hohle Fels Vb	31290±180	OxA-19860	Conard 2009
Hohle Fels Vb	31380±180	OxA-19780	Conard 2009
Hohle Fels Vb	34720±280	OxA-19779	Conard 2009
Hohle Fels Vb	32140±310	OxA-19782	Conard 2009
Hohle Fels Vb	33290±270	KIA-16035	Conard 2009
Hohle Fels Vb	34190±335	KIA-18880	Conard 2009
Hohle Fels Vb	35710±350	KIA-16034	Conard 2009
Hohle Fels Vb	40000±500	OxA-19781	Conard 2009
Geißenklösterle II	35700±640	OxA-21737	Higham et al., 2012
Geißenklösterle II	33000±510	OxA-21656	Higham et al., 2012
Geißenklösterle II	34900±600	OxA-21738	Higham et al., 2012
Geißenklösterle II	34800±600	OxA-21742	Higham et al., 2012
Geißenklösterle II	34100±500	OxA-21727	Higham et al., 2012
Geißenklösterle II	33950±500	OxA-21724	Higham et al., 2012
Geißenklösterle III	37400±800	OxA-21725	Higham et al., 2012
Geißenklösterle III	35050±500	OxA-21695	Higham et al., 2012
Geißenklösterle III	36850±800	OxA-21744	Higham et al., 2012
Geißenklösterle III	36650±760	OxA-21745	Higham et al., 2012
Geißenklösterle III	36850±700	OxA-21746	Higham et al., 2012
Geißenklösterle III	38900±700	OxA-21722	Higham et al., 2012
Geißenklösterle III	36100±800	OxA-21743	Higham et al., 2012
Geißenklösterle III	37800±750	OxA-21723	Higham et al., 2012
Geißenklösterle III	37300±700	OxA-21721	Higham et al., 2012

Appendix 2. Uncalibrated radiocarbon dates discussed in the text for German sites.

THE NOMADISM CYCLE OF RECENT PALAEOLITHIC SOCIETIES FROM REINDEER ANTLER ECONOMY

Laure Fontana
François-Xavier Chauvière

Abstract: *Circulation in mobile hunter-gatherer societies is particularly highlighted by the transport of resources, such as lithic and animal hard materials, and by seasonal occupations. Studying the annual cycle of nomadism is especially interesting in regions where the majority of used siliceous items is allochthonous, and where there are many faunal remains and used cervid antler materials to document seasonality and procurement/exploitation patterns. Regarding the Magdalenian societies of the Massif Central (France), the challenge of our on-going studies is to identify the patterns of reindeer antler acquisition and exploitation. The integration of data stemming from the zooarchaeological and technological analysis allows us to document such strategies on a local scale as an annual cycle of nomadism within a geographical area whose boundaries remain to be defined. This is demonstrated by the study of a northern Magdalenian site (Les Petits Guinards, Allier) that required a specific method of study of faunal and reindeer antler remains (raw material, waste debris, final products) that raised focused questions. It allowed us to identify procurement and exploitation patterns that support the rare data gathered at a few other sites. It revealed for the first time the transport of objects (more or less shaped) and even of (male) shed antler rough materials from manufacturing sites currently unknown which might be located in the northern source area of procurement of the allochthonous flint and occupied during the cold season in the Massif Central—winter occupation, however, have not yet been found in the Massif Central.*

Recent Palaeolithic, Reindeer, Antler, Resource procurement, Mobility, Territory

INTRODUCTION

If reconstructing the nomadic annual cycles is one of the main issues in the study of Palaeolithic and Mesolithic hunter-gatherer societies, our understanding makes slow progress despite more numerous and diverse data. Indeed, very little is known about nomadic annual cycles from the data relating to the origin of lithic materials, the provenance of certain artefacts, the movement of animals, the hunting seasons, and the manufacturing traditions. As a matter of fact, such a goal requires the integrated study of economic systems, human group mobility and settlement patterns, drawing on 1) a multi-scale approach, requiring at least two sets of information: local and regional; 2) a definition of the questions at issue; 3) a particular attention to the kind of remains (in terms of material and type) respectively used in relation to its possible contribution to the nomadic annual cycle. Far from being a truism, does such a procedure generally remain an aspiration given some problems inherent to the archaeological field: the representativeness of the studied sample at a site and of the regional data, variable amount and still insufficient data, a time-scale too large? The main obstacle seems rather associated with the following twofold problem: on the one hand, formulating the global issues precisely (on the territory scale), which is essential for a multidisciplinary investigation; and on the other, clarifying the type of information needed for each kind of remains on the local scale by clearly distinguishing between useful and useless data and, in this view, prioritizing information.

Within our current multidisciplinary research related to economic system and human group mobility during the Recent Palaeolithic period, we seek to understand how the exploitation of animal resources—through the study of faunal remains (food and technical products)—can contribute to reconstruct the nomadic annual cycle. Focused on the exploitation of reindeer (*Rangifer tarandus*) during the Late Pleniglacial in Western Europe, our research documents the particular interest of antler materials when analyzed as variable access resources to identify the annual organization of their procurement and exploitation on

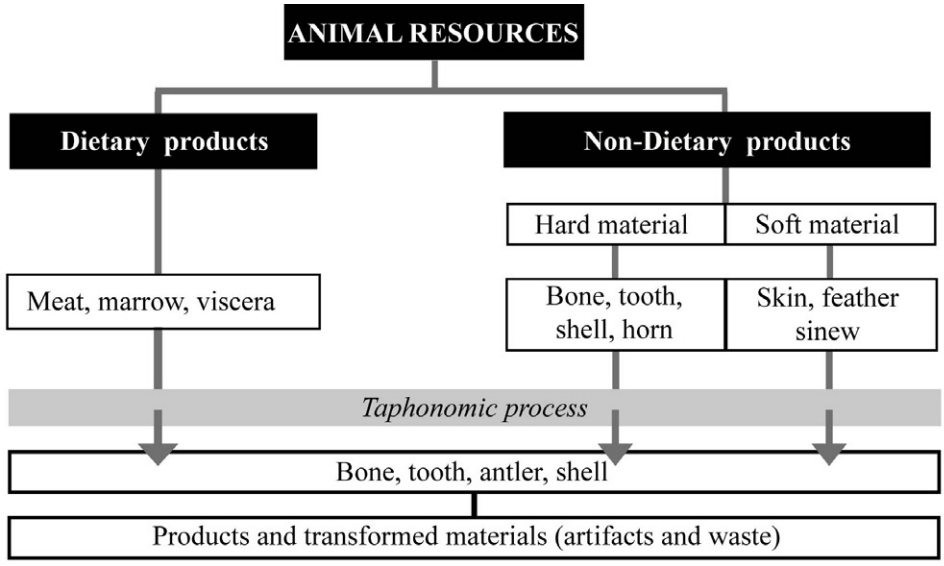

Figure 1. Animals as theoretically sourced and archaeological materials (revised after Fontana *et al.*, 2007:119/Fig. 1).

the local and regional scales. Our article presents various levels in the hierarchy of questions on reindeer antler procurement and exploitation and using examples of our preliminary results related to Magdalenian groups in the Massif Central.

Reconstructing reindeer antler economy in the annual cycle: issues and study scales

How did human groups travel and live in their territory and how were resources procurement and exploitation organized throughout the year? We focus here on the economy of reindeer antler because, during the Last Glacial in Western Europe, the economic system was based on this animal resource and the use of antler as raw material to produce weapons, tools and personal ornaments was significant. Considering this animal as a whole set of potential resources that were acquired for dietary regimes & non-dietary purposes (Fig. 1), these are studied within a global approach by integrating various informative sets of data having an initial questioning in common. With this in mind, the analysis of the archaeological material, —the reindeer as an animal game and as an animal providing the antler material—, may produce very different information as mobile, seasonal and portable or easy to collect. For instance, shed antler is a stationary but a seasonal resource; from it, the season of procurement can be suggested, but not the gathering location *ex nihilo* (if near the site or far from it, before or at the time of occupation). Reindeer antler as a mobile source represents a seasonal resource too, but the location procurement of the unshed antlers is automatically deduced from the study of the slaughtered animals *in situ*. It therefore appears that both sets of data required in the study are not quite equivalent; the implied seasonal and local versus non-local procurement possibly derives from analyzing the resource as a gathered raw material versus a processed animal species (introduced) on the site. One has thus to specify the study-scale to be used, — local rather than non-local or regional—, by formulating specific questions for reconstructing reindeer antler economy based on the known antler annual cycle from actualist studies of reindeer animal populations (*e.g.* Skoog, 1968; Bergerud, 1976). Some characteristics of the reindeer antler pertaining to certain cultural contexts and associated reconstruction of economic lines available for the lithic scales are used for the Palaeolithic, in particular the kind and the size of the antler material.

Antler economy: the territory scale

Our aim is to provide evidence of the annual organization of reindeer antler economy. It can be summed up with the following questions: what kind of antler materials were acquired

and exploited? How and where in the territory? When in the course of the year? How were they managed?

Regarding its procurement, we explore five sets of information (I to V), with the following questions:

I/ "What?" or the diversity of acquired antler

Were all types of antler acquired (shed/unshed, large/small module)? In similar amount? Or was one (or two) type (s) a priority? Are there any modules and sex ratio (from antler compared to bone) selected? Were only mature (never immature) antler (unshed) acquired?

II/ "How?" or the choice of one or two procurement strategies

What was the respective amount of collecting and hunting in the procurement? Quantification is the most significant problem caused by the general over-representation of beams and tines, since only the basal parts can be used to distinct shed from unshed antler anatomies.

III/ "When?" or the way procurement is spread out over the year

1) Did procurement take place many times throughout the year according to the antler annual cycle, meaning during its four episodes as unshed and shed (mature) materials (start and end of autumn for males, winter and spring for females)?

2) Was the procurement focused on one or two of these periods (maybe a single part of the year) documenting a choice in favor of one or two possible episodes?

IV/ "Where?" or the supply sources

1) Were there many gathering and hunting locations?

2) How were these distributed over the territory (distant, local)?

3) Were the antler raw materials always collected near the settlement sites or were some acquired from elsewhere or during a previous halt constituting the annual cycle of mobility?

V/ "Which way?" or the management of antler resources as a raw material

Was the antler used as raw material always acquired and subsequently transformed during the human occupation? Or was the amount of transported raw material important? This issue is essential in terms of nomadic annual cycle, when considering not only locations (procurement area, settlement site if not quite local storage facilities) but also time: were antler materials collected/recovered from carcasses in a small number of locations and moments of the year? This would involve 1) anticipating the transportation throughout the year from site to site of a certain amount of antler pieces, or 2) anticipation in transformation of most antler materials at a particular site (where acquired), some of which would later be taken away as by-products.

Regarding the antler exploitation, the questions concerning the nomadic annual cycle are focused on the local manufacture and the way the used antler material was spread out over the year: was the antler exploitation planned throughout the year and at how many sites? Or was it predominantly limited to only one or two episodes and specific sites? Was it practiced according to a local and episodic procurement? Moreover, we need to know if manufacturing was delayed in time or immediate and in which amount, and what was (if existed) the proportion and shape of transported antler items (by-products? preforms? tools?).

All these issues can be further addressed using the answers to other specific questions related to the site scale and, drawing from the analysis of antler, to other reindeer remains. To this purpose, an integrated study of faunal resources is essential to produce useful information.

Antler procurement and exploitation: the settlement-site scale

Prior to asking specific questions and then producing related data, we need to characterize the reindeer exploitation is on a local scale at each site:

Was the reindeer hunting important locally and when was the settlement site occupied?
Was this location a main antler procurement area and what kind of antler (type and module) was acquired?
Was this settlement a major manufacturing place?
Was it a place of significant use of reindeer antler artefacts?

The challenge of this issue, —identifying and quantifying specific human activities—, is to compare the sites of a particular region in order to provide evidence of a time span (annual) and space distribution of procurement, manufacturing and transport of antler as raw (rough complete or fragmented antler) or/and as worked materials (preformed, shaped, used and recycled antler products). Therefore, it is essential to measure the importance of the activities (manufacturing, gathering…) so that we create a hierarchy between them.

From our perspective, the study of each site is essential since its occupations not only reflect a position inside the annual cycle thanks to its characteristics (status) but also as it reveals what happened before and after the site was occupied. Thus, the exploitation (*sensu lato*) at a site for this key resource, —namely the reindeer antler—, is to be analyzed keeping in mind three aspects as following:

1. The site constituted a locale in the territory where antler industry was manufactured partially (the antler was prepared as blank-products, involved in debitage, pre-shaping…) or totally (until the antler is discarded once shaped as a used material object, including all its maintenance and recycling sequences);
2. The manufacturing relied on the procurement of antler material that was acquired during the site occupation (hunting/collecting) or/and before (for those antler materials that were brought onto the locale from a procurement area or another site previously occupied);
3. The manufactured and used artefacts were either discarded at the site or carried away at the end of the duration stay, and also, only part or all of these were brought onto the site.

To answer the questions mentioned above, further issues regarding the faunal remains have to be raised:

What kind of antler was <u>acquired</u> around the site (type and module)?
What was <u>introduced</u> to the site and in which form?
What was <u>manufactured</u> on the site and from what kind of antler material?
What was <u>abandoned</u> on the site and what are the items manufactured on the site?
What was <u>transported</u> out of the site and in which form?

Since there would be many possible scenarios involved in the reconstruction of an annual cycle of nomadism for the Upper Palaeolithic based on reindeer subsistence strategies (Fig. 2), we aim at providing evidence of how the procurement and exploitation of reindeer antler were organized on a site by studying the antler not only as a specific material but also in its relation to all of the reindeer remains and for which four main sets of data are examined:

1. The amount of reindeer remains;
2. The hunting seasons involved (not only reindeer);
3. The amount and types of items identified as raw material and the corresponding production on the site;
4. The seasons of antler procurement (if possible).

Therefore, we present below how we have already used these data sets.

The local scale: the antler exploitation at Les Petits Guinards

The Magdalenian annual cycle in the French Massif Central

Since we started investigating the economic system and the nomadism of hunter-gatherers who were living in the Massif Central during the Gravettian and the Magdalenian between 28,000 and 13,000 calBP, several studies related to the reconstruction of the annual

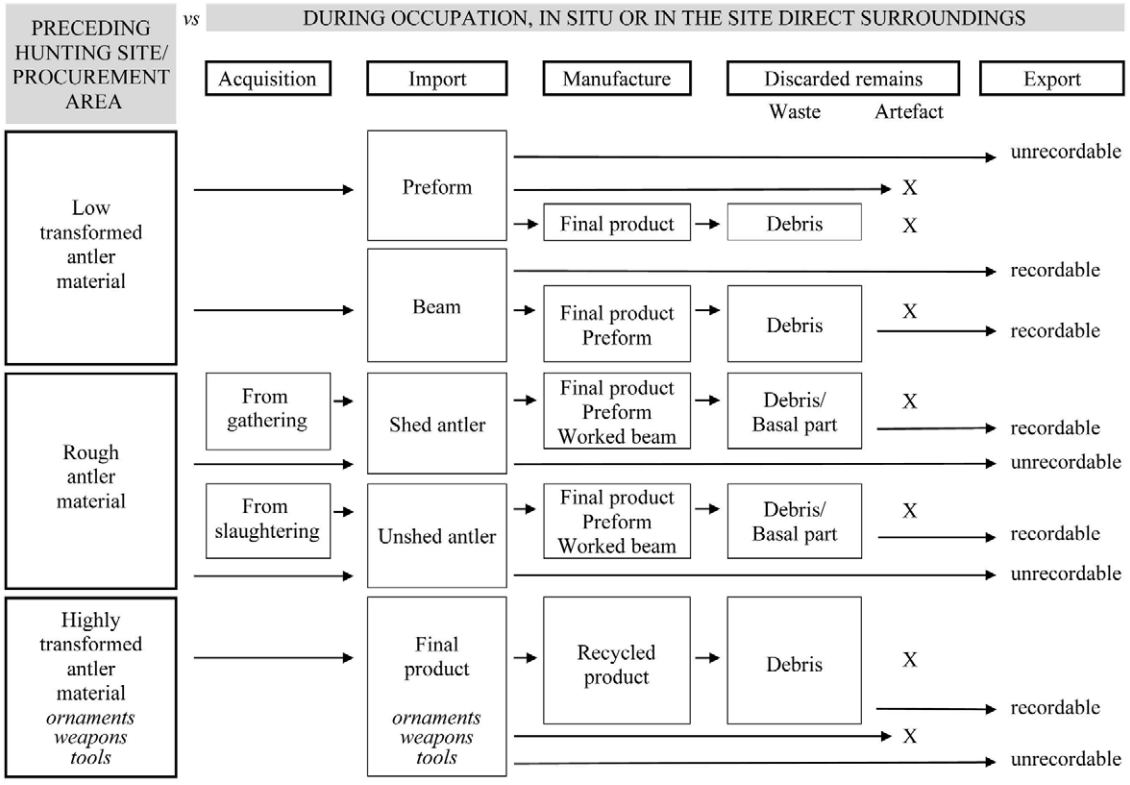

Figure 2. Approach to reconstructing the nomadic cycle of Recent Palaeolithic societies based on reindeer antler economy.

cycle of nomadism based on the "total animal resources exploitation" have already been published (Fontana, 1998, 2000, 2005, 2012 & 2022; Fontana/Chauvière, 2009; Fontana *et al*., 2009a & b; Fontana *et al*., 2018). A central research issue for this vast region concerns the Recent Palaeolithic societies, at least from the Gravettian, who used a distant non-local flint for the vast majority of their lithic industry unlike their contemporaries at the scale of Western Europe. This resource has been identified by Annie Masson as originating from Upper and Lower Turonian in the southern Paris Basin (Masson, 1981). Later on, various studies were aimed at specifying these patterns (for references, see Fontana *et al*., 2018). This systematic supply, —distributed over 200 kilometers in the region and for at least 15,000 years chronologically—, is considered as a distant and massive procurement of one of the main resources, *i.e.* an essential component of the economic system and the nomadic annual cycle, whose visibility is then incomplete on this scale. Indeed, we could conclude from the analysis of the whole published faunal data that any of these (small) sites were occupied during the cold season and that the osseous industry was rarely abandoned at these sites. In fact, whether or not this industry was constituted of antler elements with or without working traces, this osseous material is relatively rare except at Le Rond-du-Barry (Polignac, Haute-Loire), (Bayle des Hermens, 1969, 1972, 1974, 1979, 1981 & 1983; Raynal *et al*., 2014; Rémy, 2013; Rémy/Bayle des Hermens, 2014), Les Petits Guinards (Creuzier-le-Vieux, Allier), (Fontana, 2005; Fontana/Chauvière, 2009; Chauvière *et al*., 2006) and maybe Moulin-sous-Chirel (Neschers, Puy-de-Dôme), (Daugas, 1979). Since part of the nomadic annual cycle was not visible, we decided to study the reindeer antler exploitation more precisely: first from the rare antler and the very poor industry of Le Blot (Cerzat, Haute-Loire), (Chauvière, 2012; Chauvière/Fontana 2005); then, looking for sites that could have been occupied in the winter and that yielded reindeer antler industry, we excavated the site called Les Petits Guinards, in the northern part of the Massif Central, since numerous reindeer antler had been previously discovered there during the construction of a road.

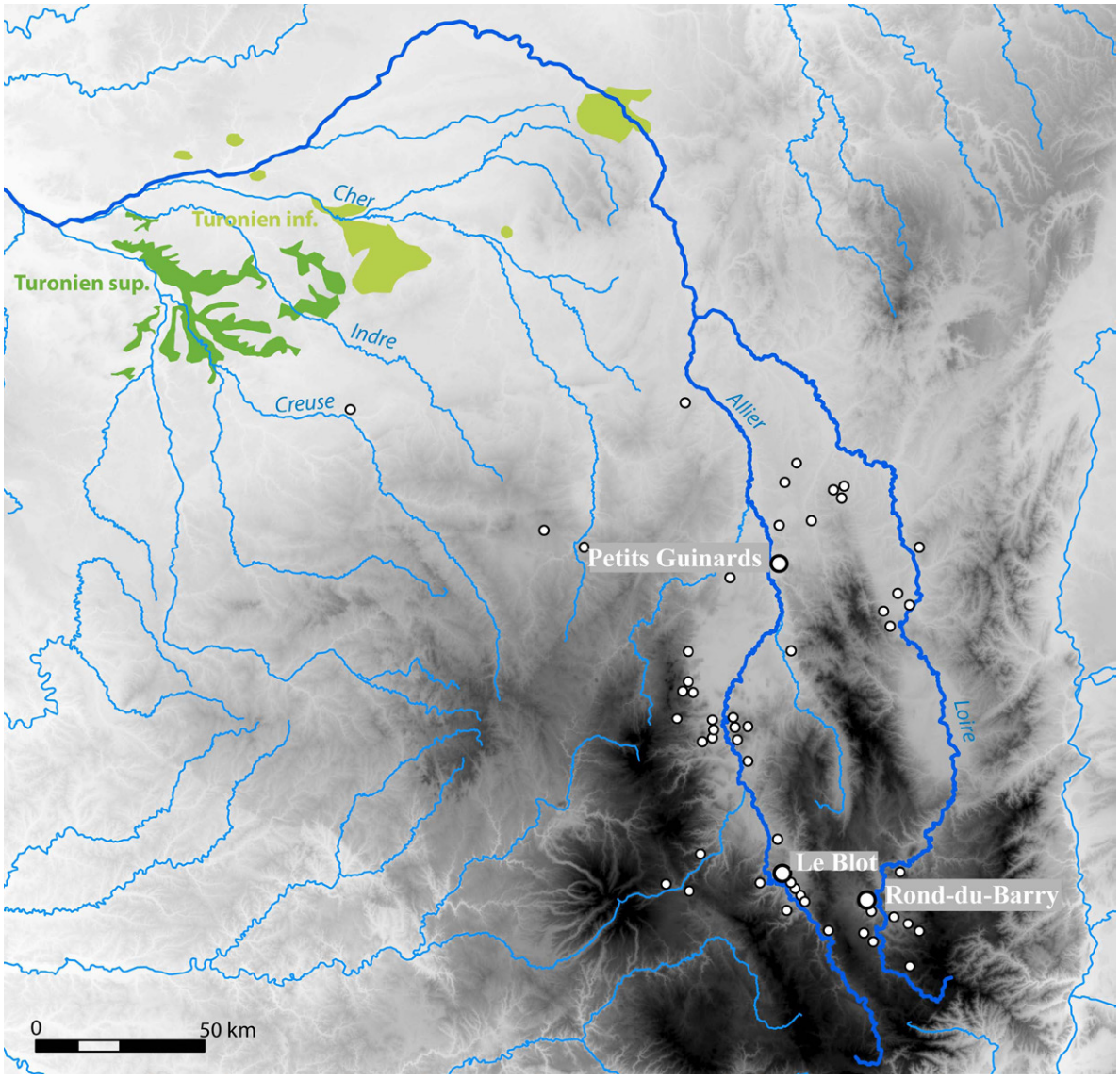

Figure 3. Map of the chert-bearing Upper and Lower Turonian outcrops in the Middle Loire Valley and location of the sites mentioned in the text (revised after Fontana *et al.*, 2018:105/Fig. 2).

Les Petits Guinards

This section provides a brief overview of the main data related to the site of Les Petits Guinard, still under study after having published various reports on this Recent Palaeolithic site (Chauvière *et al*., 2006; Fontana, 2005; Fontana/Chauvière 2007; Fontana *et al*. 2003a & b, 2014 & 2018; Fontana/Chauvière, 2009; Jeannet /Fontana, 2015). Located in the Massif Central along the Allier River and a few miles north of Vichy (Fig. 3), it lies at the foot of a steep slope with a very specific topography marked by the presence of mounds of varying size attributed to solifluction flows. Whereas it was initially characterized as an open-air site, the stratigraphic and taphonomic studies of new soundings on the slope itself conducted in 2002 allowed us to identify these deposits as secondary due to land sliding. This thin layer of sliding sediment originated initially from the filling of a rock shelter located at the top of the slope and of which remains only a limestone cliff of about twenty meters wide. Thus, we excavated this archaeological deposit despite its secondary position, which yielded a stratigraphy generally well-preserved over a surface area of about 20 m^2. The study of the newly uncovered lithic and osseous industries as well as the radiocarbon dating (AMS) of 13 bone remains (including bone industry), show that this site was actually occupied at various periods—spanning between 19,500 and 13,230 BP— particularly by Magdalenian

but also Solutrean groups (Fontana *et al.*, 2014). Nevertheless, the sedimentary matrix of the archaeological layer corresponds to sandy loams associated with limestone blocks of all sizes, and our sedimentological observations were not able to distinguish any sublayers within this archaeological level representing, to a great extent, Magdalenian occupations. Surprisingly, we exhumed out more than 1,200 antler remains, including finished items and waste in such a limited excavated area. More generally, numerous osseous and dental remains (dietary and manufacturing waste products, artefacts) document the exploitation of animal resources, and reindeer whose bone, tooth and antler account for 60-70% of the 2,000 identified remains (MNIc: 45), is the most hunted animal game (Fig. 4). The ongoing study also documents, from the stages of tooth eruption and antler growth/shedding, that reindeer and horse hunting was carried out between May and September (at least at three different times); one young Chamois has been killed at the end of August. Unfortunately, the bone fragmentation rate is high, making it impossible to identify the sex ratio from post-cranial measurements data.

Antler exploitation in Les Petits Guinards

Reindeer bone and antler remains account for 70% of the faunal material of Les Petits Guinards of which *circa* 55% is reindeer antler and represents the most of the preserved skeletal elements (Fig. 5). Among the 73 remains recorded for the bone industry, in addition to the 80 antler basal parts yielded as reindeer faunal rests, *i.e.* as unworked basal parts of larger shed or unshed antler materials (initially worked?), reindeer antler is represented with 43 artefacts (worked materials) and 30 debris of production (Fig. 6). Thus, for the first time, the on-site manufacturing could be documented and the diverse sequences constituting the whole *chaîne opératoire* of the antler transformation were substantially available for its reconstruction.

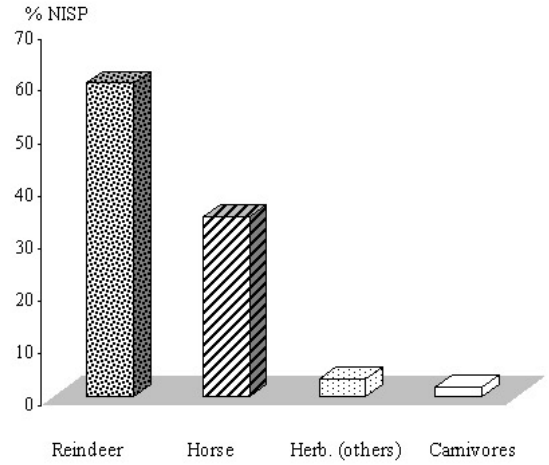

Figure 4. Distribution (percentage) of the identified taxa (from left to right–reindeer, horse, other herbivores, carnivores) at Les Petits Guinards (NISP = 2,000).

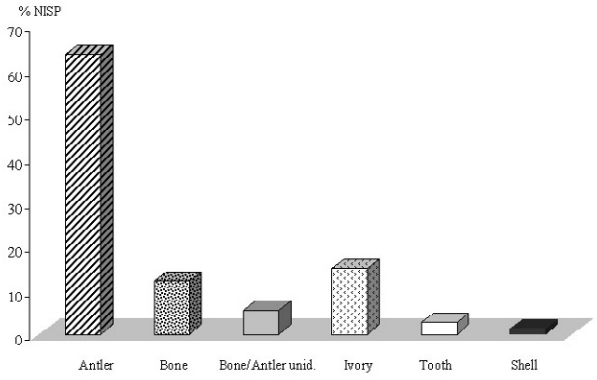

Figure 5. Distribution (percentage) of the kinds of hard-organics (from left to right–antler, bone, unidentified bone or antler, ivory, tooth, shell) at Les Petits Guinards (NISP = 73).

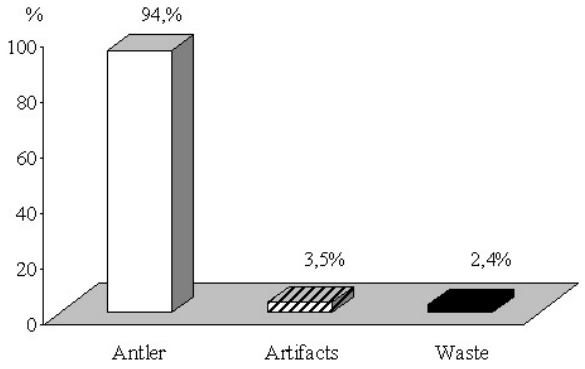

Figure 6. Distribution (percentage) of the "antler" as faunal material (94%) including rough basal parts (80 pieces) and the then (6%) industrial antler remains constituted of "artefacts" (43 pieces or 2,4%) and "waste" debris of production (30 pieces or 3,6%) at Les Petits Guinards (NISP = 1,230).

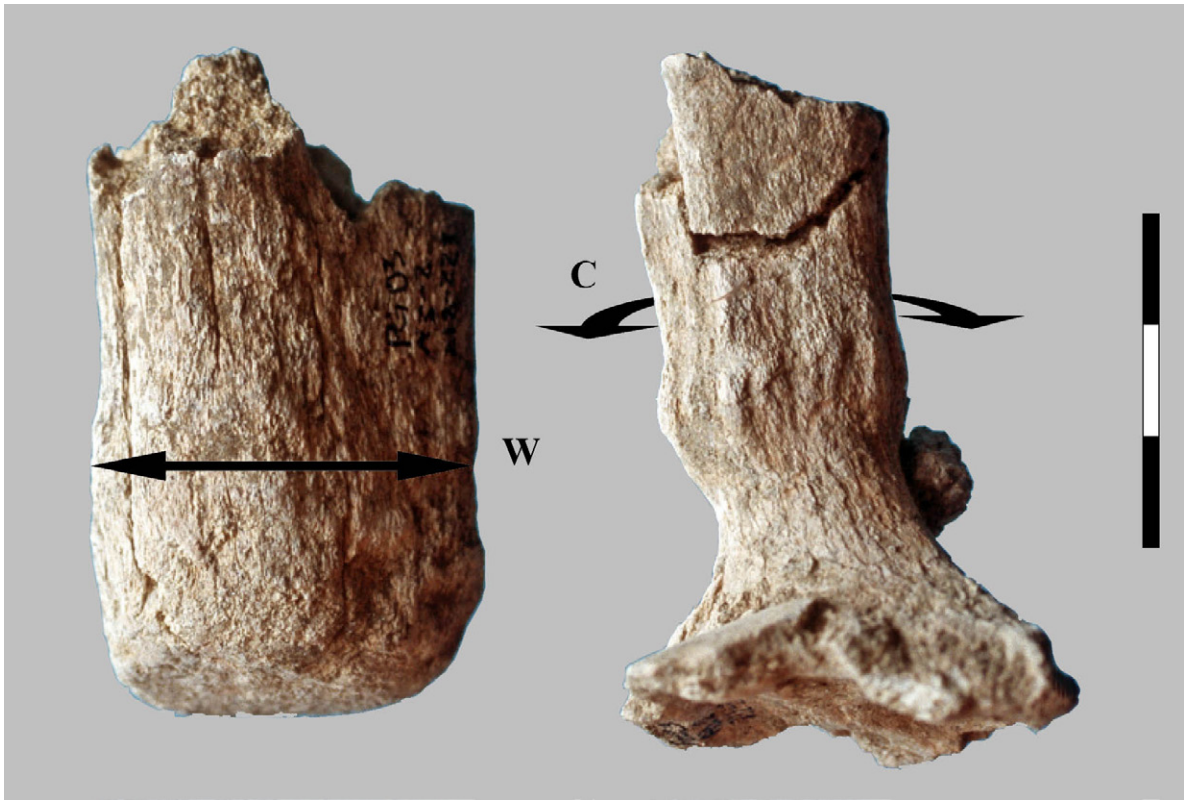

Figure 7. Basal parts of shed (left) and unshed (right) female adults or subadults reindeer antler at Les Petits Guinards (double black-arrow indicates where circumference "c" and width "w" are measured, *i.e.* above the burr on the stump). Scale subdivision in cm. Photos, F.-X. Chauvière.

Antler basal parts		Number of pieces measured	Total number of pieces measurable	Total number of pieces
shed	male	2	22	27
	female/juvenile	20		
unshed	male	3	48	53
	female/juvenile	45		
	total:	70	70	80

Table 1. Identified antler sources from the study of basal parts at Les Petits Guinards.

Concerning antler procurement, both shed and unshed materials are present (Fig. 7) but unshed antler are more numerous. Moreover, there are from adult females and males, the latter ones constituting a minority (Tabl. 1). The vast majority of basal parts belongs to adult females, juveniles and subadults (Fig. 8). We note that the value (9/10 cm) which represents the limit between the two populations interpreted as the boundary between adult males and adult females+all juveniles based on the significant profiles of plotted circumferences measurements (originally published in Fontana/Chauvière, 2009), is similarly recorded at La Madeleine (Bonnissent, 1993) including Jean-Marc Bouvier and Denis Peyrony's antler collections currently under study (Fontana/Chauvière, forthcoming). Besides, thickness measurements of the compact bone indicate that the male/female limit is around 5 mm for shed antler (Fig. 9). These two values for reindeer antler basal parts (circumference: 9/10 cm and thickness of compact bone: 5/6 mm) are otherwise identical to those published for actual European reindeer populations (see Averbouh, 2015).

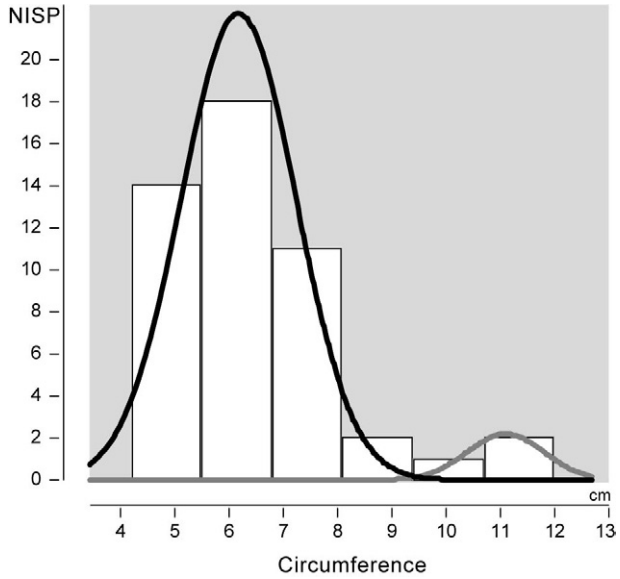

Figure 8. Distribution (in number of pieces) of the circumference (in cm) of unshed reindeer antler basal parts (NISP = 48) at Les Petits Guinards (black line–all males and females juveniles and adult females; grey line–adult males), assuming the measured antler specimens relate to only one same reindeer population, and knowing that nowadays the circumference of the adult females never reach more than 9 cm for a complete antler, regardless of the reindeer (sub)species in presence.

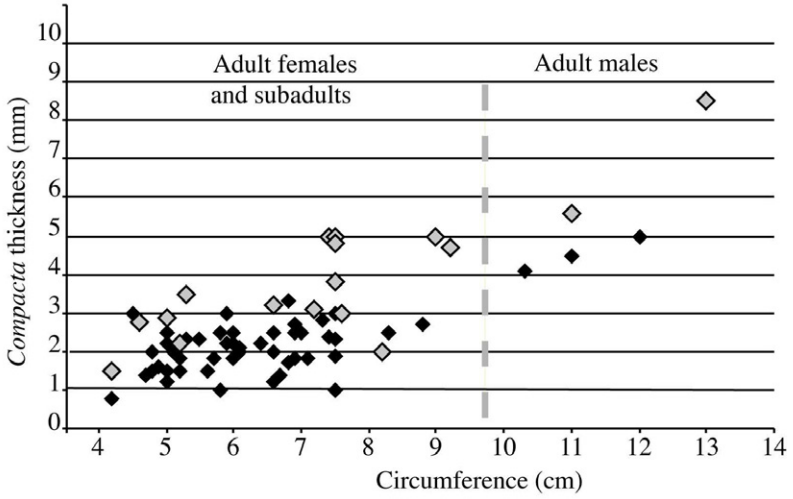

Figure 9. Ratio between the circumference (in cm) of unshed reindeer antler basal parts and the thickness of their compact bone (in mm) at Les Petits Guinards (NISP = 106).The dotted line represents the boundary suggested by the authors between adult males and adult females+all juveniles based on profiles of plotted circumferences measurements, as illustrated in previous figure, to which can be added the boundary above 4 or 5 mm in width of the compacta for the first population (adult males) versus below for the other reindeer population as expected (grey–shed; black–unshed).

It appears that a part of the shed antler pieces belonging to mainly adult females was gathered at the end of spring (as inferred from their very deep shed line), and the other part during the time of the unshed antler procurement (as inferred from the antler bearing reindeer hunt that was focused mostly on juveniles -see below) which lasted from the beginning of spring to the beginning of autumn. Thus, the proximity of the gathering area to the hunting place and to the site is possible. If mature antler of adult males were removed or gathered at the site or its proximity, it necessarily would have been done at fall (see Bouchud 1959:70/Fig. 37). In order to demonstrate whether these two procurements of shed/unshed antler materials, —juveniles+adult females *versus* adult males—, did contribute to the

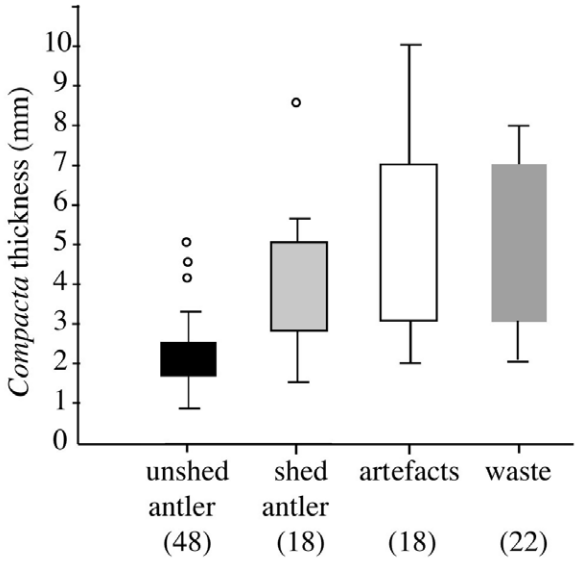

Figure 10. Boxplot of categories of reindeer antler materials (from left to right–48 unshed antler basal parts, 18 shed antler basal parts, 18 antler artefacts, 22 antler waste products) at Les Petits Guinards (NISP = 106).

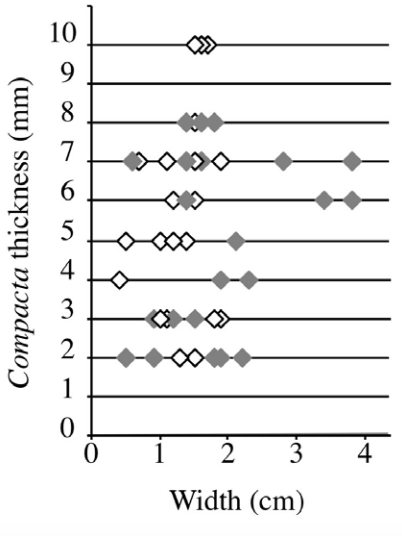

Figure 11. Ratio between the width (in cm) of 43 reindeer antler basal parts and the thickness of their compact bone (in mm) at Les Petits Guinards (grey–waste products, white–artefacts).

manufacture of antler artefacts in situ, the compacta thickness of the shed and unshed basal parts as well as the industrial products have been compared (Fig. 10). As the compacta thickness relates to the original size of the antler material (Fig. 11), the analysis revealed that the module used for waste products was often bigger than the module for unworked shed or unshed basal parts represented at the site. Since the worked pieces once shaped can leave the outer surface unmodified, the compacta thickness of artefacts corresponds then to raw antler (Averbouh, 2000; Goutas, 2004; Pétillon, 2006). Therefore, it results from the comparison that a substantial number of artefacts and waste debris was not produced *in situ*; the basal parts expected to have a thicker compact bone were found to have the thinnest compacta in contrast to the industrial remains. Thus, part of the collection has been produced from other antler preforms and/or blank-products than those left on the site, and these were eventually gathered or removed from slaughtered reindeer carcasses prior to the occupation of Les Petits Guinards. From the illustrated data, it can be drawn as a conclusion:

1. The main unshed antler procurement was deriving from hunting of adult females, subadults and juveniles, between spring and autumn;
2. The gathering of female shed antler took place partly at the same time from June, and near the site;
3. The two male shed antler pieces were probably imported from a previous procurement area and the three male unshed antler pieces came from young adults slaughtered at the end of summer/start of the fall;
4. Despite a large number of antler fragments and artefacts, the amount of on-site manufacture is low and was carried out from small and medium-sized modules; the largest modules were brought to the site as imported goods from (an)other place(s).

As a large amount (45) of unshed antler pieces from females/subadults/juveniles is made of small and very small modules constituted of quite much spongiosa with no shed line, these seems to principally belong to basal parts of male's and female's immature antler (ongoing research). These were removed from having slaughtered the reindeers during summer/fall. On few basal parts, we have identified scraping planes; thus, documenting that removing of the antler outer surfaces of the beam was processed. Since no beam of the corresponding

module, even as fragments, have been recovered, consequently, it seems that the beam parts from small and very small modules were deliberately transformed in situ albeit being in the shape of immature, *i.e.* as mainly constituted of spongy core, unsuitable for tools and projectile-points production. If the purpose of using such a resource, —technical or not technical—, should be addressed, the major issue at this stage of the study and from our perspective is less to understand the purpose of using the (immature) antler but rather to provide evidence that the reindeer carcasses bearing antlers recovered at Les Petits Guinards were imported to the site, where the ones from juveniles were systematically removed from the slaughtered animals and the majority of antler pieces were also deposited and exported. This juvenile antler procurement line thus leads to quite a different pattern than that of the female shed antler similarly documented from basal parts only which mature material would have been transformed on-site, as seen from the occurrence of small size waste debris.

Regional scale: the Upper Palaeolithic economy of reindeer antler in the Massif Central
The contribution of Les Petits Guinards, Le Blot and Le Rond-du-Barry

We initially thought that the site of Les Petits Guinards, which yielded numerous fragments of reindeer antler (basal parts, artefacts, waste products), was an ideal candidate for a procurement and especially manufacturing locale in the Magdalenian nomadic annual cycle. Yet, the integrated study proved it was not. Firstly, unshed antler enabled us to demonstrate that the slaughtered reindeers were, for the most part, adult females and subadults, and only three adult male antler basal parts. We are not able to provide any analysis of bone measurement that may confirm this observation, which is nevertheless similar to that of other sites (see below). Secondly, the analysis of antler measurement made clear that modules of worked basal parts, manufacturing debris, and abandoned artefacts do not perfectly match. Indeed, the largest shaped items (10 mm compacta thickness) have been produced from adult male antler which is not particularly recovered at the site (no antler basis nor waste debris of corresponding module); similarly, based on the only matching shed antler, the other artefacts and waste, between 6 and 10 mm compacta thickness, do not come from on-site manufacture. All of this indicates that half of the waste debris and two-thirds of the artefacts were produced elsewhere and brought to Les Petits Guinards, which is not really surprising. However, this had to be discussed to further identify the nature of the on-site manufacturing. Moreover, a large part of antler, female and subadults from reindeers slaughtered at the end of the summer or the start of autumn, was removed and the beams exported while still immature as an histological material.

Published data concerning reindeer antler exploitation are available for only two other sites, Le Rond-du-Barry and Le Blot (Chauvière, 2012; Chauvière/Fontana, 2005). Throughout the Final Gravettian occupations at Le Blot, human groups hunted female and subadult antlerless reindeers in the early summer. No manufacturing waste has been recovered and the only two artefacts (two beam fragments of large size class) have been brought to the site from elsewhere (Fig. 12). The situation is substantially different at Le Rond-du-Barry (Badegoulian and Magdalenian levels) where all antler pieces are identified as shed material, being in a very large part (31/33) of "large" and

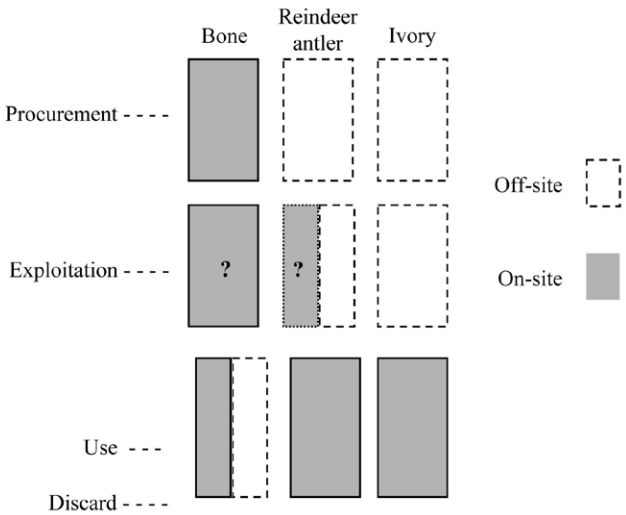

Figure 12. The various stages recognized in the exploitation of animal material-based resources at Le Blot during the Final Gravettian.

"middle size" modules. As the base circumferences are up to 95 mm (Rémy, 2013), it seems clear they belong to adult males only. If procurement sources remain unknown, these large antler pieces, at least for some of them, were exploited at the site (Rémy, 2013; Rémy/de Bayle des Hermens, 2014). But, the main issue concerning this unique site where primarily a shed male antler material was exploited is as following: was it a place where large shed antler pieces were transformed 1) (only) to produce artefacts, 2) (also) to produce many preforms or blank-products intended to be transported out of the site when leaving to the North? We cannot actually answer this question since the integrated study of antler procurement and exploitation still needs to be conducted with concern of the whole of the industrial material (is this all sorted out from the initial faunal assemblage?), especially by producing measurement data to highlight patterning of on-site manufacturing. We also note that the seasons of antler procurement are usually obtained only from unshed antler whose age, sex and maturity are identifiable and not from shed antler, notably if results from the latter do not match equivalent data obtained from teeth of fawns and possibly fetal long bone (Fontana, 2017). Unfortunately, there are still no reliable data related to reindeer hunting season at this site. So, we do not know exactly where and when these male shed antler pieces were collected: far or near the site; immediately or long after the reindeer males have shed their antler? In fact, we have no evidence of reindeer fall hunting, whereas many ibex and horse hunting episodes are identified between spring and autumn, and fishing at the start of the fall. So, we hypothesize that during the autumnal settlement, horse, ibex and fishes were acquired and reindeer (females, and males?) had been hunted only at the end of fall (excluding the mating period). Otherwise, why has any male unshed not been recovered? To get large antler, populations may have preferred or had to gather them after mating, at least before reindeer males would leave the high valley for other geographical territories (November-December?), and then, transform them maybe mostly in the shape of preforms to be transported.

The economy of reindeer antler

Our understanding of reindeer antler economy in the Recent Palaeolithic of Massif Central is at the moment still limited for two reasons. On the one hand, antler industry is very poor in this region and the low number of preserved antler materials (rough and/or transformed shed/unshed antler pieces and objects) makes any analysis of the importance of the industrial activity very difficult to grab; on the other, getting precise data and useful information relating to rare large sites is still very problematic. Nevertheless, let's try to answer as many questions as possible from the initial issue we addressed earlier in the introduction relating to the regional scale: what kind of antler was acquired and exploited, and how? Where in the territory, and when in the course of the year? How was this managed?

If all types of antler (even immature) were acquired and large modules were rather scarce, we do not know the respective part of shed and unshed antler: the diversity of procurement remains unknown. More interestingly, the male unshed antler remains are extremely rare and they never prevail at sites, indicating:

1. An apparent scarcity of fall hunting (and what about settlement?), when males and females are naturally together in the landscape before and during mating time, which remains to be explained (to the benefit of other hunts, perhaps towards the horse or ibex?);
2. Unshed antler parts were removed from slaughtered males and systematically carried away as exported raw materials, which consequently would explain why fall hunting is so badly recorded while only the unshed antler material is used to document this hunting season.

In both cases, sex ratio can be known from the bone material measurements to identify and quantify the proportion of male reindeers. Next, antler procurement took place in various locations from North to South, in spring and autumn, at least at three different episodes:

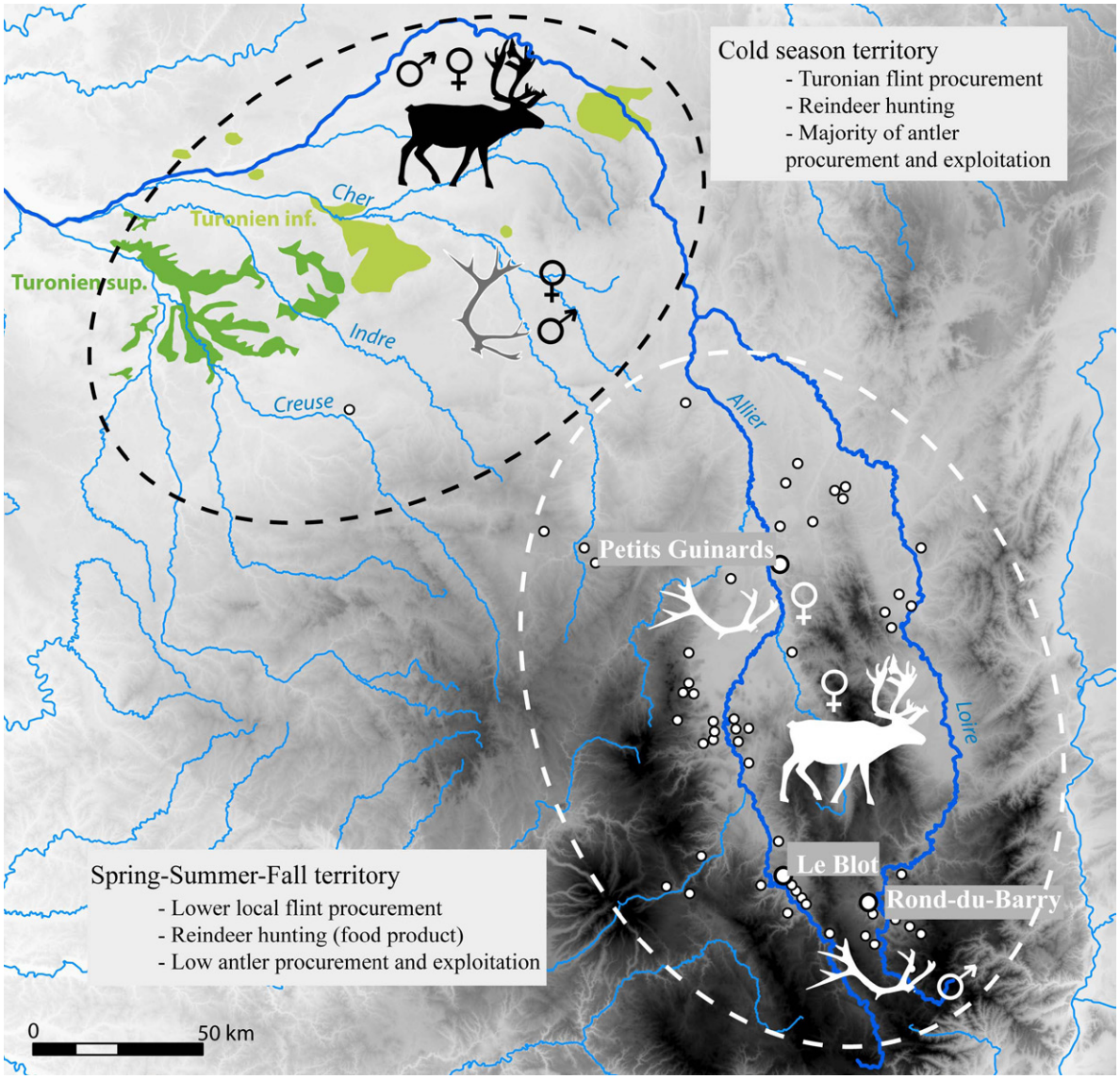

Figure 13. Reconstructed annual cycle of nomadism of Recent Palaeolithic societies (Magdalenian, Badegoulian, Final Gravettian, Recent Gravettian) from the studied archaeological sites located in the Massif Central based on the antler economy with consideration the lithic economy.

before females shed their antler (May); after they did (from June); and when males carried mature antler and females carried immature antler (fall). We ignore if this supply, spanning half of the year, was limited to spring or autumnal periods, and, the geographical zones for gathering are unknown, perhaps close to Les Petits Guinards, and Le Rond-du-Barry. Such a procurement, distributed in spring and fall, involves rather an on-site manufacturing of the major part of antler (where there were acquired). Finally, the management of antler resource as a raw material is the less known within the antler economy. We just provided here evidence of the import and the discard in situ of some artefacts at Les Petits Guinards and Le Blot, which were previously made elsewhere from large modules and at an unidentified settlement site. Since the manufacture of antler was not an important activity in this vast region, and, without any unshed male antler exploitation, it is possible that the proportion of transported raw material was low, except if large modules were transported between the North to the South, in one or both directions. We concluded our 2009 article by stating that, if sites of male shed antler exploitation existed in the Massif Central, they should be identified, thus making the completion of Le Rond-du-Barry's antler production (Fontana

et al., 2009a). Preliminary results confirm our hypothesis that not only some shaped items and antler preforms but also the single male shed antler from Les Petits Guinards came from an outdoor procurement and manufacture although the original site was not identified. We now believe that Le Rond-du-Barry could endorse this location for gathering male antler pieces as raw material and preforms used to manufacture the equipment, when people were about to leave the southern zone of the Massif Central before stopping at Les Petits Guinards on their way to the northern region just before winter. However, this does not preclude the reverse possibility for some large artefacts at Les Petits Guinards: to come from the northern area when Magdalenian populations came back to the Massif Central the following year.

The mobility of Upper Palaeolithic human groups

Considering the data from three sites dated to the Final Gravettian, the Badegoulian, and the Magdalenian (Fig. 13), we noticed that we still do not know any location for the origin of the unshed antler of adult males, whereas the gathering area of their shed antler was potentially close to a mating zone, supposedly not very far from Le Rond-du-Barry. Male hunting is rarely documented due to the fact that unshed antler precisely is scarce at these sites. This is no archaeological bias, but it means that hunting reindeer was rather uncommon during the fall, even when people still lived there in the region as they eventually hunted other animals. In the same way, the manufacture of the antler industry rarely occurred in the Massif Central as documented at Le Rond-du-Barry (male antler) and Les Petits Guinards (female and subadult antler based). However, antler of reindeer adult males was essential to the production, notably to implement the daily equipment (mainly weapons and tools) for which these antler matrices were only available through slaughtering during the first part of fall and through gathering as from November. Regarding the mature and smaller antler pieces that belong to adult females and subadults, only the winter hunting made a direct procurement possible whereas their gathering was between mid-winter and June based on the reindeer age restituted from the study of these sites. It is therefore possible that a large part (still to be characterized) of reindeer antler procurement and production occurred in the autumn and the winter outside of this vast region in some adjacent northern territories (Fontana *et al*., 2018). This hypothesis is even more likely since we consider that such scarcity of industrial antler remains could be linked to the absence of winter occupations as known as in many other regions (Fontana, 2012).

The various evidences suggest that human groups were living in a very vast area used distinctively depending on the seasons, from the Loire and Allier high valleys to Middle Loire (Touraine region): to fulfill most of the annual cycle needs, they spent the cold season in the North for acquiring and transforming antler resources (Fontana, 2012; Fontana/Chauvière, 2009; Fontana *et al*., 2009b, 2014 & 2018), and in the Massif Central conversely, the exploitation of reindeer hunting was almost exclusively turned towards consumption lines. Keeping in mind the treatment of all the immature beams at Les Petits Guinards and even if we do not presently understand the reason of such a practice as linked to the usual reindeer exploitation and antler export, it is unknown whether this resource was common, perhaps a priority during a specific period (end of summer/start of fall). In parallel, the procurement of Upper and Lower Turonian siliceous rocks took place during the cold season whereas in the Massif Central local flints were then mainly acquired during the rest of the year. In such a setting, other sites corresponding to the autumn-winter occupations should be found with regard to the same antler and flint exploitation patterns (see Fontana *et al*., 2018).

CONCLUSION

The study of reindeer antler contributes to reconstructing the nomadic annual cycle of Recent Palaeolithic hunter-gatherers. The data presented in this paper, though these are scarce and of diverse nature, illustrate this purpose well. The case of the Massif Central, despite the fact that it is very specific on the scale of France, highlights the two main difficulties of

the economic study of reindeer antler, namely its exploitation patterns on the annual and spatial scales: occurrence and location of the related practices (gathering, transport) and their relative importance with regard to the possible various economic lines in using the antler. To proceed to the identification of the main features and the ranking of procurement and exploitation patterns within the whole economic system, the study of more sites (be they from old or recent excavations) where antler is a well-preserved material is therefore required further with, as a priority, the quantification of any of the on-site activities. Even if this could be problematic, the antler debitage being hardly reconstructed from the occurrence of only rare waste debris of production, our examination shows that the reconstruction of reindeer antler economy is necessarily limited when it lacks an integrated study, *i.e.* when the other data from animal resources are not fully integrated due to being regarded as only partly significant. In our opinion, it is only in considering the different sets of data obtained from the various sites as a whole that a relevant scenario will be finally reconstructed. The understanding of the antler economy then includes integrating a discussion on hunting seasons regardless of the animal game (from teeth and fetal data) as well as on the reindeer hunting strategies (based on ages of death and sex ratios). The proportion of adult males to identify the hunting seasons (not from the study of antler) indeed is the only data to evidence the presence of people and reindeer at specific locations. At a final study stage when the analysis is therefore conduct as deriving from a single research achievement (not as a pile of data), it benefits from other aspects notably the lithic resource procurement although precise issues related to complete annual cycle reconstructions from diverse raw materials still need to be formulated more clearly (Fontana, 2022; Fontana *et al*., 2009a & 2018). Such an integrated study—as we continuously try to improve—is the only way to identify the status of the site used to discuss Palaeolithic antler economy (procurement/ manufacturing locations) and choices in terms of sites function and economic strategies. Obviously, these choices are driven in their patterns by the exploitation of other resources such as flint, —especially when procurement areas are relatively distant geographically—, and further study will progress if relevant aspects related to flint economy are available.

As long as winter reindeer hunting has not been demonstrated so far for the Massif Central otherwise than with the occurrence of shed antler from males on sites, which is not sufficient as already demonstrated (Fontana, 2017), the hypothesis of the Massif Central being part of a vast territory including a northern area remains positively relevant. This adjacent northern area where Cretaceous flint was acquired and transformed was probably the zone where adult males and females with mature antler were originally slaughtered in the cold season. The way antler and flint were transformed (or not) and transported when populations left this cold seasonally-used area to join the Massif Central from the spring and until the next fall is still to be understood, notably by studying sites located in the Touraine such as La Garenne (Saint-Marcel, Indre) for instance.

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RÉSUMÉ

LE CYCLE DE NOMADISME DES SOCIÉTÉS DU PALÉOLITHIQUE RÉCENT À PARTIR DE L'ÉCONOMIE DU BOIS DE RENNE

La reconstitution du cycle annuel de nomadisme des sociétés paléolithiques est un exercice délicat dans la mesure où sa visibilité archéologique (habitats, lieux d'approvisionnement et déplacements) est réduite et son étendue, méconnue. Chaque type de vestige est un témoin du sous-système économique, dont chaque site représente un épisode fragmentaire, en termes d'activités, de lieu et de temps. C'est pourquoi l'analyse de l'exploitation des ressources contribue à documenter le cycle de nomadisme des chasseurs collecteurs, mais ceci a deux conditions : travailler aux échelles locale et régionale et formuler des questions précises en les hiérarchisant depuis la problématique globale jusqu'à la production des données. Dans cette perspective, l'étude de l'économie du bois de renne est un excellent moyen de produire des informations indispensables à la connaissance du cycle annuel de nomadisme paléolithique. L'article présente, aux deux échelles, deux niveaux de hiérarchie de questions dans l'étude des bois de renne, puis une application de ce type d'étude dans la perspective de reconstruction du cycle annuel de nomadisme des sociétés du Paléolithique récent du Massif Central.

À l'échelle du territoire, notre objectif étant d'identifier l'organisation annuelle de l'exploitation des bois, nos questions ont porté sur la diversité des bois acquis et exploités (chute/massacre, gros ou petit module, maturité), au choix d'une ou plusieurs stratégies d'acquisition (collecte, chasse), à la répartition de l'approvisionnement et de la fabrication dans l'année et au sein du territoire, à la gestion de cette matière première en termes de degré de mobilité (transport) et de formes de circulation. À l'échelle locale, il fallait caractériser le site du point de vue de l'acquisition et l'exploitation des bois : était-il un lieu majeur de chasse au renne et d'acquisition des bois de massacre, et à quel(s) moment(s), ou plutôt de collecte de bois de chute ? Était-il un endroit majeur de transformation/fabrication de produits en bois de renne ? Pour caractériser les sites du point de vue de l'exploitation de cette ressource, il apparaît impératif d'identifier et de quantifier ce qui fut acquis durant l'occupation du site, de ce qui fut apporté, fabriqué (et à partir de quel type de bois ?) et abandonné sur le site ou emporté à l'issue de l'occupation. Ce type d'étude a été mené sur un site du Massif Central, région où l'économie lithique des sociétés du Paléolithique récent était en partie fondée sur l'exploitation d'un silex allochtone septentrional, et où l'économie du bois de renne est très faiblement documentée, alors que l'occupation hivernale ne l'est pas du tout. Ce site magdalénien des Petits Guinards, de l'extrémité nord du Massif Central, est un des très rares sites à avoir livré de nombreux fragments de bois de Renne de tous types (bases, objets et déchets de fabrication) mais nous avons démontré qu'il n'était pas un lieu privilégié d'acquisition ou de fabrication. En effet, en dépit du grand nombre de bases, de déchets et d'objets, la part de la fabrication sur place est très faible et fut réalisée en très grande partie à partir de petits et moyens modules appartenant à des femelles adultes et à des subadultes abattus entre le printemps et l'automne : les rares bois appartenant à des mâles adultes ont été acquis ailleurs et apportés sur le site, et les deux tiers des objets ont été réalisés vraisemblablement sur un autre site.

À l'échelle du Massif Central, il apparait à présent que 1) les bois de massacre de mâles restent exceptionnels, ce qui témoigne, soit de la rareté des chasses automnales (et donc des occupations ?), soit d'un prélèvement systématique de ces bois avec emport hors site ; 2) l'approvisionnement, faible, en bois de renne a eu lieu dans cette région en plusieurs endroits, durant le printemps et à l'automne ; 3) la fabrication de l'industrie en bois de renne était donc une activité peu importante dans cette région en particulier ; 4) le transport de bois de renne bruts ou mis en forme, suggéré pour les Petits Guinards et Le Rond-du-Barry, attesterait du transport de ce matériau entre le nord et le sud du territoire. La très grande rareté des bois de mâles adultes et celle de la fabrication, ainsi que l'absence de sites d'hiver suggèrent que la plus grande part de l'acquisition et de l'exploitation du bois de renne se serait déroulée durant les mois d'automne et d'hiver sur un territoire adjacent. Probablement que les groupes humains vivaient dans une région très vaste à l'échelle d'un territoire fréquenté saisonnièrement, depuis les hautes vallées de la Loire et de l'Allier, au Sud, jusqu'à la Touraine, au Nord. Ce secteur nord aurait alors été occupé à la saison froide, période pendant laquelle les bois de renne matures auraient été principalement acquis et transformés dans l'optique d'une utilisation immédiate et différée, notamment à l'échelle du cycle entier vers les sites septentrionaux du Massif Central.

MAGLEMOSIAN IN CONTACT: THE DISRUPTIVE INVENTION OF STONE PRESSURE FLAKING ON THE CURVE CRUTCH 7000 CAL BC

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Abstract: When looking at archaeological pieces identified as pressure-flaker tools, the means and ways of integrating a stone reduction technique into the production of regular lithic blades/bladelets, so called 'termed' products, in Denmark at the end of the Early Scandinavian Mesolithic period are taken into consideration. In that, this paper examines the forms of interaction between territorially close populations known as possessing distinct technologies: in the Eastern Baltic regions, populations using percussion and pressure techniques in stone reduction as well as composite tools made of bone with lithic inserts, whereas, in the most Western Baltic regions (Denmark), populations using percussion techniques only, without having any knowledge of the composite tool. According to the lithic archaeological material, it is in this latter area of Maglemosian culture that pressure flaking in debitage appears ca. 7300/7000 calBC, thus raising the question of whether this sudden new practice originated from the arrival of a new population bringing with them the new (Eastern) technology, from a technological transfer between groups of crafting traditions initially distinct, or from itinerant craftsmen?

The research is conducted using several interconnected fields of analysis which form the structure of this paper, as following: 1) the physical principles inherent to the practice of the pressure debitage technique; 2) the ontology of the identified pressure technique as understood from a first experimental test; and, 3) the compatibility of shapes and use wear obtained from the replicated antler pressure-flaker tools compared with the corresponding archaeological pieces. Note that the patterns of wear observed on the used antler tools, and from which the pressure technique was identified and reproduced, are not compared by analogy with the archaeological pieces but, rather, are considered in relation to the tool's dynamics in use, i.e. how the replicated antler tool is transformed from using it in pressure flaking. The first field relates to the biography of archaeological pieces identified as Maglemosian pressure-flaker tools represented by a sort of curve crutch made from removed red deer antler tine. The second field refers to the experimental research presentation and an observation of flintknappers' postures that vary during the replication of the pressure debitage with this type of tool regardless of the production of bladelets, extracted anyway on a regular basis. The third and last field are in line with the collected observations and draw inferences based on the context of the findings for the Southwestern Scandinavian Mesolithic. Our investigation shows that these crutches were certainly used in pressure debitage. Appearing as suddenly as the pressure knapping, almost all the curve crutches derive from a single geographical area: the Danish Zealand region, where they also are found together in considerable numbers. They also come from archaeological dwelling sites which are markers of the beginning of the second great period of the Maglemosian culture called the 'Sværdborg phase' dated around ca. 7000 calBC. It lasted several centuries starting from after, or soon after, the transition from Boreal to Atlantic chronozones in Eastern Denmark, when the Baltic Sea started to take its actual shape.

From a theoretical point of view, the study highlights the importance of the relationship to instrumentation when searching into technical change mechanisms to seek explanations of cultural evolution in Prehistory. In this paper, the appearance of a new (pressure) stone reduction technique seems to have no immediate relationship with the flintknappers' skills (social vector) nor with the profitability expected from the new technique (economic vector), but rather, to be depending on its operability (technical vector). It was by means of an experimental test and, when better considering material evidence with regard to the role of the knapper in technical action—as a reflexive contra passive use of instrumentation regardless of his modus operandi*—that records of body motion during the task and according to the tool employed gave new insights about transfer phenomenon: the actually possible inherent permeability in Stone Age*

between techniques apparently distinct. For what concerns the Mesolithic, the sudden appearance of the curve pressure-flaker tool used in debitage on the Maglemosian territory and almost unknown otherwise than in Zealand would be a consequence of a convergence of ontological order between different stone knapping techniques acquired which were concomitantly or diversely transported within the Southern Scandinavian area between 7300 and 7000 calBC. As a result, the Danish technique—the pressure mode on a (shoulder or chest) curve antler crutch—appears as a disruptive invention that would have arisen out of an assimilation by impregnation or direct contacts with foreign neighbouring (technologically Eastern-related) groups holding original techniques in stone reduction from a technological transfer developed in Zealand within the Maglemosian culture. In this, the Mesolithic pressure technique for flint reduction employed in Zealand and the culturally Maglemosian border-zone areas would have resulted from using pressure mode on a reinvented punch tool: the antler tine was adopted for its viscoelastic property while remaining long and curve in use, that is, adapted to pressure flaking on a flexible mode. Its appearance would have emerged at the end of the classic Maglemosian (transition between phases 2 and 3 with respectively Ulkestrup-Hut 1 and Sværdborg-1917) from using the antler tine in reflexive motion as a flaking tool involved in pressure debitage for termed lithic production from the new knowledge acquired in both the genuine punch technique and the standing pressure, then on the flexible straight crutch.

It seems then that the driving force of human cultural evolution during this Mesolithic period in this part of the Southern Scandinavia area might have arisen more from how things (pressure flaking) were precisely achieved, rather than just replicated in practice. As a future research hypothesis, it follows that technical change in the manufacture of common cultural products would arise only when techniques are genuine adequate to regular behavior in technical task, although the 'ignition' factor for change could have a social-origin. In this, how regular technical practices were conducted in intimate details would considerably pertain to issues relative to socio-historical scenario reconstruction. But, since the occupation layers in the Danish context involved are still badly dated when this technical shift occurred in the Maglemosian transitional phase 2/3, scenario about specific, multiple or with multi-scale entry-routes between neighbouring territories and the presumed established populations needs to be refined, notably with the study of the lithic productions in its most conformity to such experimental records (aspects of the bulb, characters of the bladelets' lips according to the various modes highlighted through the flexible contra the stiff used crutch, etc.).

INTRODUCTION

After being first identified on the Northern coast of Finland in the 9th millennium calBC's series (Rankama/Kankaanpää, 2008 & 2011), pressure debitage is now recorded in Scandinavia from Danish series at later sites (Sørensen *et al.*, 2013). Listed throughout the ancient world from the 23rd (*e.g.* Tabarev 1997) to the 3rd millennium BC (*e.g.* Méry *et al.* 2007), and, during its old phase, evolving to several axes of diffusion along an East-West gradient towards Europe (*e.g.* Inizan 2012), the use of the pressure modality in stone reduction would in principle have facilitated the mobility of hunters groups: the lithic inserts or 'termed' products obtained and used directly, that is, left unretouched in the tool' slots when recovered from therein (Callahan, 1985:25), are then both more regular and lighter, thus, in theory, easily replaceable in an interchangeable way once inserted into blanks of organic material designed for this purpose (wood, ivory, bone, tooth, antler). In fact, new composite tools in the form of hunting projectile points, knives and daggers integrate Denmark concurrently with the introduction of novel knapping modes on the territory ca. 7300/7000 calBC (David/Kjällquist, 2018; Sørensen, 2018). There, however, it remains difficult to find the witnesses of the new technology in its entirety on a single site: the cores and stone products obtained by pressure debitage together with both the organic composite artefacts made with these products as well as the organic-based tools and devices used in knapping. Since the organic artefacts are rarely preserved as archaeological material, classical approaches to knapping techniques reconstruction in previous studies were solely based on lithic production analysis and ethno-historic knowledge restored from experiences (*e.g.* Clark, 2012; Tixier, 1984). However, the Mesolithic sites in

this Northern part of Europe provide exceptional preservation of bone and antler artefacts. The examination we are conducting in this domain of research is therefore aimed at finding the correlative patterns between these diverse used mineral and organic items. It will allow highlighting particular knapping techniques and tools among the various modes inferred from experiment in order to attribute to those possibly used, the ones that are archaeo-compatibles.

According to the lithic studies which were mainly focused on the dimensions of the knapped stone products, as well as on the aspect of their butt-end and their removed surfaces (Pelegrin, 2012), the pressure action in knapping involved several modes: standing pressure, lever, etc. (Pelegrin/Texier, 2004). For the purpose of systematic debitage (Pelegrin, 1984a & b), which is only discussed here, the pressure knapping requires a well-prepared core that must be stabilized in an appropriate device in order to extract, while exerting pressure using a pressure tipped end placed on its striking platform, a thin regular elongated or 'termed' lithic product: the regular blade or the bladelet (Pelegrin, 2006). The stone products extracted in this way were most likely utilized as transformed into inserts during the Scandinavian Mesolithic, although the lithic studies have not yet formally established this point except for a hand of Danish slotted points (*e.g.* Callahan, 1985). The series of stone inserts was mounted with a kind of adhesive mastic in the groove prepared on purpose on the organic shaft to form a single delineation which constituted in there the sharp edge of the composite artefact (Fig. 1). Apart from the recent periods when a copper tip-end was probably required to surge on the pressure point (Inizan/Pelegrin, 2002), it is the natural tip-end of antlers from large cervid (red deer, elk) that at the beginning of the Holocene period in the Southern Scandinavia area served in pressure debitage. This has been demonstrated from successful experimentally achieved replications of Mesolithic flint cores' reduction, however undertaken then with factice-forms of pressure crutches in the use of antler (Callahan, 1985), and, more recently, from functional identification

Figure 1. Gilleleje (stray find dated to 7700 BC from Sjælland, Denmark) – series of stone inserts mounted with a kind of adhesive mastic in the groove prepared on purpose on the bone shaft to form a single delineation which constituted in there the sharp edge of the composite arrowhead. Scale subdivision, in cm. Illustration, É. David.

Figure 2. Sværdborg (Denmark), Friis Johansen excavations, Inv. n° X.3796 – Used Mesolithic curve red deer antler crutch for pressure flaking in debitage. The useful angle between the initial working plane of the nipple (top) and the axis of the antler will probably have tended to an orthogonal conformation (red lines). Scale subdivision, in cm. Illustration, É. David.

of antler crutches in Mesolithic artefacts series on the basis of use wear patterns (David/Sørensen, 2016). Only a handful of settlement sites in Zealand (Denmark) have delivered most of a particular type of these antler pressure-tools partially arranged for this purpose: a sort of curve crutch (baton or stick) made from a complete antler tine (Fig. 2). These tools are listed there by the tens (David/Sørensen, 2016). Elsewhere, however, this particular type of crutch is represented by only a few pieces, including those from more specific contexts (Fontana *et al.*, 2014 & 2020) and also more recent (David, 2018). Considering the relative sudden appearance of these tools in Mesolithic Denmark, it raises the question of what is the agent or phenomenon responsible for the introduction of the pressure knapping on the curve crutch there: effect of colonization? Technological transfer? etc.

THE CURVE ANTLER CRUTCH

Each of the documented crutches (David/Sørensen, 2016) is related to a blunted piece (blunt) rather than a point-sharpened piece (point) or even to a bevel ended piece (bevel) which would have become pointed, if seen in side view only. While the natural tip of the antler may be perceived as having been transversally cut at the expense of the inner and natural-curved anatomical side, it has actually become so only by use (Fig. 3). Actually, as seen in front view, the tip has been reduced from the two lateral and medial anatomical sides of the tine as in the case of a bilateral truncation only. It is difficult to decide on the initial aspect that will have prevailed in the final shaping (?) of the antler's natural tip-end, since each piece shows a different stage of use with an active part which, in general, is only residual. However, according to the most complete records, it appears that the tip of the tine has been used in its original entirety, that is to say by flattening this extremity on the antler material in convergent planes from these both anatomical sides preferentially. As an effect, the very top of the antler's natural tip-end remained untouched. This form of 'bending' was intended to let emerge a protuberance centrally placed on this antler extremity. Born from the convergence of the opposing truncations often kept tangential to the main axis of the piece, the emerged 'bud' or

Figure 3. Sværdborg (Denmark), Friis Johansen excavations, Inv. n° X.4733, and Becker excavations, Inv. n° X.17650 – Used Mesolithic curve red deer antler crutches. The working end (straight line) has been reduced to a nipple from scraping the two lateral and medial anatomical sides of the tine as in the case of a bilateral truncation (arrows). Illustration, É. David.

'nipple' singularity was properly reduced to the anatomical top, and following the flattening by nicking or scraping, to that of its cortical tissue only (without the usual pearl features of the antler material, for instance). In the case of the osseous tissue being already very spongious where the tip-end's core naturally occurs at this anatomical end, the singularity was placed externally and only in the thickness of the cortical part of the tine**.** The antler so worked, constituted the active part of the pressure-flaker tool made from the brow (basal), bez (second, if long enought) or trez (central) tine.

The worked area shows the search for a contact point that can be compared to the dimensions of the nipple alone, estimated at an average of about 2 mm in diameter in the restored complete state. This dimension potentially allowed setting a good direction of propagation of the fracture wave during material rupture of the stone (Texier, 1984). Although the curve of the antler tine where the active part is standing would be more or less pronounced because of its anatomy at this extremity, it seems the useful angle between the initial working plane of the nipple and the axis of the antler will probably have tended to an orthogonal conformation (Fig. 2, red lines), so that the flint product could have detached appropriately from the pressure point (Pelegrin, 1988). The antler part in contact has also always been positioned in the extension of the longest curvature of the tine, even if there, it is found slightly diverted towards one (dextral) or the other part (sinister) of the tool's central axis which also corresponds to the main axis of the antler in average. This has been reported to be due to the cerebral lateralization of the user—right-handed or left-handed—when it was possible to account for the inclination of the pressure plan on the nipple (David/Sørensen, 2016).

With use, the nipple will have poured towards the inner (anatomically concave) side of the antler. This is related to the effect of an alteration of the area underlying the singularity, whether previously locally regularized or not. Here the matter is studded with notches, striations, scratches and incises or 'cut' marks spread sporadically and also inscribed in the spongy bone which appeared incidentally. Likewise, it will have poured towards the back of the items (the outer convex side of the antler tine) as indicated there by a smooth surface more or less unequally scratched, and also deeply marked in some single areas. All these recognized forms of alteration are clearly superimposed on the already abundantly multi-striated or

zoned micro-scratch pattern of the antler material in its natural state (David/Sørensen, 2016). The various aspects of these alterations were regularly recorded from most well-preserved pieces. They indicate use of the artefact's tip-end, its internal part acting toward the operator and/or even toward the outside. The very abrupt profile of the stigmata and the orientation they always similarly display regardless of the items also eliminates the blunting of the tine's extremity by percussion with/on a sharp stone tool for instance, or even by friction, in rough contact with a harder material, like a kind of sharp gravel for instance. In facts, these traces are distributed in a random way but all in the direction of an action towards the opposite of the working-end where the nipple stands. This evokes the effective degradation of the tine at this extremity due to repeated anthropogenic actions resulting from its tip exerting pressure force in contact with a hard-mineral material. In there, the marks are accurate and evolved in their conformation from the use of the singularity without apparently making any other real damaging pattern due to utilization. The nipple itself provides evidence of the 'compressed' aspect expected locally as firstly identified on such items from the Mesolithic Sværdborg site, in Denmark (David 1993:38, 'MIAC'). On its circumference, this aspect diffused in a concentric manner. The nearest damaged areas (scratches, incises) would derive from effects of involuntary actions when practicing the pressure flaking on the always acute and protruding core's edge. In most cases, the effect of the many expected counterblows (notches, striations) is indeed rendered in the oblique series of marks inscribed there, superimposed higher on the active part's side-edges.

Once the nipple has represented the active part of the implement, the antler tine has generally been transformed only by duration of use. Except for the alterations evoked above and other post-depositional patterns not described here, it is evidenced by the 'shiny' or *lustre* aspect occurring in the surface's relief that also reminds of the original shape of the natural antler material. The extremely smooth and diffuse display of the lustrous aspect suggests that the surface of the tool has not become 'shiny' due to percussion only (anyway not from the deer's own action). A lustrous of a same kind is evidenced also on the highest convexities of the fractured zones on the basal-end of the tine which corresponds to the butt-end of the pressure-flaker tool. The other modifications of this part otherwise give evidence of the previously-achieved removal of the tine from the antler by grooving and flexion break (the grooving was made on the largest circumference of the tine using the sawing or the nicking techniques). Thus, the archaeological pieces regularly show the same lustre that evokes in surface certain areas in particular and whose aspect is even denser locally. This is the case of the active part as well as some locations somehow arranged in diagonal opposite on the stem where, sometimes, they even record a 'leather effect' (Fig. 2 & 3, see shiny zones): respectively, the inferior margin of the active part where its most bulging edge seems to merge from an underneath very thinly marked axial lustre centrally placed; the lustre diffusing in gradient on the concave part of the antler (internal edge) joining that which occurs on the tool's butt-end contra the anatomical convex part (external edge), notably where it is adjacent to the active-end. That some opposite parts of the tool have become smooth in a same way, including the smooth aspect of the marks themselves regardless of what the items suggest, the lustrous derives from hand-holding and using the tool as a chest crutch. Sometimes, the edge of the antler has even been regularized before use along the internal anatomic curvature by scraping. Also, a rectangular 'paddle-like shape' of the butt-end, seen from the front, associated with a heavy use wear of its lateral side(s) resulting from regularly occurring side-frictions shows that, on rare occasions, the butt-end of the antler piece could be inserted in another (wooden?) element constituting together with the club where it was possibly attached a particular composite square-shape device, as a socketed flaker-tool (like a particular *itzcolotli*? - see Clark, 1982; Thouvenot, 1984). In this case, the antler tine is particularly rectilinear, preferably taken including part of the palm of the antler. With their own characteristics (David/Sørensen, 2016), all these artefacts belong to quite straight (elk) or curve (red deer) elongated crutches from what constituted natural antler tine from large cervid with a bi-truncated top, and ready to be used so.

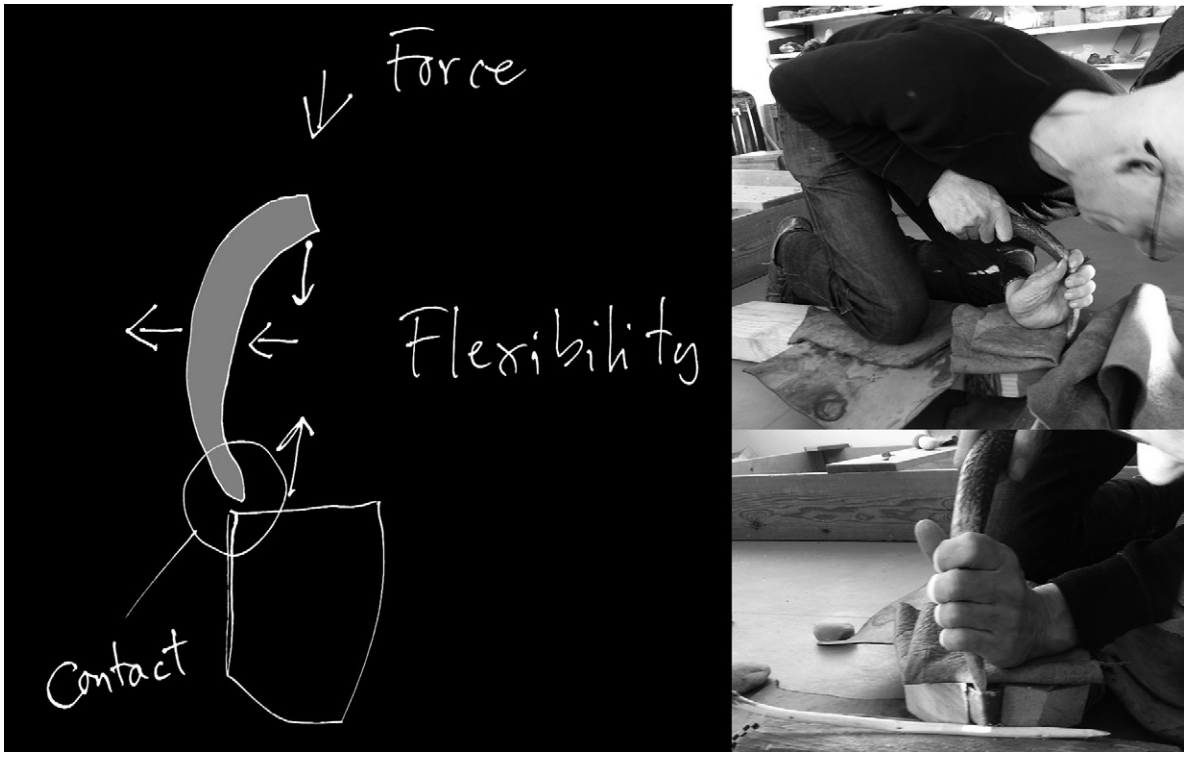

Figure 4. Mechanical principle relating to the technical action and gesture applied using a Mesolithic replica of curve red deer antler crutch for pressure flaking in debitage of handle flint core (with Mikkel Sørensen). Illustration, É. David.

ISSUES FROM EXPERIENCING PRESSURE MODE ON CURVE ANTLER CRUTCH

An experimental test utilizing this type of antler pressure-flaker tool on microblades cores was conducted to discuss the way pressure technique in flint nucleus would have been acquired. The lithic products obtained are currently under study, but the data recorded from the six antlers used by the four flintknappers already lead to some questions coming from a common impression deeply felt during the replication of the recognized pressure technique: the fact that, from the start, some flintknappers show an obvious greater potential than others in using this type of crutch.

This does not seem to be linked to any particular care in the preparation of the pressure platform on flint cores because, in order to enable considering nucleus as equivalent bases for comparisons, the nucleus made available have all been very well prepared by experts already experienced in this kind of exercise (Mikkel Sørensen, Éric Boëda, Stefano Grimaldi); and, the flintknappers have all very well produced several series of bladelets of the same type of nucleus made of the same raw materials. Neither does it appear that it is a divergence due to a greater control of the mechanical principle relating to the technical action itself (Fig. 4) whose constraints had been well understood by all, as strongly evidenced by the effective experimental production of bladelets. Yet, out of the four of the flintknappers of different levels who were solicited—Mikkel Sørensen and Simon Diemer as 'experts' having respectively 15 and 8 years of regular knapping practice, and Svein Nielsen and Fabio Santaniello as 'novices' having both less than 5 years of practice—, only two who also used the same nucleus immobilization system (see Clark, 2012:76-c, and *infra* Fig. 5) delivered crutches with use wear similar to the archaeological pieces.

In the form of incises from the nipple, the latter has a compressed aspect, although in one case it has become partially crushed (in the case of Simon's work, he was asked not to regularize the tip-end of the antler tine too much by 'pecking' it - see Inizan *et al.*, 1999:147), and in the other case (Mikkel), it remained well bent (Fig. 5, lower half of the illustration). On

the contrary, the novices have completely rubbed the nipple even after regularizing it. The abraded aspect of this active part has never been recorded so far in the archaeological material that is usually found snapped or 'uncapped' in this state of exhaustion. It is possible that the quality or freshness of the antler material used was unsuitable for the debitage activity. Indeed, we note the already naturally spongy aspect of the implemented antler tine which subsequently became very damaged (Fabio). Nevertheless, the other novice (Svein) used a very high-quality elk antler whose cortical tissue was there extremely dense and abraded the tip in a similar way (Fig. 5, upper half of the illustration). As Svein also used a different nucleus immobilization system—the nucleus was clamped between two jaws made of wood and held in hand on the model of Errett Callahan and Andrei V. Tabarev (Callahan, 1985; Tabarev, 1997), after Crabtree's first investigations (Crabtree, 1968:467), later called 'mode 2' by Pelegrin (2012:471)—, it is possible that the abraded aspect observed on the antler tip could have resulted from very frequent sliding and/or unsuccessful attempts. Nevertheless, such incidents were also frequently recorded for the other flintknappers. It follows that the novices tended to technically develop the action of tearing the lithic material, rather than really trying to produce a shock wave when detaching the bladelet.

Since only the 'skilled' flintknappers produced archaeo-compatible tools, these observations could suggest archaeological productions attributable to flintknappers of equal high skill in the Mesolithic context previously mentioned. Although this is perfectly conceivable, it only suited us moderately because of the results of an earlier study which, according to lithic refitting, proposed that prehistoric productions could not be so considered; the nucleus that apparently represented the same level of expertise also delivered some technical patterns that were apprehended in terms of 'will-to-do' differences occurring supplementary to those regarding nucleus modifications otherwise understood as due to changing apprentices (Ploux, 1984). In the absence of such a study applicable to Mesolithic lithic material, the difficulty of classifying flintknappers into objectively comparable skill levels led us to group them arbitrarily by levels of expertise according to their years of experience, and also based on comparative studies where lithic productions from actual trading workshops had been classified the same way (Roux/Bril, 2005). However, it could be possible that this apparent duality 'experts vs non-experts' prevented us temporarily from realizing that our knapping implied less task

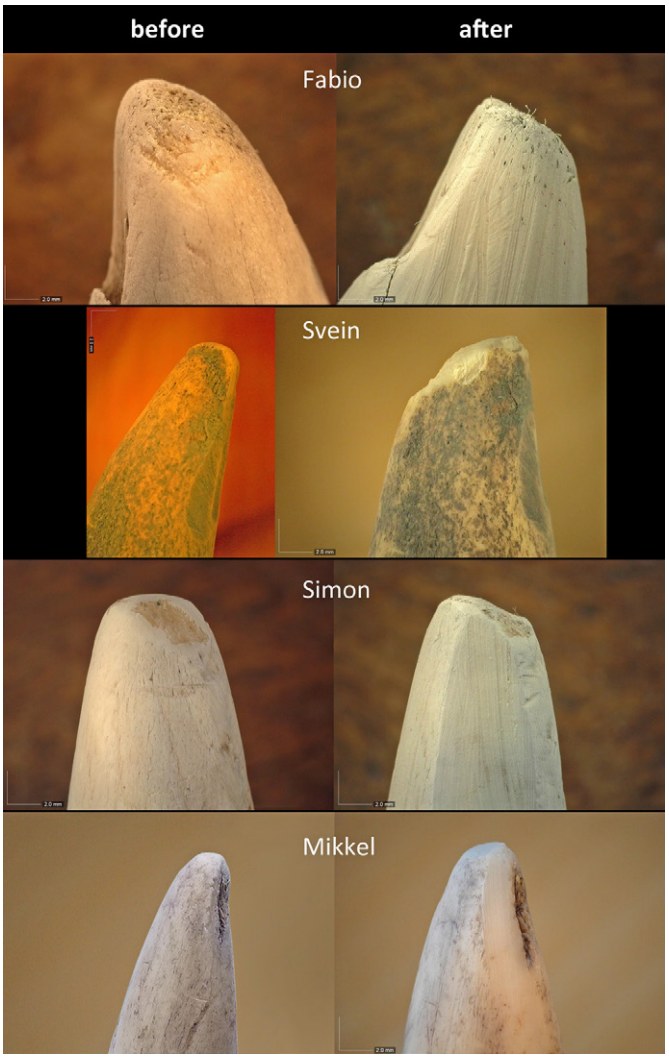

Figure 5. Aspects of the working end of experimental red deer antler crutches (left or right view) used by the flintknappers to produce several series of bladelets of the same type of nucleus made of the same raw materials before nipple needs rejuvenation again. Magnification 20×. Scale, 2 mm. Illustration, É. David

automation (like in the case of trading workshops economy) than automatism in the knapping itself or how to proceed with any stone core to obtain an available detachment. Actually, by changing framework, it became apparent that the practice of pressure debitage with the antler crutch did not once refer to a task automation (even minimal) since the production of only one bladelet often necessitated readjusting each time the body position, the nucleus, and the tool complements. On the other hand, in the analysis of their debitage, those flintknappers who showed the highest 'level of expertise' would clearly refer to a better individual technical mastery (Ploux ,1991), as expecting from their production in a high number of regular products (Brenet *et al.*, 2013). The fact of being 'skilled', that is to say to be able to detach the bladelet in an optimal way (in other words without thoughtlessly damaging the antler crutch), is also demonstrated in the way (just as optimal) they managed the nucleus by taking advantage of, or looking for, a less resistant spur, the one that required the application of a minimum force for the stone material to fracture with best control of its way to detach. As far as it went, even when we told the 'novices' where the appropriate pressure point was (because the pressure point is not placed as close to the core's edge with this pressure technique than as it would be if using the more familiar copper-tipped pressure-flaker, for instance - see Callahan, 1985:35), and advise them how to proceed thoroughly, *i.e.* pressure on the exact pressure point, the less experienced flintknappers always greatly damaged the replicated antler crutch. Considering that lithic production was in practice achieved—detachment of the bladelets occurred and extracted products were available (even less often in a good shape for the youngest novice, Svein)—, it was deduced that the abraded aspect or non archaeo-compatible pattern of the replicated crutches could relate more to issues in dexterity (performance) than to motor skill (competence) solely (see Mestre, 2004).

We therefore examined what could account for dexterity (Bernstein, 1996[1953]), understood here as the potential that led flintknappers to undertake preferentially, to be significantly invested, or to come to 'appropriate' technique. In other words, it appears there would be differences of 'possible' or 'power-to-do' between the flintknappers, not implying an act necessarily conscious nor in relation to a cerebral faculty or a physical capacity in particular. In fact, field recording during the experimental test reveals, when we attach to it, very clear differences of posture even though the pressure movement of the flintknappers during the debitage action was perfectly identical. In the case of flintknappers delivering archaeo-compatible crutches, the whole body tilted over together with the crutch to exert a pressure on the nucleus (Fig. 6, left); conversely, in the case of others, only a part of the body was solicited—as evidenced by the tendency to require several points of support with arms and elbows using the immediate environment to allow for the motion (Fig. 6, right). During the knapping, while using the same type of core and antler tool, tool complements and immobilization system of the nucleus, the flintknappers thus followed through differently in an inevitable micro-tilting of the nucleus from its initial place until the bladelet popped off. The fact that the used antlers were better preserved, that is close in the aspects of their active-end to those archaeological, by the flintknappers who showed the most dexterity seems to stem from the fact that the crutch, once well positioned, was pushed in synergy with the entire body in motion. This observation leads us to having to take a holistic view of the technique.

The implementation practiced *ab initio*, a condition of the technique acquisition

Since the experimental requirements were equivalent, it did not appear that this difference between the 'best invested' flintknappers and the others comes from a better psychological perception on the milieu or the environment (Gibson, 1977; Lewin, 1926). The flintknappers' personal experience suggested that the body motion involved here in the pressure technique may have been driven from a former apprenticeship previously integrated during a technical practice of stone reduction. As the latter must have required exerting the physical effort rather at the level of a single anatomical segment in the individual—at the level of the pelvis only, with 'a jerk' and a bending of the knees (Pelegrin, 1984c:120) which precisely happened in

Figure 6. In the case of flintknappers delivering archaeo-compatible crutches, the whole body tilted over together with the crutch to exert a pressure on the nucleus (left, with Simon Diemer). Conversely, in the case of others, only a part of the body was solicited—as evidenced by the tendency to require several points of support with arms and elbows using the immediate environment to allow for the motion (right, with Fabio Santaniello). Illustration, É. David.

the standing pressure on the stiff straight crutch previously acquired by Fabio—, this could have acted as a grip of the *acquis*, forcing a psychosomatic behavioral 'fold' during the normal course of the technical action (perhaps also cognitive if the related coordination would be best achieved in association with mental template - see Granit, 1980). This inhibitory tropism will have even prevented the optimal reach of the force to be applied on the nucleus by practicing the technical execution entirely, in this case being really curved when pushing on oneself with feet. This executive motion of the entire body tilting over together with the crutch appears indeed to be essential to carry out most efficiently the exercise of this pressure technique, that is to say knowing how to negotiate the expected course of the curve crutch from the contact point on the flint core according to an axis resulting from the effective motion given by the individual. So, to speak, it is the whole body that must be fully mobilized on the curve crutch during the pressure flaking so that all the ideal conditions involved in the execution of the pressure technique (see Fitts, 1954) relating to the grip, the pressure point, the pressure exertion, the pressure angle, and also the amplitude of the shock wave propagation, as we understood it through this experimental test, are met.

In the case of the youngest 'best invested' flintknapper who immediately 'seized' the technique (Simon), with, for main corollary, the diligent practice of the (direct and) indirect percussion in knapping, there was a small prior-experience of use of pressure mode on the flexible straight crutch (rather than stiff). From Crabtree's pioneer experimental tests on the basis of using replicated (sub)historical items, it is now known that this latter was made of a long club of wood with the one of its ends, replaced in attaching there a harder material for that this pressure head could suit with a better grip on the striking platform of the lithic core (Crabtree, 1968). Once implemented, such a composite tool was hold with the two hands to crush on the core platform's edge in abdominal pressure (with use a protection to prevent from possible gut's perforation). From Pelegrin's revision of this kind of straight crutch, certain club, called flexible, would particularly allow for its slight curvature during effort (Pelegrin, 1984c:120). In the case of Simon, it is correspondingly the natural curvature of the antler that would have been similarly integrated. As opposed to Fabio, based on the knowledge acquired from his previously pressure flaking understanding in practice through a flexible stand, its comparable potential—the antler matter is precisely an osseous material more viscoelastic than other hard organic tissues (MacGregor/Currey, 1983), which therefore allows it 'to store' the energy required during the pressure at the level of its natural curvature—, this curved antler pressure-flaker tool was solicited with the same rendering and according to the same possibilities as the standing on a flexible straight crutch, that is to say by experiencing the properties of the 'flexible' implement mechanism, rather than by applying only the principles of pressure. As the straight crutch (flexible or stiff) for the action of the pressure requires a two-paths muscular effort—downward pressure followed by 1,250th of a second of the one called outward pressure (Crabtree, 1968:Fig.11's caption)—, it is possible that the lack of experience of Fabio resulted in him not properly managing this coordinate effort. However, the static nature of the upper body part of this flintknapper during the task demonstrates that the executive body motion he actually developed referred immediately to the one he used in his previous practice, and which he acquired through a stiff stand, thus demonstrating a body motion non-compatible to the one to be produced that was requiring a much higher velocity. In fact, by seeking only the support of one of his limbs especially during the effort, only the last action time has been fully realized, that is the outward action, as evidenced by the very abraded aspect of the crutches he produced experimentally. And this, even though all the other stigmata (impact marks as well as lustre aspects that exclude also any more possible use of other systems for this kind of curve crutches) correspond in all points to those found on the Mesolithic pieces whoever the flintknappers were.

Of course, these observations would need to be reiterated from a larger experimental corpus by analysing the bio-mechanical recordings of physical effort during action, considering however the whole-body during pressure technique instead of the upper limbs only as classically seen (see Biryukova *et al.*, 2005). By integrating in real time, the effective chronological events in the nucleus, it would also be possible to work on quantifiable data (see Bril *et al.*, 2000). As long as their personal history is recorded in the exercise of the stone reduction, less to evaluate flintknappers' competency in techniques than to tune inter-technical compatibility through their use of implements, it is already expected from the analysis of productions including in terms of stigmata that a certain variability exists between the stone products obtained in pressure debitage on the flexible use of the pressure-flaker tools—from the 'best invested' flintknappers—contra these deriving from the crutches used in a 'static' mode—from the 'already folded' flintknappers, who would have eventually incorporated a 'compartmented behavioral answer in executing technical action' from a previously acquired knapping technique, as when standing on the stiff straight crutch (this, regardless of the differences of patterns expected between all of these and the one detached with a copper-tipped crutch).

Conclusion from the experimental test

Our first observations on the replicated (shoulder or chest) curve antler crutch show that only the flintknappers who were able to mobilize their whole body during technical action were able to produce archaeo-compatible pieces, regardless of years of apprenticeship.

The inference deriving from this first experimental test on pressure debitage on chest antler crutches coupled with the survey on flintknappers' own evolution in their technical practice of stone reduction suggests, the condition for the acquisition of the technique produced with pressure-flaker tools in the Mesolithic could have rested on a psychosomatic behavioral pre-requisite, potentially integrated prior to the task, in principle independent from the skill levels involved, and not using an already known 'conditioning' practice in stone knapping which maintained the body in a far too static position during the effort. On the contrary, this pre-requisite always solicited the human body as a whole, in a one and only driving force. Therefore, one could interpret the differences in the crutches experimentally based on the relation to the implementation.

DISCUSSION

The relation to implementation, a proxy to grasp mechanisms of technical change in prehistory

Given that the flintknappers who have 'best integrated' the antler crutch for pressure flaking are also those who have first and fully mastered the practice of (direct and) indirect percussion during their previous learning experiences, it is possible that the effort provided during the exercise of pressure on the curve crutches can actually be linked from an intuitive perspective to an implemented punch through which the body more fully participated to the knapping; the intermediate piece—the deer antler tine used as punch or crutch—then intervenes indifferently in the indirect or in the pressure knapping mode as a *chasse-lame* (Poplin, 1979 & 1980). It should be noted here that it is not uncommon to record on archaeological crutches that have become thick and very rounded in the active part, that they were utilized as a punch at the last resort (David/Sørensen, 2016). In this case, the curve part of the antler is removed for that the remaining straight part can be reshaped to serve as punch (*ibid*.). This attests to a real permeability between the two modes of knapping with regard to how the antler was commonly employed. These assumptions on the role of the knapper in this technical exercise will nevertheless have to be corroborated by a much larger study, notably regarding the body motion expected to be achieved with a 'reflex' trait in the punch technique.

The systematic recording of the solicited flintknappers' previous experiences with stone knapping suggests that practices acquired *ab initio* may have had a direct impact on their ability to integrate or not a new technique; even if it is based on the same motor skills (hold and push, here). It would require 'reflexivity' in the case of the pressure flaking with the curve and the flexible straight crutches; on the contrary, it would require 'passivity' in the case of the stiff straight crutch. The flexible practice did not prevent Simon and Mikkel, mainly focused on (direct and) indirect percussion, to project themselves into the curve antler crutch's experience, unlike the other flintknapper taken in comparison (Fabio) who, perhaps because he had formerly been introduced to the stiff straight crutch, severely damaged the replicated curve antler crutches in use; it seems he was always challenged in his approach to anticipate (Granit, 1980) or integrate the new kinematic (see Varignon, 1700); and that, whatever the stabilization systems used and whatever the forms of nucleus tested ('handle' microblade core, conical, and 'Yubetsu'). In the cases herein of a replication (by Fabio and Simon) through a simple reading and/or an observation (of the movement and device of Mikkel), the conditions for the acquisition of the technique could be based then on the technical practice already acquired as the latter would already be familiar in terms of implementation generated by the human operator: flexible tool/reflexive mode[1]/whole body involved versus static tool/passive mode/body segment involved. The technical behavioral prerequisite in this case would lead to the possibilities of technical 'transduction', that is to say to the potential of a technique

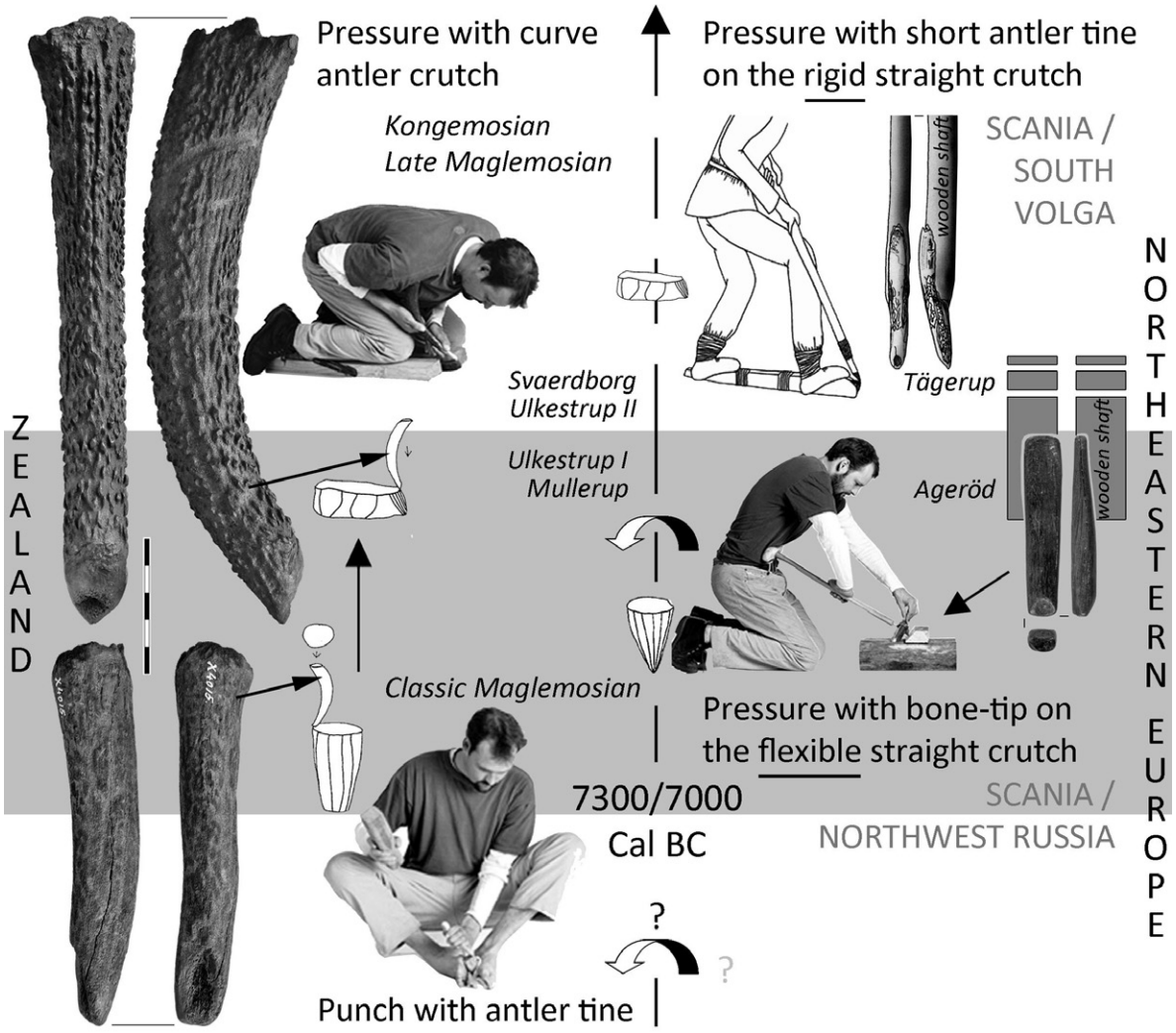

Figure 7. Recorded morphologies of used pressure flaker tools fully support the transduction hypothesis developed here on the various pressure modes possibly involved at the end of the 8th millennia calBC mainly through one axe of diffusion along an East-West gradient via Scania, for that pressure flaking in debitage on the flexible mode (straight crutch) is also recorded in bone industry (grey). Drawing of the well-preserved archaeological rigid crutch, after Karsten/Knarrström 2003:144. Illustration, É. David.

that could propagate (at psychosomatic scale) through the (technical) activities of individuals (Chabot, 2003:85; Stiegler, 1998). In other words, the fact of 'appropriating' a hitherto foreign technique would be more borne out of technical inter-compatibility (possible-to-do) than of the learned aptitude of the knappers (skill). This hypothesis promotes interactive cognition where technique preserves key relationships to environment at empirical scale (Kirsh, 2009).

The perception of technical change in terms of technical skills or competency levels or abilities only would then considerably limit the possibilities of characterizing technical transfer mechanisms because of the large role of implementation in the emergence of new techniques and material cultures during human evolution. The lesson learned here from the few observations on the permeability potentials between distinct techniques, whatever the modalities of realization (pressure or percussion)—as this one brings closer at the psychosomatic and functional levels to the flexible straight crutch, the curved as well as potentially the punch antler tools—, leads in the concerned archaeological field to consider how important is the relationship to the tools and how these are practically used in their contribution to understanding cultural shifts from archaeological sequences (Fig. 7). In other words, it would be less in the *modus operandi* or planning than in the *modus agendi* or implementing (Geiger,

1942)—the human agent in its individual relationship to implementation throughout *habitus* (Mauss, 1934)—that one would understand the mechanisms of technical change in Prehistory.

Evidences in the archaeological field

Keeping the idea of the permeability or transduction potentials between distinct knapping techniques according to the perspective of the relation to implementation, it appears that the acquisition of a pressure mode in debitage could eventually have been linked to the direct observation of a foreign practice: the standing pressure on the flexible straight crutch in this case. When searching for its evidence, it is actually found in the archaeological material of the surrounding regions, notably in Scania, Ageröd (Sweden), where a very short segment taken in the cortical thickness of a long bone of large mammal represents a good candidate. With a length of 67 mm, a width of 13 mm and a maximum thickness of 9 mm, it shows, at its thickest end, an active part of compressed aspect which has been significantly damaged by micro-scars developed in facial-axial. With these dimensions in this state of exhaustion nevertheless complete, its profile and the other stigmata suggesting that it was fixed to (the open socket of) a corresponding elongated wooden club (Fig. 7, right picture grey framed), it could well represent the head of a flexible straight crutch, rather than, in agreement with stone inserts dimensions that theoretically exclude the so-called 'modes 1 and 2' on the site (Pelegrin 2012), a hand-held crutch (*presseur*) as it was first suggested to us for the publication of the princeps census of Mesolithic knapping tools (David/Sørensen, 2016:133, n° 11). The same can be mentioned about another similar antler piece from the Zamostje-II 1991 site, in Russia (*ibid*. & 125, n°2). It is a regular tip-end of an elk tine whose slightly larger base was used as an active-end for pressure flaking, as rendered by its compressed aspect. The other patterns remind that its butt-end, which corresponds to the natural tip-end flattened by sharpening, was socketed into a longer piece (wooden element), calling though for a plausible use as a flexible straight crutch-head, first published as such (David, 1996:19). It prefigures this part of Russia (Dubna River Valley) as one of the initial geographical zones from where the pressure practice on a reflexive mode would have originated during the Mesolithic. The bone-head of a lever device in another site located more north of this central part of the Russian plain, Veretye (Ošibkina, 1989), where it was found still stuck into its 'L-shape' wooden handle-shaft, shows however that several regions might actually have been involved in the spread of the pressure debitage 'reflex' practice from Russia towards Europe (David/Sørensen, 2016). As already said, there are also occurrences of elongated straight antler tines from elk relevant to a particular type of crutches in Denmark; thus, a possible integration of various pressure debitage techniques—standing on flexible straight as well as other clamp holding positions involving the lever principle—in the same time, whether curve, elongated or socketed, the crutch antler forms are invented in the Maglemosian culture (M3).

This transfer evoked between various 'reflex' techniques involved in the pressure flaking would be more plausible than the one which refers to a practice directly from the oldest standing pressure found in Russia's Volga-Oka interfluve, as suggested by previous lithic studies (Sørensen, 2018; Sørensen *et al*., 2013). In the light of the present investigation and, on this subject, since it also refers to more squat forms in antler (made of a thick-straight and short complete deer antler tine at Ivanoskoye layer IV, for instance–Cf. Zhilin, 2014:Fig. 43-1 & 2), it could clearly be linked to a more static practice of the pressure when standing on a straight crutch, hence the stiff implement. In turn, this 'passive' mode[1] would have happened on the Southern Scandinavian territory only a bit later, as recorded in flint in the last phases of the Maglemosian and in bone industry in the so called 'Kongemosian culture', then located in Scania also; the stiff straight crutch was in fact found there as a complete implement whose head, still fixed in a perennial way in the extension of a stiff club of wood, consisted in a thick-straight and short complete antler tine bound there (Karsten/Knarrström, 2003:143).

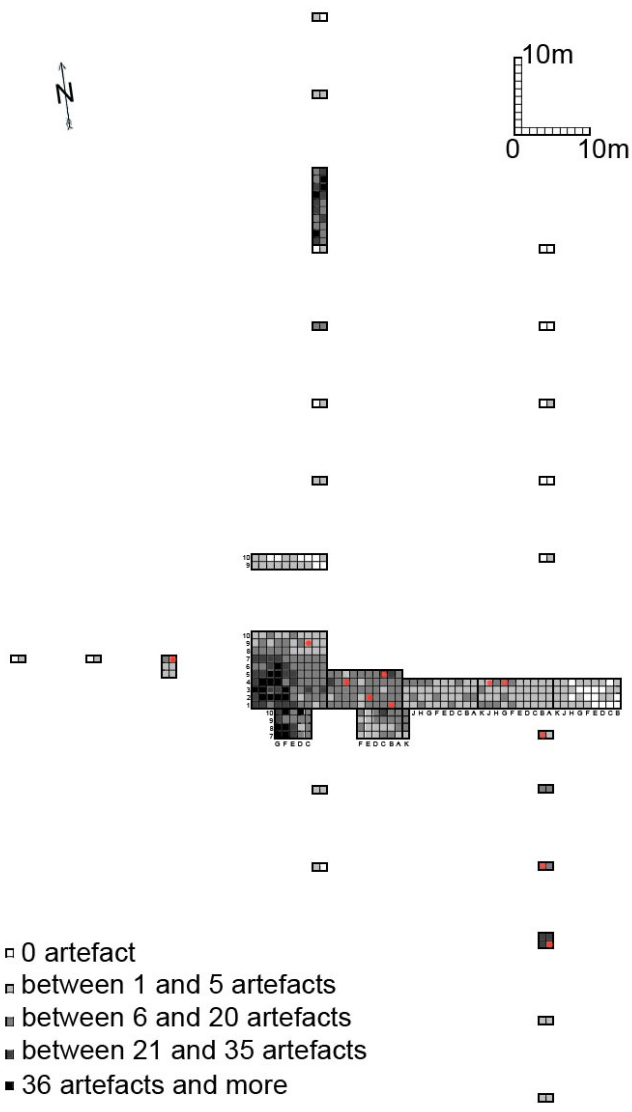

Figure 8. Distribution of the curve antler crutches (red dots) used in stone pressure flaking as recovered in the cultural layer amongst the faunal and flint artefacts at a Maglemosian site from late phase (Sværdborg I), after K. Friis Johansen excavations 1917-1918 from his notebooks stored at the National Museet Copenhagen (N=15 – see David/Sørensen, 2016:Table 1). Illustration, É. David.

The invention of the curve crutch, it seems a Maglemosian disruption from punch technique

Over a few centuries, there would therefore have been in Southern Scandinavia at least two successive contributions relating to the pressure practice as used in debitage, each corresponding to two distinct knapping modes—'reflex' then 'passive'—as individualized in the bone material in Zealand and Scania: respectively, the technique on the flexible straight crutch dated 7000 calBC (Maglemosian 3), and that on the stiff straight crutch a bit later around 6800 calBC (at its highest venue, Maglemosian 4 and 5), surely 'Kongemosian'. These two distinct contributions in stone reduction would have been independent of each other; this particularly would explain the very different aspect of the nucleus, knowing that both types of cores have been reduced by pressure (Callahan, 1985), which are prismatic in Maglemosian phase 2 and 3, then (slowly?) 'replaced' during phase 3 (Andersen *et al.*, 1982) by those known as 'handle' cores in Maglemosian phases 4 and 5 (Andersen, 1984; Becker, 1953; Brinch Petersen, 1973), and the 'Kongemosian' (Sørensen, 1996). In line with the previous identification of a published unique 'T-shape' antler crutch at Mullerup (David, 1999: Pl.10-1), together with the introduction on this eponymous site dated to Maglemosian phase 2 of composite forms of tools with inserts (David/Kjällquist, 2018), the use of pressure technique already in (the last stage of) this cultural phase has also been recognized from the lithic at Ulkestrup Lyng Øst 1 (Sørensen, 2006). This presumes the existence of older contacts with groups of the East, notably with established populations in Scania (Sweden) traditionally familiar with insert technology, probably maintained at the highest since the phase of Mullerup (7500-7100 calBC), before several chronological 'waves' in Zealand apparently occurred from the Maglemosian conception of cores in the process of integrating pressure knapping (Fig. 7). These observations find echoes in recent studies on lithic productions from other parts of the Scandinavian Peninsula to indicate that several pressure techniques would have coexisted within this territory (Damlien *et al.*, 2018).

Only familiar then with the direct percussion in the initial phases of the Maglemosian (M0 and M1), Danish groups will have integrated these new way and waves shortly after or even at the same time as the indirect percussion (Sørensen, 2006). In Denmark, it is true, the adoption of the pressure flaking practice actually tightens to the classical Maglemosian industry just as

supplementing it with a few composite tools (slotted points) and peculiar shapes of nucleus that have been knapped according to the new technique on the antler crutch. Thus, when the pressure debitage is used in Denmark, we do not see any industrial replacement but simply a superimposition of technologies including new materials in debitage: a new form of microblades cores, the (already known?) antler punch, and the totally new elongated antler crutch elsewhere unknown. Under the *modus agendi* evoked above, the invention of the shoulder/chest curve or socketed elongated antler crutch for practicing the newly acquired pressure flaking in Zealand appears then as a 'disruption' (Stiegler, 2016): by appropriating the 'reflex' mode to reduce flint with antler tine precisely, it seems Maglemosian flintknappers would have known how to reinvent pressure debitage from exploration of (or from prior) practice of punch since it combines all in one a flaking technique for termed production and an antler-tool used for its reflexive potentiality (it would not be so argued if the antler would not have been used as a whole, as in the case of a splinter for instance).

Indeed, as observed in the experimental test, the flintknappers who 'easily seized' the Danish chest antler crutch for pressure debitage were also those who already mastered the punch technique. As its practice in the Mesolithic also requires the use of a deer antler, it is felt that knowledge of the new pressure practice could have generated in reality the invention (in Derrida's meaning of the term -Cf. Derrida, 1998[1983]) of the implementation observed in the pressure flaking on the flexible straight crutch, from the punch. The (preceding?) practice of indirect percussion could possibly have acted as a real catalyst by the very fact that it requested an implementation that became familiar and, as we have said, was open to permeability. Moreover, the flint knapping as occurring in Denmark seems to have retained at a first stage the same cores' conception between the ones knapped with the punch and the others reduced with the curved antler initially (Sørensen, 2018). Actually, between the phase (M2) and when pressure debitage was fully acquired (M3), the nucleus has preserved prismatic shapes and smooth platforms (the farther east populations used to facet them instead). This would explain why the invention did not spread, if not within the Maglemosian groups themselves through their own mobility, although the eventual disadvantage of the faceting of the cores has not been particularly addressed in our experiments. Those Eastern populations living in bordering regions in connection with, it is true, a technology more turned towards the elk (David, 2017)—thus with a preference for the thick quite straight and short complete antler tines when designated as crutches—would however have not favored the Maglemosian pressure-flaker tools, obviously improper to the Eastern way in stone reduction if not by removing the tradition of faceting the cores itself.

The Maglemosian 'reflex' mode of pressure has also concretized in the form of an exceptional concentration of crutches taken here from curved or straight antlers (Fig. 8) but, in any case, elongated, in major sites (Ulkestrup, Sværdborg and Holmegård) of the Late Early Mesolithic in Zealand (David/Sørensen, 2016). The reason for also finding similar crutches in the neighbouring traditionally Eastern-oriented Scanian region, technologically (David/Sørensen, 2016:133, n° 8-10), but in a few amounts only, seems deriving from the fact that this region corresponds to the border-zone area of the Maglemosian 'core' territory. The concentration of elongated antler crutches on various sites of typical Maglemosian culture suggests a kind of emulation between flintknappers, perhaps stimulated in reality by the form of sociality or the inter-objectivity (Latour, 1994) that the practice of the pressure debitage itself may eventually have brought in situation (Mauss, 1983[1950]:372). Based on the available radiocarbon dates (Damlien *et al.*, 2018; David/Sørensen, 2016; Sørensen, 2012; Sørensen *et al.*, 2013), this scenario does not exclude the integration of new groups into Zealand, but the disruptive nature of the curve crutch shows that the demic arrival, if any, was composed of only a few individuals, and that it did not affect at first the Maglemosian evolution in its material culture during this end of the 8th millennium calBC. So, to speak, even though it seemed to appear in a brutal way, the technical change which saw the introduction of the pressure knapping and insert technology in Zealand probably sprouted through an evolution of regular or successive inputs but over a

few centuries on a Scanian-Zealandic line where contacts were probably already frequent on the Western Baltic (Sørensen/Casati, 2015). Just like the stone technology, the one inscribed on the bone used to reduce stones suggests contacts between the Eastern groups who held the composite tool and the pressure practice and the Western groups who did not yet use them on a daily basis from 7500 calBC in Southern Scandinavia (Zealand, Scania). Contacts would have been rather direct given the need through observation for integrating the new practice (Pelegrin, 2006). It is indeed difficult to imagine that the pressure debitage could arise in Zealand only from the observation of the inserts carried by previously acquired composite forms in material goods and which could have just changed hands, for there are techniques that involve impregnation if not training, just like the pressure flaking (Pelegrin, 2012:495).

CONCLUSION

Curve antler pressure-flaker tools examined in this paper it seems attest to both an acquisition by direct contact of new knapping practices—indirect percussion and pressure flaking—in the latest stage of the second half of the 8th millennium calBC, and—if we believe they are culturally strictly contemporary to the rest of the archaeological material characterizing the Maglemosian in situ (phase 2/3)—to a 'disruption' in the whole territory of Southern Scandinavia where Maglemosian culture was established. Applied with elongated antler tines bi-truncated at their tip-end to serve directly as pectoral or chest crutches, the pressure debitage practiced this way was indeed completely new to neighbouring contemporary worlds. From the replicated antlers used as pressure-flaker tools, this Maglemosian pressure technique bears in its instrumentation a reflex-mode that is close to that occurring when standing on the flexible straight crutch for microblades cores' reduction. In this, it suggests an initial incoming introduction route from abroad, not from the Northeastern part of upper Volga in Russia (Volga-Oka interfluve with the Ivanoskoye 7-layer IV pressure tools, here) as it was classically assumed but, instead, from the adjacent Scanian area in line with further evidence from the Northwestern part of upper Volga (Dubna River Basin with the Zamostje pressure flaker-tip head, here). These different geographical areas represent in upper Volga sites that belong to a single Upper Volga Complex which employed the pressure knapping in stone reduction (Lozovskaya/Lozovkiy, 2003; Zhilin, 2012). These are either mentioned as representing a single Butovo Culture (Zhilin, 2009) or, conversely, constituted of various cultural components (Lozovski, pers. comm.). The region of the great lakes in Russia (with the Veretye lever pressure device, here) shall be added then to the introduction route from the Northwestern area of the upper Volga of the Russian plain. When we attach to it, this is fully supported by archaeological evidences from several organic finds. Their exact recording show however that the possible scenario might have been relatively complex locally, around the Baltic, with (a) not zone(s) in Scania.

It seems, when it was introduced and adopted in the Maglemosian area, the pressure knapping was more a new concept in debitage than a technique. How pressure debitage was applied in details is attested in the Maglemosian antler industry as illustrated through the invention of unprecedented ways of pressure flaking emerged in Denmark with use of unknown antler crutches (the 'T-shaped' shoulder crutch at Maglemosian phase 2, the numerous chest elongated crutches at phase 3-5, and at 'Kongemosian'). It is also evidenced in flint industry there with relation the appearance of these crutches, with that of a new kind of (handle) cores that was previously foreign to Maglemosian culture, for which the prismatic cores with unfacetted platform were mainly familiar. But, associated to such cores, the effective adoption of the antler pressure-flaker tool on a stiff stand is evidenced from a dated Scanian piece on a later period only (Kongemosian). This suggests, the idea of pressure debitage with handle cores seems arriving before use of the stiff straight crutch itself in the region from available organic evidence. Yet, it seems, the curve antler crutch was particularly well suited to this core-type, meaning that it would have been introduced precisely because it was more adapted to the use of the reinvented Danish pressure flaking technique (not reverse). In this, change in

the Maglemosian material culture would have derived from technique transduction for which introduction of a new concept in flint debitage would have follow, although first due to a substantial interest in the somehow attractive foreign insert technology from anciently-rooted (regular?) direct contact with Eastern populations. When we attach to it, recorded morphologies of used pressure flaker tools fully support the transduction hypothesis developed here on the various pressure modes possibly involved at the end of the 8th millennia calBC through two axes of diffusion along an East-West gradient via Scania:

With use a reflexive mode:
Bone or antler tip-heads associable to the straight flexible crutch from Russia (Dubna River Valley, in addition to the region of the great lakes of the Northern Russian plain for a 'L' shape lever system);
With use a disruptive reflexive mode:
Elongated and/or curve antler crutch in the Maglemosian context only;
With use a passive mode:
Short straight antler tine associated to the straight stiff crutch from Russia (Volga-Oka interfluve), and of a younger chronological stage (7th millennium calBC) when from Scania.

Our observations from recovered facts on the Maglemosian bone and lithic archaeological material suggest that diverse knapping modes did co-exist contemporarily and even initiate a cultural shift in the Danish Mesolithic. This is in line with the idea that various traditional conceptions in the use and the production of a tooling may have occurred at a same time locally (for other Postglacial contexts, see Berg-Hansen *et al.*, 2019; David *et al.*, 2022).

PERSPECTIVES

By pointing out the putative importance of the relation to the Technique in the interpretation of cultural evolution from archaeological material, we based our study on different fields of investigation stemming from the holistic analysis of some prehistoric technical practices. From a pure analytical perspective, it promotes a techno-functional study with a focus on implementation linked in its experimental understanding more to the technical execution and the operability than to the technical modality and the productivity. The continuation of this research, based on further experimental and archaeological analyses should lead to a more detailed characterization of the various knapping modes, as newly apprehended here, in order to grasp transfer phenomenon more in the details, notably between regions in the Northern and the Southern parts of the Baltic Sea, and the possibility to identify the exact pressure flaking technique from patterns on the lithic.

Note

The term (knapping) 'mode' is employed here in reference to the execution of a technical task through which the body-motion involved is either passive or, conversely, reflexive, regardless of the type of implement used. The term was first employed in reference to the differences in body-position (Pelegrin, 2012). This paper, however, supports that the use of any type of implement causes anyway subsequent body-positioning when performing pressure knapping, thus almost unlimited attitudes.

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RÉSUMÉ

LE MAGLEMOSIEN AU CONTACT : L'INVENTION DISRUPTIVE DE LA PRESSION À LA BÉQUILLE COURBE, 7000 CAL BC

Dans la recherche sur la raison du changement technique en préhistoire, des marqueurs d'ordre psychosomatique sont apparus en travaillant sur l'ontologie de la technique à partir de la reproduction expérimentale du geste technique impliqué dans le débitage par pression. Le résultat des enregistrements a été analysé en découplant les données observées des inférences issues d'une visée progressiste de l'évolution technique de l'homme. Nos déductions n'ont pas uniquement découlé d'analogies recensées dans les aspects de surface entre pièces reproduites et pièces archéologiques mais d'une dissociation menée dans l'analyse entre réalisation technique et habileté technique. L'évaluation du niveau de compétence des tailleurs de silex n'a alors pas été fondée sur leurs années d'apprentissage mais sur leur habileté à utiliser un outil-presseur (béquille courbe) avec efficacité (de manière à ne pas l'endommager), indépendamment des effets positifs obtenus sur le lithique (débitage effectif de lamelles). Nous avons déterminé qui était un tailleur investi (expert) versus un tailleur peu-aguerri (non-expert) en examinant ce qui n'a pas fonctionné dans l'expérience. L'examen a porté sur les cinématiques 1) du corps pendant l'action technique et 2) de l'outil en bois de cerf dans le cours de la modification de sa partie active par l'action technique.

Bien que préliminaires, les résultats font apparaître que le modèle précédemment suggéré, selon lequel les populations préhistoriques auraient adopté les différentes pratiques de pression selon un cadre

progressant en chronologie, de la plus simple (à la main) à la plus complexe (système de levier), n'est pas réaliste. À la lumière de nos observations, les faits recensés à partir du réexamen du matériel archéologique osseux du Maglemosien suggèrent que divers modes ont coexisté de manière synchrone et ont même initié un changement majeur dans la culture matérielle de ce Mésolithique danois marquant la transition entre ses phases anciennes (de Mullerup – M0 à 2) et récentes (de Sværdborg, M3 à 5) vers 7000 calBC. Notre approche en rapport au lithique de la technologie osseuse met en lumière un phénomène de transfert à partir de deux techniques de débitage introduites sur le territoire de la Scandinavie méridionale ayant eu pour effet de réinventer le punch en une béquille courbe aux fins de débiter par pression pour produire des supports lamellaires normalisés en silex. En mettant l'accent sur le mode réflexe par lequel ces techniques semblent offrir une perméabilité dans leur opérabilité, l'invention disruptive de la béquille courbe conduit à réinterpréter l'évolution industrielle au Danemark, cœur du Maglemosien, en particulier les changements affectant l'armement devenu à inserts et dont l'obtention requière de nouvelles formes de nucléus.

Ces avancées soulèvent une nouvelle compréhension du changement technique, ou de son refus, à partir de la connaissance des techniques du corps sur la base de ce paradigme positiviste de l'évolution des techniques, avec tout ce que cela propose à l'interprétation en termes d'interactions entre les groupes, de leur mobilité et de leur trajectoire ou même de leur disparition en archéologie préhistorique.

LONG-DISTANCE CIRCULATION OF EXOTIC TEETH AND NON-LOCAL MINERALS IN FORESTED NORTHEASTERN EUROPE 4TH MILLENNIUM BC

Aija Macāne
Elena Kostyleva
Kerkko Nordqvist

*Abstract: The Sakhtysh archaeological complex is situated in the Upper Volga area and is one of the main locations of hunter-fisher-gatherer archaeology in the forested parts of central European Russia with eleven stratified multiperiod settlements and camp-sites spatially overlapping with cemeteries and adjoining so-called ritual activity areas. The chronological framework of the complex covers a period between the Early Mesolithic (the 9th millennium BC) and the Early Iron Age (*circa *600 BC–500 AD), but the most intensive occupation takes place during the Lyalovo and Volosovo culture phases from the 5th to the early 3rd millennium BC. This article gives an overview of non-local materials recovered at the Sakhtysh sites and presents their find contexts. The majority of artefacts, considered to be imported or "exotic", come from burials or "ritual activity areas". Exotic items include ornaments and tools made of different raw materials, amber, various stones (serpentine, rock crystal, metatuff) and an animal species not native to the region (marmot). The geographic origin of these materials takes different directions within a radius of nearly 1,000 km from Sakhtysh: the Baltic Sea coast (amber), the shores of Lake Onega (metatuff), the Ural Mountains (rock crystal, serpentine) and the forest-steppe and steppe areas of western Eurasia (marmot). Most of the artefacts are ready-made objects and can be classified as ornaments (pendants, beads, rings, buttons). They have been interpreted as decorations, most likely attached to the clothing or used as personal ornaments. In the domestic contexts, only the Russian-Karelian tools made of metatuff are commonly encountered. In the burial contexts, the distribution of non-local materials shows certain patterns indicating either temporal differences in the use of different parts of the sites, the specific status of the deceased and the social group that performed the burial, or specific events during which these imported goods may have played a particular role. The circulation of diverse materials in the forest zone illustrates the rising complexity and intensification of contacts between the hunter-fisher-gatherer communities of the 4th millennium BC. Extensive exchange and communication networks exploiting the natural waterways made it possible for certain materials and artefacts, some even produced in specialized workshops, to be transmitted over great distances between the Baltic Sea and the Urals. In this context, the Sakhtysh complex can be regarded as a border point in the distribution of various exotic materials: east from Sakhtysh, amber finds are rare, and west, marmot incisors and serpentine are uncommon.*

Prehistory, hunter-fisher-gatherers, burials, resource procurement, exogenous materials, exchange network

INTRODUCTION

A recent re-evaluation of animal remains from a burial of a young female at the Sakhtysh IIa cemetery revealed a large number of marmot teeth (*Marmota bobak*), (see Kostyleva / Macāne, 2018; Kostyleva *et al*., 2018). Although materials of non-local origin (in the literature also called "exotic" or "prestigious") are previously known from the Sakhtysh cemeteries located in the forested Upper Volga Basin, the discovery of an animal species inhabiting only steppe or forest-steppe zone was surprizing and encouraged us to take a fresh look at the foreign materials present in the Sakhtysh collection.

The Sakhtysh archaeological complex (Fig. 1) in the Upper Volga area (central European Russia) includes eleven settlements and camp sites, and a major concentration of burials. The transition to the Neolithic in this region is marked by the appearance of pottery vessels around 6000 BC (Dolbunova *et al*., 2017:187), while freshwater fishing, hunting and gathering continued to be the main source of subsistence throughout the period. The most intensive

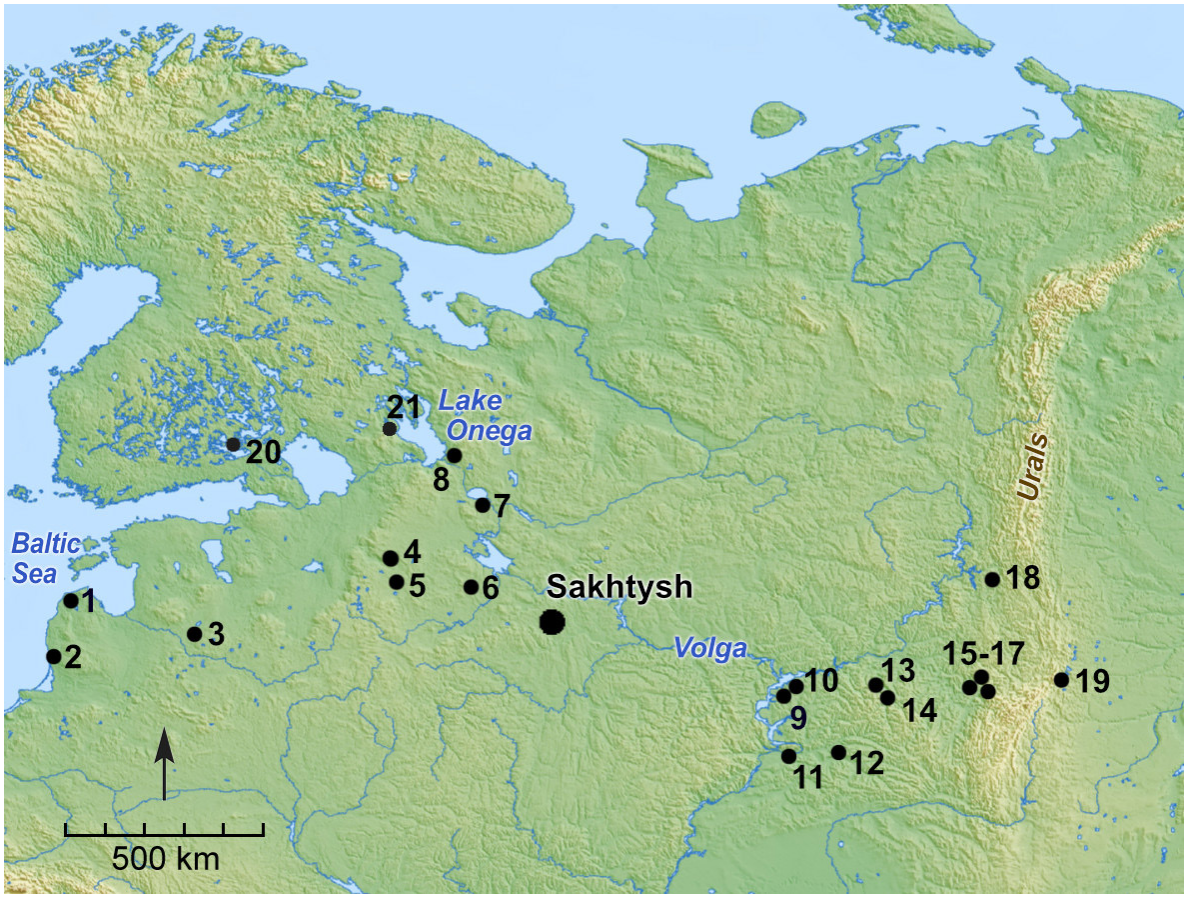

Figure 1. Location of the Sakhtysh archaeological complex (black dot) and the other places mentioned in the text. Illustration, A. Macāne (map, mapswire.com). 1 - Sārnate (Latvia), settlement site with amber workshops; 2 - Šventoji (Lithuania), a group of settlement sites with amber workshops; 3 - Lake Lubāns (Latvia), a group of settlement sites with amber workshops; 4 - Konchanskoe (Russia), burial site; 5 - Repishche (Russia), burial site; 6 - Yazykovo I (Russia), burial site; 7 - Kargulino (Russia), burial site; 8 - Tudozero V (Russia), burial site; 9 - Tenishevskiy (Russia), burial site; 10 - Murzikhinskiy II (Russia), burial site; 11 - Ekaterinovskiy cape (Russia), burial site; 12 - Maksimovka I (Russia), burial site; 13 - Mellyatamakskiy V (Russia), burial site; 14 - Russko-Shuganskiy II (Russia), burial site; 15 - Ust´-Katavskaya II cave (Russia), burial site; 16 - Buranovskaya cave (Russia), burial site; 17 - Staricheskiy Greben (Russia), burial site; 18 - Kumyshanskaya cave (Russia), burial site; 19 - Berezki Vr (Russia), burial site; 20 - Vaateranta (Finland), burial site; 21 - Shuya (Russia), metatuff outcrops and workshops of Russian Karelian tools (RKT).

habitation of the Sakhtysh area is associated with the Lyalovo and Volosovo culture phases of the 5th to the early 3rd millennium BC. In this article, the main focus is on the Volosovo-related material remains from the 4th millennium BC.

The collections from the Sakhtysh sites encompass several imported materials, namely amber, different stones (metatuff, serpentine, rock crystal) and exotic animal remains (Kostyleva/Utkin, 2000 & 2010a; Kostyleva *et al.*, 2018; Tarasov/Kostyleva, 2015). Non-local materials are mainly ready-made artefacts (personal ornaments and tools), predominantly discovered in burials and related ritual contexts. Origins of these materials can be traced to various areas in the eastern coast of the Baltic Sea, the western shores of Lake Onega and the Ural Mountains, thus giving evidence of a wide circulation of exogenous materials among the hunter-fisher-gatherer communities that occupied the vast forested zone of north-eastern Europe.

In this article, we introduce the main categories of non-local materials discovered in the Volosovo-related contexts in the Sakhtysh area. Firstly, we present each raw material class, including the artefact types and find contexts, as well as the nearest parallels and the

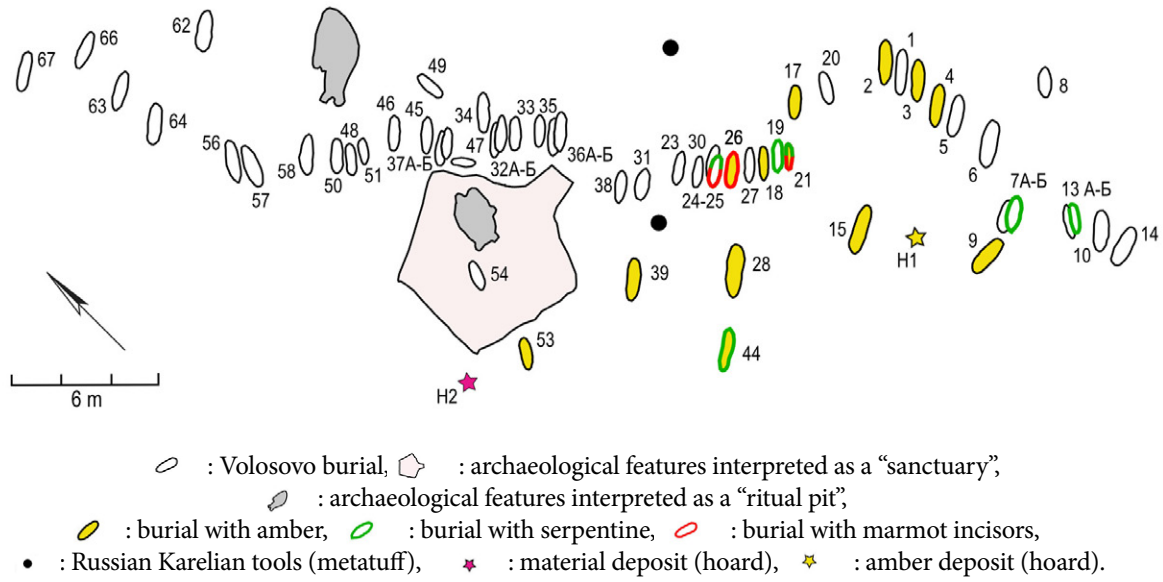

Figure 2. Map of the Sakhtysh IIa settlement site and cemetery with Volosovo burials, "ritual structures" and non-local materials marked on the plan (redrawn after Kostyleva/Utkin, 2010a:Fig. 44). Scale subdivision 2 m. Illustration, A. Macāne & K. Nordqvist.

possible origins of these materials. Secondly, the intra-site distribution is examined in order to demonstrate the use and the potential exclusivity of these materials. Thirdly, the paper explores the circulation of non-local materials over great distances. The intensification of contacts and mobility between the hunter-fisher-gatherer communities is considered as part of wider socio-economical processes during the 4th millennium BC, a dynamic period of forager prehistory.

THE SAKHTYSH COMPLEX

Since the 1960s, the Sakhtysh peat bog (Ivanovo region, Teykovskiy district) has been the subject of systematic archaeological excavations directed by D.A. Kraynov, O.S. Gadzyatskaya, E.L. Kostyleva, A.V. Utkin, M.G. Zhilin and V.A. Averin (Kostyleva/Utkin 2010a:9-10). The investigations have revealed traces of habitation since the early part of the Preboreal, *circa* the 9th millennium BC (Zhilin, 2002:101), and continuing until the early Iron Age (about 600 BC–500 AD). The most intensive use of the area is represented by the hunter-fisher-gatherer communities associated with the Lyalovo and Volosovo archaeological cultures and dated between the 5th and early 3rd millennium BC. Archaeological evidence includes stratified multiperiod settlement sites with dwellings, spatially overlapping with cemeteries and adjoining "ritual activity areas". The sites are located in the area of the Sakhtysh paleolake (peat bog) and constitute a cluster *circa* 3 km long and 500 m wide at the mouth and along the River Koyka.

Altogether 149 burials from five sites (Sakhtysh I, II, IIa, VII and VIII) located from some hundred metres to about one kilometer apart have been investigated on both sides of the river. The majority of the burials belongs to the Volosovo culture (128 burials), while the remaining ones are attributed to the Lyalovo culture (20 burials at Sakhtysh II, IIa, and VIII) and one to the Bronze Age at Sakhtysh I. The Sakhtysh IIa cemetery (Fig. 2) is the largest one and includes 57 Volosovo burials, followed by Sakhtysh VIII with 37 burials, (Fig. 3), Sakhtysh II with 19 burials (Fig. 4) and Sakhtysh I with 14 burials (Kostyleva/Utkin, 2010a; Kraynov, 1973 & 1982; Kraynov *et al.*, 1994). Sakhtysh II and IIa are the most extensively studied sites of the complex and both burial grounds are considered fully investigated (Kostyleva/Utkin, 2010a:11).

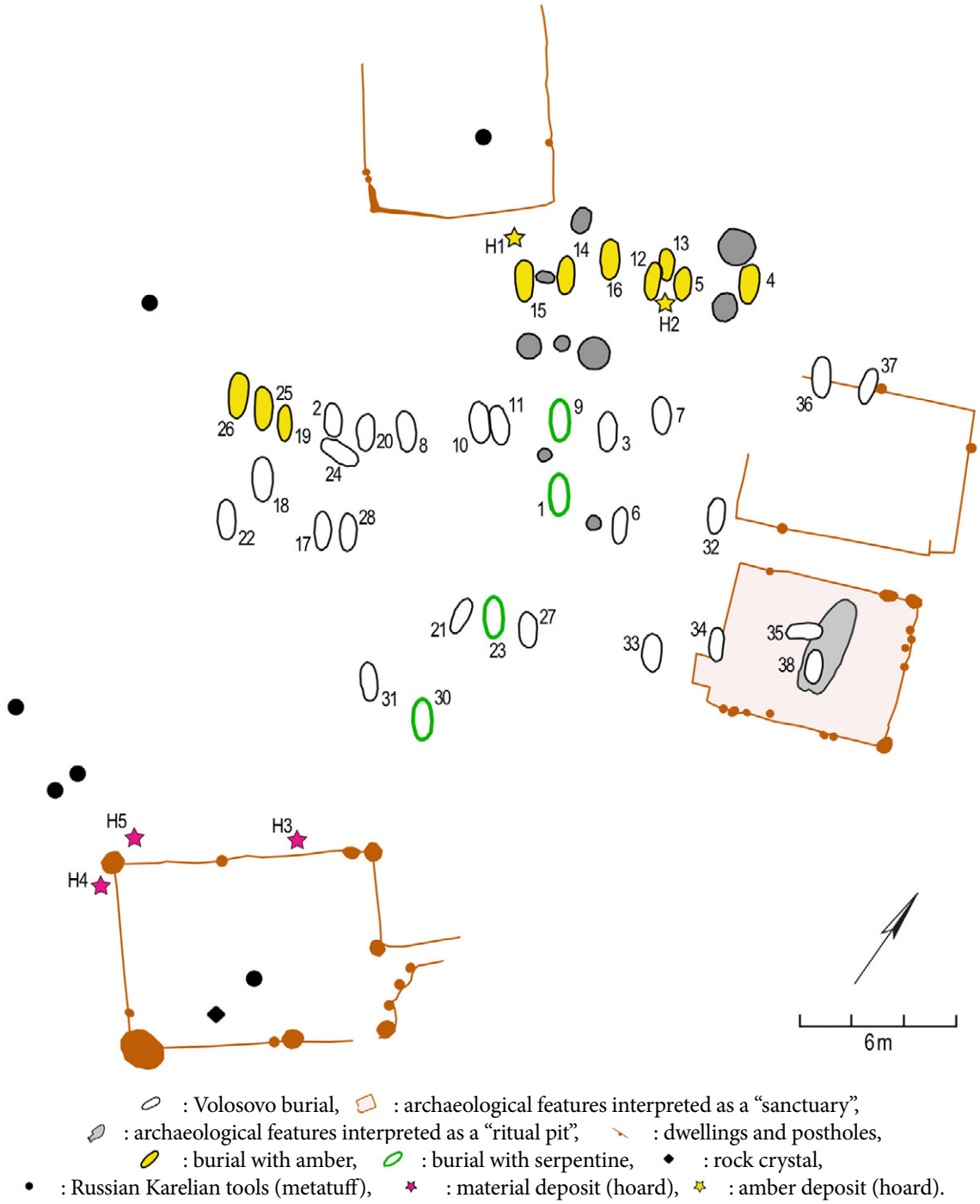

Figure 3. Map of the Sakhtysh VIII settlement site and cemetery with Volosovo burials, dwellings, "ritual structures" and non-local materials marked on the plan (redrawn, except two RKT extra finds, after Kostyleva/Utkin, 2010a:Fig. 71). Scale subdivision 2 m. Illustration, A. Macāne & K. Nordqvist.

The chronology of the sites has been based on artefact typologies and stratigraphy (Kraynov, 1973 & 1987), and some conventional radiocarbon dates carried out in the 1980s and 1990s (Kostyleva/Utkin, 2010a; Kraynov *et al.*, 1991). During the last decade, the first AMS datings were made from burial materials, as well as charred organic residues on pottery from settlement contexts (Dolbunova *et al.*, 2017; Hartz *et al.*, 2012; Macāne *et al.*, 2019; Piezonka *et al.*, 2013 & 2016). Especially the recently obtained AMS dates on animal

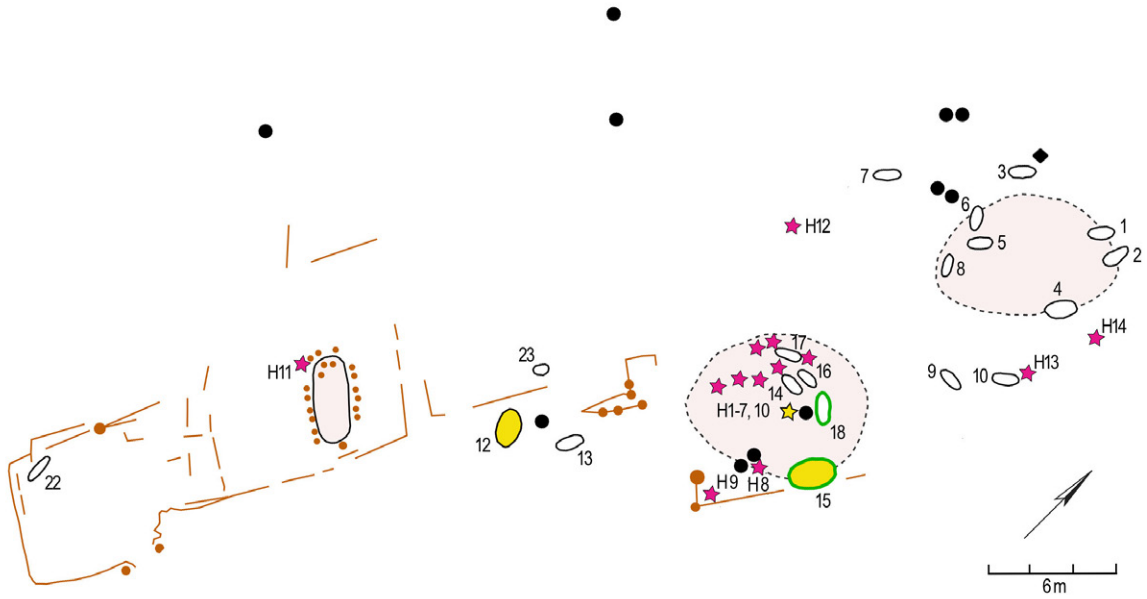

Figure 4. Map of the Sakhtysh II settlement site and cemetery with Volosovo burials, dwellings, "ritual structures" and non-local materials marked on the plan (redrawn, except three stone finds missing precise information, after Kostyleva/Utkin, 2010a:Fig. 6). Scale subdivision 2 m.
Illustration, A. Macāne & K. Nordqvist.

remains from the Sakhtysh II and IIa cemeteries allow to set the existence of the Volosovo culture here between *circa* 3700 BC and the early 3rd millennium BC (Macāne *et al*., 2019; see also Piezonka *et al*., 2013). Four newly-dated burials included objects of non-local origin. Graves n°12 and 18 at Sakhtysh II and graves n°7, 19 and 24 at Sakhtysh IIa produced relatively coeval dates (Tabl. 1) indicating that interments with imported objects at the Sakhtysh cemeteries were made in the mid-4th millennium BC (see Macāne *et al*., 2019 for full information on the datings and discussion on chronology).

NON-LOCAL RAW MATERIALS AT SAKHTYSH

Amber

Amber is the most numerous non-local material documented at Sakhtysh (I, II, IIa and VIII) with 744 recorded items (Tabl. 2). Nearly all amber comes from burials (696 pieces) and from adjacent ritual contexts (hoards near the burials, 38 items). Ten amber fragments have been documented from the settlement's cultural layer at Sakhtysh I, but the proximity of destroyed burials suggests that these amber objects may have derived from mortuary contexts originally (Kostyleva/Utkin, 2010a).

Only ready-made amber artefacts have been documented at Sakhtysh. Most of the amber ornaments are variously-sized buttons, usually with a V-shaped perforation. At Sakhtysh IIa, 342 such items were documented, while other artefact-types comprised tubular beads, discs and pendants. In the hoards, pendants are the most numerous finds (*ibid*.). The number of amber objects in one grave may vary from a single item up to several hundreds. A few extremely rich burials stand out: at Sakhtysh IIa, the most amber ornaments (nearly 90%) came from two male burials (n°15 and 28), while at Sakhtysh VIII, the majority of amber was similarly discovered in two graves (ca. 60%, graves n°14 and 25), (see Appendix). At Sakhtysh IIa, nine of the 13 deceased buried with amber were male, three were children,

Site	Burial	Lab. code	^{14}C age (BP)	$\delta^{13}C_{IRMS}$ (‰$_{VPDB}$)	$\delta^{15}N_{IRMS}$ (‰$_{VPDB}$)	2σ range (calBC)	Dated material	*Princeps* reference
Sakhtysh II	Burial n°12, individual a or б	UBA-34097	5170±40	-23.8	7.50	4160-3810	tubular bone bead	Macāne *et al.*, 2019
		UBA-40193	5164±38	-21.8	7.60	4150-3810	tubular bone bead	
	Burial n°18	UBA-40191	4865±35	-21.7	5.20	3760-3530	elk tooth pendant	
		UBA-40192	4737±31	-20.4	9.10	3630-3380	bear tooth pendant	
Sakhtysh IIa	Burial n°7б	UBA-34099	4719±45	-20.2	9.90	3630-3370	bear tooth pendant	
	Burial n°19	UBA-34990	4881±42	-20.4	7.50	3770-3530	bear tooth pendant	
	Burial n°24	UBA-34098	4769±38	-20.6	5.90	3640-3380	marmot tooth	

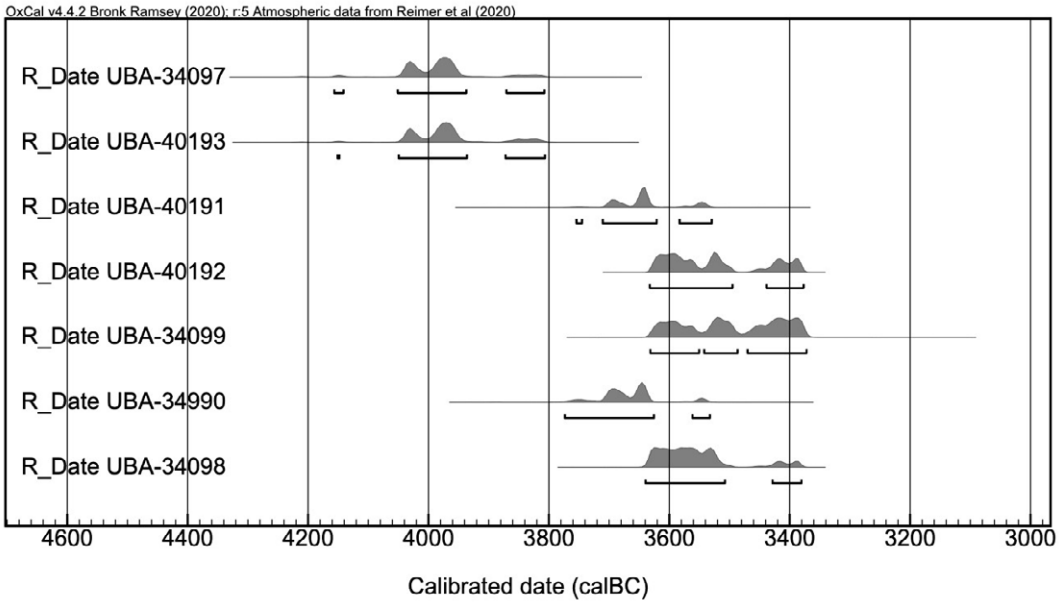

Table 1. AMS radiocarbon dated burials from the Sakhtysh sites containing non-local imported materials; especially results obtained from Burial n°12 may be subject for freshwater reservoir effect due to the undetermined species of dated bone (after Macāne *et al.*, 2019). Calibrations have been obtained with OxCal v4.4.2 (Bronk Ramsey, 2009), using IntCal20 atmospheric curve (Reimer *et al.*, 2020).

Site / Material	Amber	Serpentine	Marmot tooth	Rock crystal	Russian Karelian tool	total
Sakhtysh I (settlement)	10	0	0	+(?)	4	14+
Sakhtysh II (settlement & burials)	44	14	0	2	15	75
Sakhtysh IIa (settlement & burials)	391	40	43+fragments	0	2	476+
Sakhtysh VIII (settlement & burials)	299	36	0	1	10	346
total	744	90	43+fragments	3+	31	**911**+

Table 2. Non-local materials from the Volosovo cultural contexts (settlements and burials) at Sakhtysh showing the presence (+) and number of finds (see Appendix for details).

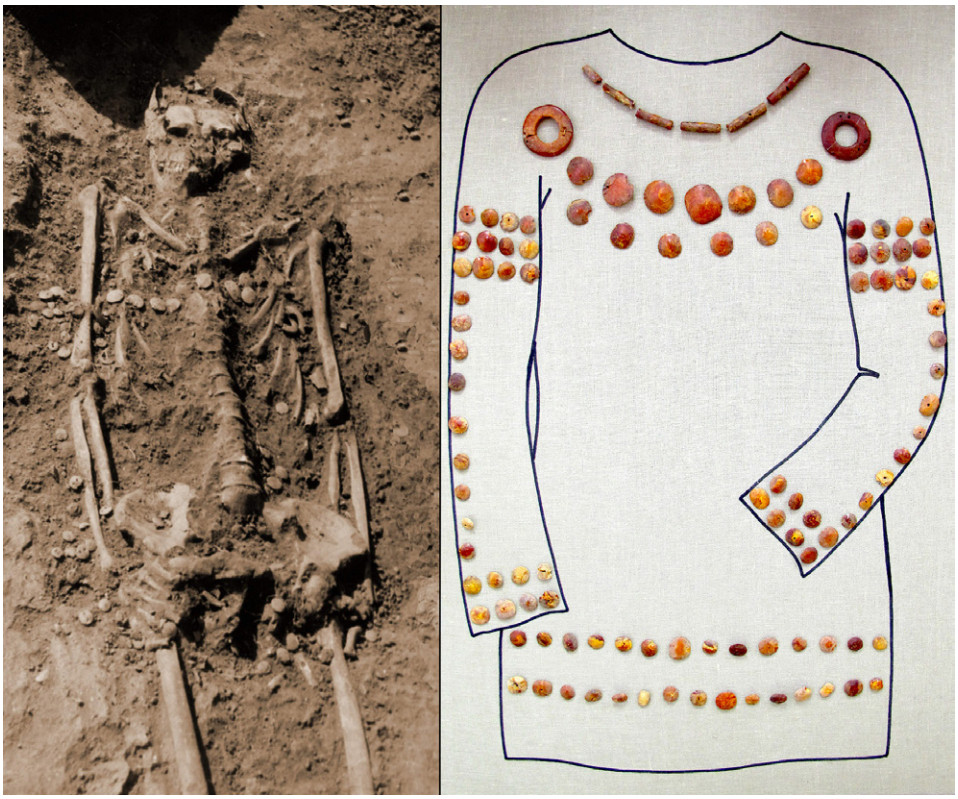

Figure 5. Burial n°15 at Sakhtysh IIa with grave goods imported from the eastern Baltic: young male buried with 217 amber ornaments (buttons, pendants, tubular beads and rings). Skeleton in situ (left) and reconstruction of the burial garment of the deceased (right) exhibited at the Archaeology Museum, Ivanovo State University. Photo, E. Kostyleva & A. Macāne.

and the sex of the last one remained unidentified (Kostyleva/Utkin, 2000:182). However, the preservation of skeletons does not allow secure estimation of sex of the deceased at the other sites (Kostyleva/Utkin, 2010a). Amber ornaments were mainly found in the area of the upper body, between the chest and the pelvis, as well as by the arms. Singular items were documented also by the skull and the knees. Reconstructions of clothing based, for example, on burials n°15 and 28 at Sakhtysh IIa suggest that amber was used to decorate a shirt or a tunica-like clothing (Fig. 5), whereas amber ornaments discovered by the head would indicate the use of some kind of a head gear or a hood (Kostyleva/Utkin, 2000:177).

The geographically nearest parallels of amber ornaments come from funerary contexts in the forested areas of central European Russia, west of Sakhtysh. At some sites (*supra* Fig.1), hundreds and even thousands of amber ornaments have been excavated (*e.g.* Repishche, Konchanskoe, Tudozero V, Kargulino, Yazykovo I cemeteries - see Ivanishchev, 1996; Ošibkina, 1978; Sidorov, 1992; Zimina, 2003 & 2004). Numerous amber artefacts have also been documented in the 4th millennium BC hunter-fisher-gatherer burials in the Baltic States (*e.g.* Loze, 2008; Zagorska, 2001 & 2006; Zagorskis, 1961 & 1987) and Finland (Ahola, 2019; Katiskoski, 2004). At many other sites, and especially further to the east from Sakhtysh, the number of amber artefacts is smaller, varying between singular items up to a few dozen (Khalikov, 1969; Koltsov/Zhilin, 1980; Tsvetkova, 1975). The large occurrence of amber in funerary contexts has been interpreted to show that amber ornaments were intended for special ritual uses and festive occasions (Zhulnikov, 2008:9; Zimina, 1993). Finds from settlements are usually few and rare, but some exceptions exist, like Northern Ostrobothnia in northern Finland, where hundreds of amber items are known from domestic contexts (Núñez/Franzén, 2011).

Amber from non-burial contexts is also common in regions of the eastern Baltic, which is generally considered to be the origin of the amber items circulating in the forest zone up to the White Sea area and the Urals (*e.g.* Loze, 2008; Zhulnikov, 2008). Baltic amber is fossilized

resin (succinite) of pine trees, and the largest deposits of this non-mineral material in northern Europe can be found mostly in the southern Baltic Sea area. In the 4th millennium BC, collection and processing of amber reached its peak; specialized workshops functioned, for example, in Sārnate and Šventoji on the Baltic Sea coast (Bērziņš, 2003; Rimantienė, 2005; Vankina, 1970) and in the Lake Lubāns area in eastern Latvia (Loze, 2008), and mass-produced items specifically for exchange.

Rock crystal

Three rock crystal finds are known from Sakhtysh I, II and VIII, but none of them comes from the burials. Two complete idiomorphic rock crystals were found in the territory of the Sakhtysh II burial ground (Kostyleva *et al*., 2018:565/Fig. 2). The first of them was located in the proximity of a destroyed burial (n° 3), while the other shows traces of fire and is associated with one of the hearths (Fig. 6). At Sakhtysh VIII, the rock crystal find is connected with a dwelling. Small rock crystal fragments have also been mentioned in Kraynov's field report of the 1970 excavations at Sakhtysh I but without precise information of the context (Kostyleva/M*a*cāne, 2018:42).

Only a few parallels for rock crystals can be found in the research literature. Many of them derive from eastern Finland, where this raw material has been documented both in settlement and burial contexts (*e.g.* the Vaateranta cemetery - see Katiskoski, 2004; Mökkönen *et al*., 2017). Rock crystal is a high-quality variant of quartz, which is one of the most common minerals on the Earth and widely used as a raw material for knapping during the prehistory. Rock crystal has been valued for its transparency and peculiar, regular geometric shape. It can be found in so-called crystal cavities, present for example in the bedrock of eastern Fennoscandia and the Ural Mountains [1] (Mökkönen *et al*., 2017). The rock crystal finds at Sakhtysh have been considered to originate from the latter area (Kostyleva/M*a*cāne, 2018:42).

Serpentine

Altogether 90 serpentine finds are documented from Sakhtysh II, IIa and VIII. Nearly all (82) of them originate from burials. Single finds come from the cultural layers at Sakhtysh II and VIII, but might originate from destroyed burials, too. All serpentine finds are complete items or fragments of ready-made objects, the majority of them in the shape of pendants (Fig. 6 & 7). They are carefully polished, but nowadays with a white patina, have an oval or triangular shape and perforation in the upper part of the pendant, which is sometimes renewed or with secondary repair holes (Kostyleva/Utkin, 2010a; Kostyleva *et al*., 2018:567).

The number of serpentine pendants in graves varies between singular items up to 25 pieces (Appendix). Like amber finds, serpentine pendants are often concentrated in individual graves, including a multiple burial (n°15) at Sakhtysh II (Kostyleva/Utkin, 2010a). When identification of the sex of the buried person is possible, females appear more often to be adorned with serpentine ornaments. Nearly all pendants were located in the area of the pelvis and the thigh bones (*infra* Fig. 7), and have been interpreted as part of some kind of a garment (Kostyleva/Macāne, 2018:42; Kostyleva *et al*., 2018:567).

The closest and most numerous parallels for the serpentine pendants as grave goods can be found in the Middle Volga area (Tenishevskiy and Murzikhinskiy II cemeteries - see Chizhevskiy, 2008; Chizhevskiy/Golubeva, 2019; Kostyleva/Utkin, 2010b). Serpentine pendants of somewhat different shapes have also been found in several solitary cave burials in the southern Urals (Buranovskaya cave and Staricheskiy Greben - see Bibikov, 1950), and in the middle and southern Trans-Urals (Berezki Vr and Kumyshanskaya cave - see Serikov, 2002 & 2013; Shorin, 1991). The Urals have been proposed as the possible place of origin for the Sakhtysh serpentine, since significant deposits of this mineral are located in the southern part of the mountain chain (the present-day Orenburg and Chelyabinsk regions). However, outcrops of this stone of green, brownish or spotted colour are widespread also in many other regions of Eurasia, like the North Caucasus, Armenia, Siberia, and Kazakhstan [1].

Figure 6. Four serpentine pendants from burials n°7 and 24 as well as cultural layer of Sakhtysh IIa (left), and a rock crystal (right) from a ritual area at Sakhtysh II. Scale subdivision in cm. Photo, E. Kostyleva.

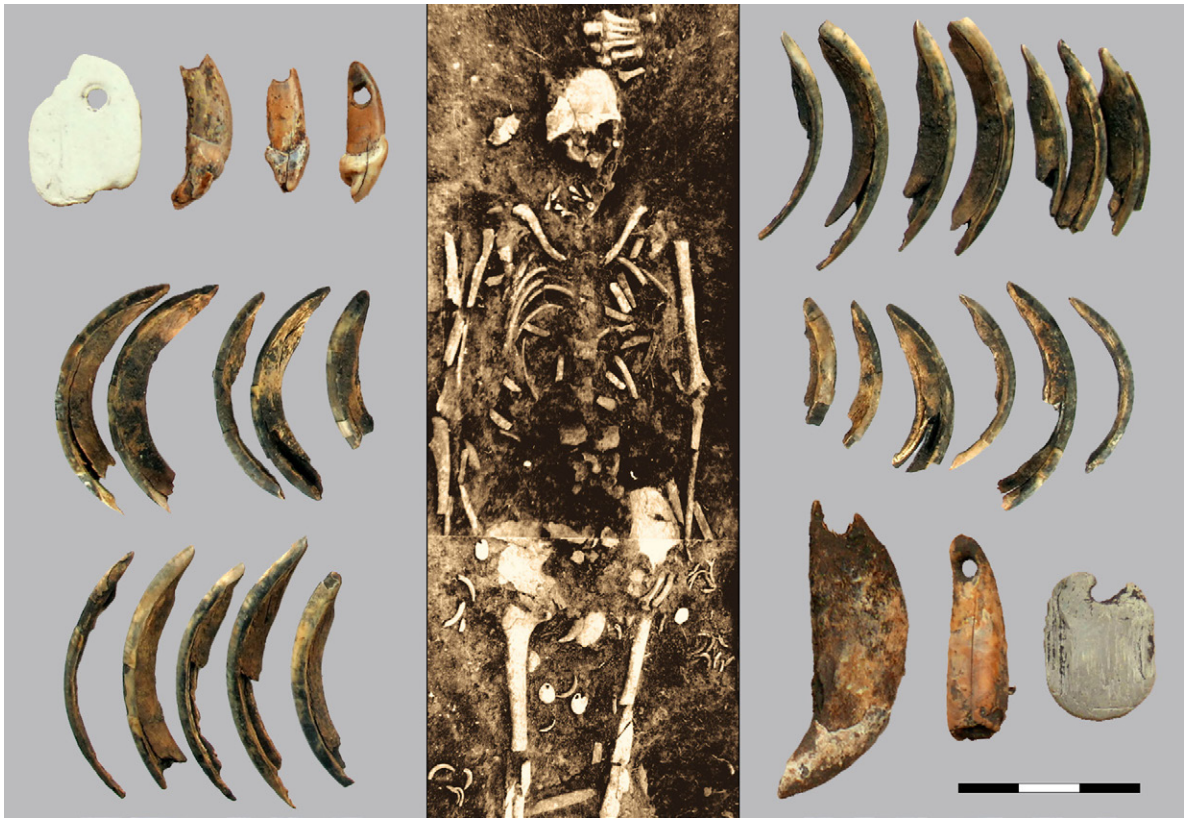

Figure 7. Burial n°24 at Sakhtysh IIa with eastern-originated grave goods: a young female buried with 11 serpentine pendants and more than 40 marmot incisors as well as five other tooth pendants made of badger and dog canines, and elk and bear incisors. Scale subdivision in cm. Photo, E. Kostyleva & A. Macāne.

Marmot

Bobak marmot (*Marmota bobak*) incisors have been documented only at the Sakhtysh IIa cemetery (Tabl. 2). Almost all of them were found in burial n°24, containing 40 fairly well-preserved incisors, and more than 20 fragments (Fig. 7). Two additional fragmentary incisors were found in grave n°21 and a single tooth in grave n°26 (Appendix). Since these three graves are partly destroyed and located in the same area, the latter teeth may also originally come from burial n°24 from were they would have been removed by the effect of post-depositional disturbances or bioturbation. Other marmot remains have not been recorded

so far in any of the faunal or burial assemblages from the Sakhtysh area (Kostyleva/Macāne, 2018:42).

No modification traces were observed on the teeth. Judging from their even number (15 dextra-/14 sinistra-; 6 dextra+/5 sinistra+) in burial n°24, the teeth were eventually placed in pairs and derived from a minimum of 15 animals (Kostyleva *et al*., 2018:573). All incisors were found in the area of the pelvis and the thigh bones of the buried female and may have been sewn to the clothing.

Marmot incisors are fairly rare finds in the coeval cemeteries located in the forest-steppe of the Middle Volga area (Mellyatamakskiy V, Russko-Shuganskiy II, Murzikhinskiy II, Ekaterinovskiy cape and Maksimovka I - see Chizhevskiy, 2008; Chizhevskiy/Golubeva, 2019; Kazakov, 1978 & 2011; Korolev *et al*., 2019; Shalapinin/Korolev, 2019) and are also documented in single cave burials in the southern Urals (Ust´-Katavskaya II cave - see Bibikov, 1950; Kazakov, 2011). The main habitat of bobak marmots, low grassland-covered rolling plains of the forest-steppe and steppe areas of western Eurasia (Kryštufek/Vohralík, 2013:66), are the probable origin of the marmot incisors found at Sakhtysh, which have never been native to these forested areas of Upper Volga.

Metatuff

Altogether 31 specimens of Russian Karelian tools (RKT) of metatuff have been found at Sakhtysh. Most of them were documented from domestic contexts, either dwellings (Sakhtysh I, VIII) or settlements' cultural layer (Sakhtysh I, II, IIa, VIII). Eight artefacts were found in connection with "ritual activity areas" or beside burials at Sakhtysh I and II. Most metatuff artefacts are ready-made axes, adzes, or fluted adzes with distinct shape of trapezoidal or half-oval cross-section, and are usually carefully polished (Fig. 8), (see Tarasov, 2015 & 2017). They represent certain import from Russian Karelia, as do likely also the few other worked items of metatuff (Tarasov, 2017:30; Tarasov/Kostyleva, 2015:Tabl. 3).

The RKT are widespread in the forest zone and particularly in northwestern Russia, Finland, Estonia and Latvia (Äyräpää, 1944; Kriiska *et al*., 2013; Tarasov, 2015 & 2017). The majority of such tools is found as ready-made artefacts, either in settlement contexts or as stray finds; the later case is commonly perceived as linked with ritual use. Origins of the metatuff tools are connected with the western coast of Lake Onega, near the mouth of Shuya River, where the main outcrops of this high-quality volcanic greenstone can be found. In this limited area, controlled large-scale production of the RKT took place in specialized workshops following a highly standardized technology (Tarasov, 2015). The ready-made artefacts were exported to wide areas and reached also the Sakhtysh region, which represents the largest eastern concentration of these objects (Tarasov, 2017 ; Tarasov/Kostyleva, 2015).

Figure 8. A tool made of volcanic metatuff was found inside a Volosovo dwelling at the Sakhtysh VIII site and represents import from Russian Karelia.
Scale subdivision in cm.
Photo, A. Tarasov, with his kind permission.

DISTRIBUTION OF IMPORTED MATERIALS AT THE SAKHTYSH SITES

The majority of non-local materials found at Sakhtysh is connected to funerary contexts and to "ritual activity areas" associated with burials. Even if singular items of amber and serpentine derive from the cultural layers, it has been suggested that they might originate from destroyed burials as well (Kostyleva/Macāne, 2018; Kostyleva/Utkin, 2000 & 2010a; Kostyleva *et al*., 2018). The only major exceptions are the finds of RKT, which more commonly appear in domestic areas (also one rock crystal find) and bear traces of use and repair as an evidence of their utilization in daily life (Tarasov/Kostyleva, 2015). Non-local materials were obviously given different meanings depending on the raw material and artefact type. However, few RKT, as well as amber objects and two rock crystals, have been found in the so-called hoards or ritual activity areas at Sakhtysh II. Small deposits (hoards) with amber ornaments, mainly pendants, have been found next to some burials at Sakhtysh IIa and VIII (*supra* Fig. 3 & 4 yellow star).

The largest number of exotic items comes from burials at the Sakhtysh IIa cemetery. Over 50% of non-local objects found at the Volosovo-related contexts of the Sakhtysh complex are located at the Sakhtysh IIa cemetery, followed by Sakhtysh VIII (nearly 40%). The burials with exotic items at Sakhtysh IIa are clearly concentrated in the southeastern part of the cemetery (*supra* Fig. 2). At Sakhtysh VIII, burials with non-local objects are scattered throughout the cemetery but burials with amber and amber deposits are grouped in the northwestern part of the burial ground (*supra* Fig. 3), (Kostyleva/Utkin, 2010a:134/Fig. 71). At Sakhtysh II, comparable clusters are not obvious and the proximity of two (out of three) burials with exotic items and an amber deposit may be ostensible (*supra* Fig. 4).

The intra-site distribution of burials with exotic materials may simply represent temporal differences in the use of different parts of the sites. Still, as relatively few members of the communities were buried with such artefacts, they rather reflect the specific position or status of the deceased or the social group they represented. They can also be connected to special occasions or events performed in certain areas of the cemetery, where these non-local items played a particular role. Variation in the amount of especially amber at the extensively excavated sites Sakhtysh II, IIa and VIII can also reflect differences between populations and practices present in these locations.

Even if non-local items are often illustrated in the literature, they are not defining characteristic to the burial custom of the Volosovo period at Sakhtysh. The proportion of burials with non-local materials is about 27% of all Volosovo burials at the studied sites. Further, exotic artefacts tend to be concentrated in a few graves only, where they may be present in large numbers. Several types of non-local materials are rarely found together in the same burials (five cases). More often, they are found with other ("local") materials, mostly bone or tooth pendants (Appendix). However, the number of these other artefacts in graves is often small as well (only a few pieces). Non-local objects are the only grave goods in 58% (Sakhtysh IIa) to 71% (Sakhtysh VIII) of burials yielding exotic items.

When several exotic materials occur in the same grave, the combination of amber and serpentine is the most common. However, nearly all of these burials are partly destroyed making precise attribution of the grave inventory problematic (this applies also to the multiple burial n°15 of 18 individuals at Sakhtysh II). Burial n°24 at Sakhtysh IIa is the only case where considerable number of marmot teeth is found, together with numerous serpentine pendants (*supra* Fig. 7). It has been proposed that they would have been part of the same decoration possibly imported to Sakhtysh in a same time (Kostyleva *et al*., 2018). Although the grave goods in burial n°24 point strongly towards the east, the burials containing both amber and serpentine show that items of western and eastern origins can also occur together in graves (see Appendix).

The lack of production waste and unprocessed raw materials suggests that items of non-local origin arrived in Sakhtysh as ready-made objects. Majority of them can be classified as ornaments (pendants, beads, rings, buttons). The locations of imported items in the

graves seem to differ depending on the raw material. Like the marmot teeth, the serpentine pendants have been placed more often in the region of the pelvis and the thighs. Amber finds are concentrated around the upper part of the body and the pelvic region with a few exceptions by the skull or near the knees (*supra* Fig. 5 & 7). Based on the artefact-type and position in the grave, they have most probably been decorations on clothing or some kind of other garments. Keeping in mind the uncertainties in sex determinations and the generally limited number of burials with exotic items, amber ornaments seem to come more often from male burials while serpentine objects are associated with females; the latter is also true for burial n°24 of Sakhtysh IIa with marmot teeth.

MOVING GREAT DISTANCES

Interest in new materials and their procurement from the surrounding environment is one of the processes transforming the hunter-fisher-gatherer communities in the forest zone (Herva *et al*., 2014; Mökkönen *et al*., 2017). Manipulation of different materials into meaningful objects through new approaches to various past technologies, such as pottery making, standardized polished stone tool production or native copper extraction (Herva *et al*., 2014; Nordqvist/Herva, 2013; Tarasov, 2015), together with changing ritual practices and other spheres of life (Ahola, 2019; Zagorskis, 1987; Zhulnikov, 1999), reflect the growing versatility and complexity of these communities. Even if these developments have long-standing roots, many of them flourish during the 4th millennium BC.

Intensification of contacts between hunter-fisher-gatherer groups is an element characterizing this period of time, and the circulation of non-local materials was integral part of this development (Kriiska *et al*., 2013; Nordqvist *et al*., 2015; Zhulnikov, 1999 & 2008). The movement of goods between the Baltic Sea and the Urals during the 4th millennium BC is traditionally interpreted either as a result of direct migrations of people (Kostyleva/Utkin, 2000) or, more commonly, of exchange (even trade) of commodities between the communities (Gurina, 1974; Kraynov, 1973; Kriiska *et al*., 2013; Loze, 2008; Zhulnikov, 2008). The contacts were aligned along the extensive waterways (lakes and rivers) connecting different groups of people, as well as procurement and production areas that contributed to exchange networks (see Houmard/Britain, in this volume). When non-local resources are discussed, access to unusual or rare raw materials, including skills and knowledge required to acquire/transform these materials into highly-valued goods, became important factors in shaping networks. Equally important is the emergence of specialized craft production and organization of particular workshops where certain materials and artefact-types were produced in large quantities specifically for export and exchange, as exemplified by amber (Bērziņš, 2003; Loze, 2008; Rimantienė, 2005; Vankina, 1970) and Rusian Karelian artefacts (Tarasov, 2015 & 2017).

Amber has long been the emblem in discussion on the hunter-gatherer exchange (Gurina, 1974; Núñez/Franzén, 2011; Zhulnikov, 2008) and RKT are other often-mentioned examples (Äyräpää, 1944; Kriiska *et al*., 2013; Tarasov, 2017). In addition to the materials discussed in this paper, many other commodities were also used in theses transactions, such as flint (Vuorinen, 1982; Zhilin, 1997), and, probably, a number of perishable goods like furs and animal skins (Kraynov, 1973:54). The exchange did not include only material culture, but disseminated knowledge and skills, identities and ideologies. The shared technologies are exemplified, for example, by certain widely spread flint knapping traditions (Berg-Hansen *et al*., 2019). Another example is the production of RKT: the elaborate technology used on metatuffs in Karelia is not exclusive to them only, but the same technological tradition is applied to local raw materials for the production of Volosovo tools elsewhere (Tarasov, 2017). The exchange is considered to have strengthened local integration and alliances between various kin-based hunter-fisher-gatherer groups (Kostyleva *et al*., 2018; Zhulnikov, 1999 & 2008). In other words, exchange was included in the social strategy of communities and, like prehistoric exchange in general (*e.g.* Bradley/Edmonds, 1993; Oka/Kusimba, 2008), it did

not pursue purely economic aims, but was closely intertwined with its social, political and ideological functions.

CONCLUSION: EAST MEETS WEST AT SAKHTYSH

Let us finally return back to Sakhtysh. Figure 8 presents a small metatuff adze imported from Karelia and discovered in a settlement context at the Sakhtysh VIII site, along with seven other Russian Karelian objects—at the same time, a similar technology was used in the Upper Volga area to produce morphologically similar artefacts from other raw materials such as flint and cherty limestone (Appendix). Why, then, somebody went through the effort to transport this adze to Sakhtysh, which in this case is located *circa* 700 km away (as the crow flies) from the most likely source of origin? The reason for the circulation of exogenous materials discussed in this paper (amber, serpentine, rock crystal, marmot teeth, metatuff) must lie in the material properties of these objects, their distant origin, or other—real or perceived—functions, qualities or biographies that at that time were associated with them. It is hard to assess the importance of the act of exchange itself, or the way artefacts functioned as a means of social communication, since their potential exclusivity is not directly reflected, for example, in other burial customs or in the sex or age of individuals. Still, the power and value embodied in the non-local items are suggested not only by their long-distance transportation or association with the "ritual" but also "domestic" contexts, but also by their potential curation within the communities, as evidenced by traces of use and wear, reshaping and repairing present on some of the imported artefacts.

The Sakhtysh complex is, indeed, located quite in the middle between the Baltic Sea, Lake Onega and the Urals, 500—1000 km from each of these areas. Such distances and the number of non-local items present in Sakhtysh concretely evidence of the wide extent of hunter-fisher-gatherer contact and exchange networks, as well as the movement of people and crafted materials. The large amount of finds also represents a high research input in the Sakhtysh area, but simultaneously, our case study suggests some limitations to the prehistoric networks. The Sakhtysh complex marks the border in the distribution of many of the non-local materials discussed in the present paper: Baltic amber and RKT are reported only rarely further east, while no serpentine items or marmot incisors are known to the authors at sites to the west from the Sakhtysh area. The reasons for this are most likely related to socio-cultural and geographical settings of the Sakhtysh region: it was an area where influences from the west and the east could reach each other, and were given an important role in daily life, and in death.

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NOTE

[1] Catalogue of minerals and geology[in Russian]. Available at: http://catalogmineralov.ru[Accessed Oct. 15, 2020].

[2] This manuscript was completed and submitted in spring 2020 and the list of references is therefore missing some relevant literature published since then; particularly for hunter-fisher-gatherer burials, exogenous materials, their production and exchange - see Macāne, 2022; Macāne/Nordqvist, in press; Tarasov/Nordqvist, 2022.

Site	Context	A	S	M	R	RK	O	Sex & age
Sakhtysh I total 14 burials	Cultural layer	10			+	1		
	Dwelling					2		
	Ritual context					1		
Sakhtysh II total 19 burials	*Burial 12 n° в*	*6*					+	*F, 25–30*
	Burial 12 n° г	*10*						*Juvenile*
	Burial 12 n° ?	8					+	
	Burial 15 n° I	7					+	F, adult
	Burial 15 n° II	1	1				+	Child
	Burial 15 n° III	6					+	F, adult
	Burial 15 n° IV	1						M, adult
	Burial 15 n° V	1	9					F, adult
	Burial 15 n° XIII		2				+	Child
	Burial 18		*1*				+	*F?, juvenile*
	Ritual context	4			2	7		
	Cultural layer		1			5		
	Stray find					3		
Sakhtysh IIa total 57 burials	Burial 2	2					+	M, 30–35
	Burial 3	4						M, 35–40
	Burial 4	13						M, 50–55
	*Burial 7*а		*16*					*F, 20–25*
	Burial 9	2					+	M, 50–55
	Burial 13б		1					M, 50–60
	Burial 15	217						M, 20–25
	Burial 17	3					+	Child
	Burial 18	1						M, 30–35
	Burial 19		*2*				+	*F, ?*
	Burial 21	1	1	2			+	?, 25?
	Burial 24		*11*	*40+frag.*			+	*F?, 20?*
	Burial 26	2		1				Juvenile
	Burial 28	110					+	M, 35–40
	Burial 39	24						M, 30–35
	Burial 44	1	2					M?, 35–40
	Burial 53	3						Child
	Cultural layer		7			2		
	Ritual context	8						
Sakhtysh VIII total 37 burials	Burial 1		1					Adult
	Burial 4	10					+	M?, adult
	Burial 5	25						M?, adult
	Burial 9		4				+	F?, adult
	Burial 12	12						F?, adult
	Burial 13	1						?
	Burial 14	105						M?, adult
	Burial 15	5						F?, adult
	Burial 16	22						Child
	Burial 21	4						F?, adult
	Burial 23		6					F?, adult
	Burial 25	80					+	F, 30–35
	Burial 30		25				+	F?, adult
	Burial 36	9						?, adult
	Ritual context	26						
	Cultural layer					5		
	Dwelling				1	4		
	Stray find					1		

Appendix. Non-local materials from the Volosovo contexts at the Sakhtysh sites showing the presence (+) and/or the number of finds according to the find contexts. Burial contexts dated by AMS are shown in italics (see Tabl. 1); grey rows show burials containing two or more types of non-local raw materials. Data from Kostyleva/Utkin 2010a and Tarasov/Kostyleva 2015, adapted to authors' personal database. Legend: n° - n° of buried individual; A - Amber; S - Serpentine; M - Marmot tooth; R - Rock crystal; RK - Russian Karelian tool; O - Other grave good; M - Male; F - Female; ? - undetermined or uncertain.

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RÉSUMÉ

CIRCULATION LONGUE DISTANCE DE DENTS EXOTIQUES ET DE ROCHES EXOGÈNES DANS L'EUROPE FORESTIÈRE NORD-ORIENTALE AU IVe MILLÉNAIRE BC

Le complexe archéologique de Sakhtysh est situé dans la région de la Haute Volga et est l'un des principaux sites archéologiques de chasseurs-cueilleurs en Russie d'Europe centrale représenté par onze sites d'habitats et de camps de base multi-stratifiés articulés dans l'espace avec des zones de cimetières et d'activités dites rituelles attenantes datées de différentes périodes. Le cadre chronologique du complexe couvre une période comprise entre le Mésolithique précoce (IXe millénaire BC) et le début de l'âge du fer (de 600 BC à 500 AD environ), mais l'occupation la plus riche concerne les phases de la culture de Lyalovo et de Volosovo entre les Ve et IIIe millénaires BC.

Cet article donne un aperçu des matériaux exogènes retrouvés dans les fouilles des sites de Sakhtysh, et présente les contextes de leur découverte. La majorité des artéfacts considérés comme de provenance non-locale ou exotique provient de sépultures ou de zones d'activités dites rituelles. Les objets comprennent des parures et des outils faits de différentes matières premières, en ambre et diverses gemmes (serpentine, cristal de roche, métatufs) et d'une espèce animale par ailleurs non documentée dans la région (marmotte). L'origine géographique de ces matériaux renvoie à plusieurs directions différentes dans un rayon de 1 000 km autour de Sakhtysh : au littoral de la mer Baltique (ambre), aux rives du lac Onega (métatuf de Carélie), aux montagnes de l'Oural (cristal de roche, serpentine) et aux zones forestières et steppiques de l'Eurasie occidentale (marmottes).

La plupart des artéfacts sont des objets prêts à l'emploi et peuvent être classés comme des parures individuelles (pendentifs, perles, bagues, boutons). Elles ont été interprétées comme des décorations très probablement fixées aux vêtements ou utilisées comme éléments de pendentifs associés aux défunts dans les sépultures. Seuls les outils en métatuf carélien servant à couper le bois sont couramment issus des contextes domestiques. La répartition des matériaux exogènes dans les lieux de sépultures rend compte de certains schémas qui renvoient à des différences temporelles liées à une fonction particulière de certaines zones des sites, ou qui reflètent le statut spécifique du défunt ou du groupe social à l'origine de l'enfouissement, ou encore, qui témoignent que des événements notables se sont déroulés au cours desquels ces biens importés ont pu jouer un rôle en particulier. La circulation de divers matériaux exotiques dans la zone forestière où Sakhtysh est précisément situé de manière

centrale démontre la complexité sociale croissante et l'intensification des contacts au cours du IVe millénaire BC entre les communautés de chasseurs-cueilleurs de divers territoires limitrophes. Des réseaux d'échange et de communication élaborés exploitant les voies d'eau naturelles ont participé à ce que certains matériaux et artéfacts, parfois même issus d'ateliers spécialisés, ont été transportés sur de grandes distances entre la mer Baltique et l'Oural. Dans ce contexte, le complexe de Sakhtysh peut être considéré comme une zone frontalière permettant l'acquisition de divers matériaux exotiques. À l'est de Sakhtysh, les découvertes d'ambre sont rares, et il en va de même pour les incisives de marmotte et la serpentine, à l'ouest.

THE BONE SUMAK FOR INFANT CARE, AN INVENTION FROM SOUTHERN SIBERIAN NOMADISM OR CONTACT WITH THE HUNNIC TRIBES?

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Abstract: Sumak *is a special pipe that was used to siphon the infant's urine out of the cradle. This practice was common in southern Siberia during the Xiongnu-Xianbei-Rouran period (the first half of the 1st millennium AD). If these objects are still employed today in many regions of Eurasia, it constitutes, in archaeology, a precious source of knowledge concerning the life of infants in the past. Usually, the* sumak *is the only preserved part of the cradle and which can be recorded on archaeological sites where it appears in both sepulchral and settlement contexts. As there is still little known about* sumaks*, identifying the origin and the spread of this invention is difficult. The distribution of finds on the map of southern Siberia and the research on bone assemblages allow us to pose the hypothesis that it does not originate from Chinese-influenced Xiongnu culture, but rather that it derives from nomadic tribes of southern Siberia, more precisely the Russian Turkestan. The* sumak *witnesses both an historic path in the evolution of the Steppes material cultures and an important source of knowledge on a practice transmitted transculturally whose tradition is still alive today.*

Xiongnu-Xianbei-Rouran period, Maima culture, Motherhood, Nomadism, Child, Low modified bone

INTRODUCTION

Models of behaviors concerning motherhood and the early years of a child's life represent an exceptionally important element of the culture of prehistoric societies. The study of children and childhood in archaeology, as both a biological phenomenon and an aspect of human culture, leads to a much fuller understanding of the organization of social life, spiritual culture and traditions. Archaeological research provides valuable sources which, together with ethnographic observations, can further develop the knowledge concerning the infancy in the past. In older studies, the occurrence and activity of children were practically ignored in archaeology and the prehistoric reality was perceived exclusively through the prism of adults. In archaeology, an interest in children and childhood started to develop in the 1990s (Lillehammer, 1989 & 2010; Moore/Scott, 1997; Pawleta, 2013:16; Sofaer-Derevenski, 1994). The underestimation of this issue in the past results from complex causes. Archaeological remains concerning children are rather modest and they are usually limited to two categories: children burials (osteological material) and miniature items interpreted as toys. An additional research problem is the fact of a partial or complete decomposition of juvenile bones due to the taphonomic process issues (Kozłowski, 2004:79). Furthermore, funerary equipment of "ordinary" children is often very modest. By its very nature, archaeology allows us to reconstruct the life of adults to a much wider extent than that of children. Remains relating to the presence and activity of children are practically elusive at settlements. An attempt to identify archaeological remains concerning children exclusively is an important starting point for further reflections about children in antiquity.

Sources of knowledge on childhood in Siberia

Texts written by ethnographers in the 19th and the 20th centuries have provided a valuable source of knowledge on childhood in Siberia. All the customs concerning the life cycle of a child were thoroughly described including birth, carrying a child, children's games and the cradle (Komarova, 2014:32). The construction of the cradle and its components has

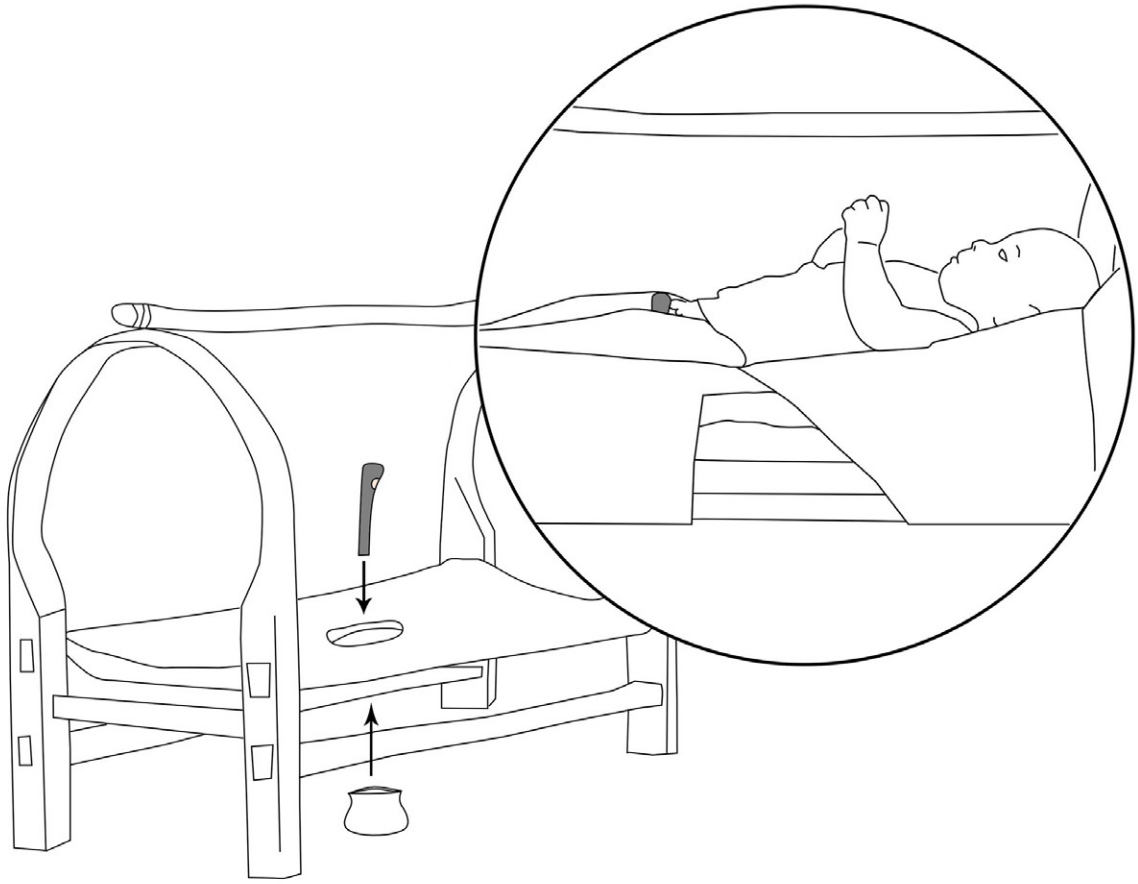

Figure 1. Once the sumak (grey) is applied as a draining pipe made of small herbivore tibia, the newborn is placed in the cradle and tight bound to it with straps. Placed underneath to collect urines, the clay pot (tuvak) is adjusted in the bedfloor. The perforated hole in the epiphysis part of the bone manufactured as a sumak is 15.5 to 19 cm long, and with a diameter of 1.2 to 1.5 cm. CAD, K. Michalczewski.

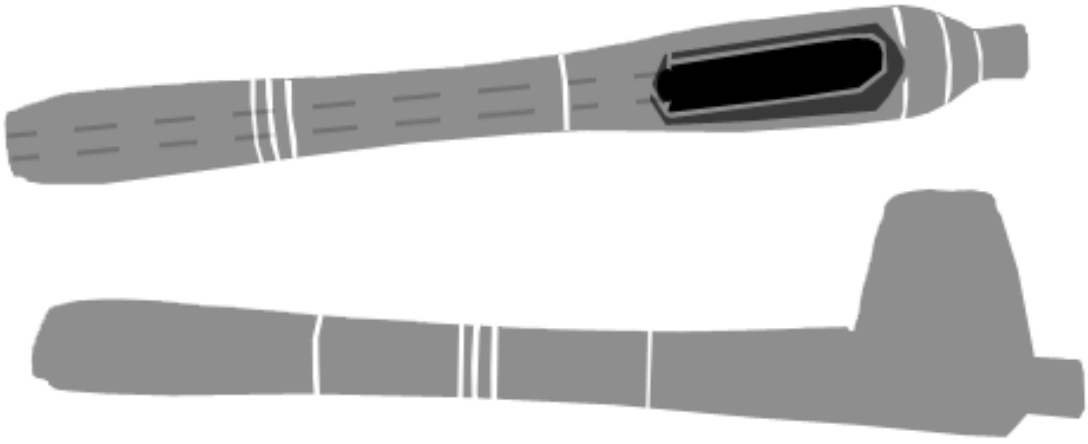

Figure 2. General aspect of two modern specimens of decorated (white strips) sumaks made of wood. Approximate length, 18 cm. Illustration, redrawn after Resvan 2004[1], K. Michalczewski.

gained attention of ethnographers and archaeologists. Among many peoples of modern-day Eurasia, children are placed in the cradle, widely known as a *beshik*. In the case of Karachays, who are living in North Caucasus, infants are placed in a *beshik* on the 6th or the 7th day after birth. This ceremony, named *beshikge salg* by Karachays (Bolurova, 2014:39) or *beshik tuy* by Uzbeks (Egambergenova, 2012:401), was connected with many customs and rituals. Even the selection of wood required for manufacturing the cradle was not coincidental.

According to the traditional beliefs, all the actions and rituals concerning the *beshik* have a direct impact on the future of the child. The newborn is always placed on its back, tied to its bed with its arms as close as possible to the body. A special pillow is usually placed under the knees so that the restricted legs remain in a permanent position (Bolurova, 2014:39). The practice including the construction of such cradles are still used, among others, by Crimean Tatars, Crimean Karaites, Greeks living by the Sea of Azov, Tajik people, residents of Dagestan, Armenians, Azerbaijani populations (Dmitriev, 1999:178), Karachays (Bolurova, 2014), Uzbeks (Egambergenova, 2012:401-402) and other nations of Caucasus (Smirnova, 1983:71). These have one thing in common: the presence of a special pipe to siphon urine out through a hole in the bottom of the cradle to a vessel located beneath (Fig. 1). The urine draining pipe is widely known under the name *sumak*, but it appears under other names as well—for example, *sibak*, *sunak*, *shmak* or *shumek*. This technical practice was first mentioned by Mahmud al-Kashgari in his written sources (Al-Kashgari, 2005[1075]:368). In the 11th century AD, the *beshik* was already used among Tajik communities (Gershenovich, 1928:18-19; Ubaydullaeva, 2014:24). The invention of the *sumak* was adopted by many peoples throughout Eurasia in later periods. An interesting example of such an adaptation are *sumaks* made of glass known from the Volga region in 13th to 14th-century AD. It is worth noting that, on the same sites, traditional bone *sumaks* were recorded as well (Busyatskaya, 1976:52). The popularity of the *beshik* type cradles (with *sumaks*) among many nomadic and semi-nomadic tribes could be explained by a few advantages. A child tied with straps to the cradle doesn't have to be under constant supervision, which allows adults to attend other activities.

Although *sumaks* nowadays are usually made of wood (Fig. 2), traditional Siberian examples made of tibia of small herbivores are still used. The length of the actual *sumak* is similar (Dmitriev, 1999:178) to that in the Xiongnu-Xianbei-Rouran period: it does not exceed 20 cm. In the past, the size of *sumaks* was determined by that of the bone matrix that was used once shaped. Today, two types of *sumaks* are manufactured: one more or less in the shape of a smoking pipe for boys, and the other one similar but with a broadened gape for girls. This part of the *sumak* is sometimes covered with a layer of wax to avoid any skin irritation (*op. cit.*)[Similar items in morphology but with narrower perforations are known in archaeology; these are presumably wrongly labeled as *sumaks* (Sadykov, 2017:21)].

The practice of using a hard cradle (*beshik* type) has led to changes during the infant's physiological development with visible consequences on the external constitution of the skeleton. The child lying in a *beshik* is bound to the cradle with special straps restricting its movements. The side effect of lying in such a cradle with a hard pillow permanently placed above and/or beneath the head is a deformation of the bones of the skull (Fig. 3), (Smirnova, 1983:71; Khudaverdyan, 2016:171). The issue of the so-called *cradle deformation* of the skull has already been examined on a wide-scale (Kyszely, 1978). This patterning was described for the first time in the 19th century by Pokrovskiy (1884:159). A characteristic feature of this deformation is the flattening of the occipital, which can still be observed among the people who are using hard cradle today (like *beshik* or *ororts*), *e.g.* Ossetians, Uzbeks, Azerbaijani people, Kazakhs, Ingushetians (Khudaverdyan, 2016:171). This deformation is also observed on skulls from archaeological excavations, notably in burial n°33 in the Bronze Age cemetery Rostovka in the Omsk region (Solodovnikov/Rykun, 2013:87) and in series of burials from Bronze and Iron Age, as summarized in the work of Khudaverdyan (2016:173). This topic even led Boas to examine both Armenian children raised in Armenia in traditional cradles (*ororts*) and in America (Boas, 1916:59). His results showed that skulls of the Armenian children raised in the hard cradle were five units smaller than in the group that was not using *ororts* (Khudaverdyan, 2016:172). It would be an interesting research perspective to analyze the skull deformation' indexes from the cemeteries culturally connected with the sites where the *sumaks* are recorded.

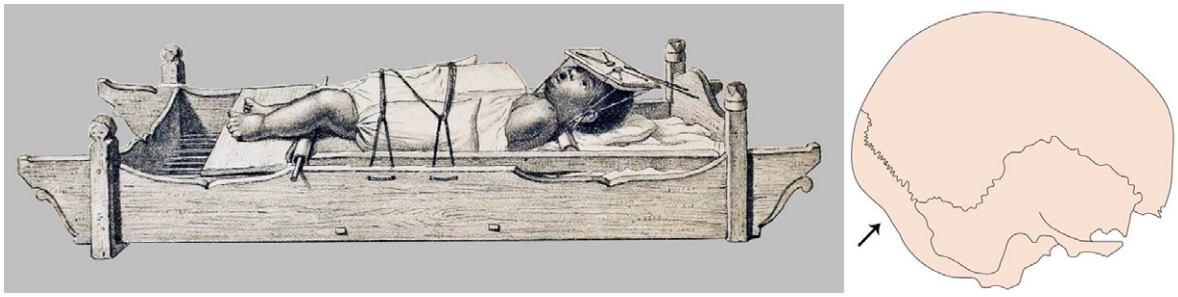

Figure 3. The infant's head as tightly bound to the cradle with straps and wooden pillow and/or frontal band undergoes a permanent mechanical pressure during growth making part(s) of his skull artificially flat, which is recorded in the archeological anthropological material from burial sites of southern Siberia (arrow) since the Bronze and Iron Ages (Khudaverdyan, 2016:172). This technical practice is not therapeutic but deliberately applied as a cultural practice and slows down the development of the skull in width causing an exaggerated increase in length (Buchet, 1988). Drawing of the comparable ethnographic apparel dated to the 19th century (1891) from the Indonesian Sulawesi island stored in the Museum Volkenkunde Leiden (944, n°1), after Van Hoëvel, 1893[the cradle is 124 cm long, 37 cm wide and 23.5 cm high, and made of bamboo and sago leaf for both the frontal tab and the pillow]. Photo, the free access archives of the Nationaal Museum van Wereldculturen Leiden. Drawing, K. Michalczewski.

ARCHEOLOGICAL RECORDS WITH A CONTRIBUTIVE EXPERIMENTAL TEST

The archaeological finds of *sumaks* from southern Siberia below discussed are mainly coming from three regions (Altai, Tuva and Kirghizia). Generally, these listed finds can be dated to the Xiongnu-Xianbei-Rouran period, known also as the "Hunno-Sarmatian" period, and can be considered one of the indicators of the first half of the 1st millennium AD (Fig. 4).

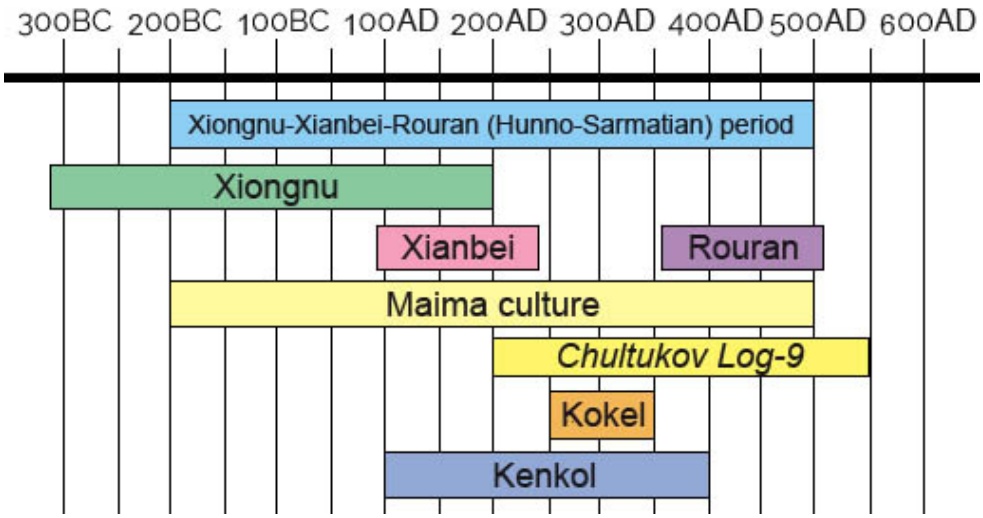

Figure 4. Timeline of the southern Siberian archaeological cultures during the first half of the 1st millennium AD (Katylyg 5 barrow mound represents the Kokel culture). Italic-Name of the archaeological site yielding the oldest sumaks.

Altai

Two *sumaks* were found on the settlement of Chultukov Log-9 (North Altai) inhabited by people of the Maima culture (2nd century BC-5th century AD). The horizon or Log (n°9) relates to several occupations of the site that are attributed to the Xiongnu-Xianbei-Rouran period. Radiocarbon dating allows to determine that the settlement was used from the 3rd until the 1st half of the 6th century AD (Oleszczak *et al.*, 2017:156). An extensive assemblage of bone artefacts has been recorded there, which indicates that cultural contacts occurred with the broadly defined *Hunnic* culture (*ibid.*). However, the provenance of some items

is probably connected with the more local influences. It is possible that *sumaks* should also be assigned to this category of objects. Both *sumaks* from Chultukov Log9 were made of tibia bone of the small herbivores like sheep. One was made from the left tibia, and the second from the right. They were recorded in the neighborhood of the pit-house n°35. An interesting observation is the fact that this object is characterized by the particularly large number of bone artefacts—in particular, splints of the composite bow, arrowheads, and hide working tools—and waste debris with manufacture traces. Presumably, children were kept in the direct neighborhood (or inside) of the area of manufacture. It also cannot be excluded that *sumaks* were only manufactured there.

Figure 5. Sumak (left tibia of a small herbivore) from Chultukov Log-9 (37/2016), in Altai. Scale subdivision in cm. Photos, K. Michalczewski.

The first *sumak* (Fig. 5), (37/2016) is made of sheep/goat tibia. It is 15.5 cm long and is characterized by a very good state of preservation. Its distal epiphysis was chopped off and it was not processed further during the manufacture (*infra* Pl. 1-4). In the area of the proximal epiphysis, an oval hole with a diameter of 1.2x1.4 cm was made to perforate the anatomical edge of the bone (Pl. 1-2). The experimental test we conducted to replicate the object shows that the perforation was probably processed using the tip of an iron knife (Pl 2-9). Then, the edge of the perforation was thoroughly regularized until it became round-smooth (Pl 2-10). The perforation's edge of the archaeological *sumak* is visibly more altered than that of the experimental replica (Pl. 1-1 compare to Pl. 1-7). Perhaps it is due to taphonomical, or particular use-wear, patterns resulting from the bone material being modified through the chemical effects of adding wax and/or through contact with the implied substance (urine). Otherwise, the surface of the diaphysis shows clearly visible traces of scraping made with an iron knife to remove the soft tissue (Pl. 1-3 compare to Pl. 1-8). The experimental test using a metallic tool, and according to finds from the Chultukov Log-9 site, shows that traces resulting from manufacturing the replica are highly in line with those observed on *sumak* 37/2016 (Pl. 1 & 2).

Figure 6. Sumak (right tibia of a small herbivore) from Chultukov Log-9 (29/2016), in Altai. Scale subdivision in cm. Photos, K. Michalczewski.

The second *sumak* (Fig. 6), (29/2016) is 16.5 cm long, and has a round hole with a diameter of 1.5 cm. After removing the distal epiphysis, the edge of the outlet, where the medullar

Figure 7. Possible waste debris of a sumak or a whip handle from Chultukov Log-9a, in Altai. It is a tibial distal epiphysis carefully transverse cut before it was removed, broken by flexion, during manufacture. Scale subdivision in cm. Photos, K. Michalczewski.

canal was transversally cut, was thoroughly regularized before it became quite smooth (Pl. 1-6). The piece is however in a bad state of preservation. In this case, the distal epiphysis was removed in a more precise way. Waste connected with such a technique of removing the distal epiphysis in an accurate way, which prevents from losing to much of the length of the raw material, was recorded on Chultukov Log-9 (Fig. 7). However, it may derive from the manufacturing of different artefacts like bone tubes interpreted as whip handles which were also found on the same site (Oleszczak *et al.*, 2017:168).

Similar *sumaks* are recorded in Altai from another site. One of them was found about 30 km from Chultukov Log-9 on the hillfort Nizhniy Cheposh-3, which is also dated to the Xiongnu-Xianbei-Rouran period (Soenov *et al*., 2011:33 & 2016:96-97). This *sumak* is 17.5 cm long and its hole is 1.3 to 1.5 cm in diameter. Manufacturing traces (cutting in length and transversally, and scraping) done with a metallic knife were observed on this find (Soenov *et al*., 2016:96).

Another *sumak* was found on the site Kuylu (Altai) in the layer dated to the early Iron Age (Fig. 8). Finds from this site cover both the Scythian and the "Hunno-Sarmatian" or Xiongnu-Xianbei period (Molodin/Efremova, 2010:Fig.72-3; Soenov *et al.*, 2016:96).

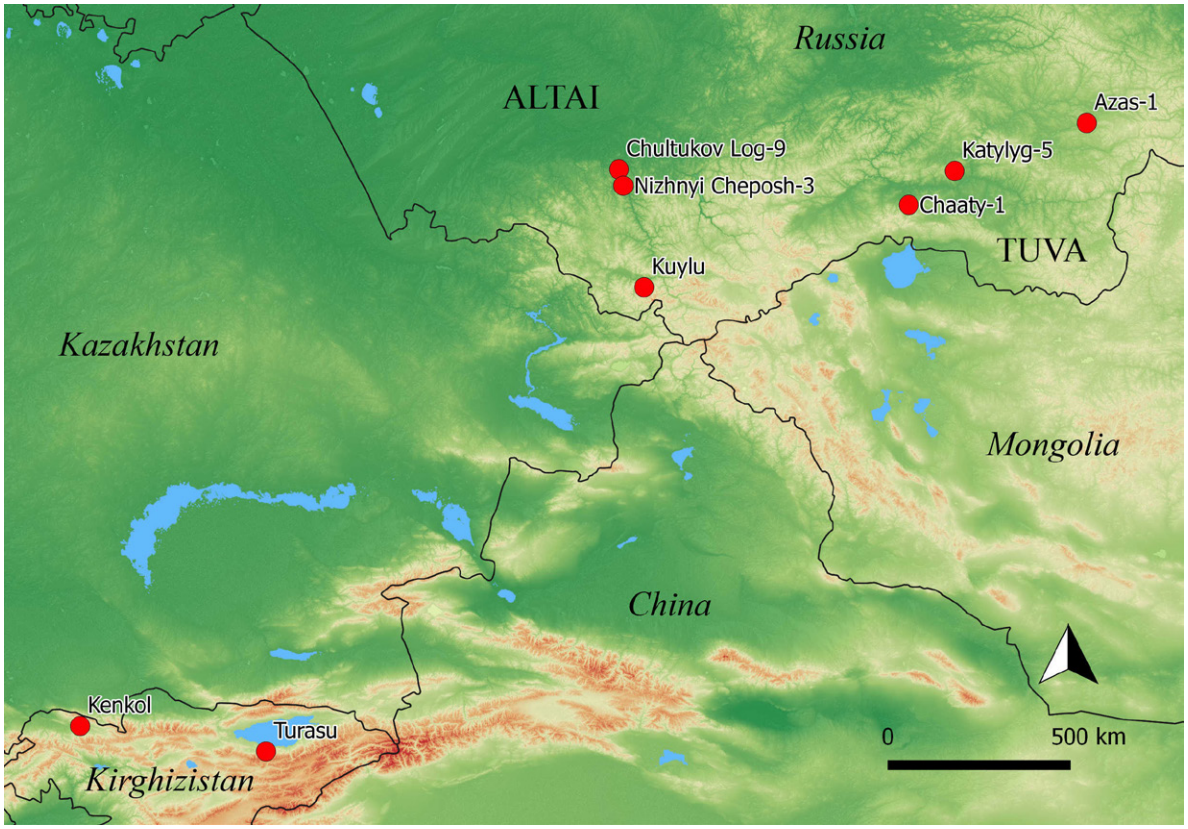

Figure 8. Location in southern Siberia of the various sites dated to the Xiongnu-Xianbei-Rouran period where sumaks are recorded. In Altai: Chultukov Log 9, Nizhniy Cheposh 3, Kuylu; in Kirgizhia: Kenkol, Turasu; and in Tuva: Katylyg 5, Chaaty 1, Azas 1. Geographical locations based on a Google map, K. Michalczewski.

Kirghizia

The argument that best interprets this category of objects as urine draining pipes is the discovery of the barrow mound n°6 in the cemetery of Kenkol (Kirghizia) excavated in 1939. A burial contained the remains of two adults (male and female aged 20-25 years old) and two children (about 1 year and 20 months old). Inside the grave pit, a wooden cradle was found. It consisted of two 36 cm long wooden bars, two boards with cutouts for five transverse crossbars (four of which were found) constituting the bottom of the cradle. The whole cradle was 70 cm long and 37 cm wide. Additional small perforations were done, probably to strain the strand that was holding the curtain of the cradle. With its dimensions and construction, the cradle does not diverge from the traditional cradles of the *beshik* type known from ethnographical sources (Bernshtam, 1940:20). Inside the grave among the wooden remains of the cradle, a 16.5 cm long *sumak* made of tibia bone was found (Fig. 9-4). Among the funerary equipment were also wooden vessels and pottery (*ibid.*:7). All the skulls had intentional deformation (the 20-month child in particular), which is a characteristic of the nomadic aristocracy of that period (Werner, 1956:5-18; Hakenbeck, 2009). Artefacts found in the Kenkol cemetery, including bone splints of the composite bow, silk textiles, are, in addition to the deformed skulls, all characteristics of the high rank burials of the Xiongnu-Xianbei-Rouran period. According to the current state of knowledge, finds from Kenkol would date to the 2nd-4th-century AD (Sorokin, 1956:3-14; Soenov *et al.*, 2016:96).
Another find of the *sumak* type was recorded in a barrow mounds cemetery on the right bank of the Kara-Kundzhur River, east of the Turasu village in central Tian Shan (Kibirov, 1959:66). The barrow mound n°18 contained burials of two adults (male and female). The funerary equipment includes, among other things, bronze bracelets, preserved pieces of textiles, astragals, a necklace made of perforated bird bones, and a *sumak* (*ibid.*:114-116). The

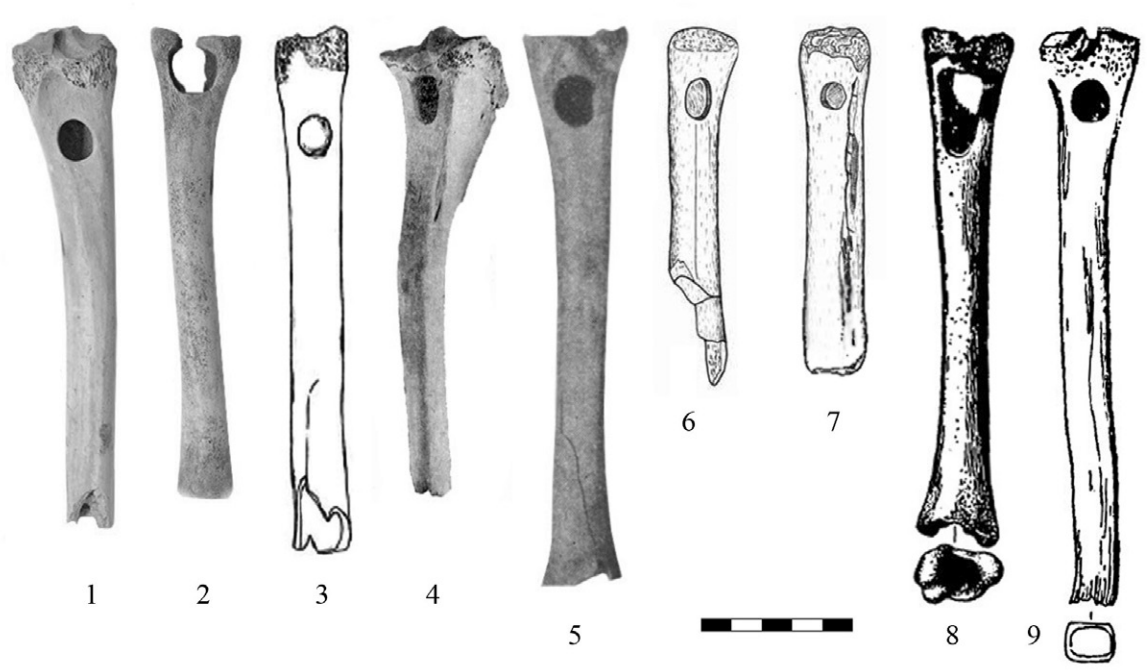

Figure 9. Sumaks of Altai (1-3), Kirgizhia (4-5) and Tuva regions (6-9). 1 - Chultukov Log-9, n°37/2016 (photo, K. Michalczewski); 2 - Chultukov Log-9, n°29/2016 (photo, K. Michalczewski); 3 - Nizhniy Cheposh-3 (after Soenov *et al*., 2011); 4 - Kenkol (after Bernshtam, 1940); 5 - Turasu (after Kibirov, 1959); 6 - Katylyg-5, n°310/43 (after Sadykov, 2017); 7 - Katylyg-5, n°K8/1 (after Sadykov, 2017); 8 - Chaaty-1 barrow mound n°10 (after Kyzlasov, 1979); 9 - Chaaty-1 barrow mound n°20(66), (after Kyzlasov, 1979).

precise location of the *sumak* in the grave was not mentioned (Fig. 9-5). *Sumak* from Turasu is about 18.8 cm long and has a hole of 1.4x1.5 cm. It cannot be excluded that a child was also buried there, but its bone remains were not preserved or were not collected during the excavations. Artefacts found in this cemetery indicate direct parallels with the bone assemblage from Chultukov Log-9 (bow splints, perforated scapulae, *sumak*).

Tuva

Another region where the invention of the *sumak* was widespread in the Xiongnu-Xianbei-Rouran period was in Tuva. Two were found on the fortified settlement of Katylyg-5 (Fig. 9-6 & 7) inhabited by the people of Kokel culture (Sadykov, 2017:22/Fig.2-4). It is most likely that the Xianbei tribes, who reached this Basin after the Xiongnu hegemony, did partly influenced the Kokel culture. Radiocarbon dates shows that Katylyg-5 settlement was used from the second half of 3rd century till the first half of 4th century AD (Sadykov, 2018:88). Interestingly, among the six pits recording children's burials on the site, no *sumaks* were found (*ibid*.:21). In the male graves in the cemetery at Katylyg-5 and Kokel, resembling items in morphology were found. Their function is not clear but they shouldn't be classified as *sumaks* since these are cut both sided (Dyakonova, 1970:119; Sadykov, 2017:21).

Conversely, in the Todzhinskaya Basin, *sumaks* participative to the funerary equipment of children were recorded in the Azas-1 cemetery for the same Kokel culture (Devlet, 2010:174; Sadykov, 2017:21). It is most likely that the Xianbei tribes, who reached this Basin after the Xiongnu hegemony, did partly influence the Kokel culture.

In the Chaaty-1 cemetery, two *sumaks* (Fig. 9-8 & 9) were also part of the funerary equipment in the barrow mounds n°10 and n°20 (Kyzlasov, 1979:166 & 168/Fig.123). In the first mound, a female of 25 years old was buried. The woman was most likely killed with a sword, as the skull was deeply injured in some parts. There, objects with the remains of some transverse planks (48x100 cm) were recorded along with a *sumak* which measured 17.2 cm long with an oval hole of 1.5x3 cm in dimensions (*ibid*.:166). Traces of planks and *sumak* suggest that a

whole cradle was buried in the grave. In the other mound n°20(66), an old man was buried together with a woman and two children. The first child was buried in the center, 0.95 m deep, and the second was buried 0.7 m deep, 4 m west from the center. The second child was buried with a *sumak* made from a tibia bone from a sheep (*ibid*.:177; Kyzlasov, 1969:72-73/Fig.22-1). This *sumak* is approximately 19 cm long with a hole of 1.2 cm in diameter. The site was formerly dated to the medieval Uyghur Khaganate (Kyzlasov, 1979). However, in the light of the most recent studies, the date of this cemetery would attest to the Xiongnu-Xianbei-Rouran period (Savinov, 2006:45; Soenov *et al.*, 2016:96-97).

***Sumaks* in Hunnic graves in Hungary**

It is also worth mentioning that analogical objects which should probably be called *sumaks* too were recorded in the Hunnic graves excavated in Hungary (Nagy, 2005). One of them was found in the grave of a 1/2-year-old child in Martély–Szépfű (South Hungary). It was described in the literature as a tool (Nagy, 2005:Fig.7-7) or a ritual item/amulet (Choyke, 2010:Fig.18.11-10). This is a significant observation because it gives evidence that the Huns continued the Central Asian tradition of using *sumaks* during their expansion to Europe.

DISCUSSION

If some *sumaks* were found in graves with preserved child remains, like in Kenkol, Azas1, and Chaaty1 barrow mound n°10, it cannot be excluded that when children's bones were not found (if this is not due to bad preservation conditions), *sumaks* would relate to the funerary equipment of females only, then with a symbolic dimension—*e.g.* Turasu and Chaaty1 barrow mound n°20(66). The rest of the finds was recorded on settlement sites, like in Chultukov Log9, Nizhniy Cheposh3, Kuylu, and Katylyg5. The Chultukov Log-9 site excavated by us was located in a particularly interesting contact zone. It was a region significantly distant from the center of Xiongnu Empire, which means that it was not under strong Chinese influences (Oleszczak *et al.*, 2017:170). Generally, items typical to the Maima culture to which the Chultukov Log9 site belongs demonstrate clear parallels with the material culture of Xiongnu and Xianbei, but artefacts like *sumaks* indicate influences of a different origin. It is worth pointing out that Chultukov Log9 is situated by the Katun River which was an important communication route in antiquity. Its location visibly favored a high economic development based on the animal resources' exploitation as attested by the huge amount of bones found at the site. This situation might have been significant in the context of the spread of *sumaks*. The current state of knowledge shows that *sumaks* appeared contemporarily in different regions of Altai, Tuva and Kirgizhia, where they were found in different types of sites (inhabitations and graveyards). Since the *sumaks* were not recorded on the largest settlement sites of Xiongnu in the Transbaikal region, *e.g.* the Ivolginsk stronghold (Davydova, 1995), it seems therefore possible that the *sumak* was invented among the nomadic or semi-nomadic people living in other parts of southern Siberia and more precisely in the Russian Turkestan[2] during the turbulent times of the Xiongnu or Xianbei expansion. In the subsequent chronological periods, *sumaks* became also popular throughout Eurasia and reached the Hungarian Plain.

CONCLUSION

The *sumak* corresponds to the tubular (left or right) tibial part of a small size herbivore such as sheep or goat and whose length, as a low modified bone object, varies from 15.5 to 19 cm for known specimens. The diameter of the hole perforating one of the cortical walls of the bone's end is usually 1.2 to 1.5 cm. From ethnographic sources and similar actual examples made of wood, these objects were most probably used as urine draining pipes for infant care, possibly invented to be relieved from the constant supervision of the infant in the cradle and/or as a way to be prepared to leave unexpectedly or more often. It cannot be excluded that the *sumaks* described in this paper are the oldest examples of this invention

then dated to the second half of the "Hunno-Sarmatian" or also called the Xiongnu-Xianbei-Rouran period, *i.e.* at the time of the hegemony of the three nomadic "empires" that controlled in turn the Steppes regions. Indeed, radiocarbon dating of Chultukov Log-9 and Katylyg-5 sites cover the period from the 2nd century to half of the 6th century AD (*supra* Fig. 4). That shows that listed *sumaks* could be rather connected with the times of domination of Xianbei and Rouran (end of 1st century – half of 6th century AD). As most of the finds don't have the narrow dating it is difficult to tell if *sumaks* were in use earlier (during Xiongnu domination times). The occurrence of *sumaks* during the same period in Tuva, Altai and Kirghizia is presumably connected to the expansion of the Xiongnu and Xianbei cultures. During those times, the frequent migrations of "Hunnic" tribes led to the extended assimilation of the traditional inhabitants of southern Siberia. Undoubtedly, it has contributed to the cultural exchange and transfer processes of ideas and perhaps materials among the thereby constituting or participating in the so-called Hunnic material culture in the region; in this case, this would refer to the Xiongnu and its subsequent Xianbei cultural phases, both remaining undifferentiated in terms of material goods. Rather than the Hunnic tribes introducing a new technical practice, via its elite for instance, it is most probable that the local populations of southern Siberia, and more precisely the Russian Turkestan, invented the *sumaks* in response to the recurrent military threats of the hegemonic tribes. Indeed, keeping a child in a portable cradle such as in a *beshik* which is fitted with a draining pipe for infant care purposes can be regarded as an invention allowing locals to run away from home faster. The current state of knowledge would support that the *sumak* was invented by local nomadic tribes in anticipation of necessary moves which represents a cultural phenomenon most probably originating from ethnic invasions. The assimilation of many Asiatic tribes into the expanding Xiongnu and Xianbei cultures made this invention popular in the broad area of Eurasia. For now, it is not possible to tell which of the recorded archaeological cultures (*supra* Fig. 4) was the first to use the *sumak*. The lack of accurate dating from *sumaks* finds in comparative contexts remains problematic. Further research will hopefully shorten the chronological period pertaining to their first appearance and shed more light on the precise starting point of the spread of this invention.

This particular issue requires tracing the diffusion of the tradition of using *sumaks*. Indeed, the spread of this invention and the fact that it is still in use today appears as an extraordinary example of a transcultural transmission of nomadic practices since the Antiquity among the Eurasian Steppes tribes. Finds of *sumaks* are also an exceptional source of knowledge of children in the past. Usually, archaeological reconstruction of children's lives in antiquity is based mainly on the study of (patterns of) their skeletal remains and items interpreted as toys. *Sumaks*, as elements of the cradle, constitute an exceptional and unique category particular to children in archeological research.

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NOTES

[1] Digital resources of the Kunstkamera Museum Saint Petersburg. Available at: http://web1.kunstkamera.ru/jeynov/rus/index.htm[Accessed Nov. 15, 2020].

[2] Southern Siberia here refers to the area of Tuva, Altai, Khakassia and Transbaikal. The Russian Turkestan areas, —the ex-Soviet Central Asia—, refers to the lands between Amu Darya, Syr Darya, Pamir, Tian Shan, Zhetysu and Hindu Kush.

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RÉSUMÉ

LE SUMAK EN OS POUR LE SOIN DU NOURRISSON EN SIBÉRIE MÉRIDIONALE, UNE INVENTION NÉE DU NOMADISME OU DES INVASIONS HUNNIQUES ?

Le sumak est constitué d'un tibia droit ou gauche de mouton/chèvre qui est percé sur un bord d'un trou de 1,2 à 1,5 cm de diamètre, et qui mesure, une fois l'os raccourci pour être évidé, régularisé et nettoyé, entre 15,5 à 19 cm de longueur. Par celui-ci, le drainage des urines du nouveau-né immobilisé dans ses langes est assuré à travers le berceau vers le réceptacle en dessous soclé à cet effet. Le sumak est attribué à la séquence Xiongnu-Xianbei-Rouran où il est représentatif de la culture matérielle des populations nomades « Hunno-Sarmates » dont les occupations sont datées entre les IIe et IVe siècles de notre ère. Dans trois régions du sud de la Sibérie (Altaï, Touva et Kirghizie), les sumaks sont retrouvés associés à des tombes d'enfants — à Kenkol, Azas-1, Chaaty-1 (tumulus 10) — et à des structures sépulcrales semblables mais où les restes d'ossements juvéniles ont pu ne pas avoir été préservés, notamment à Turasu et Chaaty-1 (tumulus 20/66). Si ces objets n'étaient là finalement associés que comme mobilier funéraire de défuntes, ils y revêtiraient alors une dimension symbolique. Ailleurs, ces objets sont découverts dans les sites d'habitats, comme à Chultukov (Log-9), Nizhniy Cheposh-3, Kuylu, et Katylyg-5. Ceci étant, les sumaks ne sont pas enregistrés dans les plus grands sites de peuplement du Xiongnu dans le sud de la Sibérie, par exemple au bastion d'Ivolginsk au Transbaïkal (e.g. Davydova, 1995). Le site de Chultukov (Horizon 9), qui nous est familier pour l'avoir fouillé, est proche de la rivière Katun aux abords d'une voie de communication déjà importante dans l'Antiquité. Il a retenu notre attention comme il se trouve être localisé dans une région particulièrement intéressante du fait de son éloignement notable par rapport au centre de l'empire Xiongnu, ce qui signifie qu'elle n'a pas dû subir la forte emprise des influences chinoises (Oleszczak et al., 2017:170). En outre, son emplacement a vraisemblablement permis un fort développement économique fondé sur l'exploitation des ressources animales, comme en témoigne l'énorme quantité d'ossements retrouvés dans le site.

À terme, cette particularité du site pourrait se révéler significative au regard de l'appréhension du contexte de diffusion des sumaks. En général, les objets typiques de la culture Maima auquel le site se rattache, montrent des parallèles plutôt évidents avec ceux de la culture matérielle de Xiongnu, mais des artéfacts comme les sumaks indiquent des influences de toutes autres origines.
Même si les objets évoqués dans l'article ne peuvent pas à eux seuls représenter les exemples les plus anciens d'une pratique propice au nomadisme en milieu steppique — dans la mesure où les sumaks renvoient bien à une invention permettant d'accéder précisément à une certaine liberté de mouvements par l'assujettissement du corps du nourrisson à l'astreinte physique — ces objets sont en revanche propres à la période où l'hégémonie des trois empires nomades Xiongnu-Xianbei-Rouran, est clairement attestée en Sibérie méridionale. Comme les sumaks y apparaissent pour ainsi dire simultanément à Touva, dans l'Altaï et en Kirghizie, et autant dans les sites d'habitats que dans les cimetières, il est vraisemblable que cette pratique impliquant leur usage, et sans pouvoir toutefois la rattacher à l'une ou l'autre des cultures archéologiques identifiées, ait véritablement été comme une invention en réponse à l'expansion des Huns. À cette époque, les migrations hunniques ont pu conduire à une assimilation prolongée avec les populations déjà traditionnelles d'Asie centrale (Bernshtam, 1940:31), contribuant ainsi aux échanges et processus de transferts entre tribus, dans ce cas constitutives ou participatives de la culture hunnique dans la région, précisément du Turkestan russe, dans ses phases Xiongnu puis Xianbei quasi indifférenciées au plan matériel (Oleszczak et al., 2017:158; Sadykov, 2017:906).
Par la suite, l'invention du sumak a été intégrée par de nombreuses peuplades dans toute l'Eurasie. Un témoignage de cette adoption suggère qu'elle aura impliqué d'autres matériaux aux côtés des sumaks traditionnels en os sur de mêmes sites, comme dans le cas des sumaks en verre connus de la région de la Volga et datés des XIII-XIVe siècles AD (Busyatskaya, 1976:52). La popularité des berceaux avec sumaks de type beshik (berceau portable en bois à poignée centrale) parmi les tribus nomades et semi-nomades s'expliquerait donc par certains de ses avantages : le nouveau-né immobilisé par des sangles à ce type de berceau n'a pas à faire l'objet d'une surveillance constante, ce qui permet une certaine autonomie dans la réalisation des tâches quotidiennes. En outre, en cas de menace ou sous la terreur d'une migration à envisager, l'enfant aura rapidement pu être saisi par son berceau comme un tout aisément transportable en s'affranchissant largement des préparatifs du voyage du nourrisson.
Dans l'attente de poursuivre les recherches pour mieux rendre compte de ce qui aura amené la diffusion de la pratique intégrant le sumak, cette invention se retrouve à travers toute l'Eurasie. Le fait que le sumak soit toujours utilisé de nos jours — ce qui autorise ici son attribution par l'analogie fonctionnelle — est un exemple extraordinaire de la pérennité d'un objet matériel par des phénomènes transculturels depuis l'Antiquité. Les découvertes de sumaks sont à cet égard une source extraordinaire de connaissances sur l'évolution des rapports aux enfants par le passé. Alors qu'elle ne repose en archéologie que principalement sur l'examen des restes osseux, sinon des objets interprétés comme jouets ou parures, le sumak, en tant qu'élément « écologique » du berceau, représente une source à part entière d'objets matériels qui permet d'enrichir à la fois nos connaissances sur les pratiques techniques de l'Antiquité liées au maternage et sur les interactions entre les cultures propres au nomadisme steppique.

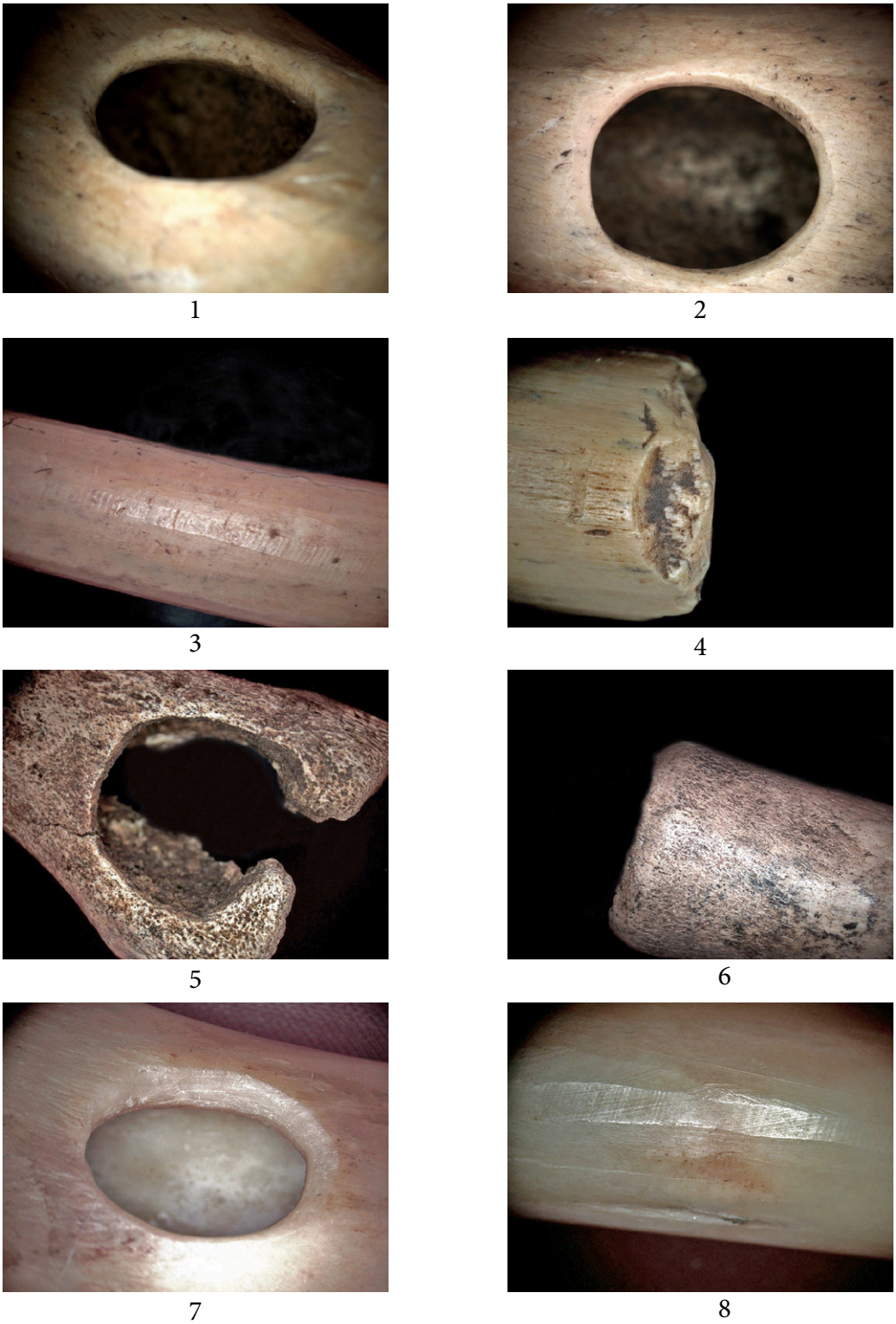

Plate 1. Comparisons between archaeological (from the Chultukov Log-9 site, in Altai) and experimentally replicated sumaks. Approximate scale, magnification 30×. Photos, K. Michalczewski.
1 to 4 Sumak n°37/2016: detail of the perforation (1 & 2), of the shaft showing axial planes (3), and of the opposite chopped off extremity that is anatomically distal (4);
5 & 6 Sumak n°29/2016: detail of the perforation (5), and of the opposite extremity that is anatomically distal with a smooth use-wear pattern (6);
7 & 8 experimental replica manufactured as in figure 5 (*supra*): detail of the perforation with hole of *circa* 1.5 cm in diameter (7), and of the shaft that was scraped in planes (8).

1 2 3

4 5 6

7 8 9

10 11 12

Plate 2. Experimentally replicated sumak using a tibia of sheep worked with a modern (iron) knife used for about twenty minutes. Photos, K. Michalczewski.
1 - Aspect of the limbs after defleshing;
2 - Soften the tissues to remove them easier by boiling the limbs;
3 - Dismembering the limbs by cutting through at the level of the articular planes;
4 - Removing the remaining soft tissues from the bone by trimming with the knife's cutting edge;
5 - Removing the protruding anatomical parts by chopping them off with the knife's cutting edge;
6 & 7 - Aspects of the grooved distal end before and after it is removed by direct percussion;
8 - Removing the remaining soft tissues by scraping with the knife's cutting edge;
9 - Perforating the bone with the tip of the knife used in alternate semi-circular motion;
10 - Broadening the hole and smoothing its edge by scraping it radial with the knife's cutting edge;
11 - Replica of a sumak with the corresponding waste debris (right) compare to a normal tibia (up);
12 - Sumak manufactured with a modern knife.

MAKING GODS IN ANCIENT GREECE: RITUALS AND CULT IMAGES DEVELOPMENT THROUGH TRACING IVORY USE IN STATUARY TRADITION

Lucia Nováková

Abstract: Agalma, a broad term, which is commonly translated as cult image, played an important role in Greek religion. Ivory was employed in the manufacture of agalmata since Orientalizing period at the latest. Highly prized on account of its exotic origins, aesthetic quality and reputed magical properties, its physical characteristics allow it to be worked by a variety of techniques, as carved in relief, cut into veneers or inlays, turned on a lathe or moulded. Most ivories were ultimately polished, painted or gilded. Manufacturing techniques, but also the form and use of cult images gradually changed during antiquity. Literary and physical evidence suggest that thin sheets of ivory used for monumental cult images of Classical period were softened in acidic baths and then moulded in clay or wooden forms. Acrolithic and later chryselephantine statues adorned interiors of major temples and became objects of various ritual activities, including coating, dressing up, bearing in procession, adorning or immersion in the water. Smooth creamy-white surface and warm lustre of ivory statues required a special care, including maintaining proper housing conditions and oil polishing. Even if almost none of these cult images survived until these days, numerous references of ancient authors and representations in other media attest their technical, stylistic and iconographic changes. Tracing ivory in sculptural tradition such cult images not only from Near East or Anatolian coast, but also Greek mainland shows multiple uses of this material in religious sphere.

Antiquity, Agalma, Akrelephantine, Chryselephantine, Ivory, Symbolism, Statuary

INTRODUCTION

Rare in Greece in certain periods, ivory is said to have been valued for combination of qualities such as fineness, glimmering color, glassy texture, its potential for detailed work, and its suitability for combination with gold. The civilizations of the ancient Near East, Anatolia and Egypt played significant roles as suppliers not only raw materials, but also models for the use of gold and ivory objects, methods of producing them and religious ideas bound to cult images in ancient Greece. Material, technique and ideas reached the Aegean long before the rise of classical civilization. The dentine of elephant tusks was imported to Greece from Afrika, Levant or India. Material had been transmitted to Greece along with religious ideas related to the cult images that point to the significantly older tradition. Despite its foreign origin, innovative use of ivory by chryselephantine cult statues seems to be the Greek invention. On account of its exotic origins, aesthetic quality and reputed magical properties, ivory was used in production of divine statues. It was almost always combined with other materials, as wood and gold. While ancient authors mostly refer to the material of statues made of ivory and gold (δὲ ἐλέφαντος καὶ χρυσοῦ), various modern terms are frequently applied (Lapatin, 2001:2-16). Chryselephantine statue refers to a high-quality statue built up on a wooden core and covered with plates of gold for the clothing and ivory for flesh, which was used in ancient Greece since the sixth century BC at the latest. Term *akrelephantine*, denoting gilded wooden images with ivory limbs, can also be used.

Exotic materials for crafting cult image

The most informative literary source for chryselephantine statuary is Pausanias (*Paus.1.39.3, 2.13.3, 2.29.1*), commenting on more than forty statues or groups in shrines on the Greek mainland. Despite numerous references of ancient authors, chryselephantine statues are extremally rare in archaeological testimony. This include finds recovered from Halos deposit at Delphi, an ivory head and forearm in Vatican, feet in Syracuse, ears from Malta and Naxos, or forearm in Corinth (Lapatin, 2001:138-150). Ivory was highly prized,

serving as symbol of wealth, status and prestige since the Bronze Age. Predecessors for chryselephantine statues in ancient Greece might be composite ivory figures from the Bronze Age Aegean, Egypt and Near East. According to some scholars, this technique transmits Minoan and Mycenaean art into the subsequent periods (Morris, 1992:255). Prehistoric inlay works are attested in epic as *daidala*. In Mesopotamian cultures, ivory and gold were employed for statues in the round, but more commonly these materials were used in construction of other ensembles, predominantly furniture and smaller ritual, martial, musical or cosmetic implements (Lapatin, 2001:7-22). Ivories from the Levantine coastal region are more linked to Egypt, with stronger sculptural tradition using this material than inland areas. What these materials in ancient Greece and Near East have in common, is that they manifested the wealth, status, prestige and piety of the owners, regardless of whether they were stored at home, dedicated in sanctuaries or deposited in tombs.

The ivory of Near East, Eastern Mediterranean and Greece was supplied by elephant of Asia, in antiquity usually known as the Indian (*Elephas maximus*) and the elephant of Africa (*Loxodonta africana*). Their tusk differs in shape and texture, the African being generally larger and more curved than the Asian. The Asian elephant was known in Western Asia, where it became extinct sometime in the second quarter of the first millennium BC. Raw material was imported from the Gulf of Indian subcontinent. African ivory was transhipped through Cyprus and Rhodes into the Near East in the first millennium BC, when the Phoenicians were in contact with the more distant coast of North Africa and the Egyptian delta (Morrey, 1999:116). A revival of *chryselephantine* production in Greece can be recognized in the Late Geometric and Orientalizing period. Increase of ivory in archaeological finds, both in raw material and objects, along with imported decoration techniques and motifs points to contact with Levant and the Near East. Material appeared along with motifs and perhaps even craftsmen from the Levant, where the stronger inclination towards ivory statuary tradition can be recognizable. Archaeological evidence from various places of the Greek world like Crete, Athens, Ephesos, Samos, Laconia, Delphi or Perachora, though sometimes exhibiting local stylistic features, provides closes parallel items that have been excavated in great quantity in the Near East, particularly at Nimrud. Near Eastern influence is seen in some parts of statues, but the style distinguishes Greek work. The Greek technique of attaching ears separately or inlaying eyes by using bronze pockets to secure the inlay and to depict lashes, differs from the Near Eastern use of bitumen (Sturgeon, 2002).

Ivory made divine statues with human appearance

Almost at the same time, new type of divine statues and sacral building began to appear in the Greek world. A temple was conceived as the abode of the deity that was impersonated in cult image. Composite statues were assembled from individually carved ivory faces, hands, and feet, attached to the wooden armatures that were subsequently sheathed in gold (Lapatin, 2010a). Ivory statues were probably painted, with red, green, and blue. Greek cult images seem to share multiple features with their Near Eastern counterparts. Idols came in a variety of shapes and sizes in the ancient Near East. Basically, human in appearance, they had distinctive, even formalized, poses, clothing and hairstyles. Most temple images were fashioned from precious wood. The shapes of the images followed some acknowledged conventions, which were also known from the ancient Greece. Some were about 10-20 cm tall, others were life-size. They generally had human shapes and proportions. Some images were seated since their thrones were mentioned. The statues were made and repaired in special workshops. Small decorative ornaments of gold or silver were sewn onto the clothing of the gods. The clothing was changed according to ritual and ceremonial requirements. They were typically carved of wood and overlaid with hammered-out sheets of silver or gold. Also, Greek chryselephantine statues did not have bronze cores, but wooden (Mattush, 1996:127). The cult image was not primarily intended as a visual representation of the deity by ancient Mesopotamians, but as a dwelling-place of the spirit of the deity enabling the god

to be physically present in many different places simultaneously. The idol was not the deity, but the deity was thought to inhabit the image and manifest its presence and will through the image (Jacobsen, 1987:18).

Dwelling place for the Greek deities were temples, while their cult images were understood as emanation of gods. However, further features that the Greek and the Mesopotamian cult images had in common can be set aside. They were usually fashioned to look like men, and they participated in most human activities such as eating, drinking, making love, losing their tempers, sulking, weeping, and sleeping. The images of deities were fed, dressed and even washed daily. Attendants were required to dress and undress the statue, and still others were employed to wash the statue and transport it in times of celebration. A secret ritual of consecration of statues was performed to endow the Mesopotamian gods with life by opening their eyes and mouths to see and eat (Bottéro, 2001:65). The divine statues were then placed on a pedestal in the inner sanctuary. Similar animation of statues was generally accepted in ancient Greece, means that the god himself is dwelling in its image (*agalma*) and that therefore the image possesses powers that would not normally be ascribed to a statue. The Greek cult images were positioned prominently, on a base centred in *naos* of temple, to command the attentions of worshippers. They were anthropomorphic, sculpted in conventional, frontal poses, which invited interaction with the viewer. The Greek *agalmata*, that were incorporated into ritual activities as parading in procession, covering with fillets of wool, dressing in garments or presenting with meals (Larson, 2016:158), were also venerated. A rite of installing a statue with special utterances and procedures, including an appropriate sacrifice, officially consecrated a sacred site was called *hidrusis*. The performance of this rite established a divinity's vital and influence in a particular sanctuary by properly situating a representation of the divinity (Landrum, 2016:45-60).

Crafted composite ivory statues

Along with the adaptation of such religious ideas, Greek artists began to use imported ivory to achieve the color of radian and smooth complexion of divine statues, and understood it more as simulated epiphany rather than a simple representation (Lapatin, 2010b:150). Greek deities began to be the most frequent subjects of chryselephantine images, made of precious materials. Chryselephantine technique became widespread during the Archaic period, attested by group of statues found in Delphi (Amadry, 1939:86-119). It was possibly dedicated by the mid sixth century BC tyrant on Samos, and its mixture of styles suggests a diversity of artists. Statues up to life-size might be rendered by assembling on a wooden core individual components carved whole from single tusk (Lapatin, 2010b:143). During the Archaic period, production of smaller images and refining techniques is recognizable. The first composite ivory statues have been fashioned on a scale significantly larger than life size in the following period. Sculptures, especially temple *colossi*, were made with an inner core of wood overlaid with ivory, to simulate flesh, and gold, to represent drapery. Such images were considered as the highest form of artistic production in classical antiquity. The transition to the High Classical Style is marked by Pheidias' colossal gold and ivory cult statue of Athena Parthenos in the Parthenon, which was, according to the literary and epigraphical testimonies (IG I 3 453-460), created in 446-438 BC. After the completion of the Athena Parthenos, Pheidias moved on to Olympia, where he produced a second chryselephantine *colossos*, the cult statue of Zeus.

Ivory, a divine substitute for flesh and bones

A principal characteristic of succesful images of the divine seems to have been their ability to elicit wonders from, or to be recognized as wonders (*thaumata*) by, their viewers by means of skillful craftsmanship that made them appear radiant and more overwhelming than the other beings or objects. Exotic materials of chryselephantine statues functioned in distancing manner. Intrinsic qualities of gold and ivory emphasized one of the divine

Figure 1. Figure made from ivory tusk, found at Egypt, Alexandria, stored at the The Walters Art Museum, Baltimore. Dimensions: 8.9 x 3.1 cm.
Photo: https://art.thewalters.org/detail/2858/alexander-the-great-3, reproducted with permission.

attributes, conspicuous physical beauty (*charis*), (Neer, 2010:18-42). In the half-light of a temple or treasury building, smooth and luminous ivory represented ideal complexion of gods. Another advantage of using ivory as incarnate lies in the nature of the material. The deposition of each layer of dentine that makes up the tusks forms a series of layers (Fig. 1), called *lamellae*; the dentine during growth forms in cones nested within each other (Poplin, 1977a & b) that are often visible as large concentric oval rings on the surface of the manufactured product in its cross section (Stern/Thimme, 2007:16). Created during growth, their last outer layout (*cement*) is usually irregular, what the Greek artists usually used modeling muscles of figures (Cutler, 1958:7). In mythology, ivory frequently appears as divine substitute for flesh and bones. During a banquet of the gods, to which he had been invited, Tantalus served up the mangled limbs of his young son Pelops, which he had boiled in a kettle. But the murdered child was restored to life by being put back into the kettle and then drawn out of it, with an ivory shoulder to replace the shoulder of flesh which Demeter or, according to others, Thetis had unwittingly eaten. The ivory shoulder of Pelops used afterwards to be exhibited at Elis (*Plin. NH 28.34*), but it was no longer to be seen in the time of Pausanias (*Paus. 1.13.6*).

Clement of Alexandria (*Protrept. 4.47*), mentions a scarce opinion that the Palladium was made out of the bones of Pelops, just as the image of Zeus Olympian was made out of ivory. In this context, part of an epitome of Valerius Maximus (*Val.Max.654*), written by Iulius Paris and Ianuarius Nepotianus, seems interesting. Pheidias may have suggested to the Athenians to use marble, which was cheaper and retained its lustre longer, but they chose the more costly and luxurious material (Palagia, 2006:122). In the final effect, the colour of statue was as important as their form: work in marble was polished with wax or encaustic, a process called *ganosis*, in the same way as bronzes were patinated. Praxiteles is said (*Plin. NH 35.133*) to have preferred those of his statues, which were coloured by Nikias, a painter who was distinguished for his treatment of light and shade, as well as possibility of a range

of brilliant colours used for painting of female flash. In the case of chryselephantine statues, ivory parts were coated by various substances. Olive oil and gall obtained from the oak-apple was generally used (*Dem.Aphob.27.10*). Polishing and oiling of ivory had the same importance for achievement of that desired colour as the preservation of material. The pores of ivory, when fresh, contain an oily substance, which not only facilitates carving, but also contributes to the familiar transparent polish of material (Moorey, 1999:116-118). To maintain its quality, ivory was anointed by olive oil (*Paus.5.11.10*).

Chryselephantine technique and craftsmen

The production of chryselaphantine statues on great scale posed new technical and financial challenges. Wood was possibly located under the gold and plaster under the ivory, although in the previous period, gold sheets were nailed to a wooden core. The massive flesh surfaces of Classical statues could not be sculpted from solitary tusks and new processes of unscrolling, softening and moulding ivory were needed (Lapatin, 2001:64-65). A wooden armature was probably used, to which clay and cast plaster were added and then the precious materials. Ivory plates were inscrolled, softened by soaking in beer, vinegar, or phosphoric acid, and molded. They were prepared for joining by scoring, joins secured with adhesives such as fish-glue, and additional security sometimes provided by cross-pins, as with some marble sculptures. Surface was finished with abrasives and polishes, using fish skin or coarse leaves. Representation of chryselephantine statues in other media is problematic, as they are often altered and of different materials, sizes, and purpose (Sturgeon, 2002). Relevant ancient texts, though abundant, can be misleading, though they are helpful about attitudes, materials, cost, iconography, and reception. Classical chryselephantine *colossi* required not only about eight years to build, but also teams of helpers and studios the size of the *naos* destined to house the statues (Palagia, 2006:123). Required materials like ivory became accessible through foreign trade (*Thuc.2.38.2*).

A more modest version of cult images were *acrolithic* statues, that were meant to replicate, in cheaper materials, the structure and appearance of chryselephantine statues (Lapatin, 2001:16). The largest number of Late Archaic and Classical *acrolithic* statues come from South Italy and Sicily (Häger-Weigel, 1997:32-48). Ancient authors provide numerous references concerning sculptors as god makers (*theopoioi*). Canachus of Sikyon, an early fifth century BC sculptor, made gold and ivory (ἔκ τε χρυσοῦ καὶ ἐλέφαντος) Aphrodite for Corinth (*Paus.2.10.5*). Several marble and chryselephantine statues of Calamis, a sculptor of the Early Classical period, who worked primarily in bronze, are also recorded (*Paus. 2.10.3*). Pheidias was one of the first artists, whose composite ivory statues have been fashioned on a scale significantly larger than life size. Together with Polykleitos worked in three media: bronze, marble and chryselephantine. Alkamenes followed Pheidias with the creation of the chryselephantine (ἐλέφαντος καὶ χρυσοῦ) cult statue of Dionysos in Athens (*Paus.1.20.3*). Pheidias' another two pupils in the Peloponnese and associates in the creation of the gold and ivory Zeus at Olympia, Kolotes of Herakleia and Theokosmos of Megara, are known to have worked mainly in gold and ivory (Palagia, 2006:126). Surprisingly, according to Plato, ivory, which comes from a body bereft of soul, was not a pure offering, suitable for making cult statues (*Pl. Leg.12.956a*).

From representation to glorification

Praising statues as divinities seems rather generally accepted in antiquity, however certain exceptions emerged. In Greek literature objections to the confusion of the god and the image appeared (*Diog.Laert.116*). Plutarch (*Plut.De Is. et Os. 379*) observes that some Greeks speak of the bronze, painted, and stone effigies as gods, rather than as statues of the gods, which is what they really are. Gods were recognized in their human disguise by their flashing eyes in Homer´s Iliad (*Il.3.397*). In the Classical period the presence of the gods in their statues was deduced from the sparkle in the statue's eyes (Bussels, 2013:141). According

to Plutarch´s Life of Aratus, the people of Pellene must take care not to look the statue of Artemis Soteria in the eye, for it could rob their senses (*Plut.Arat.32.2-3*). Speech was also cited as an expression of life. An interesting insight is afforded by the stories of how the images of the gods were chained in order to prevent them from escaping (*Paus.* 3.15.7, 9.2.3). In Plutarch´s Life of Alexander (*Plut.Alex.24.3*), a statue of Apollo was tied up and fixed with nails to prevent it leaving the town of Tyre during Alexandre´s siege. Late Classical period brought revolutionary changes in sculpture, reflecting transformation of the Greek society. Under the influence of innovative artists, traditional view of deities had changed, obtaining more humanized form, unexpected poses or attributes. Emotions, individualized features or nudity were frequently stressed, including cult images.

Demetrios of Phaleron took the *hetaira* Lamia up to the Acropolis and had sex with her in the Parthenon, not being able to marry the statue of Athena (*Protr.4.48*). Kleiosophos the Selymbrian fell in love with the statue of Aphrodite at Samos, locked himself in the temple, in the belief that he would be able to have intercourse with it. When he was unable, he set out a small piece of meat and had intercourse with that (*Ath.13.605f*), (Younger, 2005:177-178). Pygmalion of Cyprus fell in love with an ivory statue of nude Aphrodite and had sex with it (*Protr.4.51*). A different version is told by Ovid (*Met.10.243-97*), mentioning that Pygmalion made the snow-white ivory statue (niveum ebur) and Aphrodite brought it to life (Lapatin, 2001:16). With the loss of egalitarian character of polis, focus of artists was shifted to the individual customer, while social-historical trend moved towards rehashed form of government, monarchy. Traditional forms of cult images were incorporated to the new types of sculptural monuments. Previously reserved for representations of gods, ivory statues came to be employed by mortal rulers seeking their own glorifications (Schultz, 2007:205-33). Philip of Macedon and his son Alexander adapted chryselephantine technique to create images of themselves as the first, erecting a chryselephantine family group by Leochares in the *Philippeion* at Olympia (*Paus. 5.20.10*).

Ivory and bone carving as an industry

With Alexander's conquest and subsequent extension of territories, the Greek world received a larger amount of precious materials, including ivory. The increased supply of this material resulted in its devaluation in the fourth century BC (Gill, 1992:235). Still, most of the images in the post- Classical period appear to have been commissioned by wealthy and powerful individuals, and they depicted extraordinary mortals as well as divinities (Lapatin, 2001:120-134). Such images demonstrated not only the piety but also the wealth and prestige of their dedicators (and later representatives). The origin and emergence of *ruler cults* is a specific issue, and depends on the regional and chronological framework. Chryselephantine technique seems to be intentionally used by royal portraiture art; however, chryselephantine material by itself might not signify divinity. Alexander understood and exploit the propagandist powers of portraiture. His portrait types were utilized and adapted for images of later monarchs, spanning many centuries. Literary sources claim that he had selected only a few artists to fashion his image: the sculptor Lysippos of Sikyon, the painter Apelles, and the gem-cutter Pyrgoteles (*Plin.Nat.7.38*). In the Hellenistic period, ivory and bone carving industry was established in Alexandria (*Ath.5.202a*). Ptolemy II Philadelphos is reported to have commissioned chryselephantine statues of his parents, Ptolemy I Soter and Berenike I (*Theoc.Epigr.17.121-8*), (Lapatin, 2001:121-123).

Other known statuary workshops using ivory were in Magna Graecia, northern Greece and Macedonia, Alexandria and Black sea region. Main routes crossing Anatolia region, by the land from the east or from Syria and by the sea from Alexandria and the islands, facilitated the settlements of ivory carvers in this region. Several other Hellenistic monarchs with ivory portraits are known (*Paus. 5.12.7*, *Amm.Marc.22.13.1*), and the Late Roman republic and Early Empire saw a proliferation of such works. These images must have helped viewers to understand the nature and power of emanated gods, rulers. Since exemplary emperors

such as Augustus were deified, their representations were given the status of cult statues (Lapatin, 2010b). In Roman times, the extent of ivory trade was impressive. Pliny the Elder rates the ivory as the most precious organic material but less precious than silver. High demand for ivory reduced elephant populations in northern Africa and increased ivory importation from India (*Plin.NH.8.7*). As the north African elephant herds became depleted, transport down the Nile supplied the Mediterranean market with ivory from Nubia, East Africa and India.

CONCLUSION

Even if almost none of chryselephantine cult images survived until these days, numerous references of ancient authors of the antiquity and representations in other media attest their technical, stylistic and iconographic changes. Tracing ivory in sculptural tradition not only from Near East or Anatolian coast, but also Greek mainland shows multiple uses of this material in religious sphere.

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RÉSUMÉ

FABRIQUER DES DIEUX DANS LA GRÈCE ANTIQUE: LE DÉVELOPPEMENT DES RITUELS ET DES IMAGES DE CULTE RETRACÉ PAR L'USAGE FAIT DE L'IVOIRE DANS LA STATUAIRE

*L'*agalma, *terme large couramment traduit par image de culte, a joué un rôle important dans la religion grecque. L'ivoire, très prisé pour ses origines exotiques, sa qualité esthétique et ses propriétés réputées magiques, était employé dans la fabrication des* agalmata *au plus tard depuis la période orientalisante, aux IVe-Ve siècles BC. Ses caractéristiques physiques lui permettent d'être travaillé selon une variété de techniques, comme le relief sculpté, la découpe en tablettes ou l'incrustation, tourné sur un tour ou moulé. La plupart des ivoires ont finalement été polis, peints ou dorés. Les techniques de fabrication, mais aussi la forme et l'utilisation des images-culte ont progressivement*

changé au cours de l'Antiquité. Des preuves littéraires et matérielles suggèrent que de minces lamelles d'ivoire utilisées pour les images de culte monumentales de la période classique ont été adoucies dans des bains acides, puis moulées dans des formes d'argile ou de bois. Des statues acrolithiques et plus tard chryséléphantines ornaient les intérieurs des principaux temples et devinrent des objets de diverses activités rituelles, y compris le revêtement, l'habillage, le portage en procession, l'ornement ou l'immersion de la statue dans l'eau. La surface lisse blanc crème et le lustre chaud des statues d'ivoire ont nécessité un soin particulier, notamment le maintien de conditions d'hébergement appropriées et le polissage à l'huile. Même si presqu'aucune des images-culte n'a survécu jusqu'à nos jours, de nombreuses références d'auteurs anciens de l'Antiquité et des représentations dans d'autres médias attestent de leurs changements techniques, stylistiques et iconographiques. Repérer l'ivoire dans la tradition sculpturale non seulement du Proche-Orient ou de la côte anatolienne, mais aussi du continent grec montre de multiples utilisations de ce matériau dans la sphère religieuse.

PARCOURS DE MOBILITÉ DANS L'ARCTIQUE AUX TEMPS THULÉENS (~1200-1900 CE)

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Résumé : Dans l'Arctique, plus qu'un trajet, un déplacement est perçu comme une tranche de vie au cours de laquelle toutes les activités quotidiennes sont maintenues : subsistance, activités domestiques et symboliques. Pour un Inuk, la mobilité fait partie intégrante de son mode de vie. Les Inuit peuvent parcourir 500 ou même 1 000 km au cours d'un même trajet, pour aller s'approvisionner en matières premières ou migrer vers un autre lieu. La majorité des biens est généralement acquise localement. Toutefois, un besoin en un matériau plus rare dans l'environnement mais essentiel à la vie quotidienne pourra motiver un déplacement sur de très grandes distances. Les traces laissées par chaque type de déplacement varient, autant en termes de culture matérielle présente sur les sites qu'en termes de contacts et d'influence culturelle. Cet article vise à regrouper nos connaissances concernant la période thuléenne et ouvre des perspectives pour orienter et adapter les recherches futures à différents contextes géographiques. Deux moyens de transport principaux sont employés pour ces voyages : le traîneau durant les 9 à 10 mois d'enneigement et d'englacement du sol, et l'umiak l'été lorsque les étendues d'eau libre de glace permettent un transport maritime plus rapide. C'est avec des umiaks que la migration thuléenne de l'Alaska vers le Canada et le Groenland autour du XIIIe siècle se serait opérée. Bien qu'employé aussi parfois pour le transport, le kayak est généralement dédié aux activités de subsistance. Même s'il reste difficile d'évaluer la durée de leur fréquentation, la localisation de nombreux sites thuléens sur les voies encore empruntées de nos jours laisse penser que nombre d'entre eux étaient établis le long d'itinéraires empruntés plusieurs siècles durant. Les circulations des hommes et des objets au Thuléen ont bien sûr pu varier au gré de nouvelles opportunités, mais les principales sources d'approvisionnement en matériaux clés, tels le cuivre, le fer, la stéatite et le bois, sont restées les plus pérennes et prévisibles au fil des siècles. À titre d'exemple, cet article présente plus en détail les modes de déplacement des Inuit du Cuivre, un des cas les mieux documentés historiquement. Pour le fer, les exemples ont été élargis au Groenland, qui possède les seules sources de fer connues pour l'Arctique : le fer météoritique de Cape York sur la côte nord-ouest et le fer tellurique de la région de la baie de Disko sur la côte ouest. Seule la fréquentation plus régulière et prolongée des navires européens à partir du XVIIIe siècle, puis l'installation des postes de traite euro-américains, ont durablement modifié les déplacements et modes d'approvisionnement des Inuit.

Arctique nord-américain, Inuit, Thuléen, Circulation, Contact, Échange, Approvisionnement, Mobilité

INTRODUCTION

Le contexte arctique semble particulièrement propice à l'étude des déplacements humains car le peuplement y est très récent et reste cantonné aux régions les plus septentrionales. En effet, la ligne des arbres semble avoir constitué une frontière nette et durable jusqu'au XVIIIe siècle, voire ultérieurement, séparant les populations arctiques des peuples amérindiens, puis européens et euro-américains. Seules deux migrations successives, vues comme des mouvements de population unidirectionnels et uniques, sont généralement distinguées. Leur datation, tout comme les motivations et itinéraires empruntés par les migrants, restent cependant encore à éclaircir.

L'Arctique est caractérisé par un climat rigoureux, une végétation clairsemée et des ressources alimentaires essentiellement animales. L'exploitation de l'ensemble des matières fournies par le gibier, qu'elles soient dures (os, dent, bois, fanon, corne) ou souples (peau, chair, graisse, tendon), occupe une place centrale dans le mode de vie des sociétés arctiques. L'industrie qui en découle est prépondérante dans la culture matérielle, en particulier au Canada et au Groenland où le bois flotté est plus rare qu'en Alaska. L'architecture de

l'Arctique occidental est constituée de bois, remplacé en raison de sa rareté dans l'Arctique oriental par des pierres, de la tourbe et des ossements de mammifères marins. L'équipement fabriqué à partir des matières animales est omniprésent, ce qui en fait un support d'étude privilégié pour reconstituer le mode de vie de ces sociétés (Houmard, 2011, 2013 & 2016).

L'objectif de cet article est de s'appuyer sur les sources ethno-historiques pour analyser les modalités de circulation des hommes et des objets au Thuléen. Régulièrement et pour diverses raisons, quelques individus ont parcouru des distances allant jusqu'à 500 voire 1 000 km au cours d'un même déplacement. Les objets transportés ainsi que les moyens de transport dépendent de la nature du déplacement — approvisionnement direct, échange, déplacement saisonnier ou migration définitive — et des conditions climatiques. Par l'étude de la culture matérielle retrouvée sur les campements, nous souhaitons examiner les implications variées qu'ont eues ces différents types de déplacement en termes de contacts, d'interactions et d'influences culturelles.

Contexte historique

Libéré des glaces il y a environ 7000 ans, l'Arctique canadien et groenlandais a été peuplé successivement par deux groupes humains qui semblent avoir évolué indépendamment comme le confirment les analyses génétiques (Gilbert *et al*., 2008 ; Hayes *et al*., 2005 ; Raghavan *et al*., 2014 ; Rasmussen *et al*., 2010). Vers 2300 BC, les premiers colons — dénommés Prédorsétiens, Saqqaq ou Independence I selon les régions — sont partis d'Alaska pour investir les côtes de l'archipel canadien, y compris le Haut-Arctique, et le Groenland (Irving, 1970 ; McGhee, 1984). C'est autour des polynies — étendues d'eau libre parfois recouvertes d'une mince couche de glace — que la présence humaine a été la plus régulière. Cet environnement offre en effet un écosystème marin très riche accueillant une faune abondante, diversifiée et pérenne. Ce sont généralement des zones refuges pendant les épisodes climatiques les plus rigoureux (Appelt *et al*., 2016). Cette première phase d'occupation de l'Arctique voit le développement, dans l'archipel canadien, des Prédorsétiens qui deviennent progressivement Dorsétiens vers 800 BC alors que dans le même temps les côtes groenlandaises sont peuplées par les groupes Saqqaq eux aussi remplacés par les nouveaux arrivants Dorsétiens (Fig. 1).

Autour du XIIIe siècle de notre ère, de nouveaux migrants —— appelés Thuléens — quittent l'Alaska, suivent les mêmes voies de migration et viennent exploiter les mêmes territoires (Fig. 2). Considérés comme les ancêtres directs des Inuit actuels, ils sont vraisemblablement à l'origine de la disparition rapide des Dorsétiens autour du XIVe siècle. Malgré le recouvrement des dates, la rencontre entre Dorsétiens et Thuléens n'a pas encore pu être démontrée. Certains chercheurs prônent l'acculturation (Appelt *et al*., 1998 ; Appelt/Gulløv, 2009 ; Gulløv, 1996 ; Gulløv/McGhee, 2006), matérialisée par des transferts de technologie en termes d'architecture, d'équipement, d'exploitation de matières premières ou de traits stylistiques (Bielawski, 1979 ; Ford, 1959 ; Hickey, 1986 ; McGhee, 1984 ; Maxwell, 1985). À l'opposé, Robert Park défend ardemment l'hypothèse d'une absence de contact, expliquant les similitudes observées par de simples phénomènes de convergence (Park, 1993, 2000 & 2016). Actuellement, l'hypothèse de contacts éphémères, avec un évitement délibéré des Dorsétiens, est souvent retenue (Friesen, 1999 ; McGhee, 1997 ; Appelt *et al*., 2016).

Conditionné par l'environnement, le mode de vie des Thuléens ne semble pas très différent de celui des Dorsétiens. Ils exploitent les mammifères marins (phoques, morses, cétacés), ainsi que saisonnièrement des espèces migratrices (caribous, oiseaux, poissons). Alors que la présence du chien est attestée pour le Dorsétien, son utilisation pour le transport semble une spécificité thuléenne, tout comme l'exploitation plus intensive des cétacés et notamment des baleines boréales (*Mysticetus borealis*). En termes de technologie, les Dorsétiens sont d'excellents tailleurs alors que les Thuléens préfèrent utiliser des outils métalliques sans toutefois maîtriser la ferronnerie. Les sources de fer et de cuivre étant rares dans l'Arctique, cet approvisionnement a toujours nécessité des déplacements et des échanges sur de très longues distances, à l'origine de contacts et d'interactions culturelles (Buchwald, 1992).

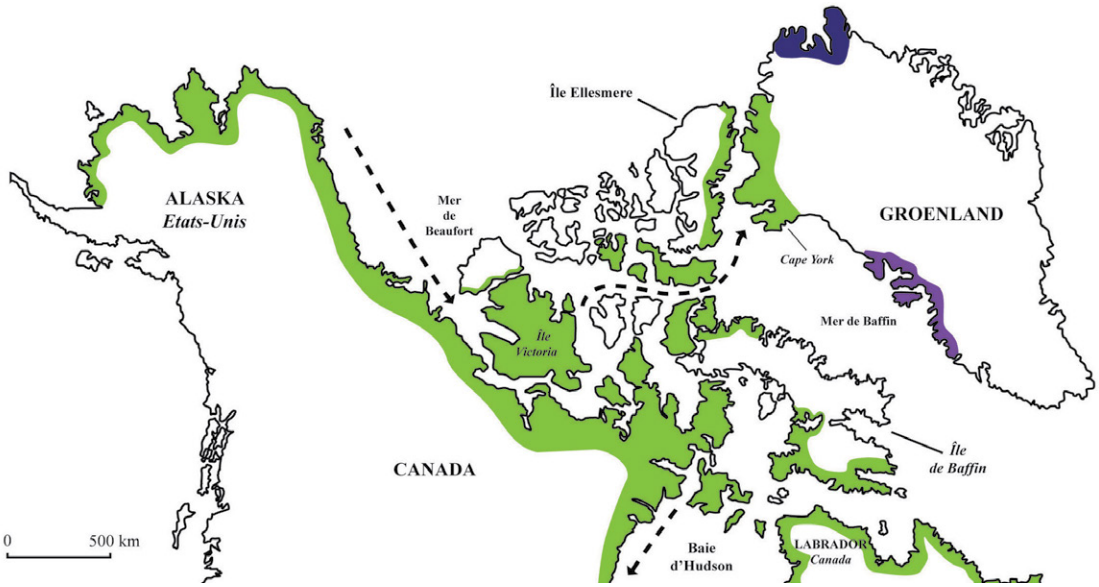

Figure 1. Carte schématisant les migrations (flèches) des différents groupes culturels Prédorsétiens puis Dorsétiens (en couleur) peuplant l'Arctique entre 2500 BC et 1300 AD environ. DAO : A. Bitrian.

Indépendance I
Saqqaq
Dorset

Figure 2. Carte schématisant les migrations (flèches) des thuléens entre environ 1200 et 1400 AD avec la localisation des sites cités dans le texte. DAO : A. Bitrian.

Sites
1 - Co-op
2 - Naujan
3 - Skraeling Island
4 - Ruin Island
5 - Inuarfigssuaq
6 - Thule
7 - Nûgdlît
8 - Kingigtorssuaq
Enclaves norroises
Thulé

Des individus peuvent ainsi parcourir régulièrement des centaines de kilomètres en petits groupes, poussés par des motivations et besoins variés : pression démographique et/ou conflit, approvisionnement en matières premières à la source ou par échange, changements saisonniers d'activités, modifications d'écosystème, etc. Notre enjeu est de cerner les natures et les modalités des déplacements afin de retracer les itinéraires suivis. En effet, se déplacer en traîneau, kayak ou umiak modifie le type des participants, le chargement, la vitesse et le terrain de déplacement. Sur ces derniers points, les sources ethno-historiques apportent de précieux témoignages.

Déplacements et moyens de transport

Les premiers explorateurs et ethnographes ont unanimement reconnu l'extraordinaire savoir géographique des Inuit. Ils ont d'ailleurs le plus souvent fait appel à eux pour s'orienter lors de leurs expéditions (Boas, 2013[1888]; Mathiassen/Calvert, 1928; Parry, 1824). Les cartes mentales des Inuit couvrent de très vastes territoires allant jusqu'à plus de 800 km en longitude (Boas, 2013[1888]). Les itinéraires sont transmis oralement de génération en génération et les parcours hivernaux sont tracés chaque année en traîneau par des hommes expérimentés lorsque la neige et la glace se forment. Les déplacements sur de longues distances n'engagent généralement pas plus de trois familles, soit une quinzaine d'individus. Lorsqu'ils voyagent, les Inuit emportent avec eux essentiellement des biens matériels et pas plus d'une ration journalière de nourriture (Stefánsson, 1914). Ils chassent en chemin au gré des rencontres. Dans la mesure du possible, ils voyagent léger, la charge s'adaptant au trajet (durée, conditions météorologiques, nombre de participants, moyen de locomotion).

Un mode de vie

Encore aujourd'hui, les Inuit considèrent les déplacements non comme une activité uniquement destinée à rallier deux lieux mais bien comme une tranche de vie durant laquelle toutes les activités de la vie quotidienne suivent leur cours : subsistance, approvisionnement, échange, mariage, naissance, exploration (Aporta, 2004). Chaque voyage a une dimension sociale, la durée variant selon les conditions météorologiques et les rencontres humaines ou animales faites en chemin. Ce point n'a pas toujours été bien compris par les premiers explorateurs qui notaient de fortes divergences selon les interlocuteurs (Aporta, 2004; Parry, 1824). Les déplacements hivernaux et estivaux diffèrent également. Le traîneau est privilégié neuf à dix mois par an, mais l'été le transport devient maritime par kayak et umiak. Souplesse, maniabilité et légèreté sont les qualités principales de tous les moyens de transport inuit (Victor/Robert-Lamblin, 1989). Le début d'hiver et la fin de printemps entraînent souvent de mauvaises conditions de circulation, donc des déplacements plus dangereux. Certains villages peuvent alors être isolés pendant plusieurs jours (Aporta, 2004). La nuit polaire hivernale ne favorise pas non plus les déplacements. Les migrations sont donc des phénomènes automnaux mais surtout printaniers lorsqu'effectuées en traîneau et estivaux grâce aux umiaks en naviguant dans les zones libres de glace.

Le traîneau

Les premiers explorateurs ont fourni des descriptions précises des modalités de déplacement des groupes inuit (Stefánsson, 1914 ; Boas, 2013[1888]). Le traîneau est le moyen de transport privilégié pour les déplacements sur les terrains enneigés ou englacés (Fig. 3). Les modèles et les dimensions varient selon le terrain et le nombre de chiens attelés : 1,5 à 6 m de long ; 0,5 à 0,8 m de large ; 0,65 à 0,8 m de haut, pour une capacité de charge allant jusqu'à 550 kg (Boas, 2013[1888]; Jenness, 1946; Savelle/Dyke, 2013; Stefánsson, 1945). Le traîneau est utilisé pour la subsistance, les déplacements saisonniers et/ou les migrations définitives. Il est généralement conduit par deux individus, l'un s'occupant de guider le traîneau, l'autre des tâches annexes, en particulier de la bonne tenue des chiens pendant la course (Hutton,

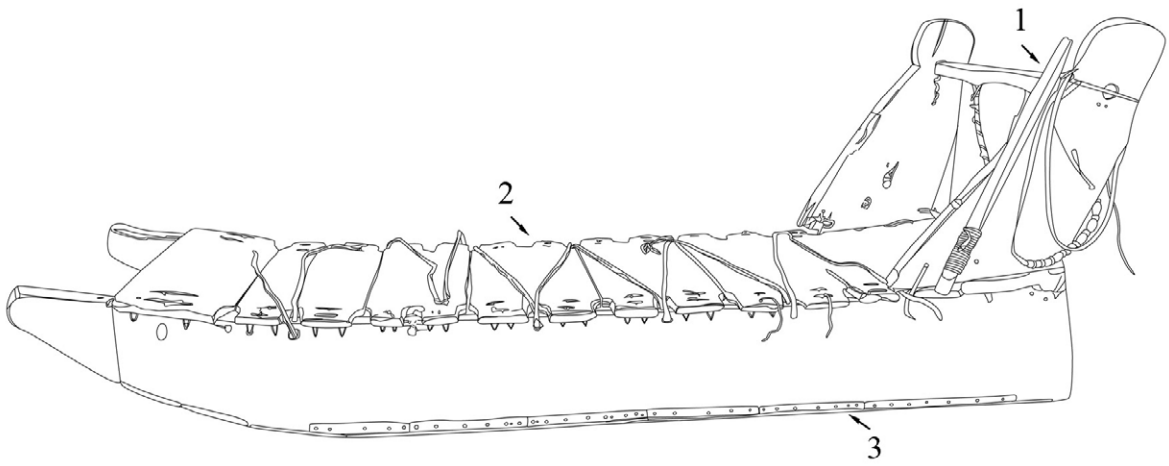

Figure 3. Le traîneau inuit, constitué d'une armature en bois végétal et lanières de cuir (2) soutenue par des patins/renforts en ivoire et/ou en matières osseuses (3), requiert l'usage d'un fouet (1) pour diriger l'attelage pendant la course à la vitesse de 3 à 5 km/h. Sa forme et ses dimensions varient selon le terrain et le nombre de chiens attelés : 1,5 à 6 m de long ; 0,5 à 0,8 m de large ; 0,65 à 0,8 m de haut, et d'une capacité de charge allant jusqu'à 550 kg. Dessin, Cl. Houmard.

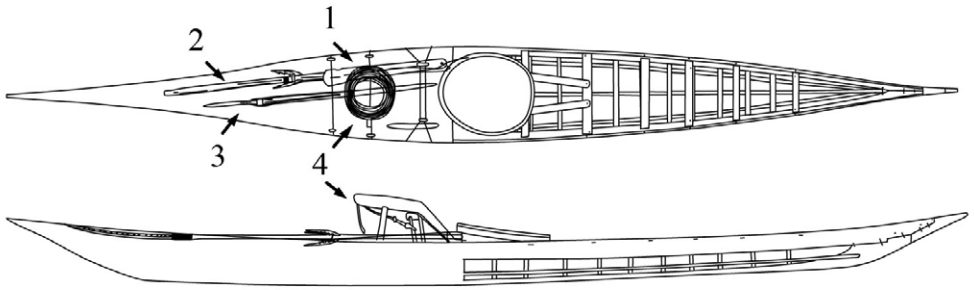

Figure 4. Le kayak inuit, constitué d'une armature en bois flotté que recouvre une couverture en peau de phoque sur laquelle reposent, apprêtés pour être immédiatement accessibles à l'usage, le propulseur (1), la sagaie à oiseau (2), le harpon (3) et l'enrouleur de ligne (4), est réalisé aux dimensions de son propriétaire. Dessin, Cl. Houmard.

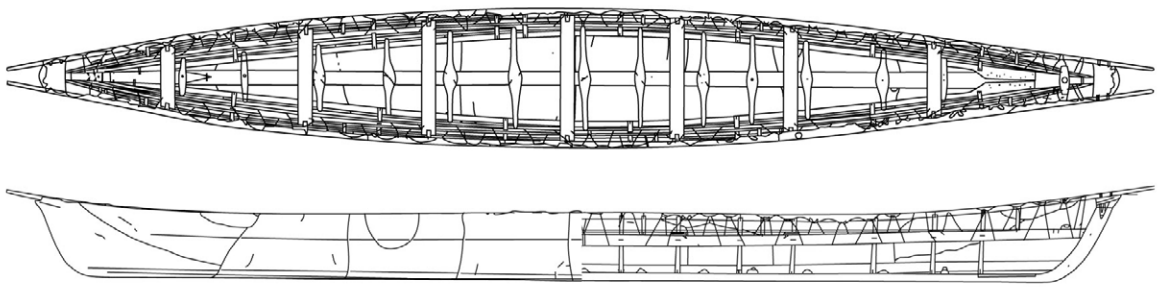

Figure 5. L'umiak inuit, constitué d'une armature en bois flotté/os de cétacé que recouvre une couverture en peau de morse ou de phoque barbu, mesure de 7 à 11 m de long, 1,5 à 2 m de largeur et de profondeur, pour une capacité supérieure à deux tonnes à 6-16 km/h en moyenne. Dessin, Cl. Houmard.

1912). La vitesse moyenne est de 3 à 5 km/h. Les personnes âgées et les enfants sont installés assis alors que les adultes marchent et/ou courent généralement à côté du traîneau, pour ouvrir le chemin, aider à pousser et/ou alléger la charge. Le traîneau est un assemblage de pièces de bois — parfois de bois de caribou — liées par des lanières de cuir, et muni de patins qui, selon les régions, sont en os, en ivoire, en métal ou plus récemment en plastique (Fig. 3:3). À défaut, d'autres matériaux gelés — eau, boue ou nourriture — peuvent être utilisés. Les premiers patins identifiés datent du Dorsétien mais la traction canine ne semble apparaître qu'au Thuléen (Park, 1987). Historiquement, un attelage pouvait comporter de deux à dix chiens, chacun étant relié par une courroie en cuir et une boucle de harnais en matière osseuse. Le fouet, nécessaire pour les diriger, peut mesurer jusqu'à 10 mètres. Il est constitué d'une lanière en cuir dont l'embout est en bois et/ou fait de matières osseuses.

Le kayak

Considéré comme un bien personnel, le kayak est une embarcation monoplace adaptée aux mensurations de son utilisateur (Victor/Robert-Lamblin, 1989). Deux modèles existent : l'un court et maniable pour la navigation en mer, et l'autre, le plus répandu, long et plus stable pour aller sur les lacs et les rivières. Ils sont chacun constitués d'une architecture de bois que recouvre une enveloppe en peaux de phoque cousues ensemble. Tous les accessoires traditionnels sont maintenus sur le pont par des lanières en cuir, et immédiatement accessibles à l'usage (Fig. 4). De nombreux éléments sont en matières osseuses :

1. L'équipement de chasse, souvent composite : harpon, propulseur, flotteur, sagaie à oiseaux, lance, couteau, stylet pour achever le phoque, bouche-plaie pour éviter que l'animal ne se vide de son sang ;
2. Les éléments de fixation sur le pont : tendeurs, boucles, enrouleurs de ligne (*ibid.*).

Au Groenland, les premières armatures d'embarcations en bois dateraient de la période Saqqaq (Grønnow, 2017). Contrairement au traîneau, plus polyvalent, le kayak est utilisé presque exclusivement pour la chasse. Dans quelques cas, il permet, accolé à un autre, de traverser plus rapidement un lac ou de porter de lourdes charges (Stefánsson, 1914:81).

L'umiak

Utilisé pour les transports maritimes collectifs, l'umiak est un bateau à fond plat en bois recouvert de peaux de phoque ou de morse. Il mesure de 7 à 11 m de long, 1,5 à 2 m de largeur et de profondeur, pour une capacité supérieure à deux tonnes (Fig. 5). Relativement léger, deux à quatre hommes suffisent pour le porter. Il peut parfois être équipé d'une voile pour les modèles les plus récents (Stefánsson, 1914). L'umiak sert à la fois de baleinière pour chasser de grands cétacés et de moyen de transport pour les déplacements familiaux (à une vitesse de 6-16 km/h en moyenne).

« Lorsque l'umiak sert à de courts déplacements, comme aller cueillir des baies, chercher de l'angélique, pêcher quelques poissons ou récolter des algues et des moules, il[est] alors chargé presque exclusivement de passagers. Mais lorsqu'il[s'agit] de quitter le lieu habité pour une autre destination, le contenu de l'embarcation[devient] inimaginable. En plus des douze à quinze passagers — femmes, enfants et nourrissons — se[trouve] embarqué un monceau d'affaires : lampes à huile, séchoirs, coffrets à outils, seaux, bassines et récipients en tous genres, bois de charpente, traîneau, rouleaux de peaux, vêtements, provisions etc. et souvent, de surcroît, des chiens. » (Victor/Robert-Lamblin, 1989:90).

Lors des haltes, il peut être vidé et retourné à terre pour servir d'abri temporaire. Pendant l'hiver, mis en hauteur et retourné, il sert de garde-manger (*ibid.*). Les premiers éléments d'umiak connus remontent à l'an mil en Alaska (Alix *et al.*, 2015). Jusqu'à présent, un seul umiak entier, dont l'architecture semble d'inspiration alaskienne, a été retrouvé au Groenland et daté du XVe siècle (Knuth, 1952).

Le barreur de l'umiak est le chef de famille, un homme expérimenté ou son propriétaire, les rameurs étant presque toujours des femmes ou des individus sans kayak. Ces bateaux nécessitent toutefois de longer le rivage, les peaux devant être régulièrement entretenues, huilées et séchées tous les quatre à dix jours, avant de pouvoir continuer le voyage (Braund, 1988:29). Dans les régions les plus septentrionales où les périodes d'eau libre sont très brèves, de même que dans les zones dépourvues de bois flotté, l'utilisation de l'umiak ne semble pas avoir perduré. En dehors d'un cas récent de migration au moyen d'embarcations de type umiak où environ 250 à 300 personnes ont migré sur 800 km (Krupnik/Chlenov, 2009), les itinéraires maritimes n'ont pas été décrits avec autant de détails que leurs homologues terrestres par traîneau.

ITINÉRAIRES ET APPROVISIONNEMENTS

L'approvisionnement en nourriture/matières premières, qu'il soit direct ou par échange, est la première motivation des déplacements. Les matériaux les plus recherchés dans l'Arctique central et oriental sont : le métal pour les outils et les armatures de projectile, incluant les éléments composites en matières dures d'origine animale dont la partie active est en métal (Fig. 6) ; le bois pour les moyens de transport et pour les hampes de projectile ; ainsi que, la stéatite pour la fabrication des lampes et des pots (Boas, 2013[1888]). Plusieurs centaines de kilomètres peuvent être parcourus pour s'approvisionner à la source.

Les itinéraires empruntés par les Inuit sont rarement cartographiés mais plutôt transmis par des chants et des narrations de voyage. Ces dernières incluent anecdotes et citations de toponymes faisant référence à la topographie (*i.e.* lacs, rivières, îles, formes remarquables, marqueurs d'anthropisation du territoire) ou mentionnant l'activité réalisée. Ces descriptions

Figure 6. Tête de harpon n°P1.2188 (gauche) et couteau n°P1.2180 (droite) composites en bois de caribou et métal du site thuléen de Naujan. Échelle, subdivision en cm. Photos, Cl. Houmard.

relatent ainsi tous les détails qui permettent de guider le voyageur (Aporta, 2004 ; Collignon, 1996; MacDonald, 1998). Chaque étape est nommée selon la tranche de vie concernée : repos, chasse, pêche, collecte dans le gîte de matière première, mise en cache pour le dépôt d'équipement ou de nourriture.

Bien que nous ne traitions ici pas plus longuement de la question des déplacements sur de longues distances car ils impliquent une logistique plus complexe et des interactions culturelles, la majorité des vivres et des matières premières était acquise de préférence localement. Une expédition n'était précisément organisée qu'en cas de carences particulières, concernant souvent plusieurs matériaux. Les besoins ponctuels étaient généralement satisfaits par échange (Nagle, 1984). La construction d'un nouveau traîneau, la nécessité d'obtenir de nouvelles peaux pour les vêtements, la recherche de métal et/ou de récipients et de lampes en stéatite pouvaient inciter un groupe à missionner quelques individus — deux à trois traîneaux — pour un périple de plusieurs semaines ou de plusieurs mois. Un individu pouvait également se joindre temporairement à un groupe extra-familial pour réaliser un tel voyage (Stefánsson, 1945; Nagle, 1984:38).

Fluctuations des itinéraires

Bien que les itinéraires fluctuent au gré des saisons et de la disponibilité en nourriture, nombre d'entre eux sont empruntés régulièrement. Les parcours terrestres, notamment, suivent des routes identiques d'une année à l'autre, alors que les parcours sur la banquise s'adaptent aux conditions de formation de la glace. Les itinéraires traditionnels conduisant aux emplacements où les ressources sont disponibles de façon pérenne sont vraisemblablement pluriséculaires (Aporta, 2009), les Inuit se déplaçant en fonction de ce qu'ils souhaitent trouver à un endroit précis. Toutefois, l'absence de caribous ou au contraire la présence providentielle de matières premières recherchées peut pousser un groupe à changer ses plans et à se déplacer de façon opportuniste dans la direction de cette nouvelle source bienvenue pour reconstituer les stocks. Les itinéraires et cycles de nomadisme peuvent alors être modifiés temporairement ou définitivement. L'abandon de l'*Investigator* par le Capitaine McClure en 1853, après son immobilisation dans les glaces, est un exemple bien connu qui a conduit à des déplacements massifs « d'Inuit du Cuivre[1] » (Canada central) en quête de bois et de métal (Stefánsson, 1914; Hickey, 1984).

Approvisionnement direct

L'approvisionnement direct et local semble être le plus pratiqué par les Inuit. Les itinéraires sont fondés sur le cycle (bi-)annuel des activités de la communauté. Ce dernier varie selon les régions en fonction de la disponibilité en ressources animales, minérales et végétales. Hormis les matériaux aux sources circonscrites et bien localisées (*i.e.* cuivre, stéatite, probablement bois flotté), l'ensemble des autres matières premières est essentiellement d'origine animale. Leur localisation est moins prévisible, en particulier pour les espèces migratrices. Les itinéraires associés sont plus difficiles à retracer archéologiquement bien que les analyses isotopiques et génétiques à partir des restes de carcasses animales découverts dans les sites d'occupation progressent rapidement et constituent un outil précieux pour les restituer.

En termes de distance, les Inuit du Cuivre parcourent le plus souvent 200 voire 600 km pour s'approvisionner directement en stéatite (Fig. 7). Par échange, les pots et lampes peuvent même circuler à plus de 1 000 km de la source. En ce qui concerne le cuivre natif, il peut être acquis par approvisionnement direct au cours de déplacements représentant en moyenne 520 km, mais aussi par échanges de proche en proche (Morrison, 1991). Notons que les distances parcourues sont approximatives car évaluées à vol d'oiseau sans tenir compte des reliefs de la topographie ni des aléas météorologiques. Plus récemment, la présence récurrente des Européens et Euro-Américains a fortement influencé les déplacements inuit. Un navire baleinier ou d'exploration, aperçu au large ou mieux encore pris dans les glaces et abandonné, représente une source providentielle de métal et de bois.

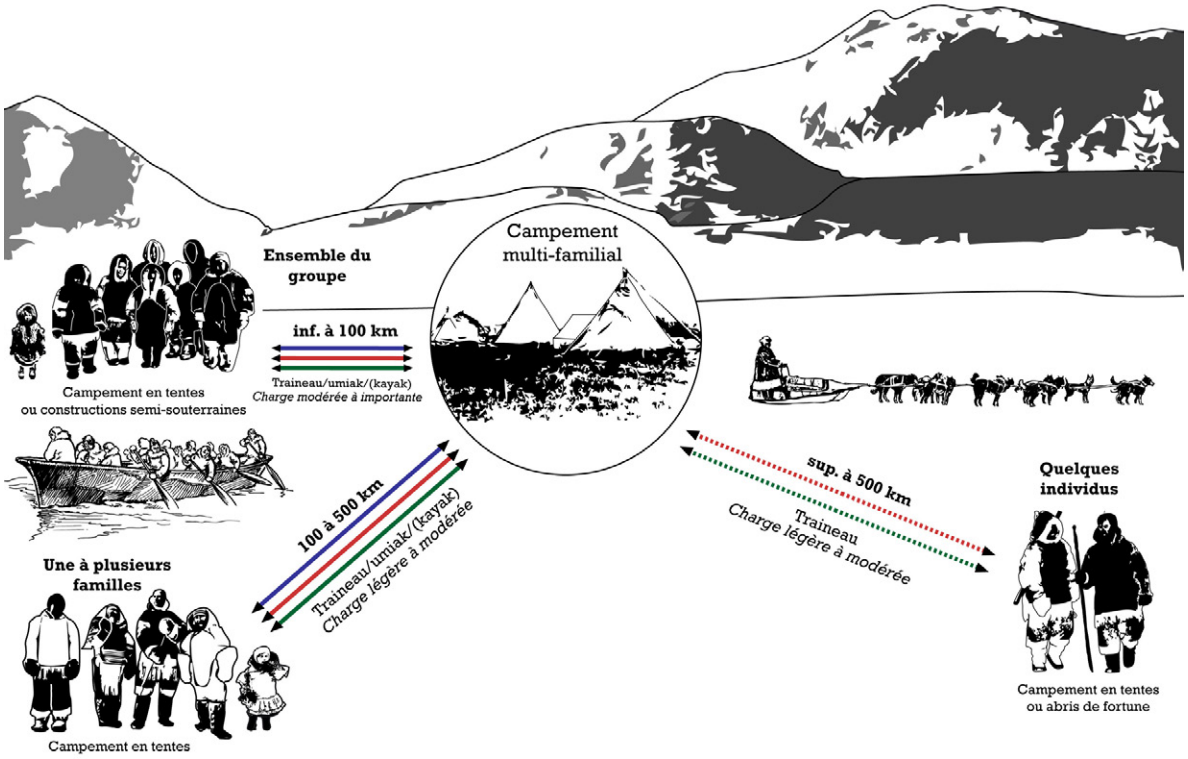

Figure 7. Carte schématisant les déplacements des Inuit du Cuivre, d'après les informations manuscrites publiées par Morisson (1991). Illustration, A. Bitrian & Cl. Houmard.

→ : Migration – Apports extérieurs aléatoires, dépendant des rencontres et découvertes fortuites

→ : Approvisionnement direct à la source – Apports extérieurs faibles à modérés avec d'autres groupes apparentés, pouvant être importants si des contacts sont établis avec les Européens/Euro-Américains

→ : Échanges – Apports extérieurs importants avec des groupes apparentés ou étrangers, y compris avec les Européens/Euro-Américains

Échanges

Les échanges servent généralement à obtenir des matériaux difficilement accessibles dans l'environnement proche (Bitrian, 2015; Fig. 8). Ils s'effectuent de préférence entre individus ayant un lien de parenté, même éloigné (Nagle, 1984). Ainsi, différents sous-groupes d'Inuit du Cuivre échangent entre eux contre du cuivre, de la stéatite, et parfois du fer, des peaux de caribou, de bœuf musqué ou d'ours polaire selon la disponibilité du gibier (Stefánsson, 1914; Jenness, 1922). Le cuivre natif est échangé sous forme d'objets finis ou de matières brutes (nodules peu transformés), laissant à l'acquéreur le soin de le modeler selon ses besoins (Nagle, 1984; Stefánsson, 1914). En revanche, la stéatite et le bois vert sont presque toujours échangés sous forme d'objets finis pour les raisons suivantes:

1. Leurs usages fonctionnels sont plus limités que ceux du cuivre — lampes et pots uniquement pour la stéatite —, traîneau, hampes et contenants pour le bois vert;
2. La charge au moment du transport est ainsi considérablement réduite (*ibid.*).

Lorsque les besoins sont trop nombreux ou qu'il n'y a rien à échanger, l'approvisionnement se fait directement à la source, quelles que soient les distances à parcourir.

Le cas du fer est plus complexe et montre une forte évolution au cours du temps. Le seul invariant est l'absence totale de ferronnerie dans l'Arctique américain quels que soient les lieux et les époques. Les premières utilisations du fer datent de la période de recouvrement entre Dorsétien et Thuléen (XIIe-XIVe siècles). Au Groenland, il s'agit de fer météoritique originaire de Cape York, martelé, et utilisé sous forme de petits inserts tranchants sur les outils et armes de chasse (Buchwald, 1992). Du fer tellurique, considéré d'assez mauvaise qualité et de très petites dimensions, a également été exploité dans la région de la baie de

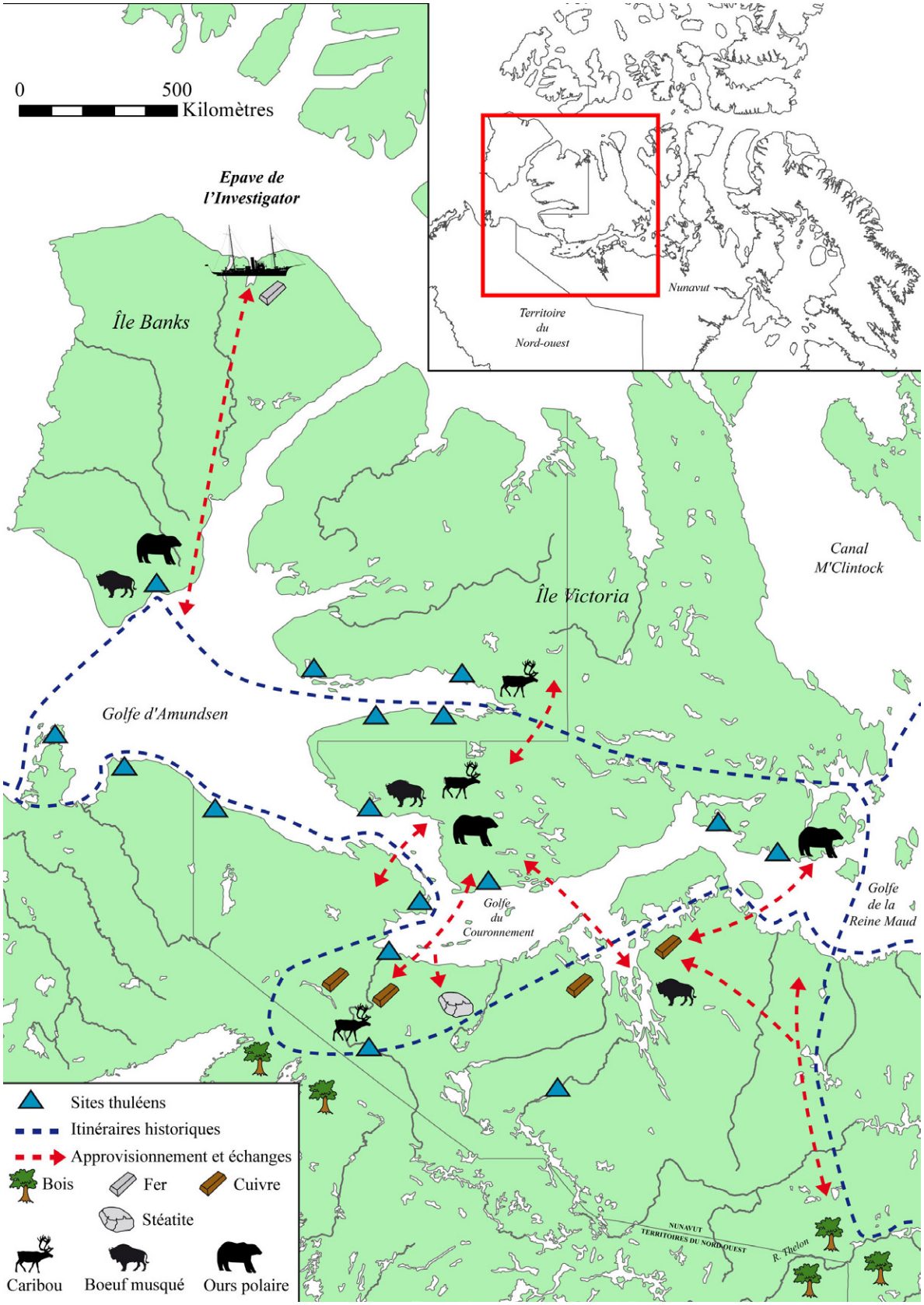

Figure 8. Mobilités arctiques des Inuit sur de courtes, moyennes et longues distances. Illustration, A. Bitrian.

Disko (côte ouest). Contrairement au fer météoritique retrouvé à plus de 2 500 km de sa source, le fer tellurique a plutôt été utilisé localement (*ibid*.). Dans le même temps, du fer forgé a également circulé par échanges directs (contre fourrures, défenses de morse et/ou fanons de baleine) ou par ramassage sur les épaves. Il provenait de Sibérie pour l'Arctique occidental ou d'Europe pour l'Arctique oriental (norrois/viking pour la période médiévale, puis baleiniers et explorateurs à partir du XVIe siècle). Auprès des Européens, fourrures, défenses de morse et/ou fanons de baleine étaient échangés contre des perles, des pipes, du tabac et/ou de la farine, ainsi que des objets métalliques (lames de couteau et hameçons utilisés tel quel, récipients ou clous martelés transformés en forets ou en inserts).

MOBILITÉS THULÉENNES : ÉTAT DE LA QUESTION

La reproductibilité des variations saisonnières rend possible l'utilisation des récits ethno-historiques comme référence pour discuter des déplacements au Thuléen. Actuellement, la migration thuléenne est envisagée comme ayant été réalisée au moyen d'embarcations de type umiak car permettant de gagner en rapidité et en capacité de charge (Krupnik/Chlenov, 2009). Toutefois, à l'heure actuelle, aucune des occupations classées parmi les plus anciennes n'a livré d'éléments d'embarcation, les patins de traîneau y sont en revanche plus fréquents. La localisation des sites thuléens à proximité des itinéraires empruntés historiquement témoignent de plusieurs réalités:

1. De l'utilisation par les traîneaux d'itinéraires pluriséculaires transmis par la tradition orale;
2. De l'attractivité pérenne des mêmes lieux (Fig. 8).

Le plus délicat reste donc de distinguer, à partir de la culture matérielle, les déplacements saisonniers des migrations, et de préciser s'ils ont été effectués en traîneaux à chiens et/ou en umiaks. Cela impose de comprendre comment les objets ont circulé, qu'il s'agisse d'un approvisionnement à la source, d'échanges ou de migrations (Tabl. 1). Certains réseaux d'échanges sont bien documentés dès le Thuléen pour le cuivre et la stéatite, et pour ceux-ci l'umiak n'a pu être utilisé car les gîtes sont terrestres (Morrison, 1987 & 1991). Bien que les déplacements sur de longues distances aient été essentiellement motivés par l'acquisition de matières premières rares dans l'environnement immédiat, et que les besoins aient pu changer en fonction des saisons et des passages de plus en plus réguliers de navires étrangers, tout un registre d'objets et de matières premières ont pu circuler lors de ces déplacements :

1. Éléments d'architecture ;
2. Armatures d'embarcations et de traîneau ;
3. Équipement de chasse/pêche ;
4. Outillage pour la production et la réparation des objets ;
5. Ustensiles de cuisine ;
6. Objets destinés aux échanges ;
7. Jeux et jouets ;
8. Vêtements, couchage et éléments de parure, y compris amulettes et autres objets protecteurs ou identitaires.

Dans tous ces registres, des matières osseuses ont pu être utilisées.

Dans le cas d'un déplacement destiné à l'approvisionnement en matières premières, la charge initiale sur le traîneau et/ou l'umiak doit être réduite au minimum et comprendre uniquement le nécessaire de survie. Les femmes ne faisant pas toujours partie du voyage, les attributs associés à la sphère masculine prédominent, en particulier l'équipement de subsistance terrestre. Lors d'une mobilité saisonnière, avec femmes et enfants, une lampe — l'élément le plus précieux — mais aussi des récipients, ustensiles de cuisine, nécessaires de couture et outils domestiques sont emportés (Jenness, 1922). Le moins utile est laissé dans des caches et repris au retour. Seule une migration définitive incitera le groupe à emporter tout ce qui peut avoir de la valeur (utilitaire comme symbolique).

Mobilités / Incidences	Approvisionnements à la source	Échanges	Migrations définitives
Types de campement	Haltes temporaires (jours) Campements saisonniers sur le gîte si transformation *in situ* (jours/semaines)	Haltes temporaires (jours) Site d'agrégation temporaire autour du « marché » (jours)	Campements saisonniers (semaines/mois)
Activités représentées	Haltes : Subsistance, repos, exploration Campements : Subsistance, repos, approvisionnement, transformation/réparation, interactions sociales	Haltes : Subsistance, repos, exploration Campements : Subsistance, repos, approvisionnement, relations commerciales, interactions sociales	Campements : Subsistance, repos, approvisionnement, transformation/réparation, interactions sociales (relations commerciales)
Cultures matérielles impliquées	Équipement de chasse Outils d'extraction/ transformation Vêtements/couchage/parure (architecture, ustensiles de cuisine, jeux)	Biens à échanger Vêtements/couchage/parure (architecture, outils, ustensiles de cuisine, jeux)	Équipement de chasse Outils de transformation/réparation Vêtements/couchage/parure Ustensiles de cuisine (architecture, jeux)
Circulations des objets	Avec les personnes	De proche en proche et avec les personnes	Avec les personnes
Apports d'éléments extérieurs au groupe	Influence indirecte (récupération d'objets européens sur les épaves)	Influence directe (échanges d'objets uniquement avec les Européens/Euro-Américains ; échanges d'objets, de matières premières, de connaissances, d'individus avec groupes apparentés)	Influence aléatoire directe et/ou indirecte au gré des rencontres et découvertes fortuites
Traditions techniques/ stylistiques	Faible influence extérieure	Influence extérieure modérée	Faible influence extérieure

Tableau 1. Les types de mobilités et leurs incidences sur l'habitat et le mode de vie des Inuit (schématisé d'après Morrison, 1987 & 1991).

Pour les déplacements saisonniers, les durées de séjour sur un même campement sont plus longues. Les outils arrivés en fin de vie, ainsi que les objets perdus ou abandonnés car trop lourds ou inutiles sur le lieu de vie suivant, peuvent alors être retrouvés, en plus des éléments communs aux haltes temporaires. Malheureusement rares sont les habitats d'été qui ont été fouillés et ceux qui l'ont été ne recelaient qu'une vingtaine de pièces de mobilier (Holtved, 1944). Les habitations semi-souterraines, occupées 9 à 10 mois de l'année, ont fait l'objet de toutes les attentions, car plus facilement reconnaissables et plus riches (*e.g.* Mathiassen, 1927). Établies sur les plages le long du rivage, ces maisons concentraient l'essentiel des activités domestiques et hivernales. Elles contiennent donc peu d'indices de mobilité. Les éléments de kayak retrouvés à l'intérieur sont rares et plus encore ceux d'umiak, les embarcations étant généralement conservées à l'extérieur. Rares sont également les éléments d'armatures de traîneaux, hormis les patins, le bois étant souvent recyclé pour la fabrication d'autres outils ou comme source de combustible. Ce sont le plus souvent les boucles de harnais qui attestent de l'utilisation de chiens de traîneau.

Retracer les trajectoires des objets au cours du cycle annuel n'est donc pas aisé car les indices permettant de retrouver la provenance de la majorité de l'équipement sont ténus. Les meilleurs marqueurs sont les éléments en fer — d'origine météoritique, tellurique ou

européenne —, et dans une moindre mesure le cuivre natif de l'Arctique central. L'analyse de la composition chimique des métaux permet en effet de retracer leur origine (Buchwald, 1992). Du fer météoritique de Cape York a ainsi été retrouvé à plus de 2 500 km de la source d'origine et du cuivre natif de l'Arctique central a été retrouvé sur certains sites de la côte nord-ouest du Groenland, *i.e.* Inuarfigssuaq (Holtved, 1944). Ces témoins restent malheureusement rares, car mal préservés, et ils ont très probablement été les plus échangés de proche en proche.

L'association de plusieurs matériaux rares au sein d'une même structure d'habitat, sera un des meilleurs indicateurs pour retracer les migrations. Comment néanmoins distinguer échanges et migrations dans la circulation des objets sur de longues distances ? L'habitation H1 du site de Co-op, situé sur l'île Victoria, a livré des restes de *Pinus sylvestris* et *Pinus banksiana*, ainsi qu'un bord de récipient en écorce de bouleau cousue par un fil en matière végétale, et deux outils en dents de castor. Tous ces éléments d'origine plus méridionale ou occidentale plaident ainsi en faveur de contacts ou d'une migration sans qu'on puisse actuellement distinguer l'un de l'autre (Alix, 2001:351). La poterie est probablement l'un des meilleurs indicateurs de migration car elle n'a jamais été développée dans l'Arctique de l'est, probablement en raison du manque d'argile à certains endroits, mais surtout du manque de combustible pour la cuisson. Tous les éléments retrouvés dans l'est canadien ou au Groenland proviennent donc de l'ouest. Ainsi, les trois tessons retrouvés à Naujan et les deux autres sur le site de Nûgdlît seraient d'origine alaskienne et auraient voyagé sur plus de 3 000 km avec des migrants thuléens (Mathiassen, 1927 ; Holtved, 1944).

Dans une certaine mesure, les traits stylistiques peuvent servir de marqueurs identitaires, les populations occidentales ayant développé des ornementations plus complexes que les orientales, par exemple sur les têtes de harpon. Ces éléments nécessitent toutefois d'être étayés et confrontés à d'autres analyses. Nous espérons pouvoir prochainement développer

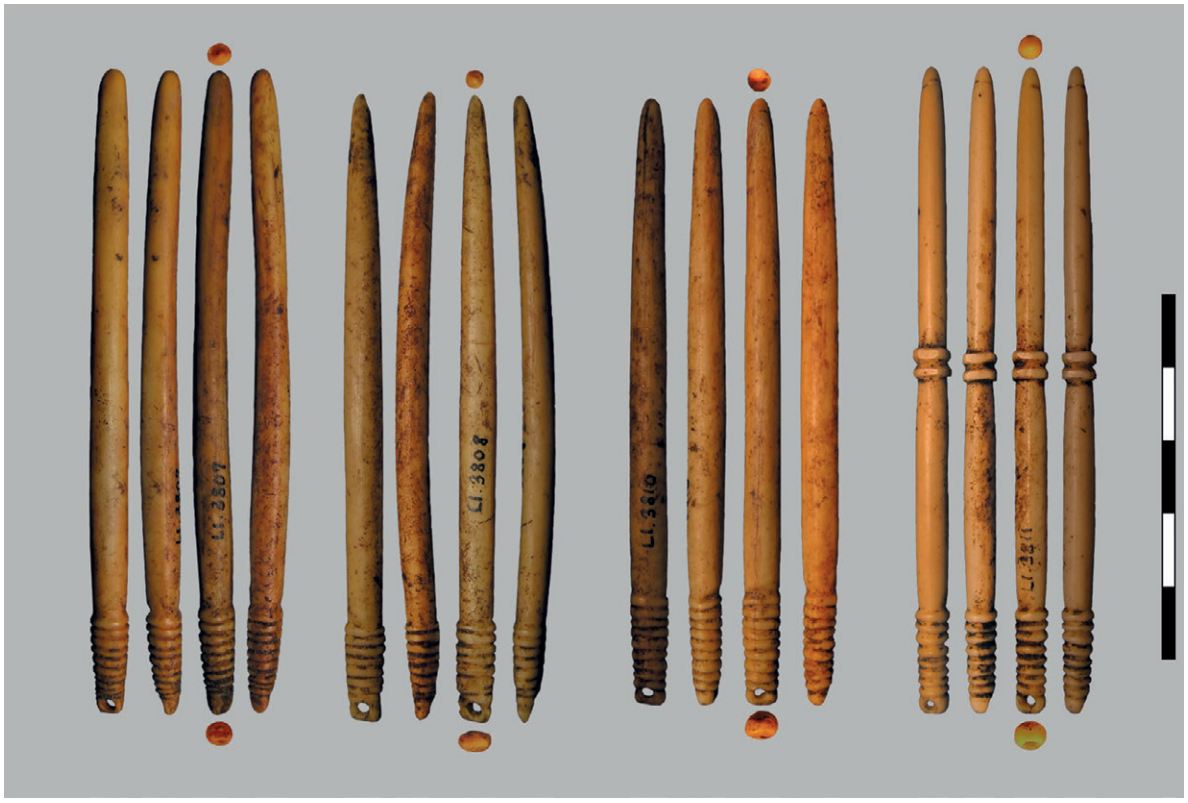

Figure 9. Exemples de stylets en ivoire d'inspiration norroise retrouvés sur le site thuléen de Cape Harry au Groenland sur la côte nord-est (de gauche à droite, n° L1-3807, L1-3808, L1-3810, et L1-3811). Échelle, subdivision en cm. Photos, Cl. Houmard.

ces recherches à partir de l'étude des matières osseuses, notamment par le développement des analyses isotopiques et génétiques, afin de mieux cibler les aires d'origine des espèces exploitées. Les différentes matières premières animales, en particulier les sous-espèces de morse et de baleine (Pacifique versus Atlantique) qui semblent ne s'être jamais mélangées génétiquement, pourront possiblement être distinguées. S'il peut être prouvé que les têtes de harpon portant des motifs alaskiens, retrouvées au Canada et au Groenland, sont bien d'origine alaskienne, — *i.e.* en ivoire de morse du Pacifique —, nous pourrons prétendre suivre la migration thuléenne avec des marqueurs autres que la poterie. Les matières osseuses et, dans une moindre mesure car plus rares, les vestiges de peaux d'espèces marines d'origine uniquement pacifique sont à ce sujet porteuses de nouveaux espoirs. D'autres éléments devront cependant être pris en compte pour la datation des occupations car les matières d'origine marine sont affectées d'un effet réservoir qui les vieillit dans les mesures au radiocarbone de 400 à 700 ans, aucune courbe de calibration fiable n'existant actuellement.

Contacts et influences culturels

Pour les temps médiévaux, il reste à ce jour difficile d'évaluer la nature du contact entre Norrois et Thuléens. Certains objets norrois — éléments de boîte, fragments de chaîne ou lame métallique, pièces d'échecs, peignes, cuillers — se retrouvent sur les sites thuléens de la côte nord-ouest du Groenland, comme à Ruin Island, Inuarfigssuaq et Thule/Uummannaq (Holtved, 1944). Il n'est cependant pas possible de savoir s'ils ont été acquis par ramassage ou échange. La présence des Norrois à des latitudes aussi hautes que 72°55′ N — soit 4° plus sud que les sites mentionnés — est attestée par des écritures runiques gravées sur un cairn à Kingigtorssuaq et datées du début du XIVe siècle (Buchwald, 1992).

Le fer forgé norrois ou européen a très vite été considéré comme de meilleure qualité que le fer météoritique ou tellurique, il a donc fait l'objet d'une recherche particulière. Hormis quelques exceptions, comme certains stylets en ivoire retrouvés dans des sites groenlandais uniquement (Fig. 9), la culture matérielle norroise ne semble pas avoir influencé les productions thuléennes de l'époque. Jusqu'à la fin du XVIIIe siècle, les contacts entre Inuit et navigateurs ne semblent pas avoir eu beaucoup d'impacts sur le mode de vie des sociétés arctiques (Gullason, 1999). Les premiers explorateurs et baleiniers ne venaient pas pour commercer, ils n'emmenaient donc pas avec eux de biens à échanger, et la présence de ces navires était trop fugace et imprévisible pour inciter les Inuit à changer durablement leurs habitudes. Ce n'est qu'avec les hivernages réguliers des navires que se sont créées des relations d'interdépendance, les Européens sollicitant les Inuit pour survivre (apports de nourriture, aide aux tâches quotidiennes du navire) et les Inuit s'accoutumant aux biens manufacturés qui leur étaient étrangers ou trop rarement accessibles (*e.g.* fer, tabac, farine, vaisselle, puis armes à feu et munitions). Nous pouvons donc considérer que les biens manufacturés d'origine étrangère, qu'ils aient été acquis par ramassage ou échange, n'ont eu qu'un impact limité sur les modes de production traditionnels des objets mais ont eu un impact certain sur les rythmes et itinéraires de déplacements des Inuit et, *a priori*, des Thuléens.

CONCLUSION

Les récits ethnographiques et le développement de nouvelles méthodes d'analyse (spectrométrie, isotopes stables, paléogénétique) permettent progressivement de préciser les provenances des matériaux organiques. À ce jour, de nombreux points restent à éclaircir sur les itinéraires de déplacement des groupes thuléens comme sur leurs motivations. Pouvoir distinguer les occupations liées à un cycle de déplacement saisonnier de celles correspondant aux étapes migratoires de l'expansion thuléenne autour du XIIIe siècle paraît essentiel. Cela implique de distinguer parmi les objets qui ont voyagé, ceux qui ont été échangés de ceux emportés lors de la migration. L'identification des sources de matières premières n'est donc

pas suffisante, il est également nécessaire de combiner les informations issues de différentes disciplines afin d'enregistrer un maximum d'indices pouvant provenir d'un même point d'origine (*i.e.* Alaska). L'approche technologique a un grand rôle à jouer dans la recherche d'éléments confondants. Rien n'est plus signifiant que les traditions et savoir-faire mis en œuvre pour l'élaboration d'un objet (Inizan *et al*., 1995; Leroi-Gourhan, 1964). C'est par ce biais que pourront être mises en évidence d'éventuelles imitations, reproduction à l'identique et/ou influences culturelles au contact d'autres populations. Bien que développée depuis une vingtaine d'années dans le contexte arctique, cette démarche nécessite d'être encore enrichie par de nouvelles études. De nouveaux éléments de réponse seront alors apportés aux questions fondamentales encore débattues que sont le trajet et la durée de la migration thuléenne, ou encore la question du remplacement rapide des Dorsétiens par les Thuléens (expansion démique et/ou acculturation), ainsi que celle de la nature des relations entre Dorsétiens, Thuléens et Norrois (Appelt/Gulløv, 2009; Sutherland, 2000).

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NOTE
[1] Les Inuit du Cuivre constituent le groupe le plus occidental de l'Arctique central canadien, leur territoire englobant l'île de Banks et la moitié sud de l'île Victoria. Ils fréquentaient régulièrement le Grand Lac de l'Ours, région également fréquentée par des groupes amérindiens (Stefánsson, 1914). Leur subsistance est principalement fondée sur la chasse au caribou, la pêche, ainsi que la traque de petits mammifères et d'oiseaux.

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RESUME

MOBILITY TRAILS IN ARCTIC DURING THULEAN TIMES (~AD 1200-1900)

Traveling in Arctic more corresponds to a way of life than to just a journey. Moving is part of the Inuit daily work. Subsistence, domestic and symbolic activities go along with simultaneously. Inuit do not hesitate to travel 500 and up to 1,000km in a single journey for fetching specific raw materials or migrating to another place. They locally acquire most of their goods but a special need for a given raw material—essential to the daily life but rare in the immediate environment—can motivate long-distance journeys. Depending on the type of journey the traces that can be retrieved depend on material culture as well as on human contacts and cultural influence encountered. This paper aims at

gathering our knowledge concerning the Thule period, and paving the way to orient and adapt future research to different geographic contexts.

Two main means of transportation can be used for long-distance journeys: sleds for the 9 to 10 months during which the surfaces are well snow- or ice-covered, and umiak during summer time when large areas of ice-free water allow a more rapid sea transport. Umiaks would have been used for the Thule migration from Alaska to Canada and Greenland that occurred around the 13th century. Although also sometimes used for transportation the kayak is mainly dedicated to subsistence activities. Even if the occupation periods remain difficult to assess, many Thule settlements have probably been occupied for centuries because they are located on routes still in use today.

During Thule times movements of the individuals and of the artefacts varied according to new opportunities but the routes towards the main key material supply sources—such as copper, iron, soapstone and wood—stay the most long-lasting and predictable over the centuries. As an example, this paper describes in more detail travel patterns for Copper Inuit, one of the best documented cases. For iron we extended the study to Greenland because it possesses the only known sources in Arctic: meteoric iron of Cape York on the northwestern coast and telluric iron of the Disko Bay region on the west coast. The Inuit travels and modes of supply have not been sustainably modified until the more regular and prolonged attendance of the European ships in the 18th century, and the following arrival of the Euro-American trading posts.

PART II — PROJECT GALLERY

BONE AND TOOTH TECHNOLOGY IN AUSTRALIA: RECENT DISCOVERIES AND LIVING TRADITIONS

Michelle C. Langley
Sue O'Connor

Abstract: Australia has a rich ethnographic record of bone- and tooth-based technologies. Despite this fact, such pieces of material culture have consistently been passed over in favour of stone technology in Australian archaeology. Recently, we described a worked and ochre-stained bone artefact recovered from a well-stratified context dated to beyond 46,000 calBP in northwestern Australia (Langley et al., 2016). As osseous technology in Australia was long believed to have a time depth of only 20,000 years—being 're-invented' in the southeast of the continent at that time—this discovery challenged previous conceptions. It also opened up a huge range of research avenues into the role and importance of bone technologies throughout Australia's 65,000 years of human occupation. This chapter overviews the current state of osseous technology studies in the Australian context, and highlights some of the most promising avenues for future research.

INTRODUCTION

Sahul, located between the Pacific and Indian Oceans, extending from 112ºE to 152ºE and from the equator to 44ºs, reached a maximum area of 9.80 million km^2 during the Last Glacial Maximum (LGM) when sea-levels dropped *circa* 130 m lower than today, creating land bridges between mainland Australia, Tasmania, and New Guinea (Williams *et al*., 2018). Today, these three main islands (Australia, Tasmania, and New Guinea) collectively cover about 8.5 million km^2. Colonised by anatomically and behaviourally Modern Humans sometime prior to 65,000-years-ago (Clarkson *et al*., 2017), this continent became home to rich cultures nurtured by the diverse environments found across the landscape.

Prior to 1788—the beginning of European influx—approximately 700 languages were spoken throughout Australia with an estimated population of 750,000 people living in hundreds of 'tribes' or 'nations' maintaining deep ties to traditional lands. Over the next 200 years, European settlers, explorers, government representatives, and anthropologists collected a vast quantity of Aboriginal material culture from all over the continent—these items ending up in both Australian and international museums. Among them, are hundreds (if not thousands) of tools and ornaments wholly or partially constructed from hard animal materials (bone, tooth, claw, shell, etc.), (Fig. 1).

Conversely, archaeologically recovered bone-based technologies are rare. Indeed, until very recently, it was believed that bone technology had been absent from Sahul until around 20,000-years-ago, leading some researchers to suggest that this technological component was 'lost' after Modern Humans left Africa owing to repeated founder effects (Mellars, 2006). With osseous (both bone and antler) artefacts a dominant artefact class in Africa Middle Stone Age (MSA), (*e.g.* D'Errico/Henshilwood, 2007; D'Errico *et al*., 2012; Henshilwood *et al*., 2001) and early Upper Palaeolithic Eurasian (*e.g.* Goutas, 2016; Tejero, 2014 & 2016; Wolf *et al*., 2016) assemblages, their absence in similarly aged sites in Sahul seemed to support this notion. Indeed, it was posited that bone technology was part of a 'phase of innovation' in southwest Australia around 20,000 years BP, where it was a "supplement" to the "flake-based stone tool assemblages" (Franklin/Habgood, 2007:11), while O'Connor and Hiscock (2014) regarded the apparent restriction of early osseous technology to the southwest and southeast of the continent as a manifestation of regional variability in Pleistocene Australian cultures. Consequently, with bone tools only found well after the initial colonisation date of Sahul, technology made on hard animal materials including bone, tooth, and claw have been rarely mentioned in discussions of the earliest Australian toolkits despite the ethnographic record being rich in such items.

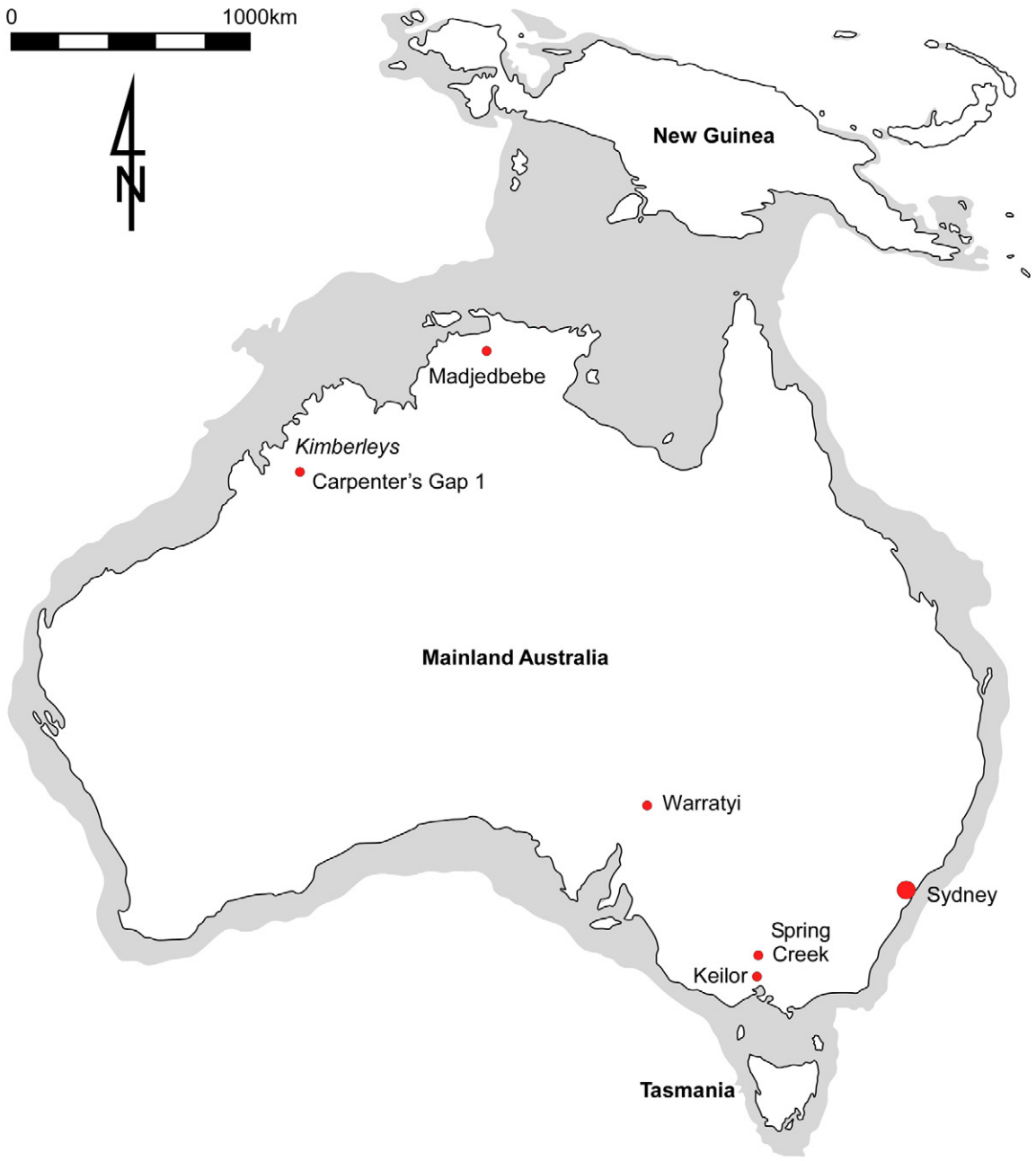

Figure 1. Locations of sites and regions mentioned in text. Light grey indicates LGM low sea-level stand.

Recent discoveries and new projects, however, are changing both our approach to Australian prehistory and our understanding of the importance of these technologies to Australia's Aboriginal peoples, past and present. We provide a brief overview of these developments in order to highlight the changing understanding of bone technology in Australia.

Recent Discoveries

Late 2016, we described a worked and utilised kangaroo bone artefact dated to beyond 46,000 calBP (Langley *et al*., 2016). Discovered in the well-stratified context of Carpenter's Gap 1 (CG1) located in northwestern Australia, use wear and residues observed on this artefact were found to most closely resemble a 'nose-bone'—a widespread ornament type found across the continent in the ethnographic period. In form, this type of ornament ranges

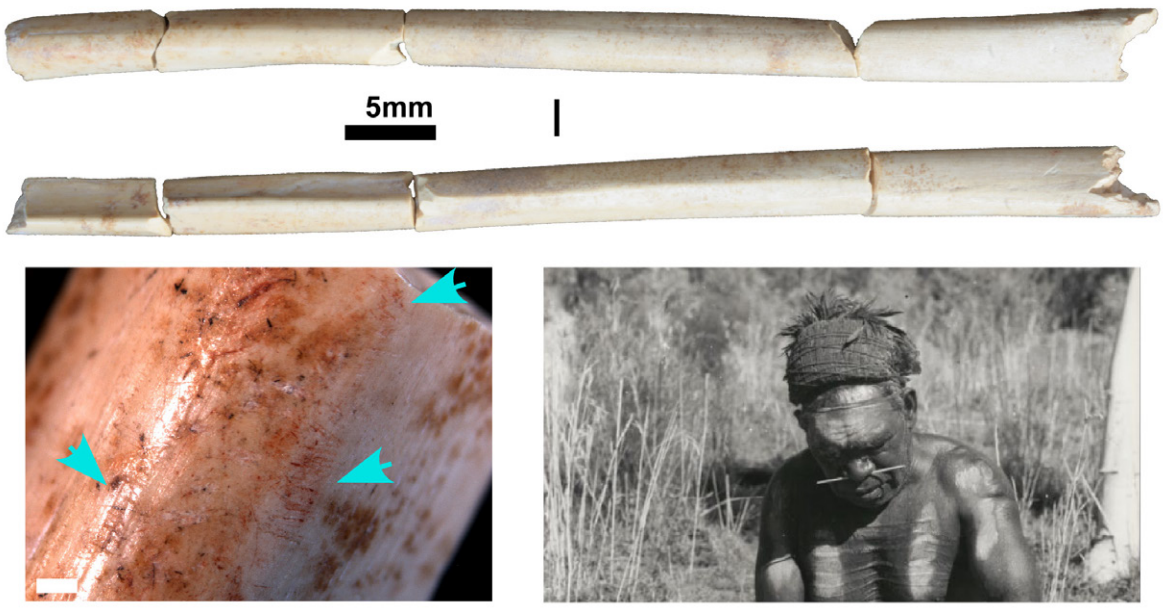

Figure 2. Macropod fibula bone point recovered from contexts dating to beyond 46,000 calBP at Carpenter's Gap 1, Western Australia. Detail of distal section with red ochre residues and use wear consistent with having been used as a nose-bone (lower left), and Walpiri hunter gutting a kangaroo and wearing a fibula point through his nasal septum, Northern Territory 1974 (lower right). Scale subdivision in cm. Photo, J. Carter, National Library of Australia (n°12,582) reproduced with permission.

in length between just a few centimetres to around 20 cm, can be uni- or bipointed, and usually bears no additional markings (such as engravings), though can have feathers or fur attached to the proximal extremity with the use of human hair, animal fur, or plant fibre-based string. These ornaments will be discussed further below.

Another recent osseous discovery, —this time in Warratyi rockshelter, located in southern Lake Eyre Basin, South Australia—, supports the authenticity of the unexpected CG1 find. Consisting of a single distal or proximal fragment of a point made on macropod (kangaroo or wallaby) fibula, this artefact is dated to around 38,000-40,000 years ago, demonstrating that pointed bone technology also has an antiquity much older than previously believed in the southeast (Hamm *et al*., 2016), (Fig. 2).

Both the age and location of the CG1 find, being at a time depth almost 25,000 years older than previous specimens, but found in the opposite corner of the country from where Australian bone technology was supposed to have been innovated, along with the Warratyi example, has resulted in the need for an earnest reassessment of the origins, development, and importance of bone-based technologies in this part of the world.

New projects: Bone and tooth technologies in Australia

In Australia, hard materials from a number of different creatures were used on a regular basis to construct various social and economic technologies (Fig. 3). The use of the fibula, ulna, mandible, scapula, and teeth of macropods is extensive, with emu tibiotarsus and tarsometatarsus, fish spines, stingray spines, and ulna from various large birds such as Magpie Goose, brolga, or Jabiru also common. Also frequently found is the use of echidna spines, crocodile tooth or mandibles, shark and snake vertebrae, wombat claws, and turtle shell (Fig. 4 & 5).

As pointed out by Akerman (1995 & 2010), the use of organic materials other than wood has been largely ignored in the literature on Australian Aboriginal technology. Consequently, the place that bone, tooth, and claw technologies and ornaments have had throughout Australian prehistory and history is little understood in archaeological terms.

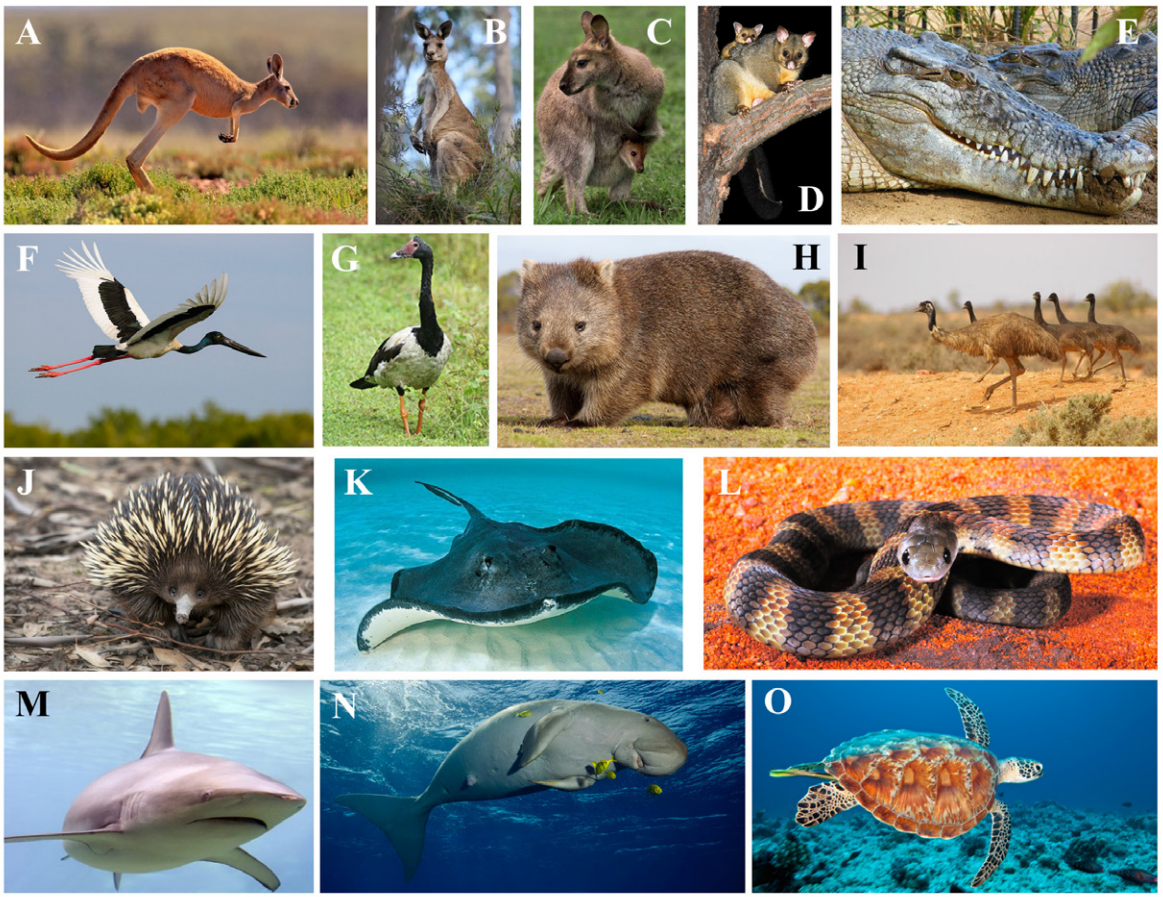

Figure 3. Species from which hard materials are commonly utilised to manufacture social and economic technologies in Australia. Please send official reproduction autorizations. A - Red kangaroo, *Macropus rufus*; B - Eastern Grey Kangaroo, *Macropus giganteus*; C - Bennett Wallaby, *Macropus rufogriseus*; D - Common brushtail possum, *Trichosurus vulpecula*; E - Saltwater crocodile, *Crocodiles porosus*; F - Jabiru, *Ephippiorhynchus asiaticus*; G - Magpie goose, *Anseranas semipalmata*; H - Common wombat, *Vombatus ursinus*; I - Emu, *Dromaius novaehollandiae*; J - Short-beaked echidna, *Tachyglossus aculeatus*; K - Cowtail stingray, *Pastinachus atrus*; L - Tiger snake, *Notechis scutatus*; M - Bronze whaler shark, *Carcharhinus brachyurus*; N - Dugong, *Dugong dugon*; O - Green sea turtle, *Chelonia mydas*.

Perhaps best described in the literature is the use of kangaroo and wallaby fibula for the manufacture of tools. Indeed, Indigenous informants from the very southwest of Australia have stated to researchers that "bone tools were made for a variety of purposes and said that the 'small bone from the leg of a kangaroo' was preferred for most of them" (Bird/Beeck, 1980:169). This preference for a single type of bone (kangaroo or wallaby fibula) is attested to in multiple ethnographies written about peoples situated across the whole continent (*e.g.* Howitt, 1996[1904]), and is known to have resulted in tools used for a range of different tasks. Recorded uses include nose-bones (Angas, 1969[1847]; Curr, 1883; Dawson, 1881; Eyre, 1964[1845]; Kenyon, 1912; Moore, 1884; Roth, 1984[1897-1910]; Spencer/Gillen, 1927), toggles for possum or kangaroo skin cloaks (Bird/Beeck, 1980; Dawson, 1881; Hammond, 1933; Smyth, 1878; Stormon, 1977), hair pins (Curr, 1883; Spencer/Gillen, 1927), points for lancing gums (Collins, 1910), ears (Roth, 1984[1897-1910]), or the nose (Dawson, 1881; Howitt, 1996[1904]), as well as for incising skin (creating scarification), (Smyth, 1878). Their use is also frequently mentioned in connection to being a favoured murder weapon (*e.g.* Bird/Beeck, 1980; Howitt, 1996[1904]), sometimes used in conjunction with poison (Howitt, 1996[1904]). Similarly, this form of bone tool was used in bone-pointing ceremonies whereby

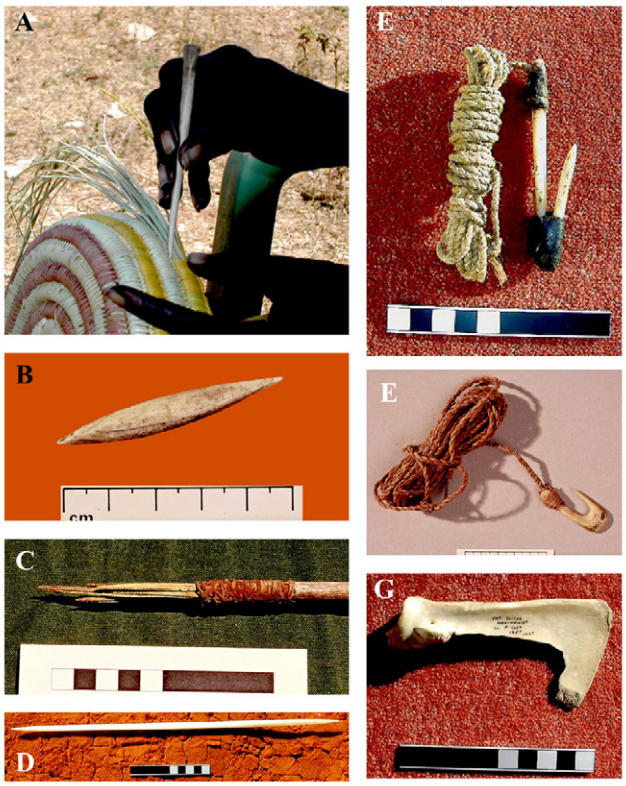

Figure 4. Examples of osseous tools in ethnographic Australia. Scale subdivision in cm. Photos, Kim Akerman reproduced with his kind permission.
A - Macropod fibula bone basketry tool; B - Macropod bone bipoint; C - Singray spine multi-prong spear; D - Macropod tibia bipoint; E - Macropod bone composite fishhook; F - Macropod bone single piece fishhook; G - Macropod scapula yam knife.

Figure 5. Examples of hard animal material-based ornaments in ethnographic Australia. Scale subdivision in cm. Photos, Kim Akerman reproduced with his kind permission.
A - Necklace of freshwater eel branchiostegal rays; B - Shark vertebra beaded necklace; C - Macropod incisor decorated headband; D - Snake vertebra beaded necklace; E - Macropod incisor head ornament; F - Wombat claw necklace.

the bone was pointed at a person deemed guilty of a cultural infringement or crime causing them to become sick and/or die (*e.g.* Elkin, 1993[1977]; Howitt, 1996[1904]; Spencer/Gillen, 1927).

These tools, while used differenty, retained very similar forms, so much so, that ethnographers have made specific cautions regarding function identification. For example, Spencer and Gillen (1927:513) state that "many of these nose-bones are so similar in form to some of the pointing bones that, unless their actual use be known it is very difficult to distinguish them from one another". Examination of a range of fibula bone points currently held in The Australian Museum, Sydney by one of us (MCL) confirmed this early observation, though it was also noted that those used in bone-pointing were distinguishable owing to their high level of decoration (highly polished, engraved, and often having human hair string attached to the proximal extremity with a plant-based resin). These differences—observed on the pointing bones—suggests that careful examination of other macropod fibula points may also result in tell-tale differences regarding their function. In fact, it may be that use wear and residue analysis may be able to tease out functional categories for archaeologically recovered fibula points.

Indeed, the study of use wear and residues (traceology) for osseous artefacts remains in its infancy in Australia. With the Pleistocene antiquity of human occupation of the continent only confirmed some 56 years ago (Mulvaney, 1964 & 1966), and stone tools being the main focus of archaeological inquiry in this country, transplantation of techniques and

Figure 6. Macropod ulna indentors and finished Kimberly point. Scale subdivision in cm. Photos, Kim Akerman reproduced with his kind permission.

methodologies for the study of prehistoric osseous technologies developed in Europe have only recently begun to be applied here. Thus, while potential bone tools (such as the 'javelin heads' from Keilor which could date back as far as 40,000-years-ago; Gallus, 1972 & 1974) and notational pieces (such as the marked *Diprotodon*[a 2.8 tonne marsupial similar to a wombat] tooth from Spring Creek; Vanderwall/Fullagar, 1989) have been found, confirmation of their anthropogenic origins and classification using modern analytical techniques is only now beginning to occur.

With increasing abilities to distinguish between different functional categories of bone/tooth tools, we are also beginning to be able to identify distinct spatial and chronological distributions of particular items. For example, in the Kimberley region of northwest Australia, kangaroo ulna were commonly used for pressure flaking finely made bifacial points of stone, which were then hafted for use as projectile points (Fig. 6). Such weapon tips appear only in the last 1,200 years or so (Maloney *et al*., 2014), and thus, the bone artefacts used in their manufacture are likely to have a restricted distribution in both time and space (*e.g.* David *et al*., this volume). Although indentors or pressure flakers are well documented ethnographically (*e.g.* Love, 1936), no studies of the manufacture or use wear on these objects has been undertaken. This situation is the case with many ethnographically documented bone tools housed in museum collections providing numerous study opportunities.

Similarly, although bone points are now known to occur in Pleistocene contexts throughout the continent, they were particularly common in upland Tasmanian during the LGM when extremely cold conditions prevailed in this most southern region of Australia. Here, they were made primarily on the fibula bones of Bennett's wallabies, with at least some thought to have been used as awls to pierce animal hides for making the warm clothing necessary for survival in these upland environments (Gilling, 2007). This interpretation is consistent with the representation of wallaby bone elements present in the cave faunal assemblages, which themselves, indicate deliberate removal of the wallaby skins—presumably to make clothing.

The dental growth patterns in the wallaby mandibles in some sites also demonstrate that the caves were mostly occupied during autumn and early spring—the coldest part of the year—when fur clothing would be most necessary.

In each of these examples—the ulna indentors and possible unipoint awls for fur clothing manufacture—it is evident that the extra attention that use wear and residues analysis lends, when combined with contextual analysis of the sites' faunal material, might allow us not only to distinguish different types of uses to which bone tools were applied at a single site, but also reconstruct spatial and temporal patterns. Additionally, and on an even more basic level, careful examination of the thousands of bones excavated from archaeological sites and classified as food refuse but which have never been taxonomically identified, or subject to detailed examination, may also bring to light many more 'informal' bone tools which have gone thus far unrecognised in collections.

DISCUSSION AND CONCLUSION

Evidently, the rich ethnographic record of Australia remains an untapped resource for the study of osseous technology, particularly in regards to future archaeological finds and the reanalysis of those artefacts excavated previously.

We are challenged by the simple fact that many of the oldest Australian archaeological sites do not preserve bone at depth, and thus, for the earliest periods of human occupation of the continent. This situation is a particular problem in the tropical north of Australia where the strongly seasonal climate results in preservation conditions which are not conducive to the longevity of organics. For example, at Madjedbebe (previously known as Malakunanja II), despite a rich and diverse worked stone assemblage, bone is preserved only in the Holocene deposits and has produced only some 20 odd points made on this medium (Clarkson *et al*., 2015 & 2017). Thus, the previously perceived regional division, with bone artefacts present in the south and absent in the north, can now be understood as a function of taphonomic processes rather than cultural patterning (Langley *et al*., 2011).

Another hurdle is that the study of osseous artefacts in Australia has been set back by the small sample sizes commonly recovered from excavated collections. In the first place, excavations in Australia tend to be of the 'telephone box' variety—a 1 m x 1 m square down to bedrock, which often barely reaches beyond 1 or 2 meters in depth. The nature of archaeology on a continent where communities retain strong ties to their traditional lands requires extended consultation, thoughtfulness, and having as minimal impact on cultural sites as possible. The realities of this situation mean that items that were curated over significant periods of time, or which are affected by any number of taphonomic processes, are recovered in far smaller quantities than is often the case elsewhere. Consequently, whereas stone tools may be recovered in the thousands, bone artefacts are often rare in single excavations, leading to their neglect owing to not having the sample sizes required to differentiate chronological change.

This, we feel, is where micro-analytical techniques such as concentrated use wear and residue analysis of single artefacts can combat the decreased samples sizes available for study. The CG1 bone point providing a case-in-point for this argument.

Finally, it should also be noted that shell technologies, while not discussed here, are found in some of the oldest identified archaeological contexts in Australia (*e.g.* Balme/Morse, 2006; Veth *et al*., 2017). Here again, modern traceological techniques and methodologies are being applied to both collections recovered from the archaeological record many years ago, as well as newly discovered ornaments and tools (*e.g.* Balme *et al*., 2018).

In conclusion, the high-resolution analysis of Australia's osseous technologies is only just beginning. Much work remains to be undertaken, and it is anticipated that over the next 10 to 20 years, our understanding of these ornaments and tools will grow considerably. There is also great potential that this newly acquired information to change our understanding of the many communities who have lived across Australia's vast landscape.

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RÉSUMÉ

TECHNOLOGIE EN OS ET DENTS, EN AUSTRALIE:
DÉCOUVERTES RÉCENTES ET TRADITIONS VIVANTES

Alors que l'Australie possède un riche registre ethnographique de technologies fondées sur l'utilisation des os et des dents, ces éléments de la culture matérielle n'ont toutefois que rarement été pris en compte dans l'archéologie australienne au profit de l'étude de la technologie lithique. Récemment, nous avons décrit un artéfact osseux travaillé et taché d'ocre que nous avons retrouvé dans un contexte archéologique bien stratifié et daté d'avant 46 000 calBP, dans le nord-ouest de l'Australie (Langley et al.*, 2016). Cette découverte a remis en question les conceptions antérieures qui soutenaient que la technologie osseuse en Australie recelait peu de profondeur historique, celle-ci était, en effet, invariablement perçue comme ayant été « réinventée » sur le territoire, dans le sud-est du continent, il y a 20 000 ans environ. Cette découverte a également ouvert un large éventail de pistes de recherche sur le rôle et l'importance des technologies osseuses tout au long des 65 000 ans d'occupations humaines en Australie. Ce papier livre un bref aperçu de l'état actuel des études sur la technologie osseuse dans le contexte australien, et met en évidence certaines des pistes les plus prometteuses pour les recherches à venir.*

ARE THERE ANY CULTURAL REFLECTIONS ON ROMAN BONE HAIRPINS WITH FEMALE BUSTS?

Ayça GERÇEK

Abstract: *This study focuses on discussing hairpins with female busts, originating from different sites of the Roman Empire during the Roman Imperial period, but adopts a non-typological approach. Hair has long been recognized as a complement to human beauty, and it is evident that various techniques were employed to craft these specific hairpins. The primary objective of this study is, therefore, to shed new light on the published materials through the examination of a hairpin with female bust, found at Arykanda in Lycia, dating back to the 3rd-4th century AD. This analysis will be conducted within the framework of cultural identity and interaction.*

Roman Period, Bone, Hairpin, Arykanda, Roman Empire, Figurine, Representation

INTRODUCTION

The most commonly utilized artefacts often hold the greatest value. Everyday objects that are repeatedly touched and become integrated into personal adornments over time can effectively reflect the character and pleasure experienced by individuals. When examined in detail, it seems that everyday objects display the same characteristics. Almost all of them might have a similar shape, but those that rarely appear in diverse forms are intricately shaped based on an individual's inclinations, the prevailing fashion trends of the time, and the imaginative creativity of the craftsmen involved. An outstanding group of everyday objects, which were well-known from the Roman period, constitutes hairpins (Stutzinger, 1995:135; Bartus, 2004:23). The primary objective of this study is, thus, to undertake a reevaluation of the existing published materials, in conjunction with the hairpin decorated with a draped female bust found in Arykanda (Gerçek, 2022:681), and this reevaluation will be conducted within the framework of the examination of cultural identity and interaction. In this context, the study focuses on the examination of female bust decorated pins from different sites of the Roman Empire, specifically dating to the Roman Imperial Period. However, the analysis is not approached from a typological standpoint. Within this framework, several questions arise regarding the significance of various aspects such as cultural identity, the cultural values imposed by the ruling authority, and the interactions between societies in influencing preferences for different types of hairpins.

Figured Hairpins

Hair has been accepted as a complement to the beauty of people, and a variety of methods have been used to shape it. Certainly, in any focused on women in the Roman world, a primary area of interest lies in their hair practices. Hairpins serve as an essential accessory for the intricate hairstyles that often involve the use of wigs and hair nets for gathering and styling the hair. Ancient sources also mention that hairpins, commonly associated with women's hairstyling, were considered a form of jewelry. These hairpins served a dual purpose as functional items for securing hairdos and as decorative accessories that added to a woman's overall adornment (Stutzinger, 1995:137; Riha, 1990:95). However, it is frequently seen in those publications that hairpins served multiple purposes, and the terminology used to describe them often encompassed various functions, regardless of whether these references were found in ancient sources or modern publications (Biró, 1994:30; Hrnčiarik, 2012:315; Oprea, 2015:149). Hairpins, in addition to their use in hairstyling, were also employed as a primary method for fastening garments before the widespread adoption of buttons (MacGregor, 1985:113). There is also information about different uses of hairpins. For example, hairpins were also believed to have been used for extracting ointments or unguents from bottles or containers (Oprea, 2015:149). Arthur MacGregor mentions that

bone pins were also used in making molds for bronze pins (MacGregor, 1985:113). Joseph A. Maurer describes the purpose of using pins with suggestions for extraordinary use:

"*The hairpin seems always to have been the convenient weapon with which the irate lady was wont to punish and seek revenge*." (Maurer, 1951:163).

Even though hairpins were made from many different raw materials such as metal and glass, the examples uncovered in the excavations show clearly that hairpins made of bone, horn, and other related materials were preferred more. Those materials, such as bone, horn, and related substances, which exhibited a wide typological range in their production, were primarily favored due to their affordability compared to metal hairpins. Hairpins, characterized by cylindrical shafts and pointed tips, are typically classified based on the shape of their heads. Common classifications include globular, spherical, conical, zoomorphic, anthropomorphic, and various other variations. Unlike the typology of Roman glass finds, where Clasina Isings serves as a commonly referenced authority (Isings, 1957), publications related to hairpins often present varying classifications due to the absence of a unified consensus in this regard (*e.g.* MacGregor, 1985; Riha, 1990). An intriguing subgroup of hairpins consists of anthropomorphic examples, characterized by their head being specially shaped to resemble a female figure. Figured pins appear in two different types: full human figure or bust. Hairpins depicting goddesses, particularly those representing Aphrodite, are observed from the Hellenistic period onwards (Stutzinger, 1995:155; Hrnčiarik, 2012:320).

The examples of pins with female busts are encountered in the first half of the 1st century AD and the beginning of the 5th century AD. The hairpins with busts, especially during the Flavian and Early Antonine periods and in the Late Antiquity, are very common and of a particularly fine quality (Stutzinger, 1995:155). Mária T. Biró explains why the fashion of these bone pins reached the peak during the Late Antiquity, not by the prevalence of hairpins, but by the prevalence of bone jewels (Biró, 1987:176). Since the figures on the hairpins usually describe empresses, or rather hairstyles, these pins are considered the most precise bone objects to be dated (Stutzinger, 1995:156; Bartus, 2004:29). The few male-headed pins are the exception of the female-headed pins, which are the majority in number of finds (Mikler, 1997:48/Taf.36-4 & 5; Rodet-Belarbi/Jannet-Vallat, 2013:66-96/Fig.29). On some pins was preserved traces of gold leaf or color (Rodet-Belarbi/Jannet-Vallat, 2013:66).

Figure1. The bone hairpin decorated with a female bust from Arykanda (Roman Anatolia) dated approx. to the 3rd-4th century AD. Scale subdivision in cm. Photo, Arykanda Excavation Archive with the kind permission of Assoc. Prof. Dr. Vahit Macit TEKİNALP, Director of Arykanda Excavation.

A New Example of the Hairpin with Female Bust

A hairpin decorated with a female bust, found during the 2006 excavations in Arykanda in northwest Lycia, has added a new center to this geographical distribution of these pins (Fig. 1). Despite being a small-scale city, the finds from the osseous material found in Arykanda form a rich

collection of functional diversity (Gerçek, 2022). The densest group in the finds is hairpins as it is in many other settlements. In addition to the commonly found spherical, drop, prism, and cone-shaped hairpins, there is also a hairpin with a duck-like head (Gerçek, 2022:681). Undoubtedly, the most striking find in this assemblage is this figured hairpin, which is known to be a unique example in the region. The example found in Arykanda was unearthed in the northern area of the Peristyle Villa's courtyard, which is located within the Late Antique quarter of the city (Bayburtluoğlu, 2007:3).

The hairpin features a meticulously carved female bust as its head. The hairstyle is depicted with backward-combed hair adorned with grooves and a protrusion on the top. The back of the head showcases a hairdo resembling crossed stripes, giving the impression of being inside a hairnet. Balls of hair are present on both sides of the neck. The face is carefully carved, with prominent features such as large eyes, a nose, and full lips. The garment, likely a tunic, is depicted with simple, V-shaped converging notches at the front, while the back remains undecorated. The lower part of the shaft is broken.

The Arykanda example of the figured hairpin is the reference point of this paper. This paper will thus focus on exploring the potential minor role of the examined hairpin, originating from an eastern province of the Roman Empire, in the broader context of Roman cultural interaction. Instead of employing a comparative analogical study, the objective is to investigate how this particular artefact contributes to and influences the cultural dynamics of the Roman Empire.

This female bust decorated hairpin from Arykanda can be dated to the 3rd-4th century AD based on both contextual finds and analogical comparisons. Similar pins of the Arykanda example were very popular in western provinces (Biró, 1994:92-No.380; Mikler, 1997:147-Taf.37-5; Stutzinger, 1995:187-Nr.94; Deschler-Erb, 1998:174-No. 2034). The closest analogue to the hairpin with a female bust from Arykanda was found during the excavations in Jerusalem, which dated to the Late Antique Period (Ariel Shatil, pers. comm.). It is possible that these two hairpins, which are quite similar to the workmanship, were shaped practically by the same bone carver, even though these two settlements are far apart from each other in the Roman Empire.

The evaluation of the published examples of different hairpins decorated with female busts suggests a higher concentration of these artifacts in the western provinces compared to other areas within the Roman Empire (Béal, 1983; Stutzinger, 1995; Biró, 1998; Mikler, 1997:48-49; Rodet-Belarbi/Van Ossel, 2003; Jung, 2013:162-163). The level of research focusing on the study of bone artefacts, including hairpins, in Roman Anatolia, is relatively limited. Archaeological items made of bone from Roman Asia Minor have systematically been neglected in the literature for years. Studies focusing on these pieces are few in number; they discuss either the bone collection of a museum or the bone finds from specific archaeological sites.

The presence of *Venus Pudica* or *Venus Anadyomené* type figurative bone distaffs or hairpins in Anatolian settlements is notably significant. The published examples are known from Ephesos (Trinkl, 2004:283 & 284-Kat Nos. 1 & 4); Perge (Özgülnar, 2007:172-K.97 ; Çokay-Kepçe, 2008:347; Garan, 2015:90-Nr. Ö.6; Çokay-Kepçe, 2017:111 & 112); Parion (Kasapoğlu, 2012:174); Smintheion (Öztepe, 2008:Taf.66); Anemourion (Russell, 1980:32); and Haluk Perk Collection (Çakmakçı/Ünal, 2021:36 to 39-Katalog Nos. 6 to 9). There are also artefacts made from osseous material decorated with female busts. For instance, a bone distaff with a bust of Athena was found in Perge, in Pamphylia (Özgülnar, 2007:171-K.98; Garan, 2015:91-Ö.7); the second example is from Hadrianopolis. This bone hairpin with bust of a woman dated to the Roman Imperial Period (Yıldırım/Karakaş, 2006:122).

Figured Hairpins and Cultural Interaction

As the Roman Empire within the broadest boundaries ruled over a geography reaching from Asia to northern Europe, many communities lived as their subjects. Undoubtedly, this represents the existence of a large number of different cultural groups and cultural heritage

within the imperial territories. In this complex context, the influence of local beliefs and regional characteristics is evident across various aspects, ranging from architecture to small artefacts. However, it is important to note that these manifestations of local and regional features coexist with distinct Roman characteristics. This synthesis is a feature of the power of the Roman Empire and the indicators of freedom and centralism. Local communities and individuals within the Roman Empire utilized clothing, hairstyles, and personal adornments as means of expressing their identity. These elements were carefully chosen and 'preferred' to serve as symbolic expressions of their cultural identity. The symbolic, small but most effective means of expressing local identity are personal accessories. In the Roman Empire, as in all antiquity, the simplest but the most used material of the personal accessories during all antiquity is obviously osseous material (Hrnčiarik, 2017). However, the Roman bone industry had a standardized production scheme: Objects of similar size and decoration are found in the farthermost provinces of the Empire (Vass, 2010:56).

Any Reference Point of the Figured Hairpins?

By examining a few examples of the figured hairpins, we can gain valuable insights into the Roman bone tool industry from the perspective of cultural identity and cultural contact, when compared to numerous non-figurative pins found in almost all settlements under the Roman Imperial rule. In other words, can we grant the cultural influence of Roman Empire on the personal objects by taking the reference point of the figured hairpins? Despite the large number of standard hairpins found in different contexts such as houses, necropolises, etc., it mightbe evidence that a limited number of pins decorated with female busts were produced for a special reason. On the other hand, it was hard to imagine that anybody tied her hair with a hairpin decorated with an empress' bust (Biró, 1998:81-82). Looking at the typological distribution of the hairpins with female busts, it seems that they bear characteristic specific to certain years and dynasties (Biró, 1998:81; Stutzinger, 1995). According to Biró's suggestions, hairpins of this nature were particularly fashionable during dynasties when women from the imperial family gained popularity. They were also favored in provinces connected to the emperor's country of origin. Biró further proposes that there may be instances in recent history where these hairpins were used for different purposes, indicating their versatility and potential for varied uses:

"*I think, the majority of the pins decorated with female busts copies the statue of a popular empress. It is rather a propaganda object, an emblem made for some political event than a pin of everyday use for fastening a braid or a bun.*" (Biró, 1998: 81).

Looking at the geographical distribution of the hairpins decorated with female busts, this special type of hairpins is known mainly from the western provinces. Recent archaeological works and the growing interest in bone finds have informed us of the presence of such female bust decorated pins in the east of the Empire. Biró states that hairpins from the different settlements of the Empire differ from each other stylistically, and emphasizes this investigation with an example: the hairpins found in Pannonia exhibit a higher level of craftsmanship and quality compared to those discovered in other western provinces, which in turn implies that they were strongly influenced by the eastern workshops of local bone carvers (Biró, 1998:79).

Despite the existence of hairpins produced during the Roman Imperial period, it is possible to say that they were very popular, especially in Late Antiquity, considering the finds of these hairpins. In the provinces, especially in the 4th century AD, despite detailed analysis of a few necropolises, the social status of the individuals involved in creating bone jewelry fashion and those who used them in society remains largely unknown (Biró, 1994:31).

CONCLUSION

Given the limited availability of publications on bone hairpins from cities in the eastern provinces of the Roman Empire, this paper highlights the challenge of engaging in an objective

debate relying solely on the existing examples of hairpins with female busts. The current publications and findings are insufficient in number to enable comprehensive comparisons and meaningful analysis. The hairpin with a female bust here represents one of the rare examples of such artefacts for Roman Anatolia. To gain a comprehensive understanding of the pin from Arykanda and other similar objects, it is crucial to conduct further research focusing on aspects such as craftsmanship, and raw materials. By examining these factors, we can effectively identify the techniques used in their production. Furthermore, investigating their production and distribution patterns will shed light on the dynamics of cultural exchange and transformation of local communities that were being changed in contact with Roman culture.

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RÉSUMÉ

EXISTE-T-IL DES REFLETS CULTURELS À PARTIR DES ÉPINGLES À CHEVEUX EN OS À FIGURATION FÉMININE DE LA PÉRIODE ROMAINE ?

Les épingles à cheveux ornées d'un buste de femme datées de la période impériale romaine et provenant de différents sites de l'Empire romain sont évoquées ici, moins d'après leur typologie qu'en tant qu'éléments de la coiffure intégrés comme un complément à la beauté et qui furent manifestement réalisés selon une variété d'artisanats. À la lumière d'une épingle à cheveux ornée d'une figurine féminine provenant d'Arykanda en Lycie, datée du IIIe ou du IVe siècle AD, la documentation déjà parue est intégrée à l'étude en utilisant les concepts d'identité et d'interaction culturelle.

OSSEOUS WEAPONRY OF LATER PREHISTORIC SOUTHERN VIETNAM

Jennifer R. Hull

Abstract: Comprehensive analyses of osseous implements in later Holocene contexts of Southeast Asia are still emerging, and there is great potential for the development of research frameworks in bone technologies that are particular to this geographic region. This is especially true of the prehistoric Holocene where there has been almost no research into the diverse range of bone implements recovered. In this paper, bone and antler pointed artefacts with clear manufacturing and hafting evidence from two settlement sites excavated in southern Vietnam are discussed. The analysis reveals impact damage suggesting their use as projectile points, but they seem to have a variety of forms and possibly functions. Some of these implements would have required a high level of technical skill to produce, and some were quite elaborate, as if designed for an outstanding purpose. In this, the paper may contribute to the more general debate on circulation of craftsmanship in Southeast Asia during the 2nd millennium BP.

INTRODUCTION

Osseous technologies have been a common occurrence in archaeological assemblages worldwide. In Southeast Asia these have not been extensively studied, particularly not in later Holocene contexts nor on the mainland. There are many documented assemblages of osseous industry throughout Thailand, and northern Vietnam, as well as early Holocene projectiles and hafted points with evidence of fibres and resins throughout the broader region (Barton *et al*., 2009; Harrisson/Medway, 1962; Higham, 1993; Pawlik, 2013; Rabett, 2008, 2012 & 2016; Rabett/Piper, 2012; Zhang *et al*., 2015). In southern Vietnam, ancient bone technology is discussed from two excavated mounds located approximately 10km from each other on the banks of the Vàm Co Tây River near the Cambodian border (Bùi *et al*. 2006; Ngô/Bùi, 1997; Hull, 2018). As we are searching for possible signs of mobility within the region in the use of projectile technology including reasons for technical change in this material domain (David *et al*., this volume; Yu, 2006), this paper will focus on presenting the characteristic bone points from these two Vietnamese mounds; Gò Ô Chùa and Lò Gạch (Fig. 1).

Archaeological background

The site of Lò Gạch (105°45'55 E/10°54'57 N) is located on the left bank of the Vàm Co Tây River (Vĩnh Hưng District, Long An Province). It is a mound approximately two metres above sea level spanning an area of *circa* 2500 m^2. This site was excavated between 2003 and 2014 with several trenches and test pits (Bùi *et al*., 2006). Four radiocarbon dates obtained from trenches 1 and 3 (2014) suggest that occupation at Lò Gạch began *circa* 2,800/2,700 BP (Philip J. Piper, pers. comm.). The archaeological excavations produced a range of cultural materials including large quantities of pottery, well-preserved animal bones, evidence of production and use of copper alloys, and several stone artefacts. A notable feature of the assemblages was the quantity and diversity of osseous artefacts recovered (Hull, 2018).

Gò Ô Chùa (11°00'18 N 105°46'18 E) is located at Hưng Điền A Village (Vĩnh Hưng District, Long An Province), roughly to the north of Lò Gạch, and is less than two kilometres from the Vietnam-Cambodia border. The site contains three linked mounds covering an area of approximately 450 m x 150 m; the central mound rises four metres above the surrounding surface with the other two only slightly lower (Ngô/Bùi, 1997). Several trenches and test pits were excavated between 1997 and 2008, out of which large quantities of ceramic, clay and, osseous materials were collected (Bùi *et al*., 2003). From several C14 dates on a range of materials, occupation at Gò Ô Chùa began *circa* 2,781±56 BP (Vương, 2008:112).

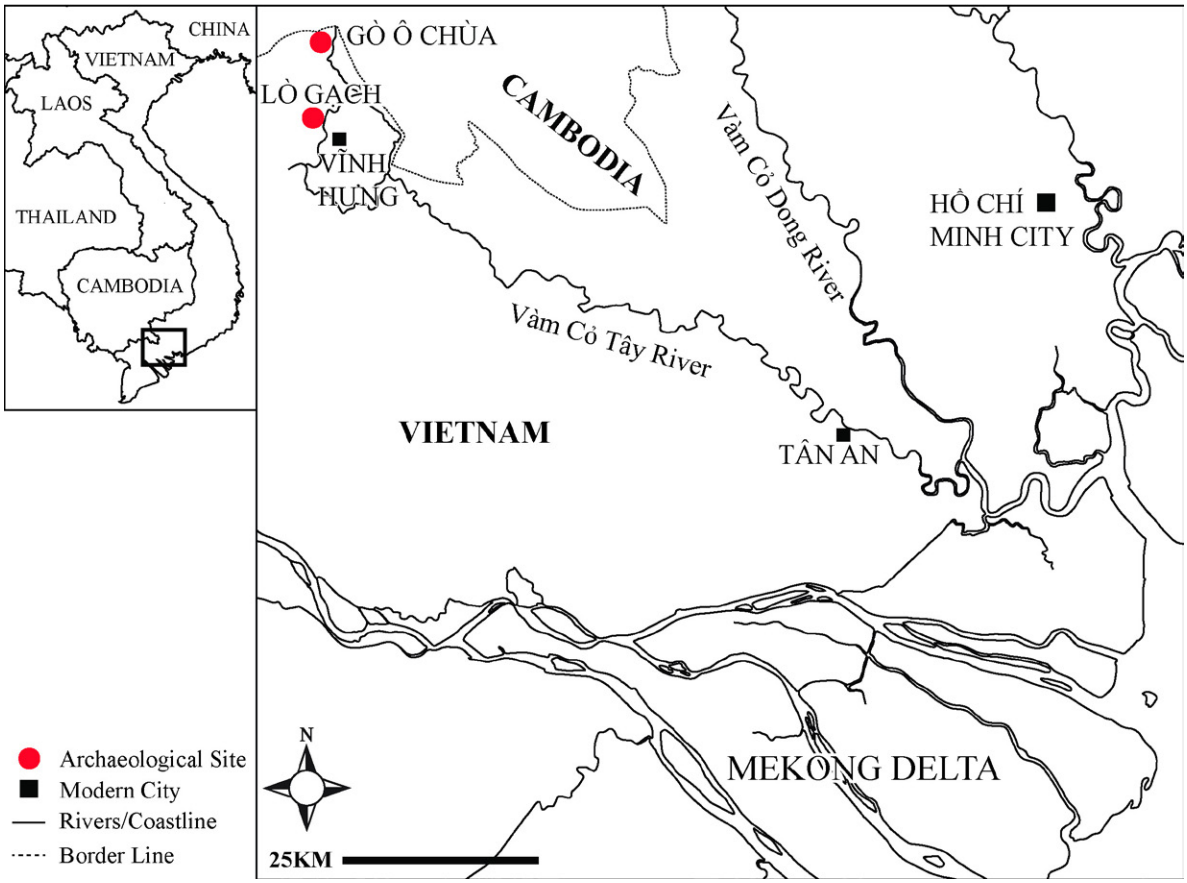

Figure 1. Location of the Gò Ô Chùa and Lò Gạch settlement sites (southern Vietnam). Map, J.R. Hull.

Figure 2. Three specimens of the "informal" (left) and three of the "formal" (right) types of projectile points respectively made of bone and antler recovered at Gò Ô Chùa and Lò Gạch settlement sites (southern Vietnam). Scale subdivision in cm. Photos, J.R. Hull.

Materials Sites	'formal' projectile points	'informal' projectile points	total bone industry
Gò Ô Chùa	21	85[44]	328
Lò Gạch	5	20[7]	241
total	26	105	**569**

Table 1. Identified bone industry of the Gò Ô Chùa and Lò Gạch settlement sites (southern Vietnam), in number of specimens[N: number of intact specimens used in morphometric analysis]. Gò Ô Chùa records 9 catfish spines included as informal points, only 3 at Lò Gạch).

OSSEOUS POINTS

Osseous points are most informative for the two sites. Lò Gạch yielded 131 bone and antler points, of which 26 were classified as 'formal' projectile points based on our observations framed by archaeological approaches to technology (Miller, 2007). At Gò Ô Chùa, 217 points were recovered, of which 106 were classified as projectile heads (Tabl. 1). These points were further categorised into 'formal' and 'informal' points based on systematised morphologies (Andrefsky Jr., 2005; Hull, 2018) attesting to the use of distinct systems in hafting this material otherwise comparable to its ergonomic properties (symmetry, balance). Based on previous research on projectile technology used in hunting (Cattelain, 1997; Cattelain/Perpère, 1993; Knecht, 1997; Pétillon, 2006; Yu, 2006), as well as the breakage patterns and evidence of composite hafting observed on the projectile points of discussion here, allow us to associate them as projectile heads with undetachable hafting systems. The proposed function of which includes: arrow-/spear-heads, leister prongs, and/or pole arms. This osseous material is recorded[1] and results discussed.

Distinct raw materials for different points

Based on the primary examination made on the faunal remains whose analysis is conducted by Trần Thị Kim Quý and Philip J. Piper (ongoing study), the worked osseous material forms only a small subset of the taxonomic diversity observed within the assemblage. The raw material identification is made all the more difficult by the mere fact that the majority of these implements are so completely worked that they remove genuine aspects of the original anatomical element from which they were manufactured. However, based on the general surface aspects of the bone where natural, and the dimensions and cross-sectional profiles in addition to osteological evidence—occurrence of foramen, cancellous bone and/or medullary cavity, and thickness and size of its distinctive cortical tissues (*cf.* Chen *et al.*, 2009; O'Connor, 1987; Vercoutère *et al.*, 2007), it is most likely that main informal projectiles are (limb) bone (large mammals), whilst the other formal projectile points consist of antler (Fig. 2); some of the informal points retain anatomical markers such as foramen and medullar canal, whilst some of the formal points possess the large cross-sectional curvature, distinct thick hard bone ring, and denser cancellous tissue of antler.

Recognised manufacturing techniques

A large part of the two assemblages was identified as the remains of *débitage* allowing the identification of various stages in manufacture, such as the removal of epiphyses from bone and of tine/burr portions from deer antler (Miller, 2007; Pelegrin *et al.*, 1988). Of the manufacturing technology, 'string-sawing' (Lothrop, 1955; Pailler, 2009; Poplin, 1974; Schibler, 2001) was the most prevalent technique at Lò Gạch to remove segments of antler and identified by the smooth aspect of the striations developed on straight cut ends with a strong wave-like pattern (Hull, 2018:Fig. 10); here the "waves" are unidirectional as opposed to concentric, as in the archaeological and experimental ivory examples provided

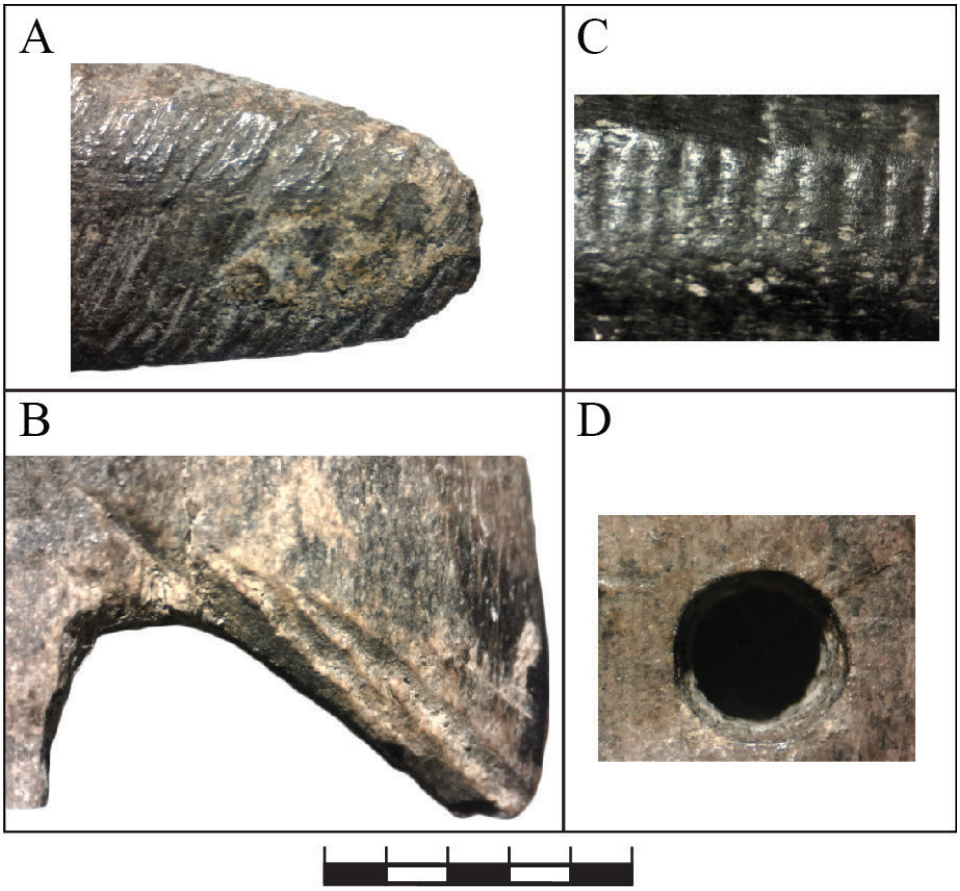

Figure 3. Identified fashioning patterns in attributes from the bone industry of the Gò Ô Chùa and Lò Gạch settlement sites (southern Vietnam). Scale subdivision in mm. Photos, J.R. Hull. A - Surface striations deriving from grinding the basal-end of a pointed implement in an oblique motion (upper view); B - Chatter marks deriving from scraping the osseous material with a cutting edge used in a radial motion (upper view); C - Barbed attribute obtained from carving through the osseous material in a facial-transverse motion (upper view); D - Drilled osseous surface with a metallic-bit used in alternate semi-circular motion (upper view).

by Poplin (1974). In this, the technique would have enabled more precision in the lengths of segments obtained; antler production using this technique might have been developed for standardised production (of formal points, for instance). In this assemblage, other segments of antler indicate they were grooved prior being snapped by flexion creating an even breakage surface; often referred to as the 'groove and snap' procedure (David, 2004; Rabett, 2008). Gò Ô Chùa antler *débitage* is meanwhile dominated by the 'ringing' technique where grooving is concentrically achieved until a flexion break can successfully create an even breakage surface (David, 2004; Wolf *et al.*, 2016). There was, however, very little evidence of string-sawing at Gò Ô Chùa.

For the main shaping phase different technical modes were used to transform the osseous material such as abrasion (grinding, scraping, and drilling techniques) and reduction by shaving (carving or nicking by direct percussion with a cutting edge), (Christidou 2008; David, 2004; Rabett, 2008). In most cases any evidence of shaping are not present on the remainder of the implement due to surface modification through use or taphonomic degradation. The grinding is primarily found on the hafted ends of informal points, possibly doubling as manufacturing technique and as a mode to assist in securing the attachment of a projectile-shaft by providing a parent surface (Fig. 3-A). Chatter marks can be observed on the wings/shoulders of the formal points (Fig. 3-B). Scraping is predominantly found on the working ends of these points also evidenced by chatter marks (*cf.* Rabett, 2008:933) visible underneath use-related polish or wear (Fig. 3-C). Drilling was also a somewhat well

Figure 4. The basal-end of the points whose tip-end has been damaged from use as projectiles has been reduced in either a double bevel (A & B - informal type), a shaved-reduced or truncated (C- informal type – catfish spine) or a tanged shape (D & E- formal types 1 and 2b).
Scale subdivision in cm. Photos, J.R. Hull.

Figure 5. Evidence for the use of fixe-hafting of informal points. Scale subdivision in cm. Photos, J.R. Hull.

used technique (Fig. 3-D), present on only six of the 21 formal points from Gò Ô Chùa and none from Lò Gạch. Given the extremely small size of the holes (~2 mm) and the fine striations associated to the few microscopic scars visible on their very regular inner edge, the perforation technique used a bow drill with a metal drill-bit (*cf.* Christidou, 2008; Nguyen, 1996; Stordeur/Pion, 1993). There also does not appear to be any use wear traces associated with the holes that would indicate they were used to suspend items or in a harpoon-type fashioning (Houmard, 2011; Stordeur-Yédid, 1980); assisting with riveting the projectile to its organic projectile-shaft would perhaps have left no use wear at all in our case.

Although not necessarily observed on all artefacts, another stage is recognised, here perceived as the final sequence in manufacture (Hull, 2018:939); this is the phase in which the implement is finalised as a manufactured and hafted object, including possible resharpening or reusing events. The surface modifications pertaining to hafting concern the grinding striations of the base of the informal points which may be oblique or perpendicular, left rough (Fig. 4-A & B), or shaving along the stem, also left rough (Fig. 4-C & D), eventually to contribute to the 'grip' or the stability of the used hafting or binding system (*cf.* Byrd, 2011, Barton *et al.* 2009; O'Connor *et al.*, 2014). Few artefacts displayed evidence here of adhesive material was used for assisting in the fixation of hafted parts to this kind of points (Fig. 5, frames). One such example (Fig. 5-left) has two distinct layers of residue indicating the bone point was perhaps re-hafted at some stage in its use-life. The second example (Fig. 5-right) only exhibits a single layer of resin, however this does not discount a re-hafting event in its use-life. The kind of breakage patterns at the tip-end considered in conjunction with this hafting procedure enabled the identification of informal projectiles among the pointed implements within the assemblages. Reuse or resharpening of implements was determined by the relative lengths of working ends versus hafted ends, overall length/size and use wear and manufacturing traces (Hull, 2018:942; Pétillon, 2006).

Morphotypes of projectile points

The distinction between formal and informal points lies in the important shaping to erect particular forms from the basal end which occur in the former. Variations in elongated shapes, 'low invested' (Stordeur, 1978) or low transformed, in hafting are commonly encountered in the therefore informal points.

Informal projectile points

The informal points concern the elongated bone products hafted at one end and made symmetrically pointed at the other end with no particular transformation of the used straight bone product in shaping (Fig. 6). This is also the case for the bone points taking advantage of the naturally barbed catfish spines. Identification of these catfish spines as informal projectiles made from rough transformation of the osseous anatomical element is based on evidence for impact damage in combination with an end deliberately regularised into a conical shape for hafting (Fig. 7).

For the straight pointed products, there is not a lot of variation in the observed morphology at either site. Predominantly, the bone points are tapered to a pointed tip, where some have a more bulbous profile, and with very straight lines taper to squared off basal ends for hafting. All have this same singular hafting arrangement, with a double-bevelled base. Three of them have confirmed evidence of added adhesive residue (Fig. 5). There are a further three that show a slight discolouration, and surface texture change transitioning between the hafted end and the shaft/tip end that may indicate the points were originally with part of an organic projectile-shaft still attached (Fig. 6-C). The straight points are oval or u-shaped in cross-section, the latter being the result of the manufacturing process which left the morphology of the medullar cavity relatively visible. However, the majority of the piece is oval in the transverse profile of their mid-shaft. There are a select few that are somewhat triangular in cross-section also. There are a few examples of fine striations on top of the shiny aspect found on the tip ends, however these ends are so thoroughly transformed that very little of the manufacturing evidence is visible. The tip damage (Fig. 6) is heavily dominated at both sites by hinge-bevel, snap, and step fractures to both the tips and ends, as well as crushing (Hull, 2018:942), all typical characteristics of impact with a hard surface at speed (*cf*. Pétillon 2006).

The fracturing patterns are quite interesting with several examples with only the tip, shaft, or hafted end fragments remaining. There are also several examples of mesial hinge-bevel fractures indicating a hard impact that removed approximately half the length of the once-

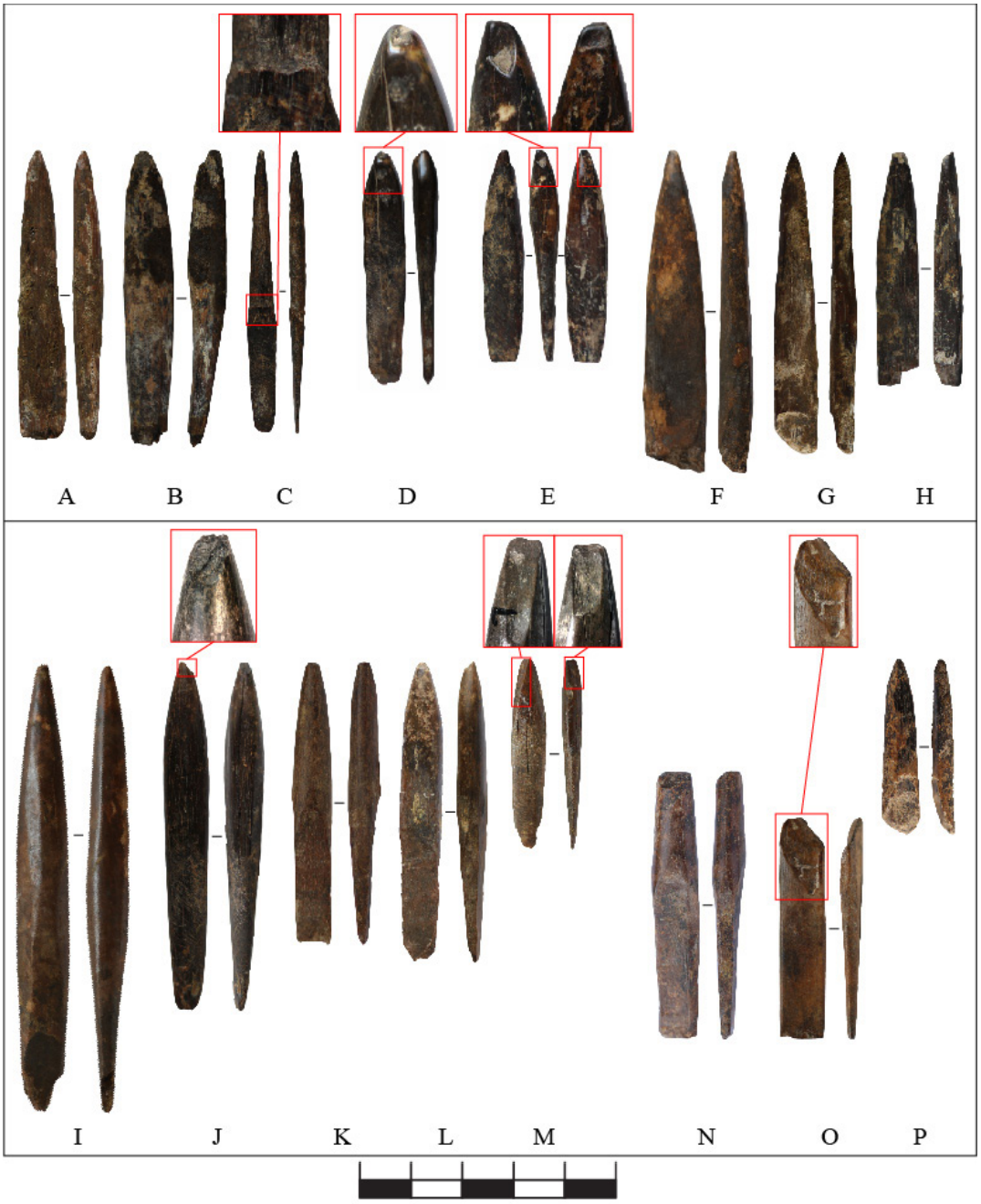

Figure 6. Morphotypes (front and side views) and use-wear of informal projectile points from the Lò Gạch (A to H) and Gò Ô Chùa (I to P). Photos, J.R. Hull.

complete implement (Fig. 6-O & P). However, many more tip-shaft fragments, resharpened complete points, and a surprisingly large number of un-resharpened complete points were recovered also (where a complete implement shows only minor damage). Resharpening and re-use have thus been included as they exhibit fracture patterns and hafting evidence that indicate the informal points were used as undetachable projectile heads, possibly removed and re-attached, or reshaped still attached where continued to be used despite the large decrease in size compared to complete initial ones (Fig. 6-M). The length of the working ends each constituting *circa* one third of the two third remaining with quite a long part then hafted to the shaft of the bone point[2], and striations under and over the worn-out shiny surface covering ancient impact-damages of the tip end, all are consistent with a use as projectile points. Somehow, these bone points would be heavily polished through use with a reiterate manner on slaughtering particular animal game. It cannot be excluded these went

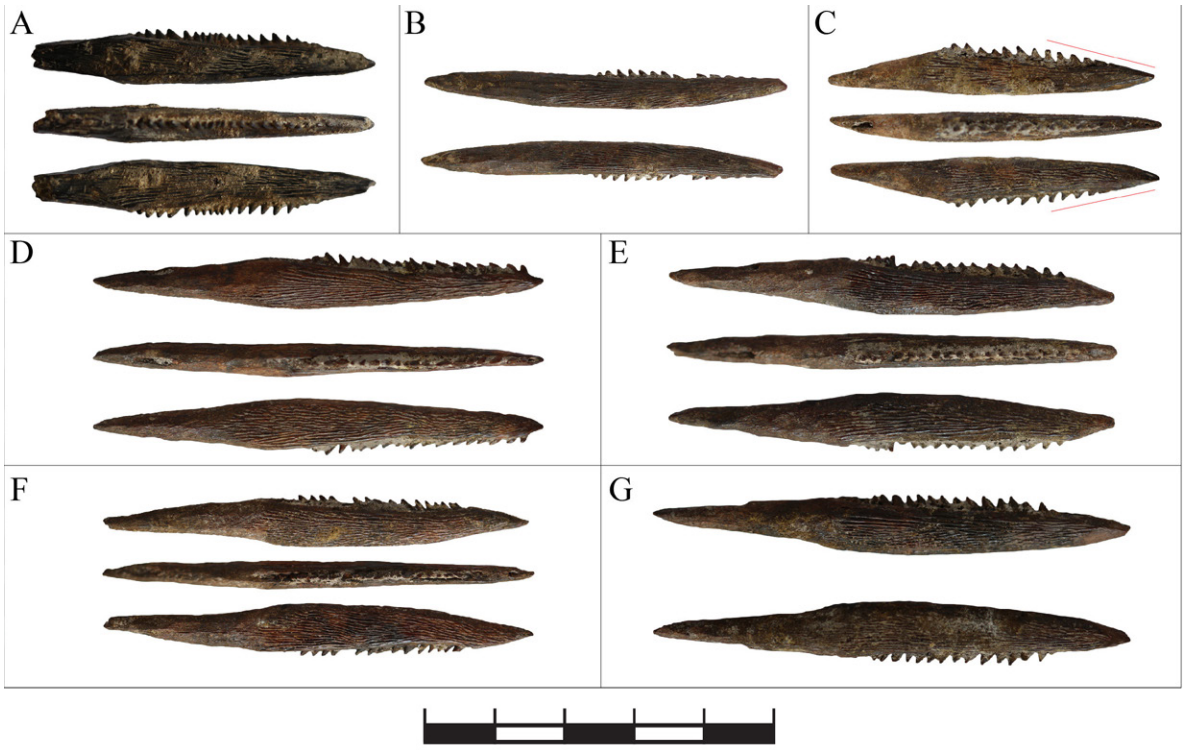

Figure 7. Catfish spines shaved-reduced and/or either facially or laterally, and uni- or bi-truncated at their basal end hafted as projectile points (front and side views) from the Lò Gạch and Gò Ô Chùa. Scale subdivision in cm. Photos, J.R. Hull.

so-abraded in working against an organic and/or abrasive material, however the resultant use-wear would likely appear dissimilar to the points discussed here, if derived from a smooth working action. Another possibility remains in that the particular glossy would have developed from recycling the projectile point for a later functional purpose once broken or no longer able to complete the function for which it was originally intended.

The exception to this damage profile and use-wear pattern are the catfish spines (Fig. 7). These points were identified as projectile points primarily on the evidence of manufacturing retaining the natural unilateral barbs, and the deliberately made (bi)facially thinner and/or or (bi)laterally truncated basal end for an undetachable hafting system. Whilst these catfish spines do not appear to have been hafted as multi-prongs, as archaeological unilateral barbed leister prongs are often interpreted (Barton *et al.*, 2009:1713; David *et al.*, 2015:182), the use-wear here is predominantly minor chipping and a few small hinge bevel-breaks as well as smoothed sides of the working end with round edges along the lateral margins; consistent with use as mono-leister points.

Formal projectile points

The category of formal points consists of two main morphotypes either shouldered, labelled as type 1, or winged as type 2. The specimens of type 1 do not vary greatly between the sites and are mostly straight-shouldered, narrower, and thicker, with a few different variations in the slope of the shoulder-attribute (Fig. 8-A to K). They are also more or less oval, triangular, or rhomboid in cross section. The hafted part of this type is mostly thick rectangular but all specimens of the type 1 points at Lò Gạch have a cylindrical base of their leaf-shaped shaft and a thinly tapered acute tip-end with a triangular cross-section (Fig. 8-I). Damage patterns here are mostly snap fractures to the tip end removing the point entirely, one of these was also snapped at the base. The type 1 from Gò Ô Chùa varies in the straight-shouldered forms with few occurrences of the leaf-shaped form seen at the other site. These all display a variety of dimensions (Appendix 1).

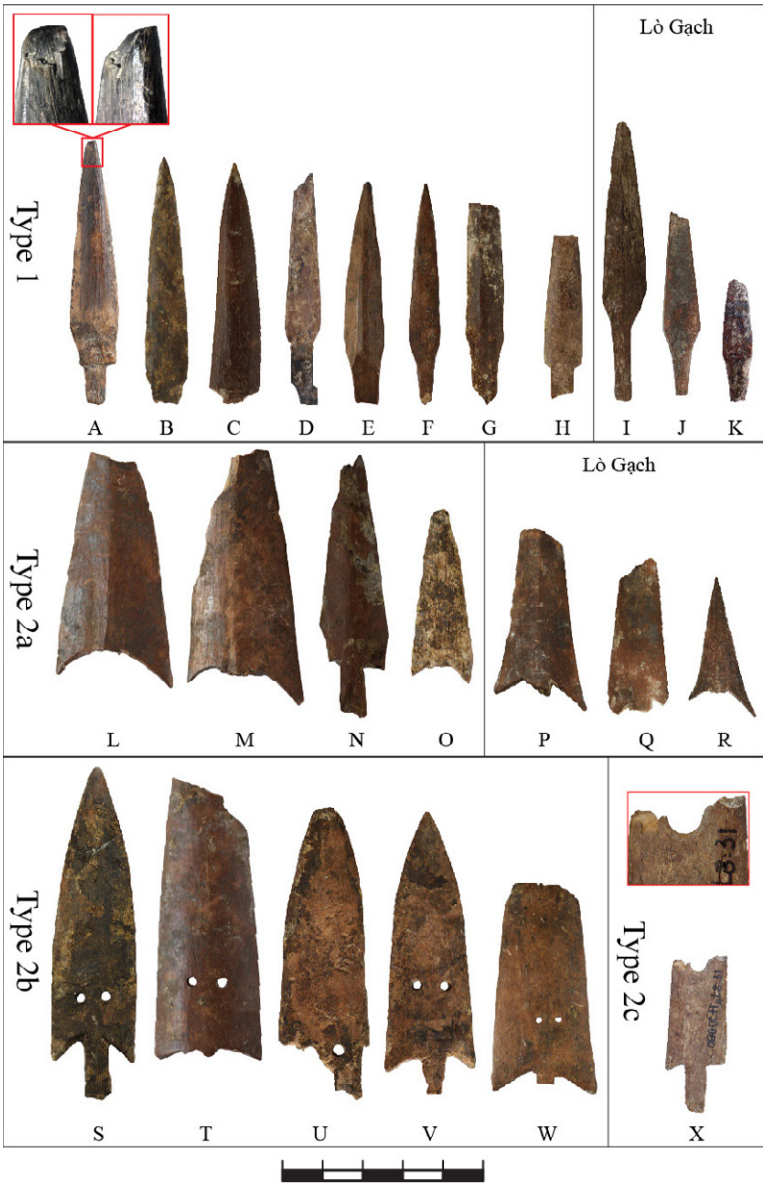

Figure 8. The two main morphotypes of formal projectile points from Gò Ô Chùa and Lò Gạch, each site with its own style (respectively with large straight, L to O, versus more arched curvature of the wings, P to R, in type 2a). Scale subdivision in cm. Photos, J.R. Hull.

There are three variations for type 2 denoted a, b, and c (Fig. 8-L to X). The three variations seen in type 2 have not been delineated into distinctive types as they share many commonalities in their elaborate design. Type 2 consists of large points with symmetrical wings which are fanned, wider before tapering to a point, the shaft is very thin with a curvature in cross-section from the antler beam segment used for manufacture. The points that are most intact have a hafting base with a flat rectangular cross-section (Fig. 8-N, Q, S, V & X). Types 2a and 2b differ only in that the latter possess two parallel perforations; each placed on either side of the un-marked central axis of the point, and roughly one third up the shaft from the hafted end. The single example denoted as type 2c, was classified separately with shorter wings, and a single, much larger, perforation directly along the central axis of the point.

As can be seen in several of the 2a-type from both sites, the wings are always lateralised towards the right side. However, noticeable differences are in the length and shape of the wings which makes them stylistically particular to a site; at Lò Gạch, they are more acute and come to a sharper point than the majority from Gò Ô Chùa (Fig. 8-P & R). They also do not

exhibit as pronounced a curvature in cross-section as those from Gò Ô Chùa likely because they are noticeably smaller in overall dimensions (Appendix 2). The fracture patterns are very similar for both 2a and 2b types; many have recently been damaged, either as a result of excavation or trampling, and where from ancient breakage, a straight perpendicular fracture pattern shows the stem completely snap off from impact. The comparable 2a examples are slightly more angular from wing to tip, whereas 2b series, although only occurring at Gò Ô Chùa, have almost straight parallel sides to the shaft before tapering to a point. There is also evidence of oblique or perpendicular fracturing removing the majority of the tip. Despite the microscopic analysis undertaken, use-wear analysis was hindered by several of the points being refit after excavation.

Possible functional attributions

Both the informal and formal categories of projectile points show typical impact-damage of tip and basal ends regardless if these parts were derived from low transformed or completely manufactured shapes. The form of these basal ends resulted in different hafting systems and/or attachment procedures using peculiar know-how (undetachable, with or without adhesive; riveting) to firmly attach the bone point to the organic projectile-shaft that was not found preserved in the archaeological material (*cf.* Stordeur, 1987). Consecutively, both the formal (antler) and informal (bone) types were hafted with their basal-end attached to the projectile-shaft along the main axis of the point in a perennial way. The only evidence of the use of adhesive material to assist in the hafting system was on the informal points, which may imply the use of a binding system (Hull, 2018:941). The used catfish spines here are understood as separate to the rest of the informal points in that their use-wear traces appear more singular. With little to no impact damage observed, and some rounding and abrasive effects would signify interaction with water and impacting abrasive materials when used as a fishing mono-leister prong (Barton *et al.*, 2009; Zhilin, 2017). In contrast, the many points within the main assemblage of informal points have a highly shiny surface which is not commonly seen on projectile points, this may have resulted from repeated contact with taxa whose skin/fur was particularly abrasive. These were used as hand-propelled spears or pole arms, perhaps for the slaughtering of arboreal fauna, if not fisch, such as the macaque, or trapped large species such as suids and other large animal game, which are known targeted taxa in the region (Piper/Rabett, 2009; Wedage *et al.*, 2019). Also, these 'low invested' informal points coupled with the more crushed and "glossy" aspects, as opposed to the formal points, is an indication of their increased durability (Anderson, 2010; Guthrie, 1983). Similar morphotypes to the informal projectiles discussed here are present at many sites throughout Southeast Asia (Mainland and Island), in particular Lobang Hangus (*circa* 32,000-1,500 BP) and Gua Kechil, Malaysia (5457±967 BP), (Barton *et al.*, 2009; Dunn, 1964). The catfish spines also resemble used stingray spines recovered from Niah Cave in Borneo (Barton *et al.*, 2009) and Khok Phanom Di (3,560±80-3,280±140 BP) in Thailand (Higham, 1993).

Observations made from the type 1 formal points place them, in principle, in another category; some of them show the same low degree of transformation and similar impact-damage patterns as the informal points; most likely as arrowheads as their stem was made shorter as compared to the point's body, as to gain the right balance for a propelled mode (weight of the point between one third where hafted and, two third, where not -*cf.* Cattelain, 1997). The major difference lies in this partitioning of the point in which the different parts were shaped and dimensioned accordingly, with a certain weight (Tabl. 2 & 3) designating to us the use of a particular hafting system or material. The type 1 formal points possess marked shoulders so that the stem would firmly fit in a type of (organic) projectile-shaft, the dimensions of which would always directly correspond therefore rendering the use of adhesive material unnecessary. More than shape, weight and dimensions are contributing factors to how the projectiles are propelled [3]: in principle, smaller and lighter for bow-propulsion *versus* larger and heavier for thrusting-types like spears, included here mono-

Sites Data	Lò Gạch [N=7]			Gò Ô Chùa [N=44]		
average dimensions (in millimetres)	length	width	thick	length	width	thick
	56.80	7.50	5.26	63.28	8.38	5.83
average weight (in grams)	2.64			3.50		

Table 2. Summary table comparing the average dimensions and weight for the "informal" points[N: number of intact specimens measured] between Lò Gạch and Gò Ô Chùa (southern Vietnam).

Sites Data	Lò Gạch [N=3]			Gò Ô Chùa [N=7]		
average dimensions (in millimetres)	length	width	thick	length	width	thick
	48.05	9.52	4.61	56.68	10.95	4.35
average weight (in grams)	2.45			2.60		

Table 3. Summary table comparing the average dimensions and weight for the "formal points of type 1[N: number of intact specimens measured] between Lò Gạch and Gò Ô Chùa (southern Vietnam).

leister prongs and/or pole arms. Based on the observed patterns and qualifications on average, it would place the formal types in the bow-propelled category and the informal in thrusting (Cattelain, 1997; Yu, 2006). The type 2 formal points with a flat rectangular stem and no presence of resins being more fragile, as evidenced by the breakage (both modern and ancient) as well as the lack of similar glossed use-wear, suggests they would make ideal projectile heads for short-term or even single use, thus in line with bow-hunting. This being said, the examples from Gò Ô Chùa are slightly longer and heavier than the specimens from Lò Gạch (Tabl. 4 & 5), making them also suitable to a thrusting mode as specific pole arms for instance. Alternatively, differences in weight/size in the single type-2 could suggest distinct devices in a propelled-mode, such as monoxyl bow *versus* composite or (proto)crossbows (with non-mechanical system -*cf.* Roth, 1992). The stylistic variation evoked above is also distinct between the sites; Lò Gạch with narrow arched style *versus* the Gò Ô Chùa large curved style.

Osseous morphotypes resembling the formal projectile points presented here have been found at Arku Cave in the Philippines (2460±80 BP), at Gua Kechil, Malaysia (5457±967 BP), and at Ban Kao in western Thailand (*circa* 3,720 BP), (Dunn, 1964; Olsen/Glover, 2004; Thiel, 1986). Composite bows made from wood, horn, sinew, and bone plates are known from burials at the cemetery site of Shombuuziin-belchir (southwestern Mongolia), which dates to the 3rd century BC (Miller *et al*., 2009; Reisinger, 2010:55). More generally, archaeological evidence of projectile technology is known throughout Southeast Asia dating as early as 45,000 years ago (Barker *et al*., 2007; Barton *et al*., 2009; Pawlik/Piper, 2018; Rabett/Piper, 2012) and linguistic studies of Southeast Asia identify in the vocabulary of proto-Austronesian languages that the bow and arrow was in use. This in combination with archaeological evidence, could place bow hunting in Taiwan *circa* 3,500 BC, and in southern Vietnam by *circa* 2,500-1,500 BC (Bellwood, 2007 & 2017; Blust, 1996).

Sites **Data**	**Lò Gạch [N=3]**			**Gò Ô Chùa [N=3]**		
average dimensions (in millimetres)	length	width	thick	length	width	thick
	40.43	18.94	3.77	55.83	24.81	5.37
average weight (in grams)	1.93			4.90		

Table 4. Summary table comparing the average dimensions and weight for "formal" points of type 2a[N: number of intact specimens measured] between Lò Gạch and Gò Ô Chùa (southern Vietnam).

Sites **Data**	**Gò Ô Chùa [N=3]**		
average dimensions (in millimetres)	length	width	thick
	75.44	22.42	3.83
average weight (in grams)	6.27		

Table 5. Summary table with the average dimensions and weight for the "formal" points of type 2b[N: number of intact specimens measured] at Gò Ô Chùa (southern Vietnam).

CONCLUSION

Regardless of the considered categories of bone points—formal antler (entirely manufactured) and informal bone (low invested elongated points)—, all are projectile heads with undetachable hafting systems. The informal points record several variations with straight shafts, hafted with possible use of adhesive material, naturally-indented anatomical elements used as points and less transformed specimens in manufacture, they also display a consistency in the way their tip-end was being impacted (damaged) and 'polished' through use (shiny/glossy aspect) as hunting and/or fishing equipment employed in thrusting-mode. In contrast, the formal points with discernible properties for bow propulsion appear elaborate in the two principal types of tanged points with shoulders (type 1) or with wings (type 2) most likely used as arrowheads and whose distinct styles also differ between the sites as to the kind of device used—monoxyl bow? composite bow? *versus* crossbow?; particularly elongated leaf-shaped shoulder and narrow-arched wings and same orientation in the main curvature which also relates to the original antler material genuinely shaped with the probable use of silica-based materials for the lighter specimens at Lò Gạch *versus* other techniques for the heavier, sometimes perforated, implements at Gò Ô Chùa.

The recorded morphotypes may well have been used in a variety of circumstances—fishing, and hunting arboreal and terrestrial prey—but outstanding purposes such as weapons for parade or war cannot be excluded so far as the type 2 points display none or single use only. As far as practicing shooting with differently assembled osseous points is concerned, there was obviously a well organised manufacturing process with preferential selection of raw materials and techniques, as well as skilled craftspeople and hunters at both of these sites. This indicates a diversified economy and a complex-organised social structure so that the very diverse functional purposes in equipment used as arrows, leisters, spears and/or pole arms are recorded from a single site. With similarities expected in the morphotypes, particular the formal points in the broader region (*e.g.* Thailand), there was possibly a network of trade/exchange for the completed implements or acquiring the

manufacturing know-how. Further investigations are required, notably to bring a better understanding of the spatial distributions and inner chronology of the sites, and to discover whether the observed differences in shape, use and skills required in the production of these projectile points might be strictly contemporary or would only register in certain sites or cultural horizons.

NOTES

[1] All of the photographs were taken with a Canon 700D, with a Canon EF 100mm f/2.8 Macro USM lens, the microscopy work and photos were taken with a Dibo-Eye AM4023CT USB C-Mount microscope camera.

[2] Of the 51 intact informal projectiles at both sites, there was an average full length of 62.39 mm. The average relative lengths for the 47 un-resharpened informal projectiles, the tip and hafted ends were 37.90 and 26.84 mm respectively. They ranged from 14.91 to 107.09 mm for the length of the tip part and 12.50 to 41.72mm for the length of the hafted part. The four resharpened informal projectiles had an average of 14.01 and 25.09 mm for their tip and hafted ends respectively. The tip ends ranged in length from 11.46 to 18.01 mm and the hafted ends ranged from 17.13 to 30.71 mm.

[3] According to recorded ethnographic hunting spear- and arrowheads, the lengths of hand-thrust projectile points (spears) vary from 8 cm to 460 cm (including the organic projectile-shaft and additional materials as adhesive and ornaments), but more tend to be 140/300 cm, their weights ranging from 50 to 600 g. Arrows, for a (long) bow-propelled system were divided into two distinct groups: the first ranges in length from 42 to 110 cm and weight to between 15 g and 30/40 g; the second group with 10/210 cm in length and weight to between 35 g and 88 g. The average lengths of bone points in Inuit and Mexican contexts range from 4 cm to 40 cm for thrusting implements and 7/24.5 cm for bow-propelled (Cattelain, 1997). However, *"the multiplicity of[contradictory] examples (…) clearly show that any generalization of a "tendency" would be abusive"* (Cattelain, 1997:20).

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RÉSUMÉ

ARMEMENT EN OS DE LA PRÉHISTOIRE TARDIVE DU SUD VIETNAM

Des analyses complètes d'instruments osseux issus des contextes les plus récents de l'Holocène en Asie du Sud-Est sont encore en train d'émerger, d'où un grand potentiel à développer des cadres de recherche propres à cette zone géographique sur les technologies de l'os. Cela est particulièrement vrai de l'Holocène préhistorique où il n'y a eu presque aucune recherche menée sur la diversité des gammes d'outils osseux tels que retrouvés dans les fouilles archéologiques. Dans ce projet de doctorat, des artéfacts pointus en os et en bois de cervidé portant des traces évidentes de fabrication et d'usure provenant de deux sites d'habitats fouillés dans le sud du Vietnam sont discutés. L'analyse révèle des endommagements d'impacts qui suggèrent une utilisation comme pointes de projectile, mais ils semblent recouvrir une variété de formes et éventuellement de fonctions. Certaines de ces pointes auraient exigé un haut niveau de compétence technique pour être produites, et certaines étaient même assez élaborées, comme si elles avaient été conçues pour servir un but exceptionnel, au IIe millénaire BP.

sites	inv. n°	length	width	thick	grams
Lò Gạch	05LG-T-63	57,37	9,69	6,98	4,40
	05LG-T-70	55,07	5,77	3,23	1,00
	05LG-T-85	60,49	8,88	6,22	3,90
	05LG-T-98	57,23	9,56	6,12	3,40
	05LG-T-105	67,27	6,54	4,78	2,40
	05LG-T-114	56,52	6,19	5,39	1,80
	14LG-T-52	49,94	7,90	5,53	1,90
Gò Ô Chùa	97GOC-T-3	61,90	10,32	5,10	3,00
	05GOC-T-3	49,02	8,69	5,53	2,30
	05GOC-T-5	32,66	4,34	2,90	0,40
	05GOC-T-7	58,24	10,36	4,59	3,70
	05GOC-T-31	70,05	9,33	6,36	4,60
	06GOC-T-1	140,48	9,43	6,99	11,70
	06GOC-T-10	79,25	11,94	10,06	3,80
	06GOC-T-16	49,45	3,37	3,05	0,70
	06GOC-T-55	94,26	10,55	8,46	10,80
	06GOC-T-62	49,76	7,38	4,13	1,40
	08GOC-T-45	74,27	10,16	5,37	5,80
	08GOC-T-48	65,56	8,71	6,33	3,50
	08GOC-T-64	55,05	7,80	6,47	3,10
	08GOC-T-65	63,25	7,79	4,23	2,20
	08GOC-T-74	70,36	10,98	4,63	3,40
	08GOC-T-75	60,86	5,38	4,38	1,80
	08GOC-T-118	72,07	9,38	7,34	5,70
	08GOC-T-121	*60,46*	*7,64*	*3,66*	*1,60*
	08GOC-T-122	*62,97*	*7,72*	*5,03*	*2,40*
	08GOC-T-123	*54,18*	*6,65*	*4,05*	*1,40*
	08GOC-T-124	*67,52*	*8,44*	*5,10*	*2,60*
	08GOC-T-125	*63,74*	*7,62*	*4,47*	*1,90*
	08GOC-T-126	*51,75*	*5,85*	*3,72*	*1,20*
	08GOC-T-148	44,30	5,42	4,87	1,20
	08GOC-T-172	*46,85*	*7,23*	*4,18*	*1,10*
	08GOC-T-174	37,15	6,84	4,16	1,10
	08GOC-T-197	*53,23*	*5,96*	*4,44*	*1,30*
	08GOC-T-207	49,06	6,08	5,08	1,70
	08GOC-T-213	*51,37*	*5,87*	*3,46*	*1,00*
	08GOC-T-232	30,27	5,81	4,08	0,70
	08GOC-T-238	69,60	6,72	6,23	4,20
	08GOC-T-239	57,46	7,98	5,48	2,80
minimum		30,27	3,37	2,90	0,40
maximum		140,48	11,94	10,06	11,70
average		60,26	7,75	5,18	2,89
standard deviation		17,98	1,95	1,48	2,39

**Catfish Spines* / All dimensions, in mm

sites	inv. n°	type	length	width	thick	grams
Lò Gạch	05LG-T-111	1	45,47	9,17	3,81	2,20
	05LG-T-122	1	69,18	11,38	4,52	2,90
	14LG-T-78	1	29,50	8,00	5,50	2,25
	05LG-T-110	2a	39,89	15,38	2,90	1,70
	05LG-T-113	2a	45,85	23,86	5,04	3,30
	14LG-T-21	2a	35,54	17,59	3,37	0,80
Gò Ô Chùa	05GOC-T-18	1	65,27	11,91	5,07	4,20
	08GOC-T-15	1	57,09	8,98	3,56	2,10
	08GOC-T-17	1	59,25	12,28	5,50	4,30
	08GOC-T-66	1	38,21	7,29	3,47	0,80
	08GOC-T-159	1	60,83	10,64	3,77	2,80
	08GOC-T-199	1	57,63	11,54	4,54	2,80
	08GOC-T-214	1	65,28	17,44	4,40	3,40
	08GOC-T-224	1	54,67	9,92	6,73	3,00
	08GOC-T-228	1	54,85	7,93	2,50	1,20
	08GOC-T-94	2a	61,34	30,06	4,90	4,90
	08GOC-T-95	2a	63,11	29,65	6,53	7,00
	08GOC-T-231	2a	43,04	14,73	4,68	2,80
	08GOC-T-22	2b	18,89	5,84	2,99	0,20
	08GOC-T-31	2b	44,99	13,00	6,27	3,40
	08GOC-T-32	2b	39,24	8,58	4,85	1,70
	08GOC-T-153	2b	74,40	26,44	6,74	7,50
	08GOC-T-216	2b	52,12	26,29	2,95	4,40
minimum			18,89	5,84	2,50	0,20
maximum			74,40	30,06	6,74	7,50
average			51,11	14,69	4,55	3,03
standart deviation			13,70	7,49	1,27	1,80
All dimensions, in mm						

Appendix 2