Written in Bones

Studies on technological and social contexts of past faunal skeletal remains

edited by
Justyna Baron
Bernadeta Kufel-Diakowska

Uniwersytet Wrocławski
Instytut Archeologii

Wrocław 2011

INSTITUTE OF ARCHAEOLOGY, UNIVERSITY OF WROCŁAW, 2011

Editors
Justyna Baron and Bernadeta Kufel-Diakowska

Reviewers
Arkadiusz Marciniak, Jarosław Wilczyński

Layout
Janusz M. Szafran, Jarosław Michalak

Cover
Justyna Baron

ISBN 978-83-61416-64-7

Wrocławska Drukarnia Naukowa PAN im. Stanisława Kulczyńskiego Sp. z o.o.
53-505 Wrocław, ul. Lelewela 4

Contents

Social contexts

Preface

Most of the papers in this book are proceedings presented as contributions, both presentations and posters, at the 7th meeting of the Worked Bone Research Group in September 2009 in Wrocław. In total, the presented volume contains 22 papers by 30 authors from 12 countries: Austria, Estonia, France, Germany, Great Britain, Hungary, Netherlands, Poland, Romania, Serbia, Spain and USA.

Owing to a great variety of presented issues, both from temporal and thematic perspectives, we decided to divide the papers into several sections. The list of papers starts with two referring to methods in studying and interpreting specific types of artefacts (S. Ashby) and to usefulness of modern ethnographic collections in studying bone tools from the past (E. Stone). The next section contains the most numerous papers which can be generally called material studies including single finds, complete assemblages or certain type of artefacts obtained from particular sites or regions. Regarding the chronological interests of the authors, the papers present collections dated to the Palaeolithic (A. Averbouh and J.-M. Pétillon, B. Avezuela *et alli*), the Mesolithic (B. Marquebielle, S. Pratsch, M. Diakowski), the Neolithic (S. Vitezović), various stages of the Bronze Age (E. Gál, P. Morgenstern), the Roman period (K. Struckmeyer, C. Beldiman *et alli*) and the Middle Ages (M. Rijkelijhuizen). In two papers authors present unique finds dated to the modern period, including whale bone and elephant ivory (H. Küchelmann, M. Rijkelijhuizen). In the same section some comments on use-wear analysis observed on flint artefacts used for bone and antler working were added (B. Kufel-Diakowska).

This part is followed by several papers focusing on social contexts of production and deposition of selected bone and antler assemblages. Again, as the papers focus on various archaeological periods, they were arranged according to their chronological attribution, starting from the Chalcolithic (C. Oleniuc and L. Bejenaru), the Neolithic/Bronze Age (H. Luik *et alli*), Bronze Age (M. Altamirano), the Roman Iron Age (J. Baron, F. Lang) and the Middle Ages (M. Konczewska, K. Pawłowska).

Acknowledgements

First and foremost we would like to thank all the authors who contributed to this volume for their effective co-operation and their infinite patience in answering all our emails. We would also like to take this opportunity to thank our colleagues and students who helped us to organise the meeting two years ago.

Steven P. Ashby, Alice M. Choyke, Alex Pluskowski, David Smith and Elisabeth A. Stone and a number of other colleagues mentioned in individual texts kindly proofread the English language version of the contributions to the present volume. Thank you.

Special thanks are also due to Alice M. Choyke for her help and advice on various stages of making this book as it was being edited.

Both the conference and the publication were possible with the financial support of our home institution i.e. Institute of Archaeology, University of Wrocław, and we would like to thank Jerzy Piekalski, the head of the Institute, for his enthusiasm for this project.

Methods and methodology

Steven P. Ashby

The Language of the Combmaker: interpreting complexity in Viking-Age Industry

Composite combs are among the most well known of early medieval bone/antler artefacts. They are well-studied in descriptive terms, with much already published on typology, chronology, manufacture and exchange. However, less time has been devoted to the attempt to understand their meaningful role in social action. It is herein argued that there is a pressing need to ask new questions of our material, to explore the potential of novel analytical techniques, and to utilise a range of conceptual and theoretical apparatus. Using examples from early medieval northern Britain, I propose a new framework for the study of variation in form, ornament, and means of manufacture, and suggest that language provides a useful analogy that may have some methodological utility.

Keywords: comb, antler-working, Viking, manufacture, ornament, morphology

This is a paper about boneworking. However, it does not relate the development of analytical techniques particular to the canon of material culture produced in skeletal materials. Neither is its aim to illustrate the application of method (be it zooarchaeological, technological, typological, or traceological). Such work has been ably undertaken and communicated elsewhere in the present volume, and my aim is different.

I strongly believe that worked-bone research belongs within the mainstream of material culture studies (that is, the project of archaeology). That is not to suggest that its faunal foundations be overlooked; a detailed understanding of animal anatomy (and, I would argue, ethology) is fundamental to the analysis and interpretation of objects of worked bone. But so is its artefactual basis. Bone awls, axes, picks, pins, combs, and caskets are all *objects,* and as such are as fundamentally cultural material as they are biological (if, indeed, any distinction is possible; see Ingold 2000). This is a simple point, but one that is often overlooked, as we have sought to redirect the treatment of worked-bone collections back toward the animals from whence they came. What is needed, rather than an effort to 'balance' the influence of zooarchaeological and artefactual approaches, is a commitment that objects of worked bone be analysed within a coherent methodological and theoretical framework that renders the resultant data and interpretation compatible with that resulting from equivalent studies of other forms of material culture (Miller 2007). Such an approach must appreciate the significance of the zoological content of these objects; it is their *animality* that is significant, rather than merely their materiality (see Ingold 2007; Conneller 2011). Within this broad theoretical context, there are multiple ways of looking at worked bone. Herein I propose just one.

Language and Material Culture

In what follows, I explore the utility of what might be broadly termed a linguistic approach to understanding the manufacture and use of early medieval bone and antler hair combs. The bringing together of language and material culture is an interesting idea both intellectually and practically. Today, we use objects as well as oral and written language to communicate with one another, different media being used in different ways, for different purposes. Although it has faded from popularity in the field of social anthropology (compare Moore 1985; Ingold 2000), and (interestingly) has failed to take a firm hold in medieval and historical archaeology, the idea of material culture as language has remained popular in prehistoric archaeology and, through conceptual borrowings from semantics and rhetoric, is finding increasingly frequent applications as a useful way of interpreting phenomena as diverse as stone tools and landscape (Shanks, Tilley 1987:133; Tilley 1991, 1999; Pluciennik 2002). In this paper, I intend to experiment a little with this idea. My medium is the composite antler hair comb.

Why a Linguistic Approach? Why Now?

It is, of course, rather less than novel to raise the potential similarities of language and material culture (*cf.* Lévi-Strauss 1963 [1958], Peirce 1958, de Saussure 1983 [1972]; see also work on archaeology as 'text', *e.g.* Hodder 1989a, 1989b, 1991, Moore 1985). Though far from reaching universal acceptance, Hodder's 'con*text*ual' model has been widely adopted, and has in many ways inspired the production of other post-processual approaches that incorporate linguistic constructions (see Buchli 2000; Preucel 2006: 8-14, Shanks, Tilley 1987:133; though see Nash 1997; Nash, Children 2008). Indeed, linguistic and literary ideas like metaphor and synecdoche – once *avant garde* and revelatory – are now commonplace in the archaeological literature of landscape (see Hodder 1993; Tilley 1999, 2004; though see Fleming 2006 for a critical review). While it is erroneous to equate the ways in which material culture and language behave and operate, the one *can* act as an instructive analogy for the understanding and interpretation of the other, and it is this spirit that I intend to adopt and apply to the study of portable material culture. While what I am suggesting is more than metaphor, there is no suggestion here that objects, their manufacture or use are governed by close material corollaries of the syntactic or pragmatic rules that make up linguistic grammar. Rather, I propose that a critical awareness of the techniques we use in verbal communication may help us to think about the meaningful matter from which material culture is constituted.

How can such theoretical abstractions elucidate an analysis of bone-artefact manufacture and use? A useful lead may be taken from the work of Tim Ingold (2000). Though Ingold himself would not propose such a linguistic approach to social study, his work does provide a context in which we might situate the superficially discrete subjects of bonework and language. Following Ingold, craftsmanship develops through a process of *enskillment*, wherein an artisan learns the techniques of their craft through guided introduction to the materials and practices involved in manufacture. Apprenticeship is thus undertaken within the environment, and through engagement with it, rather than through the generational imparting of traditional knowledge. This idea is relatively easily appreciated in the case of bone industry, given its reliance on a material that is conventionally understood as the quarry of environmental archaeologists. However, the same might be said of the way an individual goes about their daily life, 'dwelling' in the world. In both cases, people learn 'the rules of the game' (after Bourdieu) through interaction with their environment, rather than through the direct reception of ideas from other human parties.

Language is vital in enabling us to 'dwell' in this way. Ingold prefers to think of speech as a form of 'singing'; a process that is fundamentally performative, and he argues for direct equivalence between the acts of playing a musical instrument, manufacturing an object, and using a tool (Ingold 2000:406-419). Thus, it can be seen that there is commonality of experience in the acts of speech, and of making and using material culture. If this is the case, then it should be possible to use what we know of the ways in which language works, to illuminate discussions of the uses of material culture (in our case, objects of worked bone). In what follows, I explore this issue, with particular regard to the early-medieval hair comb, though it should be noted that a similar approach could be applied to the study of a range of elements of worked bone technology, or to other forms of material culture.

Language and Combs

Composite combs are relatively common finds from early-medieval urban sites, and represent one of the best-studied classes of bone/antler artefacts. Indeed, much has been written – by myself and others – about their typology, dating, and, to a lesser extent, their raw materials and means of distribution (*e.g.* Ambrosiani 1981; Ashby 2005a, 2005b, 2006, 2009, in press a, in press b; Smirnova 2005; Vretemark 1989, 1997; Wiberg 1977, 1987). However, less attention has been paid to their style, social significance, or biographies, though a few examples of recent work provide ambitious exceptions (Clarke, Heald 2002; Luik 2008). If the field is to progress, we need to ask novel questions of our material, and explore alternative methods of analysis.

The rationale for the approach taken herein is a hope that it might engender a better understanding of the interface between material culture and the structure, boundaries and cues of society. Following anthropologists such as Polly Weissner (1983), a single object may simultaneously transmit elements of both group and individual identity, and many researchers have consequently experienced difficulty in developing predictive models for the recognition of meaningful artefactual style. A linguistic metaphor might work well in this scenario, but first it is well to consider the means by which combs in particular may have transmitted stylistic or social information.

As has been discussed elsewhere (*e.g.* Ashby 2009:9-10; Sorrell 1996), early medieval combs could be used as gifts in reciprocal relations of exchange, and as such became bound up in networks of power, kinship, alliance and allegiance. This is important, as such an arrangement implies the investing of significance in the comb on the part of the gift giver, prior to it even reaching its intended recipient. On changing hands, the comb's meaning would undergo a perceptible transformation: its original message of allegiance and support would have been retained (at least in the mind of its new owner), but would then be overlain with a more general statement of status and group membership, a message that could be perceived by any 'literate' observer. In this way, the biography of the comb becomes entangled with those of all the agents involved in its manufacture, exchange, use, and display. For meaning to be transmitted to such a range of actors, we might assume that the 'language' expressed via the comb was readily understood, at least within its particular context.

However, in Viking-Age towns like York or Lincoln, we might expect that the majority of combs were produced – if not *en masse* – at least in advance of the appearance of a potential purchaser. Though the consumer still ultimately had the power to select a comb for purchase, the range of forms and designs from which they could choose was controlled by the decisions, preferences, and skills of the combmaker. The curation and continued use of outdated combs represents a more active decision, and surely has social meaning, perhaps referring back to ancestors or memories and traditions, in an effort to legitimise status or other aspects of social identity. In addition to this 'inherited' identity, inscriptions and graffitti facilitated communication on a more personal – though not necessarily idiosyncratic – level. However, in contrast to what we see in Scandinavia (Tesch 1987, Fig. 8), combs featuring such deliberate modification (particularly literate inscription) are poorly represented in the British Isles; examples from Nassington (Okasha 1999), Whitby (Page 1973:168) and Dublin (Barnes *et al*. 1997:44-45) constitute notable early medieval exceptions.

Thus, any search for meaning must take as its quarry more frequently recorded aspects of comb morphology, and this is an approach that must be explicitly theorised. A fundamental component of the nature of discourse is the 'field' in which it takes place (Barrett 1988), and it is now a truism to state the importance of an understanding of the social contexts within which combs could be used to express identity (see Jones 1997). We will come to this later, but equally important is some form of analogical framework that models the means by which such communication is articulated. It is here that the linguistic metaphor holds such interpretative power.

Language functions on a range of scales. When a person speaks, we recognise not just the words they use, but unconsciously note their language, their familiarity with it, their wordchoice, their accent, their dialect. That is to say that we note not just *what* is said, but also *how* it is said (see Preucel 2006; Ingold 2000:399-401). This provides a powerful analogy for the ways in which material culture is used to communicate: some themes are screamed out in form and ornament, others are more understated. Familiarity with a medium may allow us to detect subtle discordances between decoration and morphology, or between method and quality of manufacture, and thus identify imitation and poor craftsmanship. Moreover, local differences in manufacturing practice - perhaps unnoticed by the users or even the makers of objects – may be envisioned in terms of a local dialect, and as such may be archaeologically informative as indicators of regionality, displacement, and culture contact.

If one accepts the validity of the linguistic analogy in outline, it remains to discuss in detail its applicability to elements of material culture. In the words that follow, I will investigate some of the ideas outlined above, and endeavour to usefully apply them to the study of composite combs from early-medieval Europe. Combs from the Viking Age in particular have often been considered homogeneous across their European range (Ambrosiani 1981).

On inspection, subtle variation is apparent, but has generally been missed, ignored, or explained away as anomalous (see Ashby 2006). I hope that a more fine-grained analysis, coupled with this novel approach, might render such complex patterning comprehensible and meaningful.

Language and Form

One might expect the more regularly recurring elements of comb form and ornament to be widely understood, and they may well have related to particular social groups. Thus, overall morphology and ornamental techniques that show limited variability may be seen as transmitters of emblemic, group-associated style, and within the linguistic framework are directly paralleled by spoken language. The degree to which comb forms were intelligible between geographically disparate regions says something significant about contact between such regions, though of course we cannot assume that shared phenomena have shared meanings. If we accept that types are something other than direct representatives of the cultures that created them, then there is a need for a more sophisticated way of rationalising spatial patterning, and a language-based model is one solution.

Figure 1 outlines the (greatly simplified) distributions of certain comb forms in the British Isles and Scandinavia. Certain forms are clearly much more common in certain areas. But of course combs are not people; these patterns are simply illustrative of networks of travel and trade, and their corollaries: communication and innovation. In our linguistic terms, the ways in which different forms are understood by different groups, societies, and demographics are easily expressed in terms of the spread of languages. Just as written and verbal language may be transferred from one region to another through conquest or colonisation, or from one group to another by domination or assimilation, so the same is true of material culture.

Furthermore, just as areas in frequent contact may develop mutually intelligible languages and dialects, so the same is true of their repertoires of material culture. However, it is one thing to be familiar with the building blocks of language, it is quite another to develop competence in its correct use. In material terms, context is everything. Particular combs may have been used in particular contexts: some were for public display, some were gifts (presumably of various categories), some were for use in private, some in public, some were probably not even for use with hair. Outside of the appropriate arenas, the visibility or use of a particular comb may appear jarring, or be misunderstood. In 18th-century England, it was seen as impolite to comb one's hair in public, and while today's social mores are in many ways more liberal, there are still contexts in which grooming would seem inappropriate. Moreover, particular forms of comb have gender associations (see Cruse 2007:56-73). The same must have been true in antiquity.

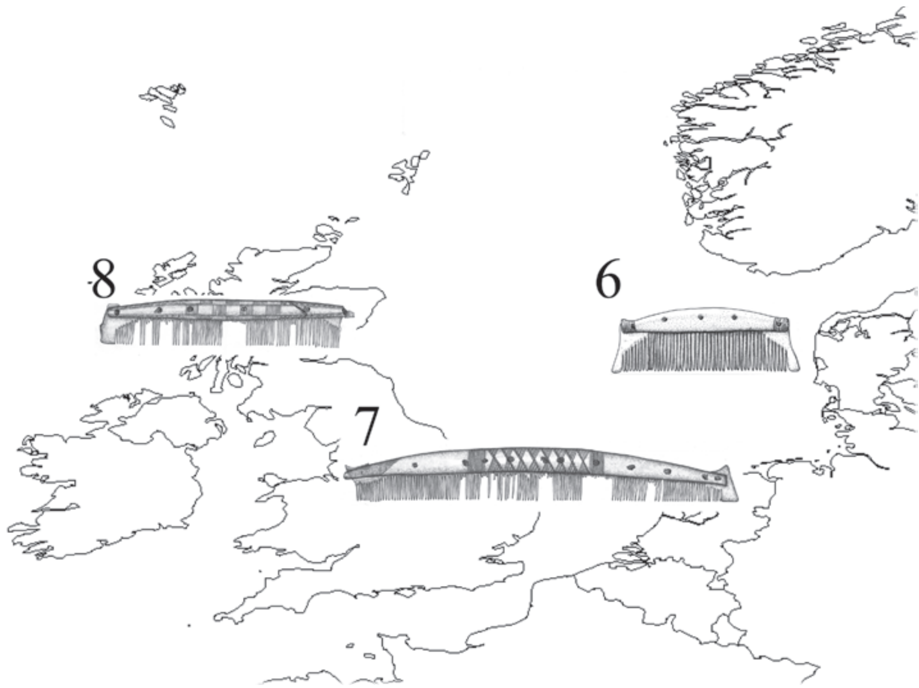


Fig. 1: Formal diversity: schematic distributions of comb types frequently recorded from 10th- and 11th-century contexts (Types 6, 7, and 8, after Ashby 2007). Illustration by the author, incorporating drawings by Hayley Saul and Pat Walsh

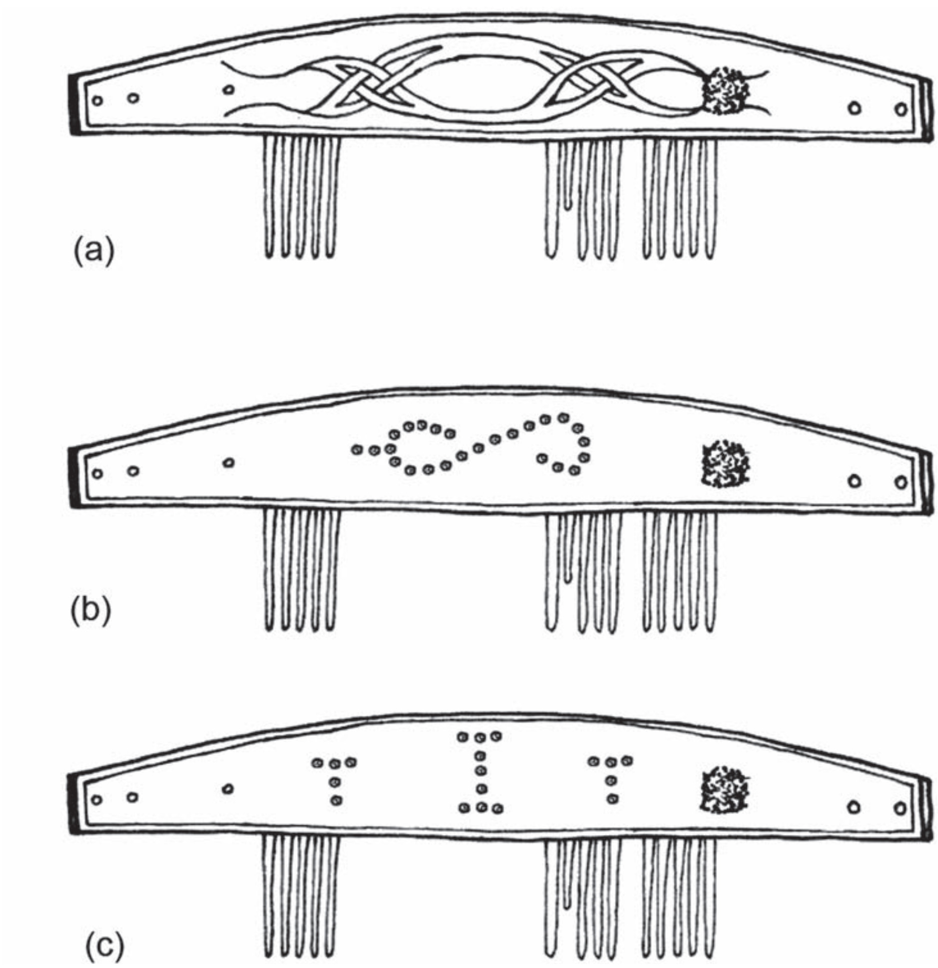


Fig. 2: Ornamental Diversity: Schematic representations of decoration recorded on Type 5 combs. (a) atypical interlace, based on an example from the Brough of Birsay; (b) recumbent-S arrangement of ring-and-dot motifs, known from Birka, the Frisian terpen and, less commonly, Orkney; (c) T- and I-shaped arrangements of ring-and-dot motifs, known from Birka and the Frisian terpen, but unknown in the British Isles. Drawings by the author and Hayley Saul

Let us take as an example the scenario in early Viking-Age Scotland, where it has been suggested that combs of an identifiably 'Pictish' style unknown in Scandinavia were being manufactured in reindeer antler – a material not native to the British Isles at this date (Ashby 2009; *cf* Weber 1992). If verified, we can only explain this scenario in terms of cultural co-existence and either co-operation or coercion; by some means or another, craftspeople familiar with Pictish styles of construction and ornament found themselves working in Scandinavian materials. They were either trading with the Norse for raw materials, or the Scandinavian incomers were providing materials and commissioning the manufacture of local forms of material culture, perhaps as part of an active policy of incorporation and acculturation.

A similar situation becomes discernible when we consider the apparently concurrent use of these 'native' and 'Pictish' type combs and other 'Scandinavian' forms (Ashby 2009). How can there be sufficient space in the market for such diverse forms, manufactured according to disparate traditions? One explanation is that this dislocation relates to factionalism within the populace; it may not be as simple as 'native' *vs* 'incomer', but combs were certainly being used to formalise, signify, and structure demographic associations.

A similar, if less clear-cut, phenomenon is apparent in Yorkshire. In the dynamic and unstable time that was the Viking Age, we might expect divisions like that in Scotland to be similarly well-evidenced in northern England. We might even hope to observe evidence for the purposeful construction of native identities in relation to some perceived Scandinavian threat. However, no 'interface' phase (in which the coexistence of Scandinavian and native material culture exist side-by-side) is visible at York, and in all levels the 'Scandinavians' are difficult to find. Only a small number of objects from York can be definitively characterised as 'Norwegian' or 'Danish' (indeed, there are few imports of any provenance; see Richards 2007: 162), and the rarity of diagnostically 'Viking' combs in northern England is remarkable (Ashby 2006; Ashby in press).

Nonetheless, if we shift our gaze beyond the towns, we do find signs of complexity. The persistence at rural settlements of traditionally 'pre-viking' style combs (Types 2a, 2b, and 12; see Ashby 2006, 2007) at least into the ninth century is indicative of a deliberate choice (Ashby 2006:175, 225-228; see also Richards 1999; MacGregor 2000; *cf* Foreman 2009). This phenomenon is unlikely to represent simple 'backwardness', and more probably relates to the construction of a shared 'Anglo-Saxon' (or perhaps explicitly Northumbrian) identity, as has been proposed for certain forms of metalwork (see Thomas 2000, 2006). This conservatism suggests that 'old', familiar comb forms retained meanings or associations that new, foreign ones did not. So once again, we can see the use of form as an act of implicit but calculated inclusion and exclusion, mediated through material culture in a way analagous to that of language, a kind of material shibboleth.

The Vocabulary and Grammar of Ornament

A similar claim might be made of ornament. Particular motifs (vocabulary) and arrangements (grammar) could be understood in diverse ways, though of course the precise significance of particular forms of interlace or chevrons are now lost to us. Distinctive and unusual designs (*e.g.* Fig. 2a) might be seen as transmitters of more personal, assertive style, particularly if we view such extravagant combs as individual commissions.

There is further potential for communication mediated through the arrangements of ornamental motifs. At Birka (Sweden), Type 5 combs frequently feature ring-and-dot ornament, and these motifs may be positioned to form distinctive chains or stings. Some of these arrangements, such as the figure-8 or recumbent-S (Fig. 2b), are evidenced, though unusual, in the British isles, while others, such as the T- or I-shape (Fig. 2c), are unknown in the North-east Atlantic archipelago, but are better represented in the Frisian area (see Roes 1963, Pl. XIX, for instance). We can envision these arrangements as a sort of grammar that might be understood in certain contexts, incomprehensible in others. Another example is the 'display face convention', the oft-cited Frisian predilection for combs with ornament on only one side (MacGregor 1985:92). This is clearly indicative of a particular way of wearing a comb, a regionally distinctive behaviour that, when observed out-of-context, may very well have been noted as 'alien'.

Thus, there are numerous examples of situations in which consumers in diverse contexts shared a common repertoire of motifs, but where the grammars by which they were used and understood were distinctly localised. The potential for linguistic analogy here is clear; one immediately thinks of the differences between US and British vernacular English, which share considerable linguistic commonality, but with significant and particular differences in vocabulary and grammar (see Platt *et al.* 1984; Rohdenburg, Schlüter 2008; Smith 1987). Though such speech is mutually intelligible, there is considerable scope for misunderstanding and consequent alienation. Similar errors are equally possible in material terms, and it is quite conceivable that combs that today seem very similar, or part of a shared tradition (see Ambrosiani 1981) may well have featured particular markers of identity that made clear references for those able to read (or rather *hear*) them. Such complexity is well documented in the anthropology of style (see Weissner 1983), and there are also modern examples from which we may learn (consider, for instance, the skills required in order to 'read' the military badges of the recent Balkan conflicts; Laycock 2008:125; see also Richards 2009).

Dialects of Manufacture

These are all visible, and consciously or unconsciously understood cultural references. But we may also talk of dialects, features that may or may not have been actively recognised by consumers, depending on their familiarity with the language of combmaking. These traits speak of the materials and techniques exploited by the combmaker, which themselves reflect the artisan's place of work, and the tradition in which they leaned their craft. Examples might include raw materials of combs and rivets, methods and arrangements of riveting, the tools and processes used to construct and finish the piece.

I have written elsewhere on the nature of technology, and the means by which manufacturing traditions are developed and passed on (Ashby, in prep.). Herein it is appropriate to consider briefly the means by which one learns a skill; it is through the experience of working with materials in a particular context. Thus, just as the knowledge acquired during apprenticeship is key to the manner in which a task is conceived and undertaken, so is the place of work, the tools employed, and the materials exploited. So, working with a particular form of raw material – red deer antler rather than reindeer, elk, or bone, for instance – would have an impact on the

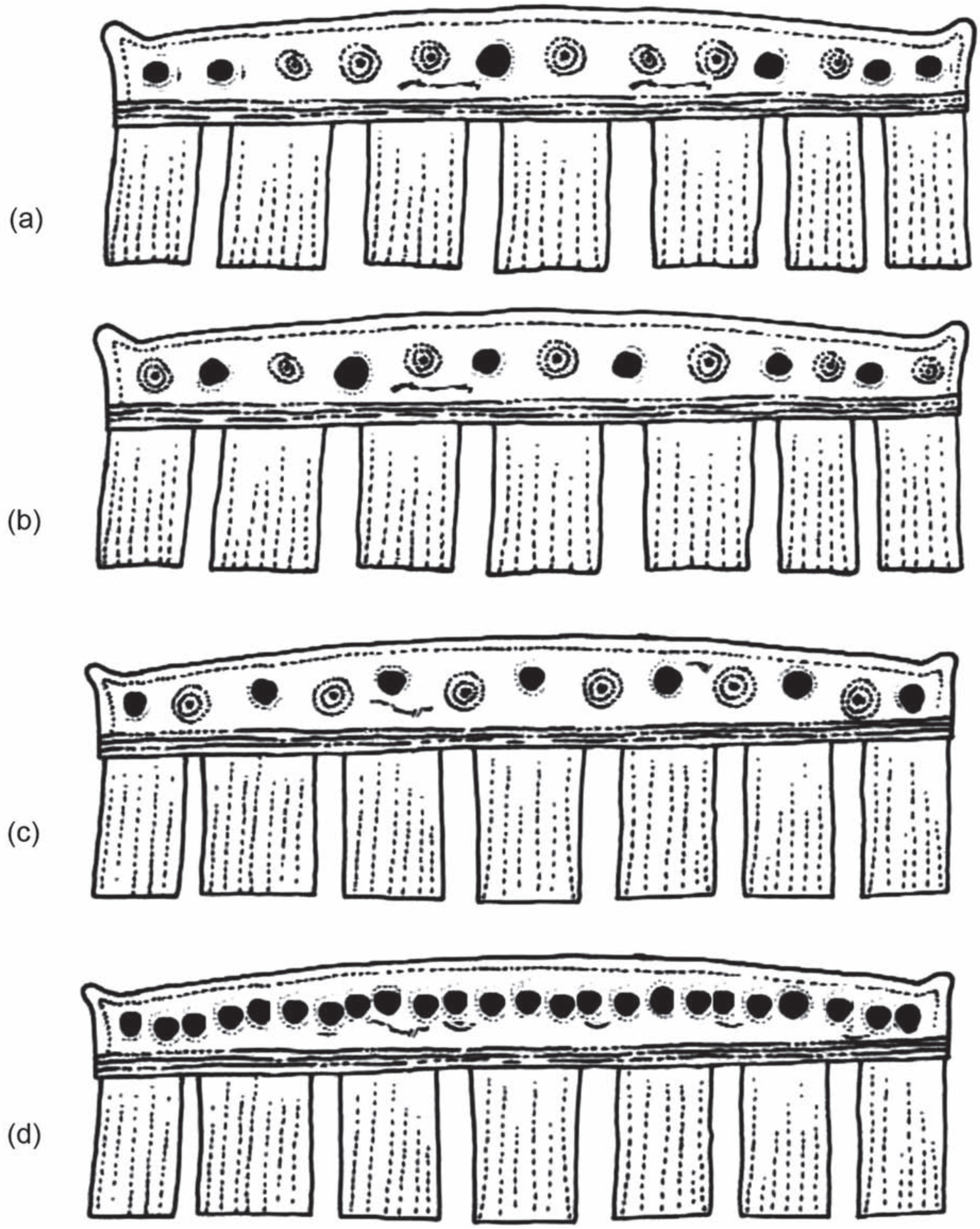


Fig. 3: Manufacturing Diversity: Schematic representations of riveting patterns from across northern Europe. (a) alternating-edge style; (b) every-edge style; (c) centrally-riveted style; (d) decorative style. After an original drawing by Sven Schroeder, originally published in Ashby 2009, fig 5

particular manner in which comb manufacture was conceived. Of course, this may have included practical concerns; the particular dimensions of the material would naturally constrain the size and shape of individual comb components. But it need not be restricted to such matters. Ways of thinking about material, or about the animal from whence it came, may equally have had an impact. This may seem fanciful, but it would be foolish to deny the possible implications of the animist beliefs that seem to have characterised relations with reindeer in the circumpolar north (Äikäs *et al.* 2009; Price 2002; Ingold 1980). Even in post-conquest England, treatment of the red deer carcass ('the unmaking of the deer') was highly ritualised, and is not easily explicable in efficiency terms (Sykes 2007:71), while we might also remember that the significance of raw materials need not have a basis in explicit religious or symbolic associations (see Conneller 2011). Indeed, meaningful content might well develop out of functional necessity, such that no distinction is made between the 'practical' and 'meaningful' basis behind the choice of a particular material. Material qualities such as toughness and lustre, as well as rarity and the degree to which exploitation is restricted to particular groups, may impart upon a material connotations of status, luxury, or the exotic. In turn, such associations may inscribe that material appropriate or inappropriate for use in the manufacture of particular object types, or for use by particular members of society. Moreover, such conceptual frameworks are not limited to raw materials, but may equally impact upon form, method of assembly, the use of tools, and ultimately the use of the finished object itself, while the significance of particular qualities may move in and out of focus, their meaningful content transforming according to context, such that the people interacting with a given comb form at a given point may be rich or poor, young or old, male or female. For this reason, it is fundamental that context (social, chronological, and geographical) is prioritised in any analysis.

To illustrate this, a specific example is necessary, but given the limitations of space, herein the focus is on just one aspect of manufacturing practice: methods of riveting (Fig. 3). There are a range of ways by which a comb may be riveted together, and these do seem to reflect local schools of manufacture, or at least regional working traditions (see Smirnova 2005:29-38 for a detailed account). To simplify, both 'every edge' and 'central' arrangements are known in Norway and Sweden, while Denmark and the British Isles seem to share the 'alternating' tradition. Thus, we may perceive significant manufacturing variation, notwithstanding any similarity in morphology or decoration. The implications of this phenomenon are considerable. 'Foreign' comb forms do seem to have been transported beyond their normal ranges (presumably by a combination of travel and exchange), and combmakers from different regions may have had occasion to interact with one another. Nonetheless, it seems clear that traditions of 'making' were discretely regionalised (see Ashby in press a, b). Thus, combs with evidence of anomalous manufacturing processes may be identified as displaced objects, and it is notable that in northern England the small number of combs displaying the 'every edge' riveting technique are concentrated in York (Ashby 2006: Tables 7.32-7.35).

To pitch this in linguistic terms, again we may use the example of US and British English. Though none would doubt the shared linguistic experience of speakers of the two languages, few familiar with the rhythms and cadences of US and British speech would confuse the two, such that it is extremely difficult for a native of one context to go unrecognised in the other. The dialect may be taken for granted in some 'home' contexts, but it becomes significant when 'abroad'. Thus, particular aspects of comb manufacture and material shift in and out of focus according to context and moment, just as do form and ornament (see above), as has been proposed for the material culture of prehistoric Europe (Edmonds 1999), and other aspects of our lived environment (Bender 2001). This is the only way in which the 'meaning' of combs might be assessed; any attempt to identify a particular significance – even for a restricted spatio-temporal frame such as Viking-Age England - is certain to end in failure. The significance of objects is too slippery to be easily grasped.

Language as Analogy and Language as Practice

The perceptive reader will realise that what is lacking in all that has been discussed so far is an apparatus to account for what happens when we put particular 'ways of making' into their broader context. In particular, how does the linguistic analogy work in the context of actual linguistic communities? In order to develop this argument, the analogy must be coupled more explicitly to a way of thinking about the relationship between 'material behaviours' and the construction of identity.

Social anthropology is again ahead of us here. Work by Judith Butler (*e.g.* Butler 1990, 1993), Andrew and Marilyn Strathern (*e.g.* Stewart, Strathern 2003; Strathern, Strathern 1971) and Tim Ingold (1993) is of particular note. Butler's concept of somatic performativity brings the complex 'chiasmic' relationship between language and materiality into focus (Butler 1993:69), while work by Andrew Strathern and others has identified connections between group identity and technologies of ritual and display. In his analysis of the use of the 'reindeerman's lasso', Ingold (1993) has demonstrated how physical properties only go so far in explaining the particular technological choices of Finnish reindeer herders. Equally important are the suites of skills associated with particular technologies, and these skills tie in closely to ideas of self, group membership, and identity.

These ideas have some application in the case of combs. Following Ingold in particular, we might suggest that identity inheres in, and is communicated by, not material culture itself, but 'skills'. This certainly applies to ways of 'making', such that particular choices in comb manufacture may be signifiers of identity (see Ashby in prep), but in Ingold's use of the term, the techniques and behaviours that make up daily life similarly constitute skills. In this sense, the use of a comb as a gift, as a dress accessory, or as a toilet implement could be described as a skill, and, as such, may be seen to have developed within a particular (social and ecological) environment. Thus, where differences in 'comb behaviour' are recognisable, these may be interpreted in terms of the production of identity, providing one has understanding of the contexts within which behaviours developed. In what follows, I apply these ideas to comb material from Viking-Age and medieval northern England.

Discussion: Communication and Contradiction

Just as Ingold (1993) showed that the reindeerman's identity could be expressed in skills and technical choices, and that the particular identity articulated through a technique was contingent upon social context, so the same applies to our combs. Thus, in order to access the ways in which comb behaviours may have created and communicated identities, it is fundamental that our studies are situated within their appropriate social and political context. It therefore behoves us to take a little time to consider both the development of comb use in early medieval northern England, and the region's socio-political climate in our period of interest.

In pre-Viking England, the display of identity through dress accessories and portable artefacts was well-established (*e.g.* Hines 1994). Moreover, the significance of combs – possibly in the making and remaking of identity – is evidenced in Early Anglo-Saxon cremation graves (Williams 2003, 2004), and suggested by both their manufacture in precious metals and records of their use in gift exchange (see Sorrell 1996). Thus, by the eighth century, the sending and receipt of signals through media that included combs would have been well-understood. We might suppose that such messages were transmitted through the distribution of well-made combs as gifts, and in their display as dress accessories. This may have applied even to poorer manufactures, but if not, then their significance may have been revealed privately in grooming rituals, as is illustrated in contemporary literature (*e.g.* Jones, Jones 1949:116-119, 134-135).

Thus, by the start of the Viking Age, combs were a firmly established medium of communication. Interestingly though, it seems that the number of people in ninth-century Yorkshire and Lincolnshire that chose to express their *Scandinavian* identity through the medium of combs was small. This may reflect either a relatively small-scale settlement or an initial reluctance to broadcast one's affiliation in an unfamiliar, unstable and potentially hostile environment. However, in the tenth and eleventh centuries, this social reticence was followed by the creation of a hybrid Anglo-Scandinavian material culture, as opposed to the apparent cultural 'takeover' that characterises other areas, such as the Northern Isles of Scotland. Combs from Viking-Age levels in York have some parallels in the Baltic and southern Scandinavia, but are most closely comparable to those of Ireland, and Dublin in particular (Ashby 2006:251). We must envision a considerable surge in local demand for combs of these new forms, which possibly held Irish associations. This sudden floruit of 'Hiberno-Norse' identity is paralleled in sculpture, where Irish artistic motifs are adopted and adapted, producing new colonial monuments such as ring-headed crosses (see Collingwood 1927).

This development must be seen in political terms. Ragnald's takeover of the Kingdom of York in AD 918 marked a significant political watershed, and though Hiberno-Norse overlordship was unstable, it persisted intermittently until the middle of the tenth century, and over this time close political ties existed between York and Dublin (Lang 1991:8). Given the importance of material culture in communication during times of social stress (Barth 1969), it is thus natural that display began to make reference to the perceived origins of dominant political magnates. The exploitation of both fixed and portable forms of material culture is particularly notable, as the two media no doubt had different audiences. Though it has been argued that combs could be used as symbols of status (see above), there is no doubt that the commissioning of sculpture was much more socially restricted. Thus, the combs add some nuance to the scenario developed on the basis of sculptural evidence; Anglo-Scandinavian identity was widely seen as desirable, and was reproduced at multiple social levels within the free population of York. Social and political advantage was to be gained through speaking the Hiberno-Norse language of material culture.

So, we have seen that new 'Scandinavian' or even 'Hiberno-Norse' templates were adopted in both Northumbria and parts of Ireland in the tenth century. These combs rapidly became extremely popular, and seem to have been produced and consumed in such numbers - especially at large settlements such as York – that it is improbable that all those using such combs were of Scandinavian genetic heritage. More likely the phenomenon suggests rapid and widespread acceptance of a new design: a new material language. In so adopting these combs, the populace ensured that these forms were reinvented as cultural references or linguistic cadences, becoming assimilated into the Anglo-Scandinavian milieu. This contrasts markedly with the situation in smaller settlements, where combs show conservatism of design, and it does appear that Viking-Age northern England had a heterogeneous population. Moreover, that population may have been factional, with intergroup relations being mediated through material culture, including combs. The well-known 'handled' combs (Type 3; see Ashby 2007) constitute a possible example of this phenomenon. They appear to persist right across the political threshold of Norse settlement. Whether they represent 'Saxon' or 'Frisian' combs, they are nonetheless a discrete group, unlike anything else in use in the British Isles, Frisia, Francia or Scandinavia between the seventh and tenth centuries. They may thus represent a specific social reference group, with its own comb language. Just as the techniques of Ingold's northern and southern Finnish reindeermen were the loci for expressions of identity, so it was for the comb behaviours of various late Viking-Age groups in northern England. Combs were used to mediate relations between various demographic, ethnic, or social groups. The linguistic analogy, then, does indeed seem appropriate.

Perhaps the most striking patterning in comb behaviour relates to material choice. Broadly speaking, Viking-Age England saw a shift in preference from bone to antler (see Riddler 1992). It is worth considering why this was the case. While the growth of towns in the Viking Age may certainly have impacted the organisation of material supply, it is difficult to see how this could have made antler more readily available than bone (the development of butchery guilds, which may conceivably have limited access to postcranial bone, seems to have been a later development). Instead, the difference may be related to a change in the perceived qualities of materials. This does not necessarily represent an ethnic influence, but it does reflect differences in skills and worldview. It is precisely these flows and 'meshworks' of material and meaning that Ingold (2007) has emphasised as priorities for archaeological research more generally.

Combmaking in late Viking-Age and Anglo-Norman England seems to have experienced a related, but perhaps more widely felt trend. From the Late Viking Age and into the Middle Ages, composite comb production seems to decline in England, while the industry thrives in Scandinavia, and its output is identifiable across northern Europe and the North Atlantic (see Ashby, in press). Quite why this occurs is difficult to ascertain. Traditionally, the decline of the English composite comb has been explained with reference to the increasingly restricted nature of access to antler, and the rise of horncraft (MacGregor 1985:32, 51). However, in itself, this explanation may not present the full story. Combs of bone/antler and of horn/wood are not morphologically, materially, technologically or aesthetically similar, and must have fulfilled fundamentally different roles (at least in terms of display). The replacement of the former by the latter must, I believe, relate to a fundamental shift in the perception of what a comb was, and what it was for. If access to antler did indeed become restricted, then the transference of responsibility for comb production to the hornworker does not seem inevitable or inherently predictable. Why did the combmaker not simply return to exploitation of postcranial bone? Though antler does exercise mechanical superiority over bone in some important ways (MacGregor, Currey 1983), we have seen that the latter was used extensively in the pre-Viking period, and its utility was not lost to memory. So why were bone/antler composite combs abandoned altogether, rather than reconceived in terms of material? It is possible that the butchery guilds (which appear to have been in place at least by the thirteenth century) attempted to limit access to domestic animal bone at this point, but the persisting production of bone items such as gaming pieces and knife handles (and the appearance of new forms such as parchment prickers) perhaps argues against this. Rather, it seems that the period following the Norman Conquest saw a change in skills that was unfavourable for the comb. It is a truism to state that the appearance of Norman lordship was accompanied by significant social change, but one particular aspect of this development holds interest here. It has frequently been argued that early-medieval notions of power and status were related to portable wealth, military might and influence, and derived from a complex network of affiliations and responsibilities borne out of relationships of reciprocity and tribute (see Hedeager 1994; Samson 1991), and that these were replaced in large part by Norman ideals founded on land ownership, inheritance, and feudal relations (see Sykes 2007 for a useful review of these issues in light of human-animal relations). The Saxon-Norman dichotomy is of course simplistic (see Bates, Curry 1992), but it is clear that the political conditions that pertained in later Anglo-Saxon England were different in kind to those that characterised contemporary Normandy, which had developed out of the Carolingian restructuring of the Romano-Germanic state of Merovingian Francia. The social and economic developments of later 11th- and 12th-century England, are then, unsurprising. It is conceivable that these changes had a material corollary. Although it would be erroneous to propose that it led to a declining need to display status through dress, it is reasonable to suggest that certain mechanisms – involving either the significance of hair, or of particular dress accessories – began to be viewed differently in this regard (see Dutton 2004 for the complexities of interpreting changing attitudes to hair in early-medieval Frankia; see also Petitjean 1995). Comprehension of the trend may be aided by further archaeological and documentary research in Britain and France, but in truth ultimate identification of a particular social cause for this development seems an unlikely goal. Moreover, though there is the temptation to apply an 'ethnic' explanation, it is problematic to privilege the impact of the Norman Conquest over contemporary alternatives, particularly when – as in this case – we are hamstrung by an inability to tightly date the phenomenon of interest.

Nonetheless, patterning in the presence/absence of examples of 'riveted mounts' suggest that the 11th and 12th centuries also saw the decline of rudimentary combs that incorporated a horn (or wooden) component (Ashby Type 4; see Ashby 2007; Biddle 1990). This comb form may be seen as the 'missing link' (morphologically, and in some senses chronologically) between the composite comb proper, and its one-piece successor in horn. Arguably, these combs represented inexpensive toilet implements with a diminished role in display, and as such provided the template for later, perhaps less symbolically loaded models. Thus, as the need for combs as active, visible dress accessories disappeared, so they were replaced by more functional grooming tools that could be expediently manufactured on single pieces of horn or wood. Though no doubt produced in some numbers, most such examples are now lost to us.

Thus, what at a superficial level appears to be a fairly coherent class of object – the comb – actually comprises several discrete forms with particular cultural associations. Let us call these forms 'phases' (in the chemical or zoological – rather than the temporal – sense). The use of the respective phases is situated within particular social contexts, and their relative fortunes are contingent upon political and socio-economic developments, resulting in distinctive chronological and geographical patterning. The parallel with the case of the reindeerman's lasso is close, and while this is just one possible explanation, such an approach is particularly interesting in light of Ingold's (2007) concern with 'materials against materiality'. Thus, while the need for hair combs was to persist, the relevance of the composite comb (with its particular material requirements, its complex and extended production process, it role as a dress accessory, and the conceptual associations drawn from both its raw materials and the symbolic content of its form and ornament) entered a slow decline. Though, as we have seen, precision is not forthcoming, the timing of this decline is interesting, coinciding as it does with perceived recessions in the production of metalwork and large-scale ecclesiastical construction (Hinton 2006; Gem 1975). It is possible that these trends share common causation, and it is not inconceivable that socio-conceptual – rather than simply economic – factors played an important role. In the case of combs, however, the disparity is stark, particularly given the thriving combmaking industry that characterised early second-millennial Scandinavia, and it is tempting to see the pattern in terms of a change in the nature of the relationship between Scandinavia and England under Cnut and the kings of Wessex (Ashby in press). This, however, only describes the situation; what I have endeavoured to do herein is to address the question of *why* the 'display comb' so rapidly became redundant. The phenomenon must relate, at least in part, to the changing role of combs in social performance and communication, and a transformation in the rules according to which this material language operated.

Notwithstanding the decline of English combmaking, we do find occasional examples of composite combs in deposits dated to the 12th and 13th centuries. Such combs are invariably Norwegian- or Danish-made (type 9), and must represent the possessions of travellers from Scandinavia or Atlantic Scotland (Ashby 2006:146-147). The size and extravagance of some such examples suggest that it was not always too much of a risk for a Scandinavian outsider to openly display their identity in Viking-Age and high-medieval England. Incidentally, the same might be said of a small number of Late Viking-Age bronze comb pendants with eastern Baltic origins, which have recently come to light in Lincolnshire (Ashby and Bolton, 2010). Such display would surely have stood out in the eleventh and twelfth centuries if decorative dress accessories (including visible combs) were as rare as they appear to have been. Indeed, the local imitation of Scandinavian forms suggests that such fashions were seen as exotic or desirable in some contexts, to the extent that their meaning was actively read, interpreted, and adopted.

I hope that this brief case study has demonstrated how a language-driven approach might allow us to understand previously uninterpreted patterning in artefactual material. To summarise, rather than – as has previously been assumed – the corpus being homogeneous, there is much variability and patterning in the combs of Viking-Age Europe. It is simply the complexity of this patterning that renders it invisible at first, and what is needed is a model to help unravel it. Of course, in this paper it has only been possible to touch upon a few of the problems and potentials of studying this complex finds material, and much has been overlooked. It has not been possible, for instance, to consider in any detail the nature of relations between combs and other meaningfully-loaded objects. The networks of association between multiple objects, people, and places are of course key to their agency, but this is a matter for another paper. Finally, this contribution demonstrates just one potential approach to our problem. Elsewhere, I have outlined and adopted processes based on style (Ashby 2006) and technological choice (Ashby in prep), and I do not suggest a particular theory or framework to be followed; diverse questions call for diverse responses. All that is important is that whatever approach is adopted, care is taken to appreciate that the meaningful content of these objects is multi-faceted: zoological and technological; ecological and communicative.

Acknowledgements

This paper builds upon research undertaken prior to 2006, as part of AHRC-funded doctoral research at the University of York, and I am grateful for the advice and ideas of staff and colleagues in the Department of Archaeology that made this research possible. In particular, I should thank my supervisor, James Barrett, whose perspicacious comments were always immensely helpful, and Arthur MacGregor, whose support is greatly appreciated. I have also benefitted from discussions with untold numbers of fellow worked bone specialists, and I am of course extremely grateful for the support and encouragement of the members of the Worked Bone Research Group, and to our Polish colleagues in particular, for organising the meeting and for their help in preparing this paper for publication. Thanks are also due to Penelope Walton Rogers, for discussion on the role of butchery guilds. Finally, I owe a big thank you to Mark Edmonds (very much the 'perceptive reader' referred to above), whose inspiration and encouragement has been priceless, and whose comments on an earlier draft of this paper have improved it immeasurably. Thanks to you all; all errors of course, remain my own.

References

Äikäs, T., A.-K. Puputti, M. Núñez, J. Aspi and J. Okkonen 2009. *Sacred and profane livelihood: animal bones from Sieidi sites in northern Finland*, Norwegian Archaeological Review 42(2), 109-22.

Ambrosiani, K. 1981. *Viking Age Combs, Comb Making and Comb Makers in the Light of Finds from Birka and Ribe*, Stockholm Studies in Archaeology 2, Stockholm.

Ashby, S.P. 2005a. *Bone and antler combs: Towards a methodology for the understanding of trade and identity in Viking Age England and Scotland*, In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Proceedings of the 4th Meeting of the Worked Bone Research Group, Tallinn, Estonia, August 2003*, Muinasaja teadus 15, Tallinn, 255-62.

Ashby, S.P. 2005b. *Zooarchaeology, Artefacts, Trade and Identity: The Analysis of Bone Combs from Early Medieval England and Scotland*, In: A. Pluskowski (ed.) *Just Skin and Bones? New Perspectives on Human-Animal Relations in the Historical Past*, BAR Intern. Series 1410, Oxford, 41-3.

Ashby, S.P. 2006. *Time, Trade and Identity: Bone and Antler Combs in Northern Britain c. AD 700-1400*, unpublished PhD thesis, Department of Archaeology, University of York.

Ashby, S. P. 2007. *Bone and Antler Combs*, Finds Research Group Datasheet 40.

Ashby, S.P. 2009. *Combs, contact, and chronology: reconsidering hair combs in Early-historic and Viking-Age Atlantic Scotland*, Medieval Archaeology 53, 1-33. www.maney.co.uk/journals/med /; www.ingentaconnect.com/content/maney/med

Ashby, S.P. in press. *Making a Good Comb: Mercantile Identity in 9th to 11th-century England*, In: L. Ten-Harkel and D.M. Hadley (eds.) *Everyday Life in Viking Towns: Social Approaches to Towns in England and Ireland c. 800-1100*, Oxford: Oxbow.

Ashby, S.P. in press (a). *Disentangling trade: combs in the North and Irish Seas in the Long Viking Age*, In: J.H. Barrett and S.-J. Gibbon (eds.) *Maritime Societies of the Viking and Medieval World*, London: Boydell.

Ashby, S.P. in press (b). *A Study in Regionality: Hair Combs and Bone/Antler Craft in the Northern Danelaw*, In: D. Petts and S. Turner (eds.) *Early Medieval Northumbria,* Turnhout: Brepols.

Ashby, S.P. and A. Bolton 2010. *Searching with a fine-toothed comb: Combs for Humans and Horses on the PAS database*, In: H. Geake, M.J. Lewis and S. Worrell (eds.) *A Decade of Discovery*, BAR 520, Oxford: Archaeopress.

Barnes, M.P., J.R. Hagland and R.I. Page 1997. *The Runic Inscriptions of Viking Age Dublin. Medieval Dublin Excavations 1962-81, Series B* 5, Dublin: National Museum of Ireland and Royal Irish Academy.

Barth, F. (ed.) 1969. *Ethnic Groups and Boundaries: The Social Organization of Culture Difference*, Boston: Little, Brown and Company.

Barrett, J.C. 1988. *Fields of discourse: reconstituting a social archaeology*, Critique of Anthropology 7(3), 5-16.

Bates, D. and Curry, A. (eds.) 1992. *England and Normandy in the Middle Ages*, London: Hambledon Press.

Bender, B. 2001. *Landscapes on-the-move,* Journal of Social Archaeology 1(1), 75-89.

Biddle, M. 1990. *Toilet Equipment: Combs of Horn and Bone*, In: M. Biddle (ed.) *Object and Economy in Medieval Winchester*, Winchester Studies 7, Oxford: Clarendon Press, 678-90.

Buchli, V.A. 2000. *Interpreting Material Culture. The Trouble with Text*, In: J. Thomas (ed.) *Interpretive Archaeology: a reader*, London: Leicester University Press, 363-76.

Butler, J. 1990. *Gender Trouble: Feminisim and the Subversion of Identity*, New York: Routledge.

Butler, J. 1993. *Bodies that Matter: On the Discursive Limits of "Sex"*, New York: Routledge.

Clarke, D. and A. Heald 2002. *Beyond typology: combs, economics, symbolism and regional identity in Late Norse Scotland*, Norwegian Archaeological Review 35(2), 81-93.

Collingwood, W.G. 1927. *Northumbrian Crosses of the Pre-Norman Age*, London: Faber and Faber.

Conneller, C. 2011. *An Archaeology of Materials. Technological Transformations in Early Prehistoric Europe*, London: Routledge.

Cruse, J. 2007. *The Comb: its History and Development,* London: Robert Hale.

Edmonds, M. 1999. *Ancestral Geographies of the Neolithic. Landscapes, monuments and memory,* London, Routledge.

Dutton, P. E. 2004. *Charlemagne's Mustache and Other Cultural Clusters of a Dark Age*, New York: Palgrave MacMillan.

Fleming, A. 2006. *Post-processual Landscape Archaeology: a Critique*, Cambridge Archaeological Journal 6(3), 267-80.

Foreman, M. 2009. *Combs. Life and Economy at Early Medieval Flixborough, c. AD 600-1000: The Artefact Evidence*, In: D.H. Evans and C. Loveluck (eds.) *Excavations at Flixborough Volume 2*, Oxford: Oxbow, 82-102.

Gem, R. 1975. *A recession in English architecture during the early 11th century and its effect on the development of the Romanesque style*, Journal of the British Archaeological Association, 3rd Series 38, 8-49.

Hedeager, L. 1994. *Warrior economy and trading economy in Viking-Age Scandinavia*, Journal of European Archaeology 2(1), 130-48.

Hines, J. 1994. *The becoming of the English: identity, material culture and language in early Anglo-Saxon England,* In: W. Filmer-Sankey and D. Griffiths (eds.) *Anglo-Saxon Studies in Archaeology and History Volume 7*, Oxford: Oxford University Committee for Archaeology, 50-9.

Hinton, D. 2006. *Gold and Gilt, Pots and Pins. Possessions and People in Medieval Britain*, Oxford: Oxford University Press.

Hodder, I. 1989a. *Material culture texts and social change: a theoretical discussion and some archaeological examples*, Proceedings of the Prehistoric Society 54, 67-75.

Hodder, I. 1989b. *This is not an article about material culture as text*, Journal of Anthropological Archaeology 8, 250-69.

Hodder, I. 1991. *Reading the Past: Current Approaches to Interpretation in Archaeology*, Cambridge: Cambridge University Press.

Hodder, I. 1993. *The narrative and rhetoric of material culture sequences*, World Archaeology 25(2), 141-51.

Ingold, T. 1980. *Hunters, pastoralists and ranchers: reindeer economies and their transformations*, Cambridge: Cambridge University Press.

Ingold, T. 1993. *The Reindeerman's Lasso*, In: P. Lemonnier (ed.) *Technological Choices. Transformations in Material Cultures since the Neolithic*, London: Routledge, 108-25.

Ingold, T. 2000. *The Perception of the Environment,* London: Routledge.

Ingold, T. 2007. *Materials against materiality*, Archaeological Dialogues 14(1), 1-16.

Jones, G. and T.J. Jones (trans. and eds.) 1949. *The Mabinogion*, London: J.N. Dent and Sons, Everyman's Library.

Jones, S. 1997. *The Archaeology of Ethnicity*, London: Routledge.

Lang, J.T. 1991. *Corpus of Anglo-Saxon Stone Sculpture. Volume III: York and Eastern Yorkshire*, Oxford: Oxford University Press.

Laycock, S. 2008. *Britannia: the Failed State. Tribal Conflicts and the End of Roman Britain*, Stroud: Tempus.

Lévi-Strauss, C. (1963 [1958]). *Structural Anthropology. (trans. C. Jacobson)*, New York: Basic Books.

Luik, H. 2008. *Could broken combs have had new lives?,* Eesti Arheoloogia Ajakiri (Estonian Journal of Archaeology) 12(2), 152-62.

MacGregor, A. 1985. *Bone, Antler, Ivory and Horn: The Technology of Skeletal Materials Since the Roman Period,* London: Croom Helm.

MacGregor, A. 2000. *Bone and Antler Objects,* In: P.A. Stamper and R.A. Croft (eds.) *Wharram: A Study of Settlement on the Yorkshire Wolds, VIII: The South Manor Area*, York University Archaeological Publications 10, York: University of York, 148-54.

MacGregor, A. and J.D. Currey 1983. *Mechanical properties as conditioning factors in the bone and antler industry of the 3rd to the 13th Century AD*, Journal of Archaeological Science 10, 71-7.

Miller, H.L. 2007. *Archaeological Approaches to Technology*, Burlington, MA: Academic Press.

Moore, H. 1985. *Space, text and gender. An anthropological study of the Marakwet of Kenya*, Cambridge: Cambridge University Press.

Nash, G. (ed.) 1997. *Semiotics of Landscape: Archaeology of Mind,* BAR Intern. Series 661, Oxford: Archaeopress.

Nash, G. and G. Children (eds.) 2008. *The Archaeology of Semiotics and the Social Order of Things*, BAR Intern. Series 1833, Oxford: Archaeopress.

Okasha, E. 1999. *An Inscribed Bone Fragment from Nassington, Peterborough*, Medieval Archaeology 43, 203-5.

Page, R.I. 1973. *An Introduction to English Runes*, London: Methuen.

Peirce, C.S. 1958. *Values in a Universe of Chance: Selected Writings of Chales S. Peirce*, (ed. P.P. Weiner), Garden City, NY: Doubleday.

Petitjean, M. 1995. *Les peignes en os à l'époque mérovingienne. Évolution depuis l'Antiquité tardive*, Antiquités Nationales 27, 145-91.

Platt, J., H. Webber and M.L. Ho (eds.) 1984. *The New Englishes*, London: Routledge and Kegan Paul.

Pluciennik, M. 2002. *Art, Artefact, Metaphor*, In: Y. Hamilakis, M. Pluciennik and S. Tarlow (eds.) *Thinking through the Body. Archaeologies of Corporeality*, New York: Kluwer Academic/Plenum Publishers, 217-32.

Preucel, R.W. 2006. *Archaeological Semiotics,* Malden, MA: Blackwell.

Price, N.S. 2002. *The Viking Way: Religion and War in Late Iron Age Scandinavia*, Uppsala: Uppsala University Department of Archaeology & Ancient History.

Richards, J.D. 1999. *Cottam: an Anglo-Scandinavian settlement on the Yorkshire Wolds*, Archaeological Journal 156, 1-10.

Richards, J.D. 2007. *Viking Age England (Third Edition)*, Stroud: Tempus.

Richards, P. 2009. *Dressed to kill. Clothing as technology of the body in the Civil War in Sierra Leone*, Journal of Material Culture 14(4), 495-512.

Riddler, I. 1992. *Bone-working and the Pre-Viking Trading Centres*, In: R.A. Hall, R. Hodges and H. Clarke (eds.) *Medieval Europe 1992, Preprinted Papers, Volume 7: Art and Symbolism*, York: Medieval Europe 1992, 149-56.

Roes, A. 1963. *Bone and Antler Objects from the Frisian Terp-Mounds*, Haarlem: HD Tjeenk Willink & Zoon N.V.

Rohdenburg, G. and J. Schlüter (eds.) 2008. *One Language, Two Grammars? Differences between British and American English*, Cambridge: Cambridge University Press.

Samson, R. 1991. *Fighting with Silver: Rethinking Trading, Raiding, and Hoarding*, In: R. Samson (ed.) *Social Approaches to Viking Studies*, Glasgow: Glasgow University Press, 123-33.

Saussure, F. d. 1983 [1972]. *Course in General Linguistics.* (ed. and trans. R. Harris), London: Duckworth.

Shanks, M. and C. Tilley 1987. *Re-constructing Archaeology. Theory and Practice*, Cambridge: Cambridge University Press.

Smirnova, L. 2005. *Comb-Making in Medieval Novgorod (950-1450). An industry in transition*, BAR Intern. Series 1369, Oxford: Archaeopresss.

Smith, L.E. 1987. *Discourse Across Cultures. Strategies in World Englishes*, New York: Prentice Hall.

Sorrell, P. 1996. *Alcuin's "comb" riddle*, Neophilologus 80, 311-8.

Stewart, P.J. and A. Strathern 2003. *Introduction*, In: P.J. Stewart and A. Strathern (eds.) *Landscape, Memory and History. Anthropological Perspectives*, London: Pluto Press, 1-15.

Strathern, A. and M. Strathern 1971. *Self-decoration in Mount Hagen*, Toronto: Toronto University Press.

Sykes, N.J. 2007. *The Norman Conquest: a Zooarchaeological Perspective*, BAR Intern. Series 1656, Oxford: Archaeopress.

Tesch, S. 1987. *Kyrkolunden: en historisk och arkeologisk tillbakablick*, Märsta: Sigtunahem.

Thomas, G. 2000. *Anglo-Scandinavian metalwork in the Danelaw: reconstructing social interaction and regional identities*, In: J.D. Richards and D.M. Hadley (eds.) *Cultures in Contact: Scandinavian Settlement in England in the Ninth and Tenth Centuries*, Turnhout: Brepols, 237-55.

Thomas, G. 2006. *Reflections on a '9th-century' Northumbrian Metalworking Tradition: A Silver Hoard from Poppleton, North Yorkshire*, Medieval Archaeology 50(1), 143-64.

Tilley, C. 1991. *Material Culture and Text: the Art of Ambiguity*, London: Routledge.

Tilley, C. 1999. *Metaphor and Material Culture,* Oxford: Blackwell.

Tilley, C. 2004. *Round Barrows and Dykes as Landscape Metaphors*, Cambridge Archaeological Journal 14, 185-203.

Vretemark, M. 1989. *Kammakeriavfallet – en osteologisk analys*, In: K. Carlsson (ed.) *Arkeologi i Kungahalla 1989*, Länsstyrelsen i Göteborg och Bohuslän, 57-66.

Vretemark, M. 1997. *Raw materials and urban comb manufacturing in medieval Scandinavia*, Anthropozoologica 25-26, 201-6.

Wallace-Hadrill, J.M. 1982. *The Long-haired Kings*, London: Methuen.

Weber, B. 1992. *Norwegian Exports in Orkney and Shetland during the Viking and Middle Ages*, In: R.A. Hall, R. Hodges and H. Clarke (eds.) *Medieval Europe 1992, Preprinted Papers Volume 5: Exchange and Trade*, York: Medieval Europe 1992, 159-67.

Weissner, P. 1983. *Style and information in Kalahari San projectile points*, American Antiquity 48(2), 253-76.

Wiberg, C. 1977. *Horn og Beinmaterialet fra "Mindets tomt"*, In: H.I. Høeg, H.-E. Lidén, A. Liestøl, P.B. Molaug, E. Schia and C. Wiberg, *De arkeologiske utgravninger i Gamlebyen, Oslo. Bind 1*, Oslo: Universitetsforlaget, 202-13.

Wiberg, T. 1987. Kammer, In: E. Schia (ed.) *De Arkeologiske utgravninger i Gamlebyen, Oslo Bind 3, Vol. 3*, Oslo: Alvheim and Eide, 413-21.

Williams, H. 2003. *Material culture as memory: combs and cremation in early medieval Britain*, Early Medieval Europe 12(2), 89-128.

Williams, H. 2004. *Artefacts in Early Medieval graves: A new perspective*, In: R. Collins and J. Gerrard (eds.) *Debating Late Antiquity in Britain AD300-700*, BAR British Series 365, Oxford: Archaeopress, 89-101.

Elisabeth A. Stone

The Role of Ethnographic Museum Collections in Understanding Bone Tool Use

Osseous tools are an important component of the material culture of many ancient and contemporary groups and are used in a wide range of activities. One of the major uses of bone tools is the preparation and manufacture of basketry, woven fabrics, mats, nets, hides, and leathers. Because fiber technologies have low survival potential in the archaeological record, I propose that some classes of osseous tools are a good proxy for fiber processing and may provide direct evidence for this practice through use-related attrition. Functional analysis of archaeological specimens may include comparison to both experimental and ethnographic tools, as the context and process of wear accumulation are known in such cases and help provide standards for the assessment of attrition patterns on archaeological artifacts. Here I examine some of the variability in morphology and use of bone tools from ethnographic and ethnohistoric museum collections and explore the utility of these collections to create comparative standards for the assessment of archaeological artifacts and for the construction of experimental programs. I discuss some of the diverse kinds of records that provide information on contemporary and historic bone tool use and argue that studies of the ethnographic material record can be productively organized at the artifact level.

Keywords: bone tools, functional analysis, ethnographic analogy, cross-cultural research

Perishable fiber technologies - objects made from plant and animal soft tissues - may comprise up to 95% of the material culture made and used by contemporary foragers but are rarely found archaeologically (Barber 1991; Croes 1997; Hurcombe 2008b; Tuross, Fogel 1994). Fiber technologies, then, are frequently archaeologically invisible in two ways: 1) physically, they are perishable and are thus recovered less frequently from the archaeological record; 2) intellectually, even when they are present, these technologies are often associated with the labor of women, children, and the elderly, who are frequently omitted from our reconstructions of the past. These two factors are interrelated and each feeds the other in the development of a gap in our knowledge about ancient perishable technologies: lack of interest in less powerful members of society – in the past and the present – limits the investigation of these individuals in the past, the difficulty of recovering this evidence minimizes the attention paid to these material classes. In the deep past, the archaeological study of fiber technologies is more problematic because of the extreme rarity of actual exemplars of such objects. However, there are many means that archaeologists can employ to study ancient economic activities such as the processing and manufacture of goods with animal and plant derived fibers.

Osseous tools constitute an important component of the material culture of many ancient and contemporary groups, and are used in a wide range of activities. One of the major uses for bone tools is the processing and manufacture of organic artifacts such as cordage, thongs, basketry, woven fabrics, mats, nets, prepared hides, and leathers (Amato 2010; Christidou, Legrand 2005; Legrand 2008; Maigrot 2003; Owen 1994, 2005). As I will discuss below, numerous tool forms are associated ethnohistorically with the processing and production of animal and plant fibers technologies and archaeological forms may be studied to understand the past use of these more perishable materials. My work on ethnographic osseous tools was developed in the context of research on the role of different fiber sources and fiber technologies in the Upper Paleolithic of northern Spain. Given the deep time depth of Upper Paleolithic sites and the poor preservation of soft organic materials from ancient sites, other means must be used to identify the processing and working of hides, sinew, reeds, and plant fibers during the end of the Pleistocene, or in other places where direct evidence is scant. I propose that some classes of osseous tools can provide a good proxy for fiber processing and may provide direct evidence for this practice through patterns of use-related attrition.

The Social Role of Perishable Materials

In the documented ethnographic and ethnohistoric record there is strong evidence for the varied and substantial role of fiber industries in economic and social life. Perishable technologies include objects manufactured from soft fibers of both animal and vegetal origin, including hides, furs, wools, leathers, sinew, thongs, bast fibers such as nettle or flax, reeds, rushes, leaves and leaf fibers, bark, roots, and small woody stems. Among the fiber industries are cordage, felt, prepared hides and leathers, baskets, woven textiles, nets and sewn or knotted flexible structures. Perishable materials constitute a major component of material culture and fulfill important social roles among all known contemporary and historic peoples (Barber 1991; Drooker, Webster 2000; Petersen 1996; Schneider 1987). Economically, baskets and bags are crucial to many subsistence activities, while lines, cords, nets and snares play an important role in the exploitation of aquatic and small terrestrial resources. Textiles and basketry were also frequently used as trade or tribute items in the more recent past (Brumfiel 1996; Drooker, Webster 2000).

In general, material culture is used in the active construction and passive reflection of group membership, cultural affiliation, and personal agency (Sackett 1977; Wiessner 1983). Perishable technologies are particularly apt to the explicit expression of social identities. Fabrics, mats, and baskets create an important locus for the expression of individual, group, and local identity on many scales beyond their crucial economic and subsistence roles. The importance of clothing, for example, includes not only protection from the elements and other "utilitarian" aspects, but also results from its critical place in the construction and communication of social identity (Barber 1991; Burnham 1992; Drooker Webster 2000; Schneider 1987). Clothing, as the most malleable aspect of the human appearance is a rich medium through which alliances and rebellions, status, age, and position are marked. Woven fabrics and baskets are key indicators of learned technical styles that express both hidden or non-explicit aspects of conformity through the learned techniques of production, along with the more evident symbolic aspects of pattern, color and design choice (Lechtman 1977, 1984). So, fiber technologies are used in many ways and take many forms, and we cannot fully understand either economic and subsistence systems or social identities without considering perishable artifacts.

Who Produces Perishable Technologies?

Of additional interest for archaeologists is the question of *who* makes perishable technologies, from the perspective of the ethnographic and ethnohistoric records and how this can inform our studies of the past. The assumption frequently made is that weaving, sewing, basketry, and hide-working are tasks done by women. There is a strong tendency for the association of women with these tasks in the record of non-industrialized societies (Murdock, Provost 1973). However, this is an empirical observation of the known patterns over the last few hundred years. Given the broad similarities in the division of labor across many peoples, numerous scholars have grappled with understanding the forces that contribute to the gendered division of labor, and more specifically to the manifestation of patterns that seem to repeat (Adovasio *et al.* 2007; Hayden 1990; Owen 1994; Soffer *et al.* 2000). In order to make an argument about the possibility of an association of women with the production of perishable technologies in the past, we must pull apart this connection to determine whether the contemporary configuration of labor divisions are a result of chance and historical contingencies or whether there are underlying factors that might drive this patterning.

Archaeological interpretations of the context and social systems ordering the manufacture of fiber industries have been influenced by two interrelated generalizations derived from 18^{th} and 19^{th} century ethnographic research conducted within a discipline dominated by men with greater access to and interest in men's activities, as well as a greater emphasis on action and change over the maintenance of cultural practices over a longer span (González-Marcén *et al*. 2008; Wobst 1978) and guided by then-prevalent notions of the ubiquity of many aspects of Western European lifeways. The first assumption is that these activities represent, for the most part, household production. Fiber goods are ubiquitous and utilitarian and their production is conservative over time and does not vary much from household to household. Secondly, this type of production is seen as having low status, both within the living context and in contemporary archaeological research structures. It does not facilitate, in a direct and obvious manner, tasks often deemed high-status, such as large game hunting, or drive the household or seasonal organization of labor. Finally, these manufacture sequences and their end-products also do not vary greatly over time and thus are assumed to have less importance for understanding patterns of cultural change and have less to tell archaeologists interested in tracking trends in social and economic behavior. Although contemporary ethnologists have problematized the concept of tradition, the remarkable stability of certain forms, such as the eyed needle, call attention to the long-term maintenance of particularly effective technologies. These conservative technologies demonstrate the utility of certain forms for accomplishing common tasks, but study of the ethnohistoric record indicates that the maintenance of a particular form does not always indicate that the context or manner of use remain unchanged.

Given theoretical models for the allocation of labor by gender and age, and patterns in the ethnographic record, can we suggest that women, elders, and children were responsible for the production of fiber technologies in much of prehistory? The allocation of time and labor among members of a household or small foraging group is driven by the kinds of tasks required to maintain social and economic life, along with the demands of scheduling, both over the year and among group members, and is typically divided along interrelated lines of age, gender, and social status. Judith Brown (1970) argued that the primary factor in determining the subsistence contributions of men and women is the compatibility of a given subsistence activity with childcare. After noting that the contributions of women to overall subsistence vary fairly systematically with the primary subsistence resources, Brown suggests that women's work can be predicted based on the ability of subsistence labor to be combined with attention to babies and children. From this, she derives the prediction that women's work must be close to home, interruptible, monotonous, and cannot require undivided attention, silence, or isolation. Although empirically generalizable, this explanation does not account for the different ways that men and women contribute to subsistence and economics, but instead assumes that women will be preferentially engaged in subsistence, unless they are prevented from filling these roles by some other task, in this case, childcare. Thus, it describes a situation that may have historical roots and so may not be relevant in the deeper past.

Nicole Waguespack (2006) argues that when male contributions to subsistence are high, women's labor will be oriented toward the manufacture of goods and other kinds of material processing, along with the allocation of time to childcare. She suggests that by limiting our analysis of the organization of labor to subsistence and childcare, we overlook other important tasks to which time and energy must be allocated, and that might be done by different members of a society, depending on competing demands for their resources and time. Thus, it may be that women, elders and children were responsible for many of the tasks associated with fiber processing and manipulation, particularly in forager groups.

Bone Tools and the Manufacture of Fiber Technologies

The ethnographic and ethnohistoric records show that osseous tools are frequently employed in sewing, weaving, basket weaving, and hide-working (Amato 2010; Densmore 1929; Hayden 1990; Kehoe 1990, 1999; Murdoch 1892; Osgood 1940; Owen 1993, 2005). The availability of bone as a raw material, along with its anisotropic structure and the ability to produce a smooth, hard surface, make bone an ideal material for fiber-working tools. Bone is both flexible and strong and comes in sizes and shapes that lend themselves to certain forms – particularly long and slender shapes that characterize many tools for fiber-working. Before the development of metal-working technology, needles and awls of diverse forms were typically made from bone in a wide range of archaeological and ethnohistoric contexts. In fact, of the common tools used in hide-working, sewing, spinning, weaving, netting, mat-making and basketry, many were historically made with osseous materials (Table 1).

Because of the importance of bone and antler tools in the processing of plant and animal soft materials, the presence of such tools may be indicative of the production of perishable artifacts that are themselves no longer present in the archaeological record. However, because many of the functional tool types vary significantly in both morphology and precise function, *there is no one-to-one correlation* between archaeological artifacts and specific fiber technologies. In order to better clarify the connection between osseous and fiber technologies, I employ a multi-scalar approach that combines the data from ethnographic, ethnohistoric, experimental, and other sources to create a framework for the analysis of the morphology, condition and attrition from use and handling of archaeological objects.

Comparative Frameworks for Functional Analysis

General frameworks for the functional study of archaeological artifacts, including osseous industry, include the construction of comparative standards from experimentation and the study of ethnographic materials and the assessment of overall variation within and between assemblages of morphology, condition, and surface attrition patterns. Three primary methods are used to assign function to artifacts.

The first, and least reliable but most common, are simple "common sense" formal analogies that draw on our own experiences to contextualize objects and are based on the inherently functional nature of many terms. Occasionally, as in the case of the eyed needle, these analogies may be fairly reasonable, but they must be tested against more rigorous standards. In general, though, such groupings are a necessary first step in creating order in an archaeological assemblage and are complementary to methods of grouping derived from archaeological practice, such as stratigraphic, raw material or size class groups.

The second method is based on the theoretically derived models that link form, materials, context, gesture, and use. This includes the ways that we conceive of the constraints and possibilities created by the physical properties of materials, availability of different products, tools, and knowledge, and socio-economic context. Many functional analysts have made effective use of mechanical models to order their understanding of the patterning in archaeological assemblages and as a way to structure experimental protocols (Buc 2005; Campana 1989; Kamp 2001; LeMoine 1997; Ono 2005).

The third approach to the assignment of function to archaeological artifacts is the use of comparative collections with known histories. These comparative collections are of two kinds: experimental and ethnographic. Experimental programs have long formed the backbone of functional research, beginning with the seminal work by Semenov (1973). Experiments allow archaeologists to clearly and systematically link surface attrition patterns with materials, gestures, or tasks. Different variables, such as pressure, length of work or condition of raw materials can be manipulated in order to understand the contribution of distinct factors to the overall accumulation of wear. Experimental programs have been shown to be widely effective for understanding bone wear and other aspects of osseous technology (Averbouh, Christensen 2003; Buc 2005; Campana 1989; Christidou, Legrand 2005; Legrand 2008; LeMoine 1997; Letourneux, Petillon 2008; Olsen 1984; Owen 1994; Sidéra, Legrand 2006). They are most effective in situations where the local research structure allows for the long-term collaboration of numerous people with interrelated interests.

However, there are certain kinds of information that cannot be obtained through even the most careful experimental protocol. Experimental programs do not eliminate the problem of equifinality, particularly in cases of complex, layered wear (Binford 1983). Archaeologists today were rarely raised making and using flint and bone tools or hunting, gathering, processing and manufacturing all of their own possessions. This means that most of us lack the motor habits developed by skilled artisans accustomed to the use of these raw materials and activities (Hurcombe 1994, 2008a, 2008b). Additionally, many experimental archaeologists are self-taught or learn skills within the "community of practice" of which they are members: archaeologists. Thus, we learn in a context where the goals of manufacture and use are distinct from those of prehistoric practitioners. Although it is difficult to determine what kind of error we may be introducing through this novel context of use, there are reasons to believe that actions and outcome are subtly affected by intention. Archaeological experimentation is also driven by our expectations for use, and so certain kinds of wear will not be replicated in the experimental context because of both logistic and intellectual constraints on the materials, gestures and tasks tested (Owen 1999).

Finally, both the primary benefit and drawback to experimentation is the ability to simplify the history, context and pattern of use of any specific tool. This simplification is what lends experimentation its utility and elegance: the life history of the object is known, documented, and manipulated to meet the requirements of the experimenter. However, this simplicity can present obstacles when attempting to apply the models produced through the study of experimental tools to the archaeological record of objects with long and complex use histories, further complicated by post-depositional taphonomic agents and post-excavation agents.

Ethnographic materials provide an alternative and complementary comparative collection for the establishment of standards for the assessment of archaeological patterns. The two methods complement each other by providing different kinds of object life histories, each strengthening the interpretation of the other. Ethnographic objects were created and used by individuals with learned, lifelong developed motor habits and were used in a living context in which they are tools with particular uses, but may also be used expediently in diverse ways. They are also subject to handling, storage, and transport over their life history. The complex surface attrition patterns on ethnographic tools may provide a good model for archaeological surface patterns. Wear on these objects was accumulated through use, handling, transport, repair, storage, and alternative uses of tools in a lived context. Experimental tools, on the other hand, are curated in special ways in order to best maintain the surface that reflects contact with a specified material and in a particular manner. Thus, the two kinds of comparative standards are complementary.

Ethnographic Collections and the Archaeological Record

Traditionally, ethnographic analogies in archaeology have been used in two primary ways: 1) to generate testable hypotheses about the role of artifacts in the past; 2) to suggest potential meaning or non-material associations of the objects. It has generally been held that analogies are strongest when there is a direct historical connection between the living people and the producers of the archaeological assemblage and that, in the absence of a direct relation to any living people, analogies should be made between groups of people in roughly similar ecological contexts (Binford 1962, 1978; Wylie 1985). I argue that these stipulations on the cultural or ecological relations between peoples are more appropriate when the analogy is one of human actions and behavior or symbolic meaning. However, in many cases, the analogy being made, when more closely examined, is not on the behavioral scale, but rather at the scale of the artifact, or even, artifact component. Assessments of archaeological function usually operate at the artifact scale because the goal is to identify the use of the object *before* it can be situated in a social and historical context. Thus analogies are frequently invoked during speculation over possible uses or as justification of experimental or other analyses aimed at clarifying use, rather than providing behavioral explanations for material patterns.

In this study, as I am considering artifacts from an archaeological population with no direct or evident cultural links to any living peoples, I draw analogies of artifact surface similarity, organized through the lens of tribological principles. Rather than beginning from the assumption that there should be direct analogs for Upper Paleolithic tools in museum collections of objects of contemporary and historic origin, I employed a sampling strategy based on contact surfaces, focusing on osseous tools used to manipulate plant and animal fibers during basket-making, weaving, netting and hide-working in order to understand the wear patterns that result from contact between bone and soft fibers of diverse kinds. The benefit of this approach is that it resulted in an increase the range of artifacts studied, along with a larger overall sample, because I considered artifacts from any historical or contemporary group where bone tools were used to modify plant or animal fibers (Table 2).

Setting the scale of analysis to the artifact, rather than behavioral, level allows us to more effectively compare archaeological and ethnographic attrition patterns and can also be useful in cases where a behavioral analogy is not evident. When there are no strong indications to suggest a pattern of tool or material use, then a wide ethnographic sample is warranted and the scale of analysis can be organized at the level of artifact wear surface rather than activity. Focusing the level of analysis on the artifact surface permits a more precise empirical understanding of the physical outcome of contact between two known materials under known circumstances. When working in deep time this approach is particularly useful, as we have a limited understanding of the social and economic life of people in the very ancient past. The patterning in ethnographic materials can be used to explore both the range of variation in the ways that people have used bone as a raw material and the physical effects of the interaction between bone and other surfaces. The range of variation in the uses and roles of tools that are morphologically similar to tools for fiber manipulation, but have distinct functions, such as nut picks that are morphologically similar to hide-piercing awls, can also be described.

Ethnographic and Ethnohistoric Documentation

Although vast collections of ethnographic material exist in museums, the archaeological study of these artifacts has been relatively scant, as there are significant difficulties in obtaining the detailed information requisite. The kind and amount of detail can vary significantly within and between ethnographic collections, ranging from simple identifying names, such as "Awl nut pick" (NMAI 021719.000) to detailed information on the owner, context of use, and meaning, such as "Bear bone awl used in making bark utensils" (NMAI 164196.000). Accompanying documentation varies more widely. The range in the reliability and kind of documentation requires significant amounts of archival research to determine the validity of artifacts for an archaeological study. Many ethnographic artifacts will not have sufficient documentation of life history. Nonetheless, artifacts with suitably detailed and specific documentation of use are not uncommon and a large sample of usable artifacts can be obtained, albeit with significant investment of labor into sorting prior to the study of the artifacts themselves. Greater detail on my sampling strategy and different means of identifying ethnographic artifacts appropriate for archaeological comparisons can be found in Stone (2011). Here, I will describe the general aspects of artifact selection, demonstrating that most difficulties can be overcome and the information that can be gained from ethnographic material justifies their study.

Research in museums with ethnographic collections can center on two sources of information: archival and object-based. Ethnographic collections are not direct representations of the tools made and used by a particular group of people any more than archaeological records are a direct reflection of the range of materials found in the past. Nonetheless, a vast amount of information can be gleaned from the combination of physical collections and written documentation that accompanies them. Judicious use of ethnographic materials requires that the units of comparison be clearly delineated in order to determine means for accepting and eliminating objects and kinds of data.

Many museum collections were compiled in an arbitrary manner, during the course of ethnographic fieldwork. There are few systematic collections of material goods and of those that exist, none that I know of focus on tools of textile, basketry, or leather production. Thus, systematic comparison of elements in these collections requires the reorganization of objects into larger groups that necessarily gloss over myriad contextual and social variables. When the goal of study is understanding the physical signatures of artifact manufacture, use or handling, this regrouping presents no analytical problems. Additionally, the degree of detail and accuracy of the names and descriptions given to accessioned artifacts varies substantially. Most objects are given names and keywords so that they can be easily tracked in collections databases. When possible, it is important to determine if the names derive from some kind of documentary information or are determined by the museum registrar based solely on form. This can usually be determined with archival research.

Archival documents are the true key to ethnographic and ethnohistoric collections: they provide the information that links object and action. Ethnographic literature contains information about the broader social and cultural context of labor, the individuals who are responsible for different tasks, and the meaning and role of objects within a social context. Ethnohistoric studies are concerned with both historical documents and other kinds of data that contribute to an anthropological understanding of historic communities, and are uncommon outside of the Americas. Archival documents in museums may be associated with ethnographic or historic collections. These documents range in quality and format and can include formal reports, publications, letters, inventories, interviews, and other kinds of records. Reports include formal statements such as those made to the Smithsonian Institution, the Bureau of American Ethnology or earlier reports sent to colonizing governments by explorers or members of the military or religious orders. These formal statements often contain descriptions that are anecdotal in nature and were designed to give the readers back in museum or government headquarters an impression of the lives of indigenous peoples, including their daily activities and general information about their technology. The reports that arose from the first anthropological expeditions were also designed to contextualize the physical collections acquired for the Smithsonian and other museums and institutions as part of the mission of early ethnographers and historians. This arose in the context of the early post-colonial phase in which the dominant paradigm in ethnology was one of documenting "dying" cultures before they disappeared. Hence, the emphasis of early ethnographers lay in identifying extremes: the most exotic behaviors and those behaviors that seemed most familiar to them, with little in between and with minimal attention to the historic processes that contributed to the configuration of social structures (Wobst 1978).

It is also useful to remember that the American four-field approach to anthropology – which integrates the study of living peoples, human biological forms, language, and history or prehistory – was developed at this time and in the context of early interest in Native American peoples by Western intellectuals and many early collections are a result of these investigations. Additionally, early ethnographers were predominantly male, interested in male activities and because of their lack of focus and access to women's work, frequently came to the conclusion that women played little role in the social and economic spheres of indigenous communities, so documentation of women's activities is less complete than that of men's tasks and more generally, ritual.

Along with formal reports, there are numerous other kinds of documentation that may accompany ethnohistoric collections. Letters discussing the experiences of early anthropologists often contain rich details on individual instances of production and use of different tools. Additionally, letters frequently contain references to the division of labor by gender, age or social role that can illustrate some of the organization of production in these indigenous societies. Written summaries or transcripts of interviews with the owners of tools that were given to the museum are also available in some cases.

The kinds of information that can be obtained from the diverse sources of documentary evidence fall into a several groups. Of lesser interest for the study of the archaeological record, but of key importance when understanding the colonial history of anthropology in the Americas, is the embedded context of colonial and early post-colonial interaction between native groups and anthropologists and other colonial intellectuals. Letters, interviews and formal reports all reflect the context and attitudes that framed the development of anthropology as a discipline. Because we operate in a context and a discipline with this strong colonial history, it is important to consider how this impacts the analyses and narratives that we construct concerning the recent and ancient past of indigenous peoples worldwide. Early biases still perpetuate themselves through the cumulative nature of anthropological and archaeological study and hidden knowledge gaps can affect our use of ethnographic and ethnohistoric data if attention is not paid to the context in which this material was produced. Left unexamined, these biases can impact archaeological interpretation.

Ethnographic and ethnohistoric records can reveal some of the ways that objects and different raw materials have meaning within a social world filled with diverse actors. The social and ritual meaning of things can have direct impact on the choices that people make in terms of the ways that seemingly similar materials and tools are used. Bone, for example, is linked to living animals and this may or may not have significance for the way that bone is employed as a raw material. Although these patterns cannot be extrapolated directly to the archaeological record or to cross-cultural ethnographic patterns, they can help explain idiosyncrasies in the use of materials and tools. The relationship between tool makers and users and the social status of each can also help explain some kinds of variation among and between tool collections.

Of greater direct relevance to the construction of comparative standards for the study of archaeological collections, are other kinds of information relating to the manufacture, use, maintenance and discard of osseous artifacts. The most obvious and concomitantly most essential data relate to the names and functions of tools, including the amount of tolerated variation in alternate uses of tools. Some kinds of tools have very specific functions while others are generalized tools in practice, even if they have names that might imply to outsiders that they have a particular and bounded use. Additionally, the methods and social, spatial, or temporal context of manufacture, use and maintenance are often identified in ethnohistoric documentation.

Assessing Form and Function of Ethnographic Tools

After reviewing the accompanying documentation, a thorough study of ethnographic collections can effectively inform on many dimensions of bone technology. Here, I demonstrate this utility by examining one small aspect of bone tool variation. I focus on whether there is a correlation between form and function, and if so, what is the nature and prevalence of this correlation? I later assessed the range and kinds of variation in microwear on bone needles, awls, and other tools to identify patterns of attrition and wear associated with different worked materials on bone. A consideration of usewear on ethnographic tools is too extensive for the aims of this paper but can be found elsewhere (Stone 2011).

The first consideration is one of terminology and begins with the recognition that the "functional" terms that we use to describe archaeological and ethnographic objects are often fluid and contextual. For

Fig. 1. Innu (Montagnais) snowshoe needles (Courtesy, National Museum of the American Indian, Smithsonian Institution, Catalogue number 028877; Photo: E.A. Stone)

Fig. 2. Alaskan sinew-sewing needles (a: Catalogue number E24463; b: Catalogue number E89395; c: Catalogue number E89392; d: Catalogue number E89394; a-d: Department of Anthropology, Smithsonian Institution; Photos: E.A. Stone

example, a "needle" could be a *sewing needle,* used to draw a thread through a fabric, or a *tattoo needle* for drawing an inked thread through skin. It might also denote a large, broad *matting needle* for rushes and thatching or a small, dense *snowshoe needle* for netting leather thongs through a wooden snowshoe frame.

In rare cases, form and function align, as in the case of bone snowshoe needles. Found throughout the northern portion of North America, snowshoe needles are usually made of bone, although examples in wood and metal are also known. Although they vary somewhat in size, and the form of the central perforation varies, overall, snowshoe needles – flat, wide, bi-pointed, and centrally perforated – are remarkably similar (Fig. 1). Conversely, the simple "sewing needle" for use with sinew thread varies more dramatically, even within the same region and broad cultural group. Alaskan sinew-sewing needles vary in dimension, curvature, form, and can be made in ivory, bone, or later, metal (Fig. 2). Thus, in the case of the sewing needle, despite serving only one

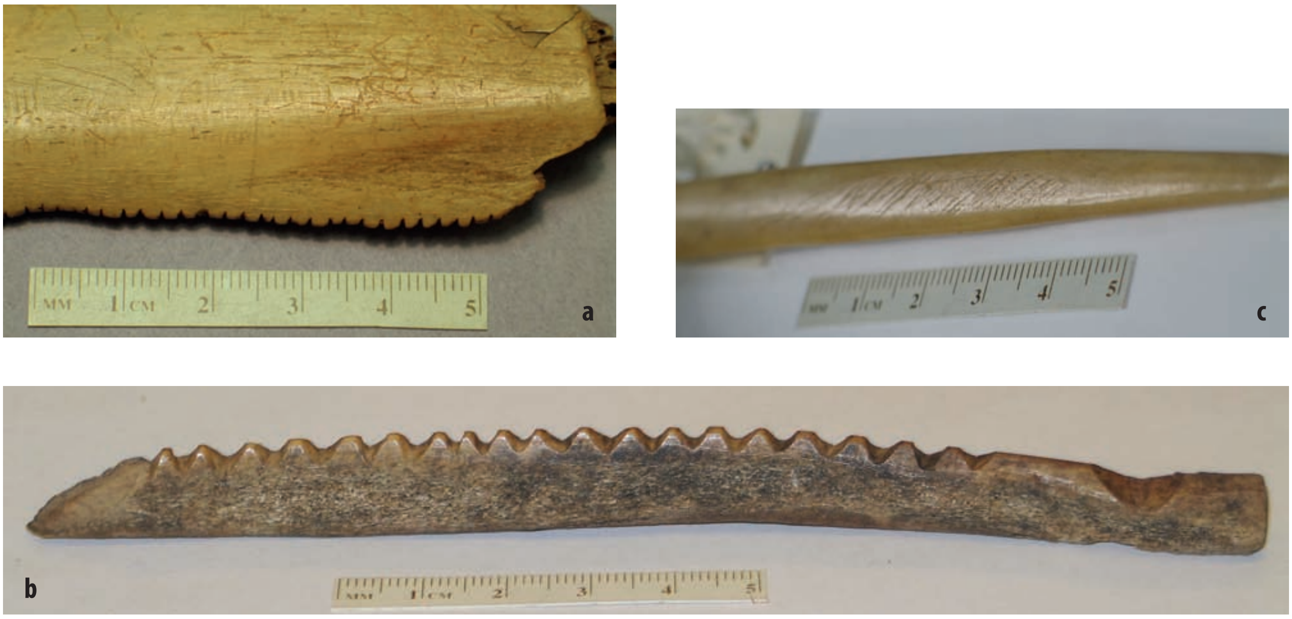


Fig. 3: Weaving battens or needles: a) Hawiku, New Mexico (Courtesy, National Museum of the American Indian, Smithsonian Institution, Catalogue number 066490, Photo: E.A. Stone); b) Inuit, Alaska (Courtesy of the Burke Museum of Natural History and Culture, Catalogue number 1996-49/12, Photo: E.A. Stone); c) Zuni, New Mexico (AMNH 50.1/8789; Courtesy of the Division of Anthropology, American Museum of Natural History, Photo: E.A. Stone)

Fig. 4: Morphologically similar tools of diverse function: a) Weaving awl; Collas Aymara (Courtesy, National Museum of the American Indian, Smithsonian Institution, Catalogue number 15/8531, Photo: E.A. Stone); b) Nut pick, Comanche, Oklahoma (Courtesy, National Museum of the American Indian, Smithsonian Institution, Catalogue number 021719; Photo: E.A. Stone); c) Basketry awl; Hopi, New Mexico (AMNH 50.1/9998; Courtesy of the Division of Anthropology, American Museum of Natural History); d) Pipe cleaner; Innu (Montagnais), Quebec, Canada (Courtesy, National Museum of the American Indian, Smithsonian Institution, Catalogue number 101433, Photo: E.A. Stone)

general function, form can vary, while the snowshoe needle is more morphologically constrained.

Tools for the same purpose may vary substantially in form, to the extent that archaeologists would rarely group them together. Weaving battens are a good example. Here, weaving battens from New Mexico and Alaska, demonstrate three approaches to accomplishing the same task, each with a distinct morphology (Fig. 3). Macroscopic and microscopic wear patterns indicate the similar gesture and materials of use for these tools, despite different morphologies.

More commonly, a shared form takes on multiple meanings, particularly in less-elaborated shapes. The ubiquitous small and pointy forms that we see in both the ethnographic and archaeological records can fall into numerous ethnographic categories, among them leather pricking awls, thread-manipulating weaving awls, knitting needles, bag pins or toggles, and more surprisingly, lice scratchers, pipe cleaners and nutpicks (Fig. 4). Context of recovery and attrition patterns would be necessary to discern difference of use in archaeological forms. Form, then, may at times reflect function but need not always do so. This is an archaeological truism, yet morphology is still frequently used as a proxy for function in day-to-day archaeological contexts.

Conclusions

Many kinds of data can be obtained from the study of objects in ethnographic and ethnohistoric museums. These data can inform on the analysis of archaeological material by providing standards for the relationship between morphology, manufacture, use, condition and meaning that complement experimentation, analogy and inter- and intra-assemblage analysis. Information on the variation of morphology of different tool types, manufacture and raw material choices can be obtained. An understanding of the morphological variability of osseous tools in the ethnographic and ethnohistoric record strengthens and enriches our approach to other analyses of archaeological tools, but variability is not the only information that can be obtained from the study of ethnographic artifacts. The patterning in tools in the ethnographic record includes form, use, wear, repair, discard, and museological aspects of tool condition and attrition. From a meta-analysis of methodology of museum collections, the study of these collections lends itself to understanding museum practices of curation and conservation and identifying changes in museum practice that might affect both ethnographic and archaeological collections. If the function and history of the tool is fairly well known, handling and wear patterns can be linked with material and gesture. Condition at time of discard can be recorded, although given the diverse ways that objects enter the museological record, this cannot indicate anything beyond the level of the individual tool. In some cases, the information generated through experimentation and archaeological study might help clarify the history of some ethnographic objects, as the assigned names and functions can be assessed based on artifact surface attrition.

The ethnographic and ethnohistoric record provides a rich source of information on material culture and its role in human lifeways. By emphasizing the study of physical objects with the methodologies developed within archaeology and structuring an analysis at the artifact level, useful comparative standards can be constructed from ethnographic collections. Many of the common methods of archaeological analysis can be applied to museum collections, but only after extensive archival documentation. The unprecedented magnitude and variability of ethnographic collections can provide an extraordinary resource for archaeologists that is currently underutilized because of fears about the reliability of ethnographic documentation. Archaeologists need not assume that ethnographic collections lack the appropriate documentation for archaeological study, as this is only sometimes the case. Consideration of the history of these collections as an integral part of ethnographic artifact sample selection allows more complex and sophisticated analyses of archaeological collections and can enhance both artifact study and the development of more inclusive and holistic interpretations of the past.

Table 1: Tools Used Ethnographically in the Production of Fiber Technologies

Tools	**Raw Material**	**Activities**
Spindles	Wood	Spinning
Spindle whorls	Clay, ceramic, shell, stone	Spinning
Combs	Bone, antler, wood	Fiber separation, ordering and cleaning; weaving.
Scrapers	Stone, bone, metal	Hide preparation; bark peeling
Smoothers	Stone, bone, metal	Hide preparation
Needles	Bone, antler, ivory, wood, metal	Sewing; weaving; tattooing
Awls	Bone, antler, ivory, metal	Piercing; fiber manipulation in weaving; thread guiding
Battens or weaving swords	Bone, wood	Weaving
Frames, looms	Wood	Weaving; hide-working
Loom weights	Stone, clay, ceramic	Weaving; dying
Tubs, baths	Stone, ceramic, earthen, wood	Dying; retting; tanning
Dyes, mordants, tannins	Vegetal and mineral sources	Dying; tanning
Blades and knives	Stone, metal	Fiber procurement, processing, and preparation; object finishing; varied tasks
Hooks, gauges	Bone, wood, baleen	Netting, crocheting
Knitting needles	Bone, wood, metal	Knitting
Hands		Basketry, weaving, netting, knotting, spinning

Table 2: Ethnographic Collections Studied

Origin Area	**Eyed Sewing Needles**	**Eyed Snowshoe Needles**	**Eyed Mat Needles**	**Eyed Fish Needles; Large Needles Use Unk.**	**Completely Worked Awls**	**Articular Awls**	**Basketry Awls**	**Weaving Awls & Batens**	**Net Needles & Guages**	**Bone Points**	**Pins, Bodkins**	**Wound Plugs, Pegs**	**Hide Scrapers**	**Worked Rib Tools**	**Total**
Arctic	32	13		15	14	11	3	3		18	12	5		5	**131**
Calif. Coast				1	1	12	4			2	1	13		1	**35**
NE N. Am.	18	68	22	4	9	16				2		5	2	1	**147**
Pacific NW	1		32	1	9	28	7		12	5		12			**107**
N. Am. Plains	3	4	37	1	4	4		1		1		4	1		**60**
Oceania			10	1		11	4	1							**27**
SE Asia							1								**1**
Siberia				2											**2**
SW N. Am.	1				5	26	9	11							**52**
Andean	3				1	5	6	2	1						**18**
SW S. Am.						2									**2**
TOTAL	**58**	**85**	**101**	**25**	**43**	**115**	**34**	**18**	**13**	**28**	**13**	**39**	**3**	**7**	**582**

[*] types drawn from museum catalogs; Museums are the American Museum of Natural History, Burke Museum of Natural History and Culture, Smithsonian Institute National Museum of Natural History and the Smithsonian Institute Museum of the American Indian; Am. = America; Calif. = California

Acknowledgements

Ann Ramenofsky and Emira Ibrahimpasic provided valuable comments on an earlier draft of this paper. Many thanks to Laila Williamson (AMNH); Rebecca Anderson (Burke); Felicia Pickering, Anta Montet-White (NMNH); Pat Nietfeld, Tony Williams, Robert Marvin Garcia Hunt, Tom Evans (NMAI) for their assistance and insight during the course of collections research. This research has been supported by the NSF Graduate Research Fellowship Program, NSF Doctoral Dissertation Improvement Grant, the Office of Graduate Studies at UNM, the UNM Graduate and Professional Student Association and UNM Career Services.

References

Adovasio, J. M., O. Soffer and J. Page 2007. *The Invisible Sex: Uncovering the True Roles of Women in Prehistory*, New York: Smithsonian Books/Harper Collins.

Amato, P. 2010. *Sewing with or without a needle in the Upper Palaeolithic?* In: A. Legrand-Pineau, I. Sidera, N. Buc, E. David, and V. Scheinsohn (eds.) *Ancient and Modern Bone Artefacts from America to Russia,* BAR International Series S2138, Oxford: Archaeopress, 201-210.

Averbouh, A. and M. Christensen 2003. *Transformation et utilisation préhistoriques des matières osseuses: Actualité des recherches universitaires en France 2000-2004,* Préhistoire Anthropologie méditerranéennes 12, 55-208.

Barber, E. W. 1991. *Prehistoric Textiles: The Development of Cloth in the Neolithic and Bronze Ages with Special Reference to the Aegean*, Princeton: Princeton University Press.

Binford, L. R. 1962. *Archaeology as Anthropology*, American Antiquity 28(2), 217-25.

Binford, L. R. 1978. *Nunamiut Ethnoarchaeology,* New York: Academic Press.

Binford, L. R. 1983. *In pursuit of the past*, London: Thames and Hudson.

Brown, J. K. 1970. *A Note on the Division of Labor by Sex*, American Anthropologist 72(5), 1073-8.

Brumfiel, E. M. 1996. *The Quality of Tribute Cloth: The Place of Evidence in Archaeological Argument,* American Antiquity 61(3), 453-62.

Buc, N. 2005. *Análisis de microdegaste en tecnología ósea. El caso de punzones y alisadores en el noreste de la provincia de Buenos Aires (humedal del Paraná inferior),* Buenos Aires: Universidad de Buenos Aires.

Burnham, D. K. 1992. *To Please the Caribou: Painted Caribou-Skin Coats Worn by the Naskapi, Montagnais and Cree Hunters of the Quebec-Labrador Peninsula*, Seattle: University of Washington Press.

Campana, D. V. 1989. *Natufian and Protoneolithic Bone Tools: The Manufacture and Use of Bone Implements in the Zagros and the Levant,* BAR Intern. Series 396, Oxford Archaeopress.

Christidou, R. and A. Legrand 2005. *Hide working and bone tools: experimentation design and applications*, In: H. Luik, A.M. Choyke, C.E. Batey, and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Proceedings of the 4th Meeting of the Worked Bone Research Group, Tallinn, Estonia, August 2003,* Muinasaja teadus 15, Tallinn, 385-396.

Croes, D.R. 1997. *The north-central cultural dichotomy on the Northwest coast of North America: its evolution as suggested by wet-site basketry and wooden fish-hooks,* Antiquity 71, 594-615.

Densmore, F. 1929. *Chippewa Customs*. Washington, DC: Smithsonian Institution Bureau of American Ethnology.

Drooker, P. B. and L. D. Webster. 2000. *Beyond cloth and cordage: archaeological textile research in the Americas* Salt Lake City: University of Utah Press.

González-Marcén, P., S. Montón-Subías and M. Picazo 2008. *Towards an archaeology of maintenance activities,* In: S. Montón-Subías, and M. Sánchez-Romero (eds.) *Engendering Social Dynamics: The Archaeology of Maintenance Activities*, BAR Intern. Series 1862, Oxford: Archaeopress, 3-8.

Hayden, B. 1990. *The Right Rub: Hide Working in High Ranking Households*, In: B. Gräslund, H. Knutsson, K. Knutsson and J. Taffinder (eds.) *The interpretive possibilities of microwear studies: proceedings of the International Conference on Lithic Use-wear Analysis*, Uppsala: Societas Archaeologica Upsaliensis, 89-102.

Hurcombe, L. 1994. *Plant-Working and Craft Activities as a Potential Source of Wear Variation,* Helinium XXXIV(2), 201-9.

Hurcombe, L. 2008a. *Looking for prehistoric basketry and cordage using inorganic remains: the evidence from stone tools*, In: L. Longo and N. Skakun (eds.) *"Prehistoric Technology" 40 years later: Functional Studies and the Russian Legacy*, BAR Intern. Series 1783, Oxford: Archaeopress 205-16.

Hurcombe, L. 2008b. *Organics from inorganics: using experimental archaeology as a research tool for studying perishable material culture*, World Archaeology 40(1), 83-115.

Kamp, K.A. 2001. *Where Have All the Children Gone? The Archaeology of Childhood*, Journal of Archaeological Method and Theory 8(1), 1-34.

Kehoe, A.B. 1990. *Points and Lines*, In: S.M. Nelson, and A.B. Kehoe (eds.) *Powers of Observation: alternative views in archeology* 2, Washington, DC: American Anthropological Association, 23-37.

Kehoe, A.B. 1999. *Warping Prehistory: Direct Data and Ethnographic Analogies for Fiber Manufactures*, Urgeschichtliche Materialhefte 14, 31-41.

Lechtman, H. 1977. *Style in Technology – Some Early Thoughts*, In: H.L. a. R. Merrill (ed.) *Material Culture: Styles, Organization and Dynamics of Technology*, New York: West, 3-20.

Lechtman, H. 1984. *Andean Value Systems and the Development of Prehistoric Metallurgy*, Technology and Culture 25(1), 1-36.

Legrand, A. 2008. *Neolithic bone needles and vegetal fibres working: experimentation and use-wear analysis*, In: L. Longo and N. Skakun (eds.) *"Prehistoric Technology" 40 years later: Functional Studies and the Russian Legacy*, BAR Intern. Series 1783, Oxford: Archaeopress, 445-50.

LeMoine, G.M. 1997. *Use Wear Analysis on Bone and Antler Tools of the Mackenzie Inuit*, Oxford: Hadrian Books.

Letourneux, C. and J. Petillon 2008. *Hunting lesions caused by osseous projectile points: experimental results and archaeological implications*, Journal of Archaeological Science 35(10), 2849-62.

Maigrot, Y. 2003. *Etude technologique et fonctionnelle de l'outillage en matières dures animales: La station 4 de Chalain (Néolithique final, Jura, France)*, unpublished PhD thesis, , Paris: Université de Paris I.

Murdoch, J. 1892. *Ethnological Results of the Point Barrow Expedition*, In: J.W. Powell (ed.) Ninth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution 9, 615, Washington, D.C.: Government Printing Office.

Murdock, G. P. and C. Provost 1973. *Factors in the Division of Labor by Sex: A Cross-Cultural Analysis*, Ethnology 12(2), 203-25.

Olsen, S.L. 1984. *Analytical Approaches to the Manufacture and Use of Bone Artifacts in Prehistory*, London: University of London.

Ono, A. 2005. *Fracture Patterns of Bone in Archaeological Contexts: Significance of the Casper Site Materials*, The Wyoming Archaeologist 42(9), 15-48.

Osgood, C. 1940. *Ingalik material culture*, New Haven: Yale University Press.

Owen, L. 1993. *Materials worked by hunter and gatherer groups of northern North America: implications for use-wear analysis*, In: P.C. Anderson, M. Otte and H. Plisson (eds.) *Traces et fonction: les gestes retrouvés*, 1, Liège: Centre de Recherches Archéologiques du CNRS, 3-12.

Owen, L. 1994. *Gender, Crafts, and the Reconstruction of Tool Use*, Helenium XXXIV(2), 186-200.

Owen, L. 1999. *Questioning Stereo-Typical Notions of Prehistoric Tool Functions – Ethno-Analogy, Experimentation and Functional Analysis*, Urgeschichtliche Materialhefte 14, 17-30.

Owen, L. 2005. *Distorting the Past: Gender and the Division of Labor in the European Upper Paleolithic*, Tübingen: Kerns Verlag.

Petersen, J.B. 1996. *A most indispensable art: native fiber industries from eastern North America* (1st ed.), Knoxville: University of Tennessee Press.

Sackett, J.R. 1977. *The Meaning of Style in Archaeology: A General Model*, American Antiquity 42(3), 369-80.

Schneider, J. 1987. *The Anthropology of Cloth*, Annual Review of Anthropology 16, 409-48.

Semenov, S.A. 1973. *Prehistoric Technology* (3rd edition ed.), Bath: Adams and Dart.

Sidéra, I. and A. Legrand 2006. *Tracéologie fonctionnelle des matières osseuses: une méthode*, Bulletin de la Société préhistorique française 103(2), 291-304.

Soffer, O., J.M. Adovasio and D.C. Hyland 2000. *The "Venus" figurines – Textiles, basketry, gender, and status in the upper Paleolithic*, Current Anthropology 41(4), 511-37.

Stone, E.A. 2011. *Through the Eye of the Needle: Investigations of Ethnographic, Experimental, and Archaeological Bone Tool Use Wear from Perishable Technologies.* Unpublished PhD Dissertation. Albuquerque: University of New Mexico.

Tuross, N. and M. L. Fogel 1994. *Exceptional Molecular Preservation in the Fossil Record: The Archaeological, Conservation, and Scientific Challenge*, In: D.A. Scott and P. Meyers (Eds.) *Archaeometry of Pre-Columbian Sites and Artifacts: Proceedings of a Symposium organized by the UCLA Institute of Archaeology and the Getty Conservation Institute, Los Angeles, California, March 23-27, 1992*, Los Angeles: Getty Conservation Institute, 367-80.

Waguespack, N.M. 2006. *The Organization of Male and Female Labor in Foraging Societies: Implications for Early Paleoindian Archaeology*, American Anthropologist 107, 666-76.

Wiessner, P. 1983. *Style and Social Information in Kalahari San Projectile Points*, American Antiquity 48(2), 253-76.

Wobst, H.M. 1978. *The Archaeo-Ethnology of Hunter-Gatherers or the Tyranny of the Ethnographic Record in Archaeology*, American Antiquity 43(2), 303-9.

Wylie, A. 1985. *The reaction against analogy*, Advances in Archaeological Method and Theory 8, 63-111.

Materials and technology

Aline Averbouh, Jean-Marc Pétillon

Identification of "debitage by fracturation" on reindeer antler: case study of the Badegoulian levels at the Cuzoul de Vers (Lot, France)

"Debitage by fracturation" is defined as the fracturing of a block by knapping in order to produce flakes. Until recently, it was considered that this method played a minor role in the production of osseous tools during the European Upper Paleolithic, and that it was rarely applied to reindeer antler, especially after the introduction of "debitage by extraction" in the Gravettian. However, recent studies show that debitage by fracturation may hold a predominant place in antler working during certain chrono-cultural phases. This could be the case of the Badegoulian, a culture contemporary with the Last Glacial Maximum and dated ca. 23,000-20,500 cal BP in Western Europe. This issue is addressed here through the study of the Badegoulian antler assemblage from the Cuzoul de Vers rockshelter (Lot, France). Our analysis shows that the two components of the antler assemblage (110 finished objects and 648 waste products and blanks) are technologically compatible and complementary, and attest to the production of blanks through debitage by fracturation for the manufacture of wedges and projectile points.

Keywords: Upper Paleolithic, Badegoulian, Cuzoul de Vers, reindeer antler, antler technology, debitage by fracturation.

During the Upper Paleolithic, two major modes of blank production dominate the exploitation of antler: "debitage by segmentation" and "debitage by extraction" (terminology after Averbouh 2000). "Debitage by segmentation" (Fig. 1:1) is the division of the antler in segments to be used as blanks for the manufacture of objects such as spearthrowers, perforated staffs (*bâtons percés*), etc. It is a transversal operation, usually made by the cutting, grooving and/or chopping techniques. "Debitage by extraction" (Fig. 1:2) is the extraction of the blank from the outer part of the antler. It is a longitudinal operation often done by the grooving procedure (the so-called "groove-and-splinter technique": Averbouh 2000; Clark, Thompson 1953; Goutas 2009; Semenov 1973; etc.). The blanks are shaped into artifacts such as projectile points, certain types of wedges and chisels, etc. However, a third mode of blank production, "debitage by fracturation", seems to dominate the transformation of antler during one particular period: the Badegoulian.

"Debitage by fracturation" consists in the fracturing of the block by knapping in order to produce flakes. This method has long been documented for bone working; its use on antler was first mentioned by J. Allain and colleagues in 1974 in the Badegoulian assemblage of the Fritsch shelter (Indre, central France: Allain *et al*. 1974). These authors also stress that no evidence of the groove-and-splinter technique is present in this assemblage, and suggest that this combination (presence of debitage by fracturation and absence of the groove-and-splinter technique)

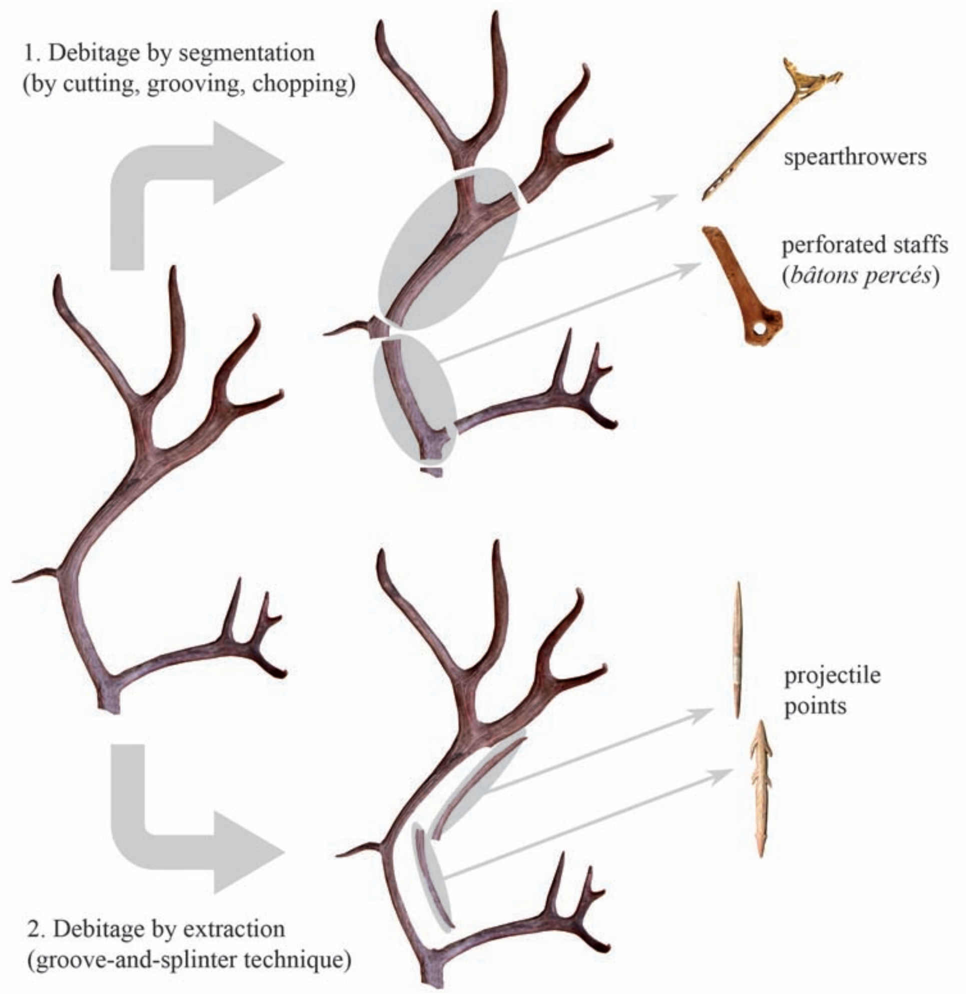


Fig. 1. The two major modes of antler exploitation in the Upper Paleolithic, and examples of typical products. 1: debitage by segmentation; 2: debitage by extraction (spearthrower picture by P. Cattelain; picture of perforated staff by the Pincevent CRP; all other pictures in the article are by J.-M. P. unless otherwise stated)

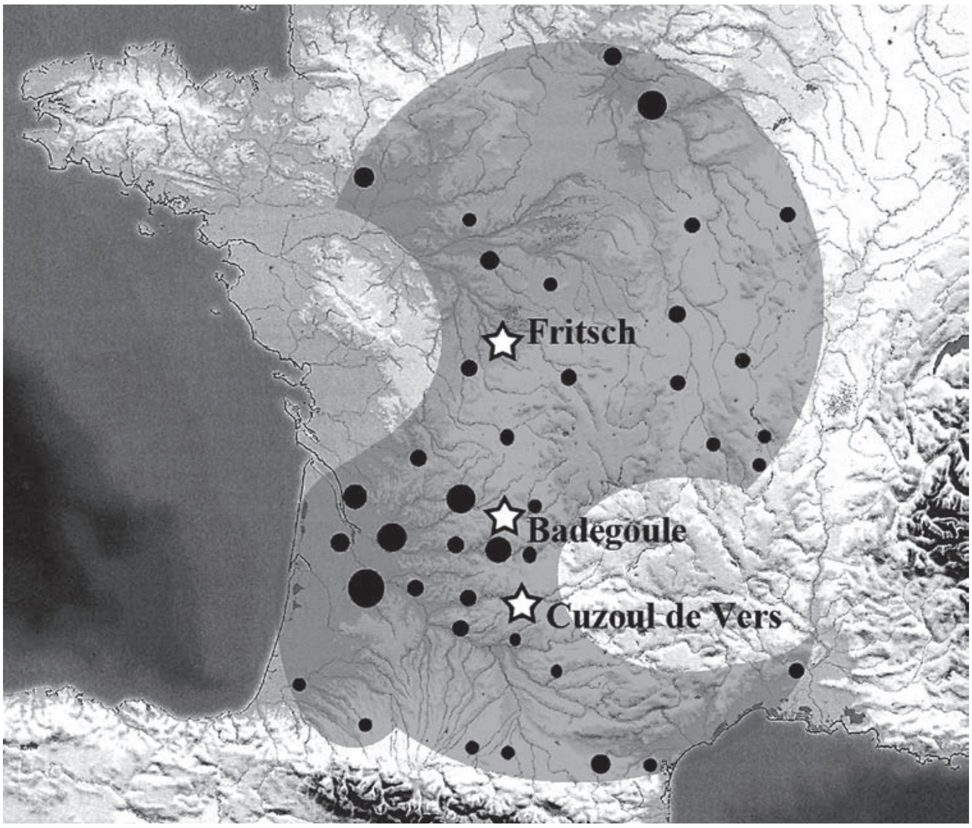


Fig. 2. Map of the Badegoulian sites (black dots) and the supposed distribution area of the Badegoulian culture in France (grey area). Sites mentioned in the text are indicated by white stars. Map after Demars 1996; Bodu et al. 2005

Fig. 3. Antler artifacts from the Badegoulian levels in Cuzoul de Vers. 1-3: wedges. 4 and 6: fragments of projectile points. 5: complete self-barbed point and its probable hafting mode

Fig. 4. Antler fragments with post-depositional breaks

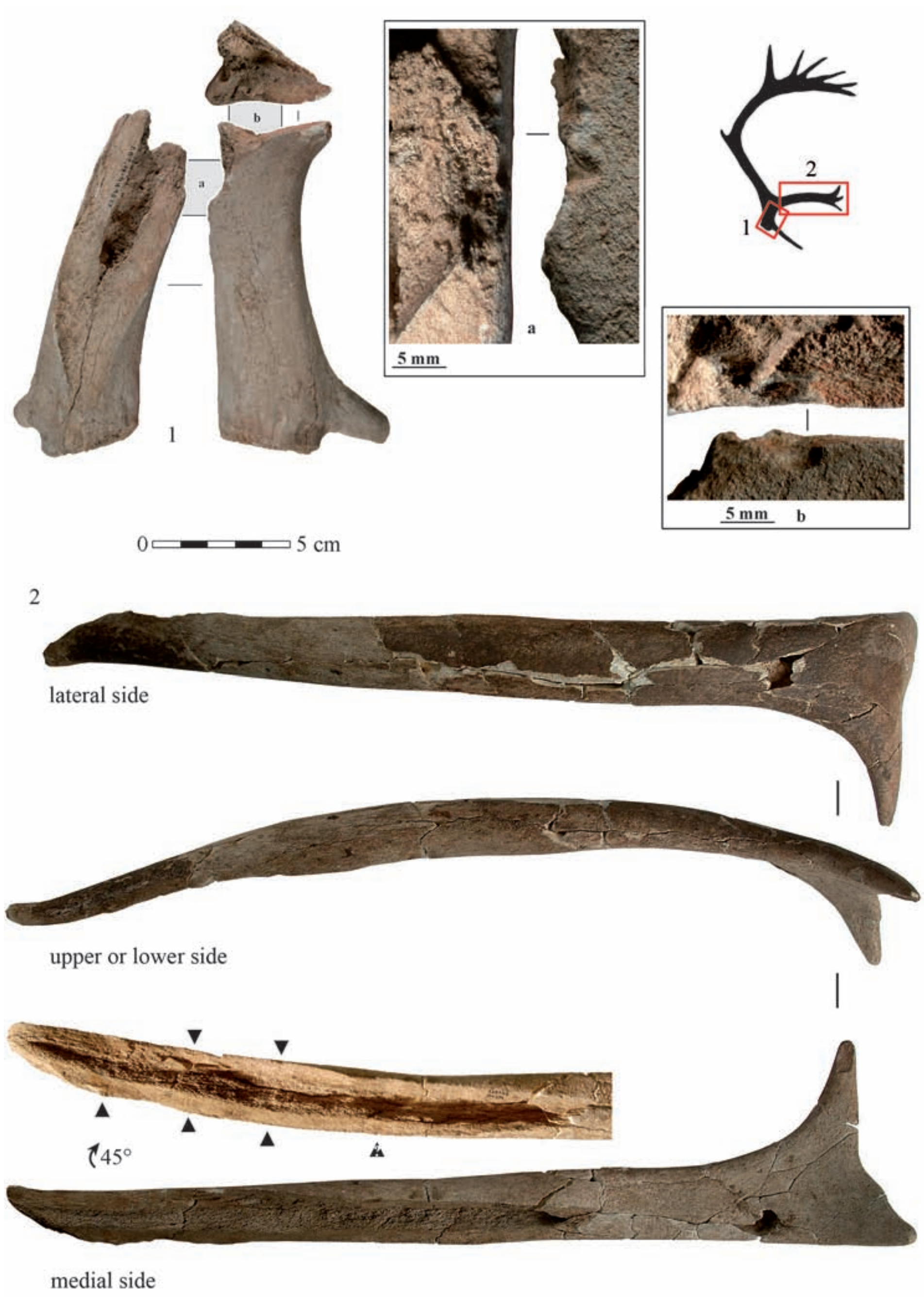


Fig. 5. Antler parts from which flakes were knapped off. 1: base of a large shed antler with the negative removal of a flake on the posterior side, and a breakage of the anterior side at the base of the tine; a, b: detail views of the percussion marks. 2: second tine of a large antler with several flake removals on the medial side; with detail view of the knapped part under low-angled light (black arrows: indication of the percussion points; detail picture: J.-F. Peiré, DRAC Midi-Pyrénées)

is specific for the Badegoulian antler technology. For more than 30 years however, the Badegoulian antler technology remained largely unstudied and Fritsch stood as the only published case of antler debitage by fracturation in the European Upper Palaeolithic (Averbouh 2006, Averbouh in press; Rigaud 2004).

In this article we briefly summarize the results of the technological study of the antler industry from the Badegoulian levels of the Cuzoul de Vers shelter (Lot, southwest France). This antler assemblage, studied in the context of the site monograph (Pétillon, Averbouh in press), is larger than the Fritsch collection and gives new insights into Badegoulian antler working.

Archeological context

The Badegoulian was named after the upper levels of Badegoule shelter (Dordogne, southwest France: Peyrony 1908). Its recognition as a specific archeological culture was a late and complex process, whose summary is beyond the scope of this article. Briefly speaking, the Badegoulian was officially

Fig. 6. Antler flakes

defined by J. Allain and his collaborators between the 1960s and the 1980s (Allain 1983, 1989; Allain, Fritsch 1967; Allain *et al*. 1974); in the 1990s and the 2000s, it has been the subject of many studies mostly centered on lithic technology (see Ducasse 2010, and contributions in Bodu *et al*. 2007). Badegoulian sites were identified only in France (Fig. 2), although there might be related assemblages in the Iberian Peninsula (Aura Tortosa 2007). In the cultural chronology of the Upper Palaeolithic in southwest Europe,

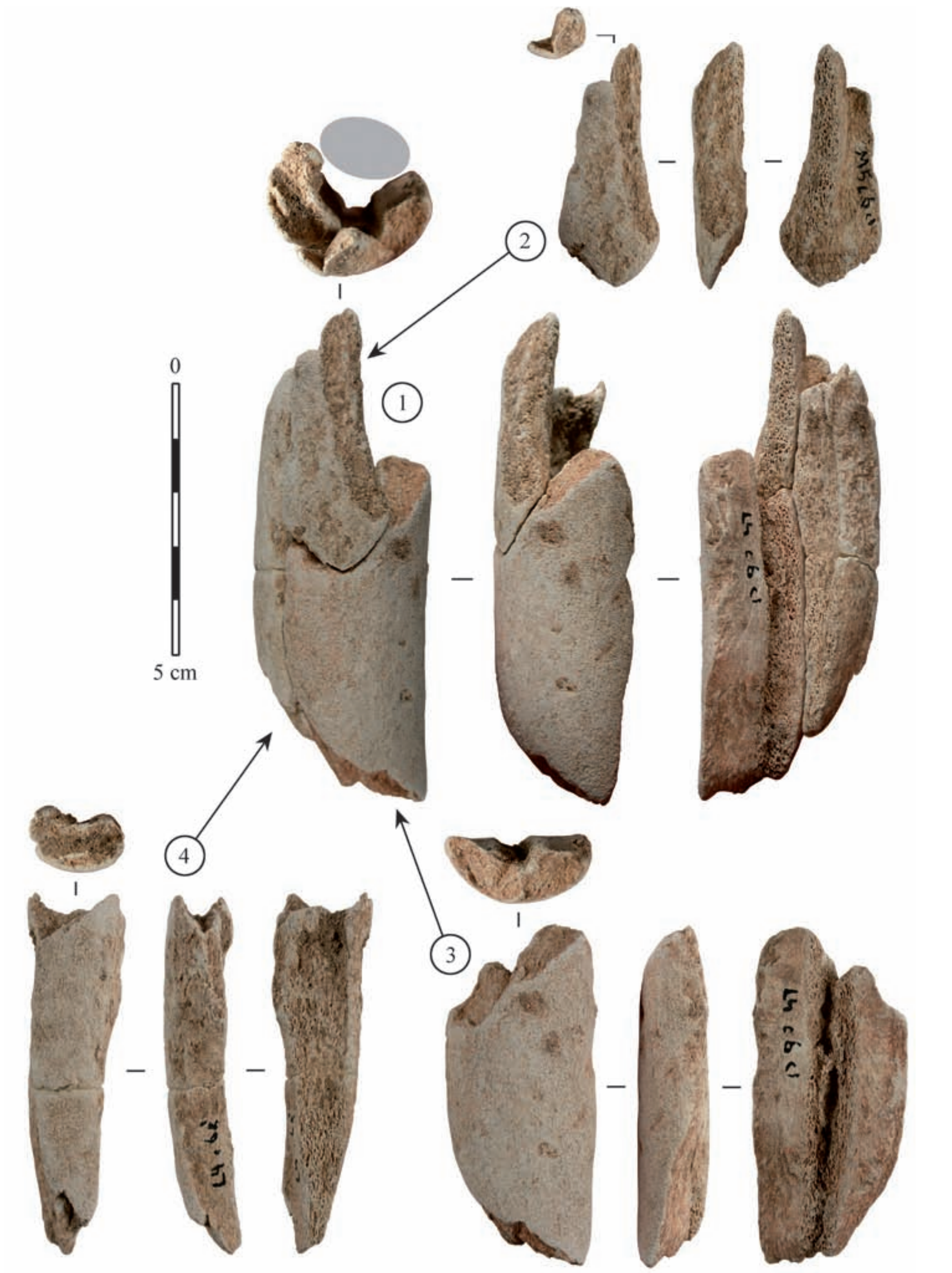


Fig. 7. Sequence of four flake removals from one segment of antler beam. 1-4: order of knapping; flake 1 is missing but its negative is still visible on flakes 2 and 3. Light grey oval: missing part of the antler circumference (likely corresponding to the blank sought by the knapper; see text)

the Badegoulian spans the gap between the Solutrean and the Magdalenian. The most reliable radiocarbon dates place it between 23,000 and 20,500 cal BP, during the Last Glacial Maximum, contemporary with the Ancient Epigravettian in southeast Europe – while most of northern Europe was uninhabited because of the extreme cold conditions.

The Cuzoul de Vers is a small rockshelter (ca. 30 square meters), located in southwest France (Lot), and excavated in 1982-1986 by J. Clottes and J.-P. Giraud (Clottes, Giraud 1986, 1989, 1996; Clottes *et al*. in press). The stratigraphy is 2.5-3 meters thick; from the 31 layers identified during the excavation, three (layers 29-31) were attributed to the Upper Solutrean, but the 28 overlying layers all yielded exclusively Badegoulian remains. A series of AMS radiocarbon dates place this Badegoulian approximately between 23,500 and 21,500 cal BP.

The antler assemblage

No differences in antler working techniques were observed from one layer to the other, and the antler material from the entire Badegoulian stratigraphy will thus be considered here as a single assemblage.

Fig. 8. Sequence of five flake removals from the lateral side of the beam of a large antler. 1-5: order of knapping; flake 1 is missing but its negative is still visible on flake 2. Black arrows: indication of the percussion points

Fig. 9. Antler "rods" shaped by percussion; possible blanks for tool manufacture

The preservation of this assemblage is quite mediocre, with an intensive post-depositional fragmentation and a frequent alteration of the surfaces of the artifacts. Only reindeer antler was identified, to the exclusion of other cervid species; reindeer is also, by far, the main game hunted by the Badegoulian groups at this site (Castel 1999).

Two components could immediately be distinguished in the antler assemblage:
– 110 finished or half-finished objects and fragments (Fig. 3). The objects that could be typologically identified are almost exclusively projectile points of small dimensions and large wedges (or chisels). All the objects are entirely shaped by scrap-

ing, thus the traces of blank production are no longer visible.

– 1,022 apparently unmodified antler fragments, with very varied dimensions.

The interpretation of the second component proved difficult. It was first necessary to distinguish between fractures on "dry" antler (likely resulting from post-depositional breakage) from fractures on "fresh" or "green" antler (possibly linked to human activity, i.e., antler knapping). While there exists an abundant literature on this topic for bone material ("fracture on dry bone" *vs*. "fracture on green bone": Aguirre 1985, 1986; ETTOS 1985; Tartar 2009; Villa, Mahieu 1991; etc.), no comparable work has been done for antler. We thus selected several criteria, based on our experience and on discussions with colleagues. We determined that on "dry" antler, the fracture plane and the outer surface of the antler form a wide angle (often close to 90°) and that the fracture surface can appear irregular, rough, but not fibrous. We thus considered that the 374 fragments that displayed only this kind of fractures (Fig. 4) were exclusively the result of post-depositional breakage; these 374 elements were excluded from the study. On the other hand, we could determine that on "green" antler, the fracture plane and the outer surface of the antler form a narrow angle (often less than 45°: "tongued" fracture) and that the fracture surface shows the fibrous structure of the material. Moreover, the extremity of the fracture surface can be irregular ("step-terminating" or "hinge-terminating" fractures: Pétillon 2006). At the Cuzoul de Vers, it is very unlikely that these fractures are related to carnivore activity, as the impact of carnivores on the faunal stock in general is negligible and traces of their intervention are almost absent on the bone remains (Castel 1999). Antler fracturing is thus an anthropic action. Of course, and contrary to bone, this action cannot be aimed at marrow collecting, marrow being absent in antler. The preparation of antler fragments as "osseous fuel" for hearths is also very unlikely (the fragments do not show any traces of burning). We thus concluded that the 648 fragments with "green" fractures were related to antler debitage activities.

The assemblage of anthropically-fractured antler consists of two complementary categories. On the one hand, there is a small collection of antler parts from which flakes were knapped off. Two examples are given in fig. 5. The base of a large shed antler (Fig. 5:1) shows the negative removal of a large flake on the posterior side, and a breakage of the anterior side at the base of the tine. In both cases, there are traces of transversal percussion – most probably direct percussion with a stone hammer (as shown by the presence of the notch, or percussion pit, and the negative bulb). The second tine of a large antler (Fig. 5:2) has had its medial side almost completely "peeled off" by the knapping of several flakes, the strokes being given from both lower and upper sides; here again, antler knapping was made by transversal percussion, likely direct percussion with a stone hammer.

On the other hand, the antler assemblage includes hundreds of flakes (Fig. 6), most of which are 2 to 6 cm long (mean length = 42 mm; maximum length = 20 cm). Some of them also bear traces of transversal percussion. Six flake refittings could be made, and were especially helpful in reconstructing the operatory sequence. Two are shown on fig. 7 and 8. A sequence of four flake removals from the same section of antler (Fig. 7) shows that what is left after the knapping operation is an antler "rod" representing about one third of the original circumference of the antler. A sequence of five flake removals from the lateral side of the main beam of a large antler shows that flaking started on the upper part of the antler and went down to the base, while percussion traces indicate that the strokes were given from alternate sides (Fig. 8).

Technological interpretation

The aim of the technological analysis is to answer the question: "what did they do this for?" – in other words: what was the objective of the debitage? In this case, it first seems that we have to deal with a flake production: the flakes would be the products sought by the antler knapper. These flakes, however, are not used as tools (they do not present any use-wear traces). They do not seem to be used as blanks either: in the assemblage of finished and half-finished objects, there is no population of artifacts that could be shaped from flake blanks (the morphology and dimensions of the two categories do not fit). Thus the flakes are most likely the waste products of the knapping process.

In this case, the objective of the debitage would be "the part that is left after the flakes have been taken off". Indeed, the knapped antler portions (Fig. 5) and the flake refittings (Fig. 7-8) show that the principle of the debitage is to knap off one half – or even the two-thirds – of the circumference of the antler beam or tine. Thus, what is left of the antler is a "rod" that represents one third to one half of the original circumference of the antler. Several artifacts in the Cuzoul de Vers actually fit this description (Fig. 9), as does the knapped part of the large tine shown on fig. 5:2; all could be examples of the type of blanks that the knapper intended to produce. This hypothesis is supported by the fact that their dimensions are compatible with even the largest finished antler tools from the Cuzoul de Vers assemblage (Fig. 3:1-3): it is technically possible that the finished tools from Cuzoul de Vers were manufactured from such blanks, but since these tools are all entirely shaped by scraping, traces of blank production are no longer visible.

Perspectives

Beyond the case of the Cuzoul de Vers and the question of Badegoulian antler working, the purpose of this presentation is to attract the reader's attention on the identification of antler flakes as evidence of debitage by fracturation. Given the difficult technological diagnosis of this antler working procedure – as compared to the more "classic" groove-and-splinter procedure – we believe that other occurrences of antler knapping in different sites and periods might have gone unnoticed. Actually, this reassessment work has started already: at the time when this article is being written, studies in progress are showing that antler debitage by fracturation is attested in several sites in southwest France, attributed to the Badegoulian or to other Upper Paleolithic cultures.

References

Aguirre, E. 1985. *Torralba: débitage d'ossements d'éléphants, approche d'une analyse morphotechnique*, In: E. Aguirre and M. Patou (eds.) *Outillage peu élaboré en os et en bois de cervidés, Deuxième réunion du groupe de travail n° 1 sur l'industrie de l'os préhistorique*, Paris, Viroinval, C.E.D.A Ed., Artefacts 1, 33-46.

Aguirre, E. 1986. *Format et technique dans la fracturation d'ossements à Torralba (Soria, Espagne)*, In: E. Aguirre and M. Patou (eds.) *Outillage peu élaboré en os et en bois de Cervidés II, Troisième réunion du groupe de travail n°1 sur l'industrie de l'os préhistorique*, Paris, Viroinval, C.E.D.A. Ed., Artefacts 3, 81-92.

Allain, J. 1983. *Matériaux pour l'étude du «Magdalénien initial» et de ses origines*, Bulletin de la Société Préhistorique Française 80, 135-9.

Allain, J. 1989. *La Fin du Paléolithique supérieur en région Centre*, In: J.-P. Rigaud (ed.) *Le Magdalénien en Europe. La structuration du Magdalénien.* Actes du colloque de Mayence 1987, ERAUL 38, Liège: Université de Liège, 193-217.

Allain, J. and R. Fritsch 1967. *Le Badegoulien de l'abri Fritsch aux Roches de Pouligny-Saint-Pierre (Indre),* Bulletin de la Société Préhistorique Française 64, 83-93.

Allain, J., R. Fritsch, A. Rigaud and F. Trotignon 1974. *Le Débitage du bois de renne dans les niveaux à raclettes du Badegoulien de l'abri Fritsch et sa signification*, In: H. Camps-Fabrer (ed.) *Premier colloque international sur l'industrie de l'os dans la Préhistoire*, Abbaye de Sénanque, Aix-en-Provence: CNRS / Ed. de Provence, 67-71.

Aura Tortosa, J.-E. 2007. *Badegouliens et Magdaléniens du versant méditerranéen espagnol*, Bulletin de la Société Préhistorique Française 104, 809-24.

Averbouh, A. 2000. *Technologie de la matière osseuse travaillée et implications palethnologiques*, Université de Paris I Panthéon-Sorbonne: Ph.D. Dissertation.

Averbouh, A. 2006. *Le Travail des matières osseuses: une activité marginale des occupants de l'unité T125*, In: P. Bodu, M. Julien, B. Valentin and G. Debout (eds.) *Un dernier hiver à Pincevent : les Magdaléniens du niveau IV0 (Pincevent, La Grande Paroisse, Seine-et-Marne),* Gallia Préhistoire 48, 83-9.

Averbouh, A. In press. *Continuité ou rupture dans le travail des matières osseuses du Badegoulien au Magdalénien moyen, communication à la séance de la Société préhistorique française, 9 décembre 2006,* Toulouse.

Bodu, P., G. Debout and Y. Taborin 2005. *De la parure chez les Badegouliens du Bassin parisien. Le cas du site de Oisy dans la Nièvre*, In: V. Dujardin (ed.) *Industrie osseuse et parures du Solutréen au Magdalénien en Europe*, Paris: Société préhistorique française, 87-99.

Bodu, P., L. Chehmana, C. Cretin, S. Ducasse and M. Langlais (eds.) 2007. *Le Dernier Maximum glaciaire et après… en France et en Espagne. Synthèses régionales et réflexions autour de la diversité des cultures matérielles de 19000 à 14000 BP*, Bulletin de la Société Préhistorique Française 104, 655-824.

Castel, J.-C. 1999. *Comportements de subsistance au Solutréen et au Badegoulien d'après les faunes de Combe Saunière (Dordogne) et du Cuzoul de Vers (Lot)*. Université de Bordeaux 1: Ph.D. dissertation.

Clark, J.G.D. and M.W. Thompson 1953. *The groove and splinter technique of working antler in Upper Palaeolithic and Mesolithic Europe, with special reference to the material from Star Carr*, Proceedings of the Prehistoric Society 19, 148-60.

Clottes, J. and J.-P. Giraud 1986. *L'Abri du Cuzoul à Vers (Lot), Rapport de sauvetage programmé*, Service Régional de l'Archéologie Midi-Pyrénées.

Clottes, J. and J.-P. Giraud 1989. *Le Gisement préhistorique du Cuzoul (Vers, Lot)*, Quercy Recherche 65-66, 82-91.

Clottes, J. and J.-P. Giraud 1996. *Solutréens et Badegouliens au Cuzoul de Vers (Lot), La Vie Préhistorique*, Société préhistorique française, Dijon: Faton, 256- 61.

Clottes, J., J.-P. Giraud and P. Chalard (eds.) In press. *Diversités et Identités des Groupes Solutréens et Badegouliens en Quercy. L'Exemple de l'Abri du Cuzoul de Vers (Lot)*. ERAUL, Liège: Université de Liège.

Demars, P.-Y. 1996. *Démographie et occupation de l'espace au Paléolithique supérieur et au Mésolithique en France*, Préhistoire Européenne 8, 3-26.

Ducasse, S. 2010. *La «parenthèse» badegoulienne: fondements et statut d'une discordance industrielle au travers de l'analyse techno-économique de plusieurs ensembles lithiques méridionaux du Dernier Maximum glaciaire*. Université de Toulouse 2: Ph.D. Dissertation, http://tel.archives-ouvertes.fr/tel-00565784/fr/

ETTOS, 1985. *Techniques de percussion appliquées au matériau osseux: premières expériences*, Cahiers de l'Euphrate 4, 373-81.

Goutas, N. 2009. *Réflexions sur une innovation technique gravettienne importante: le double rainurage longitudinal*, Bulletin de la Société Préhistorique Française 106, 437-56.

Pétillon, J.-M. 2006. *Des Magdaléniens en armes. Technologie des armatures de projectile en bois de Cervidé du Magdalénien supérieur de la grotte d'Isturitz (Pyrénées-Atlantiques)*, Artefacts 10,Treignes: CEDARC, http://halshs.archives-ouvertes.fr/halshs-00201995/fr/.

Pétillon, J.-M. and A. Averbouh. In press. *Le travail du bois de renne dans les couches badegouliennes*, In: J. Clottes, J.-P. Giraud and P. Chalard (eds.) *Diversités et Identités des Groupes Solutréens et Badegouliens en Quercy, l'Exemple de l'Abri du Cuzoul de Vers (Lot)*, ERAUL, Liège: Université de Liège.

Peyrony, D. 1908. *Nouvelles fouilles à Badegoule (Dordogne), Solutréen supérieur et transition du Solutréen au Magdalénien*, Revue préhistorique 2, 97-116.

Rigaud, A. 2004. *Transformation du bois de renne au Badegoulien. L'exemple de l'abri Fritsch (Indre, France)*, In: D. Ramseyer (ed.) *Fiches typologiques de l'industrie de l'os préhistorique, Cahier XI: Matières et techniques.* Paris: Société préhistorique française, 75-8.

Tartar, É. 2009. *De l'os à l'outil. Caractérisation technique, économique et sociale de l'utilisation de l'os à l'Aurignacien ancien. Étude de trois sites: l'Abri Castanet (secteur nord et sud), Brassempouy (Grotte des Hyènes et Abri Dubalen) et Gatzarria*. Université de Paris 1 Panthéon-Sorbonne : Ph.D. Dissertation.

Semenov, S.A. 1973. *Prehistoric Technology: an Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*, Bath: Adams and Dart.

Villa, P. and É. Mahieu 1991. *Breakage patterns of human long bones*, Journal of Human Evolution 21, 27-48.

Bárbara Avezuela Aristu, Esteban Álvarez-Fernández, Jesús Jordá Pardo, Emilio Aura Tortosa

The barnacles: A new species used to make a Gravettian suspended object from Nerja Cave (Málaga, Spain)

The Cave of Nerja is situated in the Southern Mediterranean coast of Spain, in the province of Málaga. Its stratigraphy goes from the Upper Pleistocene to the Early Holocene – between 30 ky and 3 ky cal BP – and is one of the most important archaeological and paleobiological records of the Western Mediterranean zone in this period. This sequence contains Gravettian, Solutrean, Magdalenian, Epipalaeolithic, Neolithic and Chalcolithic levels.

In this work we present one suspended object from Nerja Cave. This object is made on the plate of a large goose barnacle (*Pollicipes pollicipes* (Gmelin, 1790) and belongs to the oldest levels of *Sala del Vestíbulo* (one of the three chambers of the site). These levels are clearly attributed to the Gravettian and the piece comes from the systematic archaeological excavations directed by Professor Francisco Jordá Cerdá between 1982 and 1987.

Keywords: body ornaments, suspended object, goose barnacle, Upper Palaeolithic, Gravettian, Western Mediterranean.

As we know, the purpose of the Worked Bone Research Group is to improve communication between individuals studying worked animal hard tissues (especially bone, antler and ivory) with a special emphasis on archaeological finds. In this paper we present one newly documented suspended object made on a worked animal hard tissue. This object is made on the plate of a large goose barnacle from Nerja Cave (Málaga, Spain) and is attributed to the oldest levels of the site, to the Gravettian. Its identification can extend the list of species and raw materials used to make suspended objects in the Upper Palaeolithic, applying a simple technique for its suspension.

Nerja Cave

The Cave of Nerja is situated on the Southern Mediterranean coast of Spain, in the province of Málaga on the northern coast of the Alborán Sea (Fig. 1:1). The cave is located in the area that bridges the high relief zone of the Sierra de Almijara and the shoreline, which lies at 158 meters below sea level and is about a thousand meters from the current coastline.

The cave was discovered in 1959 and has a vast subterranean system, however, the archaeological deposits are found only in the most external halls (Fig. 1:2). These galleries formed a large rock shelter while occupied by human groups, but the area is now partly filled in with sediment. The chambers of archaeological interest are Torca, Mina, and the Vestíbulo (Fig. 1:3).

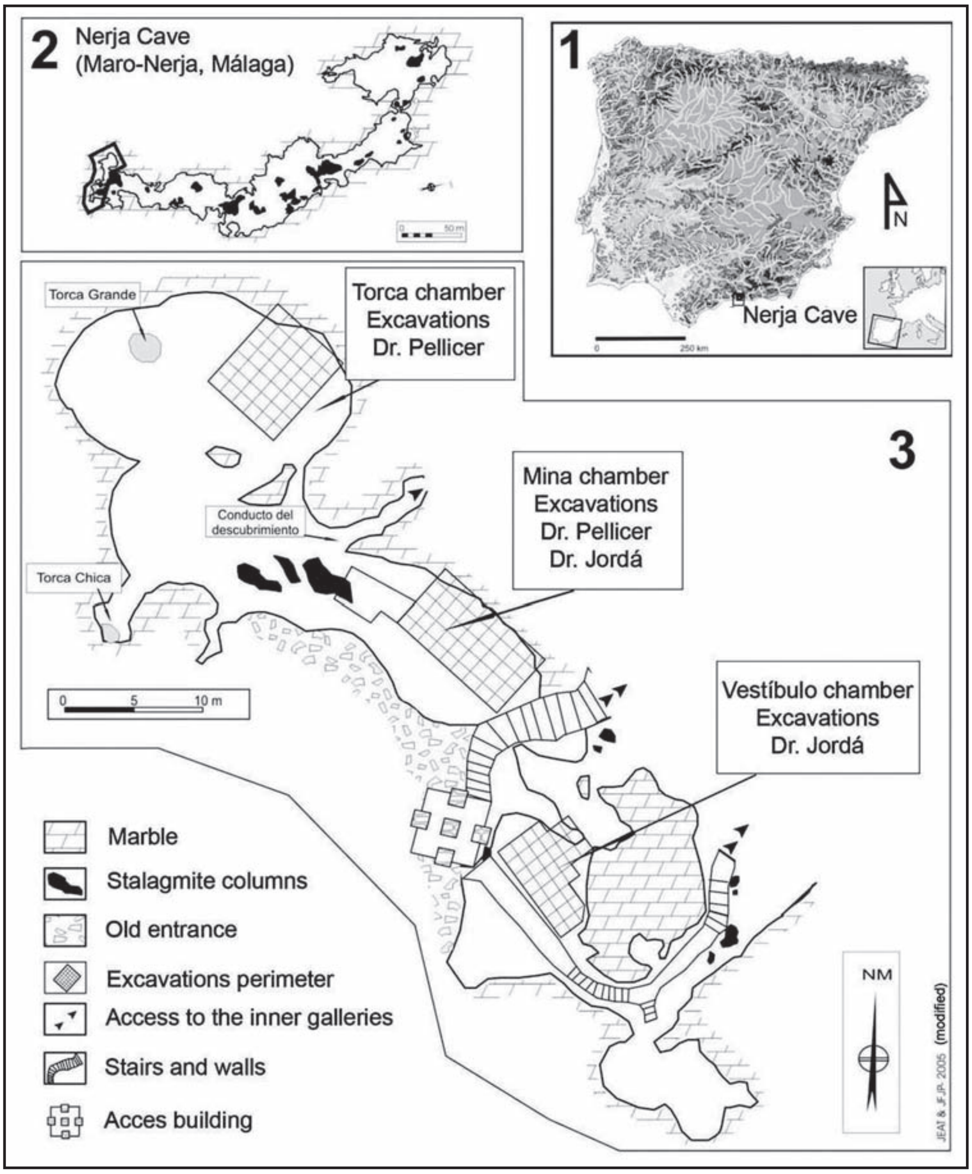


Fig. 1.
1: Nerja Cave localization;
2: subterranean system;
3: chambers of archaeological interest

The stratigraphy goes from the Upper Pleistocene to the Early Holocene – between 30 ky and 3 ky cal BP – (Jordá Pardo, Aura Tortosa 2006) and is one of the most important archaeological and palaeobiological records of the Western Mediterranean zone for this period. The sequence contains Gravettian, Solutrean, Magdalenian, Epipalaeolithic, Neolithic and Chalcolithic levels (Fig. 2).

Archaeological work done at the site by different teams in each of the different chambers allows us to have an unbroken archaeological sequence that has been reported in a vast scientific literature concerning artefactual, vegetal and faunal remains associated with anthropogenic activities at the site. About a hundred species of invertebrates (Gastropoda, Scaphopoda, Bivalvia, Cephalopoda, Crustacea and Echinoidea) and more than a hundred species of vertebrates – including fish, reptiles, birds and mammals, and the contemporary human species – have been documented. An extensive bibliography can be consulted in a recent publication (Aura Tortosa *et al.* 2010).

The Gravettian levels of the Nerja Cave vestíbulo chamber

The known stratigraphic sequence of Nerja Cave starts with the phase of Nerja 1 that contains the Gravettian levels (NV 13, NV 12 and NV 11). This unit has a thickness of 120 cm. and lies over a speleothem (Fig. 2). The three levels that compose this unit are made up of orange-red sands, with non-introduced local cobbles and all have the same texture and are also characterized by the presence of carbonate

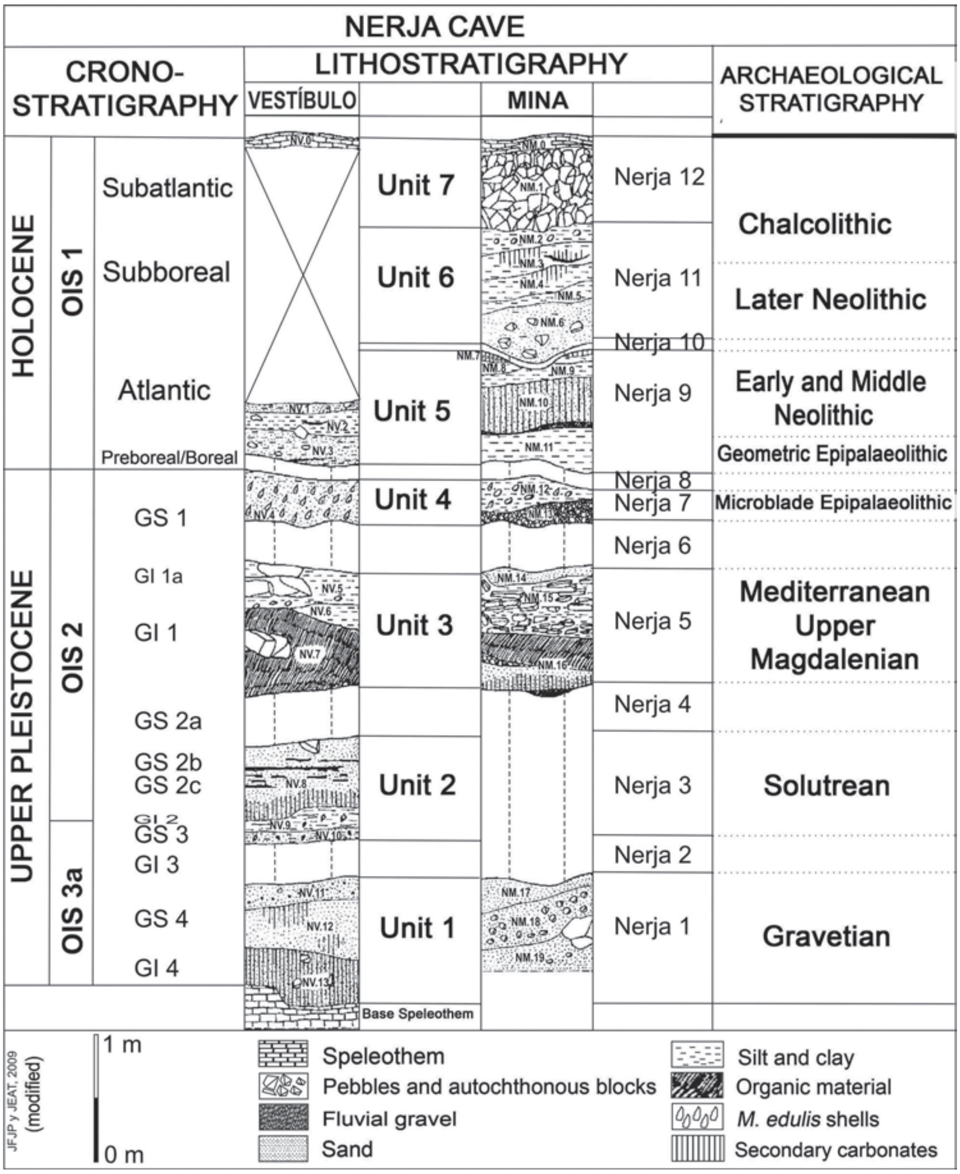


Fig. 2. Nerja Cave stratigraphy

concretions. This sedimentary make-up is due to the action of surface run-off currents, generally flowing planarly, but occasionally cutting down into channels. (Jordá Pardo, Aura Tortosa 2009). In the base level (NV 13) some macro-mammal remains were found in anatomical position, which could indicate low energy sedimentation. In the same base level remains of *Crocuta crocuta spelaea* coprolites announce the absence of humans in the cavity during the first period of sedimentary registry (Arribas Herrera *et al.* 2004).

For this period we have 6 dates obtained from radiocarbon dating (Jordá Pardo, Aura Tortosa 2006). Only 3 dates are made by AMS carbon dating, are considered valid (Table 1). After calibration, these dates situate Unit 1(NV 13, NV 12, NV 11) at 30,180 to 28,550 calibrated years before present (BP) (Jordá Pardo, Aura Tortosa 2008, 2009).

The vegetal remains from these levels consist of pinecone and pine nut charcoal (*Pinus pinea*) which increases consistently in quantity as dates advance in years. The same tendency toward greater accumulations is seen with marine molluscs (*Patella* sp., *Patella caerulea, Osilinus* sp., *Osilinus turbinatus, Mytilus edulis, Cerastoderma edule, Ruditapes* sp. and *Pecten* sp. in addition to the *Littorina obtusata* and *Dentalium* sp. that appear transformed into personal ornaments) that unlike in the rest of levels, is less that the presence of continental gastropods (*Iberus alonensis* –introduced as food-, *Iberus marmoratus, Rumina decollata, Sphinterochilla cariosula hispanica, Hydrobia* sp. and the freshwater gastropod *Theodoxus fluviatilis*, manufactured into personal ornaments) (Jordá Pardo *et al.* 2010).

The mammalian osseous remains are distributed among 7 species: *Capra pyrenaica, Cervus elaphus, Equus ferus, Bos* sp., *Rupicapra rupicapra* and two carnivores, *Felis silvestris* and *Lynx* sp. In the base level (NV XIII) juvenile remains of *Bos* sp. and

Equus sp. with carnivores' teeth marks, an extremity of red deer and the coprolites of *Crocuta crocuta spelaea* are also present. *Oryctolagus cuniculus* is very abundant with a bigger anthropogenic contribution than that of carnivores and birds of prey. Finally there is also the presence of *Testudo hermanni* remains (Aura Tortosa *et al.* 2010).

These Gravettian levels of the Vestíbulo are of low density in lithic and bone artifacts. The identified flint is good quality and was used to produce narrow laminar blanks of medium-large size. These are the most employed blanks used to produce lithic industries that contain the main gravettian lithics groups: scrapers, burins, truncated blades, tools with abrupt or crushed retouch and microblade technologies (Aura Tortosa *et al.* 2006).

The worked bone industry group is made up of 10 objects: four are debris from osseous tool manufacture while the rest are undecorated gracile points with circular cross-sections. (Aura Tortosa *et al.* 2010).

The Gravettian personal ornaments from Nerja Cave

The Nerja Cave personal ornaments collection contains eleven pieces along with two other gastropods, that, although fragmented so that the perforation area is gone, conserve some traces of manufacture, and in any case, their presence in the deposit cannot be due to introduction to the site as food. The used raw material, with the exception of the goose barnacle and one fox perforated canine, is the molluscs. The selected species are two gastropods, *Littorina obtusata* and *Theodoxus fluviatilis,* and one escaphopod, *Dentalium* sp. The gastropod *Littorina obtusata* is represented by three units that are conserved complete; perforations are on the back near the outer lip and differ in form, surely due to the length of use, since the specimen that has the more regular perforation is, as well, the one with less use wear. *Theodoxus fluviatilis* is represented by two whole individuals and a fragment; the perforations are located in the back and the wearing down of its lips has erased the preparation wear traces completely. Two of these have thermal alterations. Of the three *Dentalia,* two were sawn and snapped at the point of the natural aperture.

Theodoxus fluviatilis is a freshwater mollusc (Fechter, Falkner 1993; Lindner 2000) and *Dentalium* sp. could be gathered on the beaches closest to the cave. However, *Littorina obtusata,* at the present, only proliferates on Atlantic coast. Thus, there is some debate about the origin on this species when found in Mediterranean sites. There are two possible explanations. On one hand, it is possible that in cold periods Mediterranean waters were colonized by typically Atlantic species (Álvarez-Fernández 2006; Taborin 1993). By now is known that during the period in question, the temperature of the sea surface on the Alborán Sea was between 10ºC and 14ºC, with occasional temperatures under 10ºC – the minimal temperature of the entire sequence of Nerja Cave – in the last cold episode of the isotopic phase OIS3a (Cacho *et al.* 2001); this would propitiate the mentioned colonisation.

The second possibility would raise the question of long distance contacts. It is well demonstrated that the circulation of this kind of object was not rare during the Upper Palaeolithic (Álvarez-Fernández 2001, 2002, 2007). Both situations, then, are plausible, but we do not have sufficient data to support either argument.

The barnacles

A barnacle is a type of arthropod belonging to infraclass *Cirripedia* in the subphylum *Crustacea*. Essentially there are two basic types: sessile forms (Order *Sessilia*) typified by the "acorn" barnacles of the suborder *Balanomorpha* (balanes) and stalked or pedunculate forms (Order *Pedunculata*) typified by the goose barnacles. The exemplar from Nerja Cave corresponds to the second type. Barnacles are exclusively marine.

The body of stalked barnacles consists of a flexible, tough stalk, the peduncle, and a capitulum at the free end of the stalk. The body is almost always covered by a series of calcareous or chitinous plates. Between the larger principal plates that compose the capitulum, we can distinguish the *terga* and *scuta* (in pairs and symmetrical) and the *carina* (Fig. 3) The form of the *scuta* and *terga* allow for the production of modern comparative collections, permitting us to orientate and side them. The *rostrum*, the *subcarina* and the other lateral plates are more difficult to identify in archaeological contexts because of their smaller dimensions. In this way, as with other archaeozoological specialties, we can weigh the total specimens, count them to establish the number of individual specimens (NISP) and calculate the minimal number of individuals (MNI). This kind of systematic study has recently been employed at sites where goose barnacles were consumed at the

Neolithic sites of Cueva de los Gitanos de Montealegre (Cantabria, Northern Spain: Álvarez-Fernández *et al.* 2010) and Zafrín (Congreso Island, Chafarinas Islands, Spain-North African shore: Álvarez-Fernández 2010) or at the Iron Age Site of Port Blanc (Höedic Island, Morbihand, France: Dupont *et al.* 2008).

Presently, in the Mediterranean Sea stalked barnacles that have plates over the peduncle are represented by the Lepadidae and Scalpellidae families (Relini 1987). The peduncle may be more or less developed and the number of calcareous or chitinous plates is variable.

Members of Lepadidae family have a capitulum with 5 plates and their dimensions vary from 1 to 12 cm. They live attached to floating objects in the intertidal zone or affixed to big marine animals: sharks, turtles, mammals etc. (Luchesi 2006).

Two genus of *Lepadidae* are present at the Mediterranean Sea – Conchoderma and Lepas. Morphologically, Lepas, is the only one with a similarity to the archaeological piece from Nerja. There are 4 species of Lepas in the Mediterranean Sea, two (*Lepas anserifera* (Linnaeus 1767) and *Lepas pectinata* (Spengler 1851) have radial stria in their plates and the other two (*Lepas anatifera:* Linnaeus 1767) and *Lepas hilli* (Leach 1818) have smooth plates or thin striae (Relini 1987). The exemplar from Nerja does not have radial striae so among the options the only one that could be valid is *Lepas anatifera,* as the biggest in the genus can have a capitulum that reaches 5 cm at most. However, the plates of *Lepas anatifera* are translucent and the *carina* is longer overall than that of Nerja.

The Scalpellidae family is currently represented in the Mediterranean Sea by two species belonging to two different genera: *Pollicipes pollicipes* (Gmelin 1790) and *Scalpellum scalpellum* (Linnaeus 1767). The latter always live at depths below 50 meters.

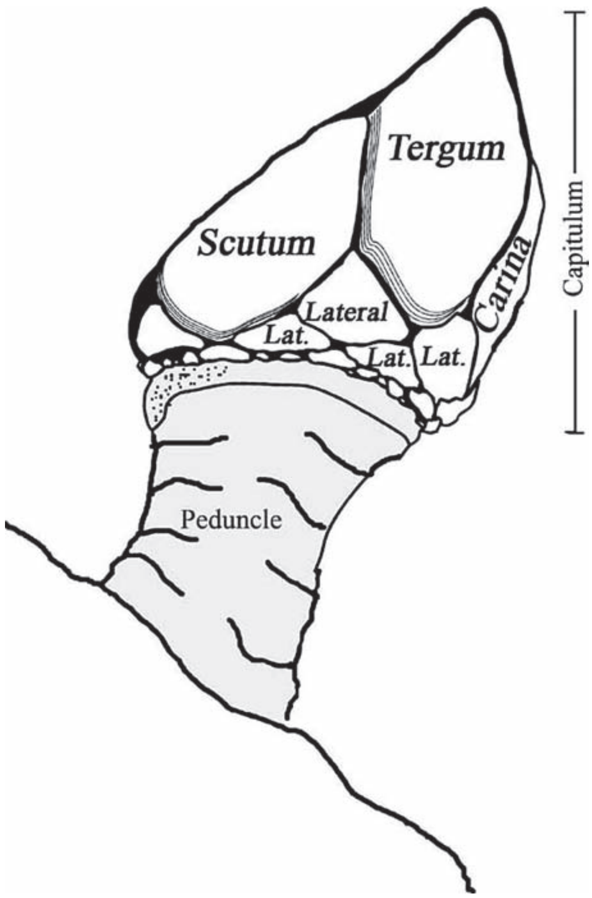


Fig. 3. *Pollicipes pollicipes* main plates

Other species cited occasionally for the Strait of Gibraltar as *Arcoscalpellum atlanticum* (Gruvel,

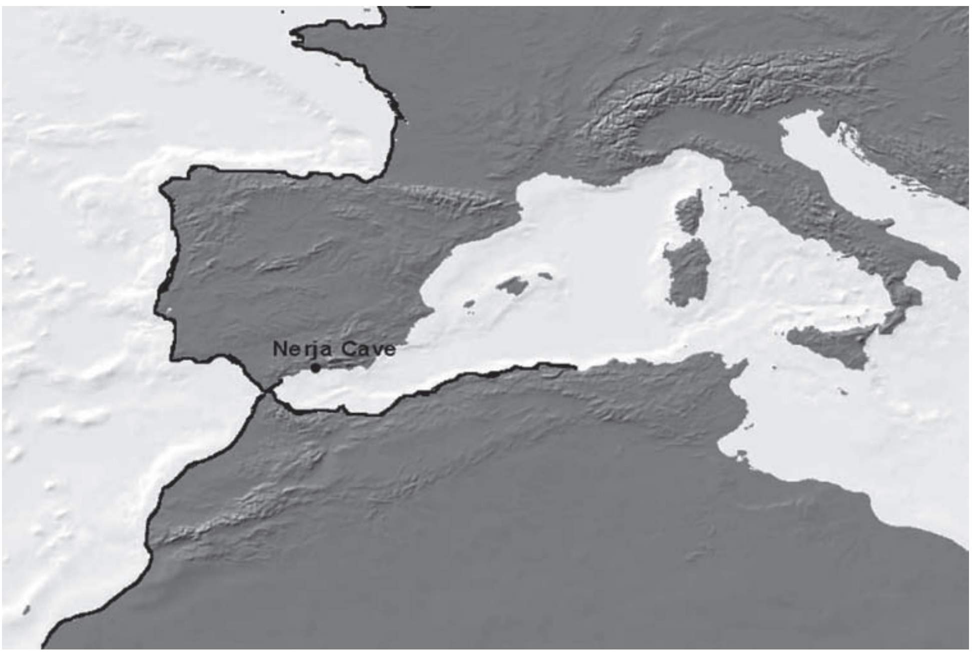


Fig. 4. Current biogeographical distribution of *Pollicipes pollicipes*

1900) or *Arcoscalpellum michelotianum* (Seguenza 1876) are of small dimensions and inhabit depths exceeding 1000 meters (Hoek 1883; Young 2002).

Pollicipes pollicipes (Gmelin 1790) is, at the moment, the option that could be considered as possible species attribution for the plate of Nerja.

Pollicipes pollicipes ("Percebe" in Spanish) or goose barnacle has at least 18 plates. Between these plates *scutum*, *tergum* and *carina* are much bigger than the secondary ones (Fig. 3). Goose barnacles can reach today a size of 12 cm (capitulum+peduncle) (Barnes 1996, 2009).

Pollicipes pollicipes inhabit shallow waters and live in the coasts in erosive settings exposed to the beating of waves, at the base of rocky cliffs. They can attach to rocks that are subject to heavy waves. The groups develop in the tide ecosystem and are often found alongside mussels, limpets and balanes. In their natural setting these barnacles tend to be found in groups or extended upon each other in bunches. The younger specimens tend to affix themselves to older individuals.

This species can be harvested by hand, either scraping the rock or with the aid of a hammer or burin tool. The difficulty in collecting these shellfish lies mainly in the slope of the cliffs and in the danger of crashing waves in the zone. Unlike other crustaceans that lack a peduncle, the part of the goose barnacle that is eaten is the internal peduncle, which should be cooked. In Spain, it is a highly valued shellfish and brings a high market price, leading to the farming of these barnacles in France and Morocco.

The current biogeographical distribution of *Pollicipes pollicipes* runs along the Atlantic coast of Europe, Strait of Gibraltar and North Africa, from the north of Bretagne to Senegal with a more minimal presence on the Algerian and Moroccan coasts (Fig. 4).

The goose barnacle personal ornament from Nerja Cave

The personal ornament presented here comes from the systematic archaeological excavations directed by Professor Francisco Jordá Cerdá between 1982 and 1987 in the Cave of Nerja.

This Gravettian suspended object from Nerja Cave is made on the plate of a stalked barnacle. This plate is called the *carina* and is one of the three biggest plates of the goose barnacle. The measurement of the piece is 26 mm long, 13 mm wide and 7 mm thick: this is a goose barnacle with considerable dimensions (Fig. 5). No species of stalked barnacles known from today has so large resemblance.

The comparison between different goose barnacle *carina* plates (maximum length and width) from a modern reference collection from Islares (Cantabria, Spain: Álvarez-Fernández *et al.* 2010) and archaeological pieces from the Neolithic sites of Zafrín and Los Gitanos de Montealegre shows that the archaeological ones are larger than the contemporary ones. The exemplar recovered at Nerja is even bigger (Fig. 6). We are certain that this barnacle was selected for its size.

The *carina* plate has been transformed with two drilled notches on the internal face where we have also identified use-polish on the notched borders. This

Fig. 5. Gravettian suspended object from Nerja Cave made on the *carina* plate of a large goose barnacle

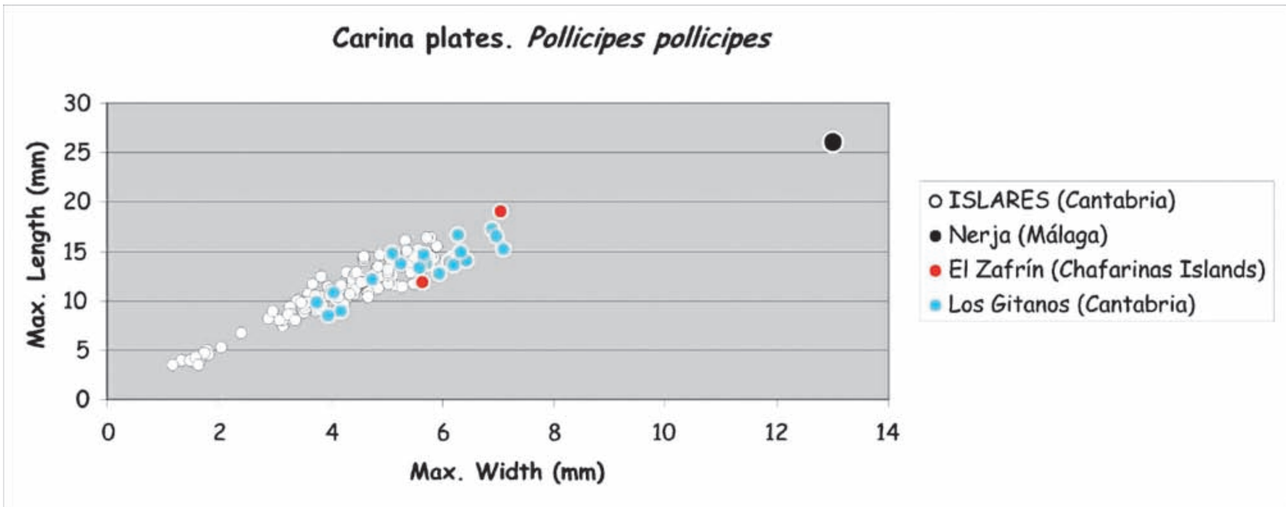


Fig. 6. Comparison between different goose barnacle *carina* plates (maximum length and width) from a modern reference collection from Islares (Cantabria, Spain) and archaeological pieces from the Neolithic sites of Zafrín and Los Gitanos de Montealegre

Fig. 7. Drilled lateral notches on the internal face of the *carina* plate with use-polish on the notched borders

indicates that the manner in which this piece was suspended or sewn was by passing a line through the two notches, which served to hold down the line (Fig. 7).

We can also see that the modification of this object of personal adornment was not limited only to the production of these two notches. Prior to perforation, the plate was abraded in order to enhance the overall form. We have identified various series of multi-directional overlapping striae that result from multi-directional abrasion (Fig. 8). Finally, we note overall polishing, which may have been produced through use.

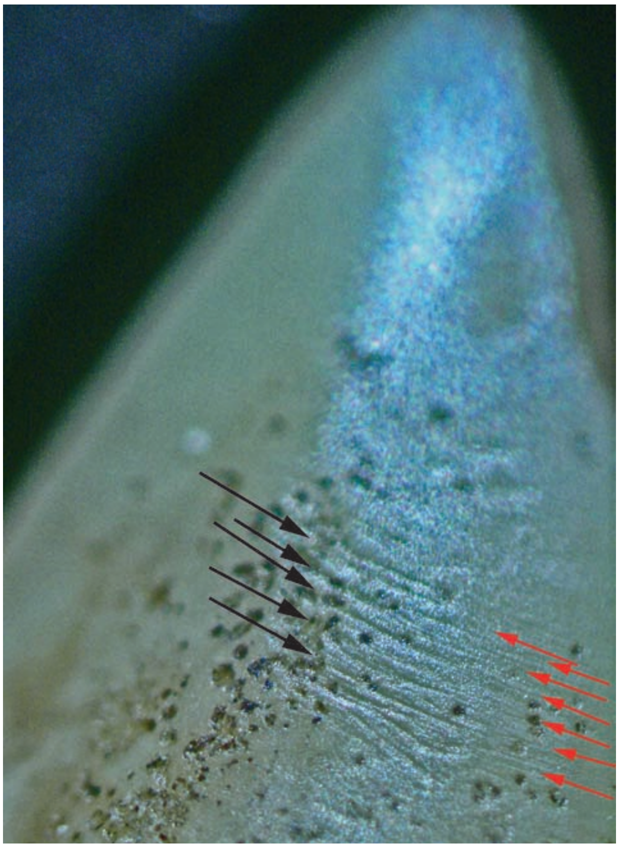


Fig. 8. Series of multi-directional overlapping striae resulting from multi-directional abrasion

Archaeological evidence of goose barnacles

The first mention of pedunculate cirripedes in archaeological sites refers to the species *Pollicipes cornucopiae* (Leach 1824), the same species as *Pollicipes pollicipes*, in the Mousterian site of Lapa de Santa Margarida (Arrabida, Portugal: Pais, Legoinha 2000). Although these goose barnacles are associated with other archaeological finds their anthropogenic origin has not been demonstrated (Álvarez-Fernández *et al.* 2010).

In the Upper Palaeolithic *Pollicipes pollicipes* has been documented in the Gravettian levels of Vale Boi (Algarve, Portugal: Bicho *et al.* 2010; Manne, Bicho 2009). As in the case of Lapa de Santa Margarida, the minimal presence of this kind of species (3 plates in this case) and association with other molluscs, especially *Mytilus* sp. and *Patella* sp., leads us to think that their presence at the site is unintentional since barnacles in their natural setting are displaced by limpets and mussels, who compete for space.

The first archaeological evidence of goose barnacle exploitation as a food consists of use documented during the Mesolithic and, more notably, in Neolithic sites of Cantabrian Spain, west and southwest Portugal and a couple of Mediterranean sites on north African shores (Álvarez-Fernández *et al.* 2010).

Conclusions

Thus, this artifact constitutes the oldest archaeological modification of the stalked barnacle (possibly *Pollicipes pollicipes)* plate known to date from an archaeological context. It is also the first personal ornament identified in this raw material.

The data that exist today about Gravettian exploitation of marine resources are not very abundant. In Nerja Cave, the use of this kind of resources becomes common starting in the Magdalenian and Epipalaeolithic. Bioclimatic changes and essentially eustatic oscillations have served to explain the chronological limit in which this exploitation starts (hunting, fishery and gathering of marine species) with the tardiglacial transgression and the approach of the coastline to the site (Aura Tortosa *et al.* 2002, 2009). However, at the first moments of occupation, the period to which the personal ornament belongs, marine resources didn't have as much importance, as the shoreline was 5-6 km away, a short distance, compared to the 25 km where flint used at the site was picked up (Aura Tortosa *et al.* 2001).

At this point we cannot be sure whether the piece discussed here could have come from the coasts closest to the site of Nerja, as it has not been established whether *Pollicipes pollicipes* was present in these seas at that time. The closest *Pollicipes pollicipes* today are about 100-150 km away. In any case, it is certainly possible that the object arrived at the site of Nerja by way of exchange with other groups, either through the movement of objects, individuals, or entire groups of people, since we know that during the Upper Palaeolithic the transfer of many kinds of goods took place on a much grander scale. It is necessary to emphasize the presence of marine molluscs transformed into personal ornaments not only in deposits located near the Atlantic or Mediterranean coasts, but in the European continent. Atlantic and Mediterranean ornaments could appear in French Dordogne region sites, but also in European deposits located many kilometers from the Mediterranean coasts (Álvarez-Fernández 2007; Taborin 1993).

The size of the piece in of itself indicates something of its singular value. Even though in general the archaeological specimens are significantly larger than the modern examples, the goose barnacle from Nerja was selected specifically for its large size.

Finally, we should keep in mind that the identification of goose barnacle remains in archaeological sites has just started; the small dimensions of the species and the difficulty in identifying it are the primary reasons for the rarity of its identification and analysis.

Table 1. Nerja Cave radiocarbon dates of the gravetian levels: laboratory code, type of sample, radiocarbon date, calibrated years before present (BP) with a 95% certainty level – CalPal2005-SFCP (Weninger and Danzeglocke: 2006) – the maximum statistical probability likely and first published appearance of the date

CODE	SAMPLE	C14 BP	C14 CAL BP	REFERENCE
GifA-102.023	*Pinus* charcoal	24730±250	30400-29160	(Jordá Pardo and Aura Tortosa 2008)
BETA-189080	*Pinus cf. Pinea* charcoal	24200±200	29730-28410	(Jordá Pardo and Aura Tortosa 2006)
BETA-131576	Pinus charcoal	24480±110	30100-28940	(Arribas Herrera *et al.* 2004)

Acknowledgements

We want to thank Elisabeth A. Stone for her friendly revision of the English version of this work.

References

Álvarez-Fernández, E. 2001. *L'axe Rhin-Rhône au Paléolithique supérieur récent: l'exemple des mollusques utilisés comme objets de parure*, L'Anthropologie (Paris) 105(4), 547-64.

Álvarez-Fernández, E. 2002. *Ejemplares perforados del gasterópodo Homalopoma sanguineum durante el Paleolítico superior en Europa occidental*, Cypsela 14, 43-54.

Álvarez-Fernández, E. 2006. *Los objetos de adorno-colgantes del Paleolítico superior y del Mesolítico en la Cornisa Cantábrica y en el Valle del Ebro: una visión europea, (Colección Vítor 195),* Salamanca: Universidad de Salamanca.

Álvarez-Fernández, E. 2007. *La explotación de los moluscos marinos en la Cornisa Cantábrica durante el Gravetiense: Primeros datos de los Niveles E y F de La Garma (Omoño, Cantabria)*, Zephyrus 60, 43-58.

Álvarez-Fernández, E. 2010. *Percebes y bellotas de mar: los cirrípedos del yacimiento neolítico de El Zafrín (Isla del Congreso, islas Chafarinas)*. In: M.A. Rojo Guerra, R. Garrido Pena, J.A. Bellver Garrido, A. Bravo Nieto, Í. García Martínez De Lagrán, S. Gámez Gómez and C. Tejedor Rodríguez (eds.) *Zafrín. Un asentamiento del Neolítico antiguo en las Islas Chafarinas (Norte de África, España)*, Valladolid: Universidad de Valladolid, 213-22.

Álvarez-Fernández, E., R. Ontañón Peredo and J. Molares Vila 2010. *Archaeological data on the exploitation of the goose barnacle Pollicipes pollicipes (Gmelin, 1790) in Europe*, Journal of Archaeological Science 37(2), 402-8.

Arribas Herrera, A., J.E. Aura Tortosa, J.S. Carrión, J.F. Jordá Pardo and M. Pérez Ripoll 2004. *Presencia de hiena manchada en los depósitos basales (Pleistoceno superior final) del yacimiento arqueológico de la Cueva de Nerja (Málaga, España)*, Revista Española de Paleontología 19(1), 109-21.

Aura Tortosa, J.E., J.F. Jordá Pardo, B. Avezuela Aristu, M. Pérez Ripoll, M. Tiffagom and J.V. Morales Pérez 2010. *La Cueva de Nerja (Málaga, España) y el Gravetiense en Andalucia*. In: E. Mata Almonte (ed.) *Ciencia y Arqueología: Homenaje a Francisco Giles Pacheco*, Chiclana: Asociación Profesional del Patrimonio Histórico-Arqueológico de Cádiz (ASPHA), Servicio de Publicaciones de la Diputación Provincial de Cádiz, 125-32.

Aura Tortosa, J.E., J.F. Jordá Pardo and F.J. Fortea Pérez 2006. *La Cueva de Nerja (Málaga, España) y los inicios del Solutrense en Andalucía*, Zhepyrus 59, 67-88.

Aura Tortosa, J.E., J.F. Jordá Pardo, J.V. Morales, M. Pérez Ripoll, M.P. Villalba Currás and J.A. Alcover 2009. *Economic transitions in finis terra: the western Mediterranean of Iberia, 15–7 ka BP*, Before Farming 2, article 4.

Aura Tortosa, J.E., J.F. Jordá Pardo, M. Pérez Ripoll and M.J. Rodrigo García 2001. *Sobre dunas, playas y calas. Los pescadores prehistóricos de la Cueva de Nerja (Málaga) y su expresión arqueológica en el tránsito Pleistoceno-Holoceno*, Archivo de Prehistoria Levantina XXIV, 9-39.

Aura Tortosa, J.E., J.F. Jordá Pardo, M. Pérez Ripoll, M.J. Rodrigo García, E. Badal García and P. Guillem Calatayud 2002. *The far south: the Pleistocene-Holocene transition in the Nerja Cave (Andalucía, Spain)*, Quaternary Internacional 93-94, 19-30.

Barnes, M. 1996. *Pedunculate cirripedes of the genus Pollicipes*, Oceanography and Marine Biology 34, 303-94.

Barnes, M. 2009. *Pollicipes pollicipes. A goose barnacle, Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line],* Plymouth: Marine Biological Association of the United Kingdom.

Bicho, N., T. Manne, J. Cascalheira, C. Mendoça, M. Évora, J.F. Gibaja and T. Pereira 2010. *O Paleolitico superior do sudeste da Peninsula Ibérica: o caso do Algarve*. In: X. Mangado (ed.) *El Paleolítico superior peninsular. Novedades del siglo XXI. (Barcelona, 27-29 january 2010),* Barcelona: Seminari d'Estudis i Recerques Prehistòriques, Universitat de Barcelona, 219-38.

Cacho, I., J.O. Grimalt, M. Canals, L. Sbaffi, N.J. Shackleton, J. Schönfeld and R. Zahn 2001. *Variability of the western Mediterranean Sea surface temperature during the last 25.000 years and its connection with the Northern Hemisphere climate changes*, Paleoceanography 16(1), 40-52.

Dupont, C., E. Álvarez-Fernández and Y. Gruet 2008. *Un nouveau crustacé identifié sur le site gaulois de Port Blanc (Île d'Hoëdic, Morbihan): le pouce-pied Pollicipes pollicipes (Gmelin, 1790)*, Bulletin de l'A.M.A.R.A.I. 21, 17-23.

Fechter, R. and G. Falkner 1993. *Moluscos,* Barcelona: Blume.

Hoek, P.P.C. 1883. *Report on the Cirripedia collected by H.M.S. Challenger during the Years 1873-1876*. In: *Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873-76 under the command of Captain George S. Nares, R.N.F.R.S and the late Captain Frank Tourle Thomson, R. N. Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S, &c. and now of John Murray, LL.D., Ph. D. &c.*, London: Longmans & Co., vol. 8(XXV), 1-169.

Jordá Pardo, J.F. and J.E. Aura Tortosa 2006. *Radiocarbono, cronoestratigrafía y episodios ocupacionales en el Pleistoceno superior y Holoceno de la Cueva de Nerja (Málaga, Andalucía, España)*. In: J.M. Maíllo and E. Baquedano (eds.) *Miscelánea en homenaje a Victoria Cabrera, vol. 1,* Madrid: Museo Arqueológico Regional de la Comunidad de Madrid, 578-97.

Jordá Pardo, J.F. and J.E. Aura Tortosa 2008. *70 fechas para una cueva. Revisión crítica de 70 dataciones*

C14 del Pleistoceno superior y Holoceno de la Cueva de Nerja (Málaga, Andalucía, España), Espacio, Tiempo y Forma. Prehistoria y Arqueología. Serie I, nueva época 1, 239-55.

Jordá Pardo, J.F. and J.E. Aura Tortosa 2009. *El límite Pleistoceno-Holoceno en el yacimiento arqueológico de la Cueva de Nerja: nuevas aportaciones cronoestratigráficas y paleoclimáticas*, Geogaceta 46, 95-8.

Jordá Pardo, J.F., J.E. Aura Tortosa, C. Martín Escorza and B. Avezuela Aristu 2010. *Archaeomalacological remains from the Upper Pleistocene-Early Holocene record of Vestíbulo of Nerja Cave (Málaga, Spain)*. In: E. Álvarez Fernández and D. Carvajal Contreras (eds.) *2nd. Meeting of the ICAZ Archaeomalacology Working Group (Santander, 19-22 February 2008)*, Donostia-San Sebastián: Munibe Suplemento 31, 78-87.

Lindner, G. 2000. *Moluscos y caracoles de los mares del mundo*, Barcelona: Omega.

Luchesi, M. 2006. *Coquillages et crustacés. La guide de la pêche a pied*, Paris: Larousse.

Manne, T. and N. Bicho 2009. *Vale Boi: rendering new understandings of resource intensification & diversification in southwestern Iberia*, Before Farming 2, article 1.

Pais, J. and P. Legoinha 2000. *Gruta da figueira brava (Arrabida): Geological setting*, Memories da Academia das Ciencias de Lisboa (Classe de Ciencias) XXXVIII, 69-81.

Relini, G. 1987. *Cirripedes*. In: W. Fischer; M. L. Bauchot and M. Schneider (eds.) *Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37*, Rome: FAO, 168-77.

Taborin, Y. 1993. *La parure en coquillage au Paléolithique*, Paris: CNRS.

Villalba Currás M.P., J.F. Jordá Pardo and J.E. Aura Tortosa 2007. *Los equínidos del Pleistoceno Superior y Holoceno del registro arqueológico de la Cueva de Nerja (Málaga, España)*, Cuaternario y Geomorfología 21(3-4), 133-48.

Weninger, B. and U. Danzeglocke 2006. *Glacial radiocarbon age conversion. Cologne radiocarbon calibration and palaeoclimate research package <CALPAL> User manual,* Köln: Universität zu Köln, Institut für- und Frühgeschichte.

Young, P.S. 2002. *Revision of the Scalpellidae (Crustacea, Cirripedia) in the collection of the Muséum national d'Histoire naturelle, France, studied by Abel Gruvel*, Zoosystema 24(2), 309-45.

Benjamin Marquebielle

Mesolithic bone tools in Southwestern Europe: the example of the French site of "Le Cuzoul de Gramat"

The Mesolithic osseous material industry of southwestern Europe seems to be less developed than in northern Europe, where Mesolithic bones tools are plentiful and have been more extensively studied. Only a small number of studies have been realized and no general synthesis exists at present. Is this because the Mesolithic populations had virtually no osseous material industry or did the remains simply suffer from poor preservation conditions? This paper advances some arguments in favour of the second hypothesis by presenting the results of a technological study of the osseous material industry at the French site of "Le Cuzoul de Gramat", situated in the Lot region. This deposit is famous for its substantial stratigraphy that is dated to the recent phases of the Mesolithic. Faunal remains, and thus the osseous material industry, are well preserved in the limestone environment. We identified several technical transformation schemes and provide evidence of real choices in the selection of raw materials and their exploitation. It is quite a new image of the Mesolithic osseous material industry that begins to appear.

Keywords: axe, Le Cuzoul de Gramat, deer antler, Mesolithic, technological analysis, wild boar canine

Introduction

Surrounded by Azilian cultures and their harpoons and Neolithic cultures and their awls, the Mesolithic cultures of southern France seem to have developed only a small-scale osseous material industry. While there are a large number of Mesolithic sites, these deposits often consist of open-air sites or are situated in environments unfavourable to the preservation of organic material.

Does this scarcity imply that bone tools were rare during Mesolithic? Or does it simply show that the remains of this exploitation suffered from poor taphonomic conditions? And, in this latter case, is it still possible to reveal the typological, technical and economic peculiarities of the Mesolithic osseous material industry? To try to answer this, we began by studying a site with good conditions for the preservation of organic remains and a long period of occupation.

The French site of "Le Cuzoul de Gramat" is one of the major sites for understanding the Mesolithic in southern France. It was first excavated between 1922 and 1933 by R. Lacam and A. Niederlender, who published a very good study (Lacam *et al.* 1944). Their work helped develop the first cultural and chronological definitions of the French Mesolithic. However, R. Lacam and A. Niederlender presented only a small number of bone tools in their publication. They did not see, or did not pay attention to the significant amount of debitage waste. Nowadays, with the development of technological studies, these

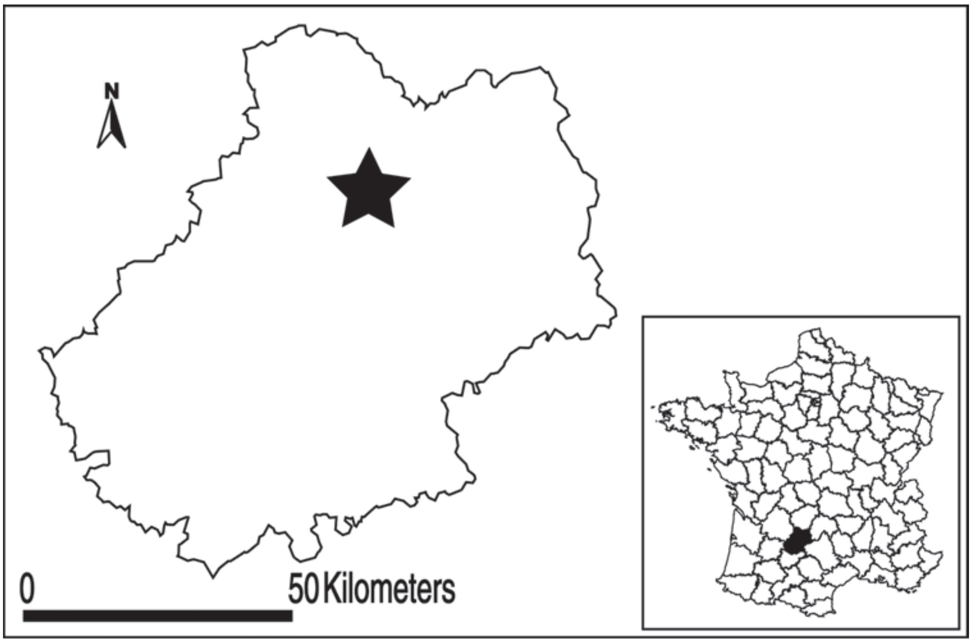


Fig. 1: localisation of Le Cuzoul de Gramat. DAO : A. Marquebielle

remains appear to be rich in information concerning the modalities of exploitation of osseous raw materials, often even richer than the finished objects. In 2005, N. Valdeyron, of the University of Toulouse, began new excavations and allowed us to study the osseous material industry of the ancient collections (Marquebielle 2007), by applying a technological approach, such as that defined in particular by A. Averbouh (Averbouh 2000; Averbouh, Provenzano 1999).

The site and stratigraphy of "Le Cuzoul de Gramat"

Le Cuzoul de Gramat consists of a rock-shelter and a cave located in the Lot region of France (Fig. 1). It is situated at the bottom of a vast depression (doline) in a karstic region. It is famous for its substantial stratigraphy – covering the entire Mesolithic period (providing information especially about the recent phases) – and for a Mesolithic burial. R. Lacam and A. Niederlender defined seven stratigraphic levels (Fig. 2). Adhering to the Mesolithic partition of the time (Coulonges 1935), they attributed the oldest level to the Sauveterrian period, the five following to the Tardenoisian period and the most recent to the Neolithic. At present, the term "*Tardenoisian*" is no longer used for the Mesolithic of southern France

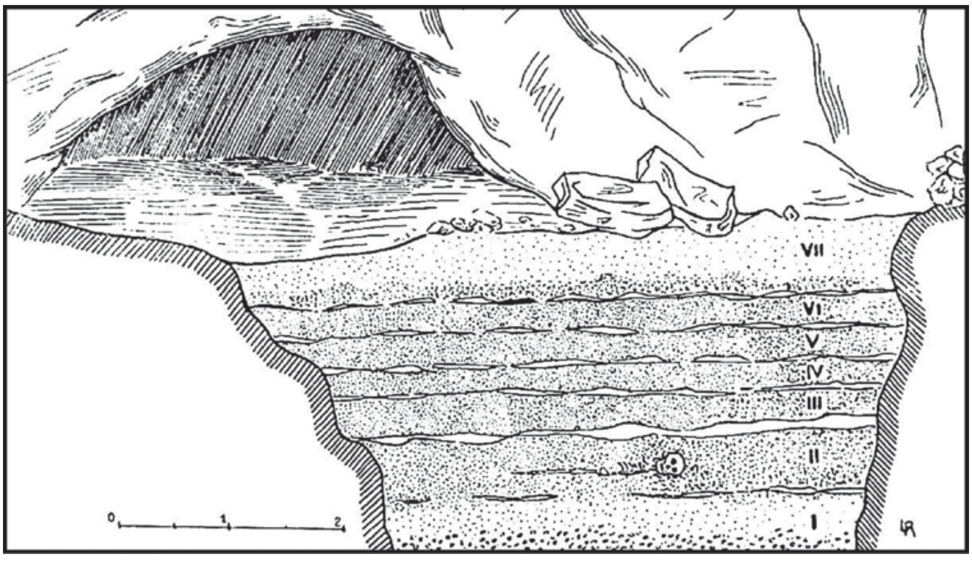


Fig. 2: stratigraphic section made by R. Lacam et A. Niederlender. Skeleton is represented in level II

but it is necessary to understand it here in the sense of the "second Mesolithic".

We know now that levels 1 and 7, as defined by R. Lacam and A. Niederlender (the oldest and the most recent respectively, the numbering of levels being inverted in the publication), are not homogeneous. Level I, the oldest, is a mixture of early Mesolithic levels and earlier levels (such as the Azilian). Level VII, the most recent, is a mixture of levels dated to the Neolithic, the Bronze Age and historic periods. The "*Tardenoisian*" levels, as R. Lacam and A. Niederlender called them, on the other hand, are well dated to the second Mesolithic thanks to the lithic industry. We consequently studied the osseous material industry of these levels, considering the five levels as one because firstly, the distinction between Tardenoisian I and II is now obsolete and secondly, the stratigraphic origin of numerous remains is not clear (many are simply marked "*Tardenoisien*", for example).

Studying an old collection

We studied a collection from ancient excavations, and while the work of R. Lacam and A. Niederlender was very good, their research objectives, and thus their methods of excavation and preservation, were very different from those employed today. Firstly, remains were selected during the excavation (we found lithic artefacts, bone tools and faunal remains in their back dirt). While some characteristic lithic objects could be identified as belonging to the Mesolithic, it is often more difficult, or even impossible, to do the same with osseous remains, whether they were worked on or not. Secondly, since the end of the ancient excavations, the state of the collection has evolved. A significant portion of the bone tools have disappeared (we found only 26 bevelled objects while R. Lacam and A. Niederlender spoke of 42 objects) or the distribution of the remains per level is different from that described in the publication. The evolution of the collection of the antler objects is the most difficult to appraise because in the publication there is no precise account of these types of remains. We thus worked on only a sample of the osseous material industry found on the site and all our conclusions must therefore be moderated.

The remains

General remarks

When A. Lacam and R. Niederlender published the results of their excavations, they presented mainly finished objects and mentioned some antlers presenting marks of sawing. In reality, the number of the debitage waste products is greater than the number of finished objects, representing 56% of the remains (Fig. 3). A massive bevelled object, which they identified as an axe or a pick, is the most studied tool (Fig. 4). Objects shaped with the canine teeth of wild boars are also well described. They called these "*tranchet de cordonnier*", in reference to a tool used by shoemakers to cut leather. By considering the morphology of their active part, we deliberately chose to group together these two types of objects in the same category as the bevelled objects. This category contains the greatest number of objects (26 artefacts) (Fig. 3). Perforating objects are well represented with 13 objects and the other finished objects are represented by only 1 or 2 examples (perforated objects, handles, smoothers and one indeter-

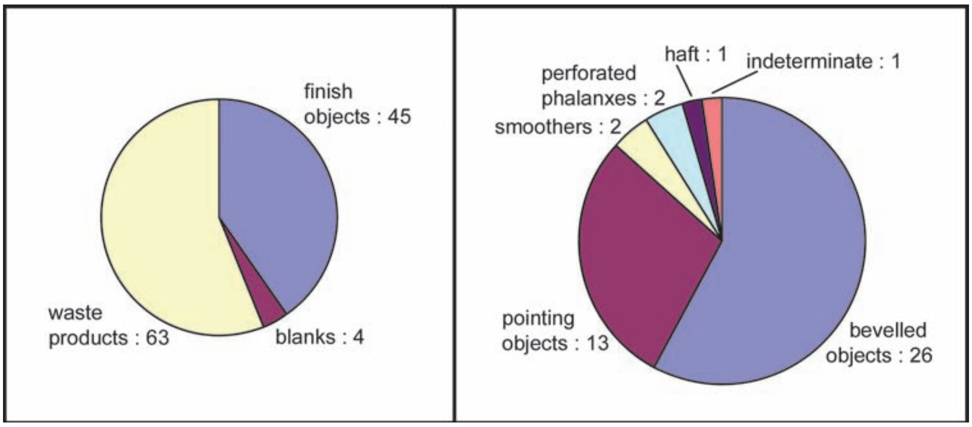


Fig. 3: items repartition by category of products and finished objects repartition by types

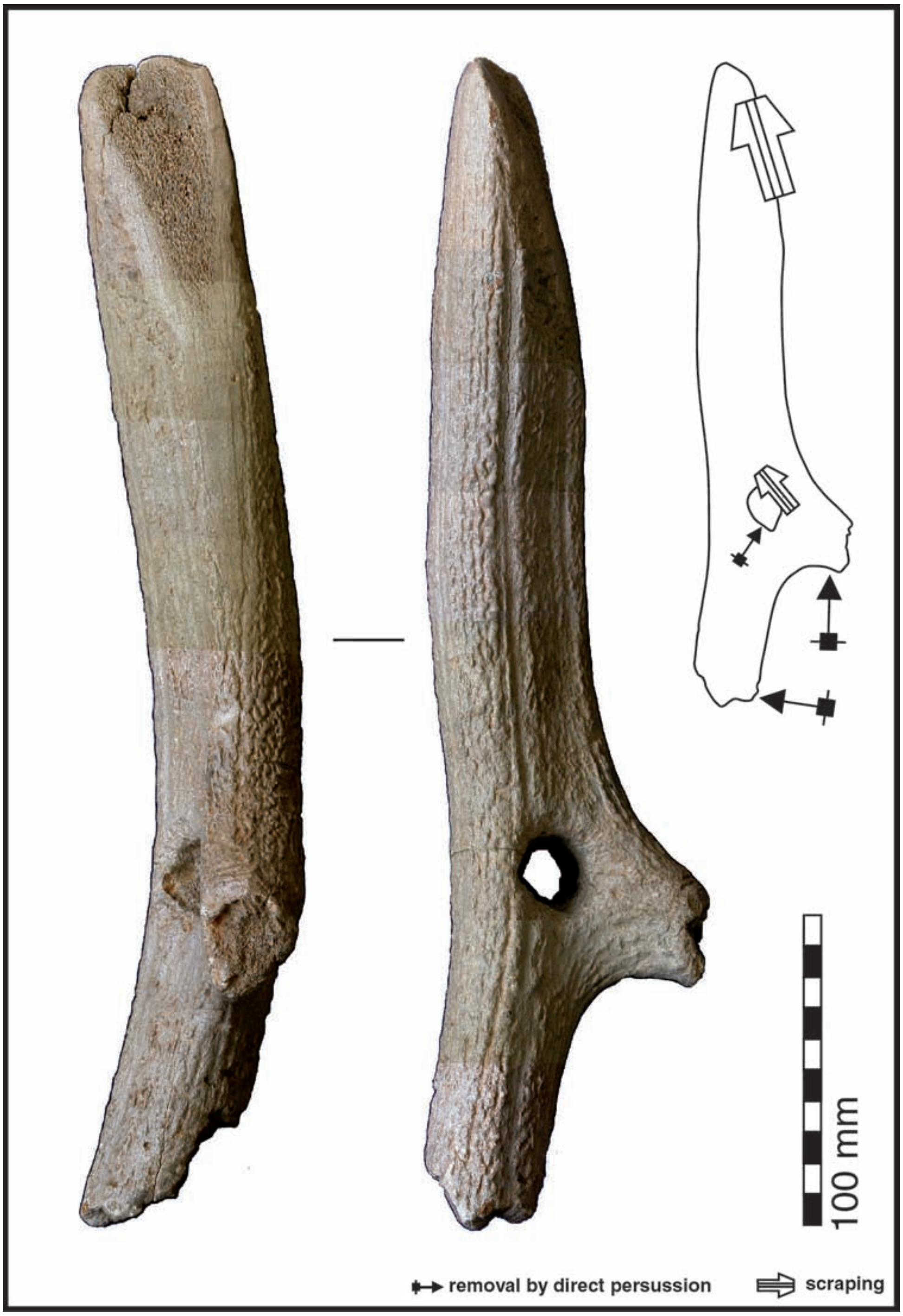


Fig. 4: the “axe” of Le Cuzoul de Gramat

minate object with a double perforation). Blanks are represented by only 4 remains, most on deer antler. The debitage waste products represent the greatest number of objects, with 63 remains. They are almost all on antlers, except 2 waste products on wild boar canines.

The state of preservation of the remains is relatively good but varies depending on the raw material. Bone and dentine remains are the best preserved. The antler objects present various states of preservation: the un-worked surfaces are often powdery but the technical traces are readable.

Finished objects

The bevelled objects constitute the majority of the finished objects. Only 7 of these are made with deer antler and most are shaped on antler segments. The biggest object, which measures 367 mm long and 48 mm wide in its mesial part is made on the lower beam (Fig. 4). The distal part forms a simple bevel and the proximal part has a circular perforation, which is linked with its hafting: there is only one object of this type in the collection. R. Lacam and A. Niederlender identified it as an axe to work

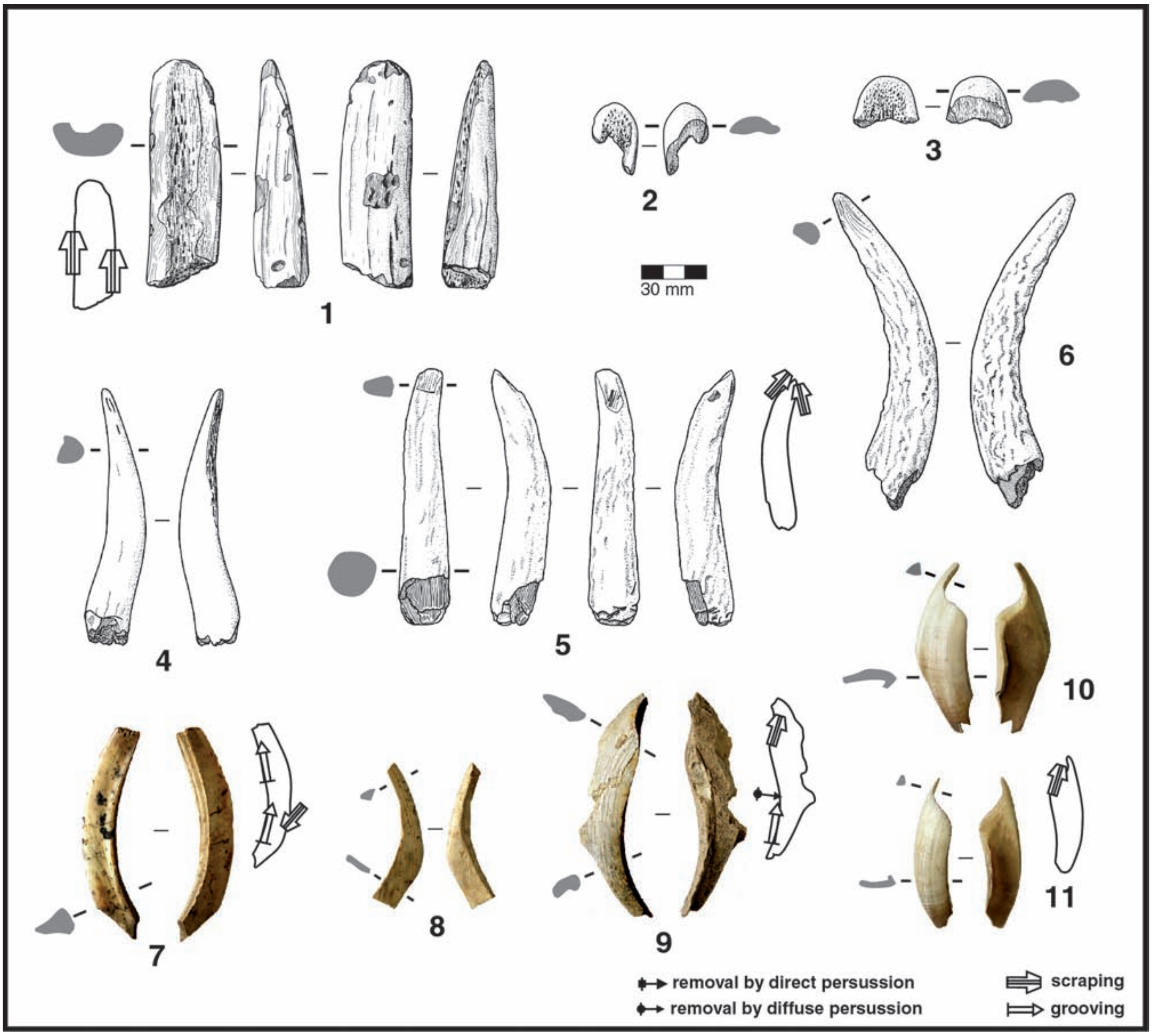


Fig. 5: bevelled objects (n° 1, 4, 5, 6: from antler segments; n° 2, 3: from antler flat blanks; n° 7: lateral convex bevel object on canines of wild boars; n° 8: lateral concave bevel object on canine of wild boars; n° 9-11: "*tranchet de cordonnier*" of R. Lacam et A. Niederlender or distal concave bevel object on canines of wild boars)

wood or a hoe to dig the ground. It is reminiscent of the northern Mesolithic axes and particularly some mattocks (Smith 1989): it presents the same morphology and similar use-wear traces. These use-wear traces correspond more to working the ground than to working with wood. The striations of shaping are still visible and the surface of the bevel is only slightly polished, while working with wood (cutting or barking) tends to highly polish the surface of the bevel and to erase the traces of shaping. These types of massive bevelled objects, often too quickly qualified as axes based on a simple morphological comparison, are well known in northern Europe but are much rarer in the south. In France, there are only a few examples at the sites of Le Poeymaü (Laplace-Jauretche 1953), Les Balmettes (Monin, Pelletier 2000) and La Vieille-Eglise (Ginestet *et al.* 1984), but they are often fragmentary or complete objects with no perforation.

Four other bevelled objects of smaller dimensions were made on antler tines. One of them (Fig. 5:1) is a fragment of an object shaped on large tine (this object measures 104 mm long and 32 mm wide). This fragment could be the distal part of a bevelled object with morphology similar to Vatte di Zambana's "axe" (Rozoy 1978). Three other objects were made from the extremity of a tine (Fig. 5:4-6). Of close dimensions, they measure on average 130 mm long; the active part is a simple bevel for two objects and a double bevel for one. These objects are morpho-

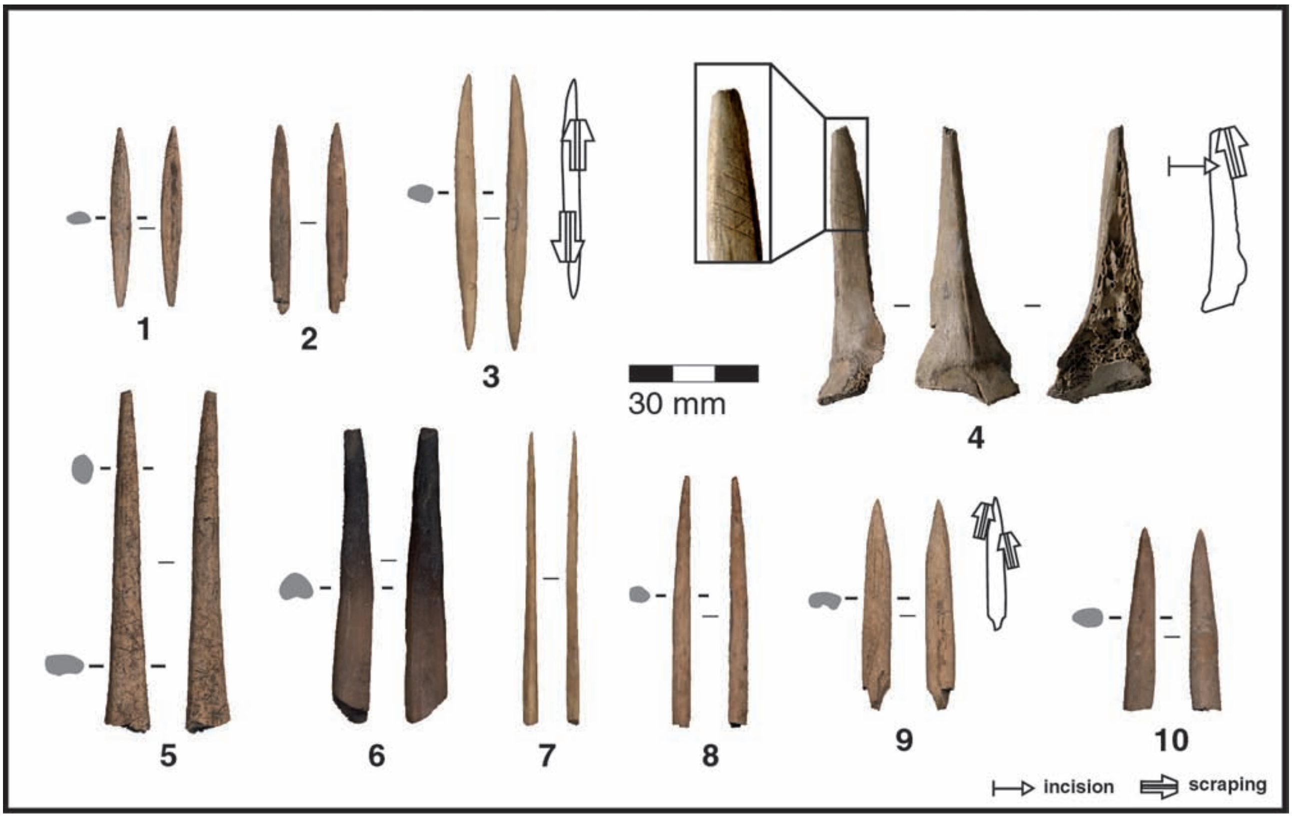


Fig. 6: perforating objects all made with bone (n° 1-3: straight elements with double points; n° 4: decorated awl and detail; n° 5-10: fragments of awls)

logically similar to wedges and chisels made on whole tines, which are well known during the Neolithic (Camps-Fabrer, Ramseyer 1998).

Only two bevelled objects could have been realized on a flat blank, and they are fragmentary (Fig. 5:2-3). They are two distal parts of small dimensions (31 and 26 mm long). The objects are thin with a plano-convex section and the spongy substance appears on the inferior face. This morphology could suggest a flat blank, such as a baguette, but the modalities of debitage are unclear. In addition their small size, their shaping and use erased the possible traces of debitage and polished the surface. Does this correspond to the debitage of a baguette by extraction, by splitting or a debitage of elongated fragments by percussion? We cannot be certain for the moment.

The great majority of the bevelled objects are made with the canines of wild boars and these objects present various morphologies (19 items). The bevel edge constituting the active part is sometimes concave and localized in distal extremity (Fig. 5:9-11) or concave, convex or straight and localized on one or two sides (Fig. 5:7-8). The dimensions of the items are also variable, between 35 mm for the smallest objects with straight bevels and 96 mm for the biggest objects with a distal bevel (the "*tranchets de cordonnier*" of R. Lacam and A. Niederlender). This type of object is known at other French Mesolithic sites with various names and presumed functions. They are sometimes described as perforating objects (Péquart *et al.* 1937; Rozoy 1978) or as perforating and sharp objects (Barbaza 1989). In a recent study of the Swiss sites of Ogens and Birsmatten, they are presented as burins that were used in the same way as their lithic counterparts, to scrape and groove (David 2000). In numerous publications, they are simply presented as being shaped teeth or tools made with the tusk of wild boars, without any other interpretation, which underlines the perplexity of the authors. Use-wear analysis of Neolithic objects mainly indicates their use in wood working (Maigrot 2001). Some modern hunters-gatherers of Irian Jaya use this type of object to shape the shaft of arrows, or less often to shape daggers made of bone (Chiquet *et al.* 1997). Though it is tempting to apply these hypotheses to our societies of Mesolithic forest hunters-gatherers, the Neolithic and modern tools present some differences. They are made in particular of a whole canine while the Mesolithic tools are shaped on split teeth. Nevertheless, in both cases, the active part sought after is a bevel, as seems to be the case for the Mesolithic objects as well.

The perforating objects, all realized on bone, consist mostly of fragments of awls that are broken at

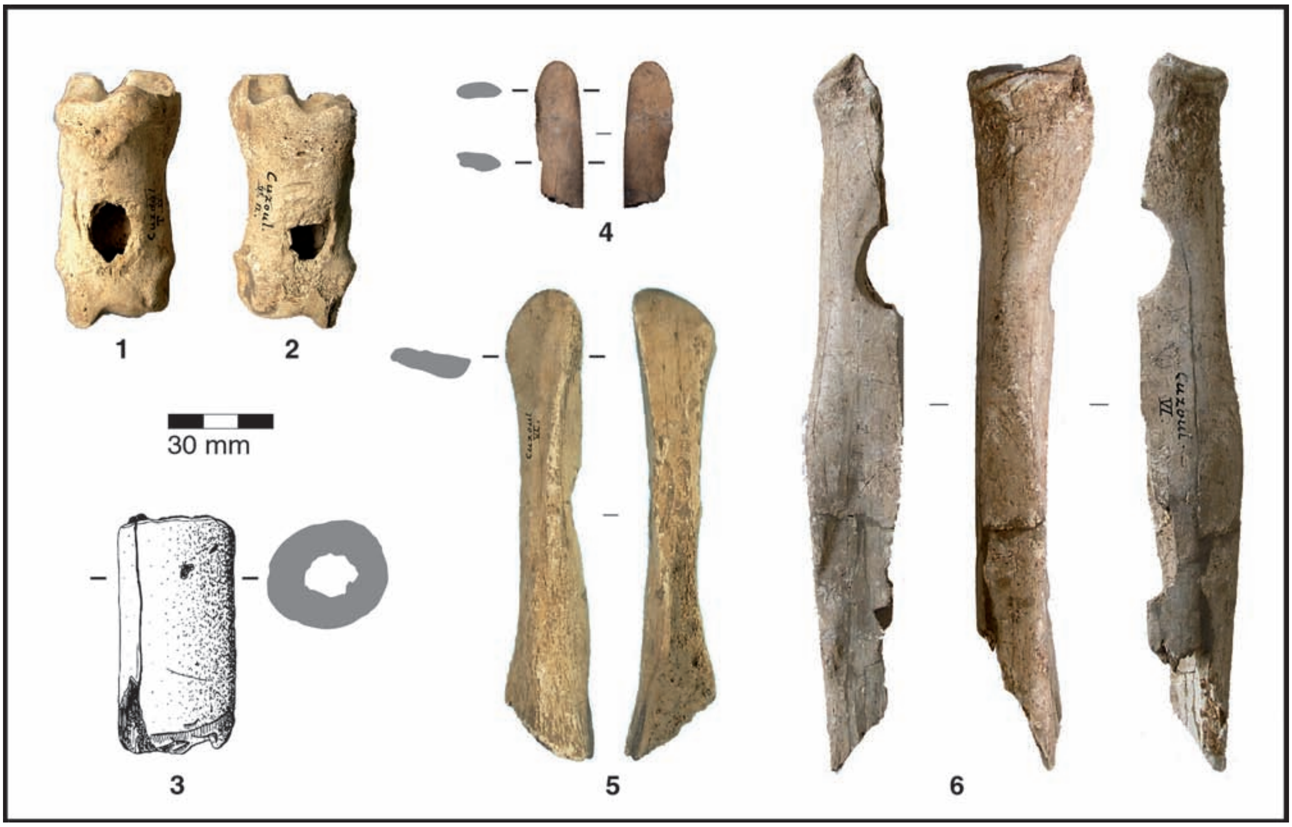


Fig. 7: n° 1, 2: perforated phalanxes; n° 3: possible handle; n° 4, 5: smoothers; n° 6: indeterminate object with double perforation

their proximal extremity and often also in their distal part (Fig. 6:4-10). They measure between 11 and 81 mm and are thin (between 2 and 10 mm wide). Some fragments are very slender, while the others are more massive, though comparisons are difficult because no object is complete. One large unbroken awl is indicated in the publication of 1944 (Lacam *et al.* 1944) as accompanying the skeleton in the grave, but this object is regrettably lost. We have only an indistinct representation that we did not include in our technological study. Another awl, realized on a fragment of a deer vertebra, is the only decorated object of the collection, with a sort of small grid or succession of crosses made by incision (Fig. 6:4). At French sites, a small number of objects with this type of decoration are known, at Rouffignac, Dordogne (Barrière 1973; Rozoy 1978) or in Brittany (Péquart 1934; Péquart *et al.* 1937; Kayser 1988). Three perforating objects are straight elements with double points. They are 42, 44 and 69 mm long, and present a regular oval section. This type of object is frequently identified as being a straight fish-hook. However, the large size of one of the objects and the absence of any arrangement in connection with the fixation of a line other interpretations possible: arrowhead, double awl, etc. (Averbouh, Cleyet-Merle 1995). Unlike awls, the shaping of the straight elements with double points is very important.

Other types of finished objects are represented by only single examples or by a very small number of items. Two objects could be fragments of smoothers. One is a fragment (53 mm long) of an active part (Fig. 7:4). It is shaped on bone and is highly polished by use. The second object, also made of bone, has larger dimensions (160 mm long). Its distal part is also very worn and polished by use (Fig. 7:5).

Among the objects, we also identified 2 bovid phalanges with a hole on their anterior face (Fig. 7:1-2). Traces of removal by direct percussion with the active cutting part of a tool are visible near the perforation, created by a nicking action. These perforations do not appear to be compatible with an alimentary exploitation of bones: the perforations have a smaller diameter and are relatively regular, and thus seem little poorly to the easy recovery of marrow. The function of these objects remains unknown; they may have been small-sized containers (Rozoy 1978). According to the publication of 1944 (Lacam *et al.* 1944), other objects of this type were discovered but have since disappeared.

One object in the collection could be a handle (Fig. 7:3). It is a deer antler section, 56 mm long, with it spongy tissue hollowed out and a com-

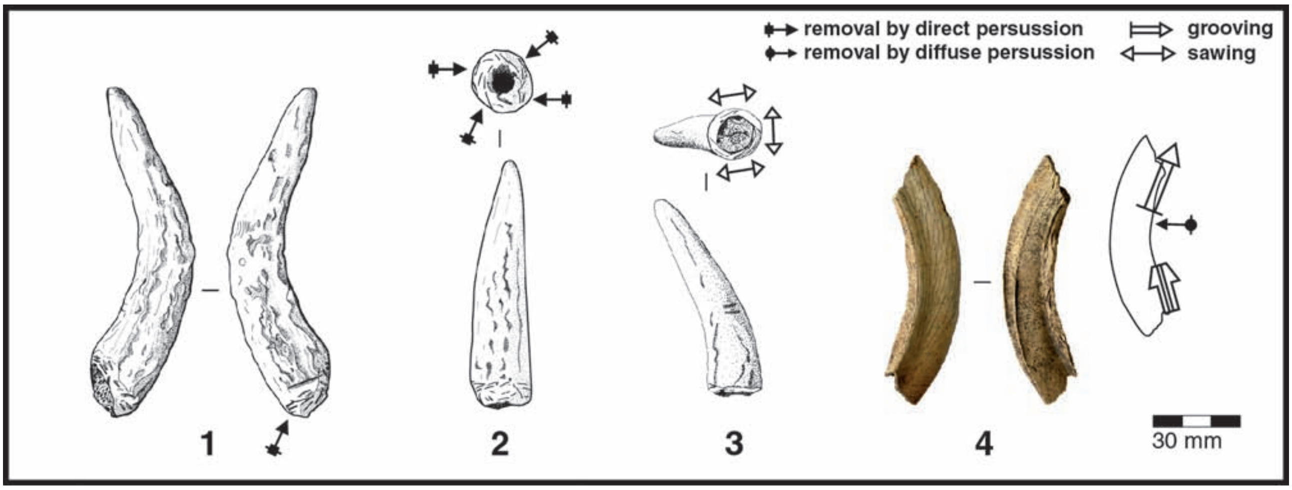


Fig. 8: possible blanks (n° 1-3: end of tines; n° 4: vestibular face of wild boar canine)

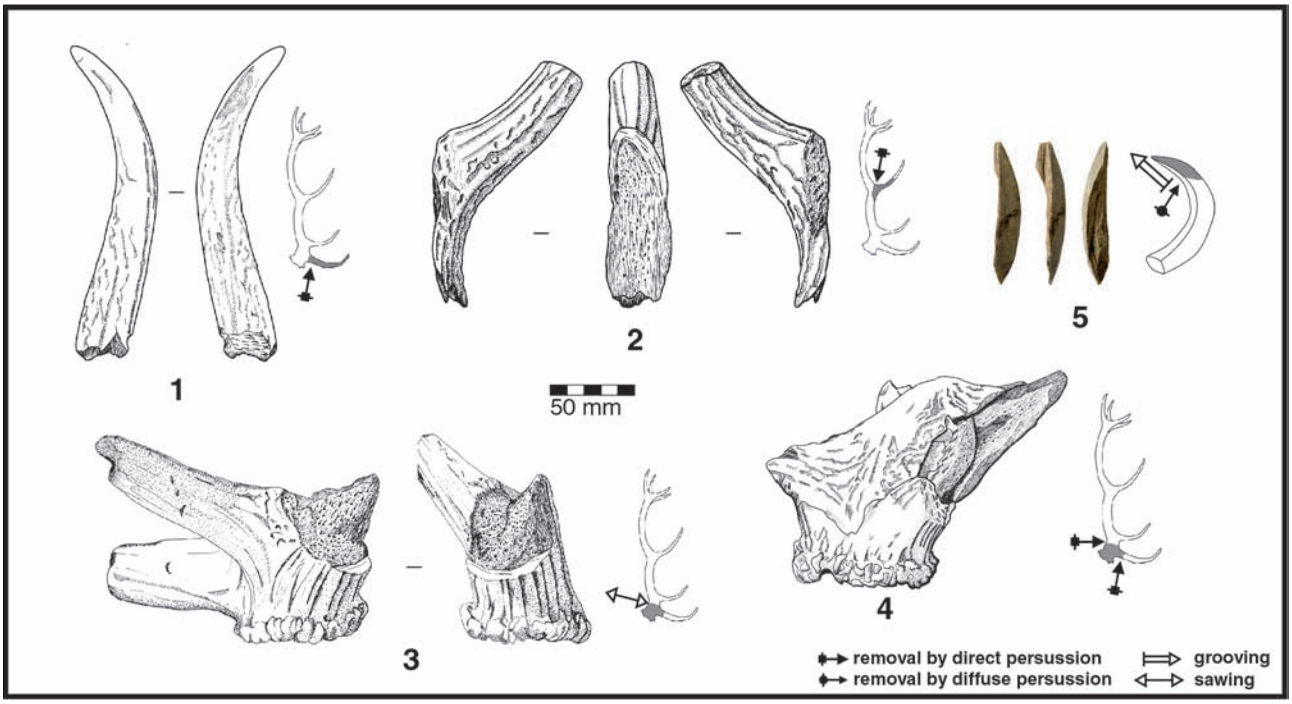


Fig. 9: waste products (n° 1, 2: antler tine; n° 3, 4: antler base;
n° 5: fragment of wild boar canine)

pletely smooth surface. However, the bad state of preservation of the spongy part and the former unfortunate restoration damage obscure the technical traces. It is thus difficult to be sure of the deliberate human origin of the disappearance of the spongy tissue.

There is also a large fragmentary object in the collection, realised on bone. It is missing an entire side and also an extremity, thus we have only a vague idea of its general morphology (Fig. 7:6). It is shaped on a whole radius of red deer and presents a bifacial circular perforation with a very regular shape at its extremity. This perforation could be connected with a hafting but we cannot be sure if this object is a handle or an active part intended to be fit to a handle.

Blanks

We found only four probable blanks. Three tines of deer antler could be blanks, due to very neat debitage marks (Fig. 8:1-3). In addition, one of the pieces has dimensions very similar to the bevelled finished objects on tine. We know our definition of an antler blank is somewhat problematic, however. We rely on clear debitage marks to distinguish blank to waste, but the finished objects on tine present rather sloppy debitage. Moreover, as discussed below, the production of blanks on tine seem to be secondary. Yet, we consider these three pieces as blanks, while waiting for more information about antler exploitation thanks to recent excavations.

The fourth blank is made with a wild boar tusk (Fig. 8:4). Its morphology and size are similar to that of the finished objects with a lateral concave bevel and they have debitage traces but neither shaping nor use marks. Its status as a blank is more assured than that of the blanks on tine because there are debitage traces and blank regularisation removals made by diffuse percussion after the debitage.

Waste products

Waste products are the most numerous objects in the assemblage. They are represented by 63 pieces, the majority on deer antler (and only two pieces on wild boar tusk).

The majority of waste results from a transverse exploitation of antler (58 pieces). Ten of them are basal parts, which provide important information about the size and the origin of the antler, along with numerous indications of technical order (Fig. 9:3-4). All these basal parts originate from shed antler. Six basal parts correspond to a large antler size class (with a circumference of more than 170 cm). All these bases are debitage waste products resulting from blank production by sectioning, showing techniques of sawing or removal by direct percussion. Tines represent the majority of the waste products on antler and come from the lower part of the antler (eye, bez and trez tine) (Fig. 9:1-2). As for the waste products on basal parts, they present traces of sawing or removal by direct percussion, though the majority of tines seem to have been cut without any preliminary work – the fracture plans are irregular, with more or less intensive saw teeth marks – (Averbouh, Provenzano 1999). In general, the debitage waste originates from the lower part of the antler (basal part, low beam, base, eye or trez tine) and there is no waste originating from the higher part of the antler (higher beam or palmation).

A very small amount of debitage waste results from a longitudinal exploitation of blocks. Two waste products attest to a splitting of the wild boar canine. One of these remains shows the end of a grooving realised in the longitudinal axis of the tooth, on the distal face (Fig. 9:5). This groove is associated with removals by diffuse percussion, maybe a beginning of shaping, but nothing comparable with the regularization of blank. Neither of these two objects show traces of use. Debitage waste that would indicate a longitudinal exploitation of the antler is much less explicit. Only three pieces, originating from the lower beam, could indicate a splitting or a fracturing by diffuse percussion. These pieces are elongated and flattened sections. Their superior faces correspond to the natural surface of the antler and their lower faces show the spongy substance.

Raw material

The Mesolithic groups of Cuzoul used antler, bone and dentin to produce their osseous material industry. The antler raw material is represented only by red deer antlers. The size classes are variable, but the large size class dominates. If we consider the ten basal parts of the collection, only two of them originate from small size class antlers. If we consider all the tines, the size and thickness of compact parts also indicate the use of well developed antlers. The basal parts all come from shed antlers. These indicate a harvest and therefore a supply of antlers not directly related to hunting. The surfaces are relatively well preserved. There are no rodent traces. This suggests that the antlers were collected soon after their shedding, at the end of winter or the beginning of spring, as deer lose their antlers around February and March.

Regarding the bone raw material, it is more difficult to define what kinds of bones were used. This is mainly due to the shaping of finished object and the absence of waste products and blanks. This is particularly true for perforating objects. The only exception is the dorsal vertebra of a deer from which the decorated awl was clearly shaped. The thickness of some other finished objects and traces of the medullary cavity on some of them indicate rather long bones of large species. The identification is clearer for a small number of objects. The largest smoother made from a red deer femur, the indeterminate object with a double perforation on a deer radius, and two bovid phalanges were perforated. All the species identified are present in the faunal assemblage and the bone supply could therefore be related to hunting, but this cannot be stated with certainty due to the small number of identifications and their inaccuracies.

As far as dentine is concerned, raw material was strictly selected. Mesolithic groups used only the lower canine (sometimes called the "tusk") of male wild boars. Most often, the right-side canine was selected. The dimensions of the finished objects indicate the large size of the teeth of well developed adults. The wild boar canines are of triangular section, hollow on the greater part of their length and deeply embedded in the jaw. Yet, the low thickness of some objects indicates they were made using the base of the tooth. This means that the tooth had to be extracted from the mandible and the bones were then fractured carefully to avoid damaging the canine. The wild boar bones in the faunal remains are numerous, but the ancient selection of these remains and the absence of recent archaeozoological study do not allow us to determine if mandibles were fractured in a specific way, which could indicate an extraction of the canine.

Debitage

The information about debitage is very different for the various raw materials, mainly due to the differences of debitage among the waste products that were preserved. However, the aims and methods of debitage still seem to be very different depending on the raw material.

In the case of deer antler, the main objective of the debitage is to produce segments. A first type of debitage aims to produce blanks on the lower beam. This type of blank is not present in the collection but several waste products and one finished object (the "axe") are indirect indications. The basal parts of antlers are the most voluminous waste products of this debitage phase and they provide the most information concerning the debitage of the proximal part of the beam. The debitage of the beam into segments was made in two stages. Initially, a preliminary stage was realized, mostly on the posterior face of the antler, by sawing into the compact part of the antler, or less often by nicking. On ten basal parts of the collection, only two, of different size classes, show traces of nicking. This preparatory work is limited to a single face and affects only the thickness of the compact part of the antler. After this, the final separation is made by flexion or direct percussion. The result is an oblique transverse truncation. This debitage could combine two advantages. Firstly it is fast, and secondly it allows the active part of the future bevelled tool to be preformed. It is difficult to be sure because we have only one finished object made from a whole beam and no blank which would allow us to specify the first stages of the shaping, but mental refitting between the axe and some basal parts is valid, in terms of morphologies, size classes and technical traces.

The second type of debitage of deer antler aims to produce blanks on tines. These blanks can be whole tines, shaped into bevelled objects, or segments of tine, possibly shaped into handles (but we have few indications about items on tine segments). The debitage of tines is made, as for the beam, in two stages: a preliminary phase by sawing or nicking before a final separation by flexion. Mostly, the preliminary work is fast and concerns only one face of the tine, but there is variability and we noted no relationship between the type of work (by sawing, by nicking, peripheral or not, deep or not) and the shape, size or type of tine. The preparatory work is mostly made by nicking and is limited to a single face of the tine. The debitage is often made without this sort of work, and directly by flexion. The resulting fracture planes are then oblique, with more or less intensive saw tooth marks. It seems that the Mesolithic populations looked for a fast debitage, whether or not there was preliminary work. The "cleanliness" of the debitage seems to be very secondary, as we can see on the finished objects, which present traces of fast debitage, not erased by shaping.

Mental refitting shows that the Mesolithic populations mainly looked for blanks coming from lower beams. The debitage waste products of the beam (basal parts and tines) are numerous by comparison with blanks and finished objects on beams. The production of blanks on tines, whatever they are, seems secondary, the majority of remains on tines being waste products.

The majority of deer antler remains indicate a transverse exploitation of block but it could indicate some possibilities of longitudinal exploitation. On one hand, we have two bevelled objects whose morphology indicates that they were shaped on flat blanks, such as baguettes. On the other hand, there is some debitage waste that could indicate either a splitting or a longitudinal fracturing of the antler: they present traces of longitudinal sawing in connection with fracture planes that are themselves equally longitudinal. It is very difficult, however, to associate these two types of remains within one technical transformation scheme. The idea of a longitudinal exploitation of deer antler is, for the moment, very hypothetical (Fig. 11).

We have little information concerning bone debitage. This is due mainly to the high shaping degree of the tools, whose debitage traces have been erased. The morphology of some awls, whose sides are longitudinal fracture planes, could indicate bone breaking by direct percussion. Other awls also present marks of the medullar cavity on their lower face, which indicate a long bone origin. However, these kinds of bones were often broken to recover the marrow. Were these bones therefore fractured to cook them or were they fractured to produce blanks (or both)? There are too few bone artefacts, consisting of only finished objects and no waste products, to help us. Moreover, there is no recent zooarchaeological study to inform us on alimentary bone exploitation. Regardless, if we consider only the number of bone tools and their morphological variety, we can suppose firstly, that the production of bone tools was not very significant, and secondly, that the morphology of blanks was varied. A debitage by fracturing, using direct percussion could have been a simple and efficient solution producing flat blanks that were shaped into perforating objects.

For the wild boar canines, the debitage modalities are well known. There are only two waste products but the traces on the finished objects allow us to reconstitute the main stages of the debitage. All the remains made on the canine teeth of wild boars indicate a longitudinal exploitation of the teeth. The purpose of the debitage is to obtain elongated, flat blanks, which we could compare with dentine blades. In fact, the debitage of the wild boar canines takes advantage of the natural characteristics of the raw material. This tooth, because of its hollow structure and its triangular shape, presents lines of natural weakness in the longitudinal axis. Furthermore, after the death of the animal, it tends to crack, especially if it is extracted from the mandible and placed in a dry environment or near a heat source (Maigrot 2003). It is this weakness in the longitudinal axis that is exploited during the debitage. The mesial edge of the canine, constituted by the junction of both enamelled faces, is a first zone of natural weakness. A longitudinal grooving, made on the distal face of the canine (the only one without enamel), makes it possible to prepare a second line of fracture. The splitting can be realized by inserting a wedge at the base of the tooth: we have no traces of this but an experiment proved the validity of this method. We obtained two blanks. The first one, wide and long, is constituted by the lingual face of the canine; it presents a double regular curvature in the longitudinal axis and in the transverse axis. The second blank is constituted by the vestibular face of the tooth, which is less wide than the lingual face and has a less pronounced, or even-nonexistent, longitudinal and transverse curvature.

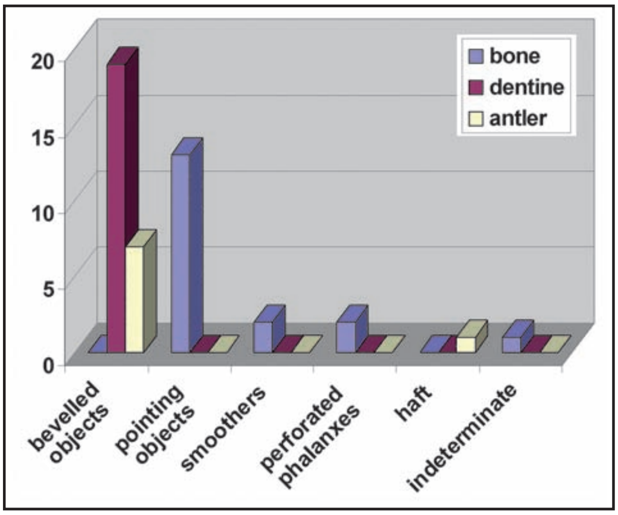


Fig. 10: repartition of types of finished objects per raw material

Nevertheless, the debitage of canine teeth seems to have been realized according to various modalities. Indeed, a number of objects do not present traces of grooving and we can imagine that Mesolithic people were able to take advantage directly of well placed natural fissuring. Some finished objects are also shaped on blanks of small dimensions and varied shapes, though we cannot determine if these represent specifically produced blanks or the opportunistic re-use of debitage waste products.

Shaping

Scraping is the main technique used for shaping. On the antler blanks, scraping was used to shape the active part into a bevel. This scraping is unifacial; it is carried out either at the end of the internal curvature of a tine, at the end of a section on beam, or on the lower face of a possible flat blank. The scraping is limited to the active part and does not extend to the rest of the surface of the object, which is left without modifications, except for one object, the axe, which is the only antler tool to present a perforation on the proximal part. The perforation was made on both faces since it presents a section "*en diabolo*" (Camps-Fabrer 1974). Some concentric striations on the first millimetres of the perforation, indicating the use of scraping, are concomitant with little readable traces, possible marks of a superficial nicking of the antler to prepare the perforation.

Scraping is used in a more intrusive manner on bone objects. Indeed, most of the awls and all the straight double-points show a complete scraping, which shaped the active part and covered the entire surface of the object. We must nevertheless remark that the majority of awls are fragmentary and that the only complete example, the decorated awl on a deer vertebra, is shaped only on the distal part: this was perhaps also the case with the other awls, for which we no longer possess the proximal part. The complete scraping is done with particular care for the straight double-points, extending over the whole surface, and their final shape is symmetric, both in the vertical and horizontal axes. Some objects on bone, of little evident function, present a perforation. For perforated phalanges, the shaping is realized by removal by direct percussion. Concerning the perforated object with an indeterminate function, shaped on the radius of a deer, we observe only that the perforation was made by scraping.

On certain objects made on wild boar canines, a first stage of shaping seems to have been realized by diffuse percussion. It would have allowed the support to be formed by eliminating the vestiges of the distal face resulting from the splitting of the tooth. The active part of the object was then shaped by scraping. The localization of this shaping is variable and depends on the morphology of the blank. For wide and concave supports, on the lingual face of the canine, the scraping is concentrated on the distal part – whereas for the less wide and rectilinear supports, on the vestibular face of the canine, it is more concentrated on the mesial part, on one side. The shaping is always localized on the lower face of the object, by scraping of the dentin. The superior face, covered with hard enamel, is not modified and constitutes the superior face of the bevel.

A first step toward understanding the Mesolithic osseous material industry of Southern Europe

Each new method of analysis has brought a new vision. The technological approach has revealed a whole realm of Mesolithic material culture that is far from ideas of poverty and opportunism. The Mesolithic populations of Le Cuzoul de Gramat used varied raw materials, in some cases carefully selected. They knew how to transform them by adapting the modalities of exploitation according to the characteristics of the raw material and the objectives of the production (Fig. 10). We have underlined particular selections and exploitations of various raw materials which do not agree with the image of regression traditionally associated with the Mesolithic osseous material industry.

Concerning the exploitation of antlers, only deer antler was used. The supply was assured by the harvest of shed antler, and large sized antlers of big size class were favoured. Their exploitation was mainly oriented toward blank production in the form of segments by sectioning beams or tines, which were shaped in bevelled objects by longitudinal scraping, limited to the active part (Fig. 11). In the present

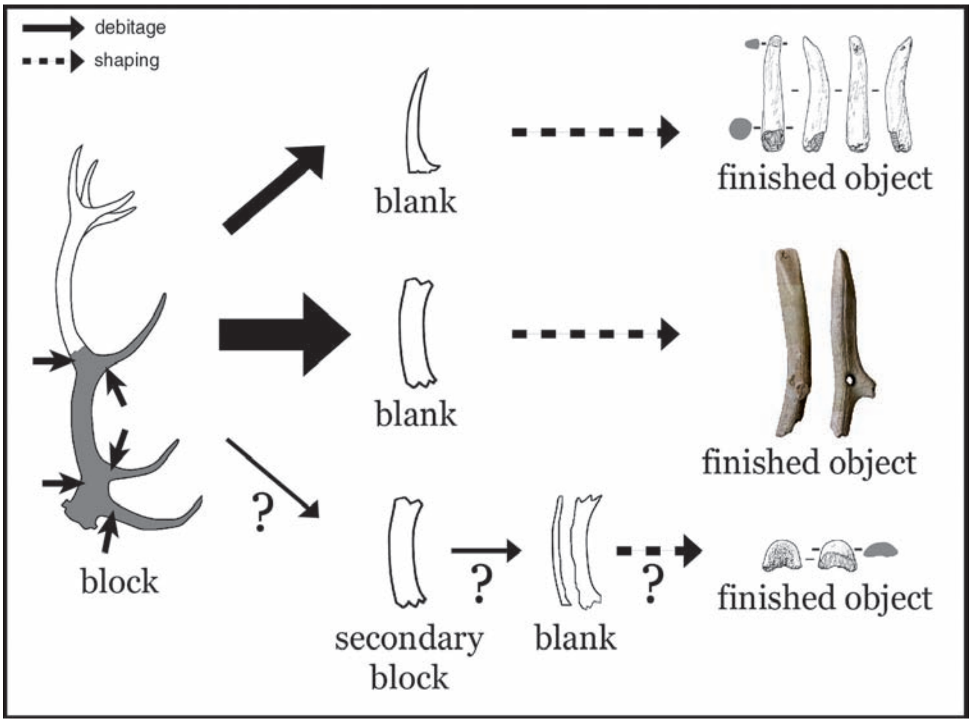


Fig. 11: technical transformation scheme of deer antler

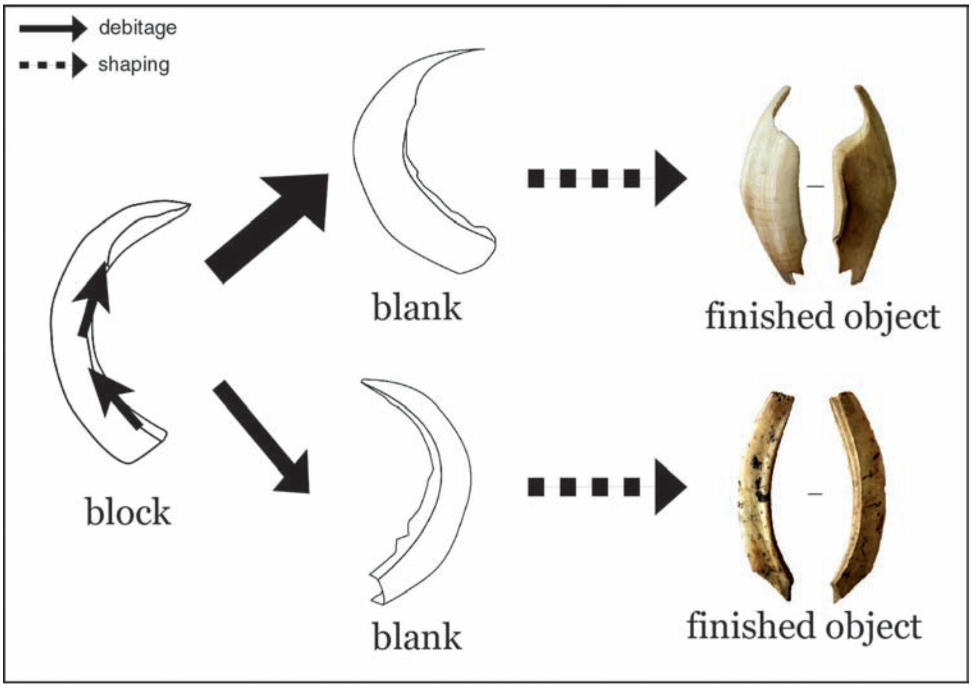


Fig. 12: technical transformation scheme of wild boar canine

state of our research, the significant number of debitage waste products on tines and mental refitting indicate that the production of blanks on beams seemed to be more frequent than the debitage of blanks on tines. The very low number of finished objects on segments of beams (a single example: the axe), compared with the number of characteristic waste products, indicates that Le Cuzoul de Gramat was a site of production of this type of object, undoubtedly in association with a contemporary occupation of the site during the period of antler shedding.

The exploitation of bone is more difficult to understand because the great majority of bone remains are represented by intensively shaped finished objects. The selection of the raw material and the debitage modalities are thus difficult to grasp. The exploitation of this raw material nevertheless shows peculiarities: firstly, the shaping was done by scraping, as it was for the other objects, but is sometimes very extensive and concerns the totality of the surface of the object, and; secondly, the production is mainly directed to the production of perforating objects.

Concerning the exploitation of teeth, the selection of the raw material was particularly selective: only the lower canines of adult male wild boars were used, with a clear preference for the right-side canine. The debitage of the canines was exclusively directed toward the production of flat blanks, mainly on the lingual face (11 finished items out of a total of 19 objects in the collection) (Fig. 12). This regularity in the choice of blanks can be dictated by various imperatives. Nevertheless, some experiments

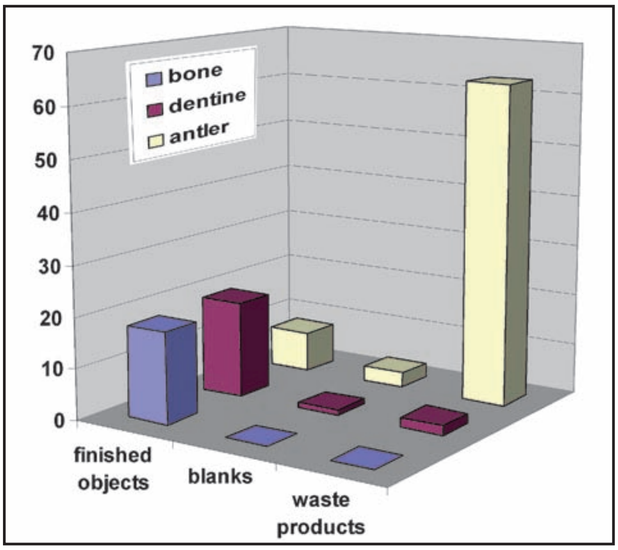


Fig. 13: repartition of finished objects, blanks and waste products per raw material

showed us that objects shaped on the lingual face of the right-side canine were particularly ergonomic when used as a scraper. We can thus evoke the hypothesis of the search for a particular morphology for these objects, in connection with their use. The production of tools made with the canines of wild boars is also remarkable because it is the only technical transformation scheme that employs the technique of grooving, used to prepare the splitting of the tooth.

Deer antler is the most abundant raw material (almost twice as many antler remains as bone and dentin remains combined) and the majority of these remains are debitage waste products. However, if we consider only the finished objects, antler objects are in the minority, while objects in bone and dentin are much more numerous (Fig. 13). It would thus appear there was a difference in the exploitation of the various raw materials: we have indications of a local and intensive transformation of antlers, but no equivalent for bone and dentin. It is nevertheless necessary to qualify our comment. In the collection of R. Lacam and A. Niederlender, we identified only very few blanks and waste products in bone and dentin. However, this kind of object is uncharacteristic and small and would thus not have been recognized and collected during the excavation. In addition, the former excavations concerned only a part of the deposit, in front of the cave: this zone could be a working area more specialized in the exploitation of antler (we know now there were occupations inside the cave and in the open-area in front of the cave). The results of the recent excavations will help us to specify, or correct, this image of differential exploitation, favouring antlers.

Comparisons and synthesis

In southern France, Cuzoul de Gramat yielded a major collection of osseous industry remains. Samples from others Mesolithic sites are smaller or do not present the same variability in terms of raw materials and types of exploitation.

Thirty km around Cuzoul, in the Lot region, three sites provided small collections (less than 20 items at each site): Les Fieux (Valdeyron, et al., in press), les Escabasses (Marquebielle, in progress) and Fontfaurès (Barbaza, 1989). The site of Le Sanglier is an exception as it yielded dozens of antler remains (mostly debitage waste products). The study of this collection is in progress (Séronie-Vivien, 2001 and Marquebielle, work in progress).

This case of a high number of remains is uncommon, however. If we compare it with sites within a radius of 150 km around Cuzoul, small collections of osseous industry remains are standard. The sites of Rouffignac, in Dordogne (Barrière, 1973 and Marquebielle, in progress) and Clos de Poujol in Aveyron (study of osseous industry by E. David in Bridault et al, 2009) each yielded nearly thirty items, often broken but recognizable, whereas the sites of Cuze de Neussargues and Baraquettes, in the Cantal region (Rozoy, 1978 and Surmely, 2003) and the site of Salzets, in Aveyron (Rozoy, 1978), yielded only fragmentary osseous industry remains that are less numerous and burned.

Much further from Cuzoul, at the mountain site of Poeymaü in Pyrénées-Atlantique, the osseous industry collection is large, composed of more than fifty items consisting mostly of finished objects (Laplace, 1953 and Marquebielle, in progress). But at other Pyrenean sites, such as Troubat in Hautes-Pyrénées (Barbaza, 1989) and Balma Margineda in Andorra (Guilaine et al., 1995), the Mesolithic populations left only slight indications of an osseous industry (less than around ten items on each site).

At some sites, the osseous industry is large and varied, but we had to compare with long distance sites, such as the British sites of Téviec and Hoëdic, (Péquart *et al*., 1937 and Péquart, 1934). This is a particular context, however, as these two sites were cemeteries and finished bone objects were found in the graves. In a context of an occupation site, the Swiss site of Birsmatten can be compared with Cuzoul. It contains a long stratigraphic sequence under a rock shelter and various raw materials were used in large quantities (Bandi, 1963 and David, 2000)

In general, though Mesolithic collections are small, diverse raw materials were used at each site. At the great majority of sites, three osseous raw materials was exploited: bone, deer antler and dentine (often from wild boar canines), even at small scale or low occupation frequency sites, such as Les Fieux or l'Aulp du Seuil, an altitude rock shelter in Isère (Bintz *et al.*, 1999 and Marquebielle, in progress).

Concerning finished objects, some implements recovered from the excavations at Cuzoul are very frequent on all Mesolithic sites that have yielded an osseous industry. Awls, for example, are always present and generally quickly and very simply made on bone (the distal part was shape by scraping a splinter).

Bevelled antler tools (such as the Cuzoul axe) are rarer but known also over the whole French territory. This type of implement, made on antler segments, has been found in the Pyrénées (Poeymaü), the Alps (La Vielle Eglise: Ginestet *et al*., 1984 and Marquebielle, in progress) and beyond the French borders in Portugal, Switzerland, Italy, England (see Rozoy, 1978) and especially in all of northern Europe (see David, 1999).

Bevelled objects on wild boar canines with a "*tranchet*" shape are less common in Europe and known in a smaller region, between the Pyrénées, Britain and northern Switzerland. Though wild boar canines were used in northern Europe, their exploitation was different than at Cuzoul or in the Swiss examples (David, 2000): it was simpler and included no finished objects with the characteristic "*tranchet*" shape. In the southern regions of Europe, however, wild boar canines were also used to produce objects with various and simple shapes.

In all of southern France, Mesolithic populations exploited osseous raw materials in the same manner that we observed at Cuzoul, which could be considered, for the moment, as a reference site.

Nevertheless some manufacturing processes used at others sites are unknown at Cuzoul. For example, to produce bevelled objects on wild boar canines, and only in this case, Mesolithic populations at Cuzoul used grooving. But at some other French sites, grooving was used with other raw materials: deer antler at Clos de Poujol (maybe in connection with harpoon fragments recovered at this site) or bone at Rouffignac. In the northern Europe, during the Mesolithic, grooving was widely used in connection with the manufacturing of projectile points and bevelled or perforating objects (David, 1999). We had to clarify the use of grooving in southern Europe, where this technique seems to have been more frequently used during the Epipaleolithic (Azilian harpoons: Mons, 1995) and Neolithic (bone awls: Camps-Fabrer, 1990).

It is now necessary to enlarge the kind of study we conducted at Cuzoul to other sites in order to attempt to specify the role of the osseous material industry within the economy of Mesolithic populations, as well as to understand how this industry evolved through time and if this evolution was concomitant with changes in the lithic industry.

Acknowledgments

We wish to thank Thomas Lafon and Magen O'Farell for their help during the translation.

References

Averbouh, A. 2000. *Technologie de la matière osseuse travaillée et implication palethnologique; l'exemple des chaînes d'exploitation du bois de cervidé chez les magdaléniens des Pyrénées*, Thèse de doctorat, Université de Paris I – Panthéon-Sorbonne, Paris.

Averbouh, A. and J.-J. Cleyet-Merle 1995. *Fiche hameçons*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique, Cahier VI : éléments barbelés et apparentés*, Treignes: Editions du Cédarc, 83-99.

Averbouh, A. and N. Provenzano 1999. *Proposition pour une terminologie du travail préhistorique des matières osseuses: I – les techniques*, Préhistoire et Anthropologie méditerranéennes 7-8, 5-25.

Barbaza, M. 1989. *Cultures et société au Paléolithique terminal, au Mésolithique et au début du Néolithique ancien dans le sud-ouest de l'Europe*, Mémoire d'habilitation à diriger des recherches, Toulouse: Université de Toulouse II – le Mirail.

Barbaza, M. 1989. *Cultures et société au Paléolithique terminal, au Mésolithique et au début du Néolithique ancien dans le sud-ouest de l'Europe*, Mémoire d'habilitation à diriger des recherches, Toulouse le Mirail.

Bandi, H.-G. 1963. *Birsmatten-Basisgrotte: eine mittelsteinzeitliche Fundstelle im unteren Birstal*, Bern.

Barrière, C. 1973. *Rouffignac, l'archéologie*, Travaux de l'Institut d'Art Préhistorique XV, 4-160.

Bintz, P., J. Argant, L. Chaix, D. Pelletier and S. Thiébault 1999. *L'Aulp du Seuil (Saint-Bernard-du-Touvet, Isère, France), un site d'altitude du Mésolithique et du Néolithique ancien, études préliminaires*, In: A. Thévenin and P. Bintz (dir.), *L'Europe des derniers chasseurs. Epipaléolithique et Mésolithique. 5° colloque international UISPP, 18-23 septembre 1995*, 611-616.

Bridault, A., E. David, et M. Boboeuf 2009. *Matter and Material: Red Deer antler exploitation during the Mesolithic at Clos de Poujol (Aveyron, France)*, In: L. Fontana, F.-X. Chauvière and B. Anne (dir.), *In Search of Total Animal Exploitation. Case Studies from the Upper Palaeolithic and Mesolithic. Proceedings of the XVth UISPP Congress, Session C61, Lisbon, 4-9 September 2006, vol. 42.*, BAR International Series 2040, John and Erica Hedges, Oxford, 135-154.

Camps-Fabrer, H. dir. 1990. *Fiches typologiques de l'industrie osseuse préhistorique, cahier III : poinçons, pointes, poignards, aiguilles*. Ed. l'Université de Provence.

Camps-Fabrer, H., L. Bourrely and N. Nivelle 1974. *Lexique des termes descriptifs de l'industrie de l'os*, Aix en Provence: Editions de l'Université de Provence.

Camps-Fabrer, H. and D. Ramseyer 1998. *Fiche objet biseauté non perforé pris sur extrémité d'andouiller de cerf*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique, Cahier VIII : biseaux et tranchants.* Treignes: Editions du Cédarc, 31-50.

Chiquet, P., E. Rachez, and P. Petrequin 1997. *Les défenses de sanglier*, In: P. Pétrequin (ed.) *Les sites littoraux néolithiques de Clairvaux-les-Lacs et de Chalain (Jura),* *III, Chalain station 3, 3200-2900 av. J.C.*, Paris: Editions de la Maison des Sciences de l'Homme, 511-21.

Coulonges, L. 1935. *Les gisements préhistoriques de Sauveterre-la-Lémance (Lot-et-Garonne*), Archives de l'Institut de paléontologie humaine 14, Paris: Masson et Cie. Editeurs.

David, E. 1999. *L'industrie en matières dures animales du Mésolithique ancien et moyen en Europe du Nord. Contribution de l'analyse technologique à la définition du Maglemosien*. Thèse de doctorat, Université de Paris X Nanterre.

David, E. 2000. *L'industrie en matières dures animales des sites mésolithiques de la Baume d'Ogens et de Birsmatten-Basisgrotte (Suisse)*, In: *Meso'97: actes de la Table ronde «Epipaléolithique et Mésolithique», Lausanne, 21-23 novembre 1997*, Cahiers d'archéologie romande 81, 79-100.

Ginestet, J.-P., P. Bintz, L. Chaix, J. Evin and C. Olive 1984. *L'abri sous roche de la Vieille Église La Balme-de-Thuy (Haute Savoie). Premiers Résultats,* Bulletin de la Société Préhistorique Française 81, 320-42.

Guilaine, J. dir. 1995. *Les Excavacions a la Balma de la Margineda (1979-1991) 2. Primera part, Estudi arqueologic de les capes historiques, neolitiques i mesolitiques (capes de la 4 a la 6)*. Govern d'Andorra.

Kayser, O. and G. Bernier 1988. *Nouveaux objets décorés du Mésolithique armoricain*, Bulletin de la Société Préhistorique Française 85, 45-7.

Lacam, R., A. Niederlender and H. Valois 1944. *Le gisement mésolithique du Cuzoul de Gramat*, Archives de l'Institut de paléontologie humaine 21, Paris: Masson et Cie. Editeurs.

Laplace-Jauretche, G. 1953. *Les couches à escargots des cavernes pyrénéennes et le problème de l'Arisien de Piette*, Bulletin de la Société Préhistorique Française 50, 199-211.

Maigrot, Y. 2001. *Technical und functional study of ethnographic (Irian Jaya, Indonesia) and archaeological (Chalain and Clairvaux, Jura, France, 30th century BC) tools made from boars' tusks*, In: S. Beyries and P. Pétrequin (eds.) *Ethno-archaeology and its transfers (Papers from a session held at the European Association of Archaeologists Fifth Annual Meeting in Bournemouth 1999),* BAR Intern. Series 983, Oxford: Archaeopress, 67-80.

Maigrot, Y. 2003. *Etude technologique et fonctionnelle de l'outillage en matières dures animales: la station 4 de Chalain (Néolithique final, Jura, France)*, Thèse de doctorat, Université de Paris I – Panthéon-Sorbonne, Paris.

Marquebielle, B. 2007. *Première approche sur l'exploitation des matières dures animales au Mésolithique. L'industrie osseuse des niveaux du Mésolithique récent au Cuzoul de Gramat*, Mémoire de Master II, Toulouse: Université de Toulouse II – Le Mirail**.**

Monin, G. and D. Pelletier 2000. *Note sur les industries mésolithiques et néolithiques ancien de l'abri des Balmettes (St Aupre, Isère), et proposition de chronologie du Mésolithique ancien et de la fin de l'Epipaléolithique au Préboréal entre Alpes françaises du Nord et Jura méridional*, In: T. Tillet (ed.) *Géologie Alpine, mémoire H.S. n°31. Les Paléoalpins, hommage à Pierre Bintz,* Grenoble: Laboratoire de géologie de l'Université I de Grenoble, 129-41.

Mons, L. 1995. *Fiche harpons aziliens*, In: H. Camps-Fabrer (dir.), *Fiches typologiques de l'industrie osseuse préhistorique, cahier VI : éléments barbelés et apparentés,* Editions du Cédarc, Treignes.

Péquart, M. and S.-J. Péquart 1934. *La nécropole mésolithique de l'île d'Hoëdic (Morbihan)*, L'Anthropologie 44, 1-20.

Péquart, M., S.-J. Péquart, M. Boulle and H. Valois 1937. *Téviec: station-nécropole mésolithique du Morbihan,* Archives de l'Institut de Paléontologie Humaine 18, Paris: Masson et Cie. Editeurs.

Rozoy, J.G. 1978. *Les Derniers chasseurs. L'Epipaléolithique en France et en Belgique: essai de synthèse*, Bulletin de la société archéologique champenoise, no. spécial.

Seronie-Vivien, M.-R. 2001. *La grotte du Sanglier à Reilhac (Lot) Du Magdalénien au Néolithique ancien*, Préhistoire du Sud-Ouest, Supplément n°4.

Smith, C. 1989. British antler Mattocks, In: C. Bonsall (ed.) *The Mesolithic in Europe. Actes du 3^rd^ symposium international de l'U.I.S.P.P., Edinburgh, 1985*, Edinburgh: John Donald Publishers, 367-78.

Surmely, F. 2003. *Le Cuze de Neussargues (Sainte-Anastasie, Cantal). Le site mésolithique des Baraquettes (Velzic, Cantal) et le peuplement de la moyenne montagne cantalienne, des origines à la fin du Mésolithique*, Pôle éditorial de l'Ouest, Rennes.

Valdeyron, N., T. Briand, L. Bouby, A. Henry, R. Khedhaier, B. Marquebielle, H. Martin, A. Thibeau, and B. Bosc-Zanardo in press. *Le gisement mésolithique des Fieux (Miers, Lot) : une halte de chasse sur le causse de Gramat?*, In: F. Bon, S. Costamagno, and N. Valdeyron (ed.) *Haltes de chasse en Préhistoire : quelles réalités archéologiques? Actes du colloque international, Toulouse, 13-15 mai 2009*, Palethnologie 3.

Stefan Pratsch

Mesolithic antler artefacts in the North European Plain

The paper focuses on five Mesolithic inventories originating from systematically investigated sites situated in different regions of Germany and Poland. The main aim of the study is to trace chronological changes in forms of antler finds and antler working techniques starting from the middle Preboreal as far as the middle Subboreal period. The author examined a total of 499 antler artefacts in order to make the chronological classification and examine them in terms of their production technique. The analysis confirmed the similarity of the set of antler tool forms and techniques in the study area, the young glacial landscape stretching between the Elbe and the Neman as well as traced the local distinctive features. We hope that our study will be helpful for correlating stray finds lacking stratigraphy or dating to particular stages of the Mesolithic.

Key words: Mesolithic, antler finds, antler working techniques, Germany, Poland

The present study focuses on five Mesolithic antler inventories originating from sites situated in the young glacial landscape of north Germany and Poland. The author examined a total of 499 antler finds for tool forms and antler working techniques. The aim was to date the occurrence and decline of individual tool forms and to trace changes, if any, in antler working techniques and, possibly, also any chronological tendencies.

All examined antler inventories originate from comprehensively investigated and reliably dated Mesolithic sites: Dudka 1 (Gumiński 1995, 1998) and Pobiel 10 (Bagniewski 1992) in Poland, Hohen Viecheln 1, Friesack 4 and 27a (Gramsch 1991, 1992, 2000) in Northern Germany (Fig. 1). Careful excavation methods applied at Dudka 1, Friesack 4 and 27a helped to grasp the microstratigraphy of the deposit sequences and obtain samples for pollen analysis and radiocarbon dating. At Pobiel 10 and Hohen Viecheln 1 only a general study of stratigraphy was made, helping to distinguish three separate sequences of layers at each of these sites. For Hohen Viecheln there are no series of radiocarbon dates.

In the following chapters an attempt is made to make a chronological classification of antler finds of interest and examine them in terms of their production technique. It should be noted however that many tool forms are represented by only a small number of pieces or, outright, by just a single specimen.

Preboreal period

During the Preboreal period the best represented form of antler artefacts are mattock heads fashioned of elk antler. A mattock head of this type discovered within Layer Sequence I at Friesack 4 is dated to the middle Preboreal (Fig. 2). It corresponds in form and size to mattock heads known from Star Carr, particularly, Clark's type I (Clark 1954, fig. 15:left side). Characteristically, the cutting edge of the mattock head from Friesack 4 is situated in the proximal section of the antler; the perforation which follows a line diagonal to the longer axis of the antler is situated at the point where the antler starts to expand.

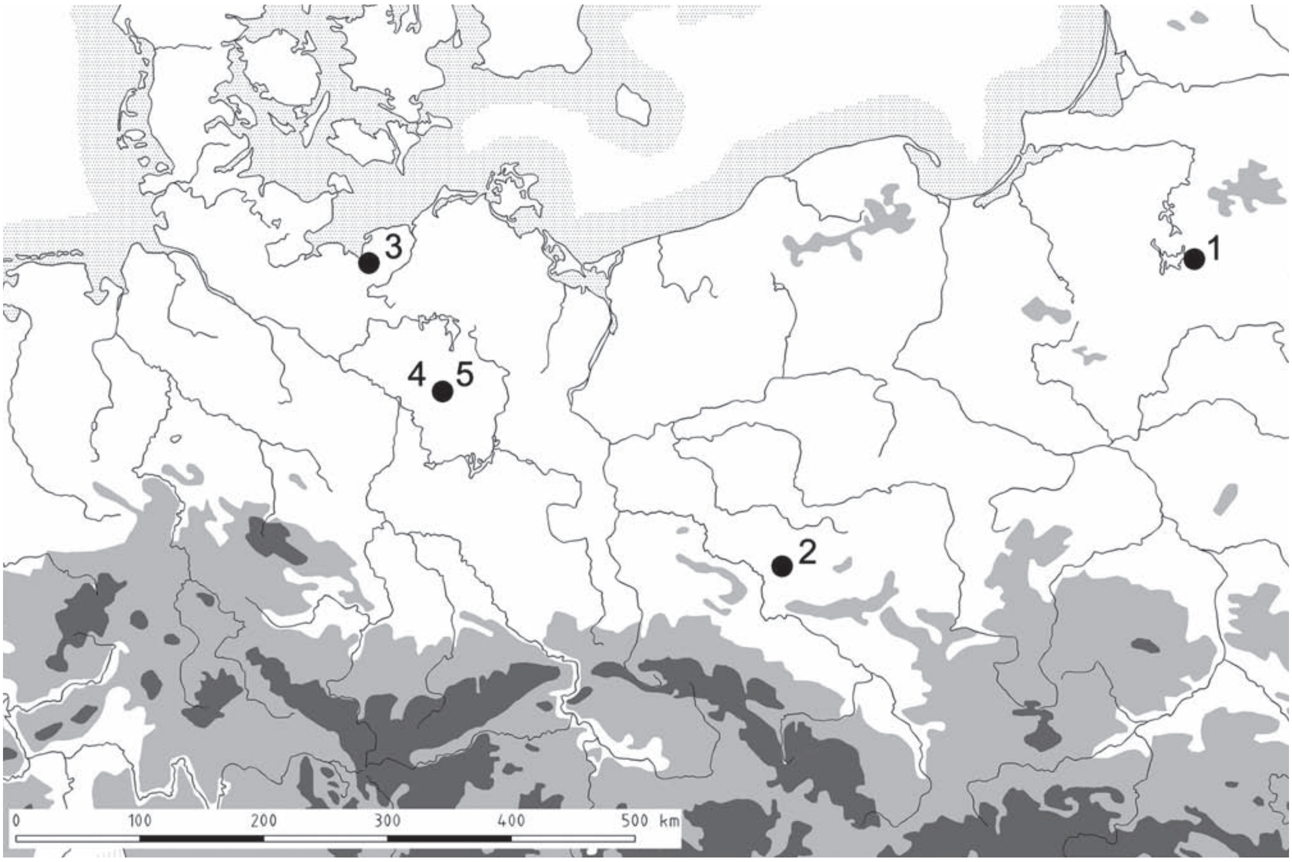


Fig.1. Mesolithic sites with antler inventories:
1 – Dudka 1; 2 – Pobiel 10; 3 – Hohen Viecheln 1; 4-5 – Friesack 4 and 27

A large part of recorded axe heads fashioned from elk antler also dates from the Preboreal (Fig. 3). One of these specimens, recovered at Friesack 4 from within Layer Sequence II, is dated to the late Preboreal-early Boreal transition (Fig. 3:4).

Hohen Viecheln 1 produced a mattock head and three insert-axes of elk antler (Fig. 3:1-3). The mattock head is somewhat different from other known forms of this type whereas two insert-axes correspond in form and length to similar pieces from Friesack 4, Wustermark 22 and Eastern Europe.

Elk antler mattock heads from Star Carr (Clark 1954), Friesack 4 (Pratsch 1994) and four specimens from Sweden (Salomonssen 1961) were dated by pollen and radiocarbon analyses to the Preboreal, possibly, early Boreal period. Of two antler axe heads with radiocarbon dates the specimen from Wustermark 22 (Beran 2001; 2002) is placed in the earliest phase of the Preboreal period, the piece from Friesack 4 is dated to the transition from the late Preboreal to the early Boreal. Basing on the above determinations it is reasonable to date the antler finds from Hohen Viecheln 1 also to the Preboreal, or possibly, the early Boreal period. Gramsch (1987:98) and Cziesla (2002:59-59) claim that there are Preboreal strata and artefacts at Hohen Viecheln 1.

Fig.2. Friesack 4.
Elk antler mattock with a shaft hole

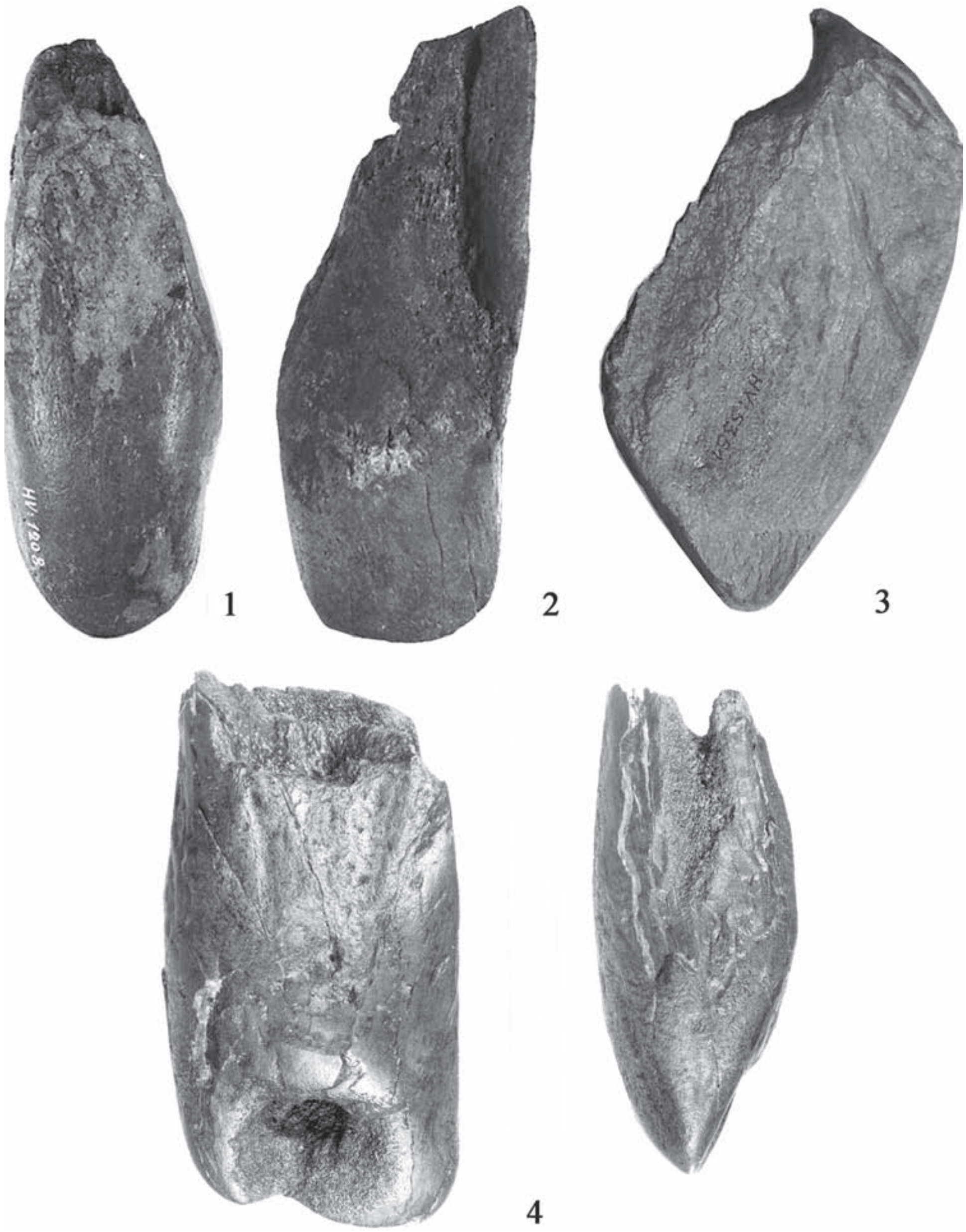


Fig. 3. 1-2 – Elk antler insert-axes from Hohen Viecheln 1; 3 – Elk antler mattock with a shaft hole from Hohen Viecheln 1; 4 – Elk antler insert-axe from Friesack 4

Fig. 4. Friesack 4. Evidences for the groove and splinter technique (1) and the percussion technique (2)

Fig. 5. Tools made from the base of a red deer`s antler: 1, 2 – Adzes from Dudka 1; 3 – Mount from Friesack 4

Other antler tool forms include an antler haft with a natural grip from Friesack 4 and a rough-out of a perforated antler beam from Friesack 27a. The antler haft was used presumably to haft a flint axe; later, when the socket wore away, the piece was used as a hammer. The perforated antler rough-out was fashioned from the distal fragment of the beam. This is unusual as most forms of this type are fashioned from proximal sections of the beam.

As regards the working technique it may be said that only a very small number of antler beams were split along their longer axis. Hohen Viecheln 1 produced an antler splinter obtained using the groove and splinter technique (Schuldt 1961, fig. 72). One of the antler tines from Hohen Viecheln 1 features two grooves made using the same technique. Friesack 4 produced an antler beam with a scar left by detaching a splinter and a distinctive point fashioned

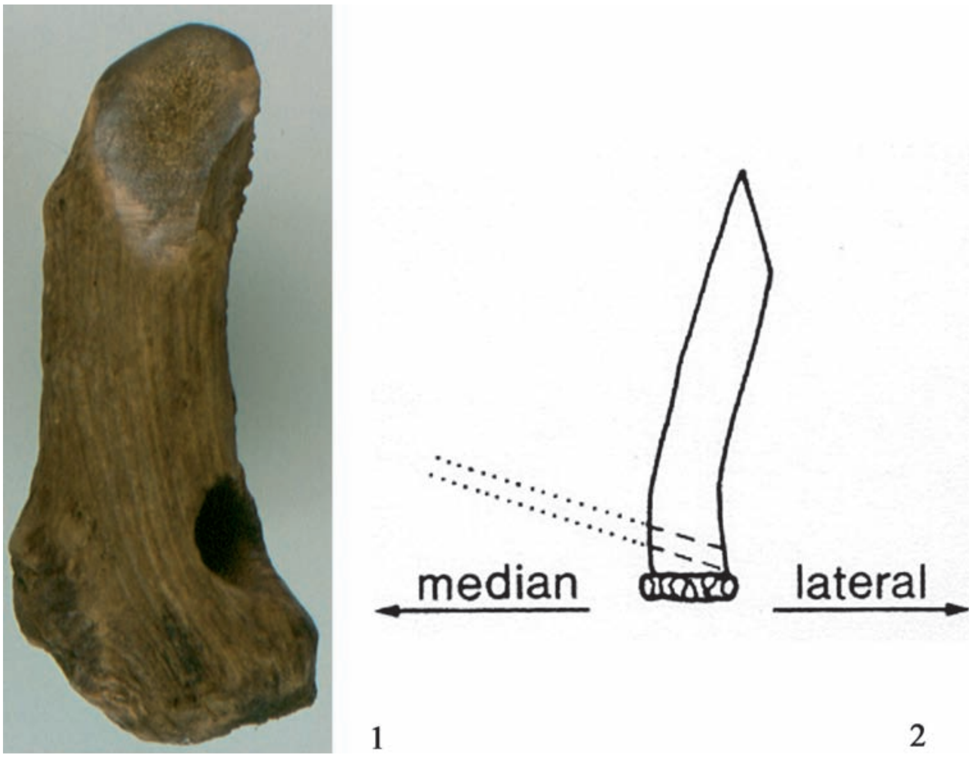


Fig. 6. 1 – Base-Axe from Hohen Viecheln 1; 2 – The angle between the wooden shaft and the main axis of the tool differs between 82° and 84°; the lateral opening of the shaft hole is near the burr

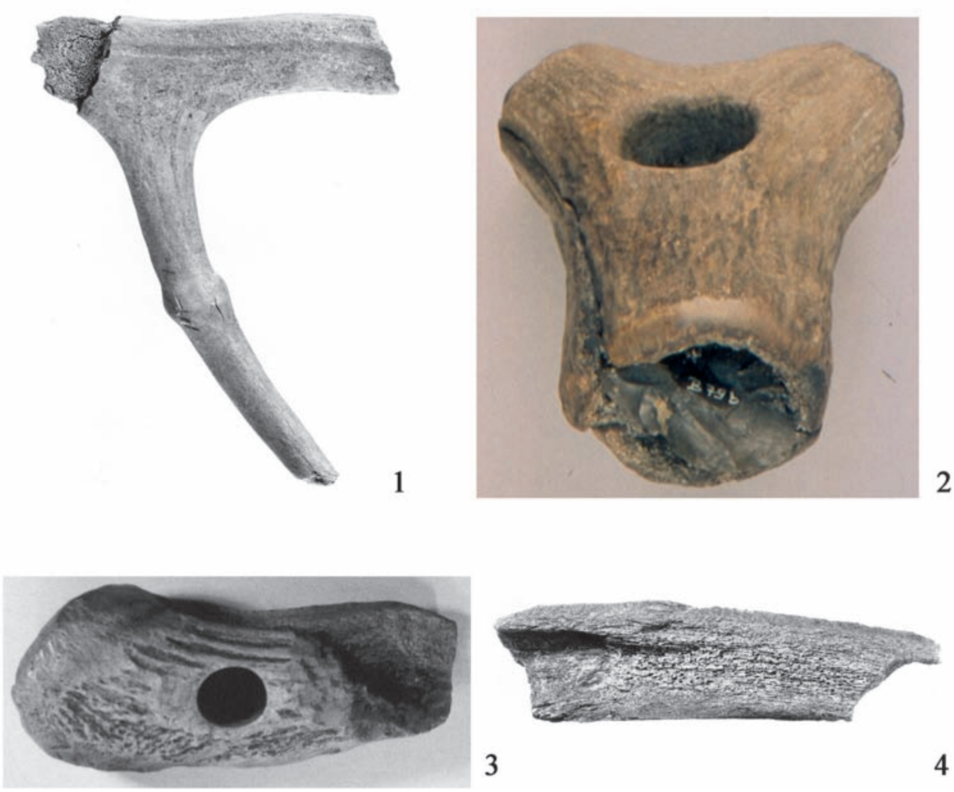


Fig. 7. Different Mounts: 1 – Mount with a tine as handle from Friesack 4; 2 – Mount from the crown with a shaft hole from Friesack 4; 3 – Mount from the base with a shaft hole from Dudka 1; 4 – Mount (handle) from Friesack 4

from red deer antler (Fig. 4:1). Use of percussion is indicated by a single piece from Friesack 4 (Pratsch 1994, fig. 16:2). Limited evidence on the groove and splinter and the percussion technique suggests that projectile points were fashioned rarely from antler splinters. This is confirmed by studies of early Mesolithic points from Friesack 4 (Gramsch 1990) – out of 92 points just one specimen was fashioned from antler. A technique which apparently gained in importance in dividing antler beams laterally was faceting, as a rule, applied in combination with breaking.

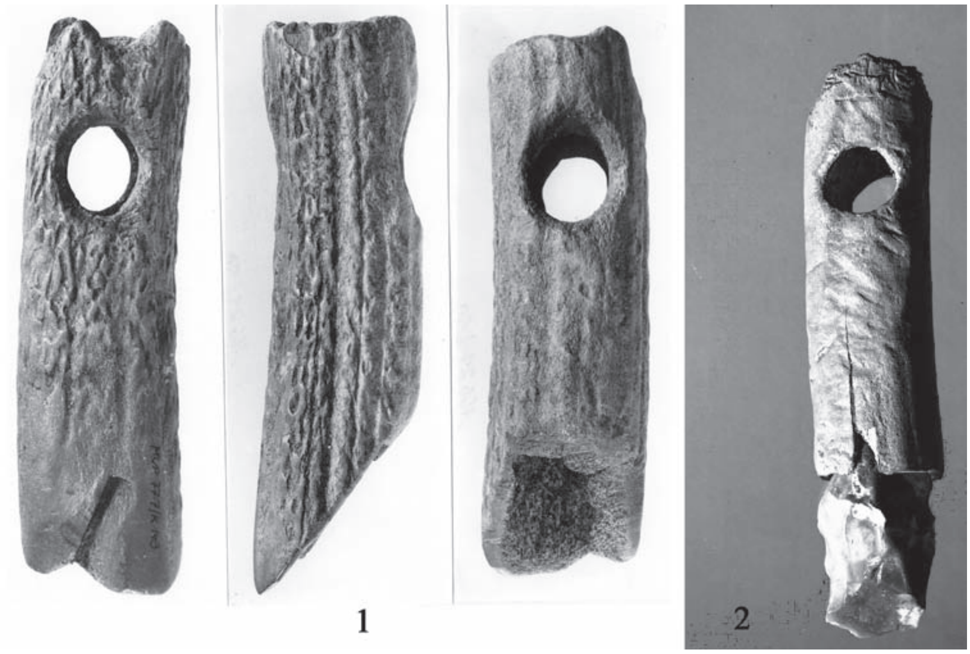


Fig. 8. Tools made from antler beam of a red deer:
1 – Adze with a shaft hole from Friesack 4;
2 – Mount with a shaft hole and a core-axe as an insert from Hohen Viecheln 1

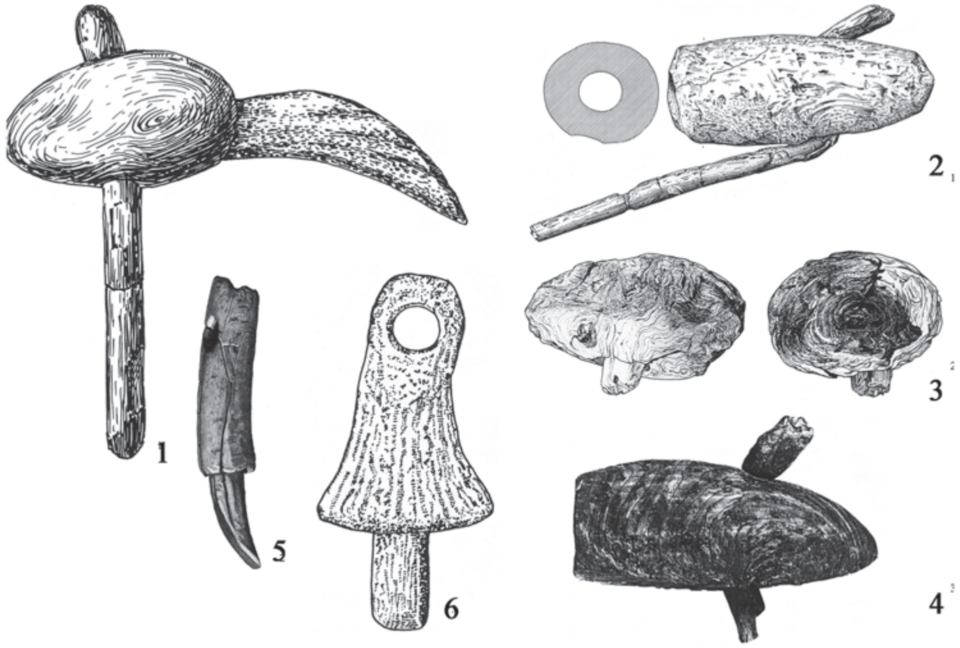


Fig. 9. Different mounts for insert-axes:
1-4 – made of wood from Zvidzienaskrogs (Lithuania), Duvensee, Friesack and Hohen Viecheln (Germany);
5 – made of red deer`s antler beam, Svaerdborg (Denmark);
6 – made of elk antler, Lisi Ogon (Poland)

Early Boreal period

During the early Boreal period we see an increase in the range of antler tool forms. The section of the antler next to the burr was used to produce mattock heads (Fig. 5-6) and mounts different typologically from earlier elk antler mattock heads. Apparently, red deer antler was more easily available and tools of this material replaced forms fashioned from elk antler. Hafts made from the base portion of antler were the first tools to be composed of three elements: wooden handle, antler haft, and the hafted tool – flint axe or antler axe head (Broholm 1924, fig. 45-46; Keiling 1988, fig. 5:c; Pl. 16:f).

Next to antler hafts made of the base of red deer antler beam a widespread form is sleeves with a natural gripping section (Fig. 7); other forms include sleeves fashioned from other parts of the beam, and sleeves-handles. The latter were produced from fragments of tines or the more slender parts of the beam. They usually have long perforations of small diameter, so we may assume that they were used as sleeves

Fig. 10. 1, 2 – Adzes made of a red deer`s antler beam from Friesack 4 and a reconstruction of the complete tools

Fig. 11. Antler insert-axes: 1, 3 – Friesack 4; 2 – Dudka 1

for bone points or slender flint blades. Sleeves with a larger perforation were used for hafting flint axes (Fig. 8) or antler axe heads (Fig. 9), (Friis Johansen 1919, fig. 38, 40; Schuldt 1961, fig. 14, 98).

Axe heads are better represented during the early Boreal period (Pratsch 1999). They were fashioned from a part of the red antler beam or from fragments of larger tines. The oldest of these specimens from

Friesack 4 are worth noting: they are fashioned from fragments of the beam between the brow and the trez tine (Fig. 10). Longer and heavier specimens were probably hafted onto elbow-shaped wooden shafts. The rest of the axe heads are shorter and are characterised by having a shorter cutting edge and an elongated and pointed butt (Fig. 11).

A new form is a perforated tool fashioned from the crown of the red deer antler beam. In a solitary specimen of this type recorded at Friesack 4 the working section was fashioned from a pointed tine of the crown (Pratsch 2006, fig. 22). Artefacts of this type dated to the Mesolithic are unknown outside Denmark. It is also notable that all of these forms are ornamented and they are unlikely to have been used as hammers (Bloksbjerg *et al.* 1948:64, fig. 142). A broken off tip of an antler tine from Friesack 4 indicates that the tool had been used for digging. The tool corresponds best to similar early Neolithic forms known from Heringsdorf-Süssau (Hoika 1987:75, fig. 76:1) and Spiennes (Gayck 2000, Pl. 7, fig. 119).

Another novelty is a tine with a perforation at the base. Such a form is represented at Friesack 4 by a single specimen – a worked piece apparently abandoned during the initial stage of making the perforation. Its small diameter suggests that instead of accommodating a wooden handle the hole was used for threading a thong or rope. We may only guess at the function of these tools; perhaps it was used as a needle for making fishing nets. As regards the production technique it may be seen that the antler beam was always broken apart transverse. This was almost always done using the technique of faceting, combined with breaking. Cutting was used very rarely.

Middle and late Boreal period

During this period we see a further increase in the range of antler tool forms. Next to mattock heads and hafts fashioned from basal section of the beam, the late Boreal period produced axes fashioned from the same part of the beam. Their cutting edges are roughly parallel to the axis of the shaft hole (Fig. 12). Perforations were made in the medial-lateral plane so that their axis is perpendicular to the longer axis of the axe. Other forms include antler sleeves with a natural grip, sleeves-handles and axe heads. Among them the prevailing forms are tools with a perforation fashioned in the base section of the beam, and

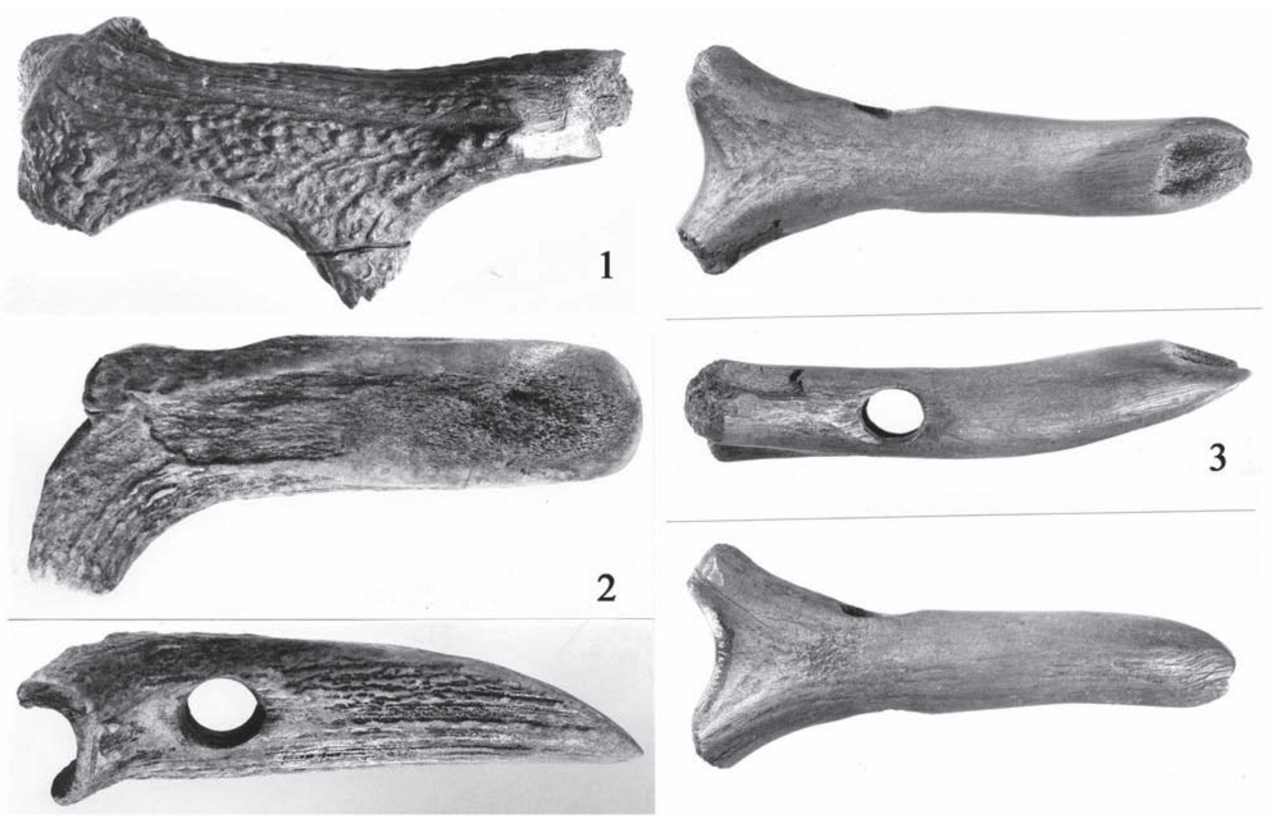


Fig. 12. Tools with a long shaft hole from Friesack 4:
1 – Base-axe; 2 – Damaged T-shaped axe with a new shaft hole; 3 – Axe made from the base of a crown

Fig. 13. Friesack 4: 1, 2 – Crown from a red deer`s antler (1) with sawing traces at the proximal end (2); 3 – Detailed picture of an artefact with sawing traces

axe heads. Hohen Viecheln 1 produced 9 tools fashioned from basal sections of the beam and 12 axe heads; Friesack 4 (Layer Sequence IV) – 20 "basal" tools and 6 axe heads. There are also some tools fashioned from antler tine: tines with perforations, tines with uni- or bifacially bevelled tips and percuteurs.

During the late Boreal period cutting gains in importance as a technique for dividing up the antler although the prevailing method is faceting used in combination with breaking (Fig. 13). This method of making perforations is illustrated by a large number of finds of antler rough-outs. Using hammer and chisel the antler workers chipped away small bits of the compact layer working at a circular surface of the antler where the perforation was to be until all of it was removed. After this was done at both ends of the future hole, the craftsman perforated the spongy matter. The last step was to widen the opening and give the perforation its final form.

Atlantic period

During the Atlantic period we see a considerable reduction in the range of antler tool forms. The trend is exhibited in an interesting way by the inventory from Friesack 4. Tools fashioned from base section of the beam no longer include hafts and other forms of antler sleeves are represented by solitary specimens. Three new forms of tools enter the record, with perforations parallel to the longer axis of cross-section. An outstanding form is a unique axe fashioned from a crown of the beam recovered at Friesack 4, Layer Sequence IV (Fig. 12:3). Similar forms are known from late Mesolithic and Neolithic sites. They have a perforation perpendicular or parallel to the longer axis of cross-section (Mathiassen 1948:63, fig. 126; Schoknecht 1962:284, fig. 188:c; Gramsch 1973:41, 91-92; Werning 1983, fig. 16; Dellbrügge 2002:119, fig. 12:2). Next to the described tool we note the first occurrence of an axe fashioned from a base beam section, with a perforation in its frontal-back plane, positioned between the brow and the trez tine. Finally, starting from the late Atlantic period we see the first T-shaped axe in which the perforation passes through the base of the removed trez tine. An increase in occurrence of T-shaped axes is observed first of all at late Mesolithic settlements of Ertebølle culture (Rosenhof: Vielstich 1992; Dąbki: Ilkiewicz 1989). By this time axe heads have become quite rare. Only tools fashioned from tines continue to be represented by a wider range of forms.

Inventories from Pobiel 10 and Dudka 1 produced mattock heads and hafts from base section of antler beams. Dudka 1 also featured a remarkable set of 5 axe heads which formed the largest group of antler tools. Other forms included T-shaped axes and a full range of antler tine tools, including percuteurs.

The main antler technique continued to be faceting, combined with the technique of breaking, and the technique of cutting was used less frequently. To pro-

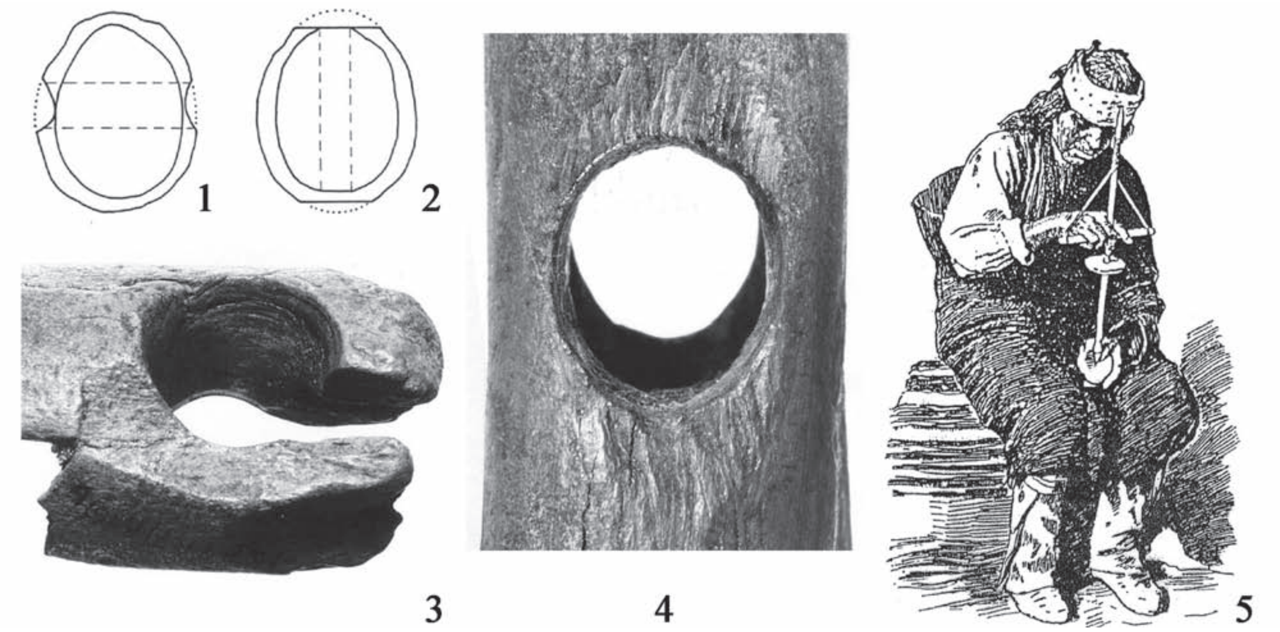


Fig. 14. 1 – shaft hole on the short diameter, chronologically older; 2 – shaft hole on the long diameter, chronologically younger; 3, 4 – detailed pictures of artefacts with boring traces from Friesack 4; 5 – Zuni Indian boring a stone

duce perforations parallel to the longer axis of cross-section the compact layer of the antler was gouged out lengthwise down to the spongy matter which was then pierced to make a hole for hafting. It has been observed that both ends of the perforation are of identical diameter which suggests that this type of perforation (in alignment with the longer axis of cross-section) was made using drilling tools (Fig. 14; Henriksen 1973).

Subboreal period

The only Subboreal layers containing antler finds survived at Dudka 1 and Friesack 4. The range of tool forms is even more limited. From Dudka 1 we have 5 axe heads, a butt fragment of a T-shaped axe, and a fragment of a tool with a bifacially shaped blade at right angles to the longer axis of a cross-section. There was also a number of antler tine tools: a tine with a perforation, a tine with unifacially bevelled tip and three tines with traces of working. The axe heads from Dudka are the chronological youngest finds of this type in Europe. Friesack 4 (Layer Sequence Vb) produced a fragment of an antler beam with a perforation and cutting edge – the remain of an axe. Its form recalls different variants of this type of tool, known mainly from the Atlantic period. The same site also yielded a percuteur made from an antler beam.

Late Mesolithic and Early Neolithic antler artefacts – comparison

Mesolithic antler inventories recovered at Friesack 4, Dudka 1 and Pobiel 10 show that the Atlantic period saw a substantial reduction in the range of forms of antler tools. To gain more insight on this tendency a comparison was made with an early Neolithic antler inventory from Eilsleben, Börde district (Pratsch 2004). It was established that both the late Mesolithic and early Neolithic were a time of an observable decrease in the number of tools made of red deer antler beams. The most common type of tool was the T-shaped axe; perforated tools fashioned from the base of the antler beam play only a subsidiary role. It has been suggested that this was due to increased manufacture and utilisation of axes of crystalline rock and flint.

Antler tine tools continue their wide range; a new tool form noted in the antler inventory from Eilsleben is the retoucher. Awls of roe deer antler, known from late Mesolithic layers at Dudka 1 and Friesack 4, are also represented in the material from Eilsleben.

A remarkable find from Eilsleben is a roe deer skull with antler. Very likely it may be traced back to similar finds (so-called trophies or head dresses)

phase / period	1	2	8	3	14	4d	6a	6c	4a	7	12	15	6b	11	5	13	4b	9	4c	16	10
Subboreal period										X	X	X				X					X
Atlantic period									X	X		X							X	X	X
Border late Boreal / early Atlantic period						X	X	X	X	X	X	X			X	X	X	X			
Middle and late Boreal period				X	X	X			X	X	X		X	X	X	X					
Early Boreal period	X	X	X	X	X	X	X	X	X	X	X	X									
Preboreal period	X						X														

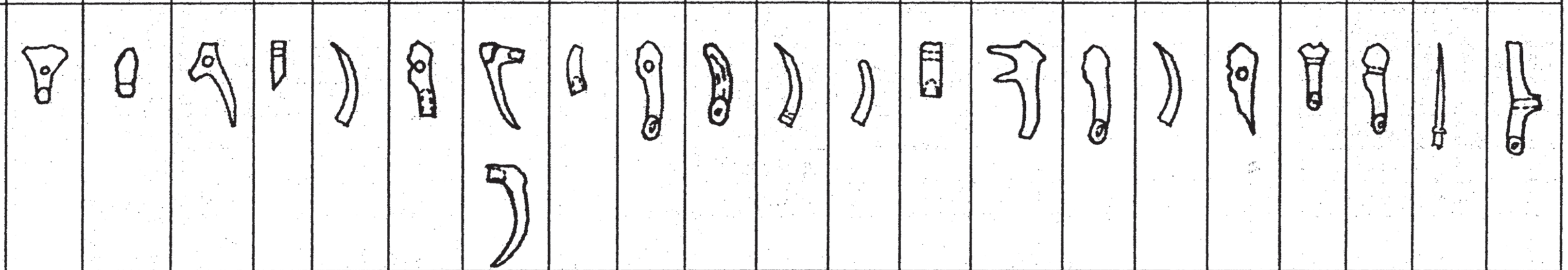


Fig. 15. Distribution of artefacts in the particular periods of the Mesolithic and Early Neolithic:
1 – Elk antler mattock-head with a shaft hole; 2 – Mace-head of elk antler; red deer: 3 – Pick/hoe made of a beam-section; 4 – Base-tools with a shaft hole (a base-pick/hoe, shaft hole median-lateral, b base-axe, shaft hole median-lateral, c base-axe, shaft hole anterior-posterior, d base-mount, shaft hole median-lateral); 5 – Base-tool with an edge but without a shaft hole; 6 – Mounts (a mount with a tine as a handle, b mount with a shaft hole – made of a beam-section, c Mount = handle); 7 – Mace-heads; 8 – Tool made of the base of a crown; 9 – Axe made of the base of a crown; 10 – T-shaped axe; 11 – Percuteur; 12 – Tine with a perforation; 13 – Tine with an oblique end; 14 – Tine with an chisel-like end; 15 – Pressure tool; 16 – Awl made of a roe deer’s antler

of modified red deer frontlets with antlers known from Mesolithic sites (Star Carr, Schötz 7, Bedburg-Königshoven, Hohen Viecheln). Frontlets with antlers were modified not for any utilitarian use but for use as hunting trophies. Apparently, roe deer skull from Eilsleben may be treated as a reflection of an age long tradition of hunting rituals handed by generations across the millennia.

Almost all antler artefacts discussed here come from settlement layers. We have much less evidence to reconstruct their role in the funerary rite. Of five sites examined in this analysis only Dudka produced human burials. An antler axe head recovered from one of the grave pits at Dudka may have been a grave offering but for further confirmation or rejection of this interpretation we must wait until the graves from Dudka have been published. Next to a number of other grave goods the late Mesolithic grave at Bad Dürrenberg (Bicker 1936) produced a haft fashioned from the basal section of a red deer antler beam and a roe deer skull with antlers. A number of burials at the Scandinavian Mesolithic cemetery sites Vedbæk (Albrechtsen, Brinch Petersen 1976) and Skateholm (Larsson 1984) contained complete red deer antlers and antler tools or tines. This suggests that in the study area antler tools could have been used as grave offerings.

Conclusion

The study of antler inventories from five Mesolithic sites with a different chronological range was helpful in tracing antler tool forms and manufacturing techniques starting from the middle Preboreal as far as the middle Subboreal period. It confirmed the major role of this resource during the Mesolithic, familiarity with properties of antler and its deliberate use in making specific antler tools.

Whereas during the Preboreal period many tools were manufactured from elk antler, in later periods the main resource collected and worked was red deer antler (Fig. 15). Crosswise breaking up of the beam into smaller fragments made it possible to use almost all its parts for making tools. Formal diversity of the tools produced sets apart the analysed antler inventories from the material recovered at the Preboreal site Star Carr, where red deer antler beams almost entirely were used for splinter production. Another distinctive feature of the Boreal period is marked diversity of tool forms. In contrast, during the Atlantic period we see an abrupt decline in the number of tool forms which is probably connected with the increase in production and use of axes made of crystalline rock and flint.

Analysis of manufacturing techniques revealed that the technique of percussion and the groove and splinter technique were only used exceptionally. The prevailing technique was faceting, used in combination with breaking. Cutting gained recognition only from the beginning of the late phase of the Boreal period. Further changes were observed in the technique of making perforations. During older stages of the Mesolithic perforations in antler beams and tines almost without exception were made at right angles to the longer axis of cross-section. From the late Boreal, particularly during the Atlantic period, perforations were made parallelly to the longer axis of cross-section, most probably using some sort of drill.

It may be said therefore that the analysis of five Mesolithic antler inventories brought the expected results. It confirmed the similarity of the set of antler tool forms and techniques in the study area, the young glacial landscape stretching between the Elbe and the Neman. Some local distinctive features were also noted: the late antler axe heads recovered from Subboreal layers at Dudka 1, and parts of a necklace from Pobiel 10. The results of the analysis have been already presented (Pratsch 2006, fig. 51-52). It is to be hoped that our study will be helpful for correlating stray finds lacking stratigraphy or dating to particular stages of the Mesolithic. It has been demonstrated that individual tool forms – such as mattock heads and axe heads of elk antler – are limited to the early Mesolithic. Other forms, like T-shaped axes, occur starting from the late Mesolithic. Next to them we see long lived forms which are noted from the early Boreal until the Subboreal period: mattock heads fashioned from base sections of the antler beam, axe heads and percuteurs. In future it would be desirable to obtain more radiocarbon dates for antler tools to refine the chronological scheme even further. Parallel to the study of Mesolithic antler inventories we examined antler finds from the Neolithic settlement at Eilsleben, Saxony-Anhalt, including in the analysis all the items - artefacts as well as fragments of antler not showing evident traces of working. We found confirmation that any comprehensive study of antler inventories should take into account all antler finds in a given inventory.

This will make it possible to refit fragments of antler and in turn, to alter the statistics and the outlook of tool forms and their dimensions. Owing to the time factor this approach could not be used with regard to inventories examined for my PhD thesis.

There is a pressing need for a continued study of Mesolithic antler finds. Priority should be given to conservation and prompt processing (recording and photographic documentation) of antler pieces recovered during excavation or originating from random discoveries. This applies fully to finds from Rothenklempenow 10, Dudka 1 and Pobiel 10, and to faunal remains from Hohen Viecheln 1. To be able, in turn, to develop a chronological scheme it is imperative to directly date as many pieces as possible. Recently antler finds from Mecklenburg and the Polish part of the Baltic Sea basin have started to be studied within the framework of SINCOS. For areas to the south of this region there is need for a project which would involve the study and reassessment of Mesolithic antler inventories from Friesack 4, 27, Pobiel 10 and Dudka 1, and from the recently explored early Neolithic site at Prenzlau, Uckermark district. Such a project could be carried out within the framework of cooperation between Monuments Conservation Authorities and universities.

References

Albrechtsen, E. and E. Brinch Petersen 1976. *Excavation of a mesolithic Cemetery at Vedbæk, Denmark,* Acta Archaeologica 47, Copenhagen, 1-28.

Bagniewski, Z. 1992. *Untersuchungsergebnisse aus der mesolithischen Torfstation Pobiel 10 (Niederschlesien),* Prähistorische Zeitschrift 67(2), 141-62.

Beran, J. 2001. *Spätpaläolithische und mesolithische Funde der Rettungsgrabung Wustermark 22 im Havelland,* Kunde N.F. 52, 173-88.

Beran, J. 2002. *Wustermark 22, Lkr. Havelland (Brandenburg) – Moorgrabung 1999 mit spätpaläolithischen und mesolithischen Funden*, Greifswalder Geographische Arbeiten 26, 175-8.

Bicker, F.K. 1936. *Ein schnurkeramisches Rötelgrab mit Mikrolithen und Schildkröte in Dürrenberg, Kr. Merseburg*, Jahresschrrift für die Vorgeschichte der Sächsisch-Thüringischen Länder 24, 59-81.

Broholm, H.C. 1924. *Nye fund fra de aeldste Stenalder. Holmegaard- og Svaerdborgfundene*, Aarbøger for Nordisk Oldkyndighed og Historie 1924, 1-144.

Cziesla, E. 2002. *Spätpaläolithische Widerhakenspitzen aus dem Heimatmuseum Friesack, Lkr. Havelland,* Veröffentlichungen des Brandenburgischen Landesmuseum für Ur- und Frühgeschichte 33, 1999, 51-63.

Clark, J.G.D. 1954. *Excavations at Star Carr,* Cambridge: Cambridge University Press.

Dellbrügge, S.B. 2002. *Steinzeitliche Knochen- und Geweihfunde im nördlichen Schleswig-Holstein,* Universitätsforschungen zur prähistorischen Archäologie 83, Bonn: Habelt.

Friis Johansen, K. 1919. *En boplads fra den aeldste stenalder i Svaerdborg Mose*, Aarbøger for Nordisk Oldkyndighed og Historie 9(2-3), 106-235.

Gayck, S. 2000. *Urgeschichtlicher Silexbergbau in Europa*, Beiträge zur Ur- und Frühgeschichte Mitteleuropas 15, Weißbach: Beier & Beran.

Gramsch, B. 1973. *Das Mesolithikum im Flachland zwischen Elbe und Oder*, Veröffentlichungen des Museums für Ur- und Frühgeschichte Potsdam 7.

Gramsch, B. 1987. *Ausgrabungen auf dem mesolithischen Moorfundplatz bei Friesack,* Veröffentlichungen des Museums für Ur- und Frühgeschichte Potsdam 21, 75-100.

Gramsch, B. 1990. *Die frühmesolithischen Knochenspitzen von Friesack, Kr. Nauen*, Veröffentlichungen des Museums für Ur- und Frühgeschichte Potsdam 24, 7-26.

Gramsch, B. 1991. *Ausgrabungen auf einem weiteren mesolithischen Fundplatz bei Friesack, Kr. Nauen,* Ausgrabungen und Funde 36, 51-6.

Gramsch, B. 1992. *Friesack Mesolithic Wetlands*, In: B. Coles (ed.) *The Wetland Revolution in Prehistory*, The Prehistoric Society, Wetland Archaeology Research Project Occasional Paper 6, Exeter, 65-72.

Gramsch, B. 2000. *Friesack: Letzte Jäger und Sammler in Brandenburg*, Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 47, 51-96.

Gumiński, W. 1995. *Environment, economy and habitation during the Mesolithic at Dudka, Great Masurian Lakeland, NE-Poland*, Przegląd Archeologiczny 43, 5-46.

Gumiński, W. 1998. *The peat-bog site Dudka, Masurian Lakeland: An example of conservative economy*, In: M. Zvelebil (ed.) *Harvesting the Sea, Farming the Forest. The Emergence of Neolithic Societies in the Baltic Region*, Sheffield: Sheffield Archaeological Monographs, 103-9.

Henriksen, G. 1973. *Maglemosekulturens Drilbor med et par boretekniske betragtninger*, Aarbøger for Nordisk Oldkyndighed og Historie 1973, 217-25.

Hoika, J. 1987. *Das Mittelneolithikum zur Zeit der Trichterbecherkultur in Nordostholstein*, Offa 61.

Ilkiewicz, J. 1989. *From studies on cultures of the 4th millennium B.C. in the central part of the polish coastal area*, Przegląd Archeologiczny 36, 17-55.

Keiling, H. 1988. *Baggerfunde von einem ältermesolithischen Rastplatz im Trebeltal bei Tribsees, Kreis Stralsund*, Bodendenkmalpflege in Mecklenburg 35, 29-46.

Larsson, L. 1984. *The Skateholm Project, A Late Mesolithic Settlement and Cemetery Complex at a South Swedish Bay*, Maddelanden från Lunds universitets historiska museum 1983-84, 5-38.

Mathiassen, T. 1948. *Danske Oldsager I Aeldre Stenalder*, København.

Pratsch, S. 1994. *Die Geweihartefakte des mesolithisch-neolithischen Fundplatzes von Friesack 4, Kr. Havelland – Formenkundlich-chronologische und technologische Untersuchungen*, Veröffentlichungen des Brandenburgischen Landesmuseum für Ur- und Frühgeschichte 28, 7-98.

Pratsch, S. 1999. *Beilklingen aus Geweih. Eine mesolithische Geräteform*, In: E. Cziesla, T. Kersting and S. Pratsch (eds.) *Den Bogen spannen... Festschrift für Bernhard Gramsch*, Beiträge zur Ur- und Frühgeschichte Mitteleuropas 20, Weißbach: Beier & Beran, 177-83.

Pratsch, S. 2004. *Die Geweihfunde der neolithischen Siedlung von Eilsleben (Bördekreis)*, Jahresschrift für Mitteldeutsche Vorgeschichte 88, 67-136.

Pratsch, S. 2006. *Mesolithische Geweihgeräte im Jungmoränengebiet zwischen Elbe und Neman. Ein Beitrag zur Ökologie und Ökonomie mesolithischer Wildbeuter*, Studien zur Archäologie Europas 2, Bonn: Habelt.

Salomonssen, B. 1961. S*ome Early Mesolithic Artefacts from Scania, Sweden*, Maddelanden från Lunds universitets historiska museum 1961, 5-26.

Schoknecht, U. 1962. *Kurze Fundberichte. Bezirk Neubrandenburg 1960*, Bodendenkmalpflege in Mecklenburg 1961, 271-94.

Schuldt, E. 1961. *Hohen Viecheln. Ein mittelsteinzeitlicher Wohnplatz in Mecklenburg*, Deutsche Akademie für Wissenshaft zu Berlin, Schriften der Sektion für Vor- und Frühgeschichte Band 10, Berlin: Akademie Verlag.

Vielstich, A. 1992. *Die Knochen und Geweihgeräte der Ausgrabungen in Rosenhof (Ostholstein) aus der Zeit des beginnenden Neolithikums*, unprinted Masterthesis, Köln.

Werning, J. 1983. *Die Geweihartefakte der neolithischen Moorsiedlung Hüde I am Dümmer, Kreis Grafschaft Diepholz*, Neue Ausgrabungen und Forschungen in Niedersachsen 16, 27-187.

Marcin Diakowski

Bone and antler artefacts from Pobiel 10, Lower Silesia, Poland. Are they really Mesolithic?

The aim of this paper is to revise the technological and typological aspects of the artefacts found on the site of Pobiel 10. Having considered the multicultural character of the site and possible translocations of the artefacts from one stratigraphic layer to another, an assumption has been made that some of the artefacts could have originated from younger chronological periods and thus may bear traces of treatment with metal tools. The purpose of these thorough technological investigations was also to reconstruct the way the tools from the site of Pobiel 10 were made and ascribe them properly to the communities inhabiting it.

The new study of faunal remains enabled to placed them in a new classification criteria according to raw material, morphology and technology. Results of the analysis of technological and natural traces verify previous functional and typological determinations.

Keywords: Mesolithic, technological analysis, bone and antler artefacts

Introduction

In recent years a number of works concerning the Mesolithic bone and antler processing technologies on the North European Plain have appeared (David 1999, 2002, 2003, 2004, 2005, 2006, 2007). Typological and technological research enabled the author to link the bone and antler artefacts to certain “traditions” of processing of these raw materials in the Boreal Period.

A couple of Mesolithic sites abounding with faunal remains are known from the territory of Poland; among them: Pobiel 10 (Bagniewski 1990a, 1990b – further reading there), Dudka (Gumiński 1995, 2003; Fiedorczuk 1995), Szczepanki 8 (Gumiński 2005) and Krzyż (Kabaciński *et al*. 2006, 2008).

Z. Bagniewski (1992) and S. Pratsch (2006) have also attempted to investigate the methods of bone and antler processing in the Mesolithic based on materials from the Pobiel 10 site. Their analysis, however, to an unsatisfactory extent took into consideration the taphonomic processes, technological aspects and the multicultural character of the site. The aim of this paper is therefore to revise the technological and typological aspects of the artefacts found on the site of Pobiel 10. Until now the artefacts of organic materials from this site were classified exclusively as Mesolithic. Having considered the multicultural character of the site (Bagniewski 1990a) and possible translocations of the artefacts from one stratigraphic layer to another, an assumption has been made that some of the artefacts could have originated from younger chronological periods and thus may bear traces of treatment with metal tools. The purpose of these thorough technological investigations was also to reconstruct the way the tools from the site of Pobiel 10 were made and ascribe them properly to the communities inhabiting it.

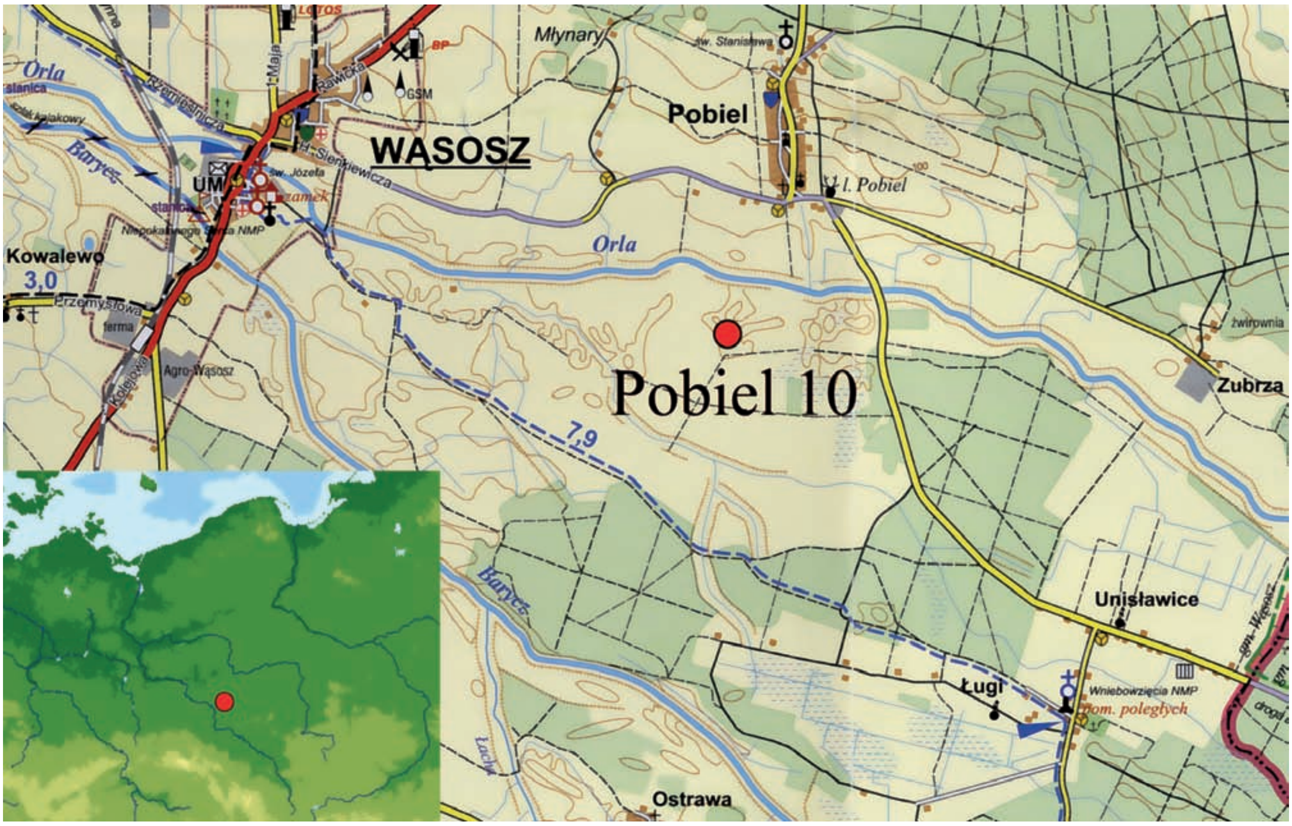


Fig. 1. Pobiel 10. Localization of the site

The site and taphonomy

The Pobiel 10 site is located in western Poland, Lower Silesia, in the valley of the river Barycz (Fig. 1). The camp site lies on the left bank of the river Orla on one of the separate sandy hills (Fig. 2). Its southern site is adjacent to the old river bank. Among all the settlement levels on the site, 3 levels can be ascribed to the Mesolithic Komornica culture (Fig. 3). Furthermore in the upper levels fragments of Lusatian (the Bronze Age), Pomeranian and early medieval pottery were found, as well as a the Bronze Age feature on the fluvial terrace. The bone and antler tools were only found on the old river bank levels.

The distribution and state of preservation of the bone and antler materials, as well as the stratigraphy of the Pobiel 10 indicate that the terrain has undergone long-lasting morphological changes and that the artefacts have been subjected to taphonomic processes. The factors that influenced those changes were first of all slope processes and gravitation. Fluvial, aeolian and chemical processes, as well as human activity should also be mentioned (Bagniewski 1990a:27).

Lack of faunal relics on the Pobiel 10 within the first excavation zone and an abundance of them within the second zone might be due to several factors. The artefacts were subject to slope and fluvial processes (periodic inundations and floods) resulting in the sliding of material from the upper terrace. Additionally the acid environment of the aeolian sands was not favourable for the preservation of organic materials (Stapert 1976:12).

One of the artefacts (P-1/85W) from the site of Pobiel 10, cultural level 2, second excavation zone was translocated from the upper layer 5 related to the Lusatian settlement. This conclusion was reached as a result of technological analysis and radiocarbon dating (3,077±65 calBP). This example illustrates how far the artefacts from the old river bank area could be translocated vertically due to fluvial processes and gravitational movements within the hydrated sediments.

Another crucial factor influencing the translocation of artefacts between layers were bioturbations, i.e. the impact of root structures and animals such as moles, voles and beavers.

Relics from the peat layer 15 in the old river bank, where an anaerobic environment prevails, were in the best state of preservation. On the surface of the relics from the higher located layer 12 traces of exfoliation and numerous natural cracks parallel with

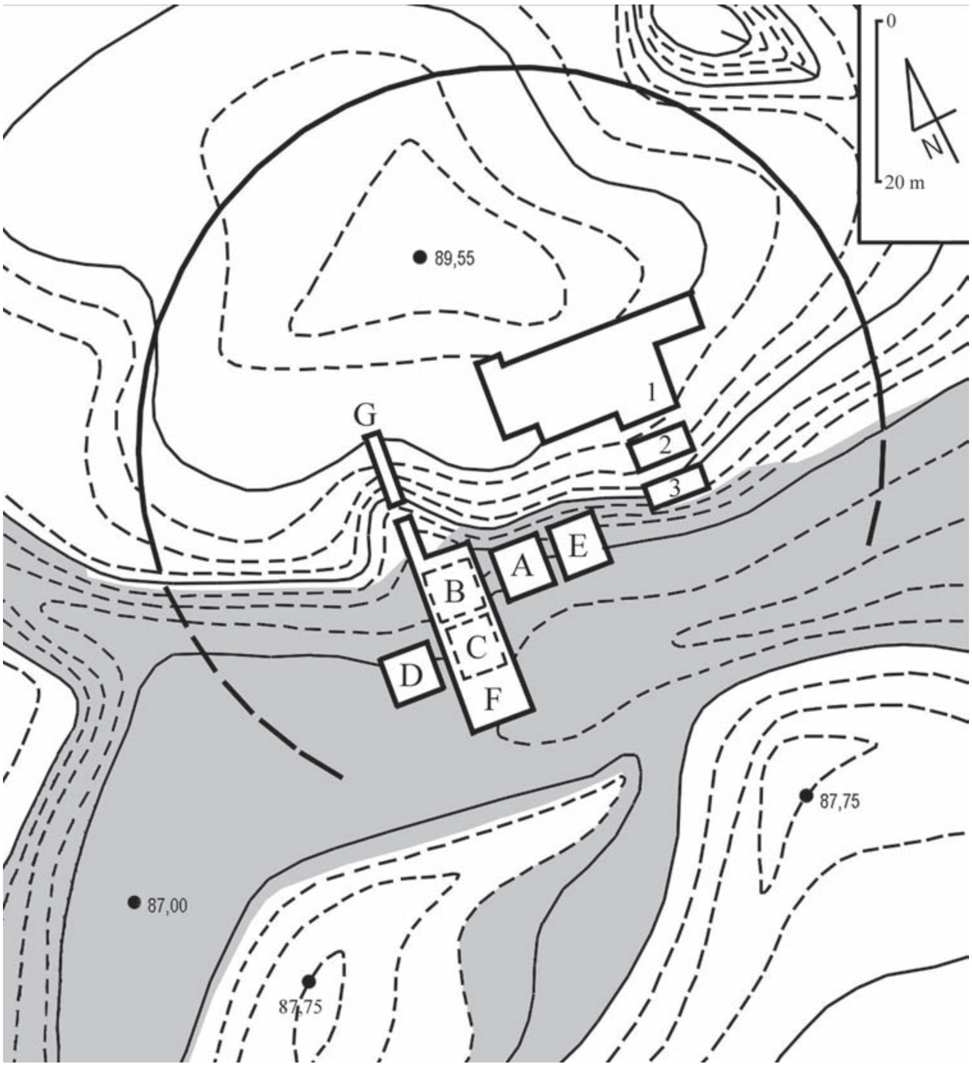


Fig. 2. Pobiel 10. Profile of the ancient riverbed (Bagniewski 1992, fig. 2 with own additions)

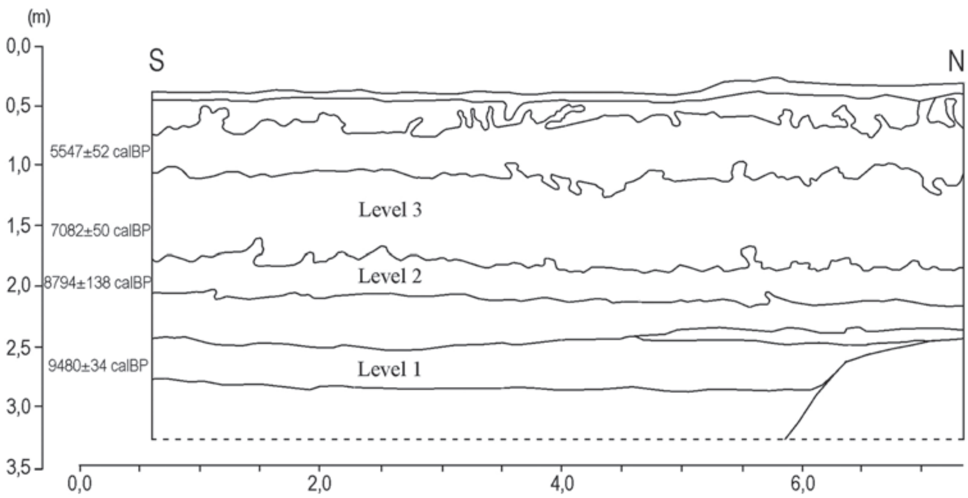


Fig. 3. Pobiel 10. Plan of the site with archaeological trenches

cortical bone fibres were visible. Similar phenomena were observed on the two pieces located in the bank zone of the old river bank within the first excavation zone. The artefacts from the Pobiel 10 site have breaks and cracks which has caused disintegration of these relics (Lyman 1994) – a result of long-lasting deposition in unfavourable conditions. The structure of the bone and antler was weakened and natural breaks occurred. These breaks were later interpreted as intentional. The impact of taphonomic

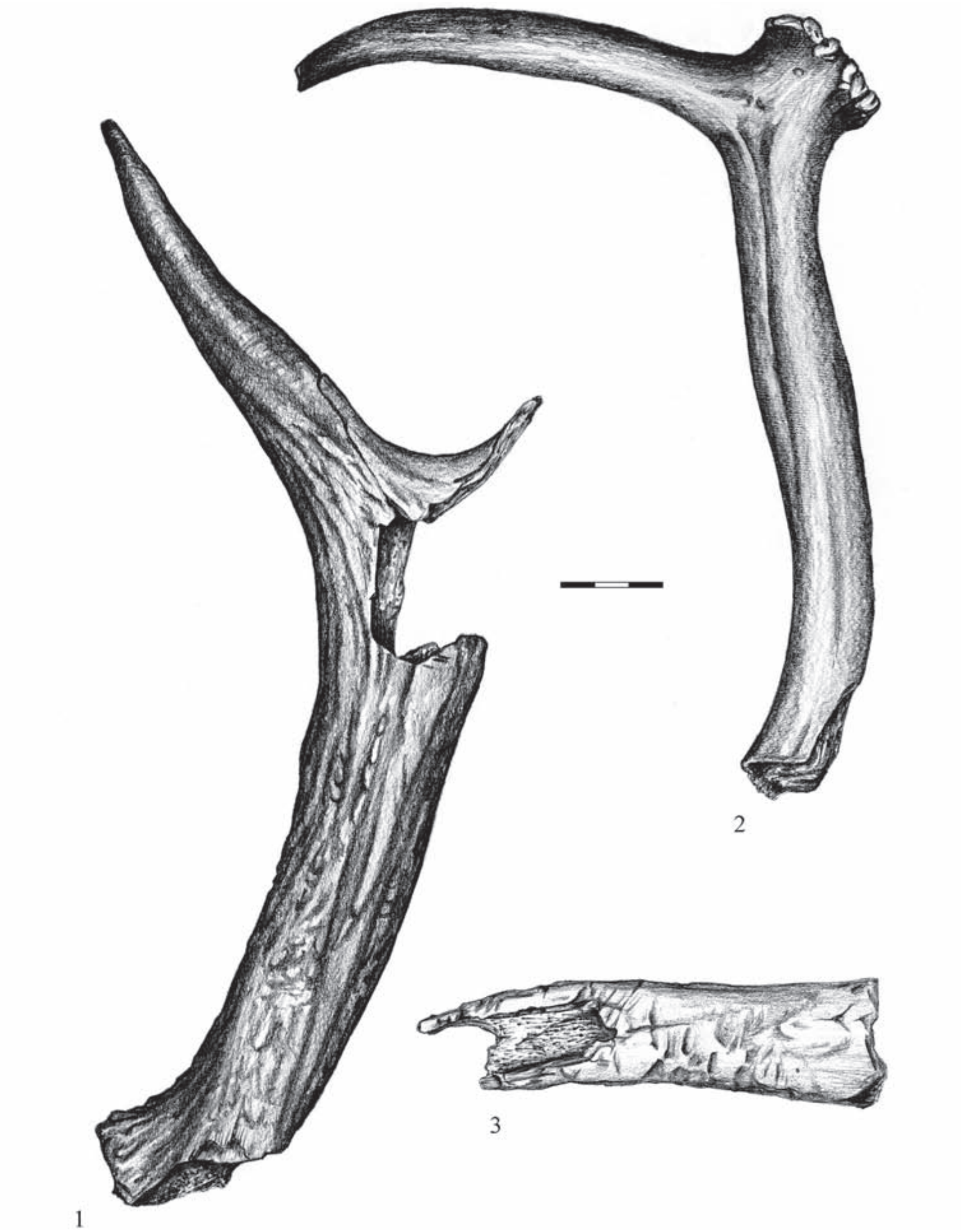


Fig. 4. Antler artifacts without traces of processing.
1 – P-10/85W;
2 – P-13/85Wb;
3 – P-26/85W

processes on these particular artefacts may be well illustrated by a couple of antler artefacts (Table 1). Three of them were classified by Z. Bagniewski as waste products, and fragments of dagger, fish spear, hoe/Lyngby axe and antler with traces of processing respectively (Fig. 4-5; Bagniewski 1990a).

Some of the artefacts bear gnawing traces. On the Pobiel 10 site rodent activity could be observed (Fig. 4:3). The traces left by those animals tend to be perpendicular to the longer axis of the antler (Lyman 1994, fig. 6:15b). Z. Bagniewski (1990a) interpreted them as traces of intentional processing.

Methods

The artefacts were analysed in order to examine other theories and ideas – namely that some of them could have been produced with the other processing methods which were in use at the turn of the Bronze and Iron Ages.

The analysis was conducted with the use of specialist analysis, which made it possible to observe differences in bone and antler processing technologies in the Mesolithic and at the turn of the Bronze Age. Microscope analysis of technological traces and casting method were helpful in determining how bone and antler was processed in various prehistoric periods and which tools were used. In the analysis of the faunal relics radiocarbon dating was also ap-

Fig. 5. Antler artifacts without traces of processing. 1 – P-14/85W; 2 – B-88-78; 3 – P-6/85W; 4 – P-9/85W

plied in order to verify the dating of the differences in technological features observed.

The conservation method applied to the artefacts, which is covering with resin varnish, impeded the microscope observations considerably making it impossible for example to identify use-wear traces.

To identify the sources of technological and use-wear traces the experimental method was applied. It was also used to specify the production stages of certain tool types. Before the experimental research was carried out, theoretical models of bone and antler processing were created on the basis of the multiple observations of the artefacts and the ideas presented in the respective literature (David 1999).

The experiments were conducted in the conditions similar to those that may have prevailed on the Pobiel 10 site when bone and antler processing took place. The red deer antlers (*Cervus elaphus*) came from wild animals or animals living in the Wrocław ZOO. For bone and antler processing replicas of flint, stone, metal and organic tools used in the Komornica and the Lusitian cultures were applied. The organic materials were prepared (softened) for processing in a few ways, believed to correspond to methods used in prehistoric times.

All the experiments were conducted at least twice. In addition to film and photo documentation, the experiments were documented using laboratory measurement methods.

The finds

Altogether 557 bone artefacts were found on the Pobiel 10 site (Bagniewski 1990a:169) and in 404 cases it was possible to identify the species of the animal. The classification was conducted by T. Wiszniowska (Bagniewski 1990a:169). Most of them, more than two thirds, were mammal remains, amongst which red deer bones and antlers prevailed. Numerous pieces of wild boar and aurochs bones were also found. Bones of other mammal species, such as beaver, roe deer and elk were not so abundant. It is worth noticing that all of these bones came from wild species. The only exceptions were the sheep or goat remains, which were found exclusively in the layer 5 (peat I) associated with the Lusitian culture settlement. Approximately one third of all the bone artefacts from Pobiel 10 were pieces of bird, fish and reptile bones, however such a high percentage is due their heavy fragmentation. This applied primarily to turtle remains.

From the assemblage Z. Bagniewski (1990a) chose 59 bone and antler artefacts, which in his opinion bore traces of processing. On the basis of typological criteria the author classified them as Mesolithic. The artefacts were once more analysed by S. Pratsch (Pratsch 2006). All of the artefacts classified by Z. Bagniewski as tools or half-products, were described by this author in the catalogue. Few of them were verified typologically with the use of refitting method (“a dagger” [Bagniewski 1990a, fig. 25:d] and “fishing spear” [Bagniewski 1990a, fig. 50] belong together and are a distal part of an antler with a piece of a beam of a red deer antler).

Typology

In the literature hitherto the authors working with the bone and antler artefacts sorted the faunal materials from Pobiel 10 in different ways. There was no separate classification for bone and antler artefacts from Pobiel 10 at this point, the individual specimens were only named with respect to raw material, shape and possible function (Bagniewski 1990a; Pratsch 2006). This kind of division, however, does not comply with the separation rule, essential for creating a logically correct classification. Moreover, in some cases the criteria for defining the respective product classes were not specified either.

In order to sort the faunal relics from Pobiel 10 properly, a new classification was constructed (Table 2). The analysis, which laid the foundations for this classification, was developed on the grounds of morphological, technological and raw material criteria. The functional categorisations were abandoned, so that no presumptions about the application of the tools could be made. The faunal relics in question were sorted with respect to processing grade: raw material, half-products and debris, tools and parts of antler composed tools, bone tools and fragments of undefined tools. Within these groups sub-groups, types and variants were specified. An important criterion was also which part of an antler was used to produce a certain artefact, as well as morphological criteria: the way the working edge was shaped, the localisation of the shaft hole, the position of the working edge in relation to the artefact, the hole and the shape of the artefact.

Raw materials constitute the largest group among the 557 artefacts (93.36%; Table 2). The other groups are half-products and debris (2.33%), bone and antler tools (3.96%) and fragments of undefined tools (0.36%). Among the 22 (without fragments of undetermined tools) bone and antler tools artefacts of prongs – 45.45%, beams – 31.82% and bone – 18.18% prevail (Table 3).

Bone and antler processing

Raw material

Of the 59 artefacts that according to Z. Bagniewski bore traces of processing, 48 were analysed. The remaining 11 were unfortunately not available. Already the initial examination had proved that 7 of the 48 artefacts did not feature any processing traces (Table 1).

The analysis was based on the observations of technological traces found on the faunal artefacts. On these grounds actions were undertaken to divide the raw material, shape tools and items, as well as finishing and aesthetic works. In this way the whole process of bone and antler processing could be followed. The group of analysed artefacts consisted of half-products, tools and their fragments, waste products and fragments of undefined tools.

When considering the raw material type within the group of 37 bearing traces of processing, the red deer antler artefacts were definitely the most numerous (33 pieces). The remaining 5 were bone artefacts. It is thus clear that antler was definitely preferred by the Mesolithic communities. This in probably due to the abundance of this material, as well as the fact that it is easier to work with than ordinary bones. The latter was proved by experimental research.

Initially the antler was processed by dividing it into distinct pieces (Table 4). These were later transformed into their respective tool types. The items made of prongs were the most numerous (15 pieces), thereafter items made from the medial part of the antler (10 pieces). The artefacts made from the proximal part constitute 15.15% of all the antler items in question. In addition 1 artefact was made from the distal part of the antler (crown in this case), 1 beam fragment and 1 item made of undefined part of the antler occurred. Each of them constitutes 3.03% of the assemblage. Two of the bone items were made of long bone shafts, which were most frequently used for bone tools in the Mesolithic (David 1999:111). Two artefacts were made of the IV metacarpal bone, one could not be classified.

Softening methods

The literature concerning bone an antler processing technologies carries a conviction that prehistoric and historic communities applied a variety of soften-

Fig. 6. Technological traces. 1 and 2 – traces of sawing by flint tool; 3 – faceting traces; 4 – chopping traces; 5 – traces of sawing by metal tool

ing methods to the raw material (Rajewski 1950:159; Żurowski 1953; Semenov 1964:159-160; Cnotliwy 1973; Bagniewski 1992a; Drzewicz 2004; Osipowicz 2005). This belief in based i.a. in morphologic analysis. Scholars claim that it would not be possible to produce certain items without having softened the raw materials previously. They conducted a number of experiments to determine which softening methods were most effective. Some believed that bone and antler were soaked in water (Cnotliwy 1956:152-154; Lindemann 2001:18-21; Drzewicz 2004:51-52; Osipowicz 2005:22-30; further reading there), cooked in water (Cnotliwy 1973:41) or various other solutions.

In spite of such an abundance of relevant literature, the only works presenting the progress of experiments more elaborately, providing details about the methods applied and describing the chemical processes going on in the water and sorrel acid, are the works of A. Drzewicz (2004) and G. Osipowicz (2005).

The softening techniques are hard to detect in archaeological material, so experimental methods and comparative analysis respecting the theoretical premises have had to be used.

The purpose of the experiments conducted by the author was also to examine the various softening methods that can be applied to bone and antler. Soaking in water alone is sufficient to make antler processing easier. Both types of raw materials were also soaked in sorrel acid and cooked. The first

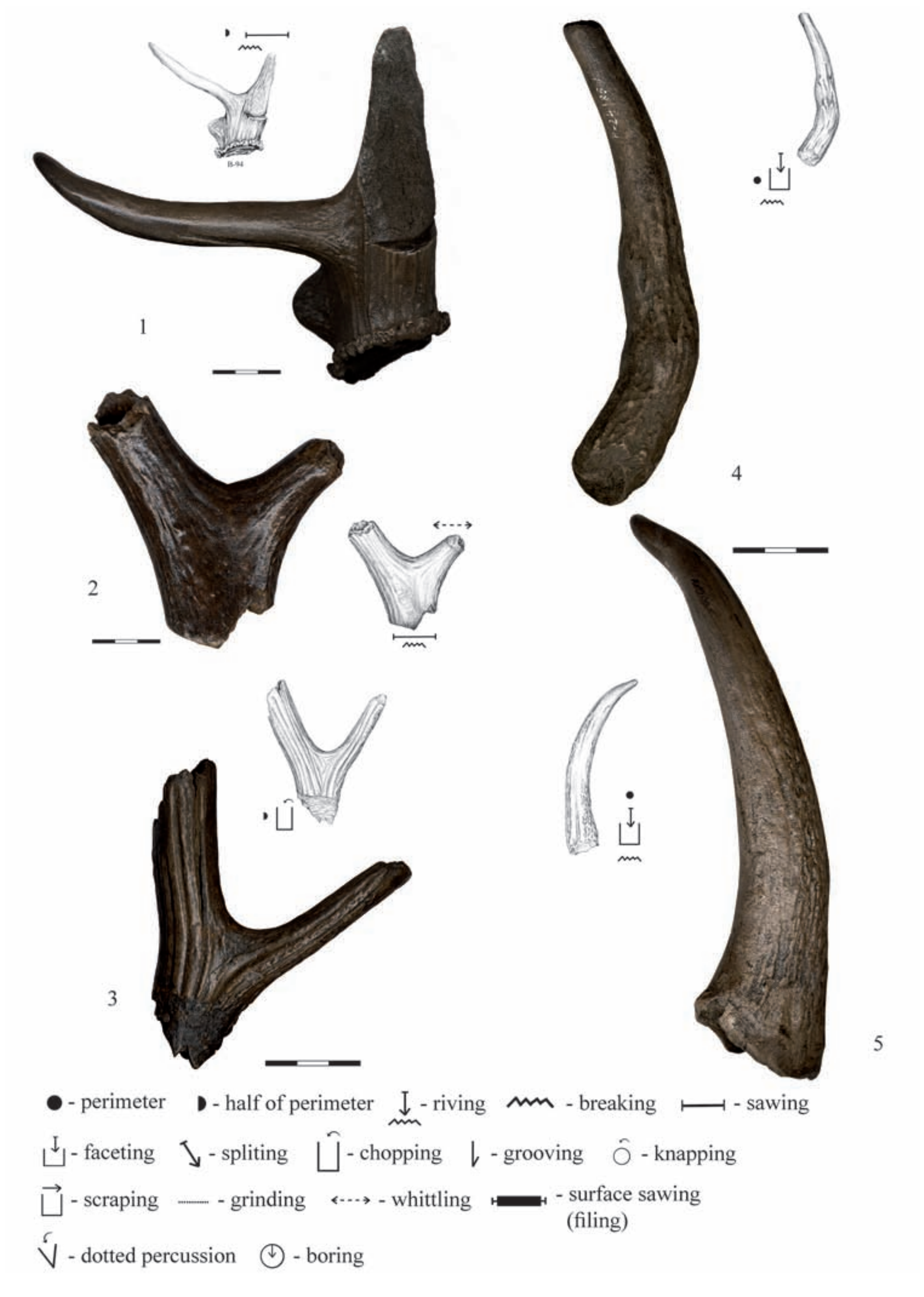


Fig. 7. Antler half- and waste products (type B).
1 – B-94; 2 – A-164; 3 – A-165; 4 – P-24/85; 5 – P-25/85W

method proved its efficiency with both bone and antler. Cooking softened the flat bones (scapula, ribs) but was inefficient in softening the long bone shafts. Antler was superficially softened but after it was taken out of the water it hardened quickly. This was caused by the fast drying process occurring as an consequence of the high temperature achieved during cooking. The above mentioned methods did not result in irreversible changes in the structure and physical properties of antlers and bones.

The raw materials and half-products in Pobiel 10 could have been deposited in the bank area of the standing water adjacent to the camp. The processing was rotational, which means that a couple of items were processed at the same time. While the worked item dried, another one was picked from the water where they were soaked (Diakowski, Płonka 2010:321).

This kind of action may be indicated by single traces of sawing on the surface of the compact layer, parallel to the edge of the base on the artefacts E-34 and P-4/85 (Fig. 6:1-2). When the respective item was worked again, the manufacturer did not target the edge of the flint tool in the previous line. Such traces may also indicate testing of the hardness of the antler. The thesis that such lines were formed as a result of the blade or flake sliding down cannot be

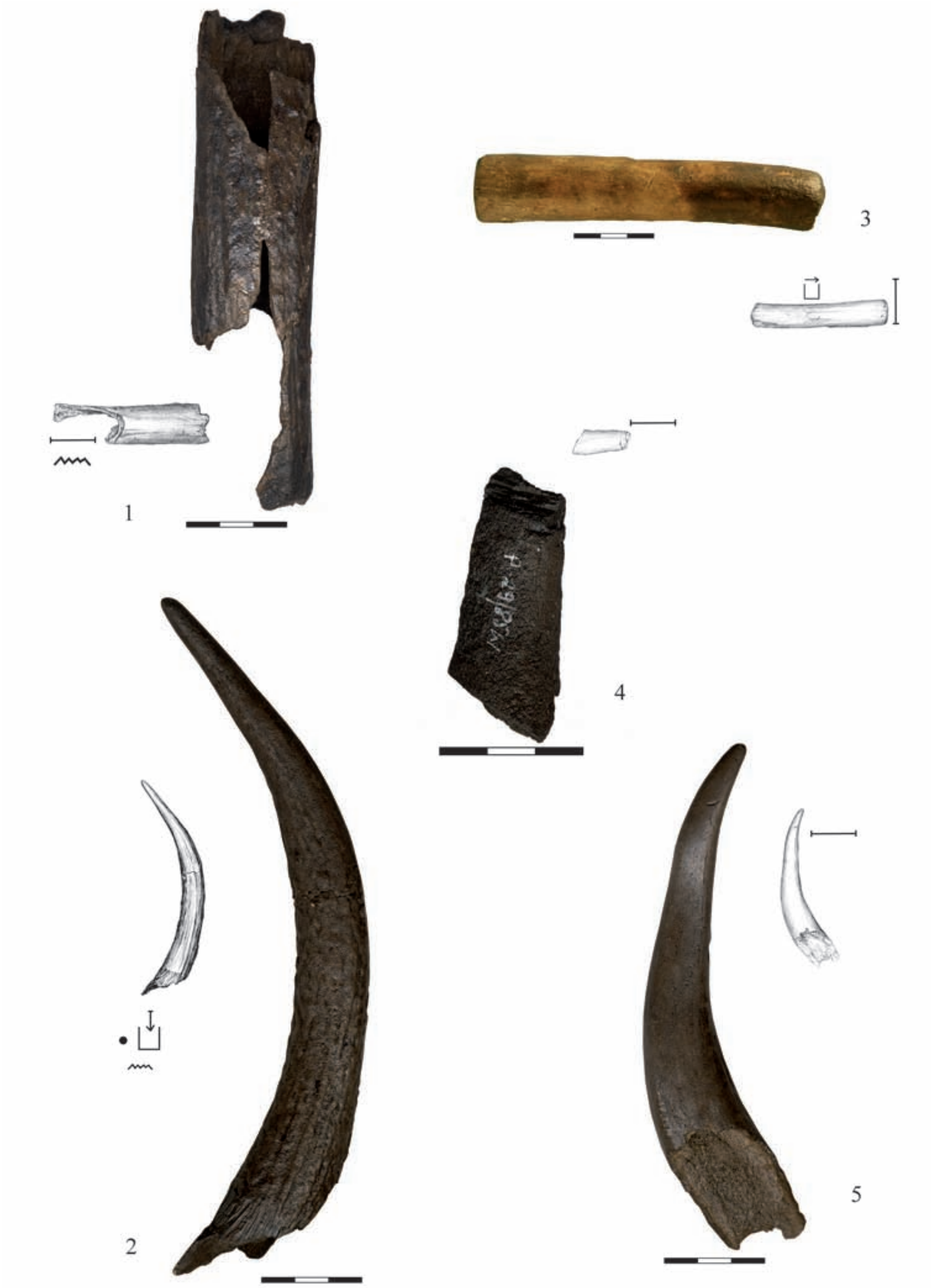


Fig. 8. Antler half- and waste products (type B). 1 – A-154; 2 – P-?; 3 – P-1/85W; 4 – P-29/85W; 5 – P-15/85W

accepted, since in this case the lines would reach the edge of the base.

Moreover, on the stamp of these artefacts overlapping surfaces are visible, which is a result of multi-stage, ambient sawing of the antler (Diakowski, Płonka 2010, fig. 4:3-4). On these surfaces parallel lines can be observed. The author's experiments prove that these kind of traces could only occur on softened antler. The artefacts featured by the traces of the use of the faceting technique may also demonstrate softening. The faceting traces observed (e.g. on P-?, A-166, 19/83, P-34/85W – Table 5-6) are analogous to the traces that occurred on the experimental materials which underwent the antler softening process.

Tools

Bone and antler processing required appropriate preparation of raw materials, as well as collecting the processing tools. Certain tools left different types of traces on the raw materials. In Pobiel 10 a substantial assemblage of flint items was found where bone and antler artefacts were deposited (Bagniewski 1990a:53-55). It is possible that it may be chronologically contemporary to at least some of the faunal artefacts found in the old river bank. Unfortunately no use-wear analysis of the flint artefacts from Pobiel 10 was undertaken. Analysis from analogous sites on the North European Plain (Jensen, Petersen 1985; Dumont 1989; Crombé

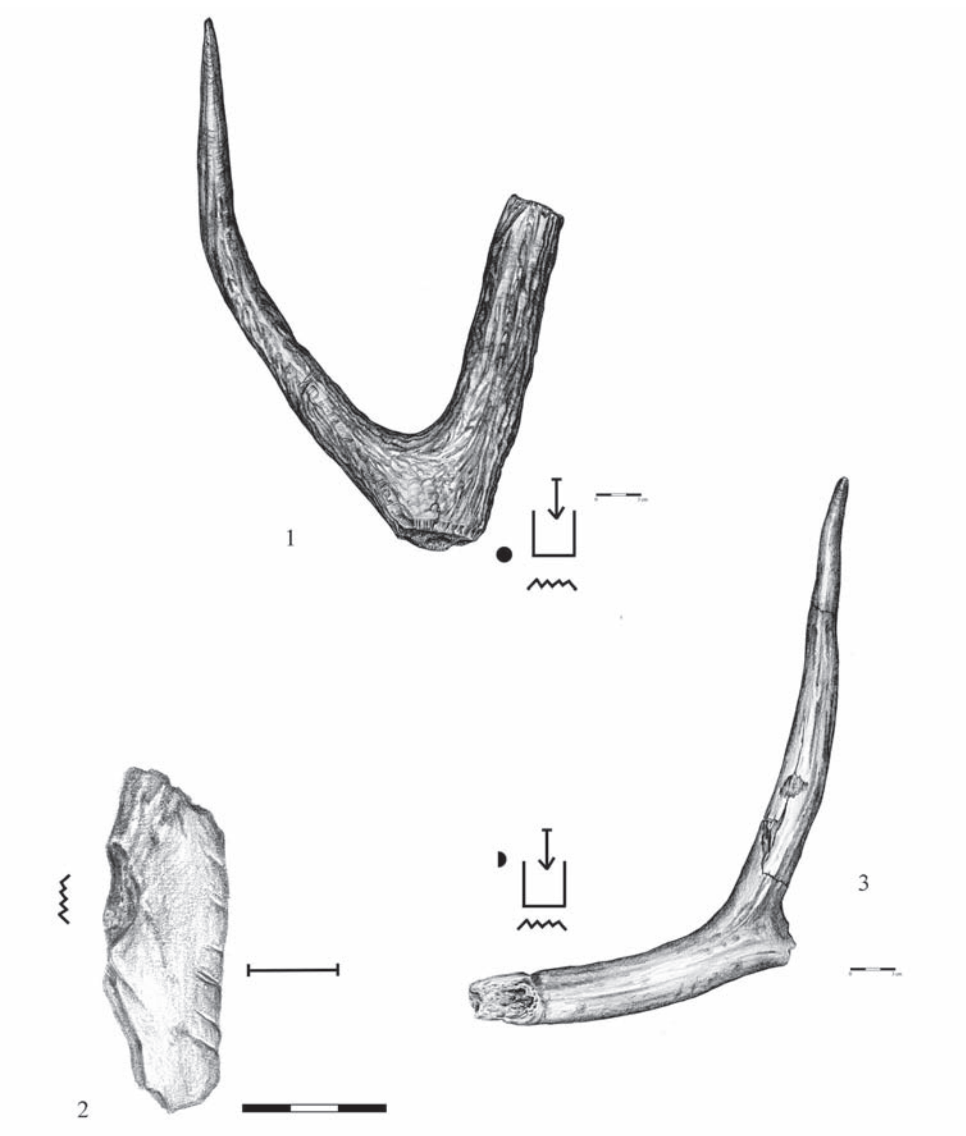


Fig. 9. Antler half- and waste products (type B).
1 – P-32/85W;
2 – P-28/85W;
3 – P-34/85W

et al. 2001), however, as well as experimental research with various flint and metal tools preceded by thorough analysis of technological traces on the artefacts, allow us to make some suppositions.

Flakes and blades with long working edges were most probably used for sawing (Fig. 6:1-2). The length of the surfaces left after sawing on the stumps of the cut off prongs of the artefacts E-34 and P-4/85 supports this view. On the other hand, the sharp tips of the above mentioned blades and flakes could also have been used for incising, which may be observed on the cross-sections of the incised lines on the artefacts P-19/35 and E-34 (Diakowski, Płonka 2010, fig. 4:1, 5).

The burins could be used both for incising and faceting. Using this kind of tools for incising produces several types of traces determined by the working angle of the burins tip. These may be deep grooves of rectangular cross section and wide, V-shaped traces. In the latter case, however, other flint tools could also be used, which was confirmed by author's experiments. Faceting traces proves that the burins in this case were used as chisels, where the shorter edge of burin spall served as a working edge and the opposite end was hit by an some kind of soft hammer (Fig. 6:3). On some antler artefacts chopping traces of pre-axe flint tool were observed (Fig. 6:4).

The presence of holes in some kinds of tools may indicate the application of picks and borers. On the chosen artefacts traces of the use of the core axe may be observed. Some technological activities could be performed with various types of tools, for example flakes, blades, scrapers and other retouched tools, burins and even core fragments could have been used for scraping.

Among the faunal artefacts classified by Z. Bagniewski as Mesolithic, the artefact P-1/85W was not produced with the use of flint tools. The sawing traces were certainly left by a metal tool (Fig. 6:5). This was confirmed by radiocarbon dating of the artefact (3,077±65 BP).

Fig. 10. Antler tools.
1–4 – type CA.1.a;
5 and 6 – type CA.1.b.
1 – D-18; 2 – A-166;
3 – P-4/85W; 4 – E-34;
5 – P-8/85W; 6 – 19/83W

Techniques of processing

After verifying 44 artefacts from Pobiel 10, which according to Bagniewski bear traces of processing, such traces were found on 37 pieces of bone and antler (Table 5-6). The remaining artefacts were classified as raw materials, since they bore no traces of intentional processing and were only modified by natural factors.

Sixteen different technological actions within bone and antler processing were observed on the material from Pobiel 10 (Table 7). They were used at all stages of the process. Some of the traces could not be found due to their obliteration in the course of the subsequent processing stages, intensive usage and the bad preservation condition of some of the items.

Dividing of the raw material

Seven different technological actions are related to the stage of dividing the raw materials, these are: riving, breaking, sawing, faceting, chopping, grooving and splitting.

The most common technique of dividing the raw materials to obtain desirable pieces was the breaking technique, which was observed on 26 antler artefacts and 3 bone artefacts. Each artefact bearing traces of

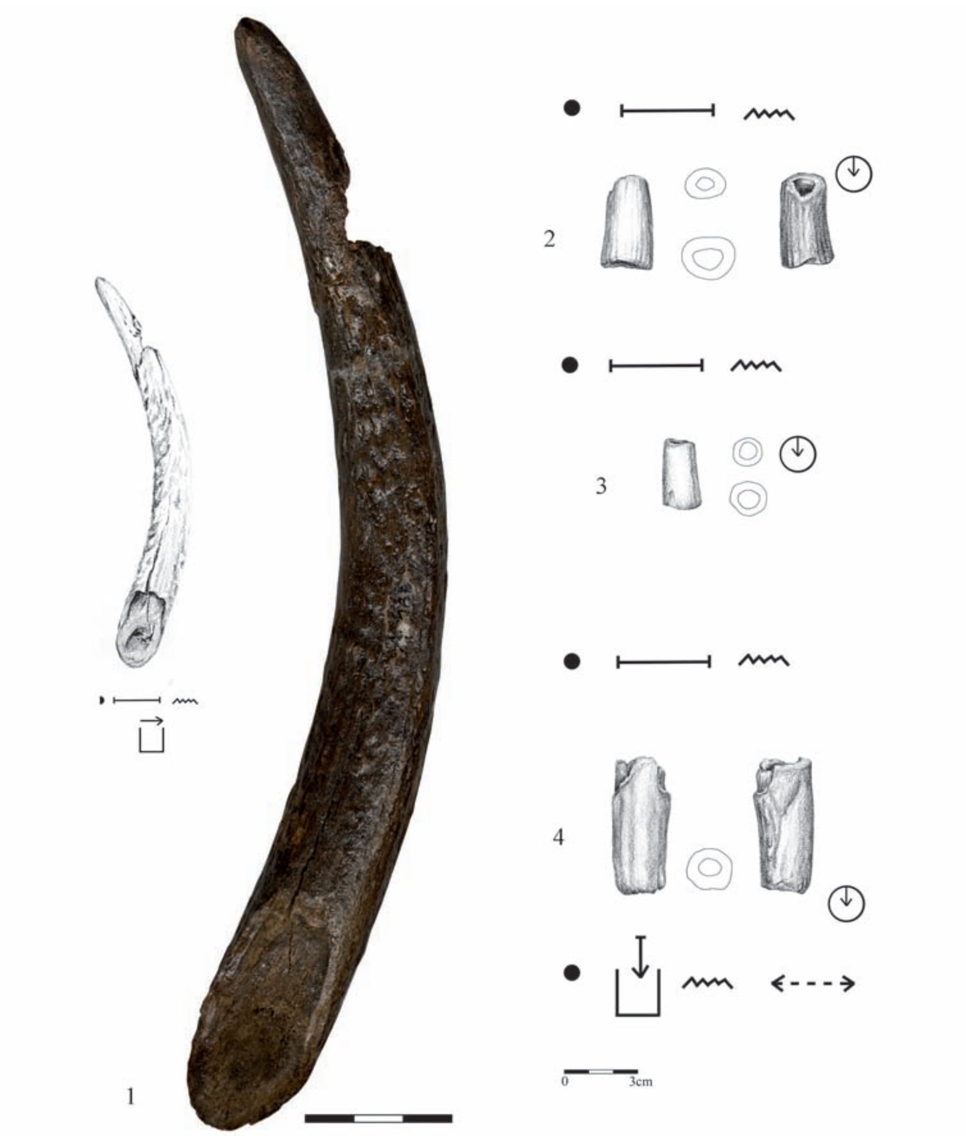


Fig. 11. Antler tools.
1 – type CA.2;
2–4 – type CA.3.
1 – A-163; 2 – E-32;
3 – B-15/78; 4 – E-31

intentional breaking also has traces of additional technological actions. Dividing the antler only by breaking was not possible due to its structure, which makes it both hard and flexible. Breaking the antler was performed after sawing the hard cortical bone or its partial removing with faceting technique. After that the antler was placed on stone or wooden bases and broken probably with the use of a wooden or stone hammer.

The experimental research has proved that the efficiency of breaking an antler depends on several factors. The most important are the depth of the sawing cut or the faceting grade and the length of the perimeter, on which those actions were performed. Secondary factors are the type and size of the soft hammer and the hitting strength and technique.

The raw materials were very carefully prepared for breaking, which can be observed in the breaking areas, provided that the traces were not obliterated in the course of subsequent technological actions. The analysis of the artefacts and the experimental material made it possible to ascertain that the antler dividing breakages occur in the variants: straight or diagonal base and cogged crown.

A straight base was formed when antler's compact layer was sawed around the whole perimeter of a beam or prong, all the way down to spongy substance. It is important to have the compact layer removed by sawing or faceting to the same depth. In this way the base after breaking is perpendicular to the longest axis of the antler and does not have any larger split-offs. This kind of trace was observed on the artefacts: P-32/85, P-24/85, P-25/85, E-34, P-4/85, B-15/78, E-31, E-32, E-35, E-45, E-70, E-36, E-33.

A diagonal base could be obtained by sawing the compact layer or removing it with the faceting technique on the half of the perimeter of a beam or prong until the spongy substance was reached. After breaking on both ends of the antler a diagonal split

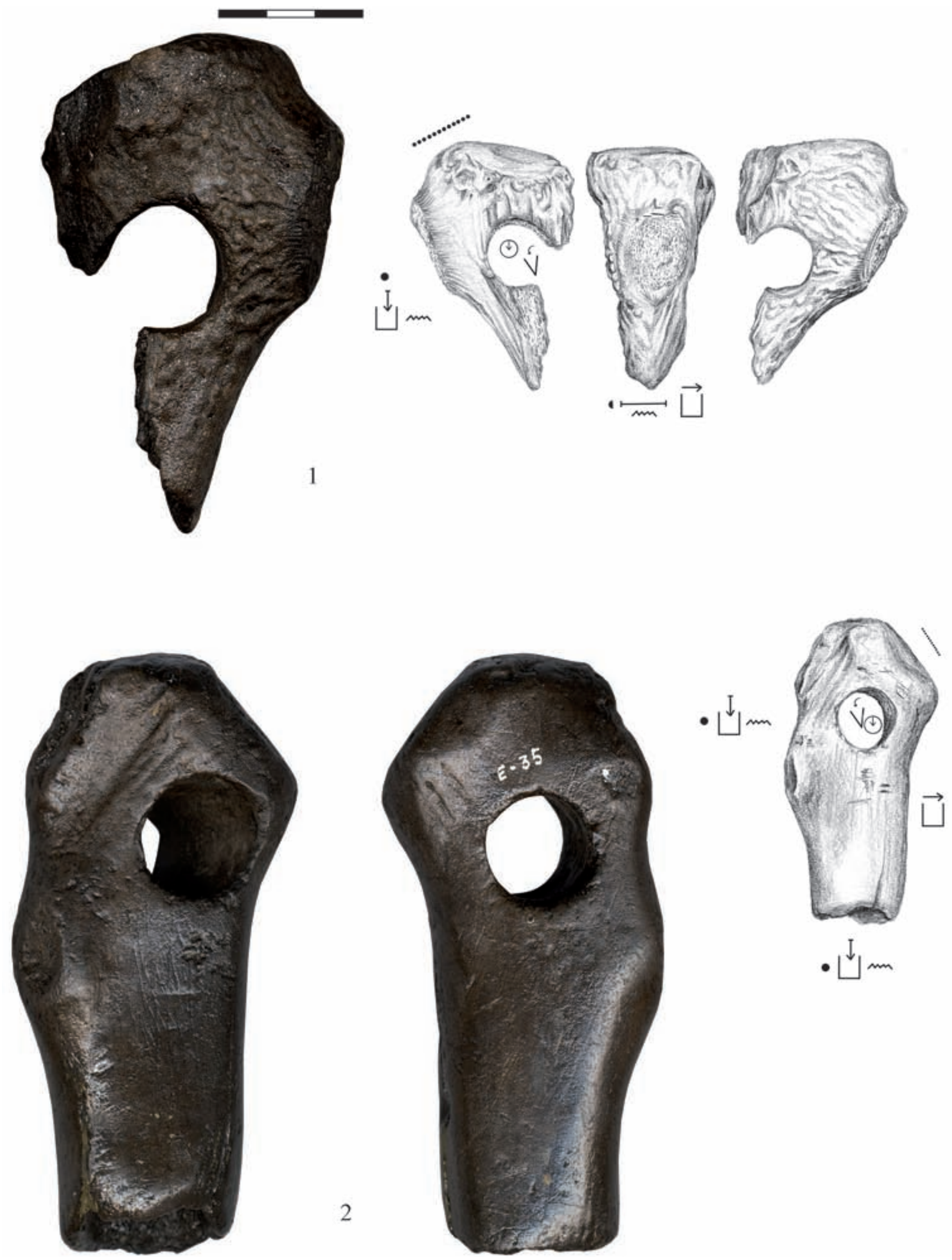


Fig. 12. Antler tools.
1 – E-45 (type CB.1.a);
2 – E-35 (type CB.1.b)

was formed. This kind of split was observed on the artefacts: P-34/85, B-94, P-?, A-166, D-18, P-35 and B-96.

According to A. T. Classon (1983:85) the working edges of the T-shaped axes were formed in this way. Thereafter they would undergo further processing, which was levelling the surfaces of the breakage by scraping. In this paper this type is represented by the artefact E-70 classified as variant CB.2.a. The diagonal working edges of other tool types (A-163, E-45, P-35/85W, E-36) were probably also formed in this way.

The cogged crown form was formed when the compact layer was not evenly removed by faceting or sawing on the whole perimeter of the antler or when the sawing or faceting was too shallow. This kind of cut-off was observed on the artefacts E-70, 19/83W and A-165. Z. Bagniewski claimed that they were formed intentionally by scraping and functioned as working edges, yet no technological traces indicating such actions were found on the artefacts.

A series of experiments demonstrated that the cogged edges of the artefacts 19/83W and A-165 were formed as a result of an intentional breakage preceded by removing the compact layer on insufficient depth. In case of the artefact E-70 the cogged split-offs occurred after breaking caused by intensive usage of the tool. The artefacts from the Spoodle region in Holland were also interpreted in this way (Clason 1983, fig. 32).

The application of the sawing technique in dividing the antler was recognised on 19 artefacts, on 17

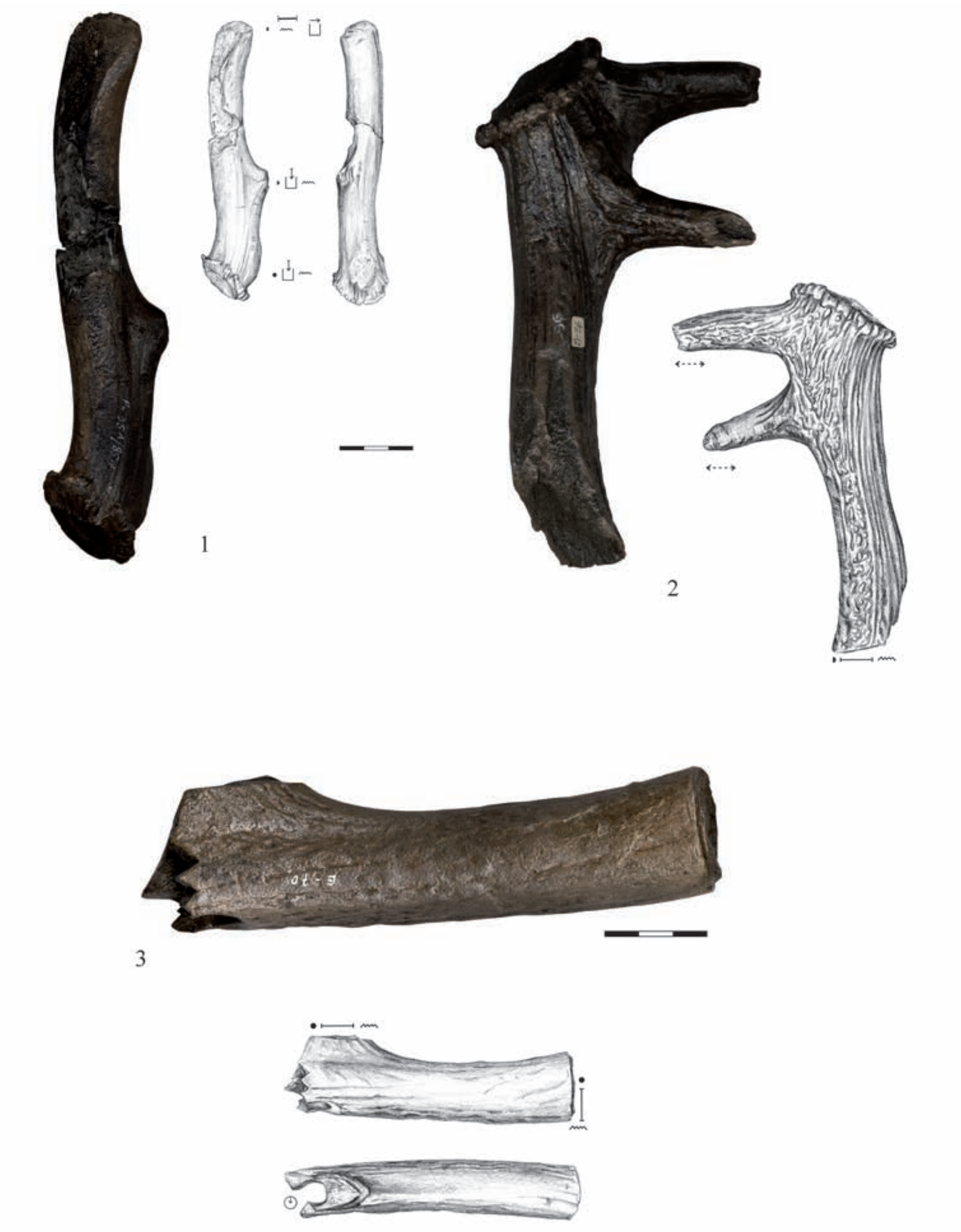


Fig. 13. Antler tools.
1 – P-35/85W (type CB.1.c);
2 – B-96 (type CB.1.d);
3 – E-70 (type CB.2.a)

it existed in parallel with the breaking technique. Traces of this technological action are visible on the breakages and their direct vicinity. There were only two cases in which there were no traces of breaking.

On the inner side of the middle part of the P-15/85W artefact a group of overlapping, diagonal to the artefact's axis cuts can be found. They are related to compact layer cutting. Most probably they should be interpreted as related to testing the hardness of softened antler or initial processing stage. On the artefact P-1/85W no traces of breaking technique were observed, which was because the antler was sawed with the use of a metal tool – on the whole surface of the split parallel to each other lines were found.

With the exception of the item P-1/85W the sawing was performed with flint flakes, blades and saws directed perpendicularly to the surface of the antler, which is indicated by the length and breadth of the traces and their shape visible on the cross sections.

On the basis of the analysed material two types of sawing used at the dividing stage were defined. The first one was defined as plain sawing, which entailed steady, even, ambient processing of a beam or prong. The sawing traces on the stamp resemble concentric circles. These kind of traces were observed on the artefacts B-15/78, E-31, E-32 and E-33.

The second type of sawing was sequence sawing, which entails multi-stage cutting of the compact layer, which is indicated by series of parallel lines forming overlapping surfaces. They are clearly visible on the split surface of the divided antler. Traces of sequence sawing were found on the artefacts P-4/85, E-34, E-36, E-70 and B-94.

Fig. 14. Antler tools.
1 – E-36 (type CB.2.b);
2 – P-5/85W
(type CB.2.c);
3 – E-33 (type CC)

The faceting technique was used to divide the antler. It has been observed on 12 specimens (P-24/85W, P-25/85W, A-165, P-32/85W, P-29/85W, P-34/85W, P-?, A-166, 19/83W, P-8/85W, E-35 and P-35/85W). This technique was noted only on artefacts which have intentional breakage traces. It means that faceting was used to control breakage of antler. Analyses of the technological traces and experiments shows that the thin layers of compact layer was removed by burin which was hit by some kind of hammer.

The faceting technique was used only to divide the antler. We can observe it on the half part or on all of the antler beam or prong circumference. Traces of this technique are parallel to the longer axis of the antler. Faceting was made from the proximal and distal end or from only one side.

The groove and splinter technique was observed only on artefact P-5/85. It was connected with dividing the antler lengthwise the long axis. According to some researchers this technique has been used mainly to obtain blades from antlers and bones (Rust 1943; Feustel 1973; Clark 1978). Most of them were used as half products for making points and harpoons.

There are no bone, antler blades, points or harpoons found on the Pobiel 10 site. The groove and splinter technique was not used for making blades. It was used to divide antler to make particular tools. On the part of the tool separated from the beam can be seen some negative after using a wedge. The divi-

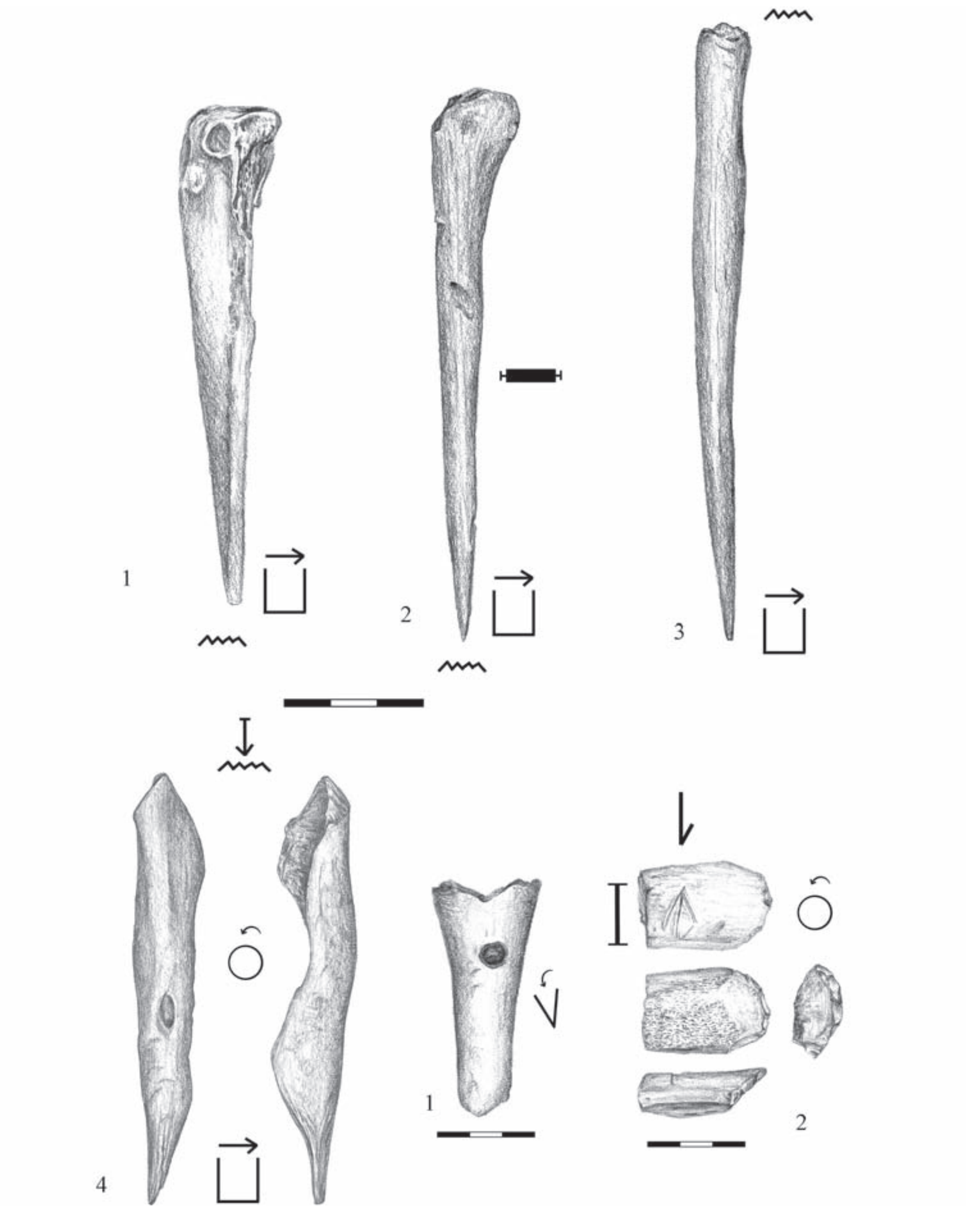


Fig. 15. Bone and antler tools. 1–4 – type CD; 5 and 6 – type D. 1 – P-2/85W; 2 – P-3/85W; 3 – E-40; 4 – P-17; 5 – P-13/85W; 6 – P-19/85W

sion of the raw material was also made by splitting. Traces of this technique were located on only one implement, made from the long bone.

Shaping of the tools

Other types of techniques used in antler and bone processing are associated with shaping different types of tools. On particular artefacts technological traces from such activities as knapping, scraping, grinding, whittling, surface sawing (filing), dotted percussion, and boring were observed.

Among these the most numerous are the traces of scraping that occurred on 16 artefacts. This technique can be identified on the basis of linear shallow traces of different length and depth, which overlap each other. The scraping technique was used to form the tips of bone tools (P-17/85, P-2/85W, P-3/85W, E-40) and a few other artefacts made of the antler prongs (P-4/85W, A-166, P-8/85W, A-163, P-5/85W, E-33). Scraping was also used to form oblique working edges of the tools such as the A-163, E-45, P-35/85W, E-36. Moreover scraping was used to flatten the surface of artefacts 19/83W and E-35.

Two types of splitting traces were identified on two specimens from the Pobiel 10 site. On the bone artefact P-17/85 there are traces of a direct percussion – lateral edges of the rived bone were struck in order to create particular shape of the bone tools. On the antler artefact E-45 the splitting technique was used to remove pearls from the burr. They were removed by indirect percussion.

On some artefacts from the Pobiel 10 site traces of grinding technique were observed, these were produced by rubbing the surface of the antler with a stone slab. Experiments demonstrated that the grinding traces depend on the type of stone. Granite produces small scratches visible under the microscope, whereas sandstone wider grooves visible macroscopically. Grinding traces were recognized only on artefacts made of antler. On the artefacts E-45 and E-35 this technique was used to remove pearls from the burr. Grinding was also used to shape the tip of antler tool made of antler prong (E-34).

Traces of whittling can be seen on three artefacts made of antler (A-164, E-31, B-96). Whittling was used to sharpen particular parts of the antler, e.g. tips of the antler prongs (A-164, B-96) or other parts (E-31). As in previous cases, this technique can be identified on the basis of surfaces overlapping each other and directed obliquely to the long axis.

Sawing (filling thin layers of compact layer) of the surface was used to shape bone and antler tools. In the case of a specimens (19/83) made of antler, it was used to form the tip of prongs. Traces of this action can be distinguished from whittling traces by a series of parallel, straight lines located parallel to the long axis. The filing technique was also observed on the bone artefact P-3/85W and it was used to shape the lateral edge of this object.

On the artefacts from the Pobiel 10 site technological traces of three methods of drilling holes were also observed. According to one of them compact layer was removed by percussion using a flint pick, prior to drilling action. These activities were done either from one side or simultaneously both sides of antler beam (E-45, E-35, E-36). Traces of their use are visible only around the holes. This method was also used in case of unidentified tool made of a long bone (P-13/85), the hole was made on one side. The second method was to drill the hole precisely in the place where an antler prong has been removed (E-70) and the third method was to drill the hole in spongy substance, parallel to the long axis of the antler beam or prong (E-35, E-33, B-15/78, E-31 and E-32).

Among the implements with technological traces there are also a group of fragments of unidentified tools (Group D- P-19/85W and no. ?). Specimen P-19/85W is a fragment of antler with traces of sawing and splitting and an arrow engraved on its surface. The second artefact is a fragment of antler prong, whose proximal and distal parts have been broken off in a natural way. On both lateral sides of the specimen zigzag ornaments is made by engraving.

Final processing and ornamentation

The final stage of bone and antler tools processing have been associated with ornamenting. At Pobiel 10 site there are 4 types of antler artefacts with different ornaments made by sawing and grooving. The first one (P-28/85W) is a waste product (type B). Artefact E-34 belongs to a subgroup of tools made of the antler prongs (CA). Another two implements (P-19/85W and ?) are fragments of unidentified tools (type D). They were subjected to different study (Diakowski, Płonka 2010).

Conclusions

The new study of faunal remains enabled to place them in a new classification criteria according to raw material, morphology and technology. Results of the analysis of technological and natural traces verify previous functional and typological determinations (Bagniewski 1990a; Pratsch 2006). Technological research also made it possible to determine what type of tools, materials and technological activities were used by in the processing of bone and antler.

The present study demonstrated that the population inhabiting the Pobiel 10 site preferred tools made from antler. This is indicated by a large number of artefacts made from this material, and the very small percentage of bone tools. According to the author's experimental studies this was probably related to how difficult is bone processing in comparison to working of antler. Technological traces were analysed to establish method of preparation of antler and bone material. On some artefacts from the Pobiel 10 traces of softening have been observed. Moreover the analysis of technological traces made it possible to recognise the particular type of tools which was used for bone and antler processing and to confirm the Mesolithic origin of the most of artefacts. Only specimen P-1/85W is younger and is dated to the Bronze Age, what is also confirmed by the radiocarbon dating.

Based on analysis of technological traces, using modern research methods, it was possible to identify different manufacture techniques used during the bone and antler processing at the Pobiel 10 site. This made it possible to identify how the Mesolithic craftsman divided bones and antlers and made different types of tools.

On the artefacts from the Pobiel 10 classified by Z. Bagniewskiego to artefacts with traces of working, no technological traces were observed. It was possible to detect taphonomic processes, which are not related to human activities.

S. Pratsch connected various types of tools, based on their forms, with certain periods of the Holocene. According to him, most types of tools from Pobiel 10 are associated with the middle and late Boreal period and Boreal/Atlantic transition. Artefacts CA.1.ai CA.1.b also occur during Subboreal period as well as specimen CB.2.a, however these type of artefacts appear first in the Atlantic period.

All types of tools that have occurred on Pobiel 10 have their analogies in other sites of the Central European Plain. The artefact belonged to a CB.2.c subtype and a tool made from distal part of red deer antler belonged to the CC subtype are the exceptions.

Due to its geographic location, Pobiel 10 provided a lot of information on the processing of bone and antler in the Central Europe during the Mesolithic. Until now, these artefacts have been mistreated in the detailed technological studies. The results of this study will develop knowledge of the technology of bone and antler processing in the Mesolithic in the Central and Northern Europe.

Table 1. Pobiel 10. Artefacts without traces of processing

No.	Catalogue no.	Fig.	Type according to Z. Bagniewski	Natural breaks	Natural cracks	Exfoliation	Traces of processing	Type according to M. Diakowski
1	P-6/85W	5.3	waste product	+	+	+	-	AA
2	P-9/85W	5.4	waste product	+	+	+	-	AA
3	P-10/85W	4.1	fragment of fishing spear	+	+	+	-	AA
4	P-13/85Wb	4.2	hoe/Lyngby axe	+	+	+	-	AA
5	P-14/85W	5.1	waste product	+	+	+	-	AA
6	P-26/85W	4.3	antler with traces of processing	+	+	+	-	AA
7	B-88-78	5.2	dagger	+	+	+	-	AA

Table 2. Types of bone and antler artefacts from Pobiel 10 site

Type	Subtype	N	%	
A. Raw material (without traces of processing)	AA. Antler	10	1.80	93.36
	AB. Bone	508	91.56	
B. Half and waste products		13	2.33	
C. Tools	CA.1.a. Tool made from antler prong (antler prong with a tip worked unilaterally)	4	0.72	3.96
	CA.1.b. Tool made from antler prong (antler prong with a tip worked around the whole perimeter)	2	0.36	
	CA.2. Tool made from antler prong (antler prong with a tip worked unilaterally and an oblique basis)	1	0.18	
	CA.3. Tool made from antler prong (haft made from a medial part of an antler prong with a hole located parallel to the long axis)	3	0.54	
	CB.1.a. Tool made from a basis (proximal part) of antler beam (tool with oblique working edge located on a lateral side, shaft hole is located on lateral side)	1	0.18	
	CB.1.b. Tool made from a basis (proximal part) of antler beam (hammer-haft with shaft hole located on a lateral side, burr has function as a butt)	1	0.18	

C. Tools	CB.1.c. Tool made from a basis (proximal part) of antler beam (tool with oblique working edge located on a lateral side, without shaft hole)	1	0.18	3.96
	CB.1.d. Tool made from a basis (proximal part) of antler beam (antler beam with basis and worked antler prongs)	1	0.18	
	CB.2.a. Tool made from medial part of antler beam (tool with oblique working edge located on a lateral side; working edge is parallel to the shaft hole located according to the longer diameter)	1	0.18	
	CB.2.b. Tool made from medial part of antler beam (tool with oblique working edge located on the lateral side; working edge is perpendicular to the shaft hole located according to the shorter diameter)	1	0.18	
	CB.2.c. Tool made from medial part of antler beam (tool made from a fragment of antler beam with pointed end and with antler prong as a handle)	1	0.18	
	CC. Tool made from a crown with two worked prongs as working edges, a shaft hole is parallel to the long axis of a beam	1	0.18	
	CD. Bone tool with pointed end	4	0.72	
D. Fragments of undetermined tools		2	0.36	
Total		557	100.0	

Table 3. Pobiel 10. Tools (type C)

Subtype	N	%
CA. Tools made from antler prongs	10	45.45
CB. Tools made from antler beam	7	31.82
CC. Tools made from antler crown	1	4.55
CD. Bone tools	4	18.18
Total	22	100.0

Table 4. Pobiel 10. Bone and antler artefacts in respect to the particular parts of antler

Antler parts	N	%
Proximal part	5	15.15
Medial part	10	30.30
Distal part	1	3.03
Antler prongs	15	45.45
Fragment of the antler beam	1	3.03
Undetermined antler fragments	1	3.03
Total	33	100.0

Table 5. Pobiel 10. Technological traces. Half-products and waste products (type B)

No.	Catalogue no.	Fig.	Type according to Z. Bagniewski and S. Prasch	Technological actions according to characteristic traces	Tools used
1	P-1/85W	8.3	Handle	Sawing, scraping	Metal tool
2	A-164	7.2	Hoe/Lyngby axe	Sawing+breaking, whittling	Flake/blade
3	A-154	8.1	Antler with traces of processing	Sawing+breaking	Flake/blade
4	B-94	7.1	Antler with traces of processing	Sawing+breaking	Flake/blade
5	P-32/85W	9.1	Pick-tool	Faceting+breaking	
6	A-165	7.3	Hoe/Lyngby axe	Chopping+breaking	
7	P-34/85W	9.3	Antler with traces of processing	Faceting+breaking	
8	P-28/85W	9.2	Antler with traces of ornamenting	Sawing, breaking	Flake/blade
9	P-29/85W	8.4	Antler with traces of processing	Sawing	Flake/blade
10	P-24/85	7.4	Waste product	Faceting+breaking	Flake/blade
11	P-?	8.2	dagger	Faceting+breaking	Flake/blade
12	P-25/85W	7.5	dagger	Faceting+breaking	Flake/blade
13	P-15/85W	8.5	dagger	Sawing	Flake/blade

Table 6. Pobiel 10. Technological traces. Bone and antler tools (type CA, CB, CC,CD and D)

No.	Catalogue no.	Fig.	Type according to Z. Bagniewski and S. Prasch	Subtypes according to M. Diakowski	Stage of work	Technological actions according to characteristic traces	Tool used
1	A-166	10.2	Awl/dagger	CA.1.a	Dividing, shaping a tip	Faceting +breaking Scraping	Flake/blade
2	P-4/85W	10.3	dagger	CA.1.a	Dividing, shaping a tip	Sawing+breaking, dotted percussion, scraping	Flake/blade Pick
3	D-18	10.1	dagger	CA.1.a	Dividing, shaping a tip	Sawing+breaking scraping	Flake/blade
4	E-34	10.4	dagger	CA.1.a	Dividing and shaping a tip, ornamenting	Sawing+breaking Grinding Grooving	Flake/blade
5	19/83W	10.6	dagger	CA.1.b	Dividing, shaping a tip	Faceting+breaking Filing technique (surface sawing)	Flake/blade
6	P-8/85W	10.5	Waste product	CA.1.b	Dividing, shaping a tip	Faceting+breaking scraping	Flake/blade
7	A-163	11.1	dagger	CA.2	Dividing, shaping a base, shaping a tip	Sawing+breaking scraping	Flake/blade
8	E-32	11.2	Part of a necklace	CA.3	Dividing, making a hole	Sawing+breaking boring	Flake/blade Borer
9	E-31	11.4	Part of a necklace	CA.3	Dividing, shaping, making a hole	Sawing+breaking whittling boring	Flake/blade Borer

10	B-15/78	11.3	Part of a necklace	CA.3	Dividing, making a hole	Sawing+breaking boring	Flake/blade Borer
11	E-45	12.1	Piece of a punch tool handle	CB.1.a	Dividing, shaping working parts, making a hole	Sawing+breaking Dotted percussion+boring Grinding Scraping Chopping around	Flake/blade Borer Pick
12	E-35	12.2	Chopper handle	CB.1.b	Dividing, shaping working parts, making a hole	Faceting+breaking Dotted percussion+boring Grinding Scraping	Flake/blade Borer Pick
13	P-35/85W	13.1	Chisel	CB.1.c	Dividing, shaping	Sawing+breaking Faceting+breaking Scraping	Flake/blade
14	B-96	13.2	Hoe-axe	CB.1.d	Dividing, shaping	Sawing+breaking Whittling	Flake/blade
15	E-70	13.3	Piece of an axe	CB.2.a	Dividing, shaping, Making a hole	Sawing+breaking Boring	Flake/blade Borer
16	E-36	14.1	Hoe with a hole	CB.2.b	Dividing, shaping, making a hole	Sawing+breaking Scraping Dotted percussion+boring	Flake/blade Borer
17	P-5/85W	14.2	hoe	CB.2.c	Dividing, shaping	Sawing+breaking Grooving+splitting Scraping	Flake/blade Burin
18	E-33	14.3	Fishing spear	CC	Dividing, shaping, boring	Sawing+breaking Scraping Boring	Flake/blade Borer
19	P-2/85W	15.1	awl	CD	Dividing, shaping	Breaking Scraping	Flake/blade
20	P-3/85W	15.2	awl	CD	Dividing, shaping	Breaking Filing technique (surface sawing) Scraping	Flake/blade
21	E-40	15.3	awl	CD	Dividing, shaping	Breaking Scraping	Falke/blade
22	P-17	15.4	awl	CD	Dividing, shaping	Riving Knaping Scraping	Hammer stone Flake/blade
23	P-13/85W	15.5	Pipe	D	Shaping	dotted percussion	Pick
24	P-19/85W	15.6	antler fragment with ornament	D	Dividing?, shaping, ornamenting	Sawing Knapping Grooving	Hammer stone Falke/blade

Table 7. Pobiel 10. Type of working techniques in different working stages

Stage	Technique	(N)
Dividing of the raw material	Riving	1
	Breaking	29
	Sawing	19
	Faceting	16
	Splitting	1
	Chopping	1
	Grooving	1
Tool's shaping	Knapping	2
	Scraping	16
	Grinding	3
	Whittling	3
	Surface sawing (filing)	2
	Dotted percussion	4
	Boring	9
Final processing and ornamentation	Grooving	3
	Sawing	1

Table 8. Pobiel 10. The occurrence of particular types of tools in different climatic periods on the Central European Plain

Period	Type							
	CA.1.a	CA.1.b	CB.1.a	CB.1.b	CB.1.c	CB.1.d	CB.2.a	CB.2.b
Subboreal	×	×					×	
Atlantic		×					×	
Boral/Atlantic	×	×	×	×	×			
Middle and Late Boral	×			×	×	×		×
Early Boreal		×		×				×

Acknowledgements

This paper is a part of MA thesis written under prof. J. Burdukiewicz's supervision, whom I wish to acknowledge for any help and support for my research. I would also thank Dr. T. Płonka for scientific advice and J. Markiewicz for help with English translation.

References

Bagniewski, Z. 1990a. *Obozowisko mezolityczne z Doliny Baryczy. Pobiel 10, woj. leszczyńskie*, Studia Archeologiczne 19, Wrocław: Uniwersytet Wrocławski.

Bagniewski, Z. 1990b. *Mesolithic peat levels at the site of Pobiel 10*, In: J. K. Kozłowski and S. K. Kozłowski (eds.) *Interregional cultural relations between Polish territories and adjacent regions of Central and Eastern Europe*, Archaeologia Interregionalis 11,Warszawa: Wydawnictwa Uniwersytetu Warszawskiego, 25-47.

Bagniewski, Z. 1992a. *W sprawie obróbki surowca rogowego w mezolicie*, Studia Archeologiczne 22, Wrocław: Uniwersytet Wrocławski, 13-33.

Bagniewski, Z. 1992b. *Untersuchungsergebnisse aus der mesolitischen Torfstation Pobiel 10 (Niederschlesien)*, Prähistorische Zeitschrift 62/2, 141-162.

Clark, J.G.D. 1978. *Excavations at Star Carr. An early mesolithic site at Seamer near Scarborough, Yorkshire*, Cambridge: Cambridge University Press.

Classon, A.T. 1983. *Worked and unworked antlers and bone tools from Spoolde, de Gaste, the Ijsselmeerpolders and adjacent areas*, Palaeohistoria 25, 77-130.

Cnotliwy, E. 1956. *Z badań nad rzemiosłem zajmującym się obróbką rogu i kości na Pomorzu Zachodnim we wczesnym średniowieczu*, Materiały Zachodniopomorskie 2, 151-79.

Cnotliwy, E. 1973. *Rzemiosło rogowe na Pomorzu wczesnośredniowiecznym*, Wrocław-Warszawa-Kraków-Gdańsk: Zakład Narodowy im. Ossolińskich.

Crombé, P., Perdaen, Y., Sergant, J. and J. P. Caspar 2001. *Wear Analysis on Early Mesolithic Microliths from the Verrebroek Site, East Flanders, Belgium*, Journal of Field Archaeology 28, 253-267.

David, E. 1999. *L'industrie en matières dures animales du Mèsolithique ancien et moyen en Europe du Nord. Contribution de l'analyse technologique à la définition du Maglemosien*, PhD thesis, Université Nanterre, Paris.

David, E. 2002. *Fiche Percuteur sur métapodien d'aurochs*, In: M. Patou-Mathis (ed.) *Fiches typologiques de l'industrie osseuse préhistorique Cahier X «Retouchoirs, Compresseurs, Percuteurs…Os à impressions et éraillures», Industrie de l'Os Préhistorique (Éditions de la Société Préhistorique Française)*, 133-6.

David, E. 2003. *The contribution of the technological study of bone and antler industry for the Definition of the Early Maglemose culture*, In: L. Larsson, H. Kingren, K. Knutsson, D. Loeffler and A. Akerlung (eds.) *6th International Conference on the Mesolithic in Europe Meso 2000, Stockholm, 4-8 September 2000. Mesolithic on the Move*, Exeter, 649-57.

David, E. 2004. *The Mesolithic Zvejnieki site (Latvia) in its European Context: Preliminary results delivered by a technological study of the bone and antler industry*, Journal of Estonian Archaeology 7(2), 99-122.

David, E. 2005. *Preliminary results on the recent technological study of the Early Mesolithic bone and antler industry of Estonia, with special emphasis on the site of Pulli*, In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present. Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003,* Muinasaja teadus 15, Tallinn, 67-74.

David, E. 2006. *Technical behaviour in the Mesolithic (9th-8th millenium cal. BC): The contribution of the bone and antler industry from domestic and funerary contexts*, In: L. Larsson and I. Zagorska (eds.) *Back to the origin. New research in the Mesolithic-Neolithic Zvejnieki Cemetery and environment, Northern Latvia*, Acta Archaeologica Lundensia, series in 8°, N° 52, Lund, 235-52.

David, E. 2007. *Technology on Bone and Antler industries: A Relevant Methodology for Characterizing Early Post-Glacial Societies (9th-8th Millenium BC)*, In: Ch. Gates St.-Pierre and R. Walker (eds.) *Bones as Tools: Current Methods and Interpretations in Worked Bone Studies*, BAR Intern. Series 1622, Oxford: Archaeopress, 35-50.

Diakowski, M. and T. Płonka 2010. *New data on ornamented artifacts from the Mesolithic site Pobiel 10, Lower Silesia, Poland*, Archaeologisches Korrespondenzblatt 40(3), 317-330.

Drzewicz, A. 2004. *Wyroby z kości i poroża z osiedla obronnego ludności kultury łużyckiej w Biskupinie*, Warszawa: Wydawnictwo Naukowe Semper.

Dumont, J. V. 1989. *Star Carr: the Results of a Micro-Wear Study*, In: C. Bonsal (ed.) *The Mesolithic in Europe. Papers Presented at the Third International Symposium, Edinburgh 1985*, Edinburgh: John Donald Publishers Ltd., 231-40.

Feustel, R. 1973. *Technik der Steinzeit. Archäolithikum-Mesolithikum*, Weimar: Herman Böhlaus Nachfolger.

Fiedorczuk, J. 1995. *Mesolithic finds at Dudka 1, Great Masurian Lakeland, and their chronological-taxonomic relations*, Przegląd Archeologiczny 43, 47-59.

Gumiński, W. 1995. *Environment, economy and habitation during the mesolithic at Dudka, Great Masurian Lakeland, NE-Poland*, Przegląd Archeologiczny 43, 5-46.

Gumiński, W. 2003. *Scattered human bones on prehistoric camp site Dudka, NE-Poland, as indication of peculiar burial rite*, In: E. Derwich (ed.) *Préhistoire des Pratiques Mortuaires. Paléolithique – Mésolithique – Néolithique. Actes du Colloque de Liège*, ERAUL 102, Liège, 111-120.

Gumiński, W. 2005. *Szczepanki 8. Nowe stanowisko torfowe kultury Zedmar na Mazurach*, Światowit 5 (46), 53-104.

Jensen, H. J. and E. B. Petersen 1985. *A Functional Study of Lithics from Vænget Nord, a Mesolithic Site at Vedbæk, N. E. Sjælland*, Journal of Danish Archaeology 4, 40-51.

Kabaciński J., D. Makowiecki, I. Sobkowiak-Tabaka and M. Winiarska-Kabacińska 2006. *Badania stanowiska mezolitycznego nr 7 w Krzyżu Wielkopolskim*, In: H. Machajewski and J. Rola (eds.) *Pradolina Noteci na tle pradziejowych i wczesnośredniowiecznych szlaków handlowych*, Poznań: SNAP, 39-43.

Kabaciński, J., E. David, D. Makowiecki, R. Schild, I. Sobkowiak-Tabaka and M. Winiarska-Kabacińska 2008. *Stanowisko mezolityczne z okresu borealnego w Krzyżu Wielkopolskim*, Archeologia Polski 53(2), 243-89.

Lindemann, M. 2000. *Die Knochen und Geweihbearbeitung im westeuropäischen Jungpleistozän*, Experimentalle Archäologie, Bilanz 2000, 7-28.

Lyman, R.L. 1994. *Vertebrate Taphonomy. Cambridge Manuals in Archaeology*, Cambridge: Cambridge University Press.

Osipowicz, G. 2005. *Metody rozmiękczania kości i poroża w epoce kamienia w świetle doświadczeń archeologicznych oraz analiz traseologicznych*, Toruń: Wydawnictwo Adam Marszałek.

Pratsch, S. 2006. *Mesolitische Geweichgeräte im Jungmoränengebiet zwischen Elbe und Neman: Beitrag zur Ökologie und Ökonomie mesolitischer Wildbeuter*, Bonn: Habelt.

Rajewski, Z. 1950. *Przedmioty z kości i rogu i obróbka obu surowców w grodach łużyckich z wczesnego okresu żelaza*, III Sprawozdanie biskupińskie, 175-85.

Rust, A. 1943. *Die alt- und mittelsteinzeitlischen Funde von Stellmoor*, Neumünster: Karl Wachholtz Verlag.

Semenov, S. A. 1964. *Prehistoric Technology*, London: Adams and Dart.

Stapert, D. 1976. *Some natural surface modifications on flint in the Netherlands*, Palaeohistoria 18, 7-42.

Żurowski, K. 1953. *Uwagi na temat obróbki rogu w okresie wczesnośredniowiecznym*, Przegląd Archeologiczny 9(2-3), 583-8.

Selena Vitezović

The Neolithic Bone Industry from Drenovac, Serbia

This paper will focus on the analysis of bone artefacts from the Neolithic site Drenovac, located in central Serbia, in the Middle Morava valley. Excavations conducted from 2004 to 2006 yielded a very rich assemblage of objects made of bone, antler, tooth and shell. In total over 300 artefacts were found, all of which were found in one single trench. For the first time complete objects, and also debris, semi finished and broken tools were collected and analysed. Since the bone industry is largely ignored in prehistoric archaeology in Serbia, results thus obtained were very important for recognizing this class of archaeological material as a valuable source of information on various economic questions. The Drenovac assemblage shows great a variety of raw materials and in the final forms of artefacts. Semi finished objects and debris helped in reconstructing the modes of production, and an attempt was also made to reconstruct the possible use. Thus, information regarding both the managing of raw materials and the level of technological knowledge was obtained. Also, this analysis revealed that small crafts, such as hide or leather working, previously ignored, were practiced in the settlement, and some shell objects revealed more elaborated exchange network of precious goods than previously acknowledged. Chronologically, most of these objects belong to Late Neolithic Vinča culture; however, some of the pieces could be attributed to Early/Middle Neolithic Starčevo culture.

Keywords: bone and antler tools, shell ornaments, central Balkan, Neolithic, Vinča culture, Starčevo culture

Introduction

The systematic study of Neolithic cultures in central Balkans began over a century ago, with excavations at Vinča – Belo Brdo, the eponymous site of Vinča culture. Today, hundreds of Neolithic sites are known in Serbia, and different aspects of both material culture and socio-economic organization have been the subject of study (Srejović 1988, with references).

Bone objects, however, were in the main given less attention. The main priority in Serbian archaeology was to answer on questions about chronology hence utilitarian artefacts received less attention than pottery. Apart from several reports on particular sites (Vranić 1987, Lyneis 1988, Russell 1990, on Žarkovo, Divostin, and Selevac, respectively), only one synthetical work appeared, on bone industry from several Mesolithic and Neolithic sites (Bačkalov 1979).

During excavations on the Neolithic site Drenovac, from 2004 to 2006, a rich assemblage of objects made of bone, antler, tooth and shell was recovered, a total over 300 complete pieces, as well as debris, semi finished and broken tools. Good preservation of bone material, rich assemblage and careful collection of artefacts explain how and why this study was able to establish a typological classification for the central Balkans. The results obtained were very important in recognizing this class of artefacts as a valuable source of information on several economic questions.

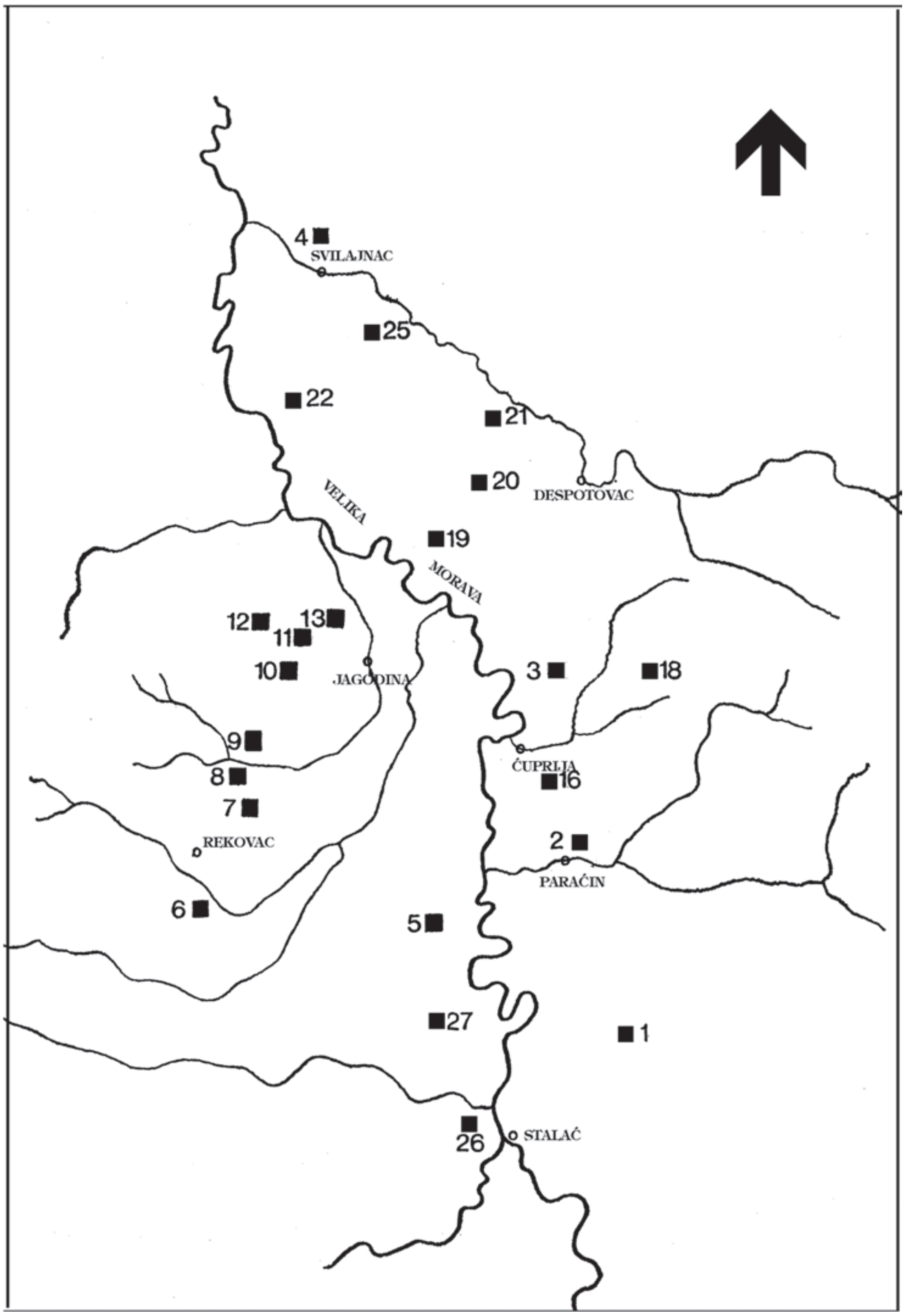


Fig. 1. Neolithic sites in the Velika Morava valley. Drenovac is no. 1

The site

The site Drenovac – Turska česma (Drenovats) is situated on a gentle slope above the terrace of Velika Morava river, near the modern village of Drenovac, 8 km south of the town of Paraćin, central Serbia. The whole valley of Velika Morava was intensively populated during the Neolithic period and the closest site, Slatina, is only 8 km north from Drenovac. The site was discovered in 1966, and in the period 1968-1972 14 trenches, covering approximately 290 m^2 were excavated. These revealed several settlement stages belonging to the Starčevo and Vinča (early and late Neolithic) culture in a layer of up to 5.5 m thickness (Ružić, Pavlović 1988; Vetnić 1974:125, 155). During new excavations, from 2004 to 2006, one trench (dim. 6 × 6 m), with a cultural layer of over 6 m, was excavated. At least four building horizons belonging to the Vinča culture were found, and also traces of the Starčevo culture settlement (for practical reasons, excavated on a limited area of approx. 15 m^2). The portable material was very rich, and among pottery, figurines, flint, stone tools, 322 objects made from animal hard tissue – bones, antlers, teeth and shell were also recovered.

Fig. 2. Traces of burnishing on point Dr 088 (Vinča culture). All photos are by S. Vitezović

Fig. 3. Traces of burnishing on awl from rib Dr 180 (Vinča culture)

Chronology

The cultural layers at Drenovac belong to the Vinča and Starčevo culture. Most objects belong to the Vinča levels and they fit into the bone industries from other Vinča sites (e. g. Selevac – Russell 1990; Vinča – Srejović, Jovanović 1959). The Starčevo layer was not excavated in the whole trench area, but only on a limited area of aprox. 15 m^2, and the number of bone tools from the Starčevo layers is not high. The unclear stratigraphic situation in the transition layers between the Vinča and Starčevo culture poses problems in interpreting similarities and differencies between respective bone industries. Some of the bone tool types – such as awls made from split long bones or from ribs – are not chronologically sensitive, i.e. they occur in both Vinča and Starčevo culture. The majority of tools described here belong to Vinča culutre. Since artefacts assigned with certainty to Starčevo layers were not numerous and since there were no sharp differences between them and Vinča artefacts, all the bone industry from Drenovac was treated as one assemblage, only with notes if some traits were exclusively those of Starčevo assemblage.

Raw materials

Among animal hard tissue used for making objects on Drenovac the most dominant are long and flat mammal bones and red deer's antlers. Other bones, teeth and roe deer's antlers were used only occasionally, while shells occur rarely.

Among bones, different long bones were used, most often metapodial or other long bones of medium size ungulate, as sheep/goat. Ribs are most common among flat bones and again smaller ribs prevail. This may be because it is easier to shape smaller bones, but also the reason may be functional – too thick a bone was not desirable for fine tools such as awls or pins. Other bones were used only occasionally, such as jaw fragments or astragals, while some bones were never used – skull bones, for example.

Most of bones used to make tools belong to animals which were probably killed for meat (sheep/goat, cattle, red deer). Also, the bones that were used are probably the ones that remain after primary butchering (cf. Lyman 2001). Most of the bones were chopped first or simply broken and then shaped, which also suggests that the selected bones were kitchen debris. A similar selection of raw mate-

Fig. 4. Traces of cutting on antler hammer Dr 126 (Vinča culture)

Fig. 5. Awl Dr 233, made from metapodial bone, with epiphysis preserved (Vinča culture)

Fig. 6. Ad hoc awl Dr 149 (Vinča culture)

Fig. 7. Needle Dr 129 with broken perforation on basal part (Vinča culture)

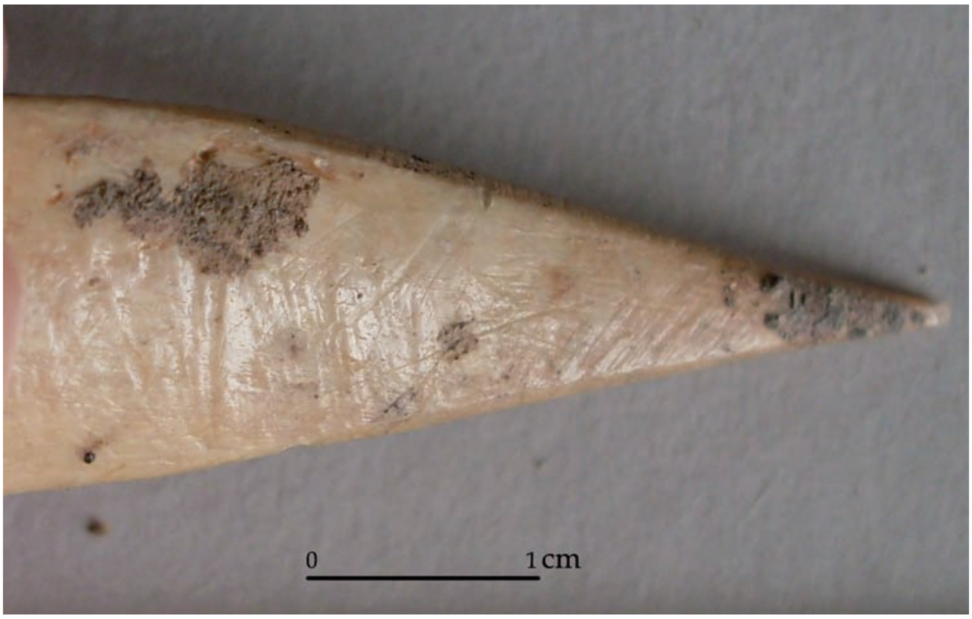


Fig. 8. Traces of use on awl Dr 170 made from rib (Vinča culture)

rials was also observed on other Neolithic sites in the area (cf. Bačkalov 1979:23; Beldiman 2002).

Among antlers, those of the red deer are the most common ones. Usually only tines were used, but segments of beam and base can also occur. Most of the antlers are shed, not only because this is the easiest way of obtaining them, but also because antlers are more solid when the growth cycle is over. Shed antlers are common on other Neolithic sites (e.g. Divostin – Lyneis 1988:301).

Antlers of roe deer are far less common, and they are never shaped into regular, common shapes – they often look like ad hoc, expedient tools or the result of some sort of experiment with a raw material. In addition, they were probably not collected in such a systematic way as the antlers of red deer – some are clearly from killed animals. The similar situation, the prevailing use of red deer antlers and the only occasional use of non-shed roe deer antlers is also observed at Divostin (Lyneis 1988:309).

Teeth are used rarely and almost never for tools.

Shells also occur only occasionally, and for decorative objects only. They belong to Spondylus and probably Glycimeris species. They were obtained through some sort of exchange, but what the mechanisms of it were, it is difficult to suppose. Also, it is not clear whether they were imported as raw materials or as finished products (or both).

Most of the raw materials were collected and selected in a systematic and planned way, with careful selection of those that fit best for desired purposes. Also, most of them could have been obtained from the settlement or the area in the vicinity of the settlement. The bones were from animals kept in the settlement and the antlers were gathered in the sur-

Fig. 9. Spatula from rib, Dr 248 (Vinča culture)

Fig. 10. Hammer-axe made from antler, Dr 126 (Vinča culture)

rounding area or perhaps exchanged with vicinal settlements. The shells are the only material which came from an extended network of exchange. More or less, the model of using resources from the vicinity would look like this: animals intended for food, kept or killed, were used entirely; after removing meat and other edible parts, leather, skin, fur and bones were selected for making different objects.

The manufacture of objects

The techniques of working bone. The reconstructed *chaîne opératoire* for most tools would look like this: Smaller pieces of bones were extracted from whole bones by breaking or by chopping with stone pebble or stone axe. Then these fragments were further shaped by cutting or sawing with a flint tool (usually finely retouched burin or blade) into the basic form. Bones were most often split vertically, so the basic preform from a long bone is one longitudinal half, while for ribs it is one bone plate. The technique of cutting the groove before sawing the bone occurs rarely. Most of the tools are finalized by burnishing and polishing – in most cases, by sandstone. Usually all the edges that have been broken or cut are then polished, especially in awls and pins.

Some authors have suggested (Russell 1990:544) that the bones were split longitudinally in order to use in a rational way the available raw materials because in that way one bone can yield two or even four preforms for tools such as awls. However, this is not consistent with the large number of bones recovered at Drenovac, which show that there was no need to save on raw material. Besides, the morphology of most objects shows that it was necessary to split bone so the obtained tools would be fine enough and sharp enough – or, in spatulas, the spongy tissue probably also had important role in the efficiency of these tools.

Most of these objects were produced in a simple way which did not demand excessive investment of labour and time; however, there are some exceptions. Pins and objects interpreted as spindles were carefully burnished and polished, probably with more than one abrasive agent. Hooks are somewhat exceptional – apparently, much more time was invested in their production, which, along with the fact that they are rare, questions their use as fishing gear.

The perforations were produced by a flint borer, probably a fine one, since some pins have perforation diameter 2-3 mm. None of the bones was decorated.

The same or similar techniques are also observed on Neolithic sites in the area, such as Selevac (Russell 1990:541-2), Divostin (Lyneis 1988:317) or on sites in Romania (cf. Beldiman 2000b, 2002).

The techniques of working antler. The technique for detaching pieces of antler for working used most often is the so-called *cut-and-break* technique – grooves or cuts were made with a flint tool in a ring around the desired breaking point or the antler was sawed in circumference; last portion is then just broken off or chopped off with an axe. Only smaller tines could have been detached with simple sawing or by several blows with a stone tool. Sometimes these basal parts were worked by whittling – thin, elongated stripes of material were removed. Working tips are usually natural tips of antlers, but sometimes they may be resharpened or adjusted for the desired job by whittling or cutting small stripes of material. Also the outer surface of the antler is

Fig. 11. Handle Dr 385, subtype made from epiphysis and diaphysis of long bone(Starčevo culture)

Fig. 12. Used astragal Dr 075 with one perforation on the middle part (Vinča culture)

sometimes smoothened by scraping with a flint tool or by burnishing with sandstone. Perforations were made by carving out the spongy tissue with a flint tool.

All these techniques were also observed on other Neolithic sites in the area – e. g. Divostin (Lyneis 1988:303), Banjica (Perišić 1984, table 20:145) and Jakovo-Kormadin (Perišić 1984: table 20:147,148).

Typological-functional analysis

Following the tradition of the French school, the typological classification is done using the following criteria – morphology of the distal end, the anatomical origin of the raw material, and the technology (i.e. the mode of shaping), encompassing these main groupes: 1) pointed objects – different types of awls, needles and pins, picks, hooks, projectile points, etc.; 2) cutting objects – chisels, wedges and axes; 3) blunt objects or implements for polishing and scraping and 4) implements for punching and pressing (Camps-Fabrer 1966; Stordeur 1988).

The typological classification of A. Bačkalov, applied on preNeolithic and Neolithic assemblages from Serbia, was also based on these critieria and the definitions of types are mostly after Bačkalov (1979). The interpretation of use wear traces is done after the results of experiments done by different authors (e. g. Semenov 1976, Peltier 1986, Legrand, Sidéra 2004, Sidéra, Legrand 2006).

Group I. Pointed tools

I 1. Awls

Awls were the most common tool type. According to their morphology and raw material, two main subtypes can be distinguished – awls made from long and from flat bones.

Awls made of long bones (I 1 A) were all made by splitting long bones, most often metapodial bones of sheep size animals, and then shaped by cutting

Fig. 13. Piece of antler bracelet Dr 336 (probably Starčevo culture)

and polishing, their cross section is usually semi annular, and their side edges usually form regular triangle and end in a sharp point. Basal parts on some of them were fragmented, but some of them had preserved epiphysis on the basal part and one of them has traces of epiphysis being removed – the basal part has traces of smoothing.

Somewhat more intense traces of polishing around the tip may suggest resharpening of the tool. The traces of use on most of these objects suggest that they were used for work on soft organic materials, in particular for skin, leather and fur, during different stages (cf. Peltier 1986, Legrand, Sidéra 2004, Sidéra, Legrand 2006).

This type of awls and its variants have a wide geographical and chronological span (Camps-Fabrer 1990a, 1990b). In the Neolithic of Serbia, the variants of awls with epiphysis on distal end are known, for example, at Žarkovo (Vranić 1987, table 2:12), on Vinča (Srejović, Jovanović 1959: sl. 1/12) and on Banjica (Perišić 1984, table 2:10, 11), while the awls with smoothened base without epiphysis are found on Jakovo-Kormadin (Perišić 1984, table 5:38) and on Žarkovo (Vranić 1987, table 3:15).

Awls made of flat bones were exclusively made of ribs, split vertically and the object was shaped out of one bony plate of rib by cutting and burnishing. The cross section of these awls is flat, but sometimes those made of larger ribs may have circular cross section. These tools show a large span of dimensions – from only several centimetres to over 15 cm. Two variants were present – one-sided awls, which have on their base traces of cutting with a flint or polishing, and double-sided awls – only one specimen was found.

The spongy tissue on the lower surface is sometimes deliberately removed by scraping, but often it is worn out from use. The outer surface is also often polished and worn out, which suggests soft, organic materials. Most of them were used on leather and fur, but some may also have been used on plant materials (cf. Peltier 1986, Legrand, Sidéra 2004), and only one has traces of being used on clay – deep and dense incisions and lines cover almost all outer surfaces (cf. Russell 1990:523, 531; Semenov 1976:183-184).

This type of flat-bone awls is also common on Neolithic sites – for example, they are known on Vinča (Perišić 1984, table 10:86), Banjica (Perišić 1984, table 9:79), and on Divostin (Lyneis 1988: fig. 10.2, j). The double-sided awls are known from Vinča (Perišić 1984:36-37, table 11:91, 93) and from Selevac (Russell 1990:528, table 14:2a).

I 2. Points

These implements have a massive and strong pointed tip, and were used for splitting harder materials, such as wood, bones or antlers. They were made of large, split long bone, and have epiphysis fragment on basal parts, or they were made from complete or split antler tine. These objects are not as carefully worked as, for example, awls, and perhaps some of them were ad hoc tools or have been re-shaped after being broken from one object into points. Traces of use suggest they may have been used on plant materials (cf. Peltier 1986), probably for splitting wood.

I 3. Pins

Usually, they were made of bones, both long and flat; only one was made of a smaller tooth, which was made thinner by scraping. All of these objects have traces of being polished with some fine-grained agent, and on pins made from flat bones the spongy tissue is completely removed. Most of them have basal parts broken, and only two had broken perforation on base. One very small pin, only 2 mm wide, had both ends pointed.

Most of these objects were used for weaving and spinning – for making fibres from plant materials, making nets, etc., and at least two needles can be associated with a house context. Similar objects are known from Anza, Macedonia (Smoor 1976: fig. 127:4, 5 and fig. 136:1, 4) and Thessaly (Stratouli 1988: Prodromos, table 6:2,4,5; Servia, table 29:4,5,6).

I 6. Hooks

Only one hook was found. A thin, small rod of bone was shaped into a hook by careful burnishing and polishing. The pointed end was not preserved. Hooks are not common in Neolithic sites, and, are only ever found, in small numbers. Probably the richest collection of bone hooks comes from Vinča (Srejović, Jovanović 1959; Bačkalov 1979), and one is known from Selevac (Russell 1990:530).

I 8. Projectile points

Two possible projectile points were discovered, made from bones, with massive pointed ends and traces of shaping by a flint tool.

Harpoons were not found, although one antler object, poorly preserved, may have been a toggle harpoon.

Group II. Cutting tools

II 1. Chisels

Chisels were made of split long bone or from split red deer antler tine of. Two chisels were found, both had their working edges damaged, with small chips, and some polish, and were probably used for woodworking (cf. Provenzano 1998a:14, 1998b:21).

II 2. Wedges

Two wedges were recovered, one made of an antler tine fragment, very damaged, and with the working edge intensively worn out from use, and the other made of a vertically split rib. Its traces of use are particularly well preserved – the spongy tissue was abraded, especially around the working edge, and on outer surface polish as well as small gouges are visible.

Fig. 14. Object Dr 359 made from rib, probably used as shoe or belt buckle (Starčevo culture)

II 4. Knives

Only one object belongs to this group, made from a large rib, whose sharp edges are abraded from use and show striations consistent with working on clay (cf. Russell 1990:523, 531).

Fig. 15. Shell bracelets, Dr 392, 391 and 390 (Vinča and probably Starčevo culture)

Group III. Polishing tools

III 1. Spatulas

Spatulas or polishers were very a numerous type and show great variety in raw materials, shape and mode of use. The most common shapes are spatulas from a split long bone with a working edge more or less semicircular, with parallel edges - they look like letter U turned upside down. Or the basis may be narrower than the working end and the form was more triangular. Usually their surfaces were heavily worn, polished and covered with different striations, suggesting they were used on soft, organic materials, often leather and hide, but sometimes also plant materials (cf. Peltier 1986; Christidou 2004; Beugnier, Maigrot 2005; Sidéra, Legrand 2006). This type of spatulas is common on many Neolithic sites, for example Vinča (Srejović, Jovanović 1959:183) and Anza (Smoor 1976).

Sometimes split rib fragments were used as spatulas, slightly modified or not modified at all, and their spongy tissue being the main working surface, often heavily worn and sometimes completely abraded. There are also spatulas made of antlers, either from cortex fragment or the tine, diagonally cut so a flat surface is obtained. Unfortunately, they are all fragmented, so little can be said on their mode of shaping and use.

III 2. Scrapers

Scrapers were made from broken pieces of different bones, and probably not carefully shaped, but more likely ad hoc, expedient tools. They have working edges worn, chipped and sometimes look as if they were retouched like flints.

III 3. Spatulas-awls

Three objects had two working edges, one end was shaped into a point, and the other was used for polishing. They were all made of ribs and intense polish suggests that they were used for working on soft organic materials. For some pointed objects from Vinča (Srejović, Jovanović 1959:183) and from Selevac (Russell 1990:524) it was noted that their basal part was used for polishing.

Group IV. Striking tools

IV 1. Strikers

Strikers or punches were made mainly from tines of red deer antler. The natural tip of antler is often shaped or repaired by whittling and cutting, or simple flaking, and their outer surface was sometimes smoothed by scraping or whittling with a flint tool. They have intense traces of use, often not only in the distal but also in the mesial part – usually lines, cuts and gouges of different size. They may have been used for woodworking, but also to break nuts or as pestles in mortars, for crushing pigments or other substances (cf. Poplin 1979).

Similar objects are known from Selevac (*blunt antler points*; Russell 1990:529 and fig. 14:5) and from Banjica (Perišić 1984, table 22:156).

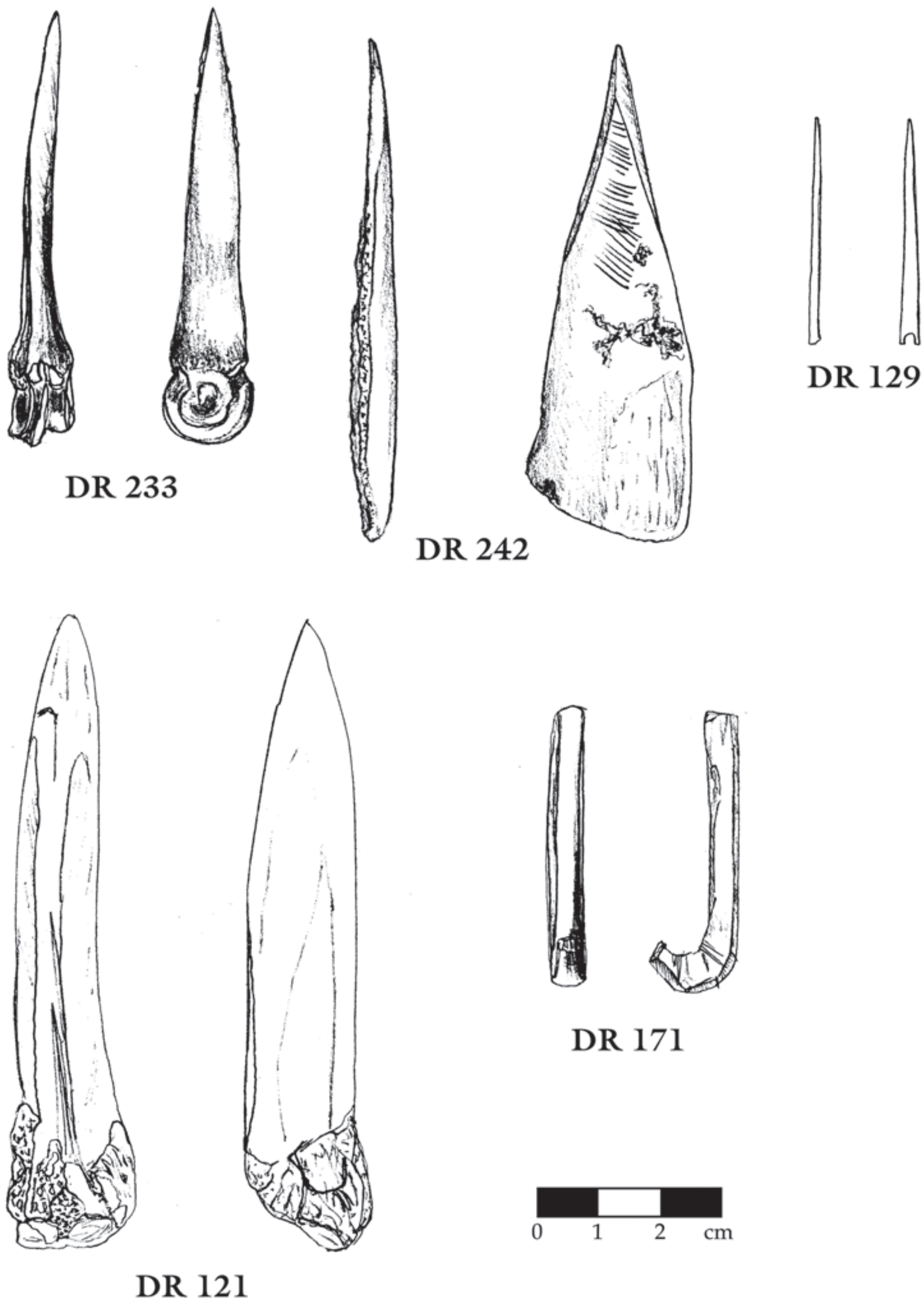


Fig. 16. Pointed tools. Awl from longe bone Dr 233, awl from rib Dr 242, needle with broken perforation Dr 129, point Dr 121 and hook Dr 171 (Vinča culture). All drawings are by Željko Utvar

IV 2. Retoucheurs

Two antler tines were probably used for retouching flints – their working tips, as well as mesial parts, are covered with short incisions and cuts, grooves and furrows (cf. Stordeur 1988:31, 39; Leonardi 1979; Schwab 2003). Antler retoucheurs are also known from Selevac (Russell 1990:538).

IV 3. Hammer-axe

One object, made from the beam of a shed antler, had the base of the antler and the base of a removed tine were used as hammers. On the other side the antler was carved out and a hollow was obtained for inserting another tool. The diameter of the hollow is about 2 cm and it is suitable for some smaller stone adze, axe or chisel. On the surface of the object small damages could be observed, while the hammer working surface is worn out.

Group V. Objects of special use

V 1. Handles

Two subtypes can be observed on Drenovac material – subtype A, made from the cylindrical diaphysis of long bones, slightly modified and polished, and subtype B, made from epiphysis and small parts of diaphysis of long bones. The bone is carefully sawed and the interior is used for placing different tools. All these handles have their outer sides polished and use marks consist of slight wear and striations that

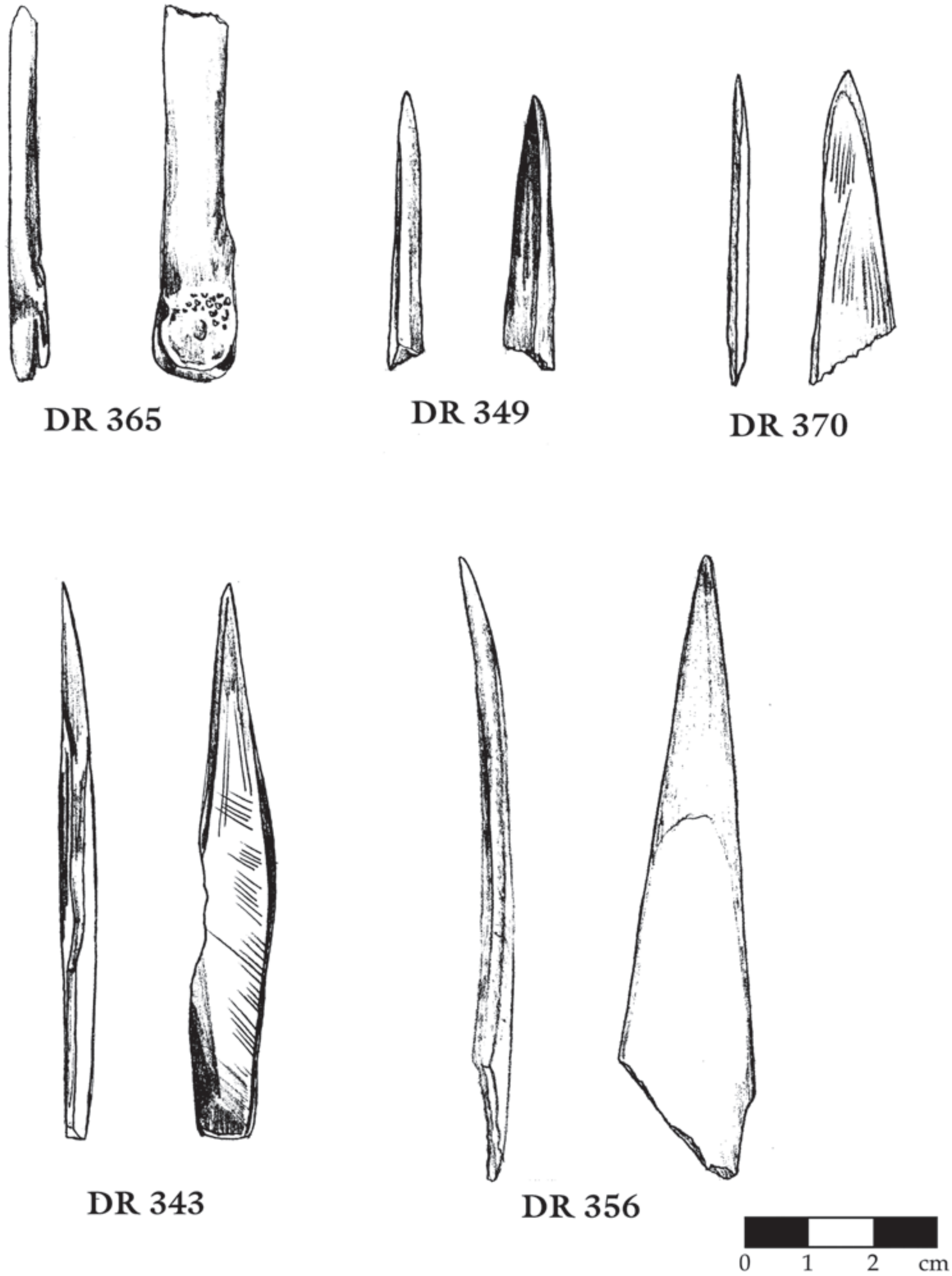


Fig. 17. Pointed tools. Broken awl from long bone Dr 365, needle or pin Dr 349, awl from rib Dr 370, one-sided awl from rib Dr 343, awl from rib Dr 356 (Starčevo culture)

show no regular pattern, and these marks suggest that these objects were used, but not as active tools. The inserted tools were probably for smaller flint or stone tools, such as small chisels or adzes. The subtype B specimens probably all belong to Starčevo culture layers.

There are different opinions on interpretations of cylindrical worked long bone fragments – e. g. as matrices for ring making (Pascual Benito 1998:156). Some of the small tubes of bones, found in France, were interpreted as jewellery until some of them were recovered with a tool inserted (Barge-Mahieu 1990). The following criteria are given for interpreting bone tubes as handles: absence or presence of traces of use inside the tube, traces of polish from use, absence or presence of decoration and so on.

V 2. Working surfaces

Several bone fragments, mostly ribs or split long bones, have their surfaces covered with random, but thick traces of use, such as striations, lines, incisions or furrows. The random pattern and morphology of these traces, as well as the absence of shaping of these objects, suggest that they were used as cutting boards or as some other supporter or surface on which the clay was prepared for shaping, meat butchered or plants processed for food.

V 3. Recipients

One antler tine, vertically split, was probably used as some sort of recipient. Traces of whittling are visible on its inner surface, while the spongy tissue has been carved out and smoothed from use. Outer sur-

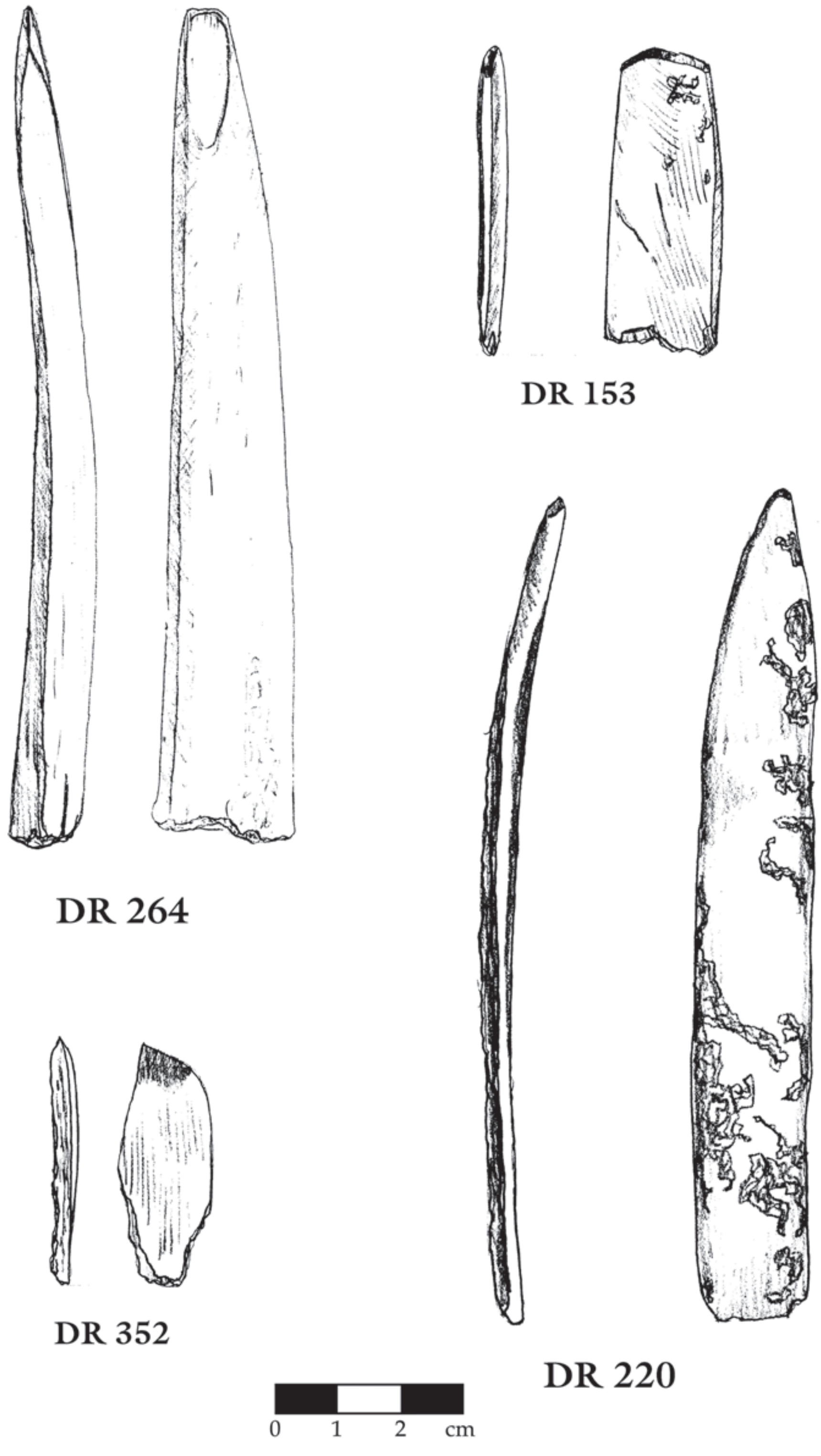


Fig. 18. Cutting and polishing tools. Antler chisel Dr 264 (Vinča culture), spatula from long bone Dr 153 (Vinča culture), spatula from rib Dr 352 (Starčevo culture) and awl-spatula Dr 220 (Vinča culture)

face was also smoothed by scraping and whittling. Perhaps this object was similar to certain objects interpreted as antler spoons, found on several sites (cf. Perišić 1984:39, 47). This artefact was found in Starčevo layers.

V 4. Used astragals

There are several worked astragals found on Drenovac. Most of them are smaller, from sheep/goat and only one is from a larger animal (probably cattle). They usually have one perforation in the proximal part; one astragal has two perforations on each end and one astragal has one perforation completed and one, maybe even two perforations just started. These perforations were made with a flint borer, whose traces can be observed on the edges.

All these objects have intense traces of use, visible especially on side surfaces and on prominent

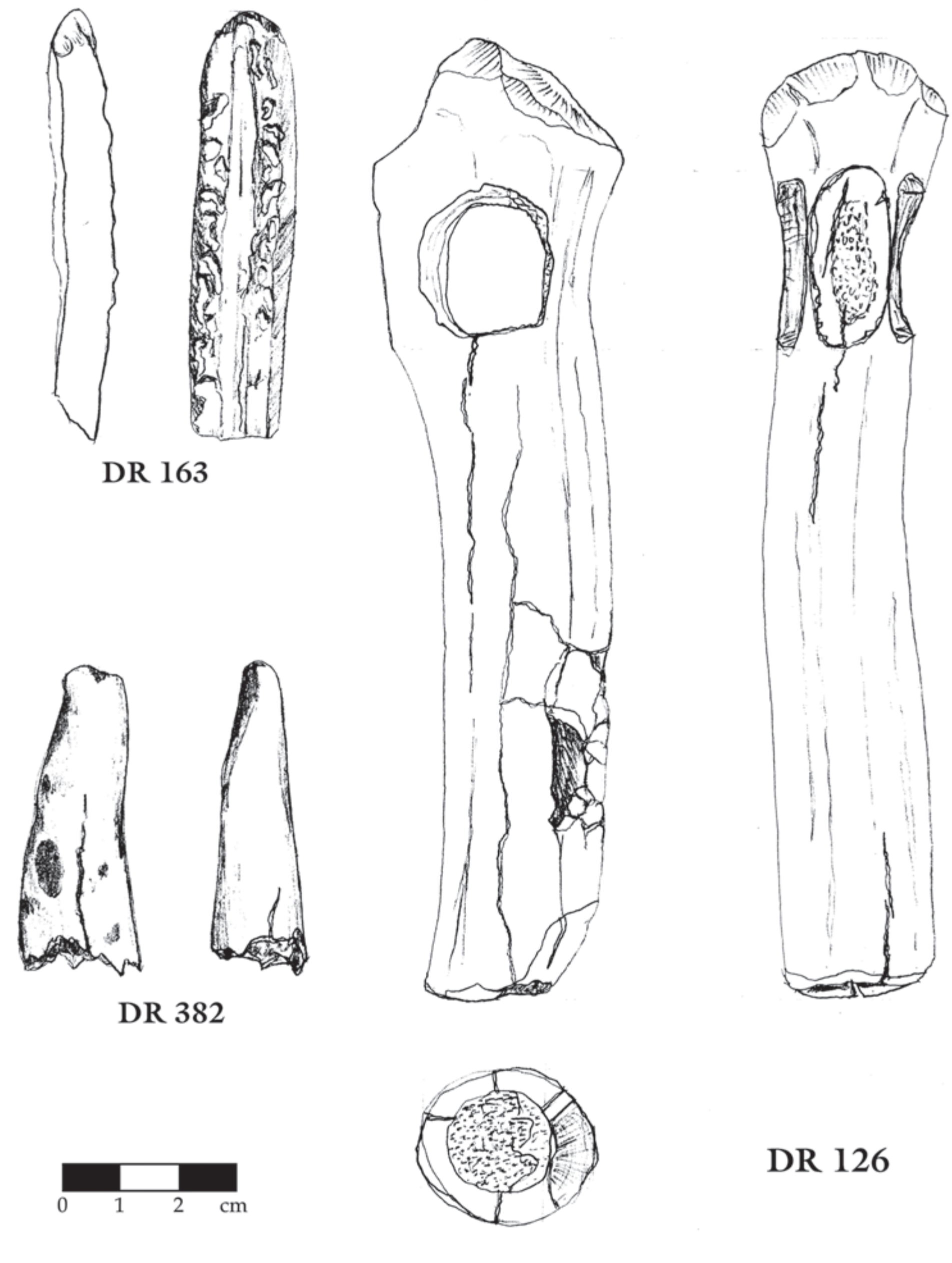


Fig. 19. Striking tools. Striker from antler Dr 163 (Vinča culture), retoucheur Dr 382 (Starčevo culture) and hammer-axe Dr 126 (Vinča culture)

parts, which are not only smoothed but also sometimes completely abraded and flattened. In addition, the first layer of bony tissue is sometimes removed due to this intense use. Other surfaces usually have patches of polish and striations.

These objects are usually interpreted as cult objects, jewellery or as dice for game (cf. Jacanović, Šljivar 2001; Russell 1990:538-539, with cited references), according to analogies with historical cultures, especially Roman, or after ethnological parallels. However, the intensive traces of use on these objects contradict these interpretations.

One astragal without perforation, also heavily worn out, from the Cucuteni culture site Draguşeni-Ostrov (Bolomey, Marinescu-Bîlcu 1988:347 and fig. 7:6) was interpreted as a polisher. These astragals could also have been used as polishers, but as some of them have perforations and some astragals found on a nearby site Motel Slatina have a groove, which runs out of the perforation, it is possible that these objects had some role in fibres processing – perhaps as a part of a loom.

V 5. Bone rods (spindles)

There is another type of objects linked with fibres processing – fine bone rods, which probably served as spindles or distaffs. They were made from different bones, long ones and ribs, and they were shaped by cutting and polishing into elongated, thin rod, of circular or triangular cross section. Although they resemble pins, their ends were not pointed, but smoothed. They were very intensively polished and sometimes they have striations consistent with traces from contact with plant materials (cf. Legrand, Sidéra 2004).

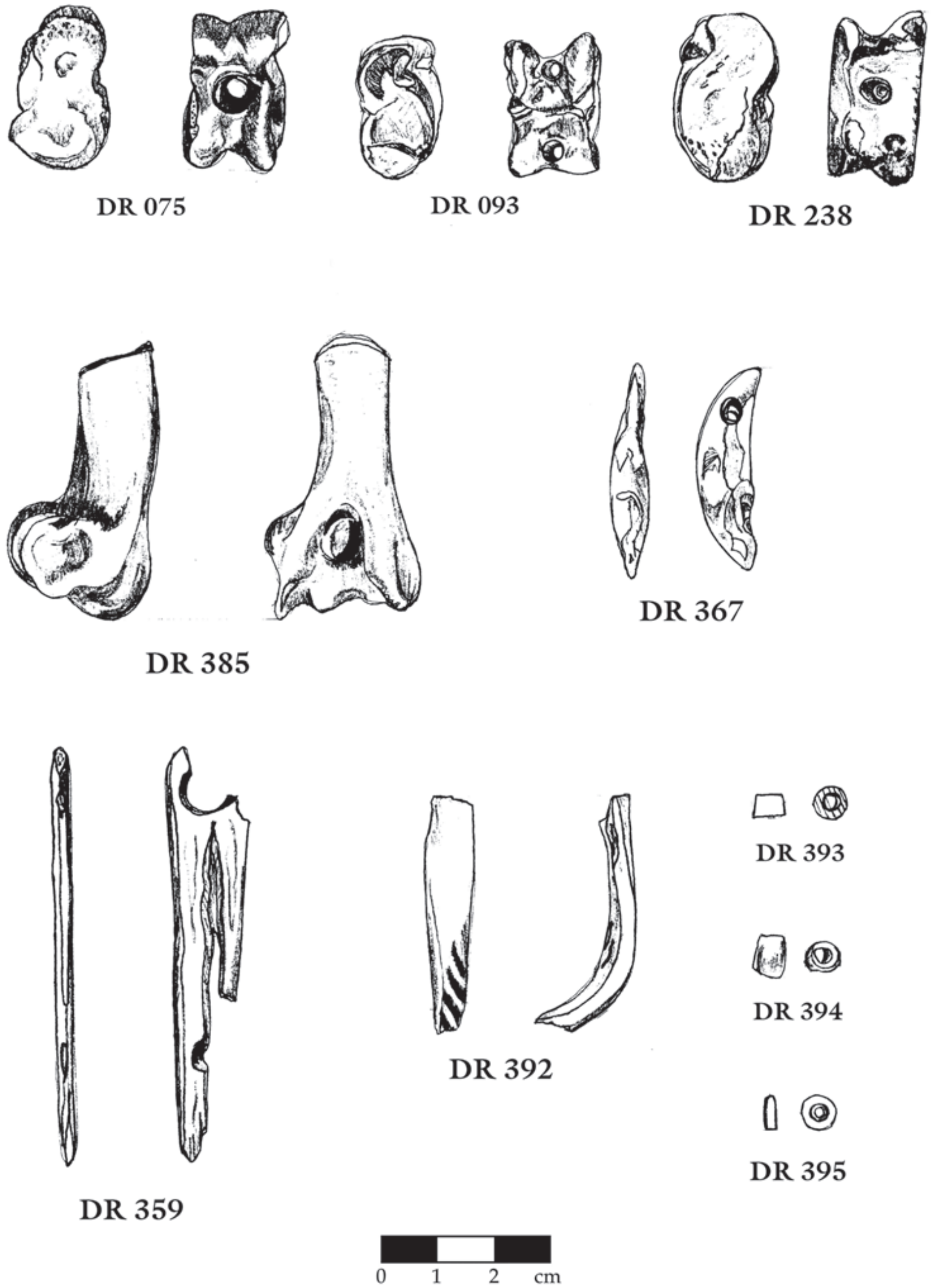


Fig. 20. Objects of special use and decorative objects. Used astragali Dr 075, 093 and 238 (Vinča culture), handle Dr 385 (Starčevo culture); perforated tooth Dr 367, belt buckle Dr 359, Spondylus bracelet Dr 392 and shell beads Dr 393, 394 and 395 (both Starčevo andVinča culture)

Group VI. Decorative objects

VI 1. Pendants

Several perforated teeth probably served as pendants. Two fragments of pig's tusks with traces of cutting may have been performs for making pendants. Only one pendant was made of bone – it was made from flat piece of bone, probably it had trapezoidal form and has broken perforation.

VI 2. Beads

Three beads was recovered, all made of shells. Two beads are very small, and flat, while the third bead is slightly bigger and has biconical shape. These are very fine objects, carefully made and highly polished. Beads of these types are known so far from several Neolithic sites in Romania (Comşa 1973), Anza – Macedonia (Gimbutas 1976: esp. fig. 213), and possibly some of the beads from Vinča are similar (cf. Srejović, Jovanović 1959:187). It is interesting to note that beads from Drenovac are the first finds of this kind from central Serbia.

VI 3. Bracelets

In total four bracelets made of shell were recovered, made of Spondylus and perhaps Glycimeris. They are all fragmented, so it is not possible to determine their original shape. They are all highly polished, with almost no traces of working. One bracelet has broken perforation on one end and perhaps this was decorative plaque (or the bracelet was turned into a plaque after being broken).

Morphologically, these bracelets do not differ much from those found in Vinča (Dimitrijević, Tripković 2002). Shell bracelets, especially those of Spondylus, found all over prehistoric Europe (cf. Willms 1985), and interpreted as luxury items, are taken as evidence of a trade and exchange network. What is significant for these specimens is that these are the first findings in the area outside of Danube valley (cf. Willms 1985; Dimitrijević, Tripković 2002). These new findings show that exchange networks were far more complex than originally suggested. It is also interesting to note that some of them may belong to Starčevo layers.

Another object was probably also a bracelet. It is a basal part of red deer's antler, the pearly part of the burr, cut out from the rest of the burr so the circular shape was obtained. It is fragmented, so original shape can not be determined, but this bracelet was probably of an open type. In the inner side, fine lines from flint tools can be observed and pearly parts are somewhat polished. So far, this is the only object of this kind found in Serbian Neolithic. Bracelets made from basal parts of the antler, the total number of 8, was found in several Neolithic sites in Romania, and they belong to Starčevo-Criş and Vinča A culture, and one of them had the representation of an animal head at one end (Beldiman 2000a). This specimen probably belongs to Starčevo culture layers.

VI 5. Buckles for clothing

Two possible buckles or other pieces of clothing were recovered. One is fragmented polished elongated plate with a broken perforation. Due to fragmentation, it is not possible to reconstruct the whole object, but it was probably some sort of hook – belt hook or maybe a footwear buckle.

The other object is was made from one bone plate of a smaller rib, on the upper part it has a large whole (diameter 1 cm) and the other end has deep cut so two legs are formed (one is broken). The form of the object gives a certain anthropomorphic impression, and the deep lines on it suggest that it was in close contact with leather or hide, and it was probably a buckle for clothing or footwear. A slightly similar object, with just one leg in distal parts, was recovered in Selevac, and has been interpreted as a belt buckle (Russell 1990: plate 14.3d).

Discussion

Pointed objects are the most common tool type on Drenovac, as they are on most Neolithic sites (e. g. Srejović, Jovanović 1959; Stratouli 1988; Smoor 1976; Voruz 1984). They are represented with awls, which occur in two subtypes and they were used most often for working on soft organic materials. Other pointed tools represented on Drenovac are points, used for splitting hard materials, and pins, used for sewing and weaving, also known in other Neolithic sites.

Hooks and projectile points are very rare.

Cutting tools are represented with a small number of specimens and in a small numbers of types – apart from one knife, only wedges and chisels were found.

Polishing tools are, along with pointed tools, the most common, and they also show great variety in types and subtypes. They were used mainly for working on soft organic materials.

Striking tools show that the Neolithic artisans had extended knowledge of the characteristics of raw material. Antler, which is very good in absorbing blows, was used almost exclusively for making these tool types. Most common types are strikers, probably used as pestles, while retoucheurs and hammers occur only rarely.

Decorative objects occur in small numbers, but they show an interesting choice of raw materials. Pendants were made from teeth, which otherwise do not occur. Perhaps the teeth were not considered to be suitable for tools – it is interesting to note that skull fragments, except antlers, were not used for tools. Perhaps teeth were chosen for jewellery because their anatomic origin had some special significance or because they are difficult for shaping – in that case, the technological skills required also had some symbolic value. The other interesting raw material were shells – they were obtained by some sort of exchange or by trade, but it is not clear whether they were imported as crude shells, as finished objects, or both. Also, an interesting example for choices of raw material is the antler bracelet.

The bone and antler objects were used for different types of tasks, but in most cases for working on organic materials, such as leather, hide and different plant materials (wood, fibres…), and to a lesser extent with inorganic materials, such as stone or clay. Most of these tasks could be linked with the manufacturing of clothes, footwear and woodworking, and to a lesser extent with food production, flint retouching or pottery production. Hunting and fishing gear is rare, while tools for working on soil are completely absent. In total, most bone and antler objects were used for small house works or for small crafts taking place within the household.

Repairing of objects and workshops. Resharpening or repairing of broken objects was rare – some of

Group/type	**Number**
POINTED TOOLS	3
Awls	5
Awls, type A	18
Awls, type B	44
Awls total	67
Points	7
Needles/pins	26
Harpoons	1
Hooks	1
Projectile points	2
Pointed tools total	107
CUTTING TOOLS	
Chisels	2
Wedges	2
Knives	1
Cutting tools total	5
POLISHING TOOLS	9
Spatulas	28
Scrapers	5
Awls–spatulas	3
Polishing tools total	45
STRIKING TOOLS	
Strikers	9
Retoucheurs	2
Hammers	1
Striking tools total	12
OBJECTS OF SPECIAL USE	5
Handles	6
Working surfaces	6
Recipients	1
Used astragali	6
Bone rods	5
Objects of special use total	29
DECORATIVE OBJECTS	1
Pendants	5
Beads	3
Bracelets	5
Clothing pieces	1
Decorative objects total	15
INCOMPLETE OBJECTS	
With traces of shaping	34
With traces of use	28
With both traces of shaping and use	47
Incomplete objects total	109
TOTAL	322

the awls may have been resharpened and two points were probably repaired. The almost total lack of evidence for resharpening or repairing was also noted at Selevac (Russell 1990: 543-5444). Workshops for making bone or antler objects were not discovered. However, two pig's tusks with traces of cutting and preparation for shaping suggest that a workshop existed, and that the uniformity of techniques and the final forms of objects suggest that they were produced in the settlement.

Conclusion

In the case of bone objects from Drenovac, the term "bone industry" is adequate – large number of finished objects and also a substantial number of debris show how important bone objects were. The technology – the methods of acquiring raw materials, the choice of raw materials, the methods of shaping and forms of finished objects all show that the manufacturing of bone objects was a carefully planned, settled and standardized activity. This suggests that jobs for which bone objects were required were also settled and standardized activities – in the first place, working of leathers and hides and processing of plant materials, for food, pigments, textiles, etc.

The bone industry from Drenovac fits well into the already known Vinča culture bone industries – those from Vinča, Selevac and Divostin, but it also yielded some new forms and some new technological solutions. Drenovac is also important for analyzing the relations between Starčevo and Vinča culture bone industries.

The future explorations of bone objects will help in studying the economic and social aspects of prehistoric communities. The differences between specific bone industries in central Balkan Neolithic, seen in the context of differences and similarities in other aspects of material culture (in the first place, flint and stone tools), supplemented with use-wear investigation, will be important for research of the labour organisation on intra-settlement level as well as between clusters of settlements.

Acknowledgements

I would like to express gratitude to the Ministry of science of Republic of Serbia, who supported my work through the fellowship programme, and to the Regional Museum of Paraćin and Archaeological Institute, Belgrade, for entrusting me with the material.

References

Bačkalov, A. 1979. *Predmeti od kosti i roga u preneolitu i neolitu Srbije*, Beograd: Savez arheoloških društava Jugoslavije.

Barge-Mahieu, H. 1990. *Les outils en os emmanchés de l'habitat chalcolithique des Barres (Eyguières, Bouches–du–Rhône) et les tubes en os du Midi de la France,* Bulletin de la Société Préhistorique Française 87/3, 86-92.

Beldiman, C. 2000a. *Obiecte de podoaba neolitice timpurii din materii dure animale descoperite pe teritoriul romaniei: bratari din corn de cerb,* Buletinul Muzeului Judetean „Teohari Antonescu" 5-7, 31-45.

Beldiman, C. 2000b. *Industria materiilor dure animale în aşezarea neolitica timpurie de la Dudeştii Vechi, jud. Timiş.*, Analele Banatului 7-8, 75-92.

Beldiman, C. 2002. *Asupra tipologiei uneltelor neolitice timpurii din materii dure animale descoperite în Romania: varful pe semimetapod distal perforat*, In: C. Gaiu (ed.) *Ateliere şi tehnici meşteşugareşti. Contribuții archeologice,* Cluj–Napoca: Complexul Muzeal Județean Bistrița-Năsăud, Bibliotheca, 7-31.

Beugnier, V. and Y. Maigrot 2005. *La fonction des outillages en matères dures animales et en silex au Néolithique final. Le cas de sites littoraux des lacs de Chalain et Clairvaux (Jura, France) au 30e siècle avant notre ère,* Bulletin de la Société Préhistorique Française 102(2), 335-44.

Bolomey. A. and S. Marinescu-Bîlcu 1988. *Industria osului în aşezarea cucuteniana de la Draguşeni-Ostrov*, Studii şi cercetari de istorie veche şi arheologie 39/4, 331-353.

Camps-Fabrer, H. 1966. *Matière et art mobilier dans la préhistoire nord-africaine et saharienne*, Paris: Mémoires du Centre de recherches anthropologiques préhistoriques et ethnographiques.

Camps-Fabrer, H. 1990a. *Fiche poinçon sur métapode fendu de petit ruminant*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique. Cahier III: Poinçons, pointes, poignards, aiguilles,* Aix-en-Provence: Université de Provence.

Camps-Fabrer, H. 1990b. *Fiche poinçon sur esquille fendue régularisée ou non à l'extrémité proximale*, In:

H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique. Cahier III: Poinçons, pointes, poignards, aiguilles*, Aix-en-Provence: Université de Provence.

Christidou, R. 2004. *Fabrication d'outils end os. Exemple d'opérations de raclage et d'abrasion*, Dossiers d'Archéologie 290, 56-7.

Comşa, E. 1973. *Parures néolithiques en coquillages marins découvertes ent territoire roumain*, Dacia 17, 61-76.

Dimitrijević, V. and B. Tripković 2002. *New Spondylus findings at Vin~a – Belo Brdo 1998-2001 campaigns and regional approach to problem*, Starinar LII, 47-60.

Gimbutas, M. 1976. *Ornaments and other small finds*, In: *Neolithic Macedonia. As reflected by excavation at Anza, Southeast Yugoslavia.* Ed. M. Gimbutas. Los Angeles, UCLA: 242-56.

Jacanović. D. and D. Šljivar 2001. *Nalazi astragala sa neolitskog lokaliteta Belovode*, Zbornik Narodnog muzeja XVII–1, 31-6.

Legrand, A. and I. Sidéra 2004. *Les outils en matières osseuses. Exemple des sites de Khirokitia (Chypre) et de Drama (Bulgarie)*, Dossiers d'Archéologie 290, 52-5.

Leonardi, P. 1979. U*na serie di ritoccatoi prevalentemente musteriani del Riparo Tagliente in Valpantena presso Verona*, Preistoria Alpina 15, 7-15

Lyman, R.L. 2001. *Vertebrate taphonomy*, Cambridge: Cambridge University Press.

Lyneis, M. 1988. *Antler and bone artifacts from Divostin*, In: A. McPherron and D. Srejović (eds.) *Divostin and the neolithic of central Serbia*, Pittsburg & Kragujevac: University of Pittsburgh and Narodni muzej, 301-19.

Pascual Benito, J. Ll. 1998. *Utillaje óseo, adornos e ídolos neolíticos valencianos.* Valencia: Servicio de Investigación Prehistórica, Serie de Trabajos Varios núm. 95.

Peltier, A. 1986. *Étude expérimentale des surfaces osseuses façonnées et utilisées*, Bulletin de la Société Préhistorique Française 83(1), 5-7.

Perišić, S. 1984. *Predmeti od kosti, roga i kamena iz Odseka za praistoriju Muzeja grada Beograda*, Beograd: Muzej Grada Beograda.

Poplin, F. 1979. *Les chasse–lame néolithique en bois de cerf*, In: H. Camps-Fabrer (ed.) *Industrie de l'os et bois de cervidé durant le néolithique et âge des métaux. Première réunion du groupe de travail no. 3 sur l'industrie de l'os préhistorique*, Paris: CNRS, 87-91.

Provenzano, N. 1998a. *Fiche générale des objets à biseau distal*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique. Cahier VIII: Biseaux et tranchants,* Treignes: CEDARC, 5-16.

Provenzano, N. 1998b. *Objet à biseau distal unifacial sans débitage longitudinal pris sur bois de cervidés*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l'industrie osseuse préhistorique. Cahier VIII: Biseaux et tranchants,* Treignes: CEDARC, 17-23.

Russell, N. 1990. *The bone tools*, In: R. Tringham and D. Krstić (eds.) *Selevac. A neolithic village in Yugoslavia,* Los Angeles: UCLA, 521-48.

Ružić, M. and N. Pavlović 1988. *Slatina, Turska česma – Drenovac*, In: D. Srejović (ed.) *The Neolithic of Serbia. Archaeological research 1948-1988, Faculty of Philosophy* 65, Beograd: University of Belgrade.

Schwab, C. 2003. *Les "os à impressions et à éraiullures" de la grotte Isturitz (Pyrénées-Atlantiques, France)*, In: M. Patou-Mathis, P. Cattelain and D. Ramseyer (eds.) *L'industrie osseuse pré- et protohistorique en Europe. Approches technologiques er fonctionnelles. Actes du colloque 1.6, XIVe Congrès de l'UISPP, Liège, 2–8/09/2001.* Bulletin du Cercle archéologique Hesbaye–Condroz, tome XXVI/2002, Amay, 9-18.

Semenov, S.A. 1976. *Prehistoric technology. An experimental study of the oldest tools and artefacts from traces of manufacture and wear*, Wiltshire: Moonrakes Press.

Sidéra, I. and A. Legrand 2006.*Tracéologie fonctionnelle des matières osseuses: une méthode,* Bulletin de la Société Préhistorique Française 103(2), 291–304.

Smoor, B. 1976. *Bone tools*, In: M. Gimbutas (ed.) *Neolithic Macedonia. As reflected by excavation at Anza, Southeast Yugoslavia*, Los Angeles: UCLA 189-97.

Srejović, D. 1988. (ed.) *The Neolithic of Serbia. Archaeological research 1948-1988*, Beograd: University of Belgrade.

Srejović, D. and B. Jovanović 1959. *Oruđe i oružje od kosti i nakit iz Vinče, Starinar* IX-X, 181-90.

Stordeur, D. 1988. *Outils et armes en os du gisement natoufien de Mallaha (Eynan), Israel*, Paris: Association Paléorient.

Stratouli, G. 1988. *Knochenartefakte aus dem Neolithikum und Chalkolithikum Nordgriechenlands*, Bonn: Habelt.

Vetnić, S. 1974. *Počeci rada na ispitivanju kulture prvih zemljoradnika u srednjem Pomoravlju, Materijali X. Počeci ranih zemljoradničkih kultura u Vojvodini i srpskom Podunavlju*, Beograd: Savez arheoloških društava Jugoslavije, 123-68.

Vranić, S. 1987. *Revizija sačuvanog materijala i predmeti od kosti i roga iz Žarkova*. Godišnjak Muzeja grada Beograda XXXIV, 5-20.

Voruz, J.-L. 1984. *Outillages osseux et dynamisme industriel dans le néolithique jurassien.* Lausanne: Cahiers d'archéologie romande 29.

Willms, C. 1985. *Neolitischer Spondylusschmuck. Hundert Jahre Forschung*, Germania 63(2), 331-43.

Erika Gál

Prehistoric antler- and bone tools from Kaposújlak-Várdomb (South-Western Hungary) with special regard to the Early Bronze Age implements

In this paper, the author presents Late Neolithic (Lengyel culture), Late Copper Age (Pécel-Baden culture), Early Bronze Age (Somogyvár-Vinkovci culture) and Late Bronze Age (Urnfield culture) artefacts made from antler, bone and tusk. The majority of these objects were found at the Early Bronze Age site, the largest fortified settlement established during the period of the Somogyvár-Vinkovci culture (ca. 2500-2300 BC) in Hungary. This assemblage, including 135 artefacts and additional workshop remains, also represents the most abundant collection found at any Early Bronze Age settlement in Hungary.

Parallel to the study of artefacts, the archaeozoological analysis of remains representing refuse bones has been also carried out, offering background information about animal husbandry, and the exploitation of various wild species. The abundance of red deer antler implements, blanks and remains representing workshop debitage evidence on site deposition and manufacture of this valued raw material in the Hungarian Bronze Age. The great number of well-made, multi-stage manufacture awls in addition to the various hafted antler implements suggested a different attitude towards bone manufacturing than that found at other coeval settlements.

The presentation of the much smaller tool assemblages from the Late Neolithic, Late Copper Age and Late Bronze Age features of the site is restricted here to the short description and summary of tools, and the illustration of the most characteristic specimens.

Keywords: antler, bone tool, Early Bronze Age, prehistory, Kaposújlak-Várdomb, South-Western Hungary

Introduction

The site of Kaposújlak-Várdomb (Fig. 1) was excavated in 2002, preceding the constructions of the bypass road Kaposvár 61 in Southern Hungary. A rather large prehistoric site was opened over 29,000 m^2. All the remains were collected by hand. Wet sieving or dry screening was not applied. The excavation surface yielded features from Late Neolithic (Lengyel culture), Late Copper Age (Pécel-Baden culture), Early Bronze Age (Somogyvár-Vinkovci culture) and Late Bronze Age (Urnfield culture) settlements. As far as the Early Bronze Age is concerned, this is the largest fortified settlement erected in the period of the Somogyvár-Vinkovci culture (ca. 2500-2300 BC) in Hungary and almost

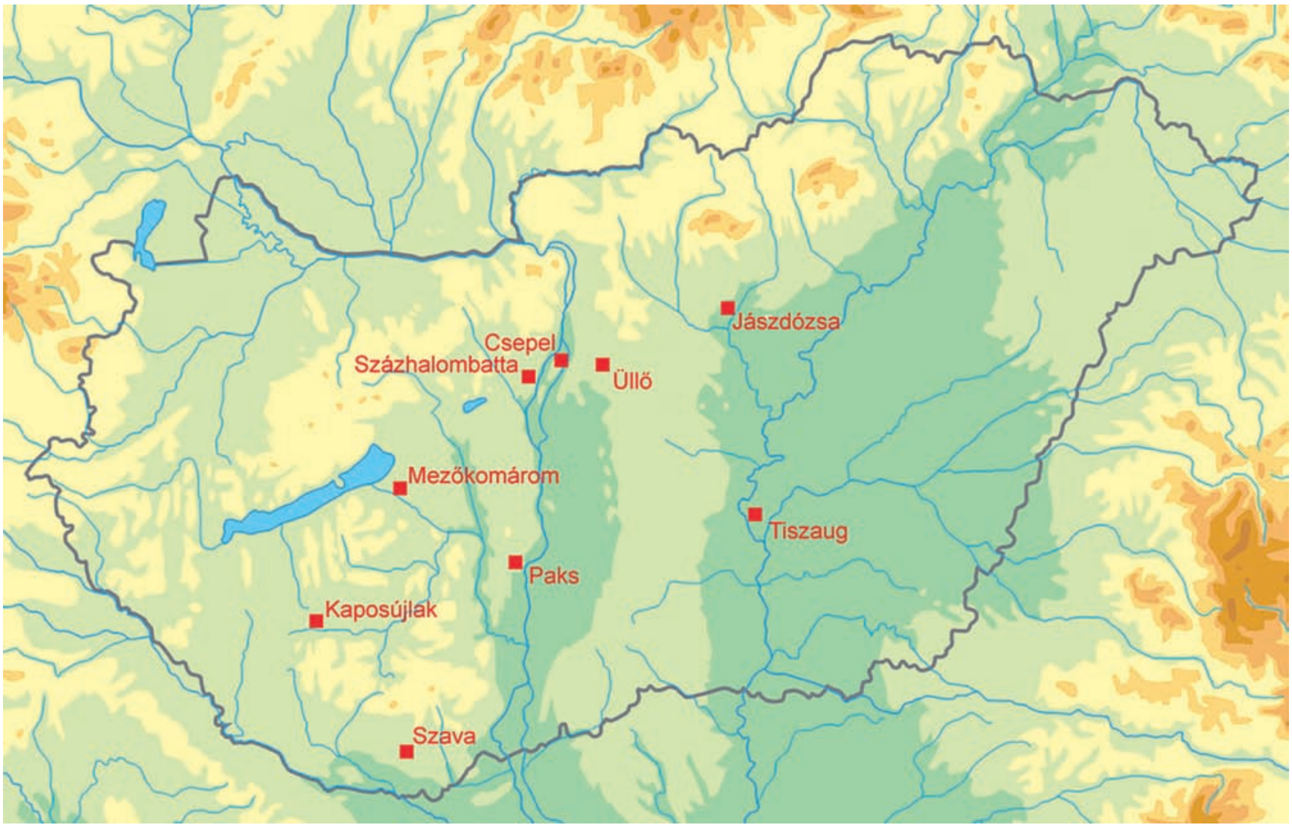


Fig. 1. The location of Kaposújlak-Várdomb and other sites mentioned in the paper

certainly the largest assemblage of worked osseous materials from this period in the Carpathian Basin.

To date, one of the most abundant and richest archaeozoological assemblages in the region has been found at the site of Kaposújlak-Várdomb, in addition to the lately studied assemblage from Paks-Gyapa (Gál, Kulcsár 2011). The other Early Bronze Age sites in western Hungary yielded a few dozens or hundreds of animal bones, except for the Kisapostag culture site of Mezőkomárom-Alsóhegy, from where 1,381 remains were identified (Choyke, Bartosiewicz 1999; Vörös 1979). Data on Early Bronze Age bone implements is even scarcer in consideration of the small tool assemblage from Mezőkomárom-Alsóhegy. A few more artefacts have been described from Százhalombatta-Téglagyár and Százhalombatta-Földvár in Transdanubia (Choyke 1984a, 2000; Choyke *et al.* 2002).

Preliminary results on animal keeping, hunting and bone manufacture at Kaposújlak-Várdomb during the Early Bronze Age have been recently published (Gál 2009). A later summary work includes all the Early Bronze Age remains from this site (Gál, Kulcsár 2011). This paper shall present the most important results concerning antler- and bone manufacturing at the settlement in the light of the ancient environmental conditions, and practices of hunting and animal husbandry.

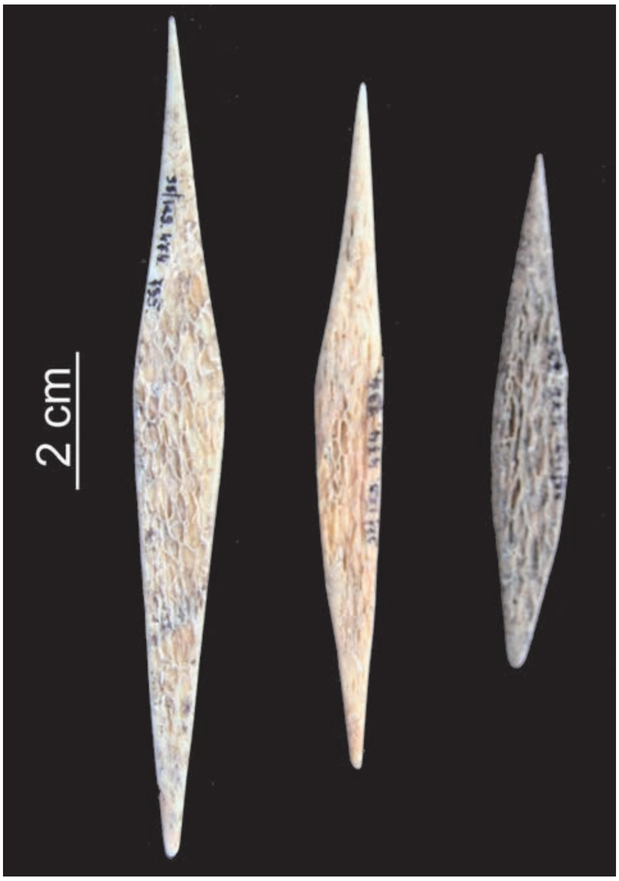


Fig. 2. Lengyel culture tools. Fine rhombus-shaped double points made from split large mammals ribs

Fig. 3. Lengyel culture tools.
Large ulna point, fine pin , chisel and blade

Fig. 4. Pécel-Baden culture tools.
Small points

Fig. 5. Pécel-Baden culture tools. Large and middle-sized points

Material and method

The present paper focuses to the outstandingly rich tool assemblage found in the Early Bronze Age features of Kaposújlak-Várdomb, but in addition to discussing the implements from the Somogyvár-Vinkovci culture, a short description of tools from the other archaeological periods will be also given. Since the archaeozoological study of bone remains from these periods has not been carried out yet, they include only the selectively collected utensils, and thus, shall be considered non-representative assemblages.

The bone and antler implements discussed below are rather various from the point of view of the typology as well as the selection of raw material and degree of manufacture. Since all the presented utensils came from prehistoric features, Jörg Schibler's well known summary work on the abundant tool assemblage from the Late Neolithic site of Twann (Switzerland) has been adopted when classifying them into the different type categories (Schibler 1981). In addition to this most often used work of international standard, Alice Choyke's paper on the classification of manufacturing quality based on the criteria of selection of species and skeletal part, the degree of manufacturing and curation (Choyke 1997) has been also applied when describing the specimens as 'Class I' or 'Class II' (*ad hoc*) implements. The name and code of tools referred are used both in the following text and summarising tables.

Results

Late Neolithic (Lengyel culture) objects

So far nine tools were identified from the features deposited during the Late Neolithic (Table 1). Four of them represent fine double points made from the split ribs of large mammals. These objects of 56.5-27.0 mm were carefully and extremely pointed at both ends. As a result, they developed a more or less rhomboid shape (Fig. 2). They were curated as can be seen by the smaller size and worn end of two specimens.

In addition, the assemblage included small and large points, and chisels. Except for a fragment of metapodial point (Type 1/1 in Schibler 1981) from a young small ruminant, all were carved from the bones of large mammals. Their raw material comprise a large ulna point, a long fine pin without a loop made from a split rib, a fine chisel made from the diaphysis of metacarpus, and a blade carved from a long bone diaphysis (Fig. 3). Seven of the nine tools represent Class I artefacts, while two of them were identified as Class II or *ad hoc* tools.

Fig. 6. Pécel-Baden culture tools.
Hafted rose and beam antler tools

Late Copper Age (Pécel-Baden culture) objects

This assemblage included 35 antler- and bone tools, as well as six antler remains representing workshop debitage. Points of different types and sizes (Fig. 4-5) were the most common implements (23=65.7%). Chisels (8=22.8%) and other types of tools including the hafted antler implements (2=5.7%) were underrepresented in the assemblage. Among the latter, a round haft hole (20.9 mm) on a small fragment of antler adze-like tool was medio-laterally drilled. The antler rose and the base of the cut-off eye tine are rounded and polished (Fig. 6, right). This implement looks much newer than the bigger axe-like tool, which is completely smooth, and was perforated by a quadrilateral haft hole of 38.6 x 15.7 mm (Fig. 6, left).

Skeletal parts from sheep and goat were the most common and included: 12 metapodia, 3 tibiae and a flat bone-fragment (Table 2). Eight artefacts (points and chisels) were made from metapodia, and other long bones and ribs of large ruminants (cattle, aurochs and red deer).

Red deer was also exploited for its antler. Chisels and the aforementioned hafted tools were made from this special raw material. In addition, one point each from a wild boar fibula and a hare tibia respectively were also identified (Fig. 5).

From the point of view of the manufacture continuum (Choyke 1997), 15 artefacts could be assigned to Class I tools, and 20 to Class II or *ad hoc* tools. Five tools, from both groups, showed clear marks of curation.

Early Bronze Age (Somogyvár-Vinkovci culture) objects

Most of the implements found at Kaposújlak-Várdomb came from Early Bronze Age features

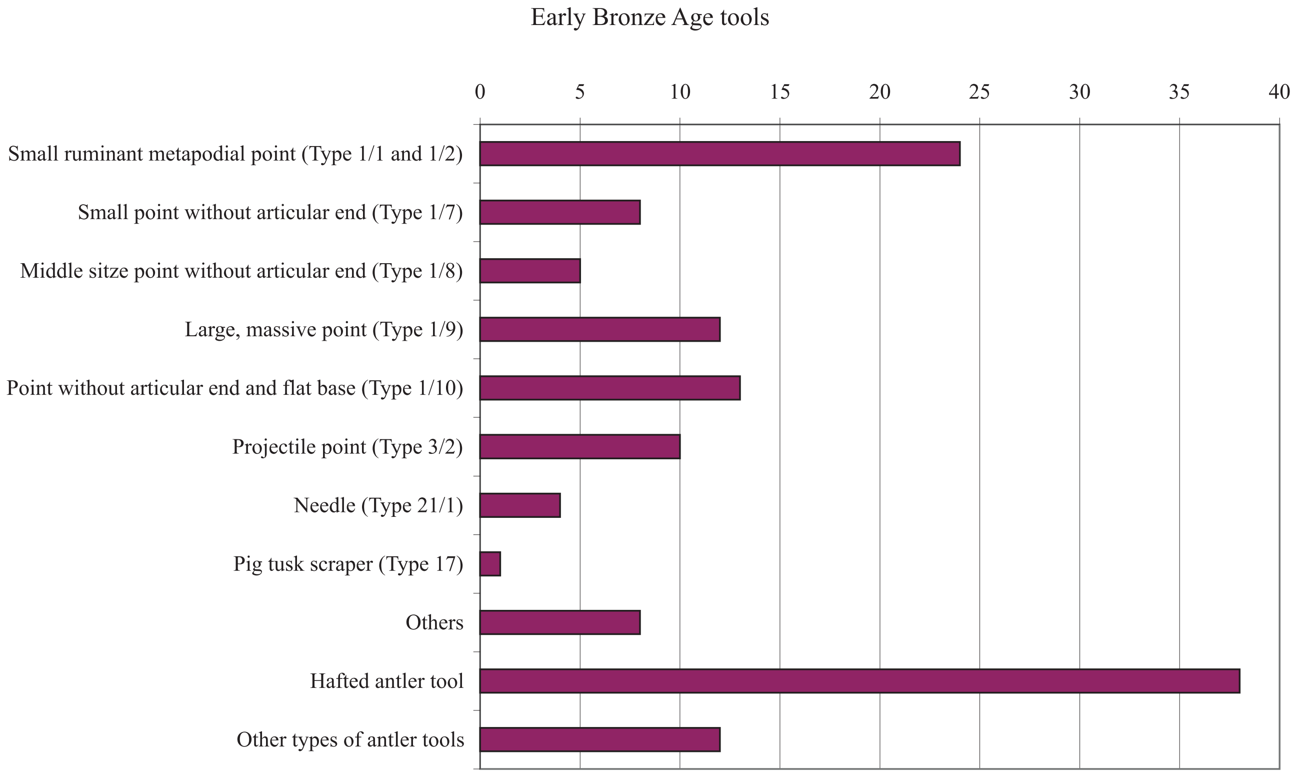


Fig. 7. The distribution of the main type of tools

Fig. 8. Somogyvár-Vinkovci culture tools. Large, middle-sized and small points as well as a massive 'chisel' or bevel-ended tool

Fig. 9.
Somogyvár-Vinkovci culture tool.
Flat polished tool with incisions

Fig. 10.
Somogyvár-Vinkovci culture tools.
Hafted rose and beam antler tools

representing (storage) pits. Altogether 3,374 animal remains have been identified from this period so far, including 135 tools made from bone, antler and wild boar tusk. In addition, seven blanks made from the metatarsus of roe deer (a proximal epiphysis showing the marks of the 'groove and split' technique), cattle (a diaphysis tube) and antler from red deer (hafted burr and beam antler tools) was also found. Fifty-eight antler fragments, many of them showing traces of chopping and cutting, were identified as

Fig. 11.
Somogyvár-Vinkovci culture tools.
Hafted beam antler tools

workshop debitage. In summary, the tools (4.00%) and waste material (1.68%) made up a rather high proportion of the total bone assemblage.

Eighty-four features yielded implements. The contextual association of features within the settlement is yet to be clarified by the archaeologist. Nevertheless, the special concentration of either bone or antler tools could not be noted. Most of the features yielded one or two implements, while the greatest number of artefacts found in the same feature was four. These features (Feature 400 and Feature 1009) contained various types of finds, but no animal bones except for the artefacts were found.

Points of various types and sized dominated the assemblage. There were 74 (54.8%) complete or fragmented specimens in the assemblage (Fig. 7). Small ruminant metapodial points with articular end or flat base (Schibler Types 1/1 and 1/2), were the most common at 24 (3+21) pieces. The greatest length of Type 1/1 varied between 63.6-104.6 mm, while that of Type 1/2 between 34.2-111.4 mm (Table 3).

The next most frequent type of points was the large, massive points without articular end (Schibler Type 1/9) represented by 12 pieces. These were carved from the metapodia and possibly other long bones of large ruminants. Their sizes, including the fragments, varied between 36.3-217.0 mm. Points without articular end with a flat base (Schibler Types 1/10) and projectile points (Schibler Type 3/2) yielded 11 and 10 pieces, respectively. The latter group of implements have been identified based on their shape, curated working end, high polish over the surface and flat base that had been hafted.

In contrast to the great variety and number of points, only five chisels were found at Kaposújlak. Seven scrapers, made from the scapulae of large ruminants, antler beam of red deer, and pig tusk were also identified. The four fine eyed needles were carved from the ribs of large ruminants (three specimens) and metapodium of a small ruminant (one specimen). Their sizes fall between 45.7-88.7 mm. Examples for the majority of the aforementioned tools are shown in Figure 8.

In addition, a 62.2 mm flat spatula-like tool with incisions, whose role is not yet clarified, was identified. It was carved from the long bone of a large ruminant. It was cut to size and highly polished. There are two short incisions in the middle of the object (Fig. 9).

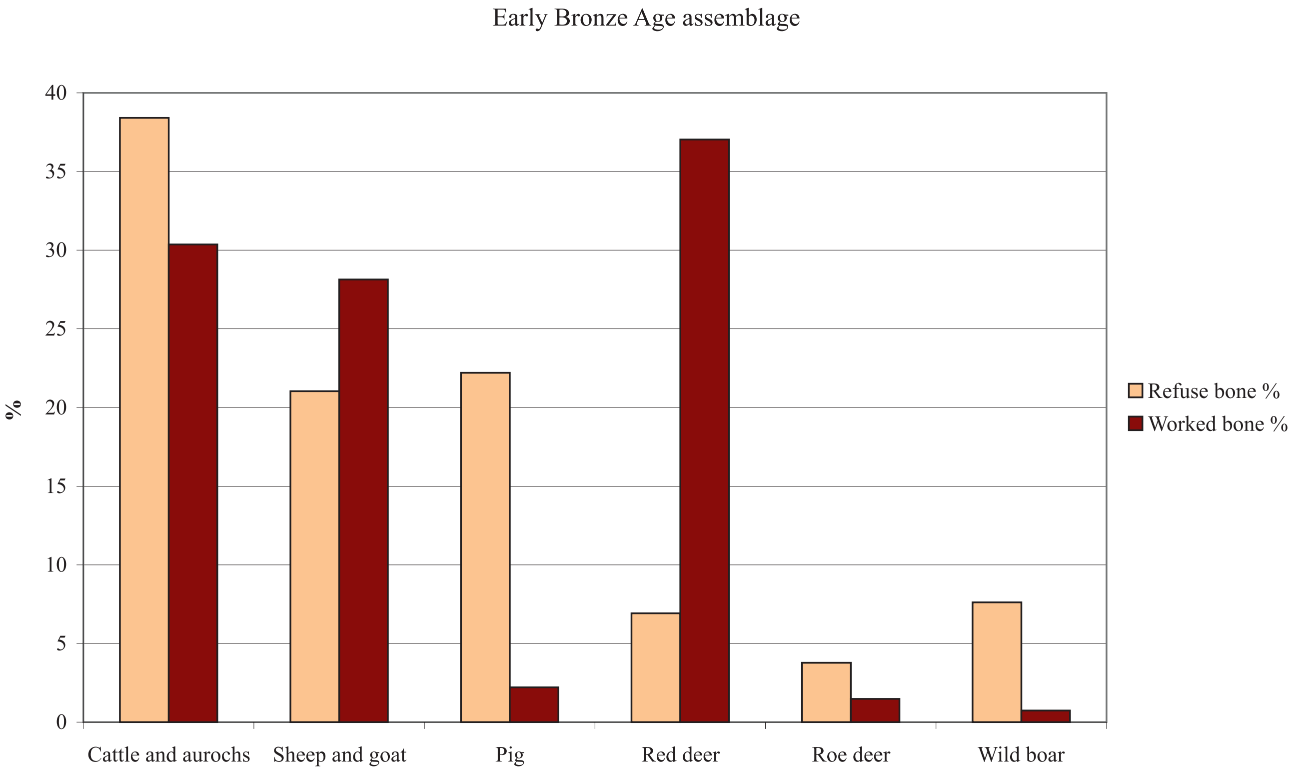


Fig. 12. Contribution of species to the refuse remains and worked bones

Aside from the bone implements, 38 complete and fragmented hafted antler tools were found. These may be grouped into two main categories based on the manufactured antler cross-section. There were 29 implements made from the base of antler, i.e. the burr (or antler rose) and beam compared to objects from other parts of the antler rack. When producing these hafted artefacts, the eye- and bez-tines were cut off from the beam, and their base was polished. The beam was perforated by a round or slightly oval hole whose diameter varies between 18-26 mm (Table 4). The haft hole was made at the level of the eye-tine, and drilled in a medio-lateral direction in most cases creating a tool used like an adze. Only one of theses objects was drilled axe-like, in a cranio-caudal direction, exactly through the axis of the eye-tine (Fig. 10).

The working-end of implements is usually damaged, making it difficult to recognise which one of these tools were used with or without a separate blade. Nevertheless, most of the fragments indicated that the working end was oblique and sat perpendicular to the tool's shaft. Consequently, the tool was most likely used as an adze rather than as an axe, perhaps in working wood or loosening soil. The working end (or blade) of axes tend to be lined up with the shaft. Only one tool showed evidence for the blade hole in this assemblage.

Based on the various sizes of complete (105.6-185.1 mm) and fragmented (72.4-235.0 mm) burr and beam tools, it is likely that most were regularly curated. Many of these implements also broke at the hafting hole although they possibly were used without hafts as well as indicated by the high hand polish on a number of tools. Based on the, more or less, well preserved antler rose, the majority of these antlers were gathered and not cut-off from the skull of a hunted deer. This hypothesis is confirmed by the under-representation of red deer bones both in the tool- and refuse bone assemblages.

The second group of hafted antler tools is represented by implements made from cut-off sections of beam and tine (end). Nine complete (83.7-266.0 mm) and fragmented (95.0-138.0 mm) artefacts could be assigned to this category. Usually the obliquely cut or bevelled end of the antler represented the working surface. Since the working edge of the tool is set in line with the shaft, these objects have been identified here as axe-like implements, in contract to the aforementioned adze-like tools. In this second group as well, there was a specimen where a separate blade was inserted in a socket drilled into the spongy tissue (Fig. 11).

As concerns the selection of species and skeletal parts, red deer yielded raw material for 50 implements, including the 38 aforementioned hafted tools and nine other types of antler tools. Consequently, only three bone tools could be identified as coming from this species although the total of 41 implements made from skeletal elements of large ruminants also

Fig. 13. Urnfield culture tool: polished and drilled cattle radius

may have included tools made from red deer bone. It is likely that mostly cattle bones were used, however, when carving implements from large ruminants, since this was the more common species in the animal bone assemblage. Aurochs yielded only 2% of the remains (Gál 2009:56, Fig. 2; Gál, Kulcsár 2011, Fig. 1). Altogether, 40 objects were made from sheep and goat bones while in the same size-range, two objects were made from roe deer bone. Points manufactured from the small ruminant metapodia and tibiae made up the biggest part of this group. In addition, there were three objects made from pig bone while a single tusk scraper tool was identified as coming from wild boar (Fig. 12).

From the point of view of the manufacture continuum (Choyke 1997), all the hafted antler tools fall into the category of Class I tools, because of the selection of raw material and labour invested in their manufacture. In addition, 52 bone artefacts out of a total of 97 worked osseous specimens also fall into this category. The remaining 45 bone and antler artefacts represent Class II or *ad hoc* tools. A number of utensils from both ends of the manufacturing continuum seem to have been curated (Table 3-4). By this measure, twice as many Class I tools than Class II or *ad hoc* tools were found in the Early Bronze Age assemblage of Kaposújlak-Várdomb which interestingly differs sharply from the majority of post-Neolithic bone tool assemblage examined elsewhere in the Carpathian Basin in general. However, the worked osseous materials from the southern part of Transdanubia are certainly not as well known similar assemblages from other parts of the country (Choyke 2010, pers. comm.).

Late Bronze Age (Urnfield culture) objects

This assemblage yielded 12 implements, the majority of them points and chisels of various sizes and different raw materials (Table 5). The most interesting artefact among them is a polished and perforated radius fragment from cattle. As illustrated on Figure 13, the cranial surface of the bone is highly polished suggesting its use on a flat surface over a long period of time. It was also perforated by a 5 mm wide hole at both ends, but in two different ways. The hole goes through the middle of articular and caudal surface on the proximal epiphysis, while the lower hole goes through the distal end of the diaphysis in medio-lateral direction. It may be also seen on the enlarged picture of the distal end, that a smaller hole, which did not break the bone wall, had been previously planned next to the present one. Since the tool is heavily fragmented in its distal part, it remains a question whether these lower holes were drilled in the diaphysis because the radius came from a subadult cattle, and the distal end of the radius had not yet ossified, or the distal part broke during the lifetime of the object, and the holes were subsequently applied as part of the curation process.

Discussion

Taking into account the small non-representative tool assemblages and the as yet unfulfilled archaeozoological analyses from the Late Neolithic (Lengyel culture), Late Copper Age (Pécel-Baden culture) and Late Bronze Age (Urnfield culture) features from Kaposújlak-Várdomb, attention will be mostly given to the Early Bronze Age (Somogyvár-Vinkovci culture) implements in this paper.

The study of bone manufacture in the Bronze Age of Hungary has been on-going for over 30 years. A rather large number of papers including results from site studies (Choyke 1979, 1983, 1984a, 2000; Choyke, Bartosiewicz 2009) and summarising works have been published (Choyke 1984b; Choyke *et al.* 2002) in the last decades. Concerning the exploitation of red deer, people's preference for antler and the expansion of its use in tool and ornament industries in the Hungarian Bronze Age has also been discussed for a long time (Choyke 1987). Nevertheless, the majority of data included in the listed papers concern the Middle Bronze Age tools since they represented the most common implements in the studied assemblages.

From a geographical point of view, most of the sites studied so far are located far from Kaposújlak-Várdomb (Fig. 1), lying either in the northern part of Transdanubia (Százhalombatta-Földvár and Százhalombatta-Téglagyár) or in other parts of the country (Central Hungary, Danube-Tisza interfluves and Eastern Hungry). Considering the three Early Bronze Age sites from the region, only 36 tools were found at Mezőkomárom-Alsóhegy (Choyke 1984a:39-49, Table 1-6), Paks-Gyapa yielded 25 artefacts (Gál, Kulcsár 2011), while Szava-Vasúti megálló did not yield any implements made from the hard tissue of vertebrate animals (Vörös 1979).

Therefore the well represented archaeozoological assemblage from the Somogyvár-Vinkovci features at Kaposújlak-Várdomb offered interesting new information on animal keeping, hunting as well as bone and antler manufacture, even if some further remains – and possibly tools – may still be expected as the result of the ongoing archaeological evaluation of the material.

The archaeozoological analysis of the remains identified so far offered some unusual results. First, the abundance of pig remains (18.6%), approaching the proportion of Caprinae (19.5), is noteworthy. Sheep and goat are usually the second best represented species at all Bronze Age sites represented by at least 1,000 remains in Western Hungary (Choyke, Bartosiewicz 1999:242, Table 1). The same result was found at a number of Early and Middle Bronze Age sites in the eastern part of the country as well (Choyke, Bartosiewicz 1999-2000; Kőrösi 2005). Pig was the second most common species at Szava-Vasúti megálló, but this assemblage is rather small, yielding only 511 identifiable remains (Vörös 1979).

On the other hand, the efficient exploitation of wild resources at Kaposújlak-Várdomb is evidenced by several data. A rather great variety of wild animals were recognised in the faunal sample suggesting that hunting was often practiced. Their proportion in terms of the identified remains rises to over 20% (Gál 2009:56, Fig. 2), while this ratio tends to be below 10% at other Bronze Age sites in Western Transdanubia (Bartosiewicz 1996; Choyke, Bartosiewicz 1999; Gál, Kulcsár 2011). Bones from wild boar were the most frequently found remains among the wild animal remains. In addition, a great number of antler remains from red deer came to light, indicating the outstanding interest in, perhaps even the need, for this raw material. The number of antler remains (157) contrasts sharply with the number of bone remains (51) from this species, suggesting that systematic antler gathering would have been a much more characteristic activity than red deer hunting. This idea is also evidenced by the number of shed antlers identified.

Differences concerning the contribution of other species to the refuse- and worked bones could be demonstrated as well. As shown on Figure 12, domestic pig and wild boar contributed significantly to the meat supply of people living at Kaposújlak-Várdomb, but neither their bones nor tusks were used often. The absence of tusk ornaments or utensils is striking considering these objects as raw material and symbol in earlier prehistoric periods. In contrast, the skeletal parts of sheep and goat seem to have been highly valued raw materials at this Early Bronze Age settlement, although as many of them seem to have been slaughtered as pig. Nevertheless, pigs were slaughtered young at Kaposújlak-Várdomb, while more sheep and goat were kept until maturity, most probably because of their secondary exploitation for wool or milk (Gál 2009). Finally, cattle and aurochs, mostly raised and hunted until a mature age, contributed in a similar degree to both the refuse and worked osseous material assemblages.

When comparing our results to the other Early Bronze Age tool assemblages, the rather large quantitative disparities, and the use of different types of implements, especially in a regional context, is striking. Both in the richer assemblage from Mezőkomárom-Alsóhegy (36 tools) and in the two poorly represented assemblages from Százhalombatta (6 and 21 tools, respectively) the abundance of various scrapers is noteworthy. This type of tool comprised only 5.38% of our assemblage and included one Class I and six Class II scrapers. Scrapers seem to have been important at Tiszaug-Kéménytető in the Duna-Tisza interfluves as well (Table 6). On the other hand, points were the most frequent type of implements in the tool assemblage (25 pieces) from Paks-Gyapa (Gál, Kulcsár 2011).

Flat butted heavy duty tools made from antler were crafted at all sites, while the oblique butt heavy duty tools and the hafted beam or tine implements were more common only at the Early-Middle Bronze Age (Hatvan culture) site of Jászdózsa-Kápolnahalom. There were altogether 19 specimens (29% of the assemblage), while the same type of tool comprised 27% of the Kaposújlak-Várdomb assemblage. Hafted burr and beam tools, that are often found in prehistoric assemblages in Hungary, have also been described from the Early Bronze Age sites of Paks-Gyapa (Gál, Kulcsár 2011) and Csepel-Háros at Albertfalva near Budapest (Choyke, Schibler 2007:61, Fig. 17).

At Jászdózsa-Kápolnahalom, the proportion of antler tools and workshop debitage even increased during the Middle Bronze Age (Hatvan/Füzesabony culture). It has been suggested, that antler may have been traded as a raw material beyond the settlement limits. Three trophy skulls, probably hanging from the palisade in the protecting ditch surrounding the settlement, evidence the special role of this species in the life of people living at this site. Moreover, the abundance of wild animals (25%) in the assemblage also showed a great similarity to the species distribution at Kaposújlak-Várdomb (Choyke, Bartosiewicz 2009).

Another common type of tool were needles, represented by four and six specimens at Kaposújlak-Várdomb and Jászdózsa-Kápolnahalom, respectively. Ornamental objects were missing from Kaposújlak-Várdomb with only a few ornamented antler tools found at Jászdózsa-Kápolnahalom. With regard to the remainder of the tools, Class I and Class II awls seem to have been produced in unusually high numbers at this South Transdanubian settlement. The proportion of these tools was rather underrepresented in the assemblages from the other sites including Jászdózsa-Kápolnahalom. Taking into account the abundance of hafted antler tools and various scrapers, the Early-Middle Bronze Age Hatvan assemblage from the latter site displayed some intermediary features with Kaposújlak-Várdomb as well as other Early Bronze sites (Table 6).

Finally, the peculiar Late Bronze Age artefact made from cattle radius should also be discussed. A number of similar objects have been already found in various Bronze Age assemblages, and were described as skates or runners (Choyke *et al.* 2002:185-187, Fig. 15; Choyke, Bartosiewicz 2005; Choyke, Schibler 2007). More recent analyses, especially in the light of faceted radius finds from late Middle Bronze Age and early Late Bronze Age contexts in Slovakia and at Hungarian Bronze Age tell sites such as Százhalombatta-Földvár, however, questioned their use in this way (Choyke, pers. comm.).

As for the specimen from Kaposújlak-Várdomb, its use as a skate cannot perhaps be totally excluded. If there was a second hole on the medial side of our object, it may have been fixed at three places, and worn as a skate, since based on the position of the hole drilled in the proximal end, the lace would have not hindered the sliding of the carved bone. Nevertheless, taking into account its bad preservation, further objects perforated and faceted in a similar way are needed for better evaluating the function of this bone tool type.

Conclusions

The rather abundant Early Bronze Age tool assemblage from Kaposújlak-Várdomb offers new information on bone and antler manufacturing in South-Western Hungary. Based on the typological range of tools, small and massive points, projectile points as well as hafted burr and beam, and hafted beam or tine antler tools were the most frequently used implements. In addition to red deer antler, bones from sheep and goat, and cattle were the favoured raw materials for producing utensils. Ornamental objects were not identified. As a preliminary conclusion, it is suggested that the artefacts discussed in the present paper were mostly used in breaking up earth (like hoes) and in wood working (the hafted tools) as well as leather working, basketry and possibly even pottery decoration (the awls). It is the first time that a high proportion of Class I tools, characterized by the strict selection of raw materials, careful manufacture and curation, has been found at a Bronze Age site in Hungary.

The accumulation of antler tools, blanks and workshop debitage at the settlement is worth noting, especially in contrast to the other coeval sites in the region, and suggests in-site deposition and manufacture of the antler. Since the archaeological study of the site is still on-going, it will remain a question for a while whether antler (and bone) manufacture was restricted to a certain part of the settlement or whether trade in such implements may be suggested. It may even be that people of higher social status were more likely to own and use carefully manufactured implements, often made from highly selected species and skeletal elements.

Table 1. List of Late Neolithic (Lengyel culture) tools.
Abbreviations: GL=Greatest length, GB=Greatest breadth, GD=Greatest depth, GSB=Greatest breadth of the edge (at 5 mm above the top in points), LMF=Length of the edge (after Schibler 1981)

Tool Type (Schibler's Typology)	Bone	Class	Top	GL	GB	GD	LMF	GSB	No. and Feature Type		Inventory no.	Note
Small ruminant point (Type 1/1)	Metapodium	1	-	54.0	13.4	6.8	-	-	649	Pit with body (human?)	649.3	From young animal, broken top
Large ulna point (Type 1/5)	Ulna (cattle)	2	7/9	174.8	45.0	74.5	-	5.3	683	Ditch	683.164	Cut-off proximal end, hand polish
Double rib point (Type 2/2)	Rib (large ruminant)	1	-	56.5	11.8	3.4	-	-	565	Pit	565.2	Curated
Double rib point (Type 2/2)	Rib (large ruminant)	1	2/1	82.3	11.8	3.5	2.5	-	474	Clay pit	474.736	Curated
Double rib point (Type 2/2)	Rib (large ruminant)	1	2/1	104.5	10.3	3.8	1.8	-	474	Clay pit	474.734	
Double rib point (Type 2/2)	Rib (large ruminant)	1	2/1	127.0	13.6	3.0	1.6	-	474	Clay pit	474.735	
Chisel form blade (Type 4/2)	Long bone diaphysis	2	34/21	35.7	19.0	6.7	5.8	-	763	Pit	763.1	
Massivel chisel (Type 4/3)	Metacarpus (large ruminant)	1	21/25	69.3	27.4	8.6	8	-	474	Clay pit	474.733	
Needle (Type 21/1)	Rib (large ruminant)	1	2/5	61.4	3.4	2.0	-	1.3	476	Pit	476.217	

Table 2. List of Late Copper Age (Pécel–Baden culture) tools.
Abbreviations: GL=Greatest length, GB=Greatest breadth, GD=Greatest depth, GSB=Greatest breadth of the edge (at 5 mm above the top in points), LMF=Length of the edge (after Schibler 1981)

Tool Type (Schibler's Typology)	Bone	Class	Base	Top	GL	GB	GD	LMF	GSB	No. and Feature Type		Inventory no.	Note
Small ruminant point (Type 1/1)	Metapodium	1	11	3/1	46.1	7.6	5.0	-	4.2	334	Pit-complex	334.116	Fragment
Small ruminant point (Type 1/1)	Metapodium	1	0	-	46.8	7.3	4.5	-	-	1127	Pit	1127.1	Fragment, polished and burnt
Small ruminant point (Type 1/1)	Metapodium	1	11	6/7	48.6	8.7	4.2	-	5.0	88	Pit fall	88.1	Fragment
Small ruminant point (Type 1/1)	Metapodium	1	2	2/5	62.1	14.7	11.5	-	2.5	614	Clay pit	614.5	Curated
Small ruminant point (Type 1/1)	Metapodium	1	1	8/11	89.2	14.8	8.2	-	3.3	279	Pit	279.370	
Round diaphysis point (Type 1/3)	Tibia (small ruminant)	2	1	2/1	90.0	17.8	21.9	-	3.4	1195	Pit	1195.4	Curated
Small point with articular end (Type 1/4)	Fibula (wild boar)	2	2	3/1	79.2	16.4	7.9	-	2.7	680	Pit of owen	680.1	Curated
Small point with articular end (Type 1/4)	Tibia (hare)	2	1	2/1	116.8	21.0	22.5	-	1.8	340	Pit with a body	340.1	
Large, massive point with articular end (Type 1/6)	Metatarsus (red deer)	1	1	10/1	158.0	25.3	15.4	-	3.5	1177	Pit-complex	1177.2	The proximal end is drilled through by a hole of 2.5x1.5 mm
Small point without articular end (Type 1/7)	Metacarpus (roe deer)	1	13	8/3	64.0	14.8	11.7	-	3.8	614	clay pit	614.4	Fragment
Small point without articular end (Type 1/7)	Metacarpus (roe deer)	1	0	2/1	70.1	12.7	5.5	-	2.9	334	Pit-complex	334.185	

Middle size point without articular end (Type 1/8)	Long bone diaphysis (large ruminant)	2	0	3/10	72.0	9.1	7.5	-	2.9	1053	Pit	1053.34	Recently broken fragment.
Middle size point without articular end (Type 1/8)	Metacarpus (small ruminant)	2	13	8/5	76.5	11.4	6.2	-	3.7	563	Pit	563.1	Curated
Middle size point without articular end (Type 1/8)	Metapodium (small ruminant)	2	0	2/1	79.4	6.6	3.8	-	1.7	568	Pit	568.1	Curated
Large, massive point without articular end (Type 1/9)	Metapodium (large ruminant)	2	0	9/5	56.0	22.8	9.5	-	8.6	518	Pit	518.1	Fragment
Large, massive point without articular end (Type 1/9)	Long bone diaphysis (large ruminant)	1	13	-	93.8	9.5	6.9	-		1313	Pit-complex	1313.1	Fragment
Large, massive point without articular end (Type 1/9)	Long bone diaphysis (red deer)	2	0	5/11	98.2	27.7	18.3	-	9.4	633	Pit	633.5	Fragment
Large, massive point without articular end (Type 1/9)	Metapodium (red deer)	2	0	-	64.0	23.4	10.4	-		99	Pit	99.21	Fragment
Point without articular end and flat base (Type 1/10)	Tibia (small ruminant)	2	12	2/1	105.1	16.2	5.8	-	3.1	292	Pit-complex	292.99	
Double point from long bone (Type 2/1)	Long bone diaphysis (large ruminant)	1	-	-	53.9	13.0	7.3	-	7.9	864	Pit-complex	864.2	
Double point from long bone (Type 2/1)	Long bone diaphysis (large ruminant)	1	-	5/1	115.5	8.3	7.6	-	3.6	36	Pit	36.1	Completely polished
Double point from long bone (Type 2/1)	Metacarpus (roe deer)	1		8/7	79.0	8.0	3.7	-	3.4	735	Pit	735.1	Flat double point

Small ruminant projectile point (Type 3/2)	Tibia (small ruminant)	2	0	2/2	53.2	10.0	2.8		2.4	211	Pit	211.1	Fragment
Chisel-fragment (Type 4/4)	Antler (red deer)	2	-	-	41.4	12.2	13.4	9.5	-	279	Pit	279.369	Fragment
Chisel-fragment (Type 4/4)	Antler (red deer)	2	-	-	75.0	32.0	16.6	36.6	-	61	Pit fall	61.2	
Chisel-fragment (Type 4/4)	Antler (red deer)	2	-	-	163.4	25.0	32.5	43.3	-	249	Pit	249.80	
Chisel-fragment (Type 4/4)	Antler (red deer)	2	-	-	194.0	28.5	39.2	24.7	-	279	Pit	279.582	
Small *ad hoc* chisel (Type 4/8)	Metatarsus (small ruminant)	2	6		65.5	13.3	8.9	15.1	11.6	92	Pit		
Rib chisel (Type 4/10)	Rib (large ruminant)	2	0	29/23	74.6	24.0	6.6	8.1	-	50	Pit	50.67	
Rib chisel (Type 4/10)	Rib (large ruminant)	2	0		97.9	23.6	9.8	3.2	-	1060	Pit	1060.101	
Rib chisel (Type 4/10)	Rib (large ruminant)	2	0	29/23	110.8	33.6	9.8	3.6	-	279	Pit	279.581	Fragment
Polished tool (Type 19)	Flat bone (small ruminant)	2	-	-	31.5	17.3	2.7	2.7	-	242	Pit	242.5	Fragment
Polished tool (Type 19)	Rib (aurochs)	2	-	-	143.8	39.0	8.4	-	-	1217	Pit fall	1217.1	Fragment
Hafted antler rose and beam axe-like tool	Antler (red deer)	1	-	-	116.7	68.2	36.2	-	-	352	Pit	352.29	Medio-laterally drilled through by a round hole of 20.9 mm
Hafted antler rose and beam axe-like tool	Antler (red deer)	1	-	-	180.0	48.0	41.7	70.5	-	76	Pit	76.57	Drilled through with a quadri-lateral hole (38.6 x 15.7 mm)

Table 3. List of Early Bronze Age (Somogyvár–Vinkovci culture) tools.
Abbreviations: GL=Greatest length, GB=Greatest breadth, GD=Greatest depth, GSB=Greatest breadth of the edge (at 5 mm above the top in points), LMF=Length of the edge (after Schibler 1981)

Tool Type (Schibler's Typology)	Bone	Class	Base	Top	GL	GB	GD	LMF	GSB	No. and Feature Type		Inventory no.	Note
Small ruminant point (Type 1/1)	Metapodium	1	1	2/1	63.6	11.2	6.6	-	1.9	910	Pit	910.1	Curated
Small ruminant point (Type 1/1)	Metapodium	1	1	12/4	80.0	9.1	5.5	-	2.1	262	Pit	262.355	
Small ruminant point (Type 1/1)	Metacarpus	1	1	2/1	104.6	14.7	12.6	-	-	14	Storage pit	14.2	Hand polished
Small ruminant point with flat base (Type 1/2)	Metapodium	1	4	-	34.2	8.0	3.9	-	-	41	Pit		Fragment. Hand polished
Small ruminant point with flat base (Type 1/2)	Metatarsus	1	4	-	54.2	9.3	5.3	-	-	389	Pit		Fragment. Hand polished
Small ruminant point with flat base (Type 1/2)	Metapodium	1	0	2/1	54.2	5.3	3.5	-	1.8	1014	Pit	1014.4	Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	0	7/1	55.1	5.0	4.0	-	2.2	751	Storage pit	751.2	Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	12	-	55.4	8.2	4.9	-	-	1009	Pit	1009.41	Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	12	-	61.5	9.0	5.3	-	-	205	Pit		Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	2	-	64.3	10.1	6	-	2.5	113	Pit	113.6	
Small ruminant point with flat base (Type 1/2)	Metapodium	1	2	-	70.4	9.7	3.7	-	-	1144	Storage pit		Fragment
Small ruminant point with flat base (Type 1/2)	Metacarpus	1	1	7/9	71.2	10.8	5.9	-	3.2	567	Pit	567.64	
Small ruminant point with flat base (Type 1/2)	Metapodium	1	2	3/1	74.2	13.6	6.6	-	3.0	1030	Pit	1030.1	Curated
Small ruminant point with flat base (Type 1/2)	Metapodium	1	2	21/1	75.0	12.3	6.3	-	2.2	994	Pit	994.1	Curated

Small ruminant point with flat base (Type 1/2)	Metapodium	1	0	2/1	75.4	5.4	5.0	-	1.6	1009	Pit	1009.1	Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	0	2/1	78.0	7.5	4.1	-	-	732	Storage pit	732.101	Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	2	2/8	79.6	11.3	7.1	-	-	968	Pit	968.39	
Small ruminant point with flat base (Type 1/2)	Metapodium	1	12	2/1	81.3	5.6	3.7	-	2.1	785	Pit	785.1	
Small ruminant point with flat base (Type 1/2)	Metapodium	1	0	12/1	89.3	9.2	5.9	-	2.0	218	Pit		Hand polished
Small ruminant point with flat base (Type 1/2)	Metatarsus	1	12	2/1	92.2	7.0	6.4	-	1.8	399	Pit	399.38	
Small ruminant point with flat base (Type 1/2)	Metapodium	1	11	29/10	92.9	7.5	6.8	-	5.1	191	Pit		Fragment
Small ruminant point with flat base (Type 1/2)	Metapodium	1	12	-	96.1	5.9	4.2	-		1263	Storage pit	1263.1	Fragment. Hand polished
Small ruminant point with flat base (Type 1/2)	Metapodium	1	1	2/1	97.8	10.8	4.7	-	1.7	1154	Storage pit	1154.1	Curated
Small ruminant point with flat base (Type 1/2)	Metapodium	1	12	2/1	111.4	5.4	6.7	-	1.8	371	Pit	371.116	Fragment
Round diaphysis point (Type 1/3)	Tibia (small ruminant)	2	2	5/7	77.4	13.8	8.6	-		1258	Storage pit		Fragment. Hand polished
Round diaphysis point (Type 1/3)	Metacarpus (sheep)	1	1	2/8	87.8	24.5	16.5	-	4.3	298	Pit	298.50	Curated
Small point with articular end (Type 1/4)	Metapodium (roe deer)	1	2	-	50.4	10.3	4.9	-	-	213	Pit		Fragment. Hand polished
Large, massive point with articular end (Type 1/6)	Metapodium (red deer)	1	1	-	54.8	28.1	18.6	-	-	1009	Pit	1009.142	Fragment
Small point without articular end (Type 1/7)	Long bone diaphysis (large ruminant)	1	0	2/1	44.7	7.2	6.9	-	2.2	676	Pit	676.1	Fragment

Small point without articular end (Type 1/7)	Tibia (small ruminant)	1	11	7/10	50.8	9.0	4.3	-	2.8	191	Pit		Fragment
Small point without articular end (Type 1/7)	Metapodium (small ruminant)	1	13	2/1	51.9	3.5	2.5	-	2.1	1318	Storage pit	1318.4	Fragment
Small point without articular end (Type 1/7)	Metapodium (small ruminant)	1	11	2/1	58.2	3.3	2.0	-	1.5	857	Pit	857.1	Fragment
Small point without articular end (Type 1/7)	Tibia (small ruminant)	2	11	10/10	60.7	9.0	4.1	-	2.1	1017	Storage pit	1017.4	Fragment. Curated
Small point without articular end (Type 1/7)	Tibia (small ruminant)	2	0	7/1	69.3	12.7	4.1	-	1.7	738	Pit	738.1	Fragment. Curated
Small point without articular end (Type 1/7)	Long bone diaphysis (small ruminant)	2	11	10/10	77.7	9.2	4.0	-	1.5	973	Pit	973.1	Fragment
Small point without articular end (Type 1/7)	Tibia (small ruminant)	2	0	7/1	85.4	11.9	4.2	-	2.3	1283	Storage pit	1283.1	Fragment. Curated
Middle sized point without articular end (Type 1/8)	Metapodium (small ruminant)	2	0	24/9	56.8	8.7	3.5	-		47	Pit		Fragment
Middle sized point without articular end (Type 1/8)	Tibia (large ruminant)	2	0	2/1	71.6	15.0	3.5	-	2.8	252	Pit		Fragment
Middle sized point without articular end (Type 1/8)	Long bone diaphysis (large ruminant)	2	0	3/9	83.7	16.8	7.9	-	3.6	31	Pit	31.28	
Middle sized point without articular end (Type 1/8)	Fibula (pig)	2	0	3/2	104.9	5.5	15.1	-	3.4	298	Pit		Fragment. Curated
Middle sized point without articular end (Type 1/8)	Metapodium (large ruminant)	2	11	2/1	106.3	8.7	4.8	-	2.2	889	Storage pit	889.2	Fragment. Curated
Large, massive point (Type 1/9)	Metatarsus (large ruminant)	2		-	36.3	15.0	7.2	-	-	126	Storage pit		Fragment

Large, massive point (Type 1/9)	Long bone diaphysis (large ruminant)	2	2	-	53.5	8.1	6.0	-	-	1144	Storage pit		Fragment
Large, massive point (Type 1/9)	Metapodium (large ruminant)	1	12	-	54.7	14.1	5.8	-	-	958	Pit	958.43	Fragment
Large, massive point (Type 1/9)	Long bone diaphysis (large ruminant)	1	12	-	73.7	14.0	5.6	-	-	3	Pit		Fragment
Large, massive point (Type 1/9)	Metapodium (large ruminant)	2	0	2/1	106.3	8.7	4.9	-	2.5	389	Pit	389.2	
Large, massive point (Type 1/9)	Metapodium (large ruminant)	2	12	10/9	108.9	13.8	9.7	-	3.7	877	Storage pit	877.2	Curated
Large, massive point (Type 1/9)	Metapodium (large ruminant)	2	0	12/3	110.9	18.9	7.6	-	3.2	717	Storage pit	717.3	
Large, massive point (Type 1/9)	Metapodium (large ruminant)	1	4	2/1	130.9	7.1	4.8	-	1.6	268	Pit	268.77	
Large, massive point (Type 1/9)	Metapodium (red deer)	1	2	2/1	134.5	8.4	5.6	-	1.7	188	Pit	188.222	
Large, massive point (Type 1/9)	Metapodium (large ruminant)	1	2	2/1	143.3	18.5	15.6	-	2.5	1121	Pit	1121.1	Hand polished. Curated
Large, massive point (Type 1/9)	Long bone diaphysis (large ruminant)	1	2	2/1	185.0	10.7	10.3	-		263	Pit		
Large, massive point (Type 1/9)	Metapodium (large ruminant)	1	12	2/1	217.0	16.5	13.5	-	2.1	736	Pit	736.3	
Point without articular end and flat base (Type 1/10)	Metatarsus (large ruminant)	1	-	-	45.8	11.2	6.7	-		126	Storage pit		Fragment. Hand polished
Point without articular end and flat base (Type 1/10)	Tibia (small ruminant)	2	12	3/3	50.1	12.7	6.0	-	4.0	188	Pit	188.221	Curated
Point without articular end and flat base (Type 1/10)	Long bone diaphysis (large ruminant)	1	12	3/1	76.6	7.2	5.8	-	2.6	1115	Storage pit	1115.2	Hand polished

Point without articular end and flat base (Type 1/10)	Metapodium (large ruminant)	1	2	-	78.3	19.9	11.2	-		400	Ditch	400.517	Fragment
Point without articular end and flat base (Type 1/10)	Metapodium (large ruminant)	2	11	7/7	92.0	18.1	12.7	-	6.0	736	Pit	736.4	Curated
Point without articular end and flat base (Type 1/10)	Metapodium (large ruminant)	1	12	2/1	96.8	6.4	5.1	-	2.0	831	Pit	831.5	Hand polished. Curated
Point without articular end and flat base (Type 1/10)	Long bone diaphysis (large ruminant)	2	12	5/9	98.5	11.5	4.4	-	3.2	1017	Storage pit	1017.3	Curated
Point without articular end and flat base (Type 1/10)	Tibia (pig)	2	12	10/1	104.2	11.1	10.2	-	2.1	831	Pit	831.4	Curated
Point without articular end and flat base (Type 1/10)	Long bone diaphysis (large ruminant)	1	12	2/1	115.0	7.0	5.9	-	2.2	567	Pit	567.63	
Point without articular end and flat base (Type 1/10)	Metatarsus (large ruminant)	1	12	12/1	160.0	6.5	7.0	-	2.3	708	Storage pit	708.1	
Point without articular end and flat base (Type 1/10)	Metapodium (large ruminant)	1	2	2/1	178.0	8.6	6.0	-	2.2	239	Pit	239.357	
Projectile point (Type 3/2)	Tibia (small ruminant)	2	12	7/4	36.1	7.9	3.2	-	4.0	912	Pit		Curated
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	0	3/1	48.8	12.3	6.4	-	3.4	1258	Storage pit	1258.3	
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	12	7/9	49.2	12.1	5.2	-	5.3	1188	Pit	1188.1	Curated
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	0	3/1	54.5	12.2	3.9	-	3.7	239	Pit	239.358	

Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	12	3/8	56.3	11.7	6.2	-	3.9	262	Pit	262.356	Curated
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	0	12/9	61.2	13.0	7.1	-	5.0	400	Ditch	400.515	
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	1	12	3/4	63.5	14.7	8.6	-	4.7	718	Pit	718.1	Curated
Projectile point (Type 3/2)	Long bone diaphysis (large ruminant)	2	12	7/4	65.0	12.8	5.2	-	4.8	1030	Pit		Curated
Projectile point (Type 3/2)	Metatarsus (large ruminant)	2	0	7/1	67.7	10.2	6.7	-	3.4	1031	Storage pit	1031.1	Curated
Projectile point (Type 3/2)	Metatarsus (large ruminant)	2	0	8/9	99.5	27.2	13.6	-	8.1	1153	Pit	1153.1	
Massive chisel (Type 4/3)	Antler (red deer)	2	-	-	95.1	33.5	11.3	10.0	-	346	Pit		Fragment
Massive chisel (Type 4/3)	Antler (red deer)	2	-	-	136.7	28.6	16.5	12.0	-	400	Ditch		Fragment
Massive chisel (Type 4/3)	Antler (red deer)	2	-	-	164.0	43.2	35.5	61.5	-	373	Pit		
Small chisel (Type 4/5)	Metapodium (small ruminant)	1	4	22	37.0	11.8	5.8	26.4	10.8	272	Pit		Curated
Massive keel-form chisel (Type 4/6)	Metapodium (large ruminant)	2	1	33/24	102.5	31.4	15.7	8.5	-	590	Pit	590.334	Hand polished. Curated
Curved scraper (Type 4/11)	Antler beam (red deer)	2	-	-	57.6	46.3	10.0	-	-	1005	Storage pit	1005.242	
Curved scraper (Type 4/11)	Scapula (large ruminant)	2	-	-	61.3	45.3	12.5	-	-	945	Pit	945.33	Hand polished
Curved scraper (Type 4/11)	Antler beam (red deer)	2	-	-	82.4	42.3	9.6	-	-	676	Pit	676.79	Hand polished
Curved scraper (Type 4/11)	Scapula (large ruminant)	2	-	-	96.8	34.4	14.4	9.6	35.1	287	Pit		

Curved scraper (Type 4/11)	Antler beam (red deer)	2	-	-	119.2	-	-	-	-	934	Pit	934.1	Hand polished
Curved scraper (Type 4/11)	Scapula (large ruminant)	2	-	-	125.9	66.3	48.4	-	-	268	Pit		
Pig tusk scraper tool (Type 17)	Lower canine (wild boar)	1	-	-	-	-	-	-	-	252	Pit		Fragment
Polished tool (Type 19)	Scapula (pig)	2	-	-	73.2	42.9	16.3	-	-	234	Ditch		
Polished tool (Type 19)	Antler (red deer)	2	-	-	79.0	28.8	11.3	-	-	144	Pit		
Polished tool (Type 19)	Mandible (red deer)	2	-	-	135.1	60.0	28.3	-	-	294	Pit		Hand polished
Polished tool (Type 19)	Antler (red deer)	2	-	-	-	-	-	-	-	1144	Storage pit		
Polished tool (Type 19)	Antler (red deer)	2	-	-	200	28.2	26.5	-	-	268	Pit		
Polished tool (Type 19)	Antler (roe deer)	2	-	-	-	-	-	-	-	176	Pit		Hand polished
Needle (Type 21/1)	Rib (large ruminant)	1	-	-	45.7	3.0	1.3	-	-	126	Storage pit		Fragment. drilled through, hole 1.2 mm
Needle (Type 21/1)	Metapodium (small ruminant)	1	12	12/12	78.9	3.7	1.7	-	1.7	785	Pit	785.2	Curated
Needle (Type 21/1)	Rib (large ruminant)	1		-	87.6	4.6	1.4	-	-	396	Pit	396.1	Drilled through, hole 1.3 mm
Needle (Type 21/1)	Rib (large ruminant)	1	12	-	88.7	4.2	2.2	-	-	612	Pit	612.217	Drilled through, hole 2.0 mm
Bone with manufacturing and use wear (Type 22)	Long bone diaphysis (large ruminant)	2	0	-	62.2	13.0	4.9	-	-	717	Storage pit	717.2	

Table 4. List of Early Bronze Age (Somogyvár–Vinkovci culture) hafted antler tools.
Abbreviations: GL=Greatest length, GB=Greatest breadth, GD=Greatest depth.

Tool Type	GL	GB	GD	No. and Feature Type		Inventory no.	Note
Hafted burr and beam antler tool	105.6	-	-	272	Pit	-	Hole 23.0 x 26.6 mm in medio-lateral direction. Rounded and polished base. Polished top
Hafted burr and beam antler tool	115.5	-	-	163	Pit	-	Hole 22.3 mm diameter in medio-lateral direction. Rounded and polished antler rose and bases of eye- and bez-tines. Polished top
Hafted burr and beam antler tool	122.2	50.5	68.0	400	Ditch	-	Hole 21.0 mm diameter in medio-lateral direction. Rounded and polished antler rose and base of eye-tine. Polised top
Hafted burr and beam antler tool	122.2	54.3	33.3	1115	Storage pit	1115.140	Hole 16.2 x 17.9 mm diameter in medio-lateral direction. Slightly rounded and polished antler rose and base of eye-tine. Polised oblique top
Hafted burr and beam antler tool	128.2	-	-	790	Storage pit	790.203	Hole 21.0 x 19.5 mm in medio-lateral direction. Highly polished on the whole surface. Used without blade
Hafted burr and beam antler tool	140.5	59.6	46.9	293	Pit	293.8	Hole 24.1 x 22.9 mm in medio-lateral direction. Rounded base. Hand polish over all. Polished around the hole for blade. Cut-off antler
Hafted burr and beam antler tool	147.5	65.2	47.4	239	Pit	239.7	Hole 23.0 mm diameter in medio-lateral direction. Rounded and polished base. The base of eye-tine is also very polished
Hafted burr and beam antler tool	163.0	78.2	52.9	294	Pit	-	Hole 24.0 x 18.5 mm in medio-lateral direction. Well preserved rose. Barely polished or used
Hafted burr and beam antler tool	185.1	78.3	-	1121	Pit	1121.2	Hole of 23.0 mm in medio-lateral direction. Well preserved antler rose. barely polished or used
Hafted burr and beam antler tool-fragment	72.4	-	-	371	Storage pit	-	Broken and burnt
Hafted burr and beam antler tool-fragment	83.5	-	-	113	Pit	-	Most probably uesed without haft as well. High hand polished
Hafted burr and beam antler tool-fragment	86.8	-	-	113	Pit	-	Hole 25.1 mm diameter drilled through the eye-tine. Polished but fragmented top

Hafted burr and beam antler tool-fragment	93.1	72.0	56.0	567	Pit	567.65	Hole 25.5 mm in medio-lateral direction. Polished antler rose and base of cut-off eye-tine
Hafted burr and beam antler tool-fragment	100.4	-	-	609	Storage pit	609.131	Hole 20.3 mm diameter in medio-lateral direction. Rounded and polished antler rose
Hafted burr and beam antler tool-fragment	105.2	-	-	917	Pit	-	Only the obliquely polished top is preserved
Hafted burr and beam antler tool-fragment	105.6	70.0	49.4	1030	Pit	1030.2	Hole 24.0 mm diameter in medio-lateral direction. rounded and polished antler rose and base of eye-tine. Oblique top
Hafted burr and beam antler tool-fragment	107.5	-	-	853	Storage pit	853.197	Drilled through in medio-lateral direction. cut off eye- and bez-tines. Their base is polished. The top is broken and polished
Hafted burr and beam antler tool-fragment	109.1	62.8	48.4	1009	Pit	1009.2	Hole 22.1 x 19.0 mm in medio-lateral direction. The antler rose is not polished unlike the base of eye-tine and the oblique top
Hafted burr and beam antler tool-fragment	120.4	29.2	10.7	106	Pit	-	Broken top
Hafted burr and beam antler tool-fragment	122.0	56.0	39.0	1318	Pit	1318.1	Broken and very much used
Hafted burr and beam antler tool-fragment	126.1	100.7	25.0	152	Pit	-	
Hafted burr and beam antler tool-fragment	129.0	-	-	359	Pit	359.2	Hole 23.8 mmn diameter in medio-lateral direction. Fragmented top
Hafted burr and beam antler tool-fragment	129.7	85.4	68.0	389	Pit	-	Broken hole in medio-lateral direction. Polished base of cut-off eye-tine
Hafted burr and beam antler tool-fragment	130.0	71.0	43.8	383	Pit	-	Hole 23.1 mm diameter. Rounded and polished antler rose
Hafted burr and beam antler tool-fragment	131.5	64.3	47.0	368	Pit	368.86	Hole 21.0 mm diameter in medio-lateral direction. Rounded and polished antler rose and eye-tine base. hand-polish over all. Polish on the top

Hafted burr and beam antler tool-fragment	138.6	62.5	53.1	1349	Pit	1349.1	Hole 26.0 mm diameter in medio-lateral direction. Rounded and polished rose and eye-tine base. Slightly polished on the top
Hafted burr and beam antler tool-fragment	139.0	-	-	359	Pit	359.1	Hole 20.4 mm diameter in cranio-caudal direction through the beztine. Badly preserved. Fragmented top
Hafted burr and beam antler tool-fragment	150.7	-	-	14	Storage pit	14.86	Hole 21.0 mm in medio-lateral direction. rounded and polished antler rose and base of eye- and bez-tine. Polished top
Hafted burr and beam antler tool-fragment	235.0	92.0	70.8	191	Pit	-	Very much used
Hafted beam or tine antler tool	83.7	25.5	21.3	268	Pit	-	Cut off tine end. Hole drilled 12.2 mm. Polished and sharped edge
Hafted beam or tine antler tool	93.3	50.0	39.3	790	Storage pit	790.202	Hole 18.7 x 17.6 mm in cranio-caudal direction. Flat base. Sharped top. Used without blade
Hafted beam or tine antler tool	266.0			676	Pit	676.78	Hole 24.3 x 28.0 mm in cranio-caudal view. Obliquely polished edge 138.2 mm
Hafted beam or tine antler tool-fragment	95.0	34.5	31.6	1087	Pit	1087.2	Hole 14.4 x 15.1 mm for the haft. Hole for the blade drilled into the spongiosa on both ends. Slightly polished around both ends. Possibly curated
Hafted beam or tine antler tool-fragment	97.9	30.0	28.2	1008	Storage pit	1008.1	Broken at the hole. Well preserved, obliquely polished edge 62.8 mm
Hafted beam or tine antler tool-fragment	124.0	-	-	790	Storage pit	790.201	Poorly preserved
Hafted beam or tine antler tool-fragment	127.7	85.7	39.2	1115	Storage pit	1115.1	Hole 22.5 x 23.4 mm in medio-lateral direction. Broken polished top. Used without blade
Hafted beam or tine antler tool-fragment	131.3	-	-	948	Pit	948.104	Broken at the hole. Obliquely polished top. Used without blade
Hafted beam or tine antler tool-fragment	138.0	49.3	23.0	1258	Storage pit	1258.1	Hole 14.5 mm. The base is broken. The oblique top is polished

Table 5. List of Late Bronze Age (Urnfield culture) tools.
Abbreviations: GL=Greatest length, GB=Greatest breadth, GD=Greatest depth, GSB=Greatest breadth of the edge (at 5 mm above the top in points), LMF=Length of the edge (after Schibler 1981)

Tool Type (Schibler's Typology)	Bone	Class	Base	Top	GL	GB	GD	LMF	GSB	No. and Feature Type		Inventory no.	Note
Small ruminant point (Type 1/1)	Metapodium	1	0	3/1	34.5	8.3	4.4	-	3.5	691	clay pit	691.6	Fragment
Middle-sized point without articular end (Type 1/8)	Metapodium (large mammal)	2	1	12	74.4	10.5	6.9	-	-	719	pit	719.3	Fragment
Large, massive point without articular end (Type 1/9)	Metatarsus (red deer)	1	2	2/1	143.0	15.5	10.9	-	2.8	720	pit	720.159	
Point without articular end and flat base (Type 1/10)	Metatarsus (red deer)	1	5	-	49.3	16.7	7.0	-	-	673		673.2	Fragment, burnt
Massive chisel (Type 4/3)	Tibia	2	0	-	42.3	22.0	7.9	12.0	-	772	pit	772.2	Fragment
Massive chisel (Type 4/3)	Antler (red deer)	1	-	-	-	-	-	5.1	-	1054	pit	1054.235	
Axe/chisel fragment (Type 4/4)	Antler (red deer)	2	0	31/25	70.0	23.5	21.3	46.5	-	880	storage pit	880.622	Fragment
Axe/chisel fragment (Type 4/4)	Antler (red deer)	2	12	-	127.9	26.2	28.4	-	-	880	storage pit	880.621	Fragment
Small *ad hoc* chisel (Type 4/8)	Tibia (small ruminant)	2	0	29/23	107.8	26.9	13.9	11.5	-	819	pit	819.42	
Fine spatula (Type 12/1)	Rib	2	-	-	147.0	23.9	3.2	-	-	584	pit	584.21	
Polished tool (Type 19)	Rib (large ungulate)	2	11	-	78.9	13.7	2.8	-	-	1095	pit-complex	1095.4	
Drilled bone (Type 21)	Radius (cattle)	2	1	-	255.7	56.9	33.7	-	-	880	storage pit	880.620	Fragment

Table 6. Distribution of different type of tools in the Early Bronze Age assemblages from Hungary.
Abbreviations: EBA=Early Bronze Age, MBA=Middle Bronze Age. Based on Choyke 1984, Choyke et al. 2002, and Choyke and Bartosiewicz 2009

Site	Flat butted heavy duty	Oblique butt heavy duty	Hafted beam or crown	Large mandible smoother	Caprinae tibia scraper	Large rib scaper	First phalanx scraper	Wild boar tusk scraper	Diaphysis scraper	Small double point	Needle	Ornamental	Class I awl	Class II awl	Class I scraper	Class II scarper	Chisel	Other	**Total**
Kaposújlak-Várdomb EBA (Somogyvár-Vinkovci culture)	1	28	9	1	-	-	-	1	-	-	4	-	46	28	1	6	5	5	**135**
Mezőkomárom-Alsóhegy EBA (Nagyrév/Bell Beaker culture)	3	-	-	-	6	6	1	-	13	-	-	1	3	1	-	-	-	2	**36**
Százhlombatta-Téglagyár EBA (Nagyrév culture)	1	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	2	**6**
Százhlombatta-Földvár EBA (Nagyrév culture)	2	-	-	-	-	5	-	-	-	-	-	2	-	4	5	3	-	-	**21**
Tiszaug-Kéménytető EBA (Makó culture)	2	-	1	2	2	-	-	-	-	1	-	-	3	-	5	-	-	-	**16**
Jászdózsa-Kápolnahalom E-MBA (Hatvan culture)	9		10	3	10	6	-	4	-	-	6	-	10	-	-	-	-	7	**65**

Acknowledgements

This paper is the written form of my lecture presented at the 7th Meeting of the ICAZ Worked Bone Research Group organised by Justyna Baron, Bernadeta Kufel and Marcin Diakowski. Archaeologists Zsolt Gallina and Krisztina Somogyi excavated the site of Kaposújlak-Várdomb. Gabriella Kulcsár, who is working on the Early Bronze Age features of the site, is thanked for providing additional information. I am grateful to Alice M. Choyke for her comments, suggestions, and revision of the English version of this work. I also thank Arkadiusz Marciniak for his remarks and suggestions that have improved the quality of this paper. The research was supported by a grant from OTKA Programme no. PD 71965.

References

Bartosiewicz, L. 1996. *Bronze age animal keeping in Northwestern Transdanubia, Hungary (Bronzkori állattartás az Északnyugat-Dunántúlon)*, Acta Musei Papensis 6, 31-42.

Choyke, A. M. 1979. *A classification of the bone and antler tools from the Bronze Age hill-fortress of Pákozdvár,* Alba Regia 17, 9-21.

Choyke, A. M. 1983. *Előzetes jelentés a tiszaug-kéménytetői ásatás csontszerszámairól*, Archeologiai Értesítő 109, 35-41.

Choyke, A. M. 1984a. *An analysis of bone, antler and tooth tools from Bronze Age Hungary*, Mitteilungen des Archäologischen Instituts der Ungarischen Akademie der Wissenschaften 12/13 (1982/1983), 13-57.

Choyke, A. M. 1984b. *Patterns in the use of cattle and sheep/goat metapodials in Bronze Age Hungary*, In: C. Grigson and J. Clutton Brock (eds.) *Animals in Archaeology 4. Husbandry in Europe*, BAR Intern. Series 227, Oxford: Archaeopress, 57-66.

Choyke, A. M. 1987. *The exploitation of Red Deer in the Hungarian Bronze Age*, Archaeozoologia 1/1, 109-16.

Choyke, A. M. 1997. *The manufacturing continuum,* Anthropozoologica 25-26, 65-72.

Choyke, A. M. 2000. *Refuse and modified bone from Százhalombatta-Földvár. Some preliminary observations*, In: I. Poroszlai and M. Vicze (eds.) *Százhalombatta Archaeological Expedition (SAX), Annual Report 1 – Field Season 1998*. Százhalombatta: Matrica Múzeum, 97-102.

Choyke, A. M. and L. Bartosiewicz 1999. *Bronze Age animal exploitation in Western Hungary*, In: E. Jerem and I. Poroszlai (eds.) *Archaeology of the Bronze Age and Iron Age: Experimental archaeology, environmental archaeology, archaeological parks*. Budapest: Archaeolingua Series Major, 239-49.

Choyke A. M. and L. Bartosiewicz 1999-2000. *Bronze Age animal exploitation in the Central Great Hungarian Plain,* Acta Archaeologica Academiae Scientiarum Hungaricae 51, 43-70.

Choyke, A. M. and L. Bartosiewicz 2005. *Skating with Horses: continuity and parallelism*, Prehistoric Hungary. Revue de Paléobiologie, Genève (décembre 2005) Vol. spec. 10, 317-26.

Choyke, A. M. and L. Bartosiewicz 2009. *Telltale tools from a tell: Bone and antler manufacturing at Bronze Age Jászdózsa-Kápolnahalom, Hungary*, Tisicum XX, 357-75.

Choyke, A. M. and J. Schibler 2007. *Prehistoric Bone Tools and the Archaeozoological Perspective: Research in Central Europe*, In: C. Gates St-Pierre and R. B. Walker (eds.) *Bones as Tools: Current Methods and Interpretations in Worked Bone Studies*, BAR Intern. Series 1622, Oxford: Archaeopress, 51-65.

Choyke, A. M., Vretemark, M. and S. Sten 2002. *Levels of social identity expressed in the refuse and worked bone from the Middle Bronze Age Százhalombatta-Földvár, Vatya culture, Hungary*, In: S. Jones O'Day and W. van Neer and A. Ervynck (eds.) *Behaviour Behind Bones. The Zooarchaeology of Ritual, Religion. Status and Identity*, Oxford: Oxbow Books, 177-89.

Gál, E. 2009. *Relationships between people and animals during the Early Bronze Age: Preliminary results on the animal bone remains from Kaposújlak-Várdomb (South Transdanubia, Hungary)*, In: G. Ilon (ed.) *Őskoros Kutatók VI. Összejövetelének konferenciakötete. Kőszeg, 2009. március 19-21. Nyersanyagok és kereskedelem (Proceedings of the 6th Meeting for the Researchers of Prehistory. Kőszeg, 19-21 March, 2009 Raw materials and trades)*, ΜΩΜΟΣ VI. Szombathely/Budapest: Kulturális Örökségvédelmi Szakszolgálat/ Vas megyei Múzeumok Igazgatósága, 47-63.

Gál, E. and Kulcsár, G. 2011. *Változások a bronzkor kezdetén – A dél-dunántúli gazdálkodás jellege az állatcsont leletek alapján (Changes at the beginning of the Bronze Age – Characterizing subsistence on the basis of animal remains in Southern Transdanubia, Hungary)*, In: A. Kreiter, Á. Pető and B. Tugya (eds.) *Környezet – Ember – Kultúra (Environment – People – Culture)*. Budapest: Nemzeti Örökségvédelmi Központ (in press).

Kőrösi, A. 2005. *The animal bones from the Early Bronze Age site at Üllő*, Communicationes Archaeologicae Hungariae 2005, 138-42.

Schibler, J. 1981. *Typologische Untersuchungen der cortaillodzeitlichen Knochenartefakte. Die neolithischen Ufersiedlungen von Twann*, Bern: Staatlicher Lehrmittelverlag.

Vörös, I. 1979. *Description of the animal bones from the Early Bronze Age settlement at Szava,* A Janus Pannonius Múzeum Évkönyve 23, 137-44.

Peggy Morgenstern

Typical hide working tools from the late Bronze Age of Moldova

Excavations at the late Bronze Age site of Odaia/Moldova yielded a significant bone artefact assemblage dominated by bone points and rib scrapers. The site itself is located within a concentration of ash-heaps between the forest steppe and steppe zones on the western bank of the Dniestr.

This analysis focuses on a specific tool from the Noua-Sabatinovka cultural complex. There is a little archeological evidence for its use in Moldova and Romania, especially in the late Bronze Age period. At these tools the scapula epiphyses had been notched. The notched teeth thus create a working edge, often displaying a high, glossy polish. Use-wear analysis has been undertaken to interpret the functional role of a sample of characteristic tools from Odaia. It is suggested here that these tools were used as scrapers for hide-working.

Keywords: late Bronze Age, Moldova, Noua-Sabatinovka culture complex, ash-heaps, settlement artefacts

Introduction

The following text deals with an analysis of a bone tool, made from the scapulae of large mammals, which was prevalent in the steppe cultures of south eastern Europe (Fig.1). Over the past decades, scientists have ascribed many different interpretations concerning the origins and functions of this

Fig. 1. A selection of several tools from the site of Miciurin-Odaia (Photo: P. Morgenstern)

tool type. Here the worked bone material of the late Bronze Age site of Miciurin-Odaia will be discussed in light of an analysis of use-wear.

As the result of cooperation between the Institute of Prehistoric Archaeology of the Free University of Berlin and the Section of Ethnography and Art History of the Moldovan Academy of Science, research on a site of the Noua-Sabatinovka culture was carried out. Excavations at the settlement site of Miciurin-Odaia took place between 2003 and 2005. The late bronze age site in the north of Moldova yielded numerous artefacts made from bone and antler.

The site of Miciurin-Odaia

The settlement site of Miciurin-Odaia is located in the northern part of Moldova (Fig. 2). The steppe landscape has a very arid climate. The site itself consists of 25 ash-heaps, situated at the edge of a southern slope, which forms the bank of a stream (Kaiser, Sava 2006:170-171). The mounds do not appear to have any kind of a discernible pattern.

Four of these mounds were examined over four campaign seasons (Fig. 3). The excavation of the ash-heaps revealed numerous pits and stone concen-

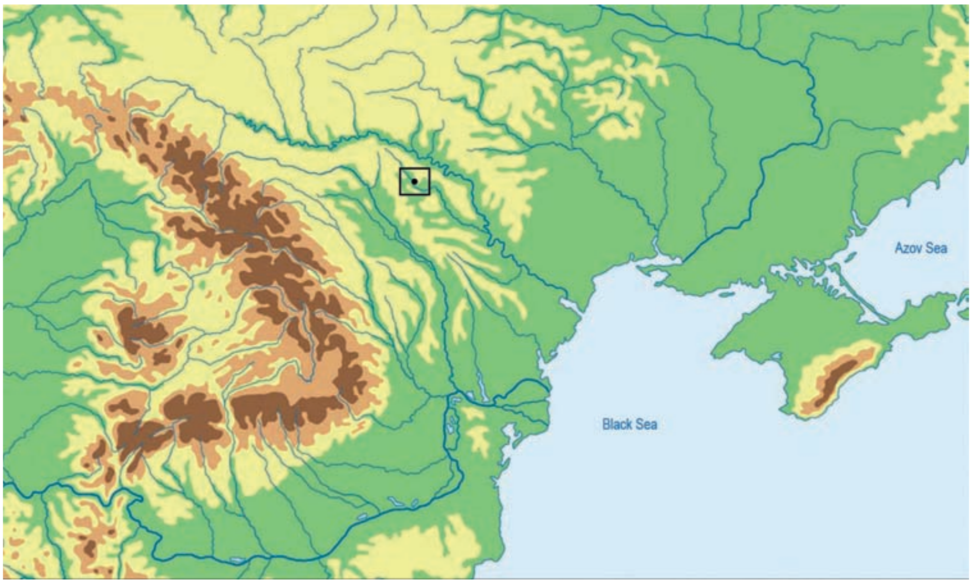


Fig. 2. The north Moldovian site of Miciurin-Odaia (after Kaiser, Sava 2006)

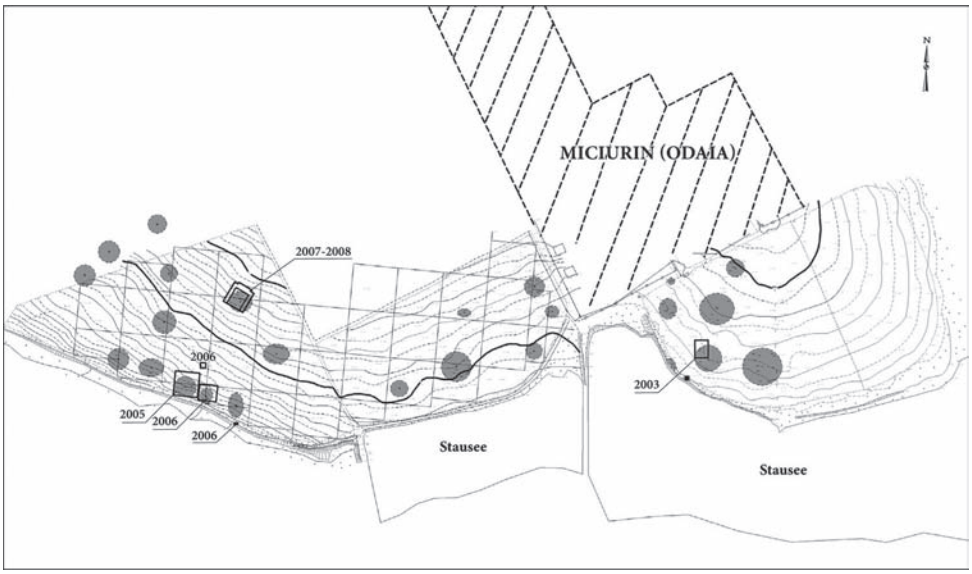


Fig. 3. Miciurin-Odaia. Topographical map of the site (after Kaiser 2007)[1]

[1] Special thanks to the excavators of Miciurin-Odaia E. Kaiser and E. Sava for this map.

trations which yielded ceramic shards and objects made from bone, antler, clay, flint, stone and bronze. The assemblage of bone artefacts was dominated by bone points and 'chisels', polished ribs, femora with perforated epiphyses, ground astragali and notched scapulae (Morgenstern in press).

The archaeological culture

The Noua-Sabatinovka culture dates to the second half of the second millennium BC and comprised a territory that reached from the Carpathian Mountains in the West to the Dnieper River in the East and from the upper Dniester River in the north to the lower Danube River in the South (Fig. 4).

The culture is characterized by non-fortified settlements with semi-subterranean houses with a wood-

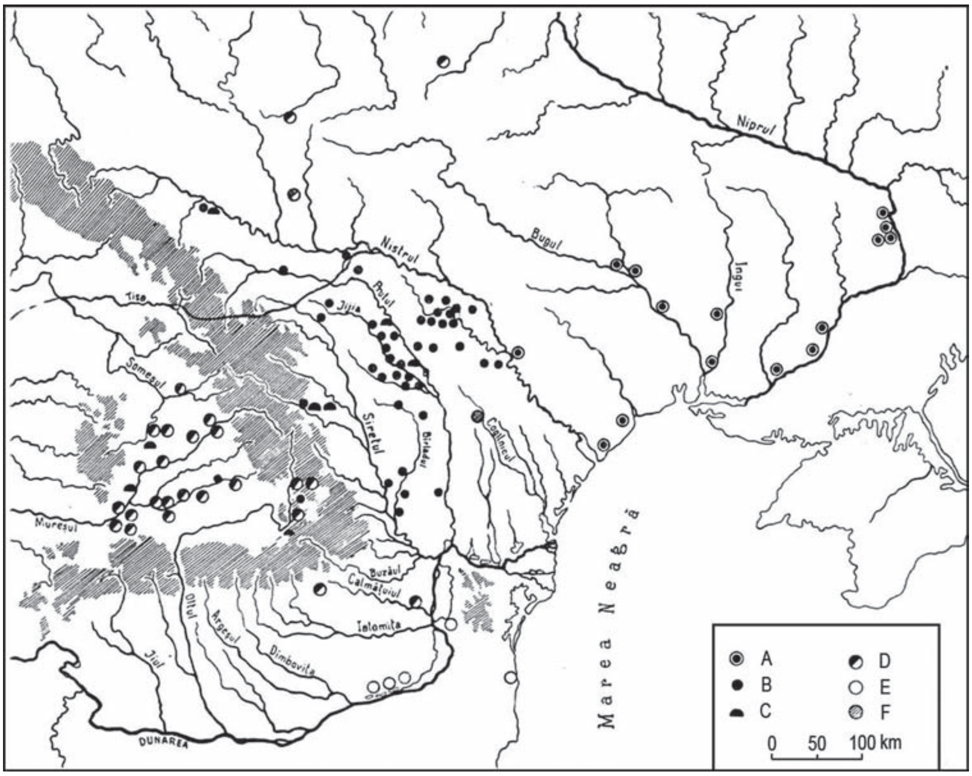


Fig. 4. Distribution of the Noua-Sabatinovka-Culture (after Florescu 1964)

Fig. 5. Miciurin-Odaia. Ash-heaps 14-21 in spring 2005 (Photo: E. Kaiser)

daub superstructure (Sava 1998:271). In the western part of the territory there are also surface wattle and daub buildings that sit on the ground surface with stone foundations. A special feature of Noua-Sabatinovka settlement sites are the so-called "Zol'niki" (ash-heaps). These are circular or oval discolorations of light-grey soil, which was visible as a mound before the intensification of agriculture (Fig. 5).

The ash-heaps, which are arranged in clusters of up to 40 mounds, contain settlement remains such as ceramic shards, faunal remains and artefacts. These ash-heaps have been interpreted as fireplaces, remains of dwelling houses or ritual places. Biochemical studies of the sediments have demonstrated that the material of Miciurin-Odaia are not ash-remains. The functional role of the mounds remains is still not known.

In accord with the arid climate of the steppe lands in the eastern part of the Noua-Sabatinovka culture distribution area, the faunal remains from the settlement sites are characterized by teeth and bones from cattle, sheep, goat and horse (Sava 2005:145). Pigs appear to be very rare in this arid zone. However, sites in the forestlands of the Carpathians, with a greater abundance of food was much better, with a higher proportion of pig remains as well as wild mammals (Sava 2005:147, Fig.2).

The tool type

Twelve fragments of notched scapulas were recovered from the faunal remains of Miciurin-Odaia. The tools are made of cattle and horse scapulae and are generally badly fragmented and with weathered surfaces. These scapula-tools have a notched pattern along the distal epiphyses, forming a half-moon shape (Fig. 6). The notched edges, like worn down teeth, were regularly located on the edge opposite the *Tuber scapulae*, that is, on the dorsal edge.

Distribution of the tool

The distribution of this kind of artefact, concentrated in the ash-heaps, comprises the same territory as the distribution area of the late Bronze Age Noua-Sabatinovka culture. The map shows the distribution of the finds (Fig.7). The tools are known from numerous settlement sites such as Cobîlnea (Levitsckii, Sava 1993, Fig. 13; Sava 1998:274), Petruşeni „La Cigoreanu" (Levițkii, Sava 1995:173, Fig. 5), Lupşanu, Cavadineşti, Rusenii Noi, Gîrbovăț, Tanacu (Florescu 1991:287, Fig. 115), Sabatinovka, Valea Lupuliu – Iaşi, Andieşeni, Ušalka, Nicoleni (Florescu 1964:160, Fig. 11), Peresadovka (Pogrebova 1960:83, Fig.7,5), Bîrlad (Haimovici 1964:225, Fig. 1), Novoselickovo Zol'nika (Černikov 1985:87, Fig. 40) and Stepovoje (Berezanskaja, Šarafutdinova 1985:497, Fig. 135).

Fragments of notched tools may already be found in the worked osseous assemblages of a few middle Bronze Age settlement sites, such as Doamnei and Otopani, of the late Wietenberg and Tei cultures (Andrițoiu 1992:66; Leahu 1963:340, Fig. 7,3). These sites were located in the southwestern part of the distribution area. With the findplace of Nikolaevskoe Poselenie, there is also evidence on the eastern edge of this tool type in the middle Bronze Age Srubnaja culture (Privalova, Privalov 1987:106). The development of the tool must therefore have begun in the transition from the middle to late Bronze Age, from 1500 – 1200 BC.

According to E. Sava, the wide range of bone tools in the culture of Noua-Sabatinovka shows the influence of eastern cultures (Sava 1998:277). Therefore, it can be assumed that the tool-type was developed in the area of the eastern steppe cultures.

The use-wears

Previously, notched scapula-tools have been described as tools used for the decoration of pottery. A short while ago, the Ukrainian and Russian archaeologists V.B. Pankovs'kij and G.F. Korobkova have come to regard the connection of these tools with leather processing (Pankovs'kij 2003:143-144). After an analyse of use-wears they came to suggest that these scapula-tools were used as punches in the leather decoration.

Following my own microscopic examinations using a 100x magnification, the assessment of the level of tooth wear on four of twelve tools indicates the presence of a high, glossy and invasive polish (Fig. 8). Invasive polish means that the whole surface and the striations within are covered by the polish.

At a magnification of 200x the surface appeared very smooth nearly without marks and only a few scratches

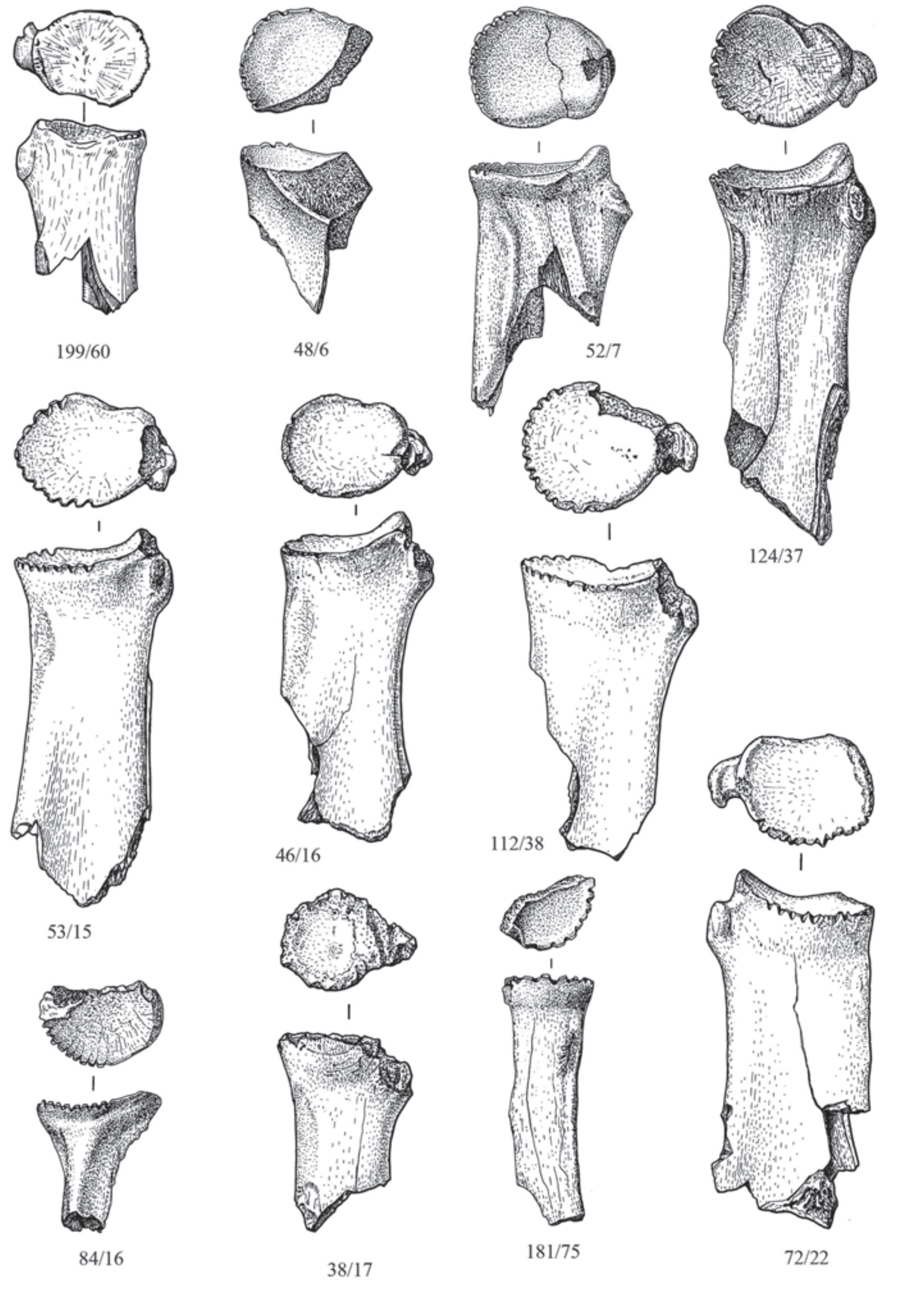


Fig. 6. Miciurin-Odaia. Notched scapula-tools made from cattle and horse scapulas

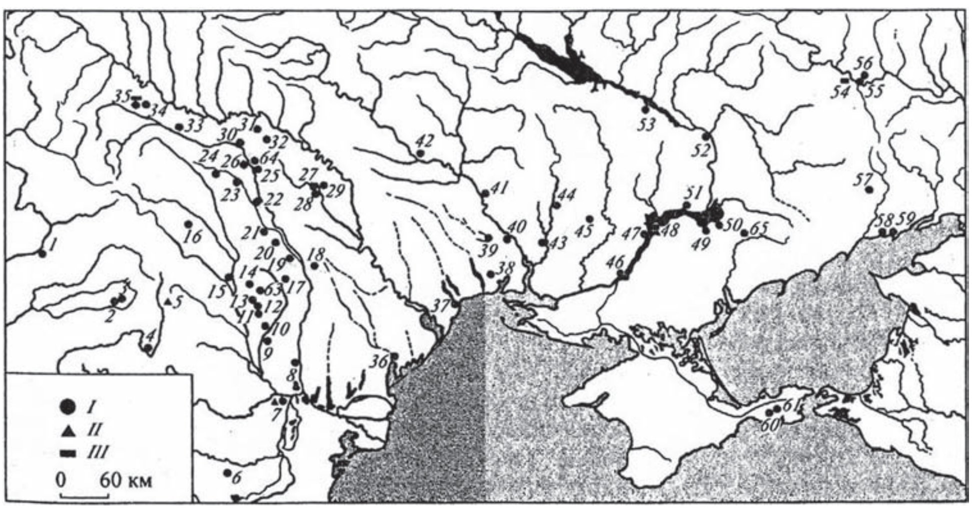


Fig. 7. The circles showing the distribution of the scapula-tools (after Pankovs'kij 2003)

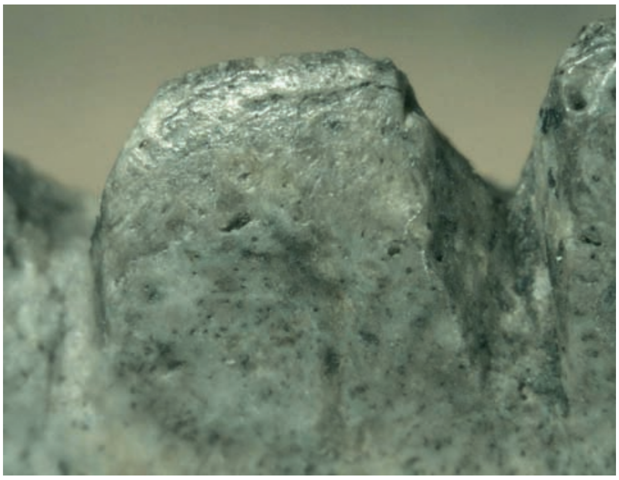


Fig. 8. Tool 124/37 – 100x magnification (Photo: P. Morgenstern)

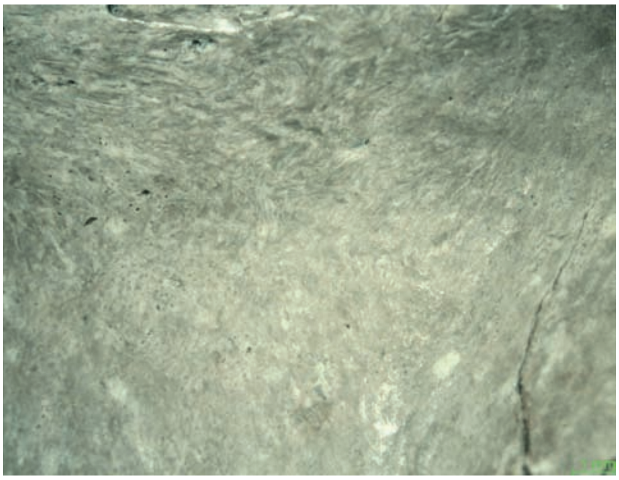


Fig. 9. Tool 199/60 – 200x magnification (Photo: P. Morgenstern)

(Fig. 9). The osteons, the holes of nutriant canals, were visible. This indicates that the working surface was coming into intensive contact with soft moist materials such as fur, skin, meat and fat . The functional appearance of the tool and clusters of traces suggests how the notched scapulae might have been used.

The functional role

Based on these wear patterns, these objects were used as defleshers to remove meat, fat and connective tissue remains from the back of fresh hides in the first step of leather production. In medieval tanneries after soaking, they removed any remaining flesh and fat by using scratchers and fleshing knifes although the later historic use of such notched tools is unknown (Fig. 10).

There is another well-known example of such tool use from the last century. North American Indians used a similarly notched tool for softening tanned skins (Feustel 1980:17). The tools were normally made from cervid metatarsi (Fig. 11). Northe also offered another kind of flat scapula-tools with a notched working edge from late Neolithic and early Bronze Age settlement sites of

Fig. 10. Hide-working (A. Schweitzer around 1800)

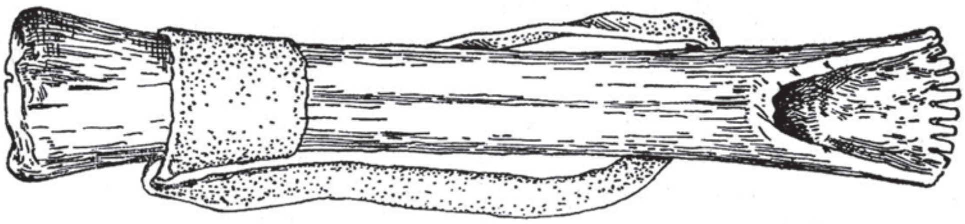


Fig. 11. A deflesher formerly used in hide cleaning by Plains Indians (after Feustel 1980)

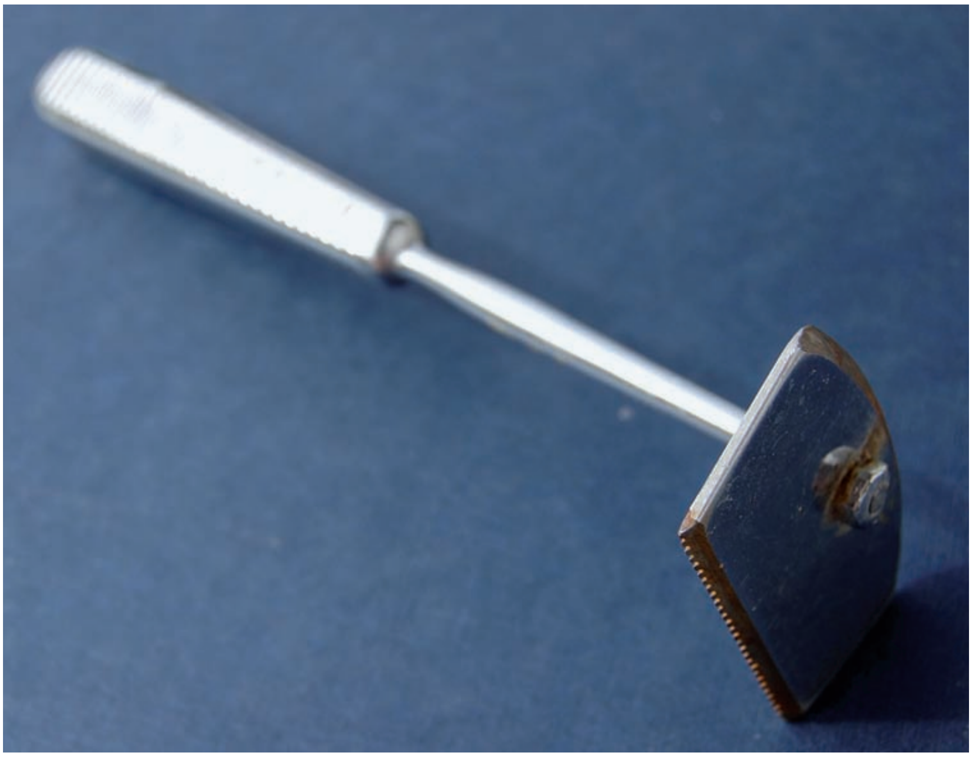


Fig. 12. Recent tools used by taxidermists in Halle (Photo: P. Morgenstern)

central Europe (Northe 2001:179-184). Use-wears indicate that several of them could be used for hide-working.

It seems quite reasonable that cattle, sheep and goat hides were worked by such scapular defleshers with dull teeth in the Late Bronze Age as well. A more recent analogy for this kind of tool may be found in the laboratory of the Museum of Domestic Mammals in Halle/Saale in Germany (Fig. 12). Taxidermists generally remove flesh, fat and other connective tissues from the skins of mammals, birds and snakes with just such a deflesher.

Conclusions

Considering the use-wear analysis, the twelve scapula-tools with a notched pattern on the distal epiphysis from the north Moldovian settlement site of Miciurin-Odaia are used as tools for hide-working. Nearly all remains of this tool type are known from the Noua-Sabatinovka culture complex in the late Bronze Age period. Fragments of this tool are already appeared on a few sites of the late Wietenberg and Tei culture and the Srubnaja culture. Therefore the development of the tool must have begun in the middle Bronze Age.

References

Andritoiu, I. 1992. *Civilizația tracilor din sud-vestul Transilvaniei în epoca bronzului*, Biblioteca Thracologicã II, 1-244.

Berezanskaja, S.S. and I.N. Šarafutdinova 1985. *Sabatinovskaja kul'tura*, Archeologija Ukrainskoj SSR 1, 489-99.

Černjakov, I.T. 1985. *Severo-Zapadnoe Pričernomor'e vo vtoroj polovine II tys. do n. ė.*, Kiev: Naukova Dumka.

Feustel, R. 1980. *Neolithische Gerberwerkzeuge aus Knochen*, Alt-Thüringen 17, 7-18.

Florescu, A. 1964. *Contribuţij la cunoaşterea culturii Noua*, Arheologia Moldovei 2-3, 143-216.

Florescu, A. 1991. *Repertoriul culturii Noua-Coslogeni din România. Aşezări şi necropoli*, Cultura şi civilizaţia la Dunărea de Jos 9, 1-414.

Haimovici, S. 1964. *Studii aspra resturilor de faună descoperite în aşezările aparţinind culturii Noua de la Bîrlad şi Piatra Neamţ*, Arheologia Moldovei 2/3, 217-36.

Leahu, V. 1963. *O nouă fază în evolutia culturii Tei: faza Fundenii Doamnei*, Cercetãri Arheologice în Bucureşti 1, 339-70.

Leviţkii, O. and E. Sava. 1995. *Aşezarea culturii Noua Petruşeni "La Cigoreanu" (inestigaţii de şantier în 1991)*, Cercetãri Arheologice în aria nord-tracã 1, 157-88.

Levitsckii, O.G. and E.N. Sava. 1993. *Nouvelles recherches des l'établissements de la culture Noua la zone comprise entre le Prout et le Nistru*, Culture et civilisation au Bas Danube 10, 125-57.

Kaiser, E. and E. Sava. 2006. *Die „Aschehügel" der späten Bronzezeit im Nordpontikum. Erste Ergebnisse eines Forschungsprojektes in Nordmoldavien,* Eurasia Antiqua 12, 167-202.

Morgenstern, P. in print. *Knochen- und Geweihartefakte aus den spätbronzezeitlichen Aschehügeln von Odaia – einem Fundplatz der Noua-Sabatinovka-Kultur*, In: E. Kaiser and E. Sava (eds.) *Die Siedlung mit "Aschehügeln" von Miciurin/Odaia, Moldawien. (Archäologische und naturwissenschaftliche Untersuchungen)*, Biblioteca Tyragetia, Chisinau.

Northe, A. 2001. *Notched Implements made of Scapulae – Still a Problem*, In: A. Choyke and L. Bartosiewicz (eds.) *Crafting Bone: Skeletal Technologies through Time and Space – Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group Budapest, 31 August – 5 September 1999,* BAR Intern. Series 937, Oxford: Archaeopress, 179-184.

Pankovs'kij, V.B. 2003. *Pro Priznačennja „Zybčastich Lopatok"*, Archeologija 3, 134-44.

Pogrebova, N.N. 1960. *Peresadovskoe poselenie na Ingule*, Sovetskaja Archeologija 4, 76-90.

Privalova , O.Ja and A.I. Privalov. 1987. *Poselenie ėpochi pozdnej bronzy vozle s. Nikolaevka v Severnom Priazov'e*, In: O.G. Šapošnikova (eds.) *Drevnejšie skotovody stepej juga Ukrainy*, Kiev: Naukova dumka, 94-107.

Sava, E. 1998. *Die Rolle der „östlichen" und „westlichen" Elemente in der Genesis des Noua-Sabatinovka-Kulturkomplexes. (Nach den Materialien des Pruth-Dnestr-Zwischenstromgebiets)*, In: B. Hänsel and J. Machnik (eds.) *Das Karpatenbecken und die osteuropäische Steppe. Nomadenwege und Kulturaustausch in den vorchristlichen Metallzeiten (4000-500 v.Chr.)*, München & Rahden/Westf.: Marie Leidorf, 267-312.

Sava, E. 2005. *Viehzucht und Ackerbau in der Noua-Sabatinovka-Kultur*, In: B. Horejs, R. Jung, E. Kaiser and B. Teržan (eds.) *Interpretationsraum Bronzezeit*, Universitätsforschungen zur Prähistorischen Archäologie 121, 143-59.

Corneliu Beldiman, Diana-Maria Sztancs, Viorica Rusu-Bolindeţ, Irina Adriana Achim

Skeletal technologies, metal-working and wheat harvesting: ancient bone and antler anvils for manufacturing saw-toothed iron sickles discovered in Romania

The paper presents the results of the analysis of recent data regarding a unique assemblage of 40 artefacts retrieved during the 2001-2008 archaeological excavations in the "Basilica extra muros" and "Basilica with Crypt ("Florescu") sectors of the ancient city of Istria (Constanța County, Romania). Almost all of the objects represent completed and used pieces (tools) and there is some raw material (cattle metapodials). There is also an exceptional piece made out of a red deer's antler (on a segment of a beam). These artefacts were used as anvils for manufacturing toothed iron sickles and have been dated back to the IInd-IIIrd centuries A.D. In the past six decades, these kind of artefacts have generated numerous controversial debates relating to their origins, diffusion and especially to their functional role. Artefacts of this kind have been discovered in two large geographical areas including the Western Basin of the Mediterranean Sea and the Western and North-western regions around the Black Sea and have been dated to between the Vth century B.C. and the XVIIIth century A.D. The research methodology included the analysis of various parameters such as: data relative to the context of their discovery, type (established conventionally after a number of technically modified and used anatomic faces: 1-2-3-4), state of conservation, raw material, dimensions, manufacture, traces of use, reshaping, and traces of reuse. The traces of manufacture and use were analysed using an optical microscope. Apart from the relative rarity of these pieces we can mention the fact that this study of antique bone and antler anvils from Romania benefits from an extended and unitary research approach and brings an important documentary contribution to the presence of these controversial artefacts in some Central-Eastern regions of Europe. The artefacts in question illustrate complex interconnections between different traditions over an extended period of time. This study of bone and antler anvils from Romania provides an important contribution to the knowledge of the technology and economy in ancient Europe.

Keywords: agriculture, ancient anvil, ancient sickle, bone and antler industry, iron technology, Istria.

Introduction

On this occasion we are going to discuss a category of artefacts which are generally called "anvils". For other European regions and for Northern Africa, the archaeological literature mentions many such artefacts dated from the Hellenistic and the Roman period (Vth century B.C.-Vth century A.D.). These artefacts were discovered in Greek cities from the Black Sea Basin (Olbia, Neapolis, Thanagoria etc.), as well as in Scythian-Greek and Getic settlements (Arnăut 2007:298-300; Peters 1986:162-3, pl. III/1-11; Semenov 1970:186-8, fig. 100-102 – with bibliography). Others are largely dated between the VIIth-XVIIIth centuries and were retrieved in settlements from the Western Mediterranean Basin (France, Spain, Portugal, some countries from Northern Africa) (Briois *et al.* 1997; Esteban Nadal, Carbonell Roure 2004; Moreno-Garcia *et al.* 2005a, 2005b, 2007; Poplin 2007a, 2007b; Rodet-Belarbi *et al.* 2007 – with bibliography).

In the context of new research interest manifested for the topic of bone anvils at the 5th and 7th WBRG some archaeologists and archeozoologists started to pay more attention to this kind of artefacts (e.g. Poplin 2007a, 2007b; Moreno-Garcia *et al.* 2005a). Consequently we can observe increasing of the list of publications dealing with this topic for Central and Western Europe, including Southern Italy (a piece dated in IInd century BC-Ist century AD) and Austria (Gál 2010; Gömöri, Szulovszky 2010; José Gonçalves *et al.* 2008).

Very recently were published some pieces coming from Hungarian Medieval sites (Xth – XIIIth centuries AD). So, at Felgyő – "*Kettőshalmi dűlő*" are mentioned bone anvils made of cattle femur coming from Avar context (Kőrősi 2010:112, fig. 7-8). From the rural site of Cegléd – "*Fertály-földek II*", there are mentioned 32 bone anvils made of horse and cattle long bones. Other artefacts were discovered in a assemblage of a blacksmith Vicus in Budapest, in an oven at the site of Hajdúnánás – "*Fürjhalom-dűlő*" (Gál *et al.* 2010:117) and in the manorial settlement of Baj – "*Öreg-Kovács-hegy*" (anvil made of a cattle radius) (Bartosiewicz 2010:338, Fig. 16; Gál *et al.* 2010:117). They are also mentioned in the medieval village of Kolon, dated from Árpád period. Bone anvils made of cattle and horse long bones (radius, tibia, metapodials, humerus) were discovered in a pit where had been thrown the debris from a smithy (Kvassay, Vörös 2010:127).

Actually, we may distinguish the area of diffusion of artefacts (considered "puzzling" for decades) around the Mediterranean Basin having its origins, probably, in East Mediterranean and Northern Black Sea regions. The presence of bone anvils in Early Medieval Central Europe is a problem to solve.

Over the years, early mentioned artefacts discovered in the Northern part of the Black Sea were wrongly considered to be polishing tools used for finishing textiles, hides, stone or wood. This is the case of first such pieces published by S.A. Semenov (1970:186-8, fig. 100-102). Due probably to the lack of recent international data, some authors still sustain such a functional interpretation decades after the assertions of "Father of Traseology" (Peters 1986:162-3; Arnăut 2007:302 – with bibliography).

There is a special case where the rows of triangular hollows made during usage of anvils were interpreted as "an unknown type of Getic writing" (the case of the artefacts from Chitila: Boroneanţ 2005).

Quite recently, "the riddle was solved": the functional role of those artefacts benefited from the observations of technological behaviour in the Iberian ethnography. In this way, and also by using experimental studies, the "manufacturing chain" of anvils and the way of using them has been established (Esteban Nadal, Carbonell Roure 2004:640-4; Aguirre *et al.* 2004; Moreno-Garcia *et al.* 2005b:623-4; Rodet-Belarbi *et al.* 2007:160).

Context. Objectives

On the bank of lake Sinoe in the area of Istria village, Constanţa County lies the Ancient City of Histria, the first Greek colony on the west shores of the Black Sea and oldest city within the boundaries of Romania. The colony was founded in the middle of the 7th century BC (year 657 BC according to historian Eusebius) by colonists from Milet, to trade with the native Getae. The city had an uninterrupted growth for 1300 years, beginning with the Greek period and ending with the Roman-Byzantine period. The ruins of the settlement were first mentioned in 1868 by French archaeologist Ernest Desjardins. Archaeological excavations were started by Vasile Pârvan in 1914, and continued after his death in 1927 by staff of archaeologists led successively by Scarlat and Marcelle Lambrino (1928-1943), Emil Condurachi (1949-1970), Dionisie Pippidi, Petre Alexandrescu, Alexandru Suceveanu (1970-2011) and today Mircea Victor Angelescu. There are several Sectors largely excavated every year with very important archaeological results (Suceveanu, Angelescu 2005).

The artefacts presented in this article were discovered during recent research directed by Alexandru Suceveanu from "Vasile Pârvan" Institute of Archaeology of the Romanian Academy, Bucharest. For the results of recent archaeological research in Histria see: Suceveanu 2010 – with bibliography. There are two sectors of the site from which the bone and antler industry was analysed in last years: the Sector *Basilica Extra Muros*, researches led by Alexandru Suceveanu and Viorica Rusu-Bolindeţ from the National History Museum of Transylvania, Cluj-Napoca during 2001-

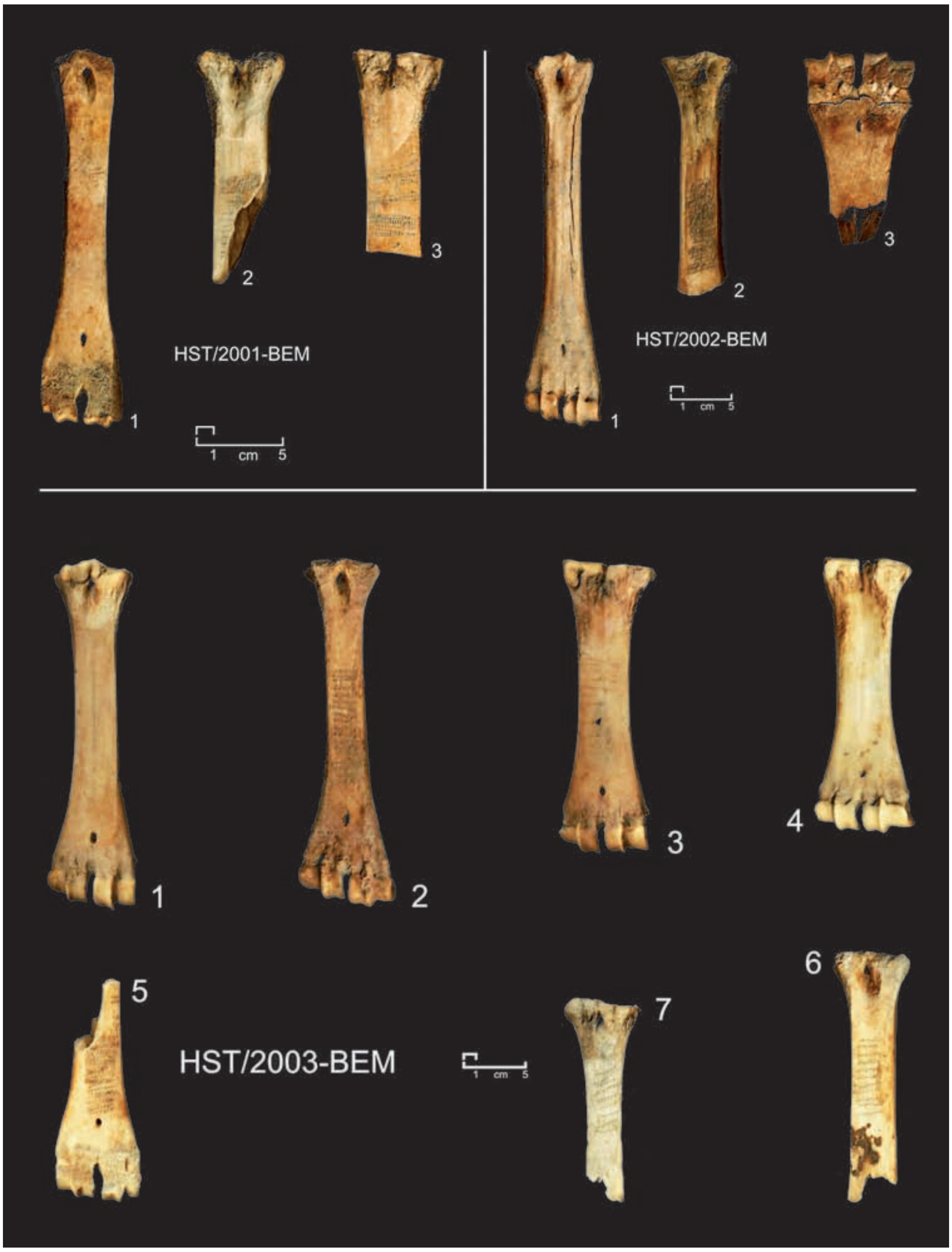


Fig. 1. Istria – Sector Basilica extra muros. Anvils on cattle metapodials and raw material: HST/2001-BEM 1-3; HST/2002-BEM 1-3; HST/2003-BEM 1-6

2006 (Suceveanu *et al.* 2004; Rusu-Bolindeț, Bădescu 2006; Rusu-Bolindeț *et al.* 2009); the Sector *Basilica with Crypt-"Florescu"*, researches led by Irina Adriana Achim during 2002 and 2008 ("Vasile Pârvan" Institute of Archaeology of the Romanian Academy, Bucharest) (Suceveanu *et al.* 2003; Achim *et al.* 2009).

The bone anvils are part of worked osseous assemblages from the two above-mentioned sectors, including 90 pieces and comprising: bone and antler anvils, bone hair pins, bone hafts, bone bands, horn sleeves, a piece of game (astragalus from sheep/goat), blanks, different partially shaped raw materials, waste products etc. (Beldiman *et al.* 2007, 2009; Beldiman, Sztancs 2010a, 2010b).

The bone and antler anvils were of particular interest. This group of artefacts has an important documentary potential because it illustrates, in a unique way, complex economic activities that seem apparently very different, but which were in reality interconnected (farming, agricultural activities, iron craft, bone and antler industry craft, woodcraft etc).

Taking into account all these aspects, the leaders of the archaeological excavations offered them to the main author of this article for a systematic and detailed study. The study began in 2007 when the artefacts discovered in 2004 in the Sector *Basilica Extra Muros* (HST-BEM) were analysed. In 2008 the systematic study of bone and antler industry discovered during 2001-2003 was finished. Other contributions were related to artefacts discovered in 2006 in the Sector *Basilica Extra Muros* and to artefacts retrieved in the Sector *Basilica with Crypt-"Florescu"*

Fig. 2. Istria – Sector Basilica extra muros. Anvils on cattle metapodials and raw material: HST/2004-BEM 1-12; HST/2006-BEM 1-13

(HST-BFL) (Beldiman, Sztancs 2007, 2009a, 2009b, 2010a, 2010b). The pieces from HST-BEM are preserved in the collections of the National Museum History of Transylvania, Cluj-Napoca, while the artefacts from HST-BFL are part of the collection of the "Vasile Pârvan" Institute of Archaeology, Bucharest.

On this occasion, we are going to present a synthesis of data regarding the special category of discoveries made of bone and antler: anvils. These were pointed out for the first time on the western shore of the Black Sea in the ancient fortress city, Histria, and they illustrate in a unique way some technological and economic aspects of those times.

The 38 artefacts from HST-BEM (Figs. 1-2, 4) were discovered abandoned in secondary contexts. They come from structures, pits and from the vicinity of some complexes used for reducing the iron ore, connected to the craft area from Section I (the western extremity, about 15.8 m) belonging to the Early Roman period (probably, 1st-7th decades of the IInd century A.D.) (Rusu-Bolindeț *et al.* 2009, 2010).

The artefacts from HST-BFL (Fig. 3) were discovered in secondary contexts and probably abandoned. They cannot be dated with certainty because of the former interventions related to Grigore Flo-

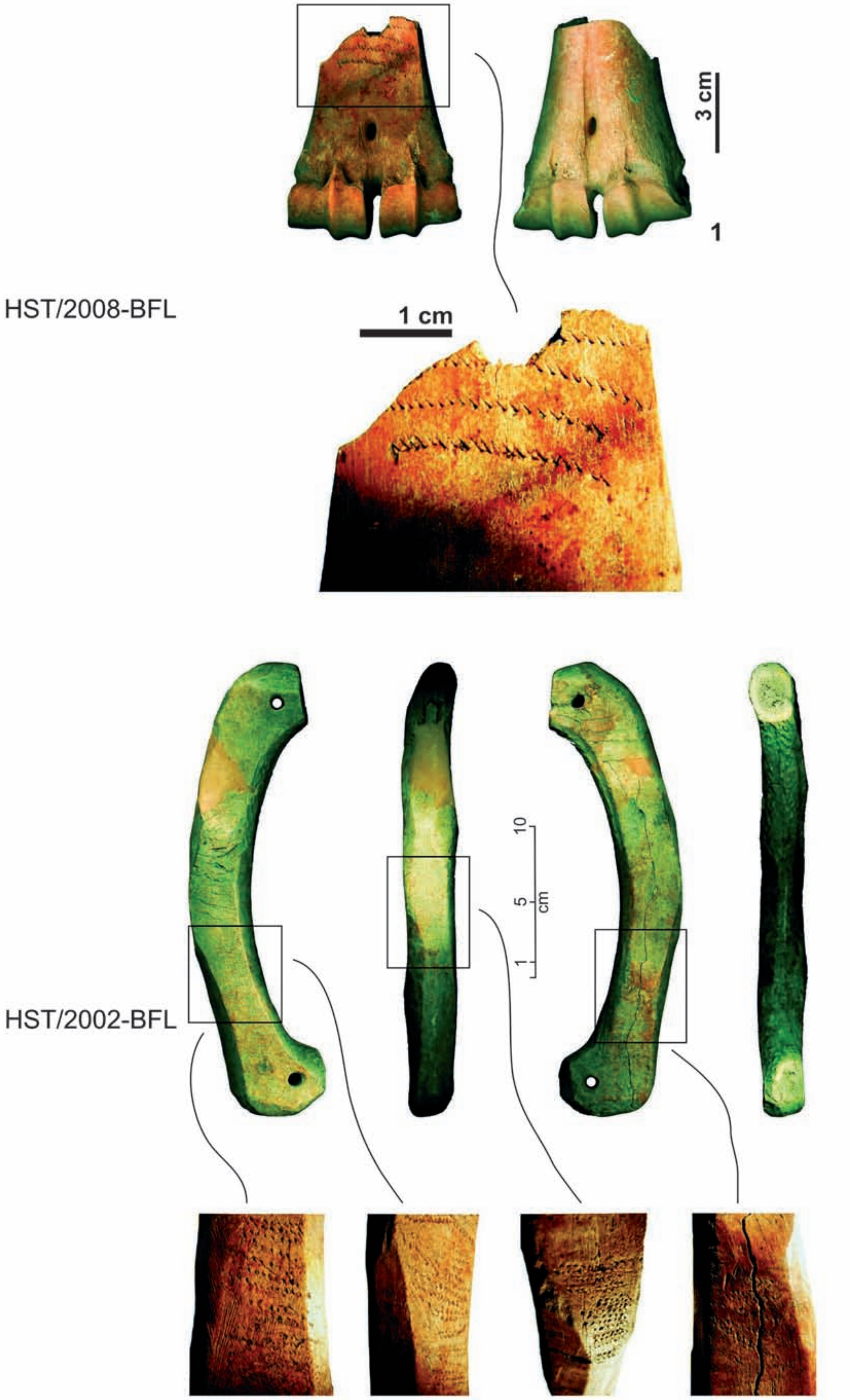


Fig. 3. Istria – Sector Basilica with Crypt ("Florescu").
Anvil on cattle metapodial: HST/2008-BFL 1. Anvil on segment of red deer antler beam: HST/2002-BFL 6

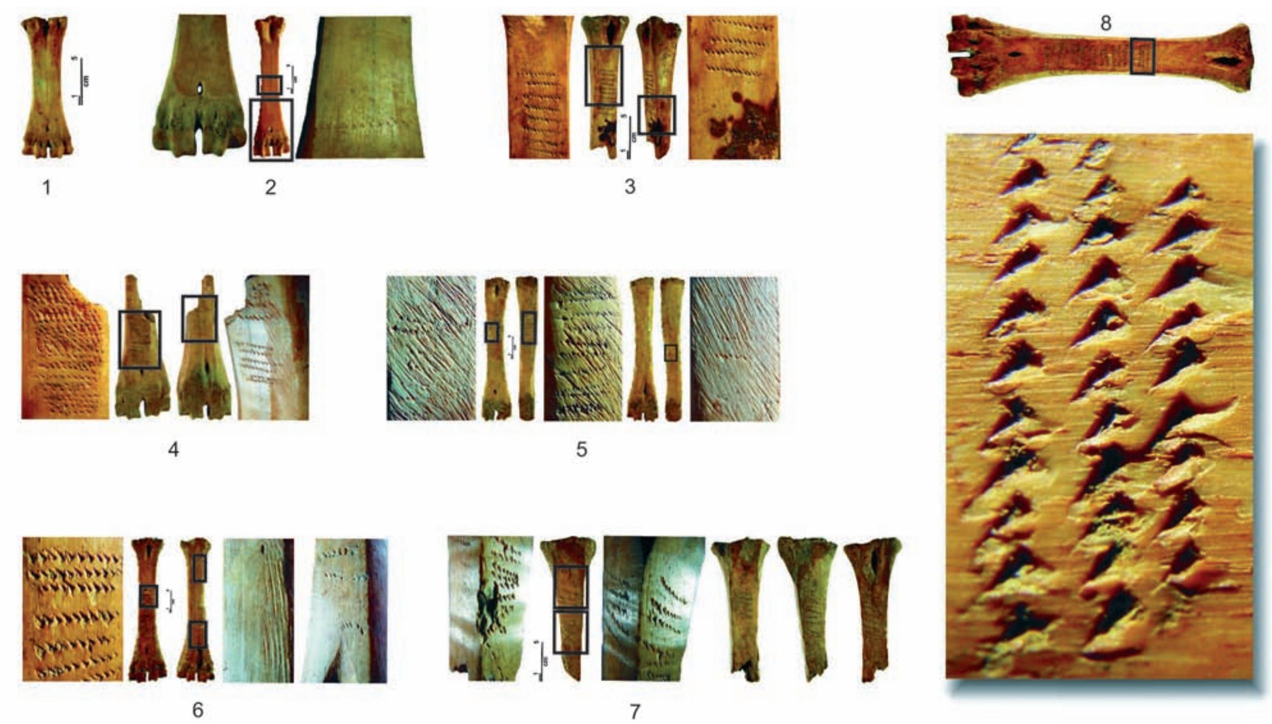


Fig. 4. Istria – Sector Basilica extra muros. Anvils on cattle metapodials – details of specific use-wear: 1 HST/2003-BEM 4 (raw material); 2 HST/2003-BEM 1 (anvil with one smooth surface); 3 HST/2003-BEM 6 (anvil with one smooth surface); 4 HST/2003-BEM 5 (anvil with two smooth surfaces); 5 HST/2001-BEM 1 (anvil with three smooth surfaces); 6 HST/2003-BEM 2 (anvil with two smooth surfaces); 7 HST/2003-BEM 2 (anvil with four smooth surfaces)

rescu's excavations. There are some clues that indicate chronological data during *grosso modo* the IInd century A.D. (Achim *et al.* 2009). From this sector two pieces have been analysed: a piece which was discovered in 2002 and another one found in 2008 (tables 1-2; charts 1-2).

Methodology. Typology

The methodology applied during our study takes into account the registration and the analysis of all essential data regarding: the artefacts' identification using a code (which is made up of the site's code, the discovery year, the sector's code and a serial number – for example: HST/2001-BEM 3); the realisation of the repertoire (which lays out the dataset regarding the code of the piece, discovery context, raw material, conservation status, subtype, description), morphometry (the total length/the preserved length; width/diameter of the edges and of the middle part; the length of active part on each side; maximal/minimal width of active part on each side – dimensions are given in millimetres).

Artefacts that are generically called anvils were set in a special wooden installation, on a workbench and were used in the façonnage/shaping of iron sickles (striking the serrated edges – using the technique of indirect percussion with a triangular section chisel/poinçon). This operation was applied at the initial shaping of the sickles' blades, and also at the sickles' repairs (Fig. 5).

The typological classification adopts conventional criteria which reflect the usage stage at the moment that the artefacts were abandoned. Taking into consideration the number of anvils' shaped anatomical faces/sides (which become active/smoothed parts) we may conventionally distinguish the next subtypes: simple anvils (with one active side), double anvils (with two active sides), triple anvils (with three active sides), quadruple anvils (with four active sides), undetermined subtypes (fragments) and raw material. As we already mentioned, the subtypes reflect the stage of shaping and usage of the artefacts (Beldiman *et al.* 2008:50-61) (Fig. 4).

The typological structure of the collection from Histria consists of: simple anvils (17), double anvils (6), triple anvils (2), quadruple anvils (6), undetermined subtypes (fragments) (2) and raw materials (7) (tables 1-2; charts 1-2).

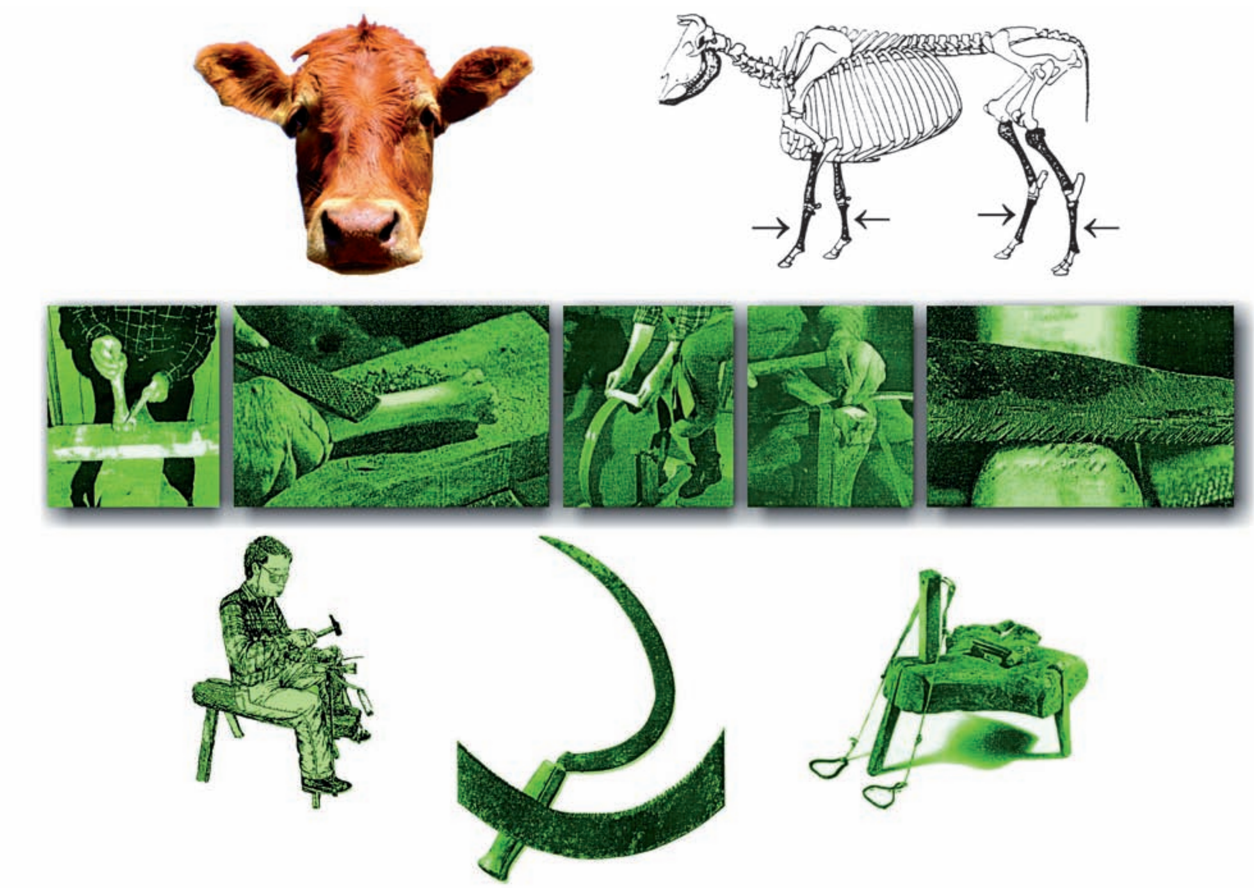


Fig. 5. Anvils on cattle metapodials: origin of raw material; phases of manufacture (façonage by chopping an polishing/abrasion); wooden installation and way of use as support for working of saw-toothed iron sickles (after Esteban Nadal, Carbonell Roure 2004:642-3, figs. 9-13; Moreno-Garcia, Pimenta, Ruas 2005:574, fig. 2; Rodet-Belarbi, Esteban Nadal, Forest, Moreno Garcia, Pimenta 2007:160, figs. 2-3)

Generally the raw materials used for these kinds of anvils were various: most of them are skeletal elements from large domestic mammals (cattle, horse, camel etc.): long bones (metapodials, tibia), mandibles, coxal bone. We also have some special cases when segments of red deer antler beams and tines were used.

Artefacts from HST-BEM are made only of cattle metapodials (metacarpal and metatarsal bones) (38 pieces). There is one exception at HST-BFL where an artefact is made of cattle metapodial and another of a red deer antler (tables 1-2; charts 1-2).

The aim of artefacts' analysis is to record all contextual, morphological, typological and technological data and to highlight the "manufacturing chain" and use wear. In this way, we may reconstruct "the technological biography" of each artefact. We currently use low power optical microscopy (4x-40x) with the aim of recording exhaustive data of the artefacts' traces of manufacture and use.

Manufacture and use

In most of the cases, the anvils were made of long bones (especially cattle and equid metapodials), but there are also cases when there have been used flat bones (like mandible). These pieces have one or more active parts shaped by chopping. They present specific triangular impressions in parallel or curved rows resulting from the operation of shaping active part of serrated sickles blades. In case of the metapodials, the surfaces of diaphysis were whittled down and smoothed. On this prepared surfaces, there are rows of triangular shaped dents. The artefacts may have one to four active parts where the smiths sharpened the serrated teeth of the sickles. The traces left by this procedure are represented by rows of triangular wholes. These rows are disposed parallel while others diverged, converged or they are crossed. The length the rows depended on the number of dents and the separation between them. There are some cases where the diaphysis was whittled and re-smoothed for more times with the purpose of reusing the artefact (Briois *et al.* 1997; Esteban Nadal, Carbonell Roure 2004; Moreno-Garcia *et al.* 2005a, 2005b, 2007; Poplin 2007a, 2007b; Rodet-Belarbi *et al.* 2007 – with bibliography).

Presented bone and antler anvils are made of cattle metapodials (*Bos taurus*) (39) and a segment of antler beam (*Cervus elaphus*) (1).

Firstly, we take into consideration the analysis of different traces of manufacture and use, so that we may propose the reconstitution of the phases of the standard "manufacturing chain" of the anvils on cattle metapodials: no débitage; façonnage/shaping in two stages: intensive chopping and abrasion/intense scrapping using a metal blade (a knife?) – so obtaining a flat and smooth surface. This smooth surface was made on one-two-three or four bone's anatomical faces (Fig. 5).

Wear traces are surprisingly uniform; the aim of using such pieces (anvils) was to shape (sawing-toothed) the iron sickle's active part (blade) or to reshape it. After all active parts/faces of the anvils were used and entirely covered by small triangular dents/hollows. There are often situations where the smooth surfaces are reshaped – including the fragments of pieces fractured on the middle part.

Wear traces were produced while the "sickle's teeth" were shaped. The dents produced have a length of 2-3 mm and were obtained by indirect striking with hammer – with a narrow active part – the cutting edge of the sickle's blade using an iron chisel/poinçon, probably one having a triangular section. The rows of around 5-10 dents are parallel, divergent, convergent or even crossed.

Covering the whole anvil's surface with rows of dents supposed: a) the preparation and the usage of another active part of anvil; there are cases when a single piece had four active parts which corresponded to the four anatomical bone's faces; those were prepared and used successively; b) unique or double reshaping of used surface by chopping, abrasion or scraping using a metal tool, as in the first stage of shaping. All these conclusions are based on observations of microscopic traces preserved on surfaces' anvils.

Because of the renewed shaping of the anvils, the compact tissue of metapodial got thinner and very often, the artefacts broke in the middle part. This break was due to the high pressure that was applied during use. In this case, the artefact was abandoned or, if the preserved length was sufficient, it was reused/reshaped.

The "technological biographies" of the anvils are various and generally implies several stages: 1. the preparation of the active part on an anatomical face/side of the bone; 2. using and covering it entirely with dents/hollows; 3. reshaping the side; 4. reusing and covering it entirely with dents/hollows; 5. preparing the active part on the second side; 6. using and covering it entirely with dents/hollows; 7. preparing the active part on the third side; 8. using and covering it entirely with dents/hollows; 9. establishing the active part on the fourth side; 10. using and covering it entirely with dents/hollows; 11. reshaping the side; 12. reusing; 13. abandoning. There are situations when probably at least two active sides were prepared from the first stage of shaping; but this hypothesis, ethnographically supported, is difficult to argue (Esteban Nadal, Carbonell Roure 2004:640-644; Moreno-Garcia *et al.* 2005b:623-624; Rodet-Belarbi *et al.* 2007:160).

Repertoire

Hereinafter, we will present typological fiches of some representative bone and antler anvils discovered at HST-BEM and HST-BFL.

HST/2001-BEM 1 • Fig. 1. Section I. Square 3. -1.56 m. On the ground-level of the iron processing workshop • Quadruple anvil made of metapodial; unbroken; the active part was shaped on four sides; raw material: cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping on all sides; use wears: dents/triangular hollows successively generated, measuring about 1 mm in length, and deep about 1 mm, arranged in rectilinear or curved short rows, almost parallels, placed transversal or oblique on the bone's flat surface. This type of traces was generated by indirect and very precise percussion using a hammer and a small iron chisel/poinçon with a distal part having probably a triangular section and a pointed end. The tool was reshaped by direct percussion/chopping. Total length 221; length of active part 150-160.

HST/2002-BEM 3 • Fig. 1. Section I. Square 5. -1.72 m. On the ground-level of the iron processing workshop • Simple anvil made of metapodial; broken in antiquity; detached epiphyses; proximal segment; active part was shaped on posterior side; raw material: cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping on posterior side; without dents/triangular hollows or wear traces; probably broken during the façonnage/shaping. Preserved length 125; length of active part 85-100.

HST/2003-BEM 2 • Fig. 1. Section I. Square 4. -2.15 m. From the rests of the furnace content (level of iron processing workshop) • Double anvil made of metapodial; unbroken; active part was shaped on two sides (anterior and posterior); raw material: cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping on all sides; use wears: dents/triangular hollows successively generated, measuring about 1-2 mm in length, and deep about 1 mm, arranged in rectilinear or curved short lines, almost parallels, placed transversal or oblique on the bone's flat surface. This type of trace had been generated by indirect, very precise percussion using a hammer and a small iron chisel with a distal part having probably a triangular section and a pointed end. Total length 215; length of active part 145-150.

HST/2004-BEM 1 • Fig. 2. Section I. Square 1. -1.72 m. In the area of furnace 2 (7) • Double anvil made of metapodial; broken in antiquity; active part was shaped on two sides (anterior and posterior); raw material: cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping on posterior side; use wears: dents/triangular hollows successively generated, measuring about 1-2 mm in length, and deep about 1 mm, arranged in rectilinear or curved short lines, almost parallels, placed transversal or oblique on the bone's flat surface. This type of trace had been generated by indirect very precise percussion using a hammer and a small iron chisel with a distal part having probably a triangular section and a pointed end. Preserved length 80; length of active part 75.

HST/2006-BEM 3 • Fig. 2. Section I. Square 5. -2.25 – 2.30 m. At the shaping of the "South" profile – from the rests of furnace no. 8 content; cattle metapodial; raw material; broken in Antiquity; superficial chopping at distal epiphysis at anterior side. Preserved length 177.

HST/2006-BEM 11 • Fig. 2. Section I. Square 5. -2.15 – 2.30 m. From the rests of the furnace no. 8 • Triple anvil made of metapodial; broken in antiquity; active part was shaped on posterior side; raw material: cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping on posterior side; use wears: dents/triangular hollows successively generated, measuring about 1-2 mm in length, and deep about 1 mm, arranged in rectilinear or curved short lines, almost parallels, placed transversal or oblique on the bone's flat surface. This type of trace had been generated by indirect very precisely percussion using a hammer and a small iron chisel with distal part having probably a triangular section. Preserved length 137; length of active part 50-115.

HST/2008-BFL 1 • Fig. 3. Section II. -1.13 – 1.38 m. Central nave, at the northern part of the brick pavement, from a brown level mixed with shells, rich in fragments of pottery • Simple anvil made of metapodial; broken in Antiquity; active part was shaped on posterior side; raw material: distal segment of cattle metapodial (*Bos taurus*); façonnage/shaping: direct percussion/chopping and axial scrapping on posterior side; use wears: 5 rows of dents/triangular hollows successively generated. Preserved length 75; Length of active part 45. Probably dated at about IInd century A.D.

HST/2002-BFL 6 • Fig. 3. Section I. Squares 11-12. -1.15 – 1.45 m. Site inventory no. 03[1] • Triple anvil made of red deer antler beam; secondary use of an earlier piece that had perforations at the ends, probably shaped probably as yoke – to fit across a person's shoulder so that can be carried two equal loads; raw material: red deer (*Cervus elaphus*) antler – basal segment of beam between the 2nd and the 3rd tines; the basal parts of tines are preserved; anatomic sides were shaped during first phase of manufacture using oblique chopping to remove the anatomical surface (perlure). In this way more planes were obtained, with smooth surfaces (multifaceted aspect). These sides were used in the second phase as anvils. Use wears: on the posterior, medial and lateral side of the beam segment we may distinguish rows of dents/triangular hollows successively generated, arranged in rectilinear or curved short lines; this type of traces had been generated by indirect very precise percussion using a small iron chisel with distal part having probably a triangular section and a pointed end. Some surfaces with dents/triangular hollows were reshaped using axial scraping and abrasion (secondary using). Total length 295; length of active parts 140-150; proximal end at perforation level 61/30; middle part 41/32; distal end at perforation level 62/32; diameter of perforation 10. Dated probably at about IInd century A.D.

[1] According to the preliminary available data, in previous publications 2003 is the year mentioned for the discovery of this artefact – Beldiman, Sztancs 2009a. Actually, the object was retrieved in the 2002 archaeological season.

Analogies

Anvils made of cattle or horse metapodials, tibias, mandibles, coxal bone etc. as well as those made of red deer antler were also discovered in other sites from Romania: Ostrov-Durostorum, Constanța County (ancient Roman city; discoveries in an adjacent site with carious workshops located near the city; 4 artefacts: Beldiman, Elefterescu, Sztancs 2009; Beldiman, Elefterescu, Sztancs 2010); Chitila, Ilfov County (open-air small site belonging to Getic autochtonous population from the Roman period; 13 artefacts: Boroneanț 2003; 2005; Bălăşescu, Radu, Nicolae 2003). These discoveries represent the analogies from Romania for the artefacts retrieved at Histria which are presented on this occasion.

In this context, we should mention the unique artefact HST/2002-BFL 6, the biggest one until now (a yoke? – reused as an anvil) which, so far, doesn't have analogies in the archaeological literature consulted. Red deer antler artefacts were initially manufactured and used like anvils and are also (but rarely) published in Romanian literature. There is another piece made of a segment of an antler's beam in Romania at Durostorum (Beldiman *et al.* 2010, fig. 4 – piece DRS 4) and in Republic of Moldavia at Saharna Nouă – a piece made of a segment of antler tine (Arnăut 2007:302, fig. 1, 3).

Wear traces that are preserved on these artefacts are identical or very similar to those observed on the pieces from Histria because of their use as anvils for shaping the sawing-toothed sickles.

Aspects of the economy. Conclusion

The bone and antler artefacts, discovered at HST-BEM and HST-BFL, (the oldest known until now in Romania) are very important finds that complete the list of discoveries which add to discoveries from other Central-Eastern European sites, i.e. those from Republic of Moldova and Ukraine. Also, they are important as they provide precise data for craft activities during the IInd century AD. The presence of "Histrian anvils" provides supplementary and specific arguments for the existence of metal-working workshops in the area. The existence of bone/antler workshops are also attested in the same area by the artefacts (associated in pits with anvils), like bone and horn waste. This is why we can presume that the anvils were shaped in the workshops too. As we know, sickles were frequently used in the harvesting of cereals in many agrarian regions of the Western Pontic shore as well. Such worked bone and antler finds are not yet systematically published by the authors of excavations or by the archeozoologists; thus, the idea about spread in time and space of manufacture and use of these artefacts is still very partial for proto-historic and historic sites in Romania or other regions of Europe and Africa. For this reason anvils have been occasionally analysed.

The artefacts under discussion show the specific and unique connections between different activities (in our case, iron smelting and the manufacture of agrarian tools, the bone and antler industry and harvesting techniques). The analysis of the bone and antler pieces and also the anvils shed light on the complex problem regarding the antique economy and iron and bone & antler technology in the region of the Lower Danube[2]

The artefacts presented in this paper offer the opportunity to draw for the first time conclusions regarding the bone and antler industry at Histria. The study should be continued with further approaches regarding the pieces that were discovered in ancient archaeological excavations or in recent ones carried out in other areas of the site.

[2] For a more general discussion on the antique economy in the Dobrogea region see Suceveanu 1977, 1998.

Table 1. Istria/2001-2008 – Sector Basilica extra muros (BEM) and Basilica with Crypt ("Florescu") (BFL). Bone and red deer anvils: distribution after raw materials and year of discovery

Typological category	2001		2002		2003		2004		2006		2008		Total	
	BEM	BFL	BEM	BFL	BEM	BFL	BEM	BFL	BEM	BFL	BEM	BFL	BEM	BFL
I Tools Bone anvils	3	–	3	–	7	–	12	–	13	–	–	1	38	1
I Tools Red deer antler anvils	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Total	3	–	3	1	7	–	12	–	13	–	–	1	38	2

Table 2. Istria/2001-2008 – Sector Basilica extra muros (BEM) and Basilica with Crypt ("Florescu") (BFL). Bone and red deer anvils: distribution after subtypes and year of discovery

Subtype	**HST – Sectors**												**Total**
	BEM	**BFL**	**BEM**	**BFL**	**BEM**	**BFL**	**BEM**	**BFL**	**BEM**	**BFL**	**BEM**	**BFL**	
	2001		**2002**		**2003**		**2004**		**2006**		**2008**		
I	2	–	2	1	3	–	4	–	5	–	–	–	17
II	–	–	–	–	2	–	4	–	–	–	–	–	6
III	–	–	–	–	–	–	–	–	1	–	–	1	2
IV	1	–	–	–	1	–	2	–	2	–	–	–	6
UN	–	–	–	–	–	–	2	–	–	–	–	–	2
RM	–	–	1	–	1	–	–	–	5	–	–	–	7
Total	3	–	3	1	7	–	12	–	13	–	–	1	40

UN = Undetermined subtype (fragments); RM = Raw material (technically non-modified metapodials)

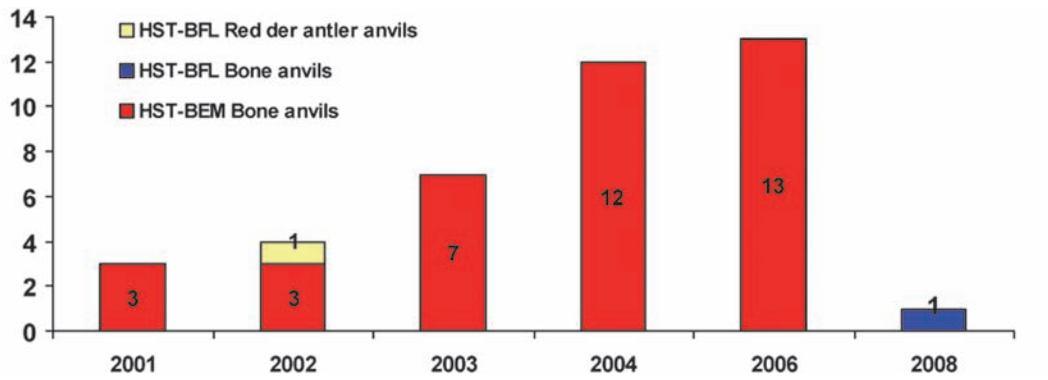


Chart 1. Istria/2001-2008 – Sector Basilica extra muros (BEM) and Basilica with Crypt ("Florescu") (BFL). Bone and red deer anvils: distribution after raw materials and year of discovery

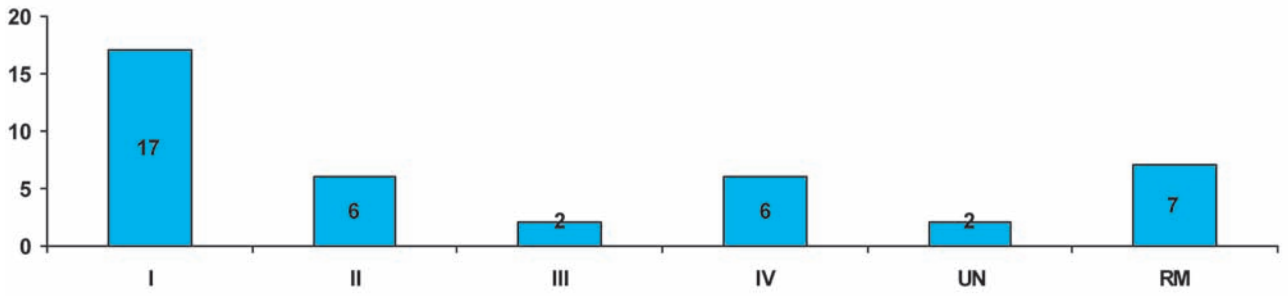


Chart 2. Istria/2001-2008 – Sector Basilica extra muros (BEM) and Basilica with Crypt ("Florescu") (BFL). Bone and red deer anvils: distribution of subtypes

Acknowledgements

During the last three decades, the remarkably constant and successfully efforts to fully research the topic of ancient bone and antler anvils are due to the efforts Dr. François Poplin – Museum National d'Histoire Naturelle, Paris. First author would like to express once again his warmest thanks to Dr. Poplin for his kind support in giving the chance to study the hard-to-find literature relating to this specific problem and for the profitable exchange of opinions and data).

We wish also thank to Dr. Alice Choyke and Dr. László Bartosiewicz who gave us access to very fresh articles dealing with discoveries from Italy and Hungary.

The contributions of Diana-Maria Sztancs to the present paper (database, artefact analysis etc.) form part of Project ID-7706 (*Invest in people!-The development of doctoral studies' and the PhD students' competitiveness in the United Europe*), "Lucian Blaga" University, Sibiu, project financed by Social European Fund (SOP HRD).

English version by Diana-Maria Sztancs and Corneliu Beldiman; translation revised by Andreea-Daniela Hompoth.

References

Achim, I.A., C. Beldiman and Fl. Munteanu 2009. *Istria, Sector: Basilica cu criptă („Florescu")*, In: M.-V. Angelescu, I. Oberländer-Târnoveanu, Fl. Vasilescu, O. Cârstina and Gh. Olteanu (eds.) *Cronica cercetărilor arheologice din România. Campania 2008. A XLIII-a Sesiune națională de rapoarte arheologice, Târgovişte, 27-30 mai 2009*, Valachica 21-22, 2008-2009, Complexul Național Muzeal „Curtea Domnească" Târgovişte-CIMEC, Târgovişte, 129-31.

Aguirre, A., F. Etxeberria and L. Herrasti 2004. *El yunque de hueso para afilar la hoz metálica dentada*, Munibe 56, 113-21.

Arnăut, T. 2007. *Data about a category of bone tools with the function of polishing and shaping*, Thracia 17, 295-305.

Bartosiewicz, L. 2010. *Állatmaradványok Baj-Öreg-Kovács-hegy késő középkori udarházának ásatásából*, In: S. Petényi (ed.) *A baji nemesi udvarház gazdasági tevékenységéről, különös tekintettel a tímárkodásra. Adatok a középkori magyar bőripar történetéhez*, Tata: Kuny Domokos Múzeum, 30/59.

Bălăşescu, A., V. Radu and C. Nicolae 2003. *Fauna de la Chitila-„Fermă". Studiu arheozoologic preliminar, Bucureşti*, Materiale de istorie şi muzeografie 17, 3-10.

Beldiman, C., D. Elefterescu and D.-M. Sztancs 2009. *Nicovale din materii dure animale descoperite la Durostorum*, Buletinul Muzeului „Teohari Antonescu", Giurgiu 12, 107-19.

Beldiman, C., I.A. Achim and D.-M. Sztancs 2009. *Artefacte din materii dure animale descoperite la Istria-Basilica cu criptă („Florescu")*, Buletinul Muzeului "Teohari Antonescu", Giurgiu 12, 95-105.

Beldiman, C., D. Elefterescu and D.-M. Sztancs 2010. *Ostrov-Durostorum. Industria materiilor dure animale*, In: M.-V. Angelescu, C. Bem, I. Oberländer-Târnoveanu, Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2009. A XLIV-a Sesiune națională de rapoarte arheologice, Suceava, 27-30 mai 2010,* Ministerul Culturii şi Patrimoniului Național, Comisia Națională de Arheologie, CIMEC, Complexul Muzeal „Bucovina" Suceava, Muzeul Național de Istorie a României, Bucureşti, 132-6.

Beldiman, C., V. Rusu-Bolindeț, Al. Bădescu and D.-M. Sztancs 2008. *Istria-Sectorul Basilica extra muros. Artefacte din materii dure animale descoperite în campaniile 2001-2004*, Materiale şi cercetări arheologice. Serie nouă 4, 39-61; http://www.instarhparvan.ro/ pagini%20institutimag%20luccru/ reviste%20pdf/ mca2008/ 03.pdf.

Beldiman, C., V. Rusu-Bolindeț and D.-M. Sztancs 2007. *Artefacte din materii dure animale descoperite la Istria-Sectorul Basilica extra muros*, Buletinul Muzeului „Teohari Antonescu", Giurgiu 10, 181-90.

Beldiman, C. and D.-M. Sztancs 2007. *Istria, Sector: Basilica extra muros. Industria materiilor dure animale,* In: M.-V. Angelescu and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2006. A XLI-a Sesiune națională de rapoarte arheologice, Tulcea, 29 mai-1 iunie 2007*, CIMEC, Bucureşti, 202-5.

Beldiman, C. and D.-M. Sztancs 2009a. *Istria, Sector: Basilica extra muros. Industria materiilor dure animale*, In: M.-V. Angelescu, I. Oberländer-Târnoveanu, Fl. Vasilescu, O. Cârstina and Gh. Olteanu (eds.) *Cronica cercetărilor arheologice din România. Campania 2008. A XLIII-a Sesiune națională de rapoarte arheologice, Târgovişte, 27-30 mai 2009*, Valachica 21-22, 2008-2009, Complexul Național Muzeal „Curtea Domnească" Târgovişte-CIMEC, Târgovişte, 129.

Beldiman, C. and D.-M. Sztancs 2009b. *Istria, Sector: Basilica cu criptă ("Florescu"). Industria materiilor dure animale*, In: M.-V. Angelescu, I. Oberländer-Târnoveanu, Fl. Vasilescu, O. Cârstina and Gh. Olteanu (eds.) *Cronica cercetărilor arheologice din România. Campania 2008. A XLIII-a Sesiune națională de rapoarte arheologice, Târgovişte, 27-30 mai 2009*, Valachica 21-22, 2008-2009, Complexul Național Muzeal „Curtea Domnească" Târgovişte-CIMEC, Târgovişte, 131.

Beldiman, C. and D.-M. Sztancs 2010a. *Istria-Basilica cu criptă („Florescu"). Industria materiilor dure animale*, In: M.-V. Angelescu, C. Bem, I. Oberländer-Târnoveanu and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2009. A XLIV-a Sesiune națională de rapoarte arheologice, Suceava, 27-30 mai 2010,* Ministerul Culturii şi Patrimoniului Național, Comisia Națională de Arheologie, CIMEC, Complexul Muzeal „Bucovina" Suceava, Muzeul Național de Istorie a României, Bucureşti, 90-3.

Beldiman, C. and D.-M. Sztancs 2010b. *Istria-Basilica extra muros. Industria materiilor dure animale*, In: M.-V.

Angelescu, C. Bem, I. Oberländer-Târnoveanu and Fl. Vasilescu (eds.), *Cronica cercetărilor arheologice din România. Campania 2009. A XLIV-a Sesiune națională de rapoarte arheologice, Suceava, 27-30 mai 2010,* Ministerul Culturii şi Patrimoniului Național, Comisia Națională de Arheologie, CIMEC, Complexul Muzeal „Bucovina" Suceava, Muzeul Național de Istorie a României, Bucureşti, 93-5.

Beldiman, C., D.-M. Sztancs, V. Rusu-Bolindeț and Al. Bădescu 2010. *Istria-Sectorul Basilica extra muros. Artefacte din materii dure animale descoperite în campaniile 2001-2004*, Analele Universității Creştine „Dimitrie Cantemir". Seria Istorie, Serie nouă 1, 30-52.

Boroneanț, V. 2003. *Câteva oseminte de cal ornamentate descoperite la Chitila-„Fermă", Bucureşti,* Materiale de istorie şi muzeografie 17, 11-25.

Boroneanț, V. 2005. *Scrierea pe oase – o scriere necunoscută identificată în săpăturile arheologice de la Chitila, Bucureşti*, Materiale de istorie şi muzeografie 19, 12-35.

Briois, F., F. Poplin and I. Rodet-Belarbi 1997. *Aiguisoirs, polissoirs médiévaux en os (XI^{e}-XIV^{e} s.) dans le Sud-Ouest de la France*, Archéologie du Midi Médiéval 15, 1995 (1997), 197-213.

Esteban Nadal, M. and E. Carbonell Roure 2004. *Sawtoothed sickles and bone anvils: a medieval technique from Spain*, Antiquity 78(301), 637-46.

Gál, E. 2010. *Bone artifacts from the chora of Metaponto*, In: L. Bartosiewicz (ed.) *Archaeozoology at Pantanello and Five Other Sites*, Austin: University of Texas, 71-86.

Gál, E., E. Kovács, I. Kováts and G. Zimborán 2010. *Kora középkori csontüllők Magyarországról: egy újabb példa az állatcsontok hasznosítására. Early medieval (10th-13th century) bone anvils from Hungary. Another example for the use of animal bones*, In: J. Gömöri and J. Szulovszky (eds.) *Csont és bőr Az állati eredetű nyersanyagok feldolgozásának története, régészete és néprajza. Bone and Leather. History, Archaeology and Ethnography of Crafts Utilizing Raw Materials from Animals*, Budapest, 117-26.

Gömöri, J. and J. Szulovszky 2010 (eds.) *Csont és bőr Az állati eredetű nyersanyagok feldolgozásának története, régészete és néprajza. Bone and Leather. History, Archaeology and Ethnography of Crafts Utilizing Raw Materials from Animals*, Budapest: Nemzeti Kulturális Alap Magyar Tudományos Akadémia VEAB Soproni, Nyugat-Magyarországi Egyetem, Sopron.

Fondul Național Cultural din cadrul Academiei Maghiare de Ştiințe, Sopron Academic VEAB Hortobágyi Conservarea Societatea Gene Ltd. Universitatea de Vest din Ungaria, Sopron.

José Gonçalves, M., V. Pereira and A. Pires 2008. *Ossos trabalhados de um arrabalde islâmico de Silves: aspectos funcionais*, In: *Actas do 5º Encontro de Arqueologia do Algarve*, Câmara Municipal de Silves, 187-214.

Kőrősi, A. 2010. *Szarmata és avarkori csonteszközök Felgyő-Kettőshalmon. Typology of the Worked Bone Implements from Felgyő-Kettőshalmi dűlő*, In: J. Gömöri and J. Szulovszky (eds.) *Csont és bőr Az állati eredetű nyersanyagok feldolgozásának története, régészete és néprajza. Bone and Leather. History, Archaeology and Ethnography of Crafts Utilizing Raw Materials from Animals*, Budapest, 100-16.

Kvassay, J. and I. Vörös 2010. *Az Árpád-kori Kolon falu kovácsműhelyének archaeozoológiai bizonyítékai. The Archaeozoological Proof of a Smithy from the Árpád Period Village of Kolon*, In: J. Gömöri and J. Szulovszky (eds.) *Csont és bőr Az állati eredetű nyersanyagok feldolgozásának története, régészete és néprajza. Bone and Leather. History, Archaeology and Ethnography of Crafts Utilizing Raw Materials from Animals*, Budapest, 127-42.

Moreno-Garcia, M., M. Esteban Nadal, C. Pimenta, M.D. Lopez Gila, I. Rodet-Belarbi, A. Morales and J.P. Ruas 2005a. *Bone anvils: not worked bones but bones for working*, In: *5th International Meeting of the ICAZ Worked Bone Research Group, August 29 – September 3, 2005,* Veliko Turnovo University, Abstracts, online: http://www.wbrg.net/index.php\abstracts; accessed 10.03.2011.

Moreno-Garcia, M., C.M. Pimenta, J.P. Ruas 2005b. *Safras em osso para picar foicinhas de gume serrilhado… a sua longa história!*, Revista Portuguesa de Arqueologia 8(2), 571-627.

Moreno-Garcia, M., C.M. Pimenta, P.M. López Aldana, A. Pajuelo Pando 2007. *The Signature of a Blacksmith on a Dromedary Bone from Islamic Seville (Spain)*, Archaeofauna 16, 193-202.

Peters, B.G. 1986. *Kostoreznoe delo v antičnyh gosudarstvah Severnogo Pričernomor'ja*. Moskva.

Poplin, F. 2007a. *Des os supports à denter les faucilles: une longue histoire technologique dans le bassin de la Méditerranée et de la mer Noir*, Bulletin de la Société des Antiquaires de France, 215-21.

Poplin, F. 2007b. *Des faucilles de silex sur andouillers de cerf de Çatal Hüyük (Turquie) aux faucilles de fer dentées sur metapodes de boeuf de Montaillou (Occitanie): une histoire de longue durée à travers l'espace méditerranéen*, In: I. Sidéra, E. David, A. Legrand (eds.) *6th Meeting of the Worked Bone Research Group/ICAZ, August 27th-31st 2007, Abstracts*, Maison de l'Archéologie et de l'Ethnologie René Ginouvès, Université Paris X-Nanterre, Paris, 9, abstract no. 20; http://www.wbrg.net/images/stories/abstracts_paris_2007.pdf; accesed 20.09.2010.

Rodet-Belarbi, I., M. Esteban Nadal, V. Forest, M. Moreno Garcia and C. Pimenta 2007. *Des aiguissoirs/polissoirs aux enclumes en os: l'historiographie des os piquetés*, Archéologie Médiévale 37, 157-67.

Rusu-Bolindeț, V. and Al. Bădescu 2006. *Histria. Sectorul Basilica extra muros*, Studii şi cercetări de istorie veche şi arheologie 54-56, 2003-2005 (2006), 103-30.

Rusu-Bolindeț, V., Al. Bădescu, Vl. A. Lăzărescu, L. Grumeza and A.-L. Ignat 2010. *Istria, Sector: Basilica extra muros*, In: M.-V. Angelescu, C. Bem, I. Oberländer-Târnoveanu and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2009. A XLIV-a Sesiune națională de rapoarte arheologice, Suceava, 27-30 mai 2010*, Ministerul Culturii şi Patrimoniului Național, Comisia Națională de Arheologie, CIMEC, Complexul Muzeal „Bucovina" Suceava, Muzeul Național de Istorie a României, Bucureşti, 87-90.

Rusu-Bolindeț, V., Al. Bădescu, Vl. Lăzărescu, O. Toda, M. Dunca, Chr.M. Turcu, A.-L. Ignat, O. Grecu, R. Mischean and I. Varvari 2009. *Istria, Sector: Basilica extra muros*, In: M.-V. Angelescu, I. Oberländer-Târnoveanu, Fl. Vasilescu, O. Cârstina and Gh. Olteanu (eds.) *Cronica cercetărilor arheologice din România. Campania 2008. A XLIII-a Sesiune națională de rapoarte arheologice, Târgovişte, 27-30 mai 2009*, Valachica 21-22, 2008-2009, Complexul Național Muzeal „Curtea Domnească" Târgovişte-CIMEC, Târgovişte, 127-9.

Semenov, S. A. 1970. *Prehistoric Technology. An Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*, Second edition. Bath-Somerset.

Suceveanu, Al. 1977. *Viața economică în Dobrogea romană (secolele I-III e.n.)*, Bucureşti: Institutul de Arheologie „Vasile Pârvan".

Suceveanu, Al. 1998. *Fântânele. Contribuții la studiul vieții rurale în Dobrogea romană*, Bucureşti: Institutul de Arheologie „Vasile Pârvan".

Suceveanu, Al. 2010. *Istria*, In: M.-V. Angelescu, C. Bem, I. Oberländer-Târnoveanu and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2009. A XLIV-a Sesiune națională de rapoarte arheologice, Suceava, 27-30 mai 2010*, Ministerul Culturii şi Patrimoniului Național, Comisia Națională de Arheologie, CIMEC, Complexul Muzeal „Bucovina" Suceava, Muzeul Național de Istorie a României, Bucureşti, 81-95.

Suceveanu, Al. and M.V. Angelescu, coord. 2005. *Histria. Ghid album*, Constanța.

Suceveanu, Al., I.A. Achim, M. Dabâca and S. Farcaş 2003. *Istria, Sector: Basilica Florescu*, In: M.-V. Angelescu, C. Borş and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2002. A XXXVII-a Sesiune națională de rapoarte arheologice, Covasna, 2-6 iunie 2003*, CIMEC, Bucureşti, 162-3.

Suceveanu, Al., V. Rusu-Bolindeț, Al. Bădescu and I. Bulgarea 2004. *Istria, Sector: Basilica extra muros*, In: M.-V. Angelescu, I. Oberländer-Târnoveanu and Fl. Vasilescu (eds.) *Cronica cercetărilor arheologice din România. Campania 2003. A XXXVIII-a Sesiune națională de rapoarte arheologice, Cluj-Napoca, 26-29 mai 2004*, CIMEC, Bucureşti, 156-8.

Katrin Struckmeyer

The bone tools from the dwelling mound Feddersen Wierde, Germany, and their functions

The excavation of the dwelling mound (*Wurt*) Feddersen Wierde, located in northwest Germany, yielded a well preserved assemblage of bone, antler and horn tools with more than 1,400 artefacts. The site was established in the 1st century BC and ended in the 5th century AD. The focus of the paper is on the functional identification of the bone objects which cover a wide range of types. Most of the artefacts were only slightly modified and can be interpreted as tools for scraping or rubbing activities. But it is unknown what processes these tools were used for in detail. To gain further information about their functions microscopic use-wear studies were carried out. This was done in combination with experiments by which different materials were worked with replicas of bone tools. In addition, ethnographical sources were included in the analysis.

Keywords: Northern Germany, 1st millennium AD, dwelling mound, use-wear

The site

Between 1955 and 1963, the Lower Saxony Institute for Historical Coastal Research excavated the site of Feddersen Wierde (Fig. 1). The settlement was established in the marshland of north-western Germany in the 1st century BC and ended in the 5th century AD. Initially, the houses were standing parallel to each other at sea level. Increasing oceanic flooding led to the construction of an elevated village in the 1st century AD. This time the design was altered to a circular arrangement of houses. In the 3rd century AD the dwelling mound reached its maximum size of approximately 4 hectares and a height of 4 metres (Haarnagel 1979; Schmid 2002).

The economic basis of the settlement consisted of agriculture, especially animal husbandry. In the farm houses, which were up to 30 m long and 7 m wide, as many as 32 large animals, mainly cattle could be kept. The zoological analysis of the animal bones proves that cattle formed the highest percentage followed by sheep and horses. There are only a few pig remains. Such a distribution of animal bones is characteristic of settlements along the coast of northwest Germany (Reichstein 1991).

Among the finds of Feddersen Wierde there are a lot of imports such as millstones, Roman glass, beads, fibulas, coins, and *terra sigillata*. Moreover, an ophthalmologic instrument and an ivory handle of a folding fan were excavated. These imports prove the intensive connections to both neighbouring and remote Germanic settlements and to the Roman Empire.

The assemblage

Because of the humidity of subsequently added layers of flooring, the organic matter from the settlement Feddersen Wierde, such as the wooden foundations of the buildings, plant rests, textiles and animal bones,

Fig. 1: View of Feddersen Wierde during excavations (photo: NIhK)

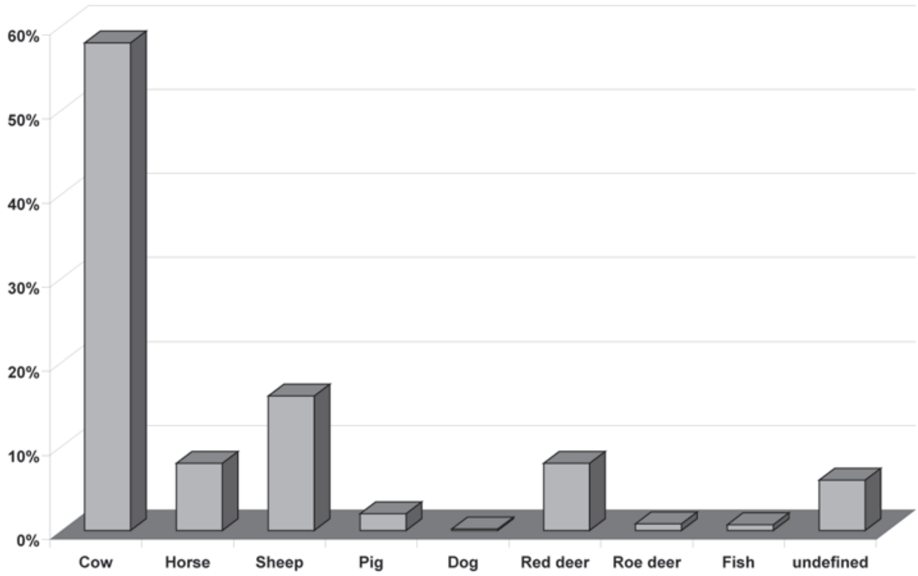


Fig. 2: Relative frequency of animal species among the raw materials

was outstandingly well preserved (Fig. 1). Among the artefacts there are about 1,400 bone, antler and horn tools and 58% of these tools were made of cattle bones. The remaining pieces are bones of sheep (16%) and horses (8%). Occasionally, also bones of pigs and dogs were found among the tools (Fig. 2). The worked antlers of Feddersen Wierde were derived from red deer and roe deer. As there was no habitat for these animals in the surroundings of the settlement, antler had to be imported. Probably only the antler was imported, because there were nearly no bones of red and roe deer in the village. Finally there are some worked bones of sturgeons (*Acipenser sturio*) and one perforated vertebra of a meagre (*Argyrosomus regius*). In manufacturing the different types of objects similar skeletal elements of only particular species were used.

Microscopic use-wear studies and experiments

The bone tools of Feddersen Wierde cover a wide range of types. Most of these objects were only slightly modified and may have been used in many different ways. To gather more information about the function of tools in the past, microscopic use-wear analyses were carried out. This was com-

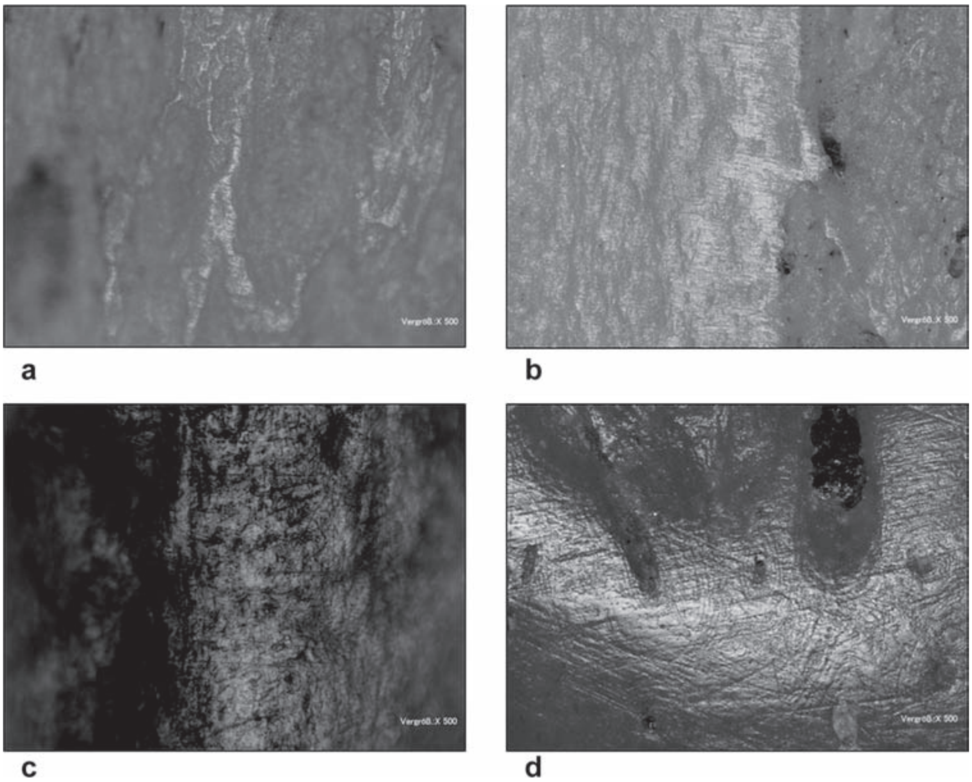


Fig. 3: Experimental wear traces.
a, b: bone used to smooth clay for 120 minutes.
c: bone used to smooth fresh cattle skin for 140 minutes.
d: bone used for debarking willow for 90 minutes;
a-d: 500x magnification

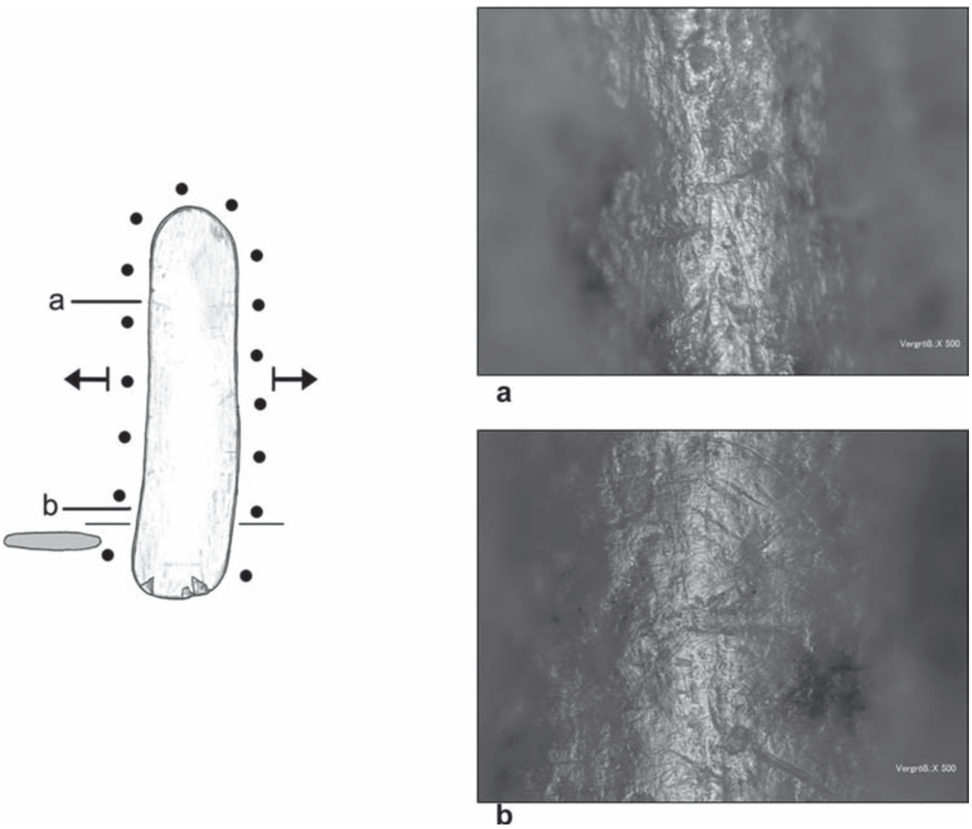


Fig. 4: Rib with rounded ends (nr. 224);
a-b: 500x magnification.
Drawing by T. Peek

bined with experiments which partly took place in the Lejre Experimental Centre, Denmark. In the course of these experiments different materials, which were available in the surroundings of Feddersen Wierde, were worked with replicas of bone tools (Fig. 3).

Ribs with rounded ends

Among the bone tools there are more than 400 objects made of cattle and horses' ribs. The modification of these ribs is restricted to the ends which have a rounded shape. The microscopic analysis shows that the flat edges and the rounded ends of the tools were in contact with the worked material. The use-wear appears as a bright polish whose structure looks much closed. It is mainly distributed at the high points of the surface whereas in the depressions the polish is only sporadic and less intense. Moreover a lot of closely spaced, very flat striations run perpendicularly to the edge (Fig. 4).

Experiments have revealed that on reconstructed bone tools used for polishing pottery comparable wear traces are visible which are characterized in particular by flat striations. In addition, the polish is spread on the highest areas of the surface and is closely linked (Fig. 3:a-b; van Gijn 2006:217, fig. 10:9e; Gates St-Pierre 2007:112, fig. 13). Due to these typical features the modified ribs of Feddersen Wierde are interpreted as tools used for the manufacture of pottery. The direction of the wear suggests that the working motion runs transverse to the edge of the artefacts.

By using these tools it was possible to smooth leather-hard pottery and to produce a uniformly thick surface. This reduced the risk of disruption during the firing process. Moreover the clay could be compressed with the tools so that the vessels became impermeable. Finally the treatment of burnishing lefts a slight gloss on the surface (Peacock 1982:60; Abbink 1999:54). The variability among the rounded ribs of Feddersen Wierde can be attributed to the fact that a wide range of tools having different size and shape was necessary in order to facilitate the production of various types of vessels. Long, slightly curved ribs could be used for finishing large vessels with a flat curvature, whereas small bone objects were also suited for smoothing their inside.

Metapodia with a bevelled edge

More than 200 tools of Feddersen Wierde are made of metapodia of cattle and horses. They were split lengthwise and have a bevelled edge with rounded sides at their distal end (Fig. 5). Under the microscope, the bones display a smooth surface and extensive rounding. The polish, which is also found at the bottom of depressions, is characterized by a rough, grainy texture. The distribution of the traces is perpendicular to the bevelled edge and follows the irregularities of the bone surfaces (Fig. 5:b).

The use-wear points to rubbing or scraping activity consisted of a back and forth movement. The rounded edges of the tools suggest that soft materials came in contact with them. The microscopic analysis of bone tools experimentally worked with animal skins have shown similar use-wear like rounded edges and a rough polish which is also present in depressions and scratches (Fig. 3:c; Christidou, Legrand 2005; van Gijn 2007:82, fig. 6:a-b). Probably animal skins were smoothed and stretched or remains of meat and tissue were removed with the bone tools.

Besides the use in leather manufacture the function of the objects should also be considered in the context of textile processing. On the one hand the objects could be utilized as pin beaters. By pushing up the loose weft use-wear develops at the tools' working edge. On the other hand it was possible to smooth textiles with the bones. Furthermore seams could be squeezed out. A comparable object made of a roe deer's metatarsus came from a sewing kit of the 19th century and was used to smooth line seams (Pfeiffer 1912:181, fig. 4).

In contrast to these carefully manufactured tools there are some objects whose surfaces were less smoothed and their working ends show no intense rounding (Fig. 6). These features apply mainly to artefacts over 15 cm long or which have a wide working end. Among the tools there are an increased number of metapodia taken from horses, which naturally are of great length, and some metapodia from cattle which were cut directly above their distal end so that a wide edge could be created. Wear traces indicate that these roughly manufactured artefacts have to be regarded as final products.

Analysing one of these tools, compression of the surface can be demonstrated at one point (Fig. 6:a). Moreover there is very smooth and bright, closely linked polish visible (Fig. 6:b). Next above the distal end the wear occurs more scattered. The edge is slightly split out and not regularly rounded.

It seems that hard material was worked with a tool such that high pressure had to be imposed onto the bone's edge. Identical traces in terms of a very bright polish with only a few striations are visible on tools used in processing bark (Fig. 3:d; Gates St-Pierre 2007:111; van Gijn 2007:82, fig. 5:a). The direction

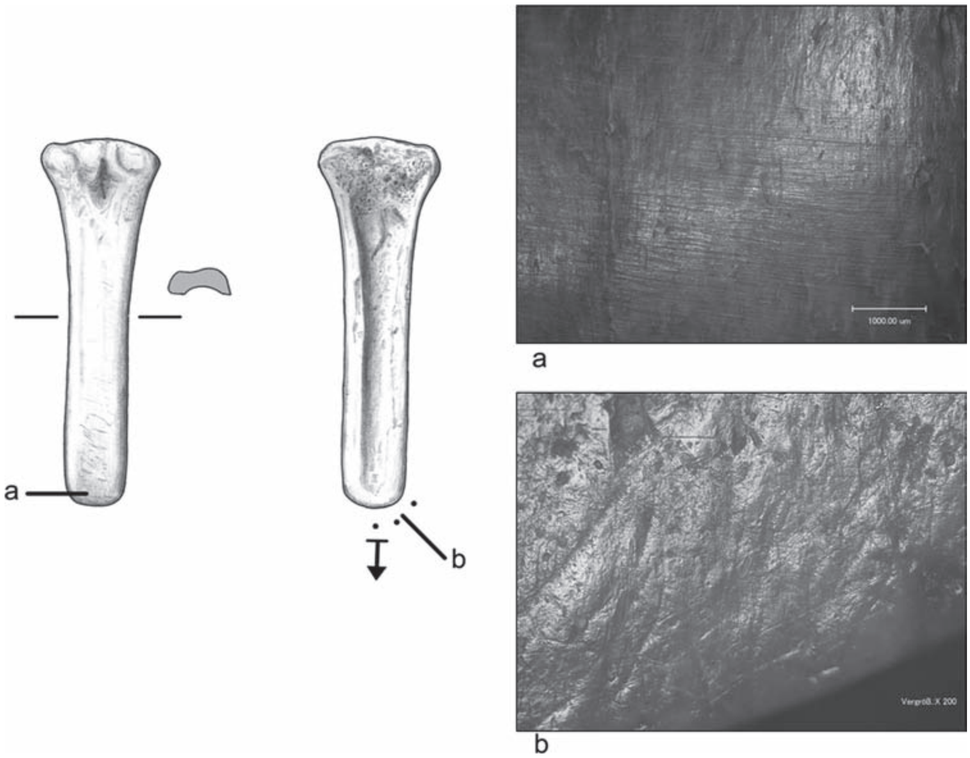


Fig. 5: Metatarsus with a bevelled edge (nr. 571); a: 50x magnification, b: 200x magnification. Drawing by T. Peek

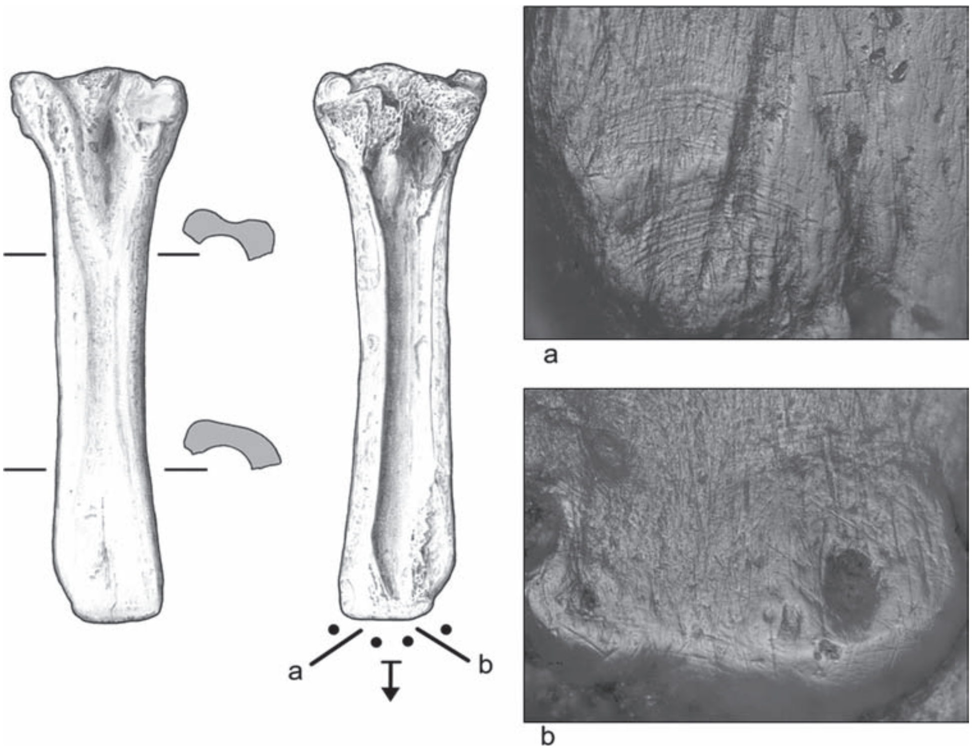


Fig. 6: Metatarsus with a bevelled edge (nr. 532); a, b: 500x magnification. Drawing by T. Peek

of the wear suggests that the object was used longitudinally to the diaphysis, at a steep angle.

Some of these bone tools were probably involved in woodworking activities within the settlement. They may be used for peeling willow bark during the manufacturing process of basketry. Also a function as a chisel cannot be excluded. However, there is only one artefact with clearly visible impact marks on the proximal articular surface.

Similar tools made of metapodia are known from equipments of the last decades (Herman 1902:238; Boucard 2000:125 ff., fig. 12). These long bones have a split and bevelled end like the objects of Feddersen Wierde and were used for peeling oak bark for tanning.

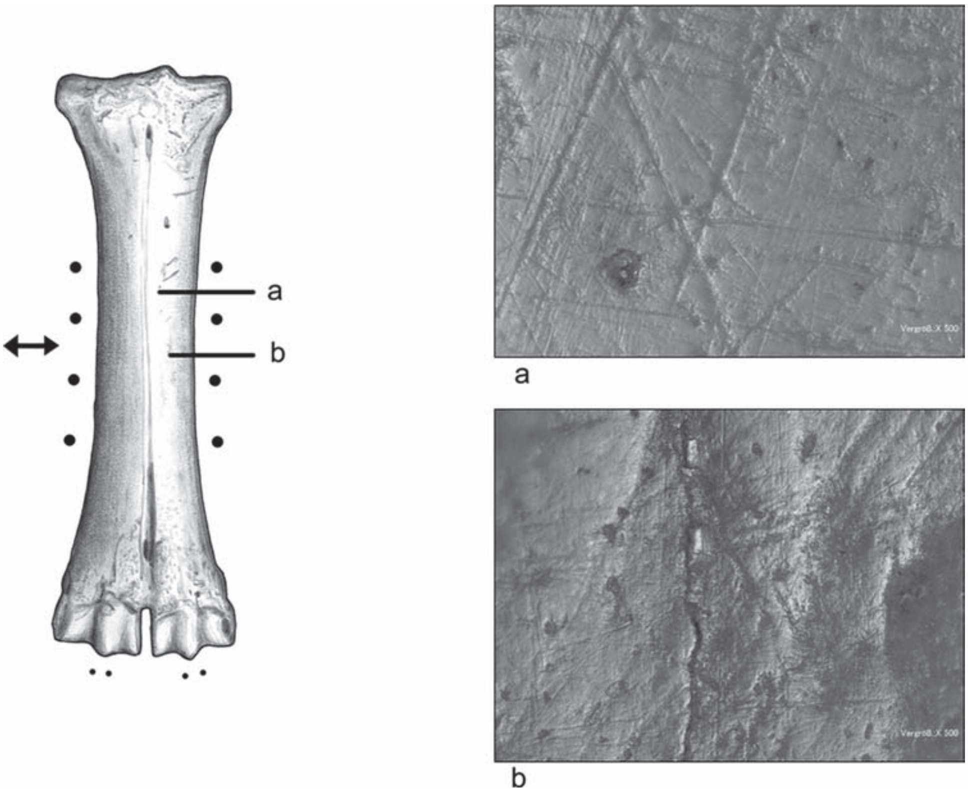


Fig. 7: Metacarpus with a smooth surface (nr. 751); a-b: 500x magnification. Drawing by T. Peek

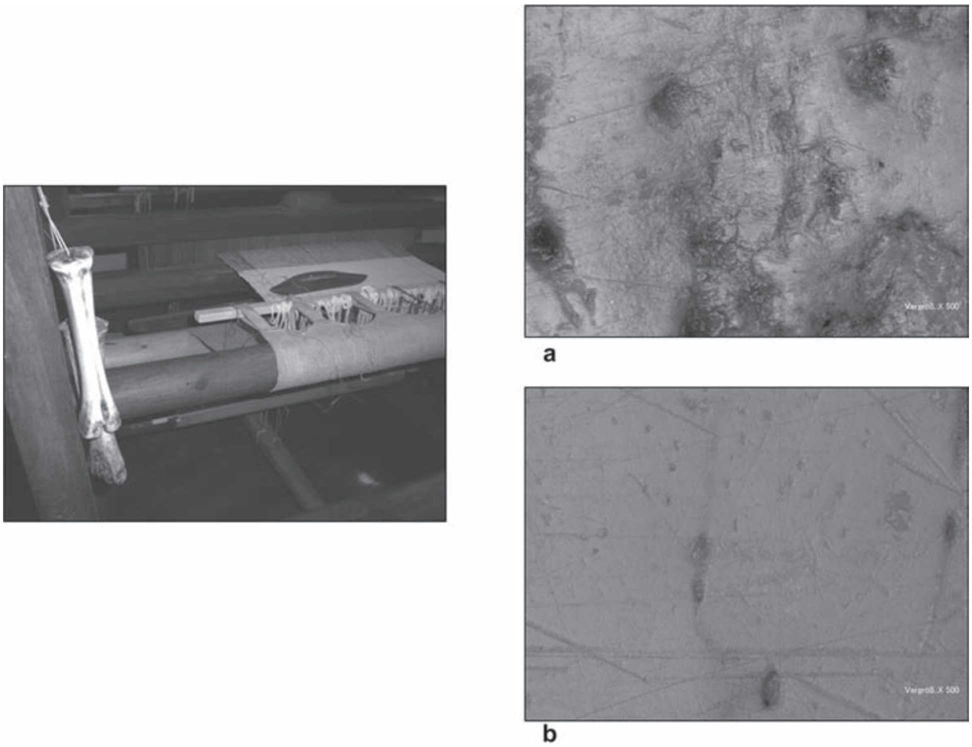


Fig. 8: Recent metapodia used for smoothing textiles at a loom in a museum; a-b: 500x magnification

Metapodia with a smooth surface

Further bone tools of the settlement consist of metapodia taken from cattle and horses which were left in their natural size and shape. However, fine manufacturing traces can be seen with the microscope and some of the bones have perforations.

The dorsal surface of one metacarpus is slightly flattened and shows use-wear (Fig. 7). At high points the wear forms a very smooth and closely linked surface whereas at the bottom of depressions there is a more granular polish. It is clearly visible that

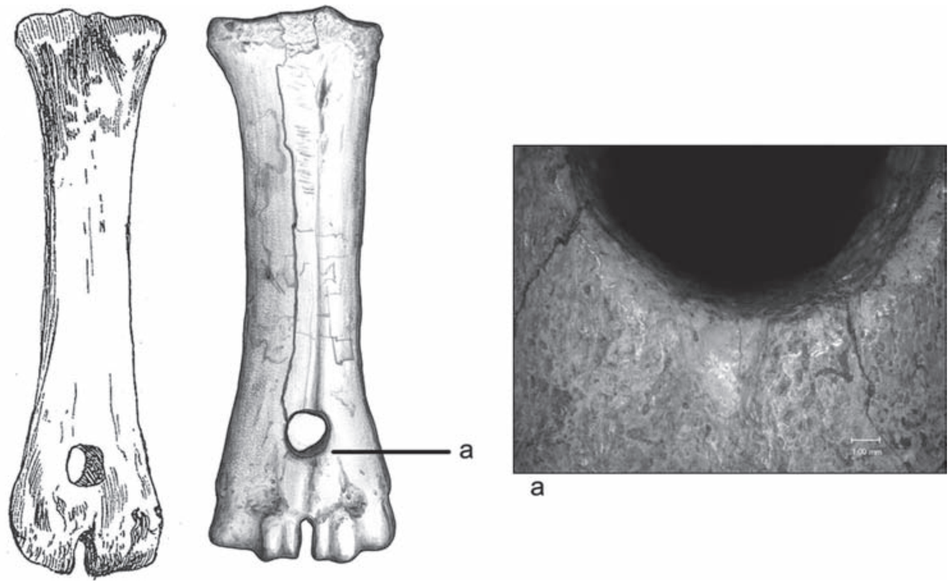


Fig. 9: Recent metacarpus (left) used for smoothing textiles (Herman 1902:238) and a metacarpus from Feddersen Wierde (nr. 748); a: 20x magnification. Drawing by T. Peek

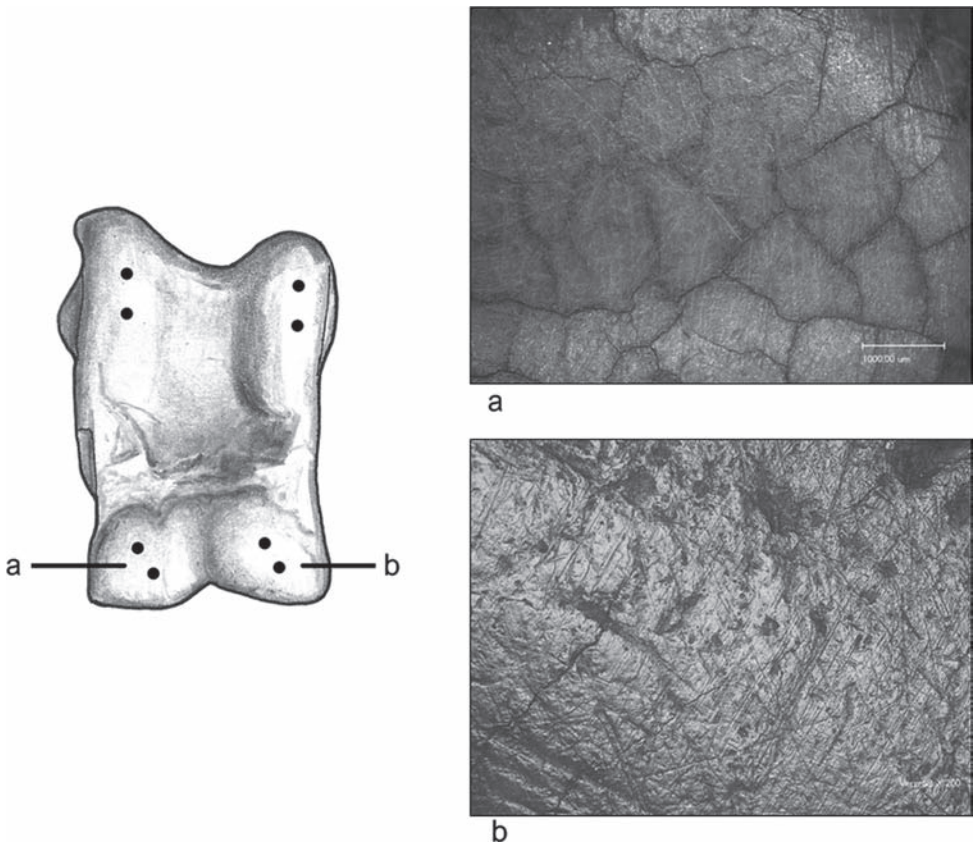


Fig. 10: Talus with a smooth surface (nr. 1223); a: 50x magnification, b: 200x magnification. Drawing by T. Peek

the dull polish has spread in a transversal direction following the contour of the bone surface. Very flat and short striations may also be associated with the function of the tool. Finally, the rolls of the distal epiphysis are smooth.

In order to identify the contact material, two metapodia taken from cattle were analysed. These were used for smoothing textiles at a loom in a museum (Fig. 8). The polish seen on these tools has a smooth structure, follows the irregularities of the surface and also occurs in depressions. These features agree with the use wear of the analyzed metacarpus of Feddersen Wierde. It can be assumed that textiles, which were still at the loom, were rubbed with this bone tool perpendicularly to its axis. In this way linen fabrics could be treated to smooth them and to give them a shiny appearance.

There are many records of the past centuries which support the effectiveness of metapodia as weaving implements (Friedel 1874:156; Virchov 1871:20; Schoneweg 1923:149). Among these objects one metacarpus taken from cattle has a perforation for hanging up the tool. From Feddersen Wierde there are two metacarpi known which have an identical hole. One of these perforations has a smooth bulge that was certainly caused by the friction of a rope (Fig. 9). Accordingly, this bone was also tied to a rope and probably hung at the frame of a loom.

Tali with a smooth surface

Finally, tali which have a remarkably smooth surface will be discussed. These were taken from cattle. The pronounced areas on the dorsal side of the bones show diagonal traces produced by a grinding stone whereas on the remaining sides such traces are only found occasionally. Moreover there is use-wear on the pronounced parts of the dorsal side. Due to this abrasion the manufacturing traces can only be seen at the edge of these areas, where a lower friction occurred with the contact material (Fig. 10).

The use-wear shows that the dorsal side of the analyzed bone came into contact with the material to be processed. Also the intentional flattening and smoothing of the pronounced surfaces suggests the importance of these areas for using the tool. Probably a rubbing movement in different directions was carried out. The dull and smooth polish, which follows the irregularities of the bone's surface, is similar to the use-wear of tools used to smooth fabrics (Fig. 8). Such a function is also adopted for the analyzed talus.

It is conceivable that the talus was utilized as a substitute for glass linen-polishers. These semi-circular objects, whose flat side is often slightly drawn in, appear since the 2nd century AD. They were used to smooth fabrics, to squeeze out seams and to create a shiny gloss on linen (Friedel 1874:156; Haevernick, Haberey 1963:138; Steppuhn 1999:115). It is also known that bones are excellently suited for smoothing textiles. Thus, even in the 20th century garments made of linen, such as hoods and collars, were smoothed with a cattle's mandible in Norway (Noss 1965:97 ff.).

In the literature tali taken from cattle are usually regarded as gaming pieces. Although such a function may be the case for many of these bones, the use-wear study shows that not all of them can be interpreted unreservedly as gaming pieces. Instead, other functions like smoothing textiles or grinding seeds and herbs have to be considered.

Conclusions

Due to the excellent state of preservation of the bone tools from Feddersen Wierde it was an opportunity to carry out extensive microscopic use-wear analyses. Involving morphological and technological factors the study reveals information about the functions of different bone tools.

It seems that a lot of objects were primarily used for processing textiles. Working with fabrics it would have been very important that the implements had rounded edges and a smooth surface, so that they did not got caught on these sensitive materials and cause damage. The carefully rounded bone tools without any sharp edges were perfectly suited for such a purpose.

Furthermore the use-wear analyses show that a general determination of the tools' functions cannot be supported. The typological classifications often consist of artefacts which were used for varied purposes. This applies for example to the tools made from metapodia which were split lengthwise and have a bevelled edge. Although the objects have a similar appearance, they differ in their use-wear from each other. For this reason, results of use-wear analyses cannot be transferred without reservation to other objects. But the wide range of various purposes of the tools becomes visible. In that way the study demonstrates that bone tools were essential for a settlement's workaday life during the first millennium AD.

References

Abbink, A.A. 1999. *Make it and break it: the cycles of pottery. A study of the technology, form, function, and use of pottery from the settlements at Uitgeest-Groot Dorregeest and Schagen-Muggenburg 1, Roman period, North*

Holland, the Netherlands, Leiden: Faculty of Archaeology, Leiden University.

Boucard, D. 2000. *Les outils taillants*, Paris: Jean-Cyrille Godefroy.

Christidou, R. and A. Legrand 2005. *Hide working and bone tools: experimentation design and applications*, In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Proceedings of the 4th Meeting of the Worked Bone Research Group, Tallinn, Estonia, August 2003*, Muinasaja teadus 15, Tallinn, 385-96.

Friedel, E. 1874. *Gnidelsteine*, Zeitschrift für Ethnologie 6,155-60.

Gates St-Pierre, C. 2007. *Bone awls of the St. Lawrence Iroquoians: a microwear analysis*, In: C. Gates St-Pierre and R.B. Walker (eds.) *Bones as tools: current methods and interpretations in worked bone studies*, BAR Intern. Series 1622, Oxford: Archaeopress, 107-18.

Gijn, A. van 2006. *Implements of bone and antler: a Mesolithic tradition continued*, In: L.P. Louwe Kooijmans and P.F.B. Jongste (eds.) *Schipluiden. A Neolithic settlement on the Dutch North Sea Coast c. 3500 CAL BC*, Analecta Praehistorica Leidensia 37/38, Leiden: University of Leiden, 207-24.

Gijn, A. van 2007. *The use of bone and antler tools: two examples from the Late Mesolithic in the Dutch coastal zone*, In: C. Gates St-Pierre and R.B. Walker (eds.) *Bones as tools: current methods and interpretations in worked bone studies*, BAR Intern. Series 1622, Oxford: Archaeopress, 81-92.

Haarnagel, W. 1979. *Die Grabung Feddersen Wierde. Methode, Hausbau, Siedlungs- und Wirtschaftsformen sowie Sozialstruktur*, Wiesbaden: Steiner Verlag.

Haevernick, Th.E. and W. Haberey 1963. *Glättsteine aus Glas. Beiträge zur Geschichte des antiken Glases XII*, Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 10, 130-38.

Herman, O. 1902. *Knochenschlittschuhe, Knochenkufe und Knochenkeitel*, Mittheilungen der Anthropologischen Gesellschaft Wien 32, 217-38.

Noss, A. 1965. *Før strykejernet*, By og bygd 18, 97-114.

Peacock, D.P.S. 1982. *Pottery in the Roman world: an ethnoarchaeological approach*, London: Longman archaeology series.

Pfeiffer, L. 1912. *Die steinzeitliche Technik und ihre Beziehungen zur Gegenwart*, Jena: Fischer Verlag.

Reichstein, H. 1991. *Die Fauna des germanischen Dorfes Feddersen Wierde*, Wiesbaden: Steiner Verlag.

Schmid, P. 2002. *Feddersen Wierde, Lower Saxony, Germany*, In: Ch.E. Orser (ed.) *Encyclopedia of historical archaeology*, London: Routledge, 200-3.

Schoneweg, E. 1923. *Das Leinengewebe in der Grafschaft Ravensberg. Ein Beitrag zur niederdeutschen Volks- und Altertumskunde*, Bielefeld: Wenner Verlag.

Steppuhn, P. 1999. *Der mittelalterliche Gniedelstein: Glättglas oder Glasbarren? Zu Primärfunktion und Kontinuität eines Glasobjektes vom Frühmittelalter bis zur Neuzeit*, Nachrichten aus Niedersachsens Urgeschichte 68, 113-39.

Virchov, R. 1871. *Geglättete Knochen zu Gebrauche beim Schlittschuhlaufen und Weben*, Zeitschrift für Ethnologie 3, 19-21.

Marloes Rijkelijkhuizen

Dutch medieval bone and antler combs

Bone and antler combs are common finds in medieval northern Europe. Two major types occur in the Netherlands: the composite comb, usually made of antler, and the longbone comb. It is widely assumed that the primary function of these combs was to groom the hair, but they could also be objects of decoration, status or have a ritual role. Early medieval composite combs have been found as burnt remains in cremation graves and buried whole with inhumations. Later finds come from settlements and towns. The shapes of these combs change through time and there is a shift in the raw material used away from antler towards bone. This increased use of bone probably reflects an increasing scarcity of antler, which is better suited to the function of combs. Changing attitudes and trading routes could also play an important role in the changes observed in comb shape and raw material throughout this period.

Key words: combs, bone, antler, medieval, Netherlands

Introduction

Combs have been found all over the world, in almost all cultures and time periods. These functional, decorative and ritual objects are found in many different archaeological contexts such as cesspits, graves, wells and ditches where they may have been accidentally lost or deliberately deposited. Hard animal tissues are commonly used in their manufacture including bone, antler, ivory, horn and tortoiseshell. The focus of this research paper is the medieval (5th until 15th century AD) bone and antler combs from Dutch archaeological collections and the current research questions that are being explored. Bone and antler combs are common finds but are often unpublished, making comparison of combs between different regions difficult to undertake and much research remains to be done. The aim of this paper is to provide a synthesis of Dutch finds and discuss the outstanding research questions.

Research questions

Function

It is not necessarily safe to assume that all combs were used just for untangling human head hair. Combs are used to reduce human head lice populations and for grooming beards or moustaches. Combs are used in the grooming of other animals, such as horses, in the preparation of plant and animal fibres, such as wool for textile production, in ritual environments, as hair decorations or to support complex arrangements of the hair. Early medieval combs are often found in rich cremation burials, whilst later finds are found in settlements and towns. The function of the late medieval longbone comb, in particular, has been questioned for many years. These combs were originally described as wool carding combs, but are recently seen as regular hair combs (MacGregor 1985:110; Van Vilsteren 1987: 41; Schelvis 1992). Is it possible to assign these different uses to specific combs with any confidence?

Raw material

What does the decrease in the proportion of antler combs through the 11th and 12th centuries indicate? From the 13th century onwards the longbone comb replaced the composite comb entirely. Was antler indeed becoming more scarce?

Trade & craft

Finally, a key point of discussion is the circulation of combs throughout Europe. The Dutch combs show similarities in shape with others found in many cultures across Europe. Was the spread of these combs a result of cultural influences and diffusion of knowledge or the result of trading networks? Where the combmakers itinerant or settled? Can we locate the production places of these combs?

Combs in the Netherlands – Collections

Some museums have yielded large collections of medieval combs, such as the Frisian Museum which houses many from terp-mounds and these have been published by Roes (1963). Another museum with a large collection of medieval terp-mound material is the National Museum of Antiquities, Leiden, and a part of this collection has been studied by the author. Other bone, antler, ivory and horn objects from sites in Amsterdam have also been published by the author (Rijkelijkhuizen 2004), and she has also undertaken the study of combs from two cities in the eastern Netherlands, those from Zutphen (Rijkelijkhuizen 2011) and Deventer (ongoing research). The Dutch medieval combs from all these sites and those published by other researchers from Dorestad (Roes 1963), Oost-Souburg (Lauwerier, Van Heeringen 1995), Kerk-Avezaath (Verhagen, Esser 2001), Maastricht (Dijkman, Ervynck 1998) have been integrated in the current paper.

Comb types – Composite combs and longbone combs

Two major types of combs occur in the Netherlands in the medieval period. The first are composite combs, which have a labour-intensive production method. The combs are usually made from pieces of antler and often elaborately decorated, varying in both form and decorative design. Two-sided and one sided combs occur, some are triangular shaped combs, some have handles, and the size can vary considerably (Fig. 1-2). Decoration may take the form of incised lines or dot-and-circle motifs. In this article no typology is constructed. Several typologies have been published for Scandinavian medieval combs (Tempel 1969; Abrosiani 1981), but these do not fit the Dutch combs as these typologies appear to be region specific. Ashby (see list of references) provides a stylistic overview of composite combs in Northwestern Europe.

The second type is the longbone comb is which simply made from a single piece of bone (Fig. 3). Only a few of these combs from the Netherlands have any decoration and this is very rudimentary, simply consisting of a few straight and crossing lines (Kerk-Avezaath; Verhagen and Esser 2001). Longbone combs which are more highly decorated, or are two-sided, have been found elsewhere, for example, in Schleswig (Ulbricht 1984) and Estonia (Luik 2008).

Small, two-sided bone combs were also produced in the medieval period and have been found in Schleswig (Ulbricht 1984), Estonia (Luik 2008), Scandinavia and England (MacGregor 1985:80-81). These are usually lozenge shaped or biconvex in cross section. According to MacGregor they date to the 11th to 14th centuries and, in time, succeed the composite combs (MacGregor 1989:113). This comb type will not be discussed here, as only two are known from this period in the Netherlands; that from Kerk-Avezaath (Verhagen, Esser 2001) and one published by Roes (1963:15, plate XVI). Two small bone combs, found in Amsterdam are flat in cross-section (Fig. 4).

Fig. 1. Triangular shaped composite antler comb. Collection: National Museum of Antiquities, photo: Marloes Rijkelijkhuizen

Fig. 2. Two side antler composite comb. Collection: National Museum of Antiquities, photo: Marloes Rijkelijkhuizen

Fig. 3. Longbone combs excavated in Amsterdam. Collection: Office for Monuments & Archaeology, photo: Marloes Rijkelijkhuizen

One is undated but the other is 18th century and both could be beard or moustache combs (Rijkelijkhuizen 2004). This type also occurs in England (Ashby 2007; type 14b).

Method of production

The production method of composite combs, from the solid outer tissues of the antler, is explained in detail in other studies (Galloway, Newcomer 1981; MacGregor, Currey 1983). Due to the properties of the antler, the method of production was very specific. Its bending strength, and the work needed to break it, is greater in the longitudinal direction than the transverse direction. Therefore the comb teeth had to be sawn in the longitudinal direction, i.e. parallel to the long axis of the antler beam. This resulted in combs with tooth plates of relatively narrow width, fixed together by two connecting plates, usually of split antler tine. The teeth were sawn after the tooth plates and connecting plates were riveted together. A uniformity in production process however is questioned by Ashby and he shows that regional differences do exist in the method of manufacture (Ashby, in press).

Dutch composite combs vary in shape, decoration and the riveting method. The rivets were either placed through the centre of the tooth plates or at the ends of the tooth plates (so that one rivet secured

Fig. 4. Two small bone combs from Amsterdam, right undated, left 18th century. Collection: Office for Monuments & Archaeology, photo: Anneke Dekker, Amsterdam Archaeological Centre

the edges of two tooth plates between the connecting plates) or a combination of both these methods were used. The endplates usually deviate from the overall pattern, which also occurs in England and Scandinavia (Ashby 2009). For example, the 7th century comb from Oegstgeest (Fig. 5) has rivets through the edges of the tooth plates, except for the end plates, which have rivets through the centre (Rijkelijkhuizen in press). In other combs both methods were used interchangeably, and seem to have no standard method. Sometimes, the rivets were placed at the same distance from each other even when the tooth plates had unequal widths, result-

Fig. 5. Composite antler comb from Oegstgeest. Photo: Marloes Rijkelijkhuizen

ing in the use of both riveting methods in one comb (Fig. 6).

The production method of longbone combs was far less demanding in terms of time and skills than that of composite combs. They were very simple and fast to execute and always made in the same way, from a single piece of bone cut from a cattle metapodials. The distal ends of the bones were removed from the shaft, and the combs were made from the back or sometimes the front of the bone. As with antler, the bending strength and work to break bone is greater in the longitudinal direction than in the transverse direction (MacGregor, Currey 1983), so the teeth were sawn longitudinally into one end and the rest of the bone shaft functioned as a handle. These teeth were sawn oblique from one side of the comb and were only sharpened at the tip of the teeth (MacGregor 1985:190; Rijkelijkhuizen 2004). The handle of the comb was usually perforated with a small hole. Combs made from the back of the metatarsal have a natural perforation, a large foramen through which blood vessels passed, but sometimes a second hole was deliberately added (Fig. 7).

Fig. 6. Close-up of a composite antler comb from Deventer. Collection: Municipal Archaeological Department Deventer, photo: Marloes Rijkelijkhuizen

Fig. 7. Longbone comb from Zutphen. Collection: Municipal Archaeological Department Zutphen, photo: Marloes Rijkelijkhuizen

Distribution and time period

Both types of combs have been found in all regions of the Netherlands, but the composite combs seem to be succeeded by the longbone combs (Fig. 8). One difficulty in constructing this time line is the large collection of undated Frisian composite combs. The problem in dating these combs is due to many of the terp mounds having been dug up to use the fertile soil as manure (Roes 1963). In figure 8, ivory combs have been added to the time line to show how these succeed the longbone combs. Wooden and horn combs were not included, because the rapid decay of these materials in the soil means that very few survive so it is difficult to draw conclusions on the geographical and period distribution of these combs.

In the Netherlands antler composite combs occur from the 4th century and dominate until the 10th-11th century, when the decline of their appearance probably begins. Evidence of wear, breakage and repair indicated that composite combs were kept in use for a very long time (see below). The production of these combs could have ceased long before some of them were lost or discarded, if they were regarded as important enough to be passed on through the generations as cherished

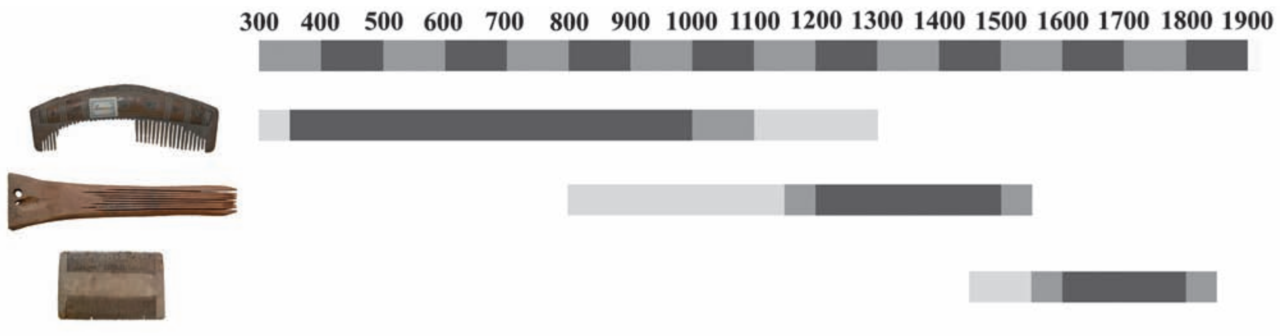


Fig. 8. Time line of Dutch medieval and post-medieval combs of bone, antler and ivory

Fig. 9. Composite bone comb from Amsterdam, 14th/15 century. Collection: Office for Monuments & Archaeology, photo: Anneke Dekker, Amsterdam Archaeological Centre

heirlooms. The date at which the longbone combs first make their appearance is somewhat uncertain, but seems to happen between the 9th and 11th century and they are most numerous in contexts dating between the 13th and 15th centuries. The ivory double sided combs that seem to supersede these longbone combs, appear from the late 16th century, when the Dutch ivory trade commenced (Rijkelijkhuizen 2009).

Composite combs are spread throughout northern Europe. In the Netherlands they have been found in the Frisian terp mounds (Roes 1963), at Dorestad (Roes 1965), Maastricht (Dijkman, Ervynck 1998), Oost-Souburg (Lauwerier, van Heeringen 1995) and Kerk-Avezaath (Verhagen, Esser 2001). Recently a 7th century example was found at Oegstgeest (Rijkelijkhuizen, in press), in Zutphen a total of four were exacavated (Rijkelijkhuizen 2011) and the remain of 26 combs have been found so far at Deventer. The earliest yet discovered is a 4th century comb from Zutphen.

A 14th/15th century composite comb from Amsterdam, made in bone rather than antler, seems a late exception. This comb consists of three bone toothplates fixed together with two bone connecting plates (Fig. 9).

Beyond the Netherlands, long bone combs are found throughout northern Europe, with the notable exception of England (MacGregor 1985:190). They are common finds in Dutch cities; in Amsterdam, for example, a total of 38 long bone combs were found (Rijkelijkhuizen 2004), and they are also known at Zutphen (Rijkelijkhuizen 2011), Deventer and many other cities (for example Roes 1963; Van Vilsteren 1987; Verhagen, Esser 2001; Van Wijngaarden-Bakker 1980). It seems likely that the production of long bone combs took place in every city.

Function – Ritual, decorative or utilitarian?

Early composite combs are often found in rich cremation graves, such as the two combs from Zutphen (Bouwmeester 2000; Rijkelijkhuizen 2011). One is dated to the 4th century (Fig. 10), the other to the 4th or 5th century. Both were burnt and buried with the remains of the bodies. The combs in these late-Roman and early medieval cremations may have had, a ritual function. Williams (2003) suggests that these combs could be used to prepare the body for the cremation pyre and had a symbolic role in the transformation of the body in both life and death. Sometimes, miniature combs were especially made for inclusion in cremations (MacGregor 1985:75).

In other cases, one could question the practical use of the very large composite combs, which can be up to 23 cm long (Fig. 11). Most composite combs, however, show intensive traces of use wear which indicates that these combs were used for a very long time, perhaps by several generations, were repaired (Luik 2008) or continued in use with broken teeth. Modern evidence for the use of combs by different family members and generations has already been described by Choyke and Kovats (in press). Human lice have also been found between the teeth of composite combs (Schelvis 1992) but evidence for utilitarian use does not exclude a decorative or ritual functions. The variations in style, shape and size of these combs could relate to different uses or cultural influences, changes in fashion or regional differences.

Longbone combs were initially interpreted as wool combs for preparing wool fibres for spinning. However they are unsuitable for such a use, while the absence of wear traces (MacGregor 1985: 190) and the presence of human lice between the teeth of some examples (Schelvis 1992) also stand against this theory. Now it is more commonly accepted that these are simply hair combs. They are unlikely to be intended for fixing a head-dress, because combs used in this way are usually more decorated and would show different use wear. Use wear is only present at the tip of the teeth (MacGregor 1985:190; also visible on a longbone comb from Deventer); which indicates that the hair was combed with the tip of the teeth.

The apparently strange shape of these combs, compared with the antler composite combs, can all be explained in terms of the shape and properties of the raw material. As detailed above, the teeth are cut in the longitudinal direction as this produces the toughest, most durable teeth. However bone is stiffer than antler and breaks more easily (MacGregor, Currey 1983) so bone comb teeth have to be thicker than antler comb teeth cut for the same purpose. To further strengthen the bone teeth, they are sawn obliquely from one side only, making the teeth longer at the front than on the reverse of the comb. This method ensured large toothbases, meaning that a greater area of each tooth lay in contact with the main body of the comb, and maximising their strength and security. In addition, the teeth were not all sawn to the same depth and this avoids producing a line of weakness across the bone at the base of the teeth. However, thickening the teeth also makes them stiffer so to improve the flexibility of the teeth they are cut longer than in the antler combs. Sadly, making the teeth longer makes them more vulnerable to breakage and the longbone combs never show much use wear, indicating that, compared to the composite combs, they were quickly discarded. This short life expectancy would explain why time was not invested in decorating them. The question is, however, was the longbone comb born out of a shortage of antler or does its adoption reflect also changes in the medieval society?

Fig. 10. Comb from 4th century cremation grave, excavated in Zutphen. Collection: Municipal Department of Zutphen, photo: Marloes Rijkelijkhuizen

Fig. 11. Antler composite comb from Deventer. Collection: Municipal Archaeological Department of Deventer, photo: Marloes Rijkelijkhuizen

Raw material selection – scarcity or choice?

As discussed, antler is preferentially used in the production of composite combs because the physical properties of antler make it more suitable than bone for comb making. MacGregor's survey of combs shows this preference for antler in northern Europe through the 8th to the 11th centuries (MacGregor 1989:113). Although the tradition of composite combs persists, later examples seem to have been made partially or wholly in bone (MacGregor 1989: 110). This early preference for antler is not only clear in the Dutch combs but also across other objects types in the collections. In Dorestad both bone and antler were used for the production of objects from the 8th century onwards and this included the composite combs, but antler predominated (Prummel 1983; Clason 1980; Rijkelijkhuizen ongoing research). Similarly in Amsterdam, as time passes, the use of bone begins to predominate and antler objects represent only 3% of the total number of excavated bone, antler, ivory and keratinous objects from the 12th to 18th centuries. This does seem to indicates a growing scarcity of antler as a raw material. One problem however, in quantifying this change, is making the correct identification of the raw material of these composite combs. Bone and antler can appear very similar when worked to this extent (Ashby 2005), however, where the evidence is clear, most composite combs do seem to be made of antler.

The reason why antler becomes less commonly available for the manufacture of objects through the medieval period is widely debated. MacGregor suggests that this was caused by changes in the legislation that controlled hunting (MacGregor 1989), whilst Ambrosiani suggests that it was due to the increasing demands of a growing population (Ambrosiani 1981). The decrease of deer in the vicinity of these developing settlements could also be a factor (van Vilsteren 1987:18-19). To address these changes in the Netherlands, evidence for the decline of deer and the disappearance of elk in the medieval period needs be studied more thoroughly. As the provenance of the raw material used to produce antler combs is also unknown, other factors, such as changing trading routes, could be of influence too (Ashby in prep).

Trade & Craft – Travelling craftsmen, sedentary craft or long distance trade?

According to Ambrosiani and MacGregor craftsmen working these materials were itinerant, as evidenced by the absence of identifiable, long-term production sites (Ambrosinai 1981; MacGregor 1989:109). But should we expect the workshops of antler or bone craftsmen to be easily recognisable? It

Fig. 12. Antler waste fragments from sieving samples. Photo: Joyce van Dijk (Archeoplan Eco)

is difficult to locate such craft centres because antler workshops probably did not produce much waste, except for the burr, the tips of the tines and small chips of antler, which are probably not always recognised or recovered at the excavation site. For example, 92% of all antler waste fragments from a 6th-8th century settlement 'Leidsche Rijn' near Utrecht (Fig. 12) were discovered by the zooarchaeologists through the sieving of soil samples (Esser 2008). Waste fragments need to be studied more thoroughly to obtain valuable information on the organisation of this craft.

In the Netherlands, clear evidence for comb making has been detected at a couple of sites. The early medieval settlement near Utrecht (Esser 2008) produced three skull fragments with sawn off antlers, five burrs, a few semi-manufactured tooth plates and fragments of finished combs, in addition to the small antler chips mentioned above. 10th century Oost-Souburg has produced a diversity of composite combs as well as semi-manufactured tooth plates (Lauwerier, Van Heeringen 1995). At Dorestad and Deventer (Clason 1980; Prummel 1983; Rijkelijkhuizen ongoing research), a great number of composite combs have been excavated, along with fragments from bone and antler working. At both these important trading sites comb-making probably took place because the waste fragments and raw material were characteristic for comb making.

Almost all crafts are sedentary by nature and an antler craftsman would need perhaps water for soaking the antler, his tools and a supply of raw material, which are not as convenient to transport over long distances as the finished combs would be. It seems more likely that the combs were distributed by travelling merchants than itinerant craftsmen. These, or other merchants, might also have kept the craftsman supplied with antlers. Gift exchange is another possible factor in the distribution of combs and could be an explanation for some of the early or elaborate examples. Such gifts or traded combs could bring in new styles from distant regions that could be copied by local craftsmen, and this might explain the apparent uniformity of composite combs across northern Europe. Ashby (2005; in press) has stated that the previous assumed homogeneity is questionable, and that different stylistic characteristics can be detected, which perhaps speaks against travelling comb makers, and should at least lead us to question the widespread applicability of the model in its original, unmodified form. Indeed, regional differences in comb-making could also occur, and it is possible that some comb makers were travelling on a small scale (Ashby in press). These subtle differences probably reflect cultural influences, as the diffusion of knowledge and trading networks combined to spread composite comb throughout northern Europe.

Longbone combs seem unlikely to be goods traded over long distances because of the ready availability of the raw material and their simple and undecorated nature. Yet, except for the British Isles, longbone combs are spread throughout northern Europe. The similar appearance of all these combs probably reflects directly the properties of the raw material and their strictly utilitarian use for combing hair. The production of these combs probably took place in almost every town and their use would have been spread by diffusion of knowledge as the antler became increasingly scarce.

Conclusions

Throughout the medieval period in the Netherlands, the use of antler in the production of combs is gradually replaced by bone, a less suitable material for comb making. Composite combs with bone elements or entirely in bone are found in deposits from the 8th century onwards, but by the 13th century only single piece, longbone combs are being produced. This change is due to an increasing scarcity of antler as a raw material. This theory is supported by a general reduction over time in antler as a raw material for objects generally. There is increasing evidence that the skilled craftsmen who produced these composite combs were not itinerant but that it was the finished combs that sometimes were traded, perhaps over great distances and then copied by local craftsmen.

The variations in style, decoration and size of composite combs was probably influenced by cultural differences, local traditions, diffusion of knowledge and trading networks. Their primary function was grooming human hair, but the combs could also have been decorative or used in rituals. Many examples of composite combs exhibit evidence of long use, indicating their value, perhaps both in terms of replacement costs and as valued heirlooms. There is also much to be learnt from considering the findspots of these objects. In particular, we can see a change in context for composite combs: early medieval combs are found in rich cremation burials, whilst later finds are found in settlements and towns.

A shift from antler composite combs to composite combs partially made of bone shows the prelude of a transition towards the fully-fledged use of bone as a raw material, wherein long bone combs seem to replace their composite predecessors. In contrast, the longbone combs that succeeded the composite combs were simply used for combing hair and were quickly and locally made from a cheap and readily available material. The uniformity in their shape was, to a great extent, dictated by the properties of the bone used, and their lack of decoration reflects their low cost, utilitarian nature and short life expectancy.

However, although many of these longbone combs had broken teeth when discarded, they were still serviceable. This, perhaps, is an indicator of the far reaching transformation produced by the increasing urbanisation of medieval society in the Netherlands. Changing social and political factors, new cultural influences and trading routes, and the development of a market economy could have transformed traditions, and even attitudes towards craftmanship. Did the adoption of these simple longbone combs mark the decline of craftmanship or the beginning of a throw away mentality?

The regional differences in antler and bone combs and changes through time have been discussed for many years and more research still needs to be done to understand the significance of these seemingly simple and common-place objects. Provenancing of the antler and identifying trading routes and craft workshops are key to this goal. The synthetic survey of combs and combmaking debris in the Netherlands has shed some new light on the production, function and cultural significance of medieval combs and has also helped to define the most pressing research questions.

Acknowledgements

Sonia O'Connor (University of Bradford), Steven Ashby (University of York), Annemarieke Willemsen (National Museum of Antiquities) Jerzy Gawronski and Wiard Krook (Office for Monuments and Archaeology), Michel Groothedde (Municipial Archaeological Department of Zutphen), Bart Vermeulen and Emile Mittendorf (Municipial Archaeological Department of Deventer), Kinie Esser and Joyce van Dijk (Archeoplan Eco), Anneke Dekker (Amsterdam Archaeological Centre).

References

Ambrosiani, K. 1981. *Viking age combs, comb making and comb makers in the light of finds from Birka en Ribe*, Stockholm.

Ashby, S. 2005. *Bone and antler combs: towards a methodology for the understanding of trade and identity in Viking age England and Scotland*, In: H. Luik, A.M. Choyke, C.E. Batey and L. Lougas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Proceedings of the 4th Meeting of the Worked Bone Research Group, Tallinn, Estonia, August 2003*, Muinasaja teadus 15, Tallinn, 255-62.

Ashby, S. 2007. *Bone and Antler Combs*, Finds Research Group Datasheet 40.

Ashby, S. 2009. *Combs, contact, and chronology: reconsidering hair combs in Early-historic and Viking-Age Atlantic Scotland*, Medieval Archaeology 53, 1-33.

Ashby, S. 2010. A Typological Guide for the Spot-Identification of Medieval Bone/Antler Combs from the British Isles and Northern Europe, Unpublished Datasheet of the ICAZ Worked Bone Research Group, http://www.wbrg.net.

Ashby, S. in prep. *The language of the combmaker. A study of craft and technology in early medieval England*, WBRG Wroclaw Conference.

Ashby, S. in press. *Making a Good Comb: Mercantile Identity in 9th to 11th-century England*, In: L. Ten-Harkel and D. M. Hadley (eds) *Everyday Life in Viking Towns: Social Approaches to Towns in England and Ireland c. 800-1100.*

Bouwmeester, H.M.P. 2000. *Eme in de Romeinse en Frankische tijd*, BAAC-rapport 98.045, unpublished report.

Choyke, A.M. and I. Kovats in press. *Tracing the personal through generations: late medieval and Ottoman combs*, In: *Bestial mirrors: using animals to construct human identities in medieval Europe*.

Clason, A.T. 1980. *Worked bone and antler objects from Dorestad, Hoogstraat I*, In: W.A. van Es and W.J.H. Verwers (eds.) *Excavations at Dorestad I, the Harbour: Hoogstraat I, Nederlandsee Oudheden* 9, Amersfoort, 238-47.

Dijkman, W. and A. Ervynck 1998. *Antler, bone, horn, ivory and teeth. The use of animal skeletal materials in Roman and early Medieval Maastricht*, Archaeologia Mosana 1, Maastricht.

Esser, E. 2008. *Vroegmiddeleeuwse bewoning langs de A2. Archaeozoologie, zoogdieren en vogels, Ossicle 152,* unpublished report.

Galloway, P. and M. Newcomer 1981. *The craft of comb-making: an experimental enquiry*, Bulletin of the Institute of Archaeology 18, 73-90.

MacGregor, A. 1985. *Bone, antler, ivory and horn. The technology of skeletal materials since the roman period,* London: Barnes & Noble.

MacGregor. 1989. *Bone, antler and horn industries in the urban context*, In: D. Serjeantson and T. Waldron (eds.) *Diet and crafts in towns. The evidence of animal remains from the roman to the post-medieval periods*, BAR British Series 199, Oxford: Archaeopress.

MacGregor A. and J.D. Currey 1983. *Mechinal properties as conditioning factors in the bone and antler industry of the 3rd to the 13th century AD*, Journal of Archaeological Science 10, 71-7.

Lauwerier, R.C.G.M. and R.M. van Heeringen 1995. *Objects of bone, antler and horn from the circular fortress of Oost-Souburg, the Netherlands (AD 900-975)*, Journal of the society for medieval archaeology 39, 71-89.

Luik, H. 2008. *Could broken combs have had new lives?* Estonian Journal of Archaeology 12(2), 152-62.

Prummel, W. 1983. *Early medieval Dorestad an archaeozoological study. Excavations at Dorestad 2*, ROB Amersfoort.

Rijkelijkhuizen, M. 2004. *Dierlijke materialen in Amsterdam*, MA-thesis.

Rijkelijkhuizen, M. 2009. *Whales, walruses and elephants. Artisans in ivory, baleen and other skeletal materials in seventeenth and eighteenth century Amsterdam,* International Journal of Historical Archaeology 13(4), 409-30.

Rijkelijkhuizen, M. 2011. *Kammen in Zutphen*, Monumentaal 20, 21-24,

Rijkelijkhuizen, M. in press. *Een merovingishce versierde kam, Upcoming report on excavation Oegstgeest*.

Roes, A. 1963. *Bone and antler objects from the Frisian terp-mounds*, Haarlem: H. D. Tjeenk Willink.

Roes, A. 1965. *Vondsten van Dorestad*, Groningen.

Schelvis, J. 1992. *Luizen, neten en vlooien*, In: P.H. Broekhuizen, H. van Angelen, K. Helfrich, G.L.G.A Kortekaas, R.H. Alma and H.T. Waterbolk (eds.) *Van boerenerf tot bibliotheek. Historisch, bouwhistorisch en archeologisch onderzoek van het voormalig Wolters-Noordhoff-Complex te Groningen*, Groningen: Stichting Monument & Materiaal, 517-23.

Tempel, W. 1969. *Die Dreilagenkämme aus Haithabu. Studien zu den Kämmen der Wikingerzeit im Nordseeküstengebiet und Skandinavien*, Göttingen: University of Göttingen.

Ulbricht, I. 1984. *Die Verarbeitung von Knochen, Geweih und Horn im mittelalterlichen Schleswig*, Ausgrabungen in Schleswig. Berichte und Studien 3. Neumünster: Wachholtz Verlag.

Verhagen M. and E. Esser. 2001. *Bewerkt been, gewei en leer*, In: A.A.A. Verhoeven and O. Brinkkemper (eds.) *Twaalf eeuwen bewoning langs de Linge bij de Stenen Kamer in Kerk-Avezaath, Rapportage Archeologische Monumentenzorg* 85, ROB, Amersfoort, 485-98.

Vilsteren, V.T. van 1987. *Het benen tijdperk. Gebruiksvoorwerpen van been, gewei, hoorn en ivoor 10.000 jaar geleden tot heden*, Assen: Drents Museum.

Williams, H. 2003. *Material culture as memory: combs and cremation in early medieval Europe*, Early medieval Europe 12(2), 89-128.

Wijngaarden-Bakker, L.H. van 1980. *Mesheften, kaardekammen en glissen*, Bodemonderzoek in Leiden, 61-6.

Hans Christian Küchelmann

Whale Bones as architectural elements in and around Bremen, Germany

During the main phase of commercial whaling between the 17th and early 20th century whaling ships carried not only blubber and baleen back home to their European harbours but also substantial quantities of whale bones. Many of them were subsequently utilised as material for various functions to be introduced here. Several such objects in the area of the city of Bremen, Northern Germany, are presented, which are now historical monuments of early industrialisation and the (over-)exploitation of whales. Reasons and motifs for their utilisation are discussed. One aim of this paper is to draw the attention to these monuments often situated in remote places and – hopefully – initiate actions to document, inventory and preserve the remaining objects in the future.

Keywords: whale bones, whaling history, Germany, (Early) Modern Time, preservation

This article is a preliminary overview about a current research in local history. One aim of this paper is to point the attention of scholars concerned with worked bone artefacts to a peculiar class of objects made of large whale bones. I am referring here to objects of large dimensions (mainly between one and seven meters) that have been used for different purposes either in building structures or in open-air situations which may be combined under the loose term ‘architectural elements’. I am using the imprecise term ‘object’ as I am not sure if ‘artefact’ is the appropriate expression in this case. The bones are often not modified very much, at least not fashioned in an elaborate planned way to fulfil a specific purpose (class I artefacts in sensu Choyke 1997) like many small bone artefacts. They are also different from artefacts defined as ‘ad hoc’ or ‘expediency tools’ (class II in sensu Choyke 1997) as they are definitely not made from raw material readily available and as they have been chosen with care for long time use. They may better be characterised as ‘used bones’.

Strange enough, keeping in mind their sometimes impressive size, whale bone objects seem to escape the scope or interest or responsibility of people quite often, even of those who are professionally concerned with related subjects. The reasons for this circumstance are various:

• Large whale bone objects are often situated in remote places on private ground and therefore they do not fall in the responsibility of public administration.

• They are not buried in the soil and hence are no subject for excavators and archaeologists.

• As most of the oldest still existing examples are not dating before the 18th century they are also too young for the interest of most archaeologists.

• They are no buildings in strict sense and hence are not in the scope of the ancient monuments departments.

• They are simply too large for most persons working with bone artefacts like archaeozoologists, archaeologists or conservators.

• They are often not documented in written form and hence escape the scope of historians.

• Weathered whale bone can easily be confused with weathered wood by the untrained observer.

To conclude, large whale bones are a class of objects caught between two stools. The reason for my concern here is that most of the still existing objects are in a highly endangered preservation status, many are about to vanish. The number of objects is deteriorating rapidly due to weather, age, neglect, ignorance, indifference, vandalism and even theft (Ahlers 1911[1988]:24; Barthelmeß 1989:261-262, Redman

2004:xi). A lot of the once existing specimens are already gone. This is regrettable as whale bone objects have a high potential as historic monuments in itself, as I hopefully will be able to demonstrate, let alone their value as biological archives.

My personal fascination for the topic and motivation for this paper probably goes back to my childhood. In the year 1961, two years before I was born, a pair of huge blue whale mandibles of 7.10 m in length were presented to the city of Bremen by a Norwegian shipping company owner. They were mounted at the harbour of Vegesack in the North of Bremen (Fig. 1) and I remember being struck by this impressive monument as a child. This object, however, does not fit to the criteria mentioned above as it is a landmark in a centre of interest with a high identification value for the local public, which definitely does not suffer the fate of being overseen and forgotten. It was under the supervision of the ancient monuments department from the beginning of its existence. However, it posed preservation and public safety problems after 20 years already and was replaced by a 1:1 bronze replica in 1987. The original bones still survive in the magazine of the Übersee Museum, although they have regrettably been sawn into pieces for transport reasons[1].

Speaking of large whale bones implies a zoological restriction. Subject of this paper are objects made from bones of the large whale species, in particular the species of the families Balaenidae (right whales) and Balaenopteridae (finback whales or rorquals) plus the Grey Whale and the Sperm Whale (see table 1 for a list of species). The size of the whales ranges from a total length of 8 m in case of Minke Whales up to a maximum of 33 m in case of adult female Blue Whales (van den Brink 1957:157, 168-173). Mandibles of the Blue Whale can reach up to 7,5 m[2]. All the listed species have been targets of commercial whaling in early modern and modern history though at different times and levels.

Fig. 1. Bremen-Vegesack, Weser Utkiek, Blue Whale jaws, erected 1961 (photo: Harry Schwarzwälder 1981)

[1] See also Redman (2009:42-44).

[2] E. g. the whale bone arch at Bragar, Lewis, Scotland with 7.49 m measured along the outer curve (Redman 2004:321-325)

Table 1. Large whale species and their taxonomic order

Order Baleen Whales (Mystacoceti)			Order Toothed Whales (Odontoceti)
Family Right Whales (Balaenidae)	Family Finback Whales (Balaenopteridae)	Family Grey Whales (Eschrichtiidae)	Family Sperm Whales (Physeteridae)
Bowhead (*Balaena mysticetus*) Northern Right Whale (*Eubalaena glacialis*) Southern Right Whale (*Eubalaena australis*) Pacific Right Whale (*Eubalaena japonica*)	Blue Whale (*Balaenoptera musculus*) Common Rorqual (*Balaenoptera physalus*) Sei Whale (*Balaenoptera borealis*) Minke Whale (*Balaenoptera acutorostrata*) Humpback Whale (*Megaptera novaeangliae*)	Grey Whale (*Eschrichtius gibbosus*)	Sperm Whale (*Physeter macrocephalus*)

Overview about the current research status in Europe

While the history of European whaling has been documented fairly well and analysed in detail in most European countries, objects of whale bones – being physical evidence and relics of these socially and historically important commercial activities – have been mentioned only in passing in most cases, if at all. For Germany Bernhard Ahlers (1911[1988]:24-25, 30-35) and Wanda Oesau (1937:308-311, 1955:195-235) may be mentioned, who refer to whale bone monuments in substantial passages of their whaling history publications. Apart from numerous regional folklore publications on single local specimens comprehensive research on large whale bone objects itself is scarce. Zoologist Erna Mohr started a photographical collection of whale bone monuments in the 1930s of which only small parts have been published (e. g. Mohr 1935), but a copy of her collection survived in the archive of the Rotterdam zoologist Antonius Boudewijn van Deinse. To be mentioned is Klaus Barthelmeß who gathered an enormous amount of information on worldwide whaling history and has published numerous papers in several of which whale bone monuments have been documented (e. g. Barthelmeß 1994, 2008). The most comprehensive work on European large whale bone objects, however, has been undertaken by Nicholas Redman, who is devoted to whale bones for more than 35 years now and initially published an extensive catalogue listing 992 objects from 664 locations of the British Isles (Redman 2004).

My own research began over ten years ago, with the idea of a survey on the remaining whale bone monuments in Northern Germany. Almost inevitably the research brought me in contact with Klaus Barthelmeß and Nicholas Redman leading to a joint project where my (small) part was to contribute detailed information on local specimens to Nick Redman's already existing overwhelming collection of facts. While gathering evidence it became obvious that a stout local base with knowledge of landscape details, personal contacts, access to archives, etc. is required for this project, resulting in the restriction of this paper to the region of Bremen where I am able to dig down deep into historical sources. In the meantime, after my presentation at the WBRG meeting in Wrocław, three additional volumes have been published on whale bone monuments of Germany, Austria, the Czech Republic and Switzerland (Redman 2009), the Netherlands and Belgium (Redman 2010a) and additional specimens of the British Isles (Redman 2010b).

Although this means that unlike the situation in 2009 a substantial part of the whale bone objects in Europe is now at least generally inventoried, there are still many large gaps to be filled. Most of the objects are still lacking a zoological identification to species level due to lack of comparative material, identification literature and scientific know-how. Identification could be and should be the starting point of a zoohistoric research. Conservational issues have only preliminary been tackled to date (e. g. Barthelmeß 2008; Huiskes 2001). Local historic data, often kept only as aural history by local families, should be documented and subsequently historically integrated.

Key data of the history of European whaling

It is not the aim of this paper to give a detailed overview about the history of European whaling, a topic that has been tackled by various authors on regional, national and international level[3]. Nevertheless the objects dealt with here cannot be understood without their historical, social, economic and political background. The changing historic circumstances are inseparably linked with their existence. It is hence necessary to outline some key features as background to understand the objects.

Historical evidence for active hunting of large whales in Europe before the 16th century does exist only for the Basque countries, the Inuit and arguably for Norway. Any other documented use of whales until then refers either to small cetacean species or to the exploitation of eventually stranded individuals of large species (Barthelmeß 1992; Clark 1989:88-90; Mulville 2005). Of special relevance here are the Basques, who set up watch posts in the Bay of Biscay at least since the 11th century – the earliest historic document existing for Bayonne in 1059 AD. The Basques were hunting the Northern Right Whales during their annual journey along the European coastline initially on a local subsistence basis. Since approximately 1535 they expanded their whaling to the North Atlantic. At the beginning of the 17th century British expeditions went for hunting seals at Spitsbergen where they realised the abundance of

[3] For summarising overviews see for instance Barthelmeß 1992; Clark 1989:87-95; Ellis 1993; Münzing 1987; Mulville 2005; Rijkelijkehuizen 2009.

whales. In the year 1611 British ship owners firstly employed Basque whalers for whaling at Spitsbergen. 1612 Dutch ships joined in the whale hunt at Spitsbergen and were immediately subject to hostility by the British. This resulted in the establishment of a Dutch whaling company in 1614, which sent out armed ships to protect the national whalers. Until 1615 Denmark and Norway were able to take part in the enterprise. Whaling was conducted on the traditional Basque way with small rowboats and hand harpoons. This method implied that only some species were in the range of the whalers, the ones who are swimming slow enough and do not sink when killed, which resulted in their English name "right whales". Hunted were almost exclusively Bowheads and Northern Right Whales in the sheltered bays of Spitsbergen, Jan Mayen and Greenland, which were their birth places. The dead whales were brought to stations at the coast, where the blubber was processed (bay fishery). Reacting to the hunting pressure the whales retreated from the coastline and probably already mid of the 17th century the population has been significantly reduced. Consequently the whaling stations became unprofitable and were all abandoned by the end of the 17th century. When the 1st German company from Hamburg joined the business in 1643, whaling was already mainly an offshore activity (ice fishery, pelagic fishery). At the beginning of the 18th century the whale populations had declined dramatically and consequently profits dropped rapidly. In search for new sources of profit the Sperm Whale came into the fore since 1713. 1789 whaling was extended into the Pacific Ocean. The supply of ships with steam engines and fire armed harpoons since the 1860s allowed hunting of the fast swimming rorquals for the first time. Between mid of the 17th and end of the 19th century more than 10.000 German whaling voyages are documented, approximately 1,600 of which were carried out from Bremen. Turning towards local issues, the 1st whaling ship left Bremen for the North Atlantic in 1653. Bremen ships took part in pacific whaling activities from 1836 on. The last classical whaling voyage from Bremen took place in 1872 (Ahlers 1911[1988]; Meyer 1965; Küchelmann 2008)[4]. To give an impression of the economic importance: Between 1653 and 1709 during 300-350 whaling voyages from Bremen 1,100-1,300 whales were caught (Küchelmann 2008:132-136; Meyer 1965). Between 1695 and 1868 1,554 ships caught 3,749 whales plus more than 590.000 seals (Ahlers 1911[1988]:35). One whale would provide approximately 100-150 barrel of blubber plus 500-550 pieces of baleen. The price of train oil in Bremen fluctuated from 1688 to 1799 between 5.5 and 28.0 Reichsthaler per barrel (Meyer 1965). As an example for baleen one ship brought 5,000 pounds from two caught whales in 1692 which were sold for 3.000 Reichsthaler (Koster 1700[2004]:375). Between 1813 and 1830 the income of an average craftsman was 150-200 Reichsthaler per year, a teacher earned 1000 Reichsthaler per year (Schwarzwälder 1995:94).

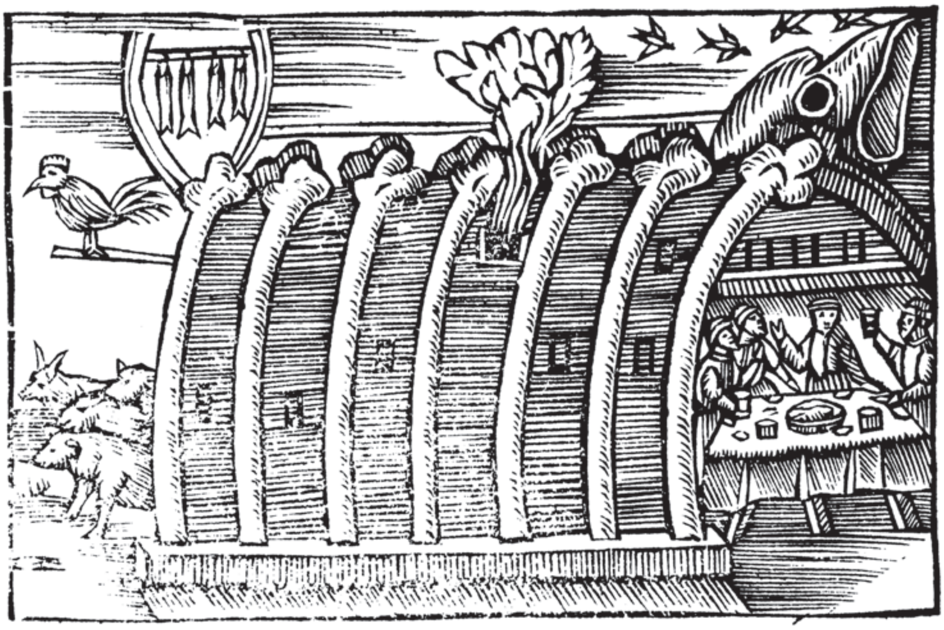
The key data given above shall highlight some important circumstances: Since 1611 European whaling was an exclusively commercial enterprise with high business risks, enormous profit rates and a large impact on the related societies. Whaling was one of the main motors of the industrial revolution. It changed the involved societies and economies completely and – who wonders – resulted in national and international political complications. And – turning to the bone objects in question here – it also left a directly visible imprint on the landscape. Applying the above outlined historic facts has implications on the species composition of the whale bone objects in the whalers home countries: Between the beginning of the 17th and early 18th century only Bowheads and Northern Right Whales were in the reach of whalers and subsequently are the only ones that could have been brought home from the Arctic. From the early 18th century onwards Sperm Whale bones can be found. Bones of rorquals cannot be used for monuments before the 1860s. Exceptions are some monuments consisting of bones of stranded individuals. Few data exist for the European subspecies of the Grey Whale, which almost certainly had been hunted to extinction already around 1700 (Barthelmeß 1992:50).

[4] There has been a short German whaling revival in the early 20th century, which is left out here.

History of the use of whale bones as architectural elements

The presently oldest documented evidence for the use of large whale bones as architectural elements has been found at the Neolithic settlement of Skara Brae, Orkney Islands, Scotland, where jaw bones and a skull seem to have been used as roofing material (Clark 1989:107; Mulville 2002:40-41; Redman 2004:297). Chronologically next following are archaeological records from the Iron Age of the Shetland Islands, Scotland. Here a Sperm Whale skull fragment has been used as cover of a stone drain at the site of Dun Vulan, South Uist, two hollowed out vertebrae were used as supports for a hearth at

a



b

Fig. 2. Woodcuts from Magnus (1555, book 21); a) carpenters sawing whale bones for construction use; b) hut built from whalebones

A'Cheardach Mhor, Drimore, South Uist, and several objects of modified whale bone have been utilised as stakes and supports at the broch of Scalloway, Mainland (Mulville 2002:40-41; Smith 1998).

For the Early Middle Ages archaeological evidence has been found again on the Shetland Islands at the Norse site of Kilpheder, North Uist, where a Blue Whale humerus has been built into a wall (Mulville 2002:40-41). More regularly whale bones have been used for house construction at sites of Arctic indigenous cultures like the Thule Inuit (ca. 1000-1600 AD) in Greenland and Canada (Clark 1989:107; Pax 1933:365-366; Savelle[5] 1997, 2000). Here large parts of the skeleton of Bowheads have been used for the construction of different buildings like dwellings, ceremonial houses, burials, caches and boat rests. Different skeletal elements have been utilised for different functions depending on their shape and dimensions, e. g. mandible, maxilla, scapula and ribs for frames and roofs and compact elements like skull, radius, ulna and vertebrae for walls.

Other evidence can be extracted from historic documents. The probably oldest reference is a report of Nearchos, admiral of Alexander the Great. Nearchos, sailing from the mouth of the Indus to the Euphrat in 327 BC, reports about his encounter with the Ichthyophagi, who use bones from stranded whales to build their houses. His report is lost but quoted in detail by Flavius Arrianus (2nd century AD) in his Anabasis Alexandri[6]. Further Strabo (63 BC

5 With lots of further references.

6 *„This man returned and reported that he found some fishermen upon the shore living in stifling huts, which were made by putting together mussel-shells, and the back-*

– 19 AD) quotes the report in his Geography[7], Plinius (23-79 AD) in his Naturalis historia[8]. Much later, in the 16th century, Olaus Magnus gives a detailed description of the features of houses made by the Scandinavien tribes from the bones of stranded whales (Fig. 2)[9]. Finally, there are medieval reports on church doors in Iceland made of whale bones[10] (Saeftel 1970:135).

At the Arctic Inuit sites it is obvious that the use of whale bones is a necessity resulting out of the lack of other appropriate construction materials. In remote Northern places like Iceland, the Shetlands or the Orkneys construction materials like wood or stone maybe not available in sufficient quantities and whale bones may at least come in handy in certain circumstances. However, this precondition does certainly not hold true for the Central European home countries of the commercial whalers where wood and other construction material is abundant. Carrying whale bones from the Arctic to Central Europe as construction material does not make sense from the economic point of view, which was the first priority of the ship owners. Nevertheless whale bones appear in significant quantities in Central Europe with the begin of the Early Modern European large scale whaling in the 17th century, not only in coastal areas but also in the inland (Redman 2004, 2009, 2010a, 2010b). In the following chapter different uses of large whale bones in Central Europe shall be presented using mainly examples from the city of Bremen. Reasons and motives shall be discussed.

bones of fishes were used to form the roofs.“ (Arrian, Anabasis, book 6b, chapter 23); „*The richest among them have built huts; they collect the bones of any large fish which the sea casts up, and use them in place of beams. Doors they make from any flat bones which they can pick up. But the greater part of them, and the poorer sort, have huts made from the fishes' backbones.“* (Arrian, Anabasis, book 8b – Indica, chapter 29); *„Some of these whales go ashore at different parts of the coast; and when the ebb comes, they are caught in the shallows; and some even were cast ashore high and dry; thus they would perish and decay, and their flesh rotting off them would leave the bones convenient to be used by the natives for their huts. Moreover, the bones in their ribs served for the larger beams for their dwellings; and the smaller for rafters; the jawbones were the doorposts, since many of these whales reached a length of five-and-twenty fathoms.“* (Arrian, Anabasis, book 8b – Indica, chapter 30); see also Ellis (1993:43) and Saeftel (1970:139).

7 *„Their dwellings are built with the bones of large whales and shells, the ribs furnishing beams and supports, and the jaw-bones, door-ways. The vertebral bones serve as mortars in which fish, which have been previously dried in the sun, are pounded.“* (Strabo, Geography, book 15, chapter 2).

8 *„The commanders of the fleets of Alexander the Great have related that the Gedrosi, who dwell upon the banks of the river Arabis, are in the habit of making the doors of their houses with the jaw-bones of fishes, and raftering the roofs with their bones, many of which were found as much as forty cubits in length*.“ (Plinius, Naturalis historia, book 9, chapter 2).

9 *„9. Of houses erected from whole whalefisch ribs. When the meat and the intestines of this monstrous animal are consumed and decomposed, the bones remain altogether. They look like a large ship. When rain and air has cleaned and whitened them, folks were ordered, who carry them to the place where they are wanted and erect them like a house. At the top of the roof ridge or at the sides smoke holes were included, the whole is divided up into convenient rooms. From the skin of this animal, which has been treated and dried by the wind in advance, they make doors. One also provides stables for cattle and pigs therein for the livestock, like in other houses*.“ Translated from the German version (Magnus 1555/2006:331-332, book 21, chapter 9) by the author.

10 *„Churches and other buildings are constructed from fishbones, that is whale bones, and these are called ‚criptoporticus'*.“ Unfortunately Saeftel (1970:135) does not give a source for his quote.

Function of whale bones in Early Modern and Modern Central Europe

Whale bones as constructive elements in buildings

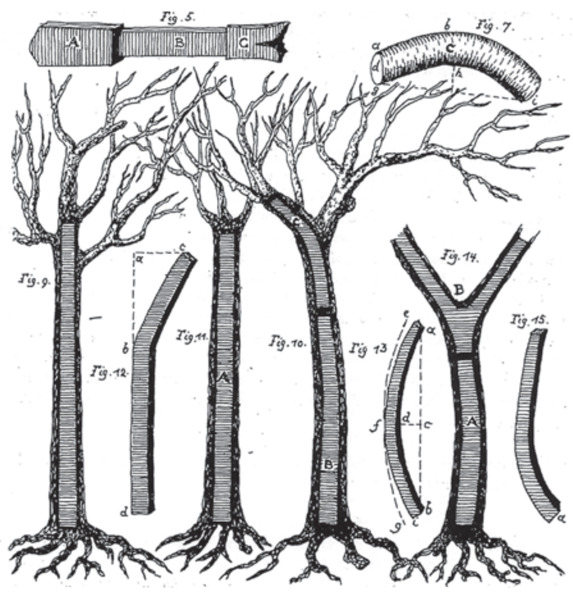
Olaus Magnus' report on whale bone houses has been sometimes questioned as an unrealistic legend. Seen from the present state of research it was probably a common practise in the Middle Ages in certain regions of Northern Europe. In fact houses that are built alike the one illustrated by Magnus (Fig. 2:b) survived until the 20th century even in England, Scotland and Ireland. Fig. 3:a shows the whale jaw shed in Whitby, Co. North Yorkshire, short before its regrettable final demolition in 1930 (Redman 2004:171-172; Saeftel 1970:132)[11]. Similarly, only a photo survived of a barn in Bremen (Lesumbroker Landstraße 111, Fig. 3:b) which was built with

11 Further buildings with incorporated whale bone supports are documented from England (a 2nd one in Whitby; Liverpool; Kings Lynn and Wiggenhall St. Germans, Co. Norfolk), Scotland (Greenland and Whaligoe, Co. Highland) and Ireland (Port, Co. Donegal; Strandhill, Co. Sligo) (Redman 2004:119, 132-133, 172, 281, 336, 342).

Fig. 3. Barns built with jaw bone supports. a) Whitby, Co. North Yorkshire, England, during demolition in 1930 (photo: Frank Sutcliffe, Whitby Museum; from Redman 2004:171); b) Bremen-Lesum, Lesumbroker Landstraße 111, during demolition in 1906 (photo: Focke-Museum Bremen, inv. no. B.477e); c) Bremen-Lesum, Niederbüren 2, barn with jaw bone segments in foundation (photo: Susanne Henßen 2009)

jaw bone supports, but had to be removed due to elevation of the dyke in 1906 (Redman 2009:31; Saeftel 1970:130-134). A few kilometres beyond another barn (Niederbüren 2; Fig. 3:c) still exists in good shape with two pieces of jaw bones incorporated in the foundations (Redman 2009: 36-38)[12].

The question remaining is, why did the builders of these houses choose whale bones in the documented cases? As already stated above shortage of wood is no reasonable argument neither for Bremen nor for Whitby or any of the other mentioned locations. For the two barns in Bremen a strong connection to the whaling business is evident: Both farmsteads, to which the barns belong, were inhabited by families of whaling ship captains in the 18th and early 19th century. This may account at least for the access and availability of whale bones and one may think of the purchase price in relation to wooden beams as a possible argument. I will return to this thread later on in the discussion. Another argument may have been the different material properties of bone and wood. Whale bones are more resistant to weathering and fouling than most types of wood (Ahlers 1911[1988]:25; Mohr 1935:369; Oesau 1937:308), which may have reduced the amount of care necessary for the maintenance of the buildings. There is one other hypothesis that needs to be discussed here. In a specific architectural type of roof-construction, the so-called bentwood or cruck-roofings, the anatomic features of trees are applied as constructive elements. Trees sometimes have been especially chosen and shaped during their growth for a later desired purpose as a specific constructive element in roof construction. In these cases trees are not sawn up into straight beams but the natural form of the tree is fit into the roof construction (Fig. 4). Cruck houses can be documented from the early Middle Ages onward in North-West Europe (Saeftel 1970). If this hypothesis holds true, Baleen Whale mandibles may have



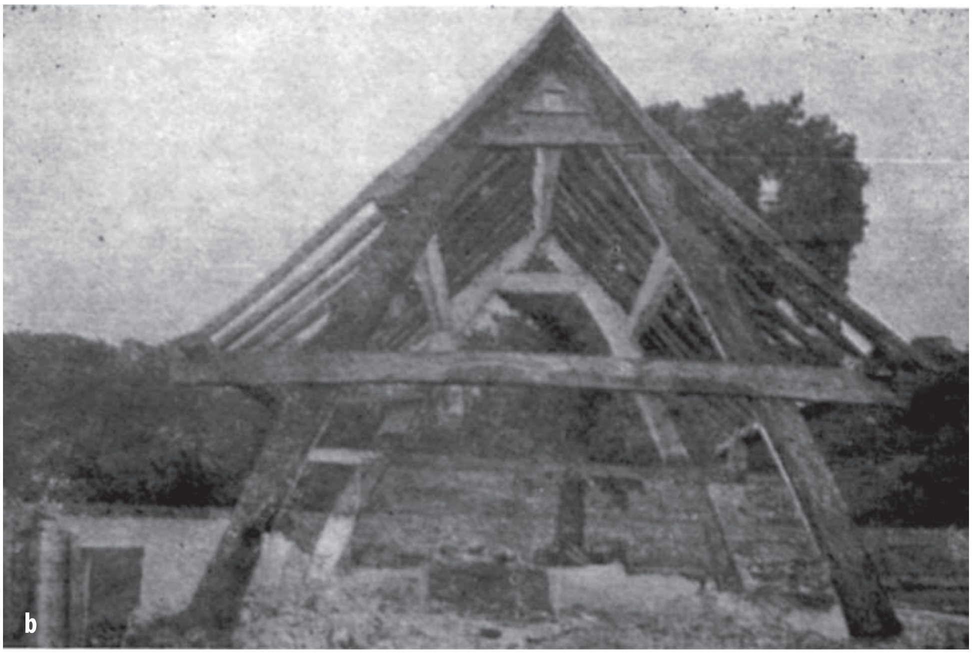


Fig. 4. a) Detail from an 18th centrury technical book on forest economics: „De l'Exploitation de Bois“ by du Monceau, Paris 1764; b) cruck house in Midhope, South Yorckshire (from Saeftel 1970:12, Fig. 2)

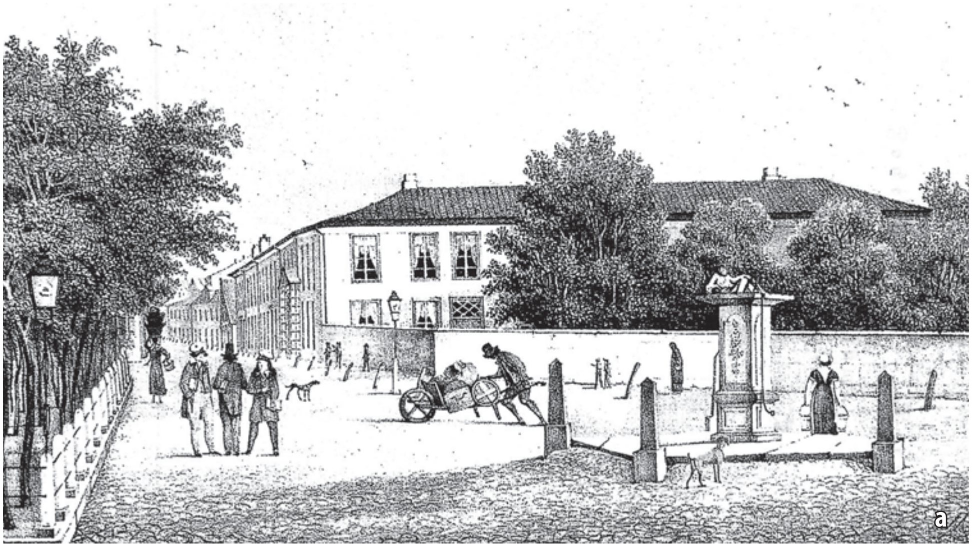
[12] Apart from the two mentioned buildings in Bremen there is one other documented building in Germany and only rumours remaining about a second one. The former is a pigsty from the village of Oevenum, isle of Föhr, built out of 10 jawbones, now restored in the Carl-Häberlin-Friesenmuseum in Wyk (Oesau 1955:216-219; Redman 2009:120-122). The latter is a barn in Klein-Grönland, Schleswig-Holstein, said to have had 10-12 jaw bone supports and to be demolished mid of the 19th century (Oesau 1937:308-309; Redman 2009:xxv, 131).

Fig. 5. Examples of jaw bone arches; a) Schwanewede, Leuchtenburger Straße 44, still in situ (photo: Küchelmann 2009); b) Bremen-Lesum, Lesumbroker Landstraße 111, arch no. 1 (photo: E. Eisinger ca. 1900; Focke-Museum Bremen, inv. no. L98); c) Bremen-Neustadt, Kirchweg 200 (photo: Helga Koch 1972); d) half of the same arch today (photo: Küchelmann 2009)

been sought for in some cases because of their shape which may have been ideal for this type of house (Barthelmeß 1989:245-247; Saeftel 1970:130-140).

Jaw bone arches

The most eye-catching use of large whale bones were archways made of two lower jaws placed upright into the ground with the condyles at the bottom. These objects pose less interpretative problems than the former. They were usually erected by individuals, families or communities with relations to the whaling business. Often captains of whaling vessels brought a pair of jawbones home and erected them in front of their estates. Ship-owners and merchants also had a preference for arches. In most cases these arches represent symbols of status, profession, prestige and wealth as well as aesthetic or decorative elements. The habit became a Europe wide fashion in the 18^{th} century and persisted until the early



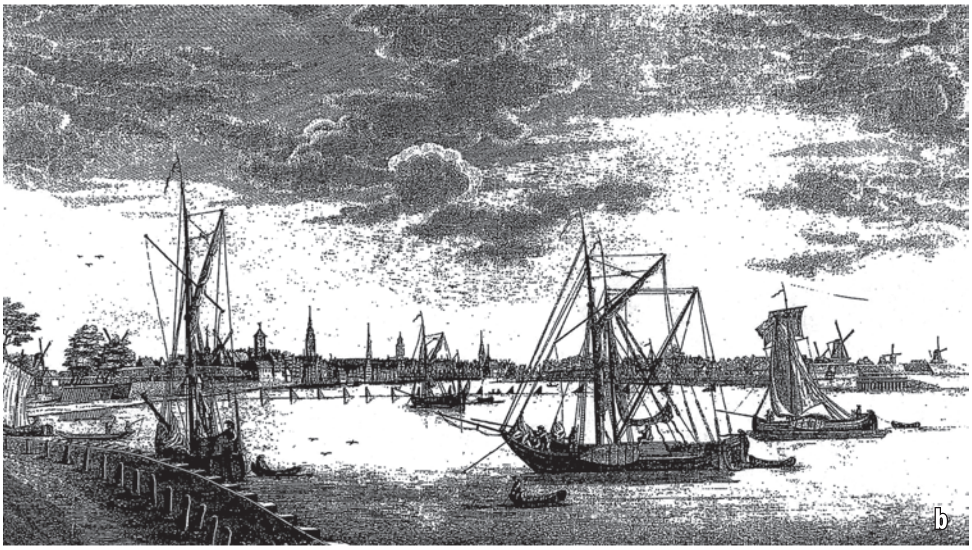
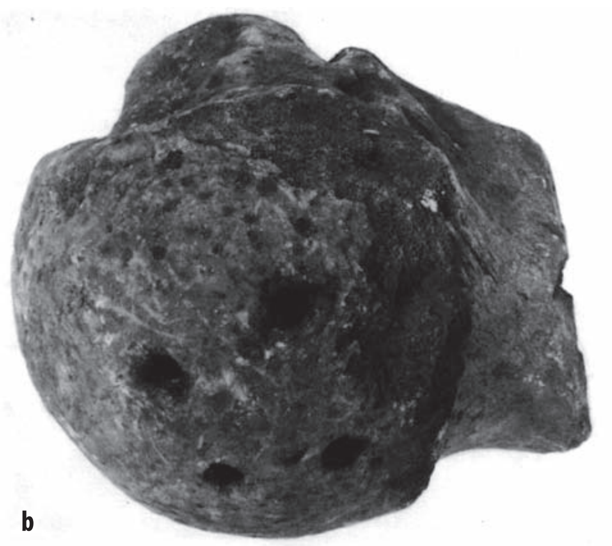


Fig. 6. Whale bone post rows in Bremen
a) Domsheide, 24 posts along the wall, lithograph of 1819, probably by Gottfried Menken;
b) Stephanitorsbollwerk, 16 posts along the river banks, copper engraving by Wolfgang C. de Mayr after drawing by J. H. Grönninger 1773;
c) Wallanlagen, photo by Erna Mohr 1933

Fig. 7. a) The bark ‚Harmony' from Hull, England, with six whale jaw bones lashed to the masts, aquatint by Edward Duncan after painting by William John Huggins 1829 (from Barthelmeß 1989:244, Fig. 1); b) Bowhead humerus head with bone oil holes (from Barthelmeß 1989:251, Fig. 8)



20th century. One can pose a gender question here: As the whalers were exclusively men, this is obviously a male habit. For Bremen at the present state of research 16 arches can be tracked historically, six of which are still remaining as mounted monuments today, one has been replaced by a bronze replica and one is stored in a warehouse (Fig. 5)[13].

Posts and post rows

Post rows probably once have been the most frequent feature of whale bones in Bremen. Several 19th and early 20th century authors report on the use of whale bone segments as fender posts to separate vehicle from pedestrian lanes, to protect houses from the wheels of vehicles or simply for decorative reasons[14]. At the present state of research it was possible to track down 11 historical objects (single posts or post rows) with a minimum of 57 posts[15]. Today three are remaining, only one of which is still in situ. Figure 6 shows three of these locations. The Domsheide (Fig. 6:a) is one of the most central and main public places then and today, adjacent to the dome and the market place. The Stephanitorsbollwerk (Fig. 6:b) is situated outside the Early Modern city defences in an area where the train oil factories were located in the 18th and 19th century (Küchelmann 2008:134). Whale bone post were obviously so abundant in Bremen, that they became objects recognised as absolute normality, not worth to be mentioned or kept in mind or any record. A particularly apparent example for this are the posts visible in fig. 6c. They are situated in the former city defence area converted into a highly frequented public park in 1802 and were photographed by zoologist Erna Mohr in 1933. Although the public parks department keeps an extensive historical archive about

[13] Two arches in the village of Leuchtenburg, located just across the city boundaries of Bremen in the adjacent county of Osterholz, are included here.

[14] For example: „*Vor den Häusern waren dickleibige Pfähle angebracht, welche die Mauer [...] zwar schützten, den Fahrweg aber noch mehr verengten. [...] In Bremen recht häufig fußdicke Stücke von Walfischkinnladen, die man oben glatt absägte und mit Blech benagelte.*" Kohl (1871:4). „Thick posts were fixed in front of the houses, which protected the wall, but further reduced the vehicle lane. [...] In Bremen quite frequently foot thick pieces of whale jawbones, which were sawn plain at the top and shod with iron covers". See also Redman (2009:45).

[15] Five additional possible locations await clarification presently.

the development of the parks there is no trace left of these quite impressive objects in the records and the exact location is still unknown.

The obvious abundance of whale bones utilised for quite profane objects in public areas makes the inconsistency with the profit interests of the whaling companies already mentioned above apparent. Digging down deeper here reveals several literal and iconographic sources from the 18th to 19th century reporting on a specific custom of European whalers to carry the jaws of the whales back home lashed to the masts of their ships (Ahlers 1911[1988]:34; Barthelmeß 1989; Oesau 1937:308; Redman 2004:xvii-xxii). A comprehensive analysis of iconographic representations of whale bones carried on sailing ships (Fig. 7:a) dated between 1780 and 1849 has been published by Bartelmeß (1989). The prime reason for this custom was not to bring jaws back home as status symbols. Instead it was a method to extract oil contained in the jaw bones. Holes where drilled into the condyles (Fig. 7:b) and a barrel was placed on deck underneath. During the return voyage the oil – said to

Fig. 8. Right scapula of Bowhead (*Balaena mysticetus*) painted as advertising sign for a distillery in 1745, Focke-Museum Bremen, inv. no. B.1151, lost (from Barthelmeß 1994:261)

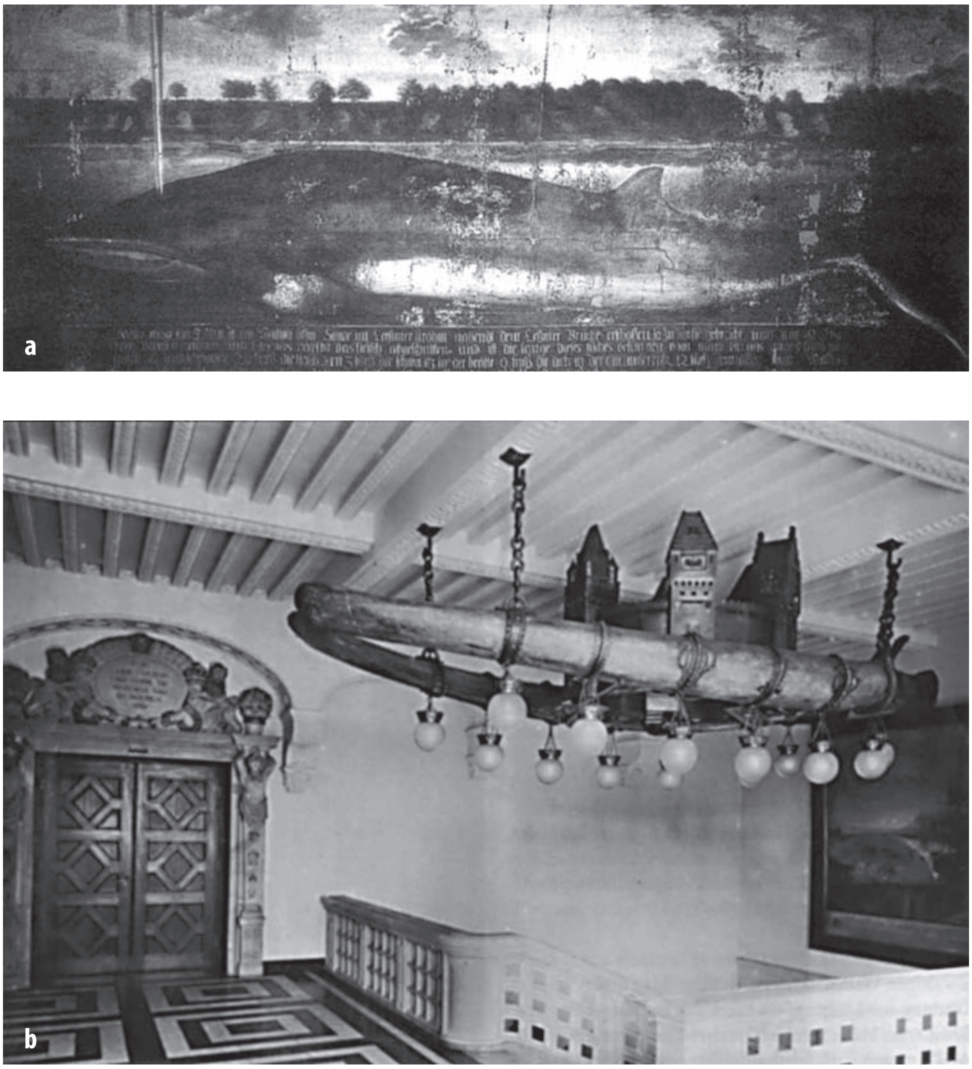


Fig. 9. a) Minke Whale (*Balaenoptera acutorostrata*) shot in the river Weser in 1669, oil painting by Franz Wulfhagen 1669; b) chandelier of Common Rorqual (*Balaenoptera physalus*) jawbones in the city hall 1921 (photo: collection Barthelmeß, from Redman 2009:39)

be of extraordinary fine quality – slowly drips into the barrels[16]. Even some notes on prices for jaws are conveyed: A pair of jaw bones was sold for 30-32 Shilling in Hull, England, in the 1820s to 1830s. Other sources from Hull are speaking of prices between 12 Shilling and 2 Pounds 4 Shilling per pair in 1844 depending on the size with an average of 1 Pound per pair. However, according to Captain William Barron from Hull, talking about the "late days" of whaling in 1895 the price declined at the end of the 19th century: "*they do not pay for the care and trouble of bringing them home. The price used to be 30s per pair*." (Barthelmeß 1989:251-252; Redman 2004:xix-xxi). The practice provides a convincing explanation for the abundance of whale bones in Europe in general and for the overrepresentation of jaw bones compared to other skeletal elements in particular.

Signs

Another function less frequently recorded is the use of whale bones as signs suspended at pubs, guesthouses, shops, etc. to attract customers. For this purpose in the majority of cases the scapula has been utilised, which offered a large flat surface area to be painted and inscribed. For Bremen one extraordinary specimen of this type of object is documented, a painted right scapula of a Bowhead used as sign for a distillery (Fig. 8)[17].The painting shows glasses, distillation devices and a Bowhead. On the bottom an advertisement tells "Here brandy is sold and distilled"[18]. The painter has kindly added the year

Fig. 10. Cattle rubbing post, Bremen-Lesum, Niederbüren 2 (photo: L. G. ca. 1905; Focke-Museum Bremen, inv. no. B.477c)

1745. The exact location of the former distillery is not known. The sign entered the records for the first time in 1884, when it was exhibited in an exposition about whales and whaling. In 1919 it became part of the collection of the Focke-Museum and although not destroyed it got lost in the 2nd World War.

Exhibition objects

At least since the origin of the Early Modern Wunderkammern in the 16th century whale bones attracted attention as collectable items (Barthelmeß 1994:260-261) and during the whole period covered in this paper – from the 17th century until today – there are numerous examples of whale skeletons and skeletal elements in museum collections and exhibitions. For Bremen presently 19 items are recorded, 16 of which are still existing[19]. Only three objects of special interest shall be introduced here.

On the 9th of May 1669 an unlucky Minke Whale swam approximately 60 km up the river Weser until the city of Bremen, where he was shot with a gun. A life

[16] An example of a lively description gives Friedrich Gottlieb Köhler in 1820: „*Die Kinnlade wird gleichfalls hinauf gewunden. Man hängt sie an die Wände des Schiffes und setzt ein Faß darunter, worein nach und nach ein feiner Thran tröpfelt* ...“ „The jaw is wound up as well. One suspends them in the shrouds of the ship and sets a barrel underneath, wherein by and by a fine train oil drips ...“. Quoted after Barthelmeß (1989:251). Other sources quoted by Barthelmeß (1989:250-251) are Carl Friedrich Posselt (1795) and William Scoresby (1820). See also Redman (2004:xvii-xix) quoting Walter Scott (1821) and William Bell (1862).

[17] Barthelmeß (1994) gives a detailed description of seven additional painted scapulae used as advertising media from other locations. In Hamburg the name of the street ‚Schulterblatt' is said to have been derived from a scapula pub sign. For these and other whale bones as signs in Germany see also Redman (2009:9-11, 15-16, 33-34, 44-45, 53-54, 56-58, 87-88, 111, 117-118, 129-130, 133, 136-137, 150). A rib in front of a pharmacy in Verona, Italy, may be mentioned here as example for other skeletal elements used for the same purpose.

[18] „*Hir vorkaufft und brenndt man Brhanndte Wein*“.

[19] Two arches, one set of posts and the above mentioned sign, displayed in two museums have been counted also in the other categories.

size painting was made of the whale (Fig. 9:a). Later on the whale was flensed and processed, the skeleton was macerated and mounted in the city hall alongside with the painting. 1809 the skeleton was transferred to the museum, where it is still on display, being the oldest mounted large whale skeleton at least in Europe (Redman 2009:40-42). In 1884 a large exhibition on whaling was held in the garden of the artists society showing a variety of exhibits around the topic whales and whaling. Today in the city hall a chandelier consisting of two 5.40 m long jaw bones of a Common Rorqual is installed (Fig. 9:b).

Miscellaneous

Other utilisations of whale bones include fences, bridges, boundary stones, cattle rubbing posts, draw wells, tomb slabs, seating devices (like chairs, stools, benches) and chopping blocks (Oesau 1937, 1955; Redman 2004, 2009, 2010a, 2010b). Of all these functions only two objects are recorded for Bremen, a chair made of a vertebra in the Museum Schloss Schönebeck (Redman 2009:36) and a cattle rubbing post (Redman 2009:38) once set in a field in Bremen-Lesum (Fig. 10).

Summary

The city of Bremen stretches approximately 50 km along the river Weser, it covers 325 km^2 and has approximately 546,000 inhabitants[20]. For this rather small area at the present state of research 46 objects could be documented consisting of a minimum of 119 bones (Table 2)[21]. This is probably only the tip of the iceberg. There are still several objects that need to be clarified before they can be included in the statistic as confidently recorded. Most probably many objects have long vanished without leaving any trace. Com-

[20] Status September 2010, http://www.statistik-bremen.de/aktuelle_statistiken/01b.htm, 26.1.2011.

[21] For a compilation of the majority of objects from Bremen described in this article see also Redman (2009:26-45).

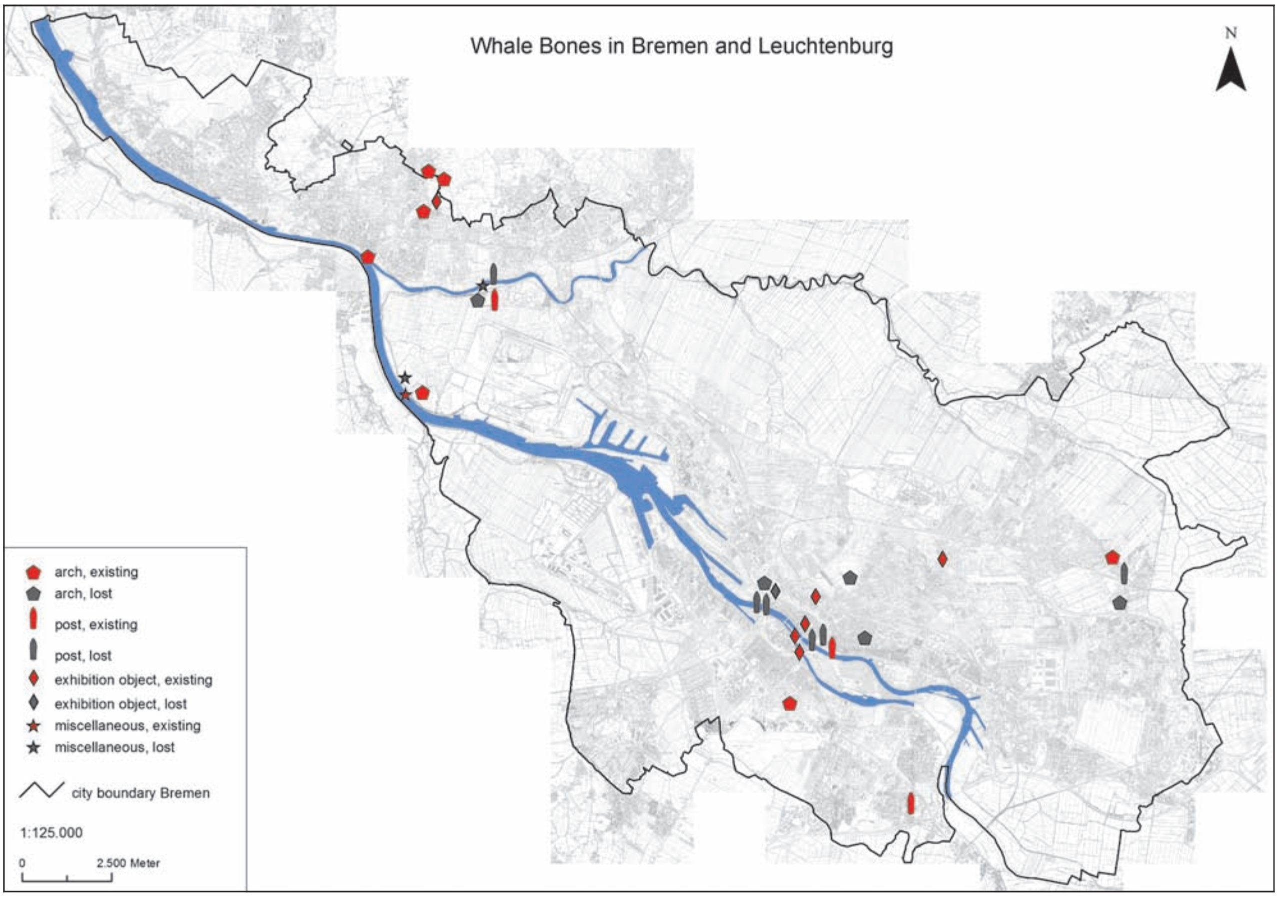


Fig. 11. Map of Bremen with the location of historic and present distribution of whale bone objects

paring the historic record with the situation today it becomes evident that at least 41% of the objects once existing have been lost, counted by single bones this number increases to 64% of lost bones. This is mainly due to the posts / post rows of which nearly all are gone today. In contrast nearly all the items stored in museums survived, a fact that can easily be attributed to curating and the lack of weathering in sheltered indoor conditions. To visualise this, the historic and present distribution of the whale bone objects has been plotted on a map of the city (Fig. 11). What becomes readily apparent here and needs to be explained are the three visible clusters. The cluster in the North-West is most strongly related to the real whaling history. The harbour of Bremen-Vegesack was built 1618-1623 and became the main whaling harbour of Bremen since the middle of the 17th century. In its vicinity many whaling ship captains had their homesteads, which resulted in a concentration of whale bone objects in this area. The cluster in the area of the city centre is probably simply due to the fact that it was the main centre of activity since the Early Middle Ages. Further, it is the location of the two main museums. Less easily to explain is the cluster in the East. These are the today's city quarters of Oberneuland and Rockwinkel, formerly independent villages in the countryside under the administration of the senate of Bremen, not within the city boundaries until 1921. Since the 17th century both villages were a favoured settlement area of wealthy citizens of Bremen, who built summer residences with large parks here (Stein 1967:92-94). Most of these citizens were involved in the trading business and therefore several arches erected here seem to have been more a reflection of the felt affiliation to seafaring of this clientele than an evidence of direct practical involvement in whaling itself. In particular: While in the Northern quarters of Lesum, Leuchtenburg, Vegesack and Schönebeck, the occurrences of whale bones are mainly related to the estates of families of whaling ship captains, often farmers, the bones in the quarters of Oberneuland and Rockwinkel are mainly related to large manors owned by persons of high social status, often ship-owners and merchants.

As I hopefully was able to demonstrate, this is just the beginning of an extensive research project. Lots of questions waiting to be revealed and resolved. Additional facts and information is still very welcome. And if you, dear reader, happen to find a whale bone in a condition like the one in figure 5:d, please take action!

Table 2. Whale bone objects in the city of Bremen and Schwanewede-Leuchtenburg

class of object	no. of objects historic evidence	no. of bones historic evidence	no. of objects today	no. of bones today
arches	16	32	8	16
posts / post rows	11	57	3	3
exhibition objects*	16	23	15	22
miscellaneous	3	7	1	2
total	46	119	27	43

1arch = 1 object but 2 bones; 1 post row = 1 object but n bones

* 2 arches, 1 at the Museum Schloss Schönebeck and 1 at the former location of the Focke-Museum, have been counted as arches; 1 set of 3 posts formerly in the Focke-Museum, now lost, has been counted as post row; of 3 complete skeletons in the Übersee-Museum (two mounted), the single bones have not been counted, they are included here as 3 objects / 3 bones.

Acknowledgements

A research like this cannot be undertaken without the aid of many helpful persons. I am first of all indebted to Nicholas Redman (Teddington, UK) without whom the large set of detailed data, of which this paper is only a short summary, would not have been as comprehensive as it is now. I would like to dedicate this paper to Klaus Barthelmeß (Köln), who contributed valuable information for several years and also to this paper. Klaus died unexpectedly in February 2011 while this article was in preparation. I am further grateful to the following persons for their contributions, interest, support, photos, patience, ... :

Satze Ariker (Bremen), Hannelore Bade (Focke-Museum Bremen), Peter-René Becker (Übersee-Museum Bremen), Ursula Beckröge (Stadtteilarchiv

Oberneuland, Bremen), Egon Binder (Osnabrück), Dieter Bischop (Landesarchäologie Bremen), Tobias Böckermann (Neue Osnabrücker Zeitung, Meppen), Wigmar Bressel (Koch & Bergfeld Bremen), Erika Gal (Budapest), Friedrich Greve (Arbeitskreis Arster Geschichte(n) Bremen), Peter Hahn (Landesamt für Denkmalpflege Bremen), Susanne Henßen (Palaeowerkstatt Goch), Heinz-Gerd Hofschen (Focke-Museum Bremen), Ludwig Koch, Hans Walter & Sigrid Küchelmann (Bremen), Bernadeta Kufel (Wroclaw), Thomas Kuppel (Bremen), Hauke Nehring (Senatskanzlei Bremen), Angela Piplak (Bremen), Ursula Pohl (Leuchtenburg), Hinrich Schierenbeck & Annemarie Schnieder (Arbeitskreis Arster Geschichte(n) Bremen), Harry & Heike Schwarzwälder (Amt für Straßen- und Brückenbau Bremen), Simone & Volker Strobel (Leuchtenburg), Marc Tienken (Göttingen), Alexander von der Decken (Weser-Kurier Bremen), Klaus Wechsler (Übersee-Museum Bremen), Manfred Wegner (Stadtgrün Bremen), Lena Wöhlke (Haus der Wissenschaft Bremen), Ingrid & Rainer Wöhlke (Bremen), Elfriede & Hinrich Wolf (Bremen).

References

Ahlers, B. 1911 [1988]. *Die arktische Fischerei wie sie von der Weser aus betrieben wurde*, Bremen: Heimat- und Museumsverein Vegesack.

Barthelmeß, K. 1989. *Walkinnladen in Wanten – Maritime Motivkunde als historische Datierungshilfe*, Deutsches Schiffahrtsarchiv 12, 243-64.

Barthelmeß, K. 1992. *Auf Walfang – Geschichte einer Ausbeutung*, In: K. Weidlich (ed.) *Von Walen und Menschen*, Hamburg: Historika Photoverlag, 4-51.

Barthelmeß, K. 1994. *Neun bemalte Walsschulterblätter und ein beschnitzter Wal-Humerus (Oberarmknochen)*, Deutsches Schiffahrtsarchiv 17, 253-72.

Barthelmeß, K. 2008. *Die Walknochen der Nordseeinsel Borkum, Speckpresse – Schriften zur Kulturgeschichte von Mensch und Meeressäuger* 1, Norderstedt: Books on Demand,online: http://www.bod.de/index.php?id=296&objk_id=144196.

Brink, F. H. van den 1957. *Die Säugetiere Europas*, Berlin: Paul Parey.

Choyke, A. M. 1997. *The Bone Tool Manufacturing Continuum*, Anthropozoologica 25-26, 65-72.

Clark, G. 1989. *Economic Prehistory*, Cambridge: Cambridge University Press.

Ellis, R. 1993. *Mensch und Wal: die Geschichte eines ungleichen Kampfes*, München: Droemer Knaur.

Huiskes, B. 2001. *Vom Grönlandwal zum Grabdenkmal – Probleme der Konservierung von Unterkieferhälften des Balaena mysticetus, verwendet als Grabdenkmäler auf Vlieland*, Deutsches Schiffahrtsarchiv 24, 187-96.

Kohl, J. G. 1871. *Alte und neue Zeit. Episoden aus der Kultur-Geschichte der freien Reichs-Stadt Bremen*, Bremen: Verlag von E. Ev. Müller.

Koster, P. 1700 [2004]. *Chronik der kaiserlichen Freien Reichs- und Hansestadt Bremen 1600-1700*, reprint, Bremen: Edition Temmen.

Küchelmann, H. C. 2008. *Ein Walknochen vom Teerhof in Bremen*, Deutsches Schiffahrtsarchiv 30, 125-40.

Magnus, O. 1555 [2006]. *Historia de gentibus septentrionalibus / Die Wunder des Nordens*, erschlossen von Elena Balzano and Reinhard Kaiser, Frankfurt am Main: Eichborn Verlag.

Meyer, H.-R. 1965. *Die bremischen Grönlandfahrten und ihr Einfluß auf die bremische Wirtschaft*, Bremisches Jahrbuch 50, 221-86.

Mohr, E. 1935. *Historisch-zoologische Walfischstudien*, Nordelbingen – Beiträge zur Heimatforschung in Schleswig-Holstein, Hamburg und Lübeck 11, 335-93.

Monceau, H. L. D. du, 1764. *De l'Exploitation des Bois,* Paris.

Münzing, J. 1987. *Der historische Walfang in Bildern,* Herford: Koehlers Verlagsgesellschaft.

Mulville, J. 2002. *The Role of Cetacea in Prehistoric and Historic Atlantic Scotland,* International Journal of Osteoarchaeology 12, 24-48.

Mulville, J. 2005. *A Whale of a Problem? The Use of Zooarchaeological Evidence in Modern Whaling*, In: G. C. Monks (ed.) *The Exploitation and Cultural Importance of Sea Mammals, Proceedings of the 9th Conference of the International Council of Archaeozoology, Durham, August 2002*, Oxford: Oxbow Books, 154-66.

Oesau, W. 1937. *Schleswig-Holsteins Grönlandfahrt auf Walfischfang und Robbenschlag vom 17.-19. Jahrhundert,* Glückstadt: J. J. Augustin.

Oesau, W. 1955. *Hamburgs Grönlandfahrt auf Walfischfang und Robbenschlag vom 17.-19. Jahrhundert,* Glückstadt: J. J. Augustin.

Pax, F. 1933. *Zoogene Bau- und Schottermaterialien rezenten Ursprungs*, Mitteilungen aus dem Zoologischen Museum in Berlin 19, 333-376.

Redman, N. 2004. *Whales' Bones of the British Isles,* Teddington: Redman Publishing.

Redman, N. 2009. *Whales' Bones of Germany, Austria, Czech Republic & Switzerland*, Teddington: Redman Publishing.

Redman, N. 2010a. *Whales' Bones of the Netherlands & Belgium*. Teddington: Redman Publishing.

Redman, N. 2010b. *Whales' Bones of the British Isles, Supplement 2004-2010*. Teddington: Redman Publishing.

Rijkelijkhuizen, M. J. 2009. *Whales, Walruses, and Elephants: Artisans in Ivory, Baleen, and Other Skeletal Materials in Seventeenth- and Eighteenth-Century Amsterdam*, International Journal of Historical Archaeology 13(4), 409-29, online: http://www.springerlink.com/content/454786w520h27327.

Saeftel, F. 1970. *Krummholz- und Cruck-Dachwerke in Nordwest-Europa. Eine bisher nicht geschlossen bearbeitete Dachwerksart im Nordseeraum*, Eckernförde: J. C. Schwensen.

Savelle, J. M. 1997. *The Role of Architectural Utility in the Formation of Zooarchaeological Whale Bone Assemblages*, Journal of Archaeological Science 24, 869-85.

Savelle, J. M. 2000. *Information systems and Thule Eskimo bowhead whaling*, In: P. Rowley-Conwy (ed.) *Animal Bones, Human Societies*, Oxford: Oxbow Books, 74-86.

Schwarzwälder, H. 1995. *Geschichte der Freien Hansestadt Bremen*, Band I, 2. Auflage, Bremen: Edition Temmen.

Smith, A. N. 1998. *Worked bone and antler*, In: N. Sharples (ed.) *Scalloway: A Broch, Late Iron Age Settlement and Medieval Cemetary in Shetland*, Oxbow Monograph 82, Oxford: Oxbow Books, online: http://www.cf.ac.uk/hisar/archaeology/reports/scalloway/catwbone.html.

Stein, R. 1967. *Dorfkirchen und Bauernhäuser im Bremer Lande*, Bremen: Verlag H. M. Hauschild.

Marloes Rijkelijkhuizen

Large or small? African elephant tusk sizes and the Dutch ivory trade and craft

In the 17th and 18th centuries, the Dutch imported large quantities of African elephant tusks from West-Africa to the Dutch Republic. These tusks were used either in the production of objects by craftsmen in the Netherlands or re-exported whole to other countries. Using both historical and archaeological sources to estimate the size of the tusks utilised in the Dutch ivory trade, this paper explores the possibility that size was a major factor in the selection of tusks for the different purposes to which they were put.

Key words: African elephant, tusk sizes, 17th-18th centuries, Amsterdam

Introduction

The Dutch ivory trade flourished in the 17th and 18th through the importation of tusks from the coast of West-Africa. Some of these tusks were then re-exported to other countries across Europe and to Asia but the majority was crafted into various objects by Dutch ivory craftsmen. The popular conception of ivory trading in the past is of great piles of enormous tusks being shipped all over the world, an image reinforced by 19th and early 20th century photographs. Figure 1 shows record breaking tusks that are larger than a tall men or even a doorpost from this later period. However, such photographs generally represent trade in East-African ivory, whereas the earlier Dutch ivory trade was based in West-Africa. Is our image of man-high tusks correct in the case of this Dutch ivory trade?

Using historical records and archaeological evidence this paper focuses on determining the size range of the elephant tusks that were shipped from western Africa to the Dutch Republic and examines the evidence for selection on the basis of size for tusks that were re-export or crafted into objects. In addition, the term ‘crevellen’, which is used in the historical sources to indicate a particular type of small tusk, is investigated.

Evidence for Determining Tusk Size and Weight

The archaeological evidence for ivory working comes from the remains of worked objects and ivory off-cuts from sites excavated in Amsterdam, currently in the collections of the Office for Monuments and Archaeology (Bureau Monumenten en Archeologie, hereafter BMA). This evidence shows that elephant ivory working was carried out on a large scale in 17th and 18th century Amsterdam and included comb makers, knife makers and ivory turners (Rijkelijkhuizen 2009). The historical sources include cargo lists that relate to the Dutch ivory trade and an ivory craftsmen’s inventory from Amsterdam.

The archaeological evidence

Observations of the shape of the waste fragments and the orientation of the ivory structure on the excavated objects reveals very standardized production processes (Fig. 2; Rijkelijkhuizen 2009). Fragments trimmed from the hollow base of the tusks (Fig. 6,

Fig. 1. The ‘Kilimanjaro tusks’;
The largest tusks recorded: 101.9 kg and 96.3 kg,
the old elephant was shot in 1899

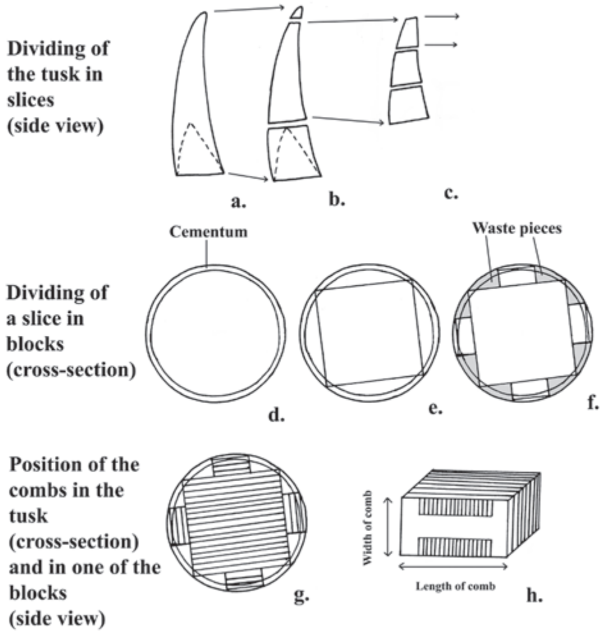


Fig. 2. Production process of elephant ivory combs (Rijkelijkhuizen 2009)

10) are found and off-cuts in the form of longitudinal strips with a triangular cross-section (Fig. 3-4) are particularly common. These longitudinal strips come from the edge of the tusk when it is cut into rectangular slabs (Fig. 2:f). They have two straight-cut sides, but the third side follows the curved edge of the tusk, and the cementum, the outer layer of the tusk, is often still present (Rijkelijkhuizen 2009). From these waste fragments, it is possible to estimate the outer circumference of the tusk and from this to gain some measure of its overall size. The circumference was calculated for 18 longitudinal strips, two flat fragments and 5 base fragments. The trimmings from the tusk bases and a complete tusk were recovered from the construction of the new underground in Amsterdam; the other fragments were excavated from several widely spaced sites across the city. Some of the waste fragments were recovered from the same site. Three of the base trimmings are complete and provide direct measurements of the tusk circumferences (Fig. 6, 10), as does the complete tusk (Fig. 9).

To calculate the circumference of a tusk from a triangular off-cut strip, the formula in fig. 5 is used. If r is the radius of a circle, its circumference is $2\pi*r$. Elephant tusks, however, are not circular in cross-section, but oval. The calculated circumference, therefore, depends on the location of the off-cut relative to the changing curve of the oval. In addition, the diameter (2r) of the tusk is not constant but can decrease slightly near the base and also tapers towards the tip. This means that the circumference calculated from an off-cut strip may give an under- or overestimate of the maximum circumference of the tusk, depending on where along the length of the tusk it has been cut. In practice, however, these waste fragments were not taken from the extreme ends of the tusks, as the tip and the hollow base were removed as the first stage of the production process (Fig. 2). This left a cylinder of ivory with only a small amount of taper, from which the rectangular blocks were then cut for object production. Another issue when calculating the tusk circumference from these waste fragment strips is the small size of the curved surface, often only 15-20 mm, from which the measurement of curvature can be taken. These calculated circumferences can not, therefore, be taken as exact measurements but only as an indication of the size of the tusks.

The circumferences of the 3 complete trimmed bases could be measured precisely and these were used to verify the outcomes of the calculation method and gauge the likely percentage error for the results gained from the triangular off-cuts. This was done by calculating the apparent circumference of each tusk at several locations with different amounts of curvature. When the results were compared with the directly measured

Fig. 3. Ivory waste fragments (PR15-4). Collection: BMA, photo: Marloes Rijkelijkhuizen

Fig. 4. Cross-section on one side of the waste fragments is triangular (PR15-4). Collection: BMA, photo: Marloes Rijkelijkhuizen

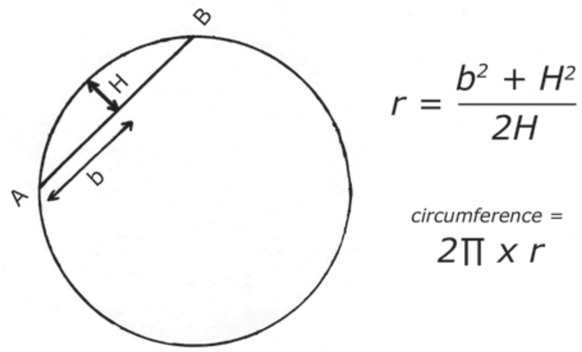


Fig. 5. Calculation method to determine the circumference of a circle based on a small fragment of the outer circumference. r is the radius of a circle

circumferences, the error varied from 7-27%, with a probable average of 10-20%. The accuracy of the calculations depended on the shape of the tusk and the location of the measurements; the most inaccurate calculated circumferences were from the least circular tusks when measured at their widest or narrowest curvature. The other base trimmings and the flat fragments, although incomplete, represent greater lengths of the tusk circumference than the triangular off-cuts and so the calculation errors are not so significant.

The historical evidence

Comparison between the archaeological evidence and the historical sources is complicated as the latter usually only mention the bulk weight of the tusks in transactions, as ivory was sold grouped into categories, instead of by individual tusks. The price of the ivory depended on the quality and size of the tusks. For instance, the West India Company (WIC) imported ivory and sold it on at one guilder per Dutch pound (approximately 0,5 kg) for 'teeth' and half a guilder per Dutch pound for 'crevellen' (den Heijer 1997:135). From the archaeological material an estimate of individual tusk weight can not be calcu-

Fig. 6. Ivory waste fragment from the base of the tusk (NZR2-789-2). Collection: BMA, photo: Marloes Rijkelijkhuizen

lated, as the original lengths of examples can not be estimated from the surviving evidence.

The National Archive holds the records of the West India Company, the major importer of ivory to the Dutch Republic in the 17th and 18th centuries. Feinberg and Johnson (1982) and Den Heijer (1997) have made a thorough study of these records in relation to the ivory trade at the end of the 17th to the beginning of the 18th century. Inventories and wills of craftsmen working in ivory and other materials can be found in the notarial archives at the Amsterdam city archives. These records provide information that both complements the archaeological data and helps in its interpretation (Rijkelijkhuizen 2009).

Results

The calculated tusk circumferences from the longitudinal strips and base trimmings fall between 122 and 573 mm ± 10-20%. The three complete waste fragments from the base of the tusk have a circum-

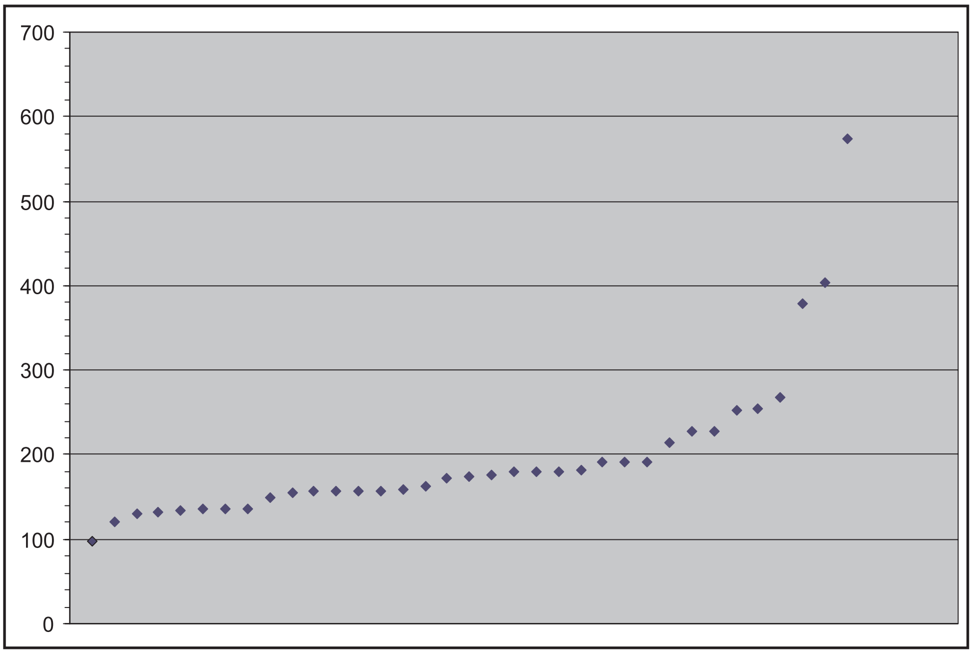


Fig. 7. Calculated circumferences from the archaeological waste fragments

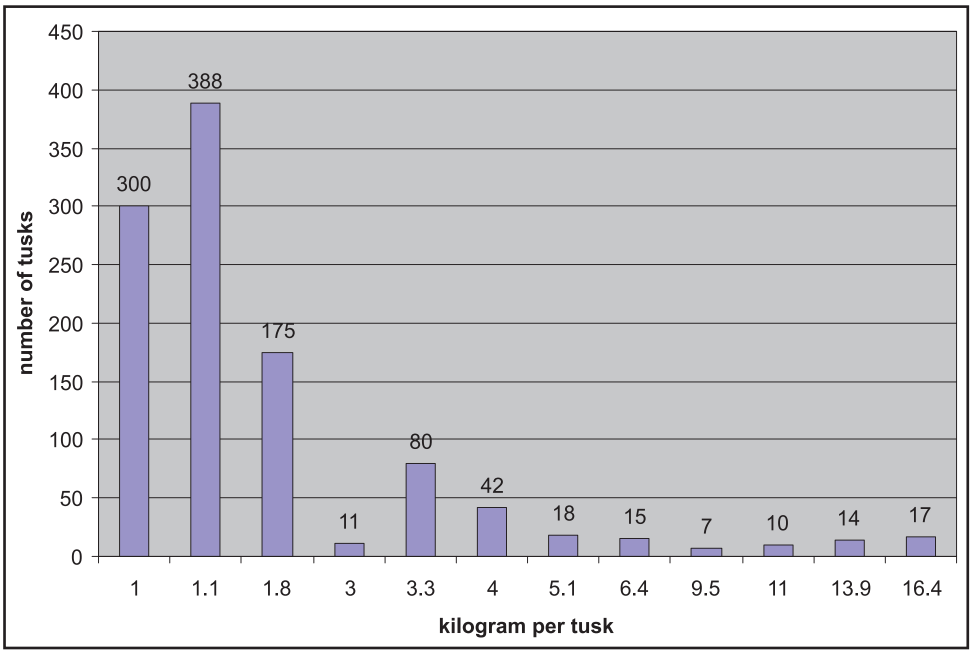


Fig. 8. Number and weight of tusks recorded in the inventory of knife maker Menso Sadelaer in 1708 (Stadarchief Amsterdam, Notarial Amsterdam 4711)

ferences of 123, 171 and 185 mm (Fig. 7). The complete tusk has a circumference of 150 mm at its base and 160 mm mid-way along the tusk, a length of 800 mm along its outer curve and 710 mm along its inner curve.

Feinberg and Johnson (1982) have used West India Company cargo lists between the year 1699 and 1725 AD to calculate the average weight of the tusks, both 'crevellen' and 'teeth', that were imported to the Dutch Republic (table 1). The weights are averages, because individual tusks were not weighed, but the figures were calculated from the total mass of tusks in each category. A small proportion of these tusks are very large and tusks up to 100 kg are recorded in the lists. Kok (1794:70) also mentions tusks of these weights but both might possibly be exaggerations.

Inventories are another important source that throws light on the Dutch elephant ivory trade and craft. The inventory of the knife maker Menso Sadelaer (Stadarchief Amsterdam, Notarial Amsterdam 4711) records the total amount of tusks present in his shop at a particular point of time in 1708. This inventory groups the tusks by weight, giving the number of tusks and total weight of ivory in each weight category (Fig. 8).

Interpretation of the evidence

When compared to tusks exported in the 19th and 20th centuries from East Africa (Table 1-2), both the archaeological evidence and the historical records indicated that the tusks entering the Dutch Republic from West Africa in the 17th and 18th centuries were generally much smaller.

Many factors influence the natural tusk size of an elephant. Male elephants, for instance, have larger tusks than female elephants (Table 2). Because the tusks grow throughout the life of the animal, those of adult elephants will be larger than those of juveniles and the very largest are liable to be from individuals of considerable age. Another important factor is the region of provenance of the elephant. The East-African elephants are particularly known for their large tusks (Sikes 1971:14). Selection pressure can also change the tusk size distribution over time. Intensive hunting of elephants in the 19th and 20th centuries, with a particular bias towards animals with large tusks, has produced a significant drop in the average tusk size of modern elephant populations (Jackson 1990:102). The average tusk weight recorded in the twentieth century by Sikes (1971:324) was only 11 to 13 kg.

Pilgram and Western (1986) have shown that it is possible to infer both the sex and age of African elephants using measurements of the length, circumference and weight of their tusks.

In order to estimate age, the weight and circumference of the tusk and sex of the elephant must be known. To infer the elephant's sex from the tusk, the length and circumference of the tusk must be known; female tusks being usually more slender than male tusks.

One major problem with using Pilgram and Western's technique to interpret the archaeological evidence from Amsterdam is the necessity for whole tusks, another is the provenance of the elephants. Provenance, according to Pilgram and Western, does not have much effect on their results but they were only working with data from East African elephants. Recorded maxima of tusks from Kenya (102 kg, 311 cm outer curve length and 62 cm circumference) are

Fig. 9. Complete tusk, excavated in Amsterdam (NZR2-PR4-2). Collection: BMA, photo: Marloes Rijkelijkhuizen

very much larger than those from the Ivory Coast (58 kg in weight, 280 cm outer curve length and 49 cm circumference; Sikes 1971, 112) so it seems unlikely that, without further testing and calibrations, Pilgram and Western's technique can be used to sex or age western or central African elephant tusks with any confidence. Another complication with the archaeological material is that although the place of shipment is known to be West-Africa, the provenance of the tusks is not certain. Some may have been traded over vast distances, even from East Africa. However, if this technique is applied to the one complete tusk from Amsterdam (Fig. 9), it appears to be from a 9.5 year old female elephant. None of the other ivory working material from the excavations provides enough information to attempt sex or age determination using Pilgram and Western's technique. The small circumferences of the archaeological material and the weights recorded in the historical sources (Fig. 7-8) all fall within the range of variation of both male or female African elephant, as shown in Table 2, which is based on data published by Pilgram and Western (1986), Sikes (1971) and Parker (1979).

Fig. 10. Waste fragment from the base of the tusk (NZR2-115-4). Collection: BMA, photo: Marloes Rijkelijkhuizen

Selection of tusks

The large variation in tusk size recorded in the WIC cargo lists suggests that no selection based on tusk size took place in the case of acquisition and importation. This does not mean, however, that there was no preference for large or small tusks but that this did not influence the available supply of tusks. The Dutch did not hunt elephants themselves, but were dependant on the African inhabitants to bring the tusks to the coastal areas where they were traded. Very large tusks were probably not often imported, or imported separately from the bulk of the tusks. In contrast, selection does seem to have been exercised at the stage of re-export. Elephant tusks were shipped from the Dutch Republic by the East-India Company (Verenigde Oostindische Compagnie, hereafter VOC) to Asia, including Persia, India and China, where large African elephant tusks were highly valued. Importers in Japan, especially requested long and perfect tusks (National Archives, Archive of the VOC 13472).

Selection also seems to have been exercised by Dutch craftsman who had different demands of the material. For instance, comb makers needed bigger tusks than knife makers. Ivory combs excavated in Amsterdam have a length of 30 to 125 mm. Observation of the structure of the ivory shows that the larger combs were formed from a longitudinal plaque cut across the diameter of a tusk (Fig. 2:g-h). The comb teeth lie in the longitudinal direction of the tusk. A tusk would have had a diameter longer than the comb and, therefore, in the case of the largest comb with a length of 125 mm, a circumference of at least 314 mm. The smaller combs were formed from shorter plaques also cut parallel to the diameter but from towards edge of a tusk (Fig. 2:g). In contrast, knife makers could make knife handles from even the smallest of tusks, as these are invariably worked from longitudinal rods of ivory. In the inventory of Menso Sadelaer's shop, 996 out of 1077 tusks in stock were 4 kg or less in weight (Fig. 8); equivalent to the 'crevellen' recorded on the WIC cargo lists (Table 1). The remainder were all quite small tusks and the heaviest, at 16.4 kg, are about the weight of the standard 'teeth' (16.8 kg) identified on the same cargo lists, whilst big tusks ware entirely absent.

The calculated tusk circumferences, gained from the waste material excavated in Amsterdam, also indicate a predominance of very small tusks. Comparing these with the typical circumferences of African Elephants in Table 2, they are around a 1/3rd of the size that male elephants can develop and even on the small side for female elephants. The one complete excavated tusk fits with this evidence, being only a little over ½ the maximum size of that observed in female African elephants. Although the smaller tusks seem to predominate, waste fragments and finished combs indicate that larger tusks with a circumference of 314 to 573 mm ± 10-20% were also used.

Crevellen

It is clear from the historical sources that 'crevellen' were very small teeth, but this term seems to convey something more than just size. As discussed, tusk size is determined by a number of factors including age, sex and provenance. The affect of provenance is a complex issue and particularly in Africa were different populations of elephant may have very different diets and experience different climatic conditions.

The forest elephant lives in dense forests in West and Central Africa and is smaller than the savannah elephant of East Africa. The forest elephant also has smaller and rounder ears, smaller, more slender and straighter tusks that point downwards, and the ivory from these tusks is said to be darker, harder and denser than savannah elephant ivory (Sykes 1971:14-15; Parker 1979:151). DNA studies have now shown that savannah (or bush) and forest elephants are actually different species; *Loxodonta africana* and *Loxodonta cyclotis* respectively (Roca *et al*. 2001). One of the waste pieces excavated in Amsterdam is especially straight and slender and is quite possibly from a forest elephant tusk (Fig. 10). The different properties of the ivories these species produce could have been of great importance to craftsmen in 17th and 18th century Amsterdam. It is unknown from historical sources if the Dutch only grouped 'crevellen' by size or classification was also based on other aspects such as hardness and colour.

Conclusions

Despite the inaccuracies inherent in the circumference calculations, these results allow some conclusions to be drawn from the archaeological data that both complements and supplements the historical records of the Dutch ivory trade and craft industry in the 17th and 18th centuries.

The variation and range of the tusk sizes in the ships' cargoes suggest that little selection was exercised in the export trade from West Africa and that tusks of old and young, male and female individuals were included. The bulk of these tusks could have derived from forest elephant populations relatively close to the ports, but the few very large tusks perhaps indicate that some had been traded over longer distances, perhaps from the savannahs of East Africa. Once imported into the Netherlands, it is possible that the very largest tusks were selectively re-exported to Asia whilst the less valuable tusks were sold on to service the domestic craft industries. Specialist craft workshops would have had different needs. Comb makers would have needed relatively large tusks for their longest combs, and probably paid a premium for them, whilst knife handle makers were clearly working with very small tusks. Selection on the basis of ease of carving, colour, strength or hardness could also have been important factors for other applications. It is possible that such physical characteristics are what distinquished a 'crevellen' from other small tusks. Perhaps a 'crevellen' was specifically the small, straight, slender tusk of a young West African forest elephant that would provide harder ivory than its East African equivalent.

Questions still remain as to the provenance of the 17th and 18th century ivory found in the archaeological sites of Amsterdam and in the definition of the term 'crevellen'. It is possible that, through a combination of new historical research, aDNA studies and stable isotope analysis, these questions could eventually be answered.

Table 1. Average weight of three categories of tusks imported by the West India Company, between 1699 and 1725, in Dutch pounds and kilograms, after Feinberg, Johnson (1982)

	minimum in pounds	maximum in pounds	average in pounds	minimum in kilograms	maximum in kilograms	average in kilograms
Crevellen	4.6	7.9	5.8	2.3	4.0	2.9
Teeth	29.6	41.4	33.55	14.8	20.7	16.8
Large teeth	60	200		30	100	

Table 2. The range of size and weight of male and female African elephant tusks from data published by Pilgram and Western (1986), Sikes (1971), and Parker (1979)

	circumference (mm)	length (mm)	weight (kg)
male	100-500	up to 3000	5-65
female	100-250	up to 1500	2-15

Acknowledgements

I would like to thank Sonia O'Connor (University of Bradford), Jerzy Gawronski (BMA and University of Amsterdam), Peter Kranendonk (BMA), Wiard Krook (BMA), Gerard Graas (BMA) and Leo Noordegraaf (University of Amsterdam), Louise van Wijngaarden-Bakker (University of Amsterdam), Rik Maliepaard (University of Amsterdam), Henk den Heijer (University of Leiden) and Josina Rijkelijkhuizen.

References

Feinberg H.M. and M. Johnson 1982. *The west African ivory trade during the eighteenth century: The "... and ivory" complex*, The International Journal of African Historical Studies 15 (3), 435-53.

Heijer, H. den 1997. *Goud, ivoor en slaven. Scheepvaart en handel van de Tweede Westindische Compagnie op Afrika, 1674-1740*, Zutphen: Walburg Pers.

Jackson, P. 1990. *Endangered species, Elephants*, London: Quintet Publishing.

Kok, J. 1794. *Vaderlandsch Woordenboek, deel 31*, Amsterdam: Johannes Allart.

Parker T.S.C. 1979. *The ivory trade. Unpublished Report of the United States Fish & Wildlife Service*.

Pilgram, T. and D. Western 1986. *Inferring sex and age of African elephants from tusk measurements*, Biological Conservation 36, 39-52.

Rijkelijkhuizen, M. 2009. *Whales, walruses and elephants: artisans in ivory, baleen, and other skeletal materials in seventeenth- and eighteenth-century Amsterdam*, International Journal of Historical Archaeology 13(4), 409-30.

Roca, A.L., N. Georgiadis, J. Pecon-Slattery and S.J. O'Brien 2001. *Genetic evidence for two species of elephant in Africa*, Science 293, 1473-7.

Sikes, S.K. 1971. *The natural history of the African elephant*, London: Weidenfeld and Nicholson.

Bernadeta Kufel-Diakowska

The Hamburgian *Zinken* perforators and burins – flint tools as evidence of antler working

Antler finds dated back to the Final Palaeolithic are rare in the Middle European Lowlands due to unfavourable depositional conditions. Moreover two important issues – antler working and flint tool utilization are considered separately in the Palaeolithic studies. Use-wear analysis of flint artifacts show traces of antler working mostly on burins and *Zinken* perforators. Nevertheless microscopic studies give information concerning worked material but do not discuss neither what type of flint tools were engaged in particular stage of antler working nor if were they multifunctional tools or a craftsman needed two or more types of tools in a particular stage of work. Experimental method allows to understand how flint tools were used and what kind of a tool edge is required in a particular activity. It also helps to determine efficiency of hafted and unhafted tools. In this paper I would like to discuss the use of burins and *Zinken* perforators in working antler. According to the general, morphological analysis of flint tools and antler artefacts, burins were used for making grooves and *Zinken* perforators for obtaining antler blades. Experimental research and use-wear analysis show that they were rather multifunctional tools.

Keywords: the Final Palaeolithic, Hamburgian, *Zinken* perforators, burins, use-wear analysis, antler working

Introduction

The Hamburgian culture represents the oldest colonization of the West and the Middle European Lowlands since the last glacial period. Settlements have been identified in north-western Germany (Schleswig-Holstein, Lower Saxony) and the Netherlands. A few sites are known from Denmark and southern Scandinavia (Larsson 1993; Eriksen 2002) as well as from Poland (Burdukiewicz 1987; Kabaciński *et al.* 2002; Kabaciński, Kobusiewicz 2007). Noteć and the middle part of the Vistula are believed to form the eastern border of the Hamburgian expansion (Bobrowski, Sobkowiak-Tabaka 2006). Assemblages have been dated back to the Bølling Interstadial (^{14}C years BP: 13,000-12,000) and the Older Dryas (^{14}C years BP: 12,000-11,800), which correspond with the beginning of the Final Palaeolithic (Burdukiewicz 1999). Faunal remains and pollen studies show that the European Lowlands were covered by tundra and birch park forest and that reindeer (*Rangifer tarandus*) were the most important prey (Bratlund 1994:60; Burdukiewicz *et al.* 2007:74). Together with shouldered points *Zinken* perforators and burins were the most numerous flint implements in the assemblages in question.

Zinken perforators and burins

Zinken perforators, characteristic in assemblages of the Hamburgian culture, first appeared at the Magdalenian sites from the Western and Central Europe (Burdukiewicz 1989, Fig 8). According to their morphology and fragmentation *Zinken* perforators were sometimes interpreted as tools for antler working (Leroi-Gourhan, Brèzillon 1966). A. Rust, who analysed antler artefacts from the excavations in Meiendorf and Stellmoor, claimed that *Zinken* perforators were used as wedges, but his hypothesis is based neither on functional analysis nor experimental research. Moreover a small fragment of the broken bone tool (wedge?) was found inside a groove incised in a reindeer antler from Meiendorf. M. Lindemann (2000) supported Rust's idea basing on his experimental studies.

It is generally accepted that the function of burins – the most universal tool types in the Upper and Final Palaeolithic – is very different, because of their typological differentiation (Knecht 1988:132-134). According to M. Brézillon's (2001) traditional idea a tip was used to make incisions in bone, antler or wood. However, E. Moss' use-wear studies on flint burins from the Hamburgian site Oldeholtwolde suggest that a burin spall was detached from a flake in order to blunt its edge. "The burin facet provides a blunt platform upon which to apply pressure by fingers" (Moss 1988:405).

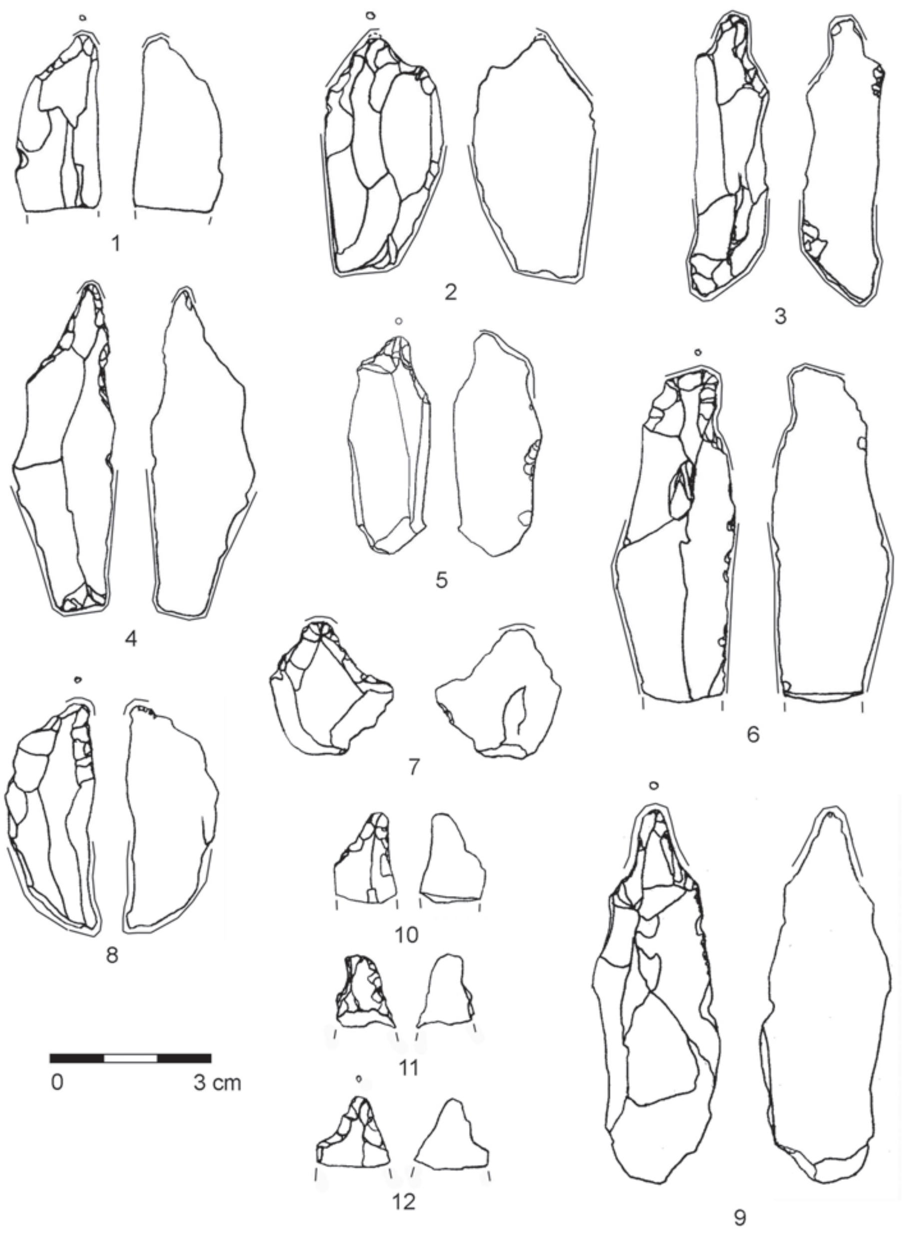


Fig. 1. *Zinken* perforators from Olbrachcice 8

Bone and antler remains

Faunal remains, bone and antler with traces of work, particularly tools (awls, projectiles and so called "hide knives" – *Riemenschneider*) were found in large numbers at only a few of the Hamburgian sites, i.a. Meiendorf and Stellmoor in the Ahrensburg Valley excavated by A. Rust in the 1st half of the 20th century (Rust 1937, 1943). Even though in recent years several Hamburgian sites have been found in Poland (see Kabaciński, Kobusiewicz 2007), they have not unfortunately produce any bone artefacts, only tiny pieces of what are probably reindeer bones in Olbrachcice 8 and the remains of small animals and fish in Mirkowice 33 (Kabaciński *at al.* 2002:112; Makowiecki 2003:170). This poor collection is the result of extremely unfavourable depositional conditions which is true of most of the Polish Final Palaeolithic sites. However, bone and antler must have played important role in life of hunting groups existing in such a harsh climate and following reindeer herds. In this case the process of bone and antler working and the bone tool kit of reindeer hunters living in the area of Middle European Lowlands in the beginning of the Final Palaeolithic remains unknown.

In this paper I discuss results of experimental research in context of use-wear analysis of flint tools (*Zinken* perforators and burins) from the Hamburgian site in Olbrachcice 8, Lower Silesia, Poland. In my studies I have tried to determine the types of antler tools made and stages of antler working at the site. In Palaeolithic studies the methods of bone and antler working, methods of use of stone tools and wear patterns on bone projectiles are usually ex-

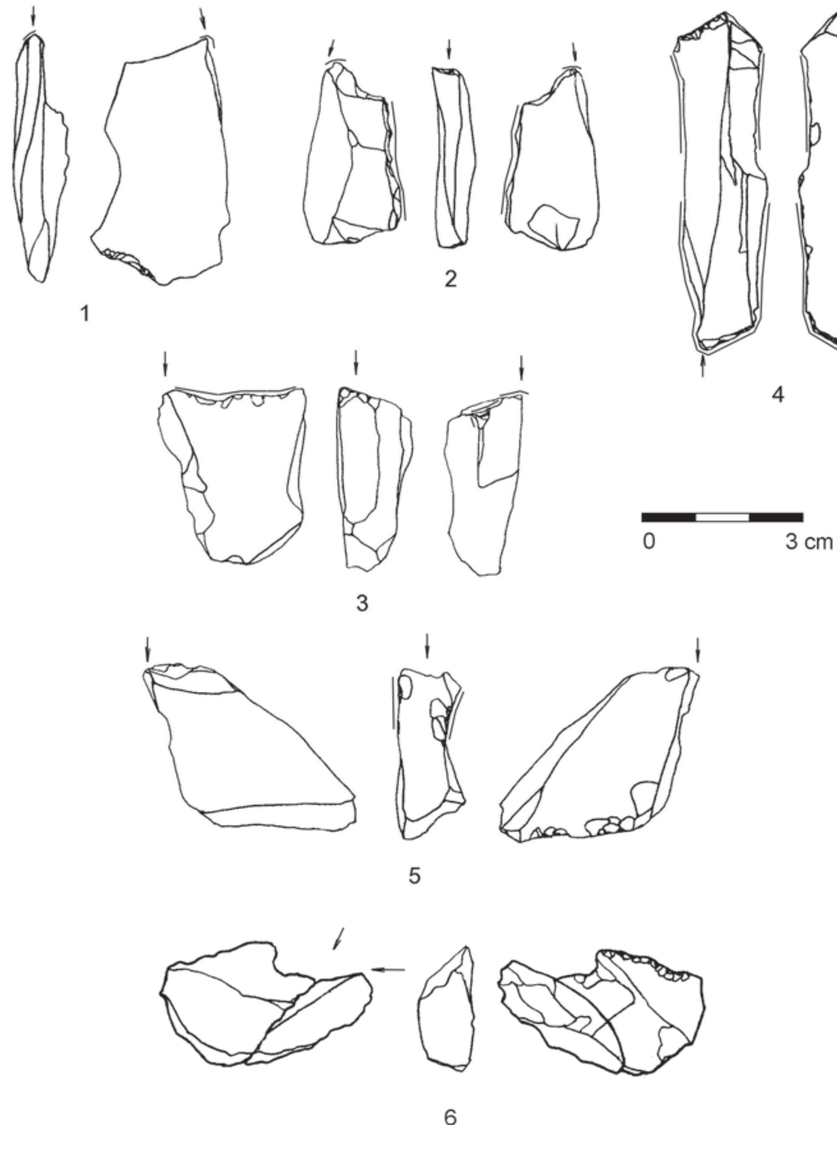


Fig. 2. Burins from Olbrachcice 8

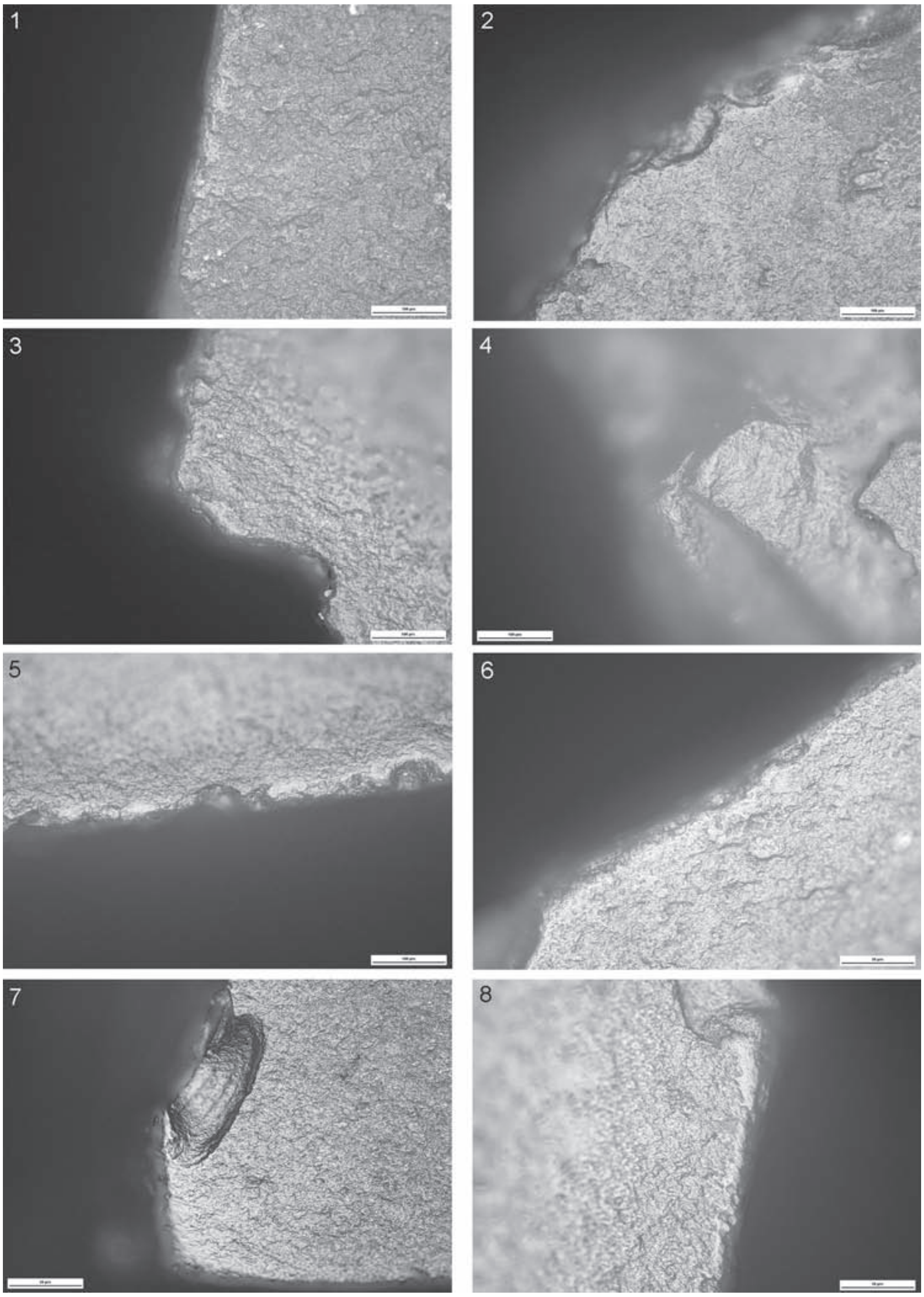


Fig. 3.
1 – use-wear polish on experimental *Zinken* perforator from scraping antler awl;
2-6 – use-wear polish on archaeological *Zinken* perforators from scraping antler;
7 – use-wear polish on experimental burin from incising antler;
8 – use-wear polish on archaeological *Zinken* perforator from incising antler

amined separately (*e.g.* Šajnerová-Dušková 2007; Petillion 2008). We do not know what types of stone implements were used for making particular bone or antler tools. I believe that some conclusions might be drawn from experiments combined with use-wear analysis of flint tools.

Microscopic analysis

A dozen complete Hamburgian concentrations were excavated by J. Burdukiewicz in the Kopanica valley, southern Poland (Burdukiewicz 1987, 1999; Burdukiewicz *et al.* 2007). Site no. 8 at Olbrachcice (Burdukiewicz 1984) represents the richest scatter and numbers over 5500 flint artefacts, including 53 burins and 49 *Zinken* perforators (together 26,7% of all retouched tools). *Zinken* perforators from Olbrachcice 8 were made from massive, mostly crested blades and blunt, slightly curved tips were mostly formed in the proximal part of blades by abrupt or semi-abrupt retouch (Fig. 1:1-9). Flake and blade burins were produced by removing at least one burin spall (Fig. 2:1-6).

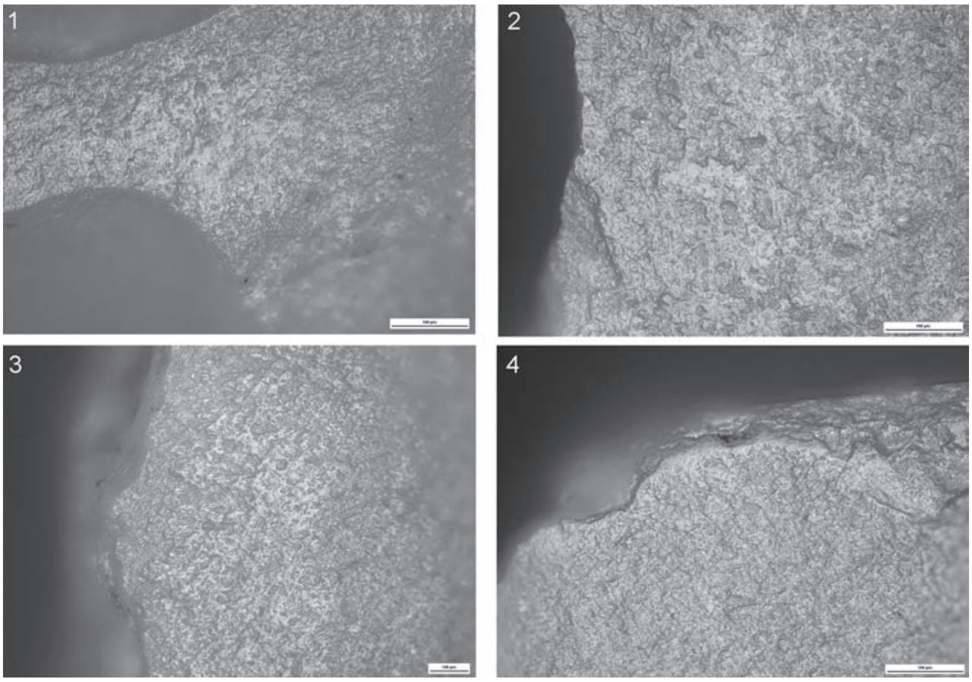


Fig. 4.
1-2 – use-wear polish on experimental *Zinken* perforator and blade from sawing antler;
3 – antler hafting polish on archaeological *Zinken* perforator;
4 – use-wear polish on archaeological burin from scraping animal hard material

Twenty one burins (on the unmodified end, with truncation and dihedral burins) and 31 *Zinken* perforators were selected for the macroscopic and microscopic observations in order to determine their function. The tools were examined using a reflected-light microscope at magnifications up to 57× and a metallographic microscope at magnifications 100-500×.

Microscopic use-wear traces were identified on 14 *Zinken* perforators (a further 8 specimens could have been used), mostly on the very edge of their tips or concave edges of tips, more rarely on the blade's edges. Moreover, a few *Zinken* perforators are broken (as a result of use?) and only curved tips were found during excavations (Fig. 1:10-12). Microwear traces are difficult to identify, but they mostly indicate the working of unspecified hard animal material. Traces of use (rounding and bright or matt polish) concentrated on one, concave edge of a tip (Fig. 3:2-6, 8). There are also step fractures that could have resulted from use or retouching (re-sharpening?) and it is not possible to differentiate between these two activities. Hafting traces were recorded on 3 implements (Fig. 4:3).

Microscopic traces of use were identified on 9 burins. Bright polish and scratches mostly appear on the tips and edges of burin facet, more seldom on the flake edges. Use-wear traces are characteristic for the working of antler, bone or unspecified hard material (Fig. 4:4). No hafting traces were recorded, only traces related to prehension on 1 implement.

Experiments

The main aim of the experimental program was to re-enact various methods of use of *Zinken* perforators and burins in order to test their efficiency in the working of antler, as well as to examine use-wear traces, their formation and dynamic. Since the working of antler was most probably done by men and required many years of training, all experiments were carried out by Marcin Diakowski, an archaeologist skilled in bone and antler working. Red-deer (*Cervus elephus)* and reindeer (*Rangifer tarandus)* antler and *Zinken* perforators, burins and blades knapped from erratic flint from Poland (Lower Silesia) and Germany (Rügen) were used in experiments. Antlers were softened by soaking in water before and during work.

In our experiments we adopted a method of antler working in the Final Palaeolithic described over 40 years ago by A. Rust (1943) and R. Feustel (1973) and improved by other scholars (for references see *e.g.* Petillon 2008, Bokelmann 1988). They described "groove and splinter technique" – a method of antler blades production. First of all a beam was divided into several parts, depending on a kind of a final product and tines were cut off (activities: sawing and breaking; tools: *Zinken* perforators, burins, blades; Fig. 5:1). Then parallel grooves 5mm wide and of various length were incised in a beam through compact layer along natural vessel canals (activity: incising; tools: burins, blades; Fig. 5:2-3) in order to

Fig. 5. Experiments:
1 – dividing antler beam (using a blade);
2-3 – groove and splinter technique (using a flint burin);
4 – obtaining antler blades;
5-8 – use of *Zinken* perforator;
5 – obtaining antler blades;
6 – making a projectile (scraping);
7 – making a haft (drilling);
8 – making a harpoon (drilling)

obtain antler blades (activity: wedging; tools: *Zinken* perforators; Fig. 5:4-5) – semi-products for making projectiles and awls (activity: scraping; tools: *Zinken* perforators, burins; Fig. 5:6). We also made hafts and harpoons from antler beams (activity: drilling and scraping; tools: *Zinken* perforators; Fig. 5:7-8). For microscopic analysis flint tools used in experiments were cleaned in ultrasonic tank.

Replicas of *Zinken* perforators were the most efficient tools for drilling holes (making hafts and harpoons) and scraping antler blades (making projectiles and awls). To obtain antler blades a craftsman needed to have a bone chisel or a different kind of wedge, because the tips of *Zinken* perforators were too thick and incising wider grooves would have been wasteful. *Zinken* perforators were robust long-life tools, but the concave edges of the tips used for scraping had to be re-sharpened from time to time. Microscopic traces of scraping and drilling are well observed on tips and are the most similar to traces on archaeological artefacts from Olbrachcice 8 (Fig. 3:1-6). *Zinken* perforators broke most often while holes were being drilled. It is worth to mention that using hafted *Zinken* perforators is more comfortable than using unhafted tools. Finally, we found *Zinken* perforators universal tools which can be used for various tasks when working with antler.

Burin tips are highly efficient for incising grooves (instead of sawing). Moreover they are much better than the edges of flint blades, because the tips do not get worn so quickly. The edges of burin facets are perfect for scraping antler blades (making projectiles). These two activities produce microscopic wear patterns that are almost identical to traces found on archaeological tools (Fig. 3:7-8; 4:4).

Discussion and conclusions

According to use-wear and experimental studies, *Zinken* perforators from Olbrachcice 8 were most probably used as "scrapers" and "borers" for antler working, which suggests that they were more or less multifunctional tools. Moreover one implement could have been repeatedly used for similar activity. Traces of hafting suggest curation – a phenomenon associated with mobile hunting groups. In this case the characteristic curve-shaped tips would be a result of re-sharpening. Thus *Zinken* perforators may represent formal tools that were used not only for making but essentially for repairing antler weapons. Burins from Olbrachcice 8 were most probably used for incising, grooving and scraping of antler. All analyzed burins are thick and irregular in shape, what could cause problems with hafting. Moreover, microscopic observations of 3 burin spalls, which were found close to burins, show similar traces of use. It means that burin spalls are the waste products of re-sharpening. Burins were produced, used and discarded at the same place.

Different traces of use observed on archaeological implements correspond with experimentally produced traces of incising, scraping and drilling of antler. It can be concluded from this study that *Zinken* perforators and burins from Olbrachcice 8 compose an actually complete toolkit for antler working. The large number of these two types of flint tools indicates that antler working was very important activity for reindeer hunters. It is possible that the whole process was performed at the site in Olbrachcice, including the preparation of semi-product, obtaining antler blades, the manufacture of tools and hafts, as well as repairing or broken antler weapons. Despite the fact that no antler artefacts were retrieved from this site, it can be suggested that hunters from Olbrachcice 8 made different antler items, that required such actions as scraping, incising and drilling (probably projectiles, awls, hafts and harpoons).

Acknowledgements

I would like to thank Prof. J. Burdukiewicz (Institute of Archaeology, Wrocław University) for access to all the archaeological material used in this study and Marcin Diakowski (PhD candidate, Institute of Archaeology, Wrocław University) for doing the experimental work.

References

Bobrowski, P. and I. Sobkowiak-Tabaka. 2006. *How far east did Hamburgian Culture reach?*, Archaeologia Baltica 7, 11-20.

Bokelmann, K. 1988. *Eine Regenweihharpune aus der Bondenau bei Bistoft, Kreis Schleswig-Elensburg,* Offa 45, 5-15.

Brézillon, M. 2001. *Encyklopedia kultur pradziejowych,* Warszawa: PWN.

Bratlund, B. 1994. *A Survey for the Subsistence and Settlement Pattern of the Hamburgian Culture in Schleswig-Holstein*, Jahrbuch des Römisch-Germanisches Zentralmuseums Mainz 41, 59-93.

Burdukiewicz, J.M. 1984. *Olbrachcice – a site of the Hamburgian Culture*, In: H. Berke, J. Hahn and C-J. Kind (eds.) *Structures d'habitat du Paléolithique supérieur en Europe, Kolloquium 8-16 Mai 1983, Reisensburg/ Günzburg*, Verlag Archaeologica Venatoria, Institut für Urgeschichte der Universität Tübingen, Urgeschichtliche Materialhefte 6, Tübingen, 209-219.

Burdukiewicz, J.M. 1987. *Późnoplejstoceńskie zespoły z jednozadziorcami w Europie Zachodniej*, Acta Universitatis Wratislaviensis 663, Studia Archeologiczne 14, Wrocław.

Burdukiewicz, J.M. 1989. *Le Hambourgien: origine, évolution dans un contexte stratigraphique, paléoclimatique et paléogéographique*, L'Anthropologie 93(1), 189-218.

Burdukiewicz, J.M. 1999. *Concerning chronology of the Hamburgian Culture*, Folia Quaternaria 70, 127–146.

Burdukiewicz, J.M., Szynkiewicz, A. and M. Malkiewicz. 2007. *Paleoenvironmental setting of the Late Paleolithic sites in Kopanica Valley*, In: M. Kobusiewicz and J. Kabaciński (eds.) *Studies in the Final Paleolithic Settlement of the Great European Plain*, Institute of Archaeology and Ethnology Polish Academy of Sciences, Branch Poznań and Poznań Prehistoric Society, Poznań, 67-85.

Eriksen, B.V. 2002. *Reconsidering the geochronological framework of Lateglacial hunter-gatherer colonization of southern Scandinavia*, In: B. Bratlund and B.V. Eriksen (eds.) *Recent Studies in the Final Palaeolithic of the European Plain, Proceedings of a U.I.S.P.P. Symposium, Stockholm, 14.-17. October 1999*, Jutland Archaeological Society Publications 39, 25-41.

Feustel, R. 1973. *Technik der Steinzeit. Archäolithikum-Mesolithikum*, Weimar: Hermann Böhlaus Nachfolger.

Kabaciński, J., Schild, R., Bratlund, B., Kubiak-Martens, L., Tobolski, K., Borg van der, K. and A. Pazdur. 2002. *The Lateglacial sequence at the Hamburgian site at Mirkowice: stratigraphy and geochronology*, In: B. Bratlund and B.V. Eriksen (eds.) *Recent Studies of the Final Palaeolithic of the European Plain, Proceedings of a U.I.S.P.P. Symposium, Stockholm, 14.-17. October 1999*, Jutland Archaeological Society Publications 39, 109-116.

Kabaciński, J. and M. Kobusiewicz. 2007. *Krągola near Koło (Central Poland) – the easternmost settlement of Hamburgian Culture*, In: M. Kobusiewicz and J. Kabaciński (eds.) *Studies in the Final Paleolithic Settlement of the Great European Plain*, Institute of Archaeology and Ethnology Polish Academy of Sciences, Branch Poznań and Poznań Prehistoric Society, Poznań, 21-51.

Knecht, H., 1988. *Upper Palaeolithic Burins. Type, Form, and Function*, Oxford: British Archaeological Reports, International Series 434.

Larsson, L. 1993. *Neue Siedlungsfunde der Späteiszeit im südlichen Schweden*, Mainz, Archäologisches Korrespondenzblatt 23/3, 275-283.

Leroi-Gourhan, A. and M. Brèzillon. 1966. *L'Habitation no 1 de Pincevent près Montereau (Seine-et-Marne)*, Gallia Préhistoire 9, 263-385.

Lindemann, M. 2000. *Die Knochen und Geweihbearbeitung im westeuropäischen Jungpleistozän*, Experimentalle Archäologie, Oldenburg, 7-28.

Makowiecki, D. 2003. *Historia ryb i rybołówstwa w holocenie na Niżu Polskim w świetle badań archeologicznych*, IAiE PAN, Poznań.

Moss, E.H. 1988. *Techno-Functional Studies of the Hamburgian from Oldeholtwolde, Friesland, The Netherlands*, In: M. Otte (ed.) *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Actes du Colloque Liége 1985, Oxford: British Archaeological Reports, International Series 444, 399-426.

Petillon, J.-M. 2006. *Des Magdaleniens en armes. Technologie des armatures de projectile en bois de cervide du Magdalenien superieur de la Grotte d'Isturitz (Pyrenees-Atlantiques)*, Artefacts, 10, Editions du Centre d'études et de documencation archéologiques, Treignes.

Rust, A. 1937. *Das altsteinzeitlische Rentietjägerlager Meiendorf*, Neumünster: Karl Wachholtz Verlag.

Rust, A. 1943. *Die alt- und mittelsteinzeitlischen Funde von Stellmoor*, Neumünster: Karl Wachholtz Verlag.

Šajnerová-Dušková, A. 2007. *Tools of the Mammoth Hunters. The Application of Use-Wear Analysis on the Czech Upper Palaeolithic Chipped Industry*, Oxford: British Archaeological Reports, International Series 1645.

Social contexts

Heidi Luik, Mirja Ots, Liina Maldre

From the Neolithic to the Bronze Age: continuity and changes in bone artefacts in Saaremaa, Estonia

The aim of the article is to analyse and compare bone artefacts between archaeological finds in Estonia in the Neolithic and the Bronze Age and investigate which artefact types were continually used and which represent new types introduced in the Bronze Age. The island of Saaremaa was selected for investigation because there are Neolithic sites where finds include bone artefacts (Naakamäe and Loona) while the overwhelming majority of Bronze Age bone artefacts in Estonia come from the fortified settlements of the Late Bronze Age on Saaremaa (Asva, Ridala, Kaali). Bone artefacts are connected with subsistence and other (especially household) activities. Changes in lifestyle also undoubtedly influenced artefacts. Fishing and seal hunting played an important role in subsistence on Saaremaa Island. Both Neolithic and Bronze Age finds include harpoons related to seal hunting. Fishing spears occur only among the Neolithic finds. Various awls and points, probably used in leather working or textile work, are artefact types that occur among the finds from both Neolithic and Bronze Age sites. New artefact types introduced in the Bronze Age include hoe blades or ard points made from antler and artefacts with notched edges made from scapula. Besides weapons and tools, finds from the discussed sites include artefacts related to clothing – pendants, buttons and pins. In the Neolithic sites such small personal items are mostly represented by tooth pendants. A new group of artefacts in Late Bronze Age consists of bone pins and antler double buttons, imitating foreign bronze objects. Their occurrence may reflect to the distribution of the ideologies and symbolic meanings connected with them on the eastern shore of the Baltic Sea, as well as the existence of a social group or rank whose status requirements these artefacts met. Changes in subsistence influenced the choice of material used for making artefacts as well. The Neolithic artefacts are made from bones of wild animals. In the Bronze Age, artefacts were made from elk antler and artefacts from the bones of wild animals are few. Bones of mainly domestic animals were used for producing artefacts in the Bronze Age.

Keywords: Estonia, Neolithic, Bronze Age, bone and antler artefacts, subsistence

Introduction

The aim of the paper is to analyse and compare the bone artefacts among archaeological finds in Neolithic and Bronze Age in Estonia and investigate which artefact types were continually used and which new types were introduced in the Bronze Age. Choices in raw material and working techniques in different periods are also compared. The problem is that bone finds definitely belonging to the Early Bronze Age in Estonia are few. The island of Saaremaa was selected for investigation because there are Neolithic sites where finds include bone artefacts (Naakamäe and Loona) while the overwhelming majority of Bronze Age bone artefacts in Estonia come from the fortified settlements of the Late Bronze Age on Saaremaa (mainly Asva, but also Ridala and Kaali) (Fig. 1). In Estonian archaeology the periods of the Neolithic and the Bronze Age are divided as follows: the Early Neolithic 4900–4200/4100 BC, the Middle Neolithic 4200/4100–3200/3000 BC, the

Fig. 1. Neolithic (Naakamäe and Loona) and Bronze Age (Asva, Ridala and Kaali) sites on the island of Saaremaa, mentioned in the analysis. (Figure by Kersti Siitan and Heidi Luik)

Fig. 2. Photos of sites: a – archaeological excavations on the Neolithic Naakamäe site in 1961 or 1962; b – Neolithic Loona site and late Bronze Age stone grave in 1958; c – fortified settlement of Asva in 1931. (Photos from the Archives of Institute of History, Tallinn University: AI FK 10982, 10983, 2879)

Late Neolithic 3200/3000–1800 BC, the Early Bronze Age 1800–1100 BC, the Late Bronze Age 1100–500 BC (Lang, Kriiska 2001).

The composition and number of finds is undoubtedly influenced by the type of site they are found on. Naakamäe (Fig. 2:a) and Loona are located on the coast where seal-hunting and fishing were the basic means of subsistence; their finds belong to the Middle and Late Neolithic (Lõugas *et al.* 1996:408-409, tables II-III; Kriiska 2002:48, table 2; Jussila, Kriiska 2004:18, tables 1-2).[1] As for Loona, it has been assumed that people lived there not only in the Late Neolithic but also in the Early Bronze Age. A late Bronze Age stone grave[2] was also found within the settlement site (Fig. 2:b; Jaanits *et al.* 1982:84, 149-150, pl. VII; Lang 2007:21, 153, fig. 3, 87).

Asva (Fig. 2:c) and Ridala are fortified settlement sites which were located on the coast, while Kaali, located beside a meteorite crater, is probably an enclosed cult site. Asva and Ridala belong to the later phase of the Late Bronze Age – 900-500 BC, Kaali is slightly later, its ^{14}C datings remain between 760-210 BC, i.e. Late Bronze Age and early Pre-Roman Iron Age (Lang 2007:60 ff., 75-77, fig. 21). Bronze casting and trade related with it was an important occupation for the inhabitants of fortified settlements; supposedly the emergence of fortified settlements was connected with the necessity of organizing bronze casting and bronze circulation and control trade routes. Animal husbandry and cultivation played an important part in daily life and people practised seal hunting and fishing as well. Finds include, besides pottery and casting moulds, quite a large number of bone and antler artefacts (Lang 2007:70-71, 95 ff.).

[1] E.g. Naakamäe 2680±210 ^{14}C cal BC and Loona 2725±375 ^{14}C cal BC (Jussila, Kriiska 2004: table 2:50, 57).

[2] Human bone fragment from Loona is dated to the Late Bronze Age: 909 (830) 802 ^{14}C cal BC (Lõugas *et al.* 1996:409, tables II, III, fig. 2).

Types of bone artefacts on Neolithic and Bronze Age sites

Tools and weapons

Tools and other artefacts are connected with subsistence and household activities. Changes in lifestyle also undoubtedly influenced which artefacts were used, including bone artefacts.

Fishing and particularly seal hunting played an important role among the subsistence on the island of Saaremaa (Lõugas 1994; 1997a; 1997b; Lõugas *et al.* 1996; Kriiska 2002). The sites under discussion here (except for Kaali) were located near the former coastline. Fish bones are particularly numer-

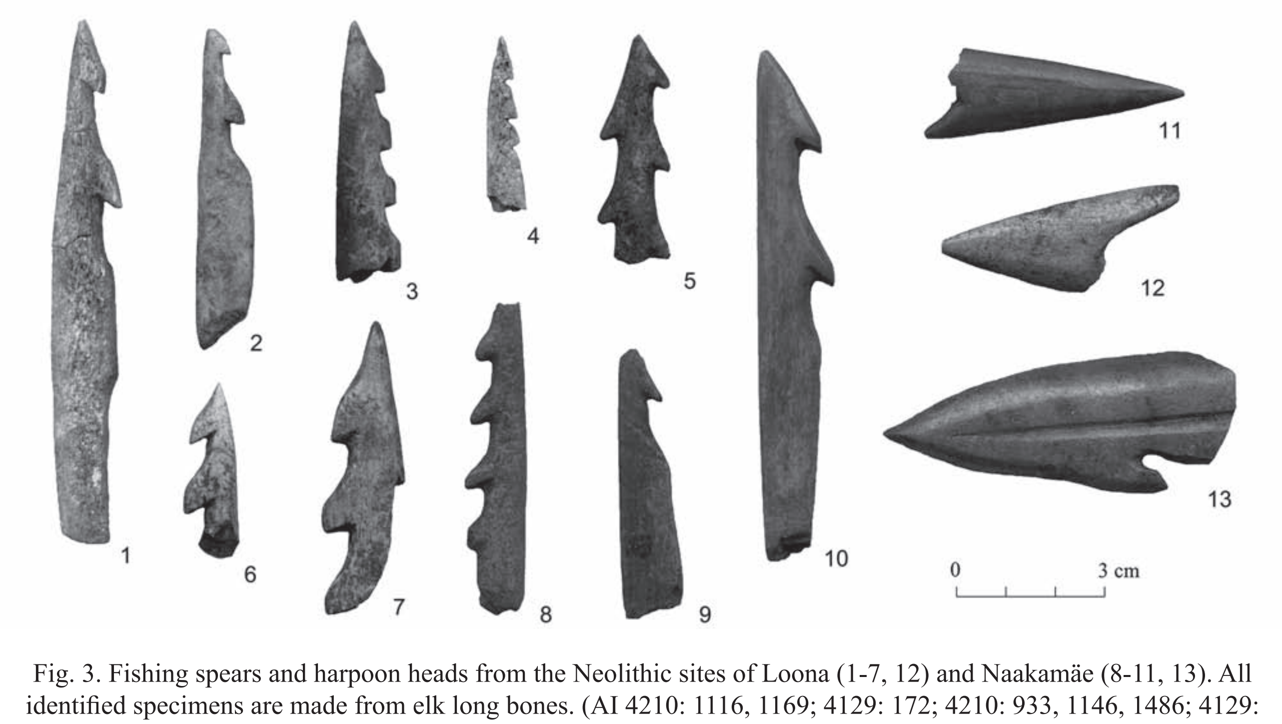


Fig. 3. Fishing spears and harpoon heads from the Neolithic sites of Loona (1-7, 12) and Naakamäe (8-11, 13). All identified specimens are made from elk long bones. (AI 4210: 1116, 1169; 4129: 172; 4210: 933, 1146, 1486; 4129: 293; 4211: 1597, 1443, 1321, 1344; 4210: 666; 4211: 187) (Figures 3-18 by Heidi Luik)

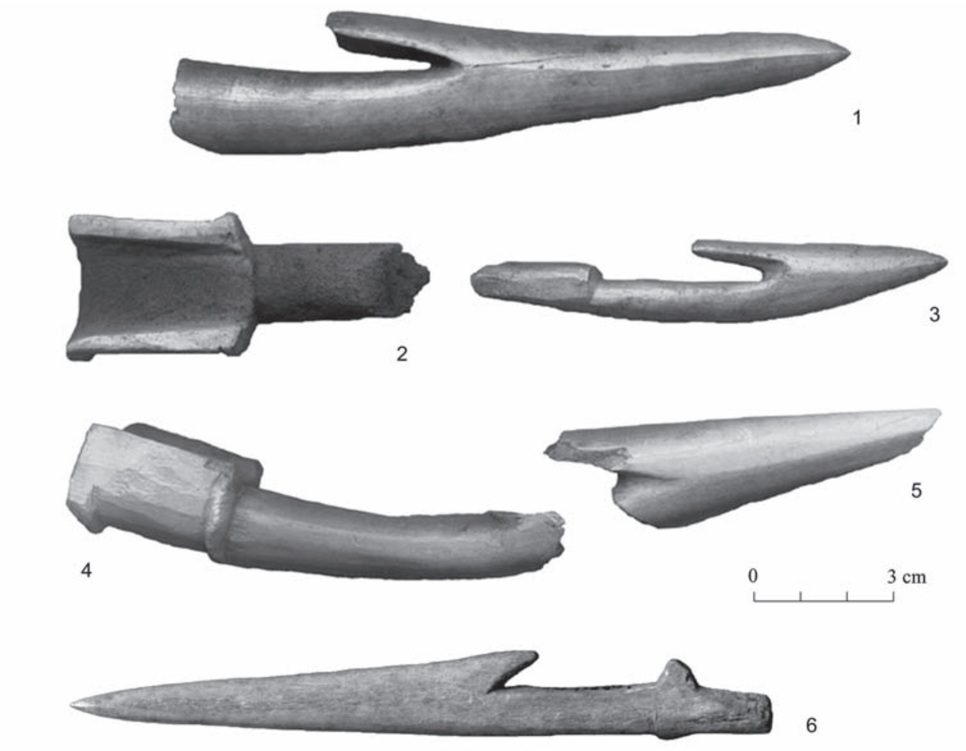


Fig. 4. Harpoon heads from the Bronze Age fortified settlement site of Asva. 1-5 – elk antler, 6 – bone. (AI 4012: 113; 4366: 642; 3307: 298; 4366: 1863, 1942; 3994: 580)

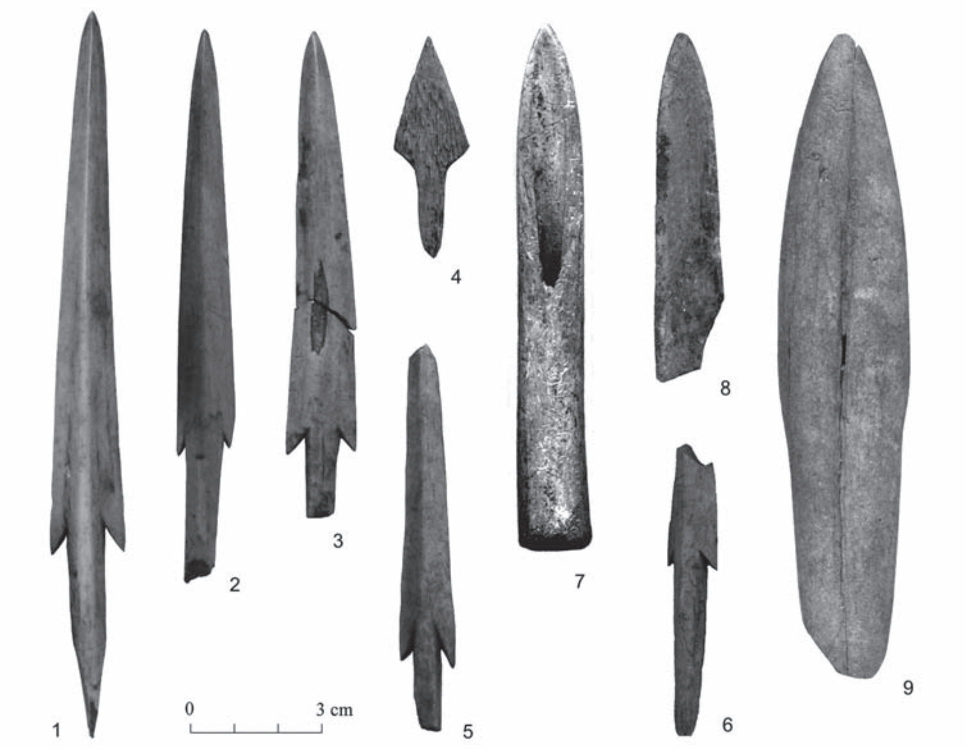


Fig. 5. Bone arrowheads from the Bronze Age site of Asva (1-6), spearhead made from sheep/goat tibia from the Bronze Age site of Ridala (7) and probable fragment of a similar object from roe deer or sheep/goat femur from the Neolithic site of Loona (8), spearhead from elk metacarpus from the Neolithic site of Naakamäe (9). (AI 3799: 338; 4366: 634; 3499: 1435/1636; 4366: 1285; 3658: 466; 3307: 296; 4329: 705; 4129: 560; 4211: 1380)

ous among the finds from Loona – over 8000 identifiable bones, the overwhelming majority of which come from cod (*Gadus morhua*); in Naakamäe fish bones are less numerous with only about fifty identifiable bones (Lõugas 1997a: table 2). Seal bones are abundant on both Neolithic sites (Lõugas 1997b: table 1), as well as at the Bronze Age settlements of Asva and Ridala (Lõugas 1994; Lang 2007:110-111; Maldre 2008). Both Neolithic and Bronze Age finds include harpoons related to seal hunting, but differences in shape and size can be observed in objects from different periods. Finds from the Neolithic sites of Naakamäe and Loona include harpoon fragments (Fig. 3:11-13; Jaanits *et al.* 1982: fig. 63:1),

Fig. 6. Bone awls from the Neolithic sites of Loona (4, 6, 7) and Naakamäe (1-3, 5, 8-12). 1-4 – seal fibulae, 5 – elk bone, 6 – bird tibiotarsus (*Cygnus* sp.), 7 – wild boar fibula, 8 – roe deer metatarsus, 9 – fox tibia, 10 – marten tibia; 11 – bird bone, 12 – bird humerus (*Mergus* sp.). (AI 4211: 1534, 1430, 1438; 4210: 848; 4211: 1434; 4129: 838, 799; 4211: 389, 202, 1377, 1456, 1395)

but they are smaller than the later, late Bronze Age harpoons from Asva and Ridala (Fig. 4; Vassar 1955: fig. 35:1-3; Luik in press: fig. 11). Fishing spears occur only among the Neolithic finds. Most fishing spears from Loona and Naakamäe are barbed on one side although a few specimens have barbs on both sides (Fig. 3:1-10; Jaanits *et al.* 1982: fig. 63:2-4, 5). Fishing spears were mostly made from bone. Those that can be identified to the species level were made from elk bone diaphyses. Neolithic harpoons are also made from bone while Bronze Age ones were usually made from elk antler (Fig. 4:1-5) with the exception of some small harpoons still made from bone (Fig. 4:6; Vassar 1955: fig. 35:6; Luik in press: fig. 12). Undoubtedly fishing was practised on Bronze Age settlements as well although in that period nets were probably used as suggested by the presence on the site of Asva of probable stone netsinkers (Vassar 1955: pl. XXIII:6). Fishing nets were already known in the Neolithic – netsinkers have also come to light at Neolithic settlements (e.g. Kriiska 1997:10; Kriiska, Saluäär 2000:18, table 1, fig. 4). Technical differences between the two periods lie in the use of fishing spears, which have not been found among the Bronze Age finds. Bone fishing hooks have been also found at Neolithic sites (e.g. Tamula and Valma in South Estonia: Jaanits *et al.* 1982: Fig. 49:1-5, 54:1-7; L. Lõugas 1996: Fig. 8:1-5) although they are absent from the Neolithic bone tool assemblages from Loona and Naakamäe.

Arrowheads are found in settlements of both periods. The Neolithic finds discussed in this paper include only one definite bone arrowhead from Naakamäe (Jaanits *et al.* 1982, fig. 63:6) along with several arrowheads made from stone, e.g. from quartz. The Neolithic arrowheads and some of the Bronze Age ones were most likely mainly used in hunting. Bronze Age assemblages also contain projectiles which, based on their shape, were apparently weapons (Fig. 5:1-6; Luik 2006). Neolithic finds include some bone spearheads as well. The spearheads found at Naakamäe were made from the limb bones of elk (Fig. 5:9; Jaanits *et al.* 1982: fig. 63:11). Bone spearheads are rare among Bronze Age finds from Estonia, one, at least, is known from Ridala (Fig. 5:7). A fragment of an artefact made from roe deer or sheep/goat femur was found at the Neolithic site

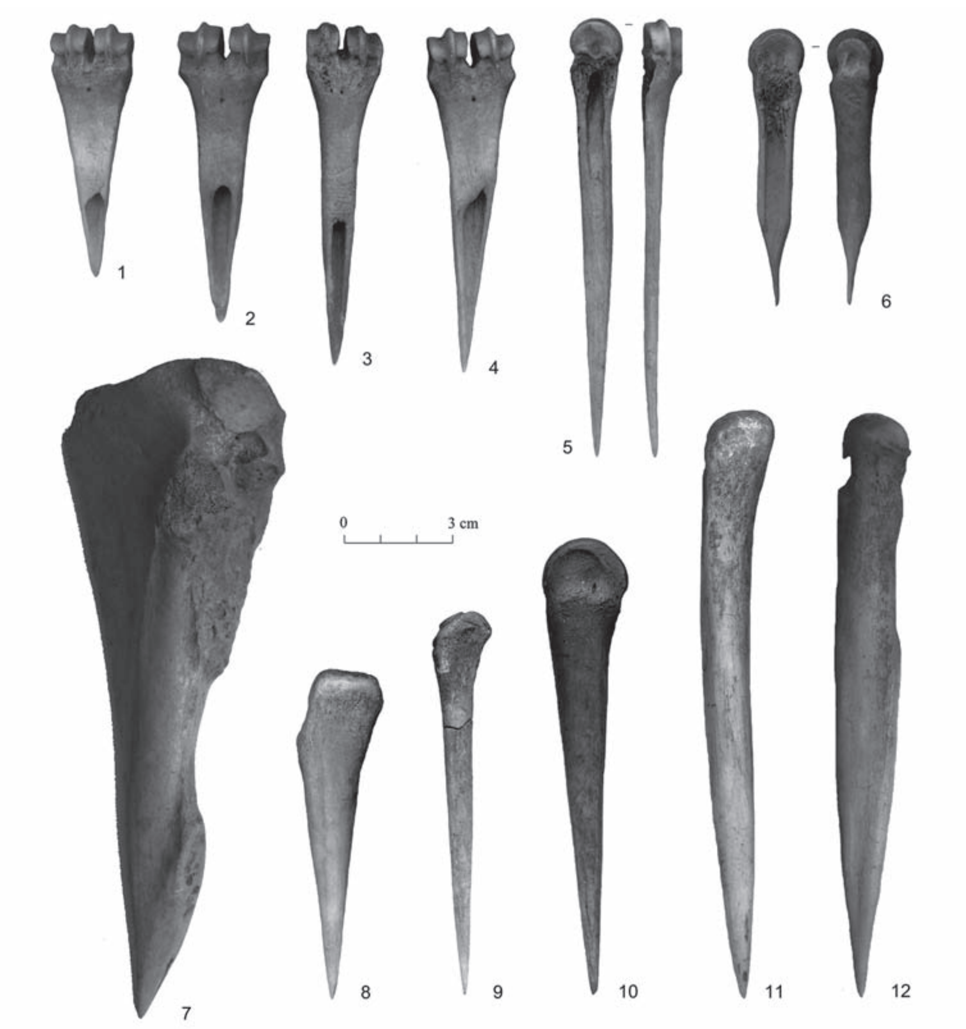


Fig. 7. Bone awls from the Bronze Age sites of Asva (1-5, 7-12) and Ridala (6). 1-6 – goat/sheep metapodials; 7 – cattle ulna, 8-11 – horse metapodials, 12 – elk rudimentary metapodial. (AI 4366: 1169, 1777, 1558, 1435, 823; 4261: 287; 4366: 1529, 691, 1804; 3658: 450; 3307: 113; 3994: 1469; 4366: 1824)

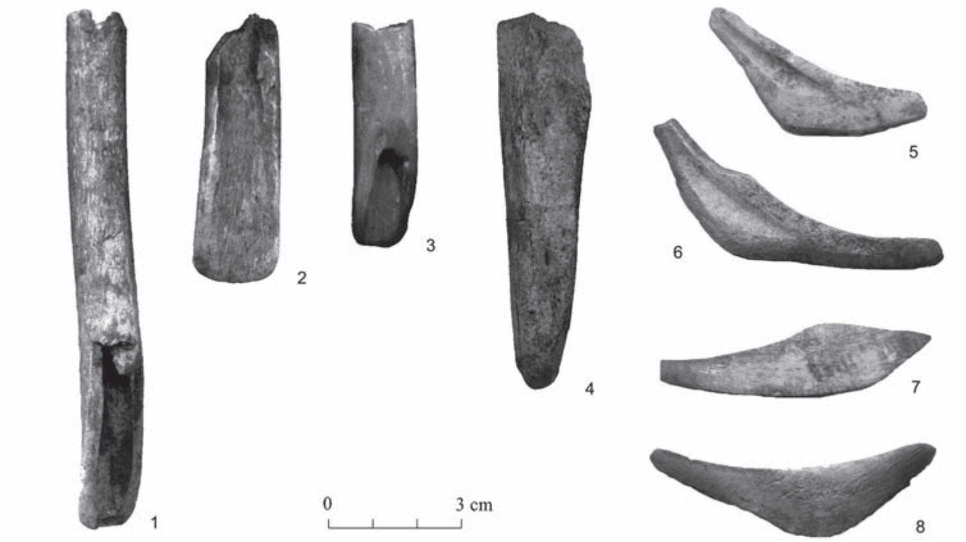


Fig. 8. Tools with chisel-shaped ends from the Bronze Age sites of Kaali (1-2) and Asva (3), and from the Neolithic sites of Loona (4-6) and Naakamäe (7-8). 1, 3 – sheep/goat tibia, 2 – pig tibia, 4 – elk or cattle mandible, 5-8 – wild boar tusk. (AI 4915: 333, 424; 4012: 101; 4129: 940; 4210: 707; 4129: 818b; 4211: 1474, 1565)

of Loona (Fig. 5:8). It resembles the tip of the spearhead from the Bronze Age site of Ridala, but because it is so fragmented it is not possible to say whether that it is definitely a spearhead. A large number of bone spearheads has been found at Bronze Age fortified settlements in Lithuania. This artefact class is not so numerous in Latvia (e.g. Grigalavičienė 1995: fig. 58; Vasks 1994: pl. VIII:3-6). In the Late Bronze Age this artefact type was characterised by extreme standardization in the eastern Baltic region: they

Fig. 9. Hoes or ard points made from elk antler from the Bronze Age site of Asva. (AI 4366: 1832, 1534)

were almost always made from tibiae of goat/sheep so that their shape was always the same – even to the point that an antler spearhead imitating the shape of bone ones has been found at Narkūnai in Lithuania (Luik, Maldre 2007:13-14, 19-20, 31, fig. 13, 26, 27).

Various awls and points, probably used in leather-working and textile production, are artefact types that occur among find assemblages from both the Neolithic and Bronze Age. Differences can be observed in their shape and material between these two periods as well. Seal bones have been used for making bone awls at the Neolithic sites of Loona and Naakamäe. Finds from Naakamäe include at least 27 seal bone awls while there are 11 of them from Loona (Fig. 6:1-4). In most cases, seal fibula was used; only a few awls are made from tibia or metatarsal bones. Awls from elk or wild boar bones have been also found (Fig. 6:5, 7) with single specimens each from roe deer, fox and marten bones (Fig. 6:8-10). Some awls were also produced from bird bones: finds from Naakamäe include two small specimens made from the humerus and ulna of *Anseriformes*; and finds from Loona include a large awl made from a swan tibiotarsus and another specimen made of indeterminable bird bone (Fig. 6:6, 11-12).[3] Some of the Neolithic awls have very fine sharpened tips, which allowed making very small holes (e.g. Fig. 6:9-12). In the Bronze Age sites of Asva and Ridala awls made from goat/sheep metapodials are especially typical (Fig. 7:1-6; Luik 2009; in press: fig. 2). One such awl is also known from the Neolithic site of Naakamäe although this specimen was made from roe deer bone (Fig. 6:8). In the Bronze Age, cattle and horse bones were also used for making awls while some specimens made from bones of wild animals, e.g. rudimentary metapodial of elk, have also been found (Fig. 7:7-12; Maldre, Luik 2009:43, fig. 8:2-8; Luik in press, fig. 3). Neolithic finds also include artefacts with chisel-shaped working edges made from wild boar tusks and elk bones (Fig. 8:4-8). Artefacts made from wild boar tusks have also been described as knives owing to their sharp edges; their other end sometimes has a sharp tip (Fig. 8:7;

[3] Identified by Teresa Tomek.

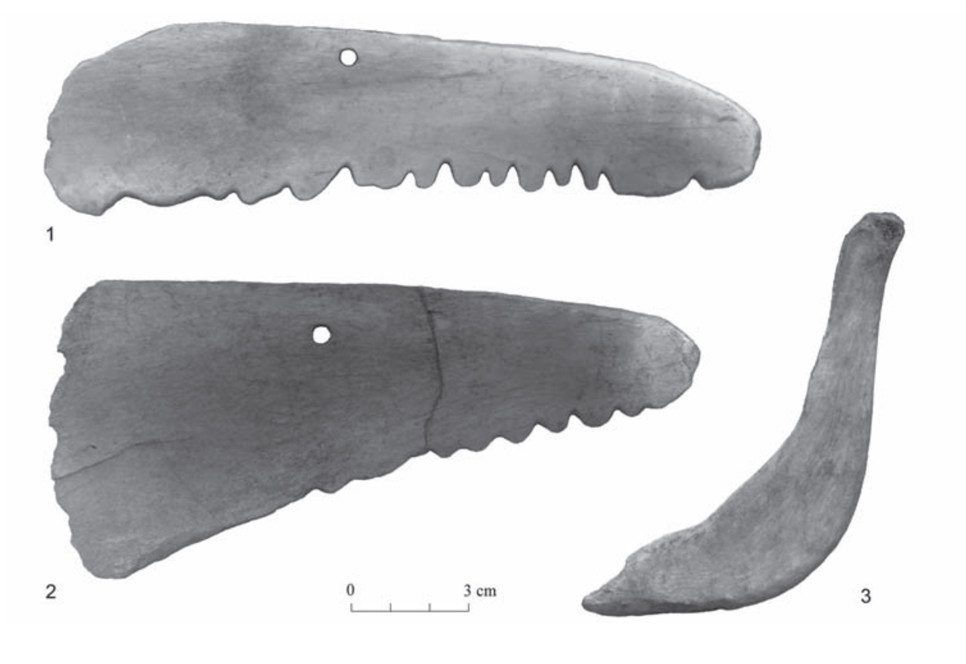


Fig. 10. Tools with notched edges and a sickle from the Bronze Age site of Asva. 1-2 – scapulae of cattle or elk, 3 – pig mandible. (AI 4012: 94; 3307: 291; 3994: 802)

Fig. 11. Antler artefacts from Bronze Age site of Asva: cheek-pieces (1-2), spoons (3-4) and handles (5-8). (AI 4366: 1644, 122, 700; 3799: 83; 4366: 1792, 1860; 3799: 48; 4366: 1849)

Jaanits *et al.* 1982: fig. 63:10). Artefacts with chisel-shaped working ends have also been found at Bronze Age settlements (Fig. 8:1-3).

New artefact types introduced in the Bronze Age include hoe blades or ard points made of antler connected to cultivation (Fig. 9; Lang 2007:107-108, fig. 48; Luik in press: fig. 7) as well as artefacts with notched edges made from scapula (Fig. 10:1-2). Their purpose is unknown although it has been suggested that they were used in the processing of leather, pottery, straps or cords, and meat (Hásek 1966:266 ff.; Feustel 1980:7 ff.; Walter, Möbes 1988:245; Northe 2001:179 ff.). It has been also supposed that the tools made from scapula were used as agricultural implements, e.g. hoes (Steppan 2001:88), tools for processing flax (Lehmann 1931:42; Indreko 1939:27-28), or sickles for cutting crop (Kriiska *et al.* 2005:25; Lang 2007:109, 111-112, fig. 51; Luik, Lang 2010). An artefact made from a pig mandible is apparently also a sickle (Fig. 10:3). Such artefacts are not found in Neolithic materials in Estonia.

The appearance of antler cheek-pieces (Fig. 11:1-2) on Bronze Age sites suggests the use of horse for riding, and the earliest definite finds of horse bones also come from Bronze Age sites. Small quantities of horse bones have been found on Neolithic sites of Southeast Estonia (Akali, Tamula) but these are supposed to belong to wild horse (Maldre, Luik 2009:37). Other new, Bronze Age types of artefacts include antler spoons, as well as handles made from antler and carefully finished (Fig. 11:3-8; Vassar 1955: pl. XXIII:4; Luik 2011:42-43, fig. 7). Such finds may be also connected with a new lifestyle, e.g. the appearance of antler spoons together with small and finely made bowls and dishes has been connected to an increased attention to table manners (Lang 2007:230-231; cf. e.g. Sørensen 2000:112 ff.).

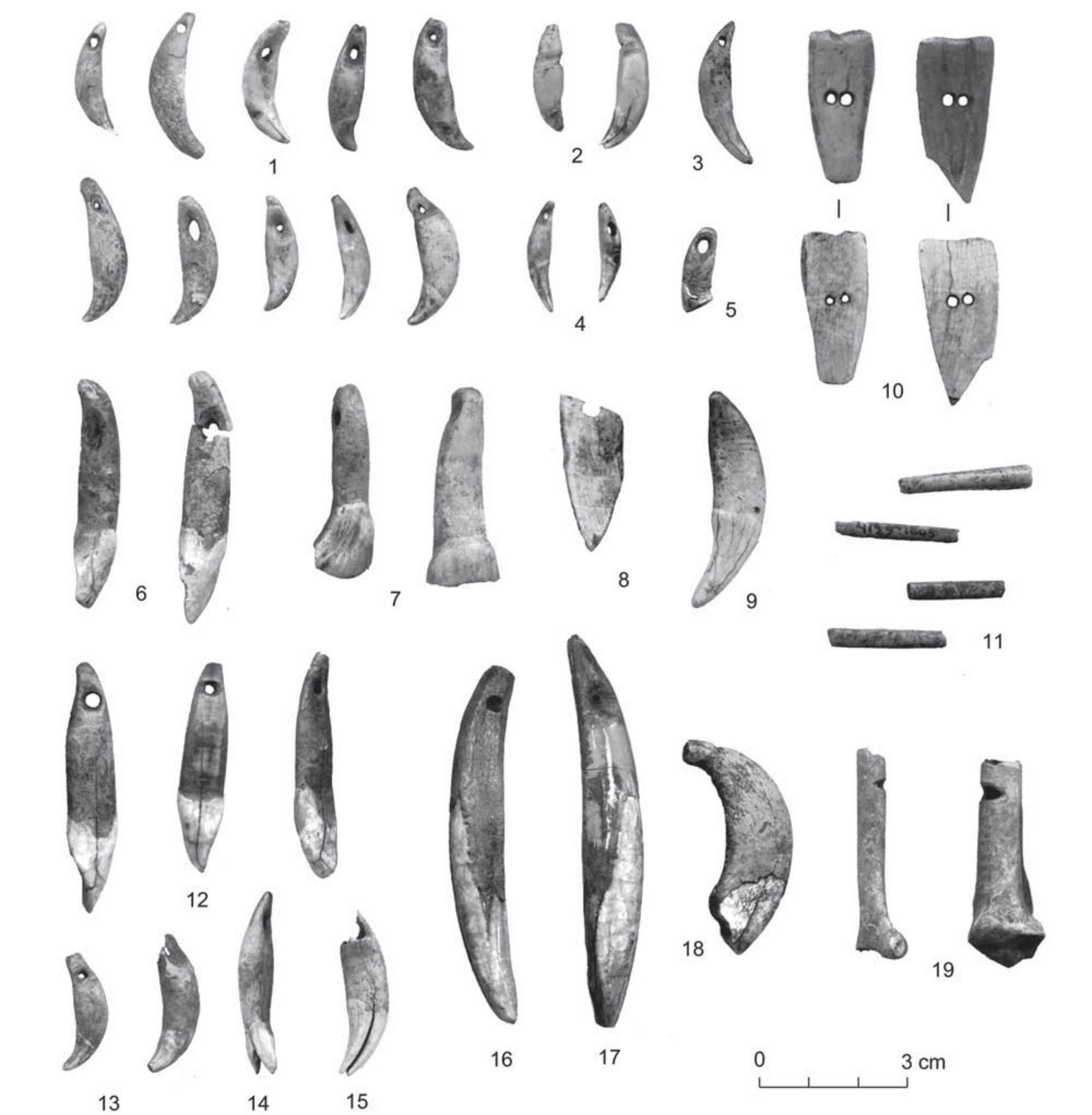


Fig. 12. Pendants and beads from the Neolithic sites of Loona (1-11) and Naakamäe (12-19).
1 – pierced seal canines, 2 – grooved seal canines, 3 – fox canine, 4 – canines of *Mustelidae*, 5 – a bear incisor, 6 – elk incisors, 7 – auroch incisors, 8 – wild boar tusk, 9 – unpierced dog or wolf canine, 10 – small pierced plates from wild boar tusks; 11 – tubular beads from bird radii, 12 – elk incisors, 13 – seal canines, 14 – elk incisor with triangular cut; 15 – dog canine, 16 – wild boar incisor with unfinished hole, 17 – pierced wild boar incisor, 18 – grooved wild boar incisor, 19 – pendants from bird bones (humerus of *Anatidae* sp. and ulna of *Anser* sp.). (AI 4210: 185, 6, 1285, 615, 756, 478, 572, 998, 1172, 793, 620, 641, 1477, 1295, 710, 416, 1534, 1488; 4129: 1448; 4210: 476, 1302; 4129: 825, 966, 1074; 1037; 4210: 1005; 4129: 958 (2x); 4211: 371, 1072, 109, 267, 1524, 422, 1084, 1391, 1433, 284, 317, 355)

Small personal objects

Besides the aforementioned artefacts, which are hunting weapons or household tools, the finds from these sites include artefacts related to dress – pendants, buttons and decorative pins.

Finds from the Neolithic site of Loona include a lot of pendants made from animal teeth – more than 60 specimens. The largest number, 48 pendants, are made from seal canines (Fig. 12:1, 2). Seal canine pendants have been also found from the Neolithic settlements of Šventoji in Lithuania and from the

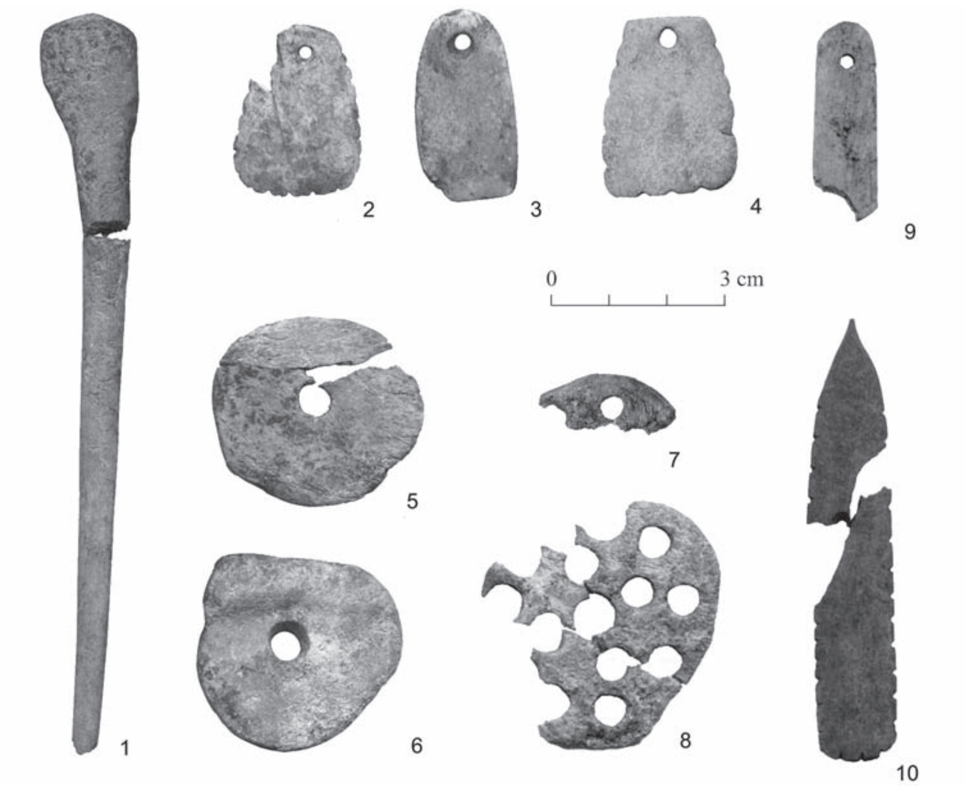


Fig. 13. Bone and antler objects from the Neolithic site and Bronze Age grave of Loona (1-7), from the Bronze Age stone grave of Kurevere (8) and from the Neolithic site of Naakamäe (9-10). (AI 4210: 1360/1828; 1117, 1190; 4129: 918; 4210: 1366, 698, 791; 4780: 280; 4211: 1087, 351/309)

Mesolithic and Neolithic cemetery of Zvejnieki in Latvia (Rimantienė 1996a:54, 76, fig. 40, 1996b:135, 169, fig. 51: 7-9; 56; Zagorska 2000:282, fig. 5: 3-10; Lõugas 2006:88, fig. 7, 8, 11). They also occur in the Neolithic burials on Gotland (Janzon 1974:132, pl. 13; Burenhult 1991: fig. 109, 112: 11; Martinsson-Wallin 2008:176, 178). Some elk teeth, mostly incisors, as well as wild boar tusks are also used for pendants (Fig. 12:6, 8), two pendants are made from aurochs incisors (Fig. 12:7). Five pendants are made from canines of *Mustelidae* (Fig. 12:4) and one from fox canine (Fig. 12:3). A rare find is a pendant made from a heavily worn bear incisor (Fig. 12:5). It is unusual since bear canines were used for pendants as a rule (e.g. Jonuks 2009:92, 97). The finds include also a canine of a dog or a wolf although it was not pierced (Fig. 12:9). Tooth pendants have been found also from the Neolithic site of Naakamäe but in lesser numbers than at Loona. The total number of tooth pendants found at Naakamäe is 19. The teeth came from the following species: elk (9 pendants), seal (5 pendants) and wild boar (4 pendants), one pendant is made from a dog's canine (Fig. 12:12-18). The same species in the above-mentioned settlements are also represented in tooth pendants at the Neolithic site of Kõnnu on Saaremaa, where one grave contained three skeletons – two adults and a child. The grave contained a total of 69 tooth pendants (36 elk incisors, 14 canines of grey seal, 8 wild boar incisors, 6 aurochs incisors and 1 horse incisor, 2 dog canines, 1 wolf canine and 1 fox canine: Lõugas 1997a:16, appendix II.B). Most of the tooth pendants were perforated although a few grooved specimens have been also found (Fig. 12:2, 18). A pendant of wild boar incisor from Naakamäe has an unfinished hole (Fig. 12:16) and one elk incisor pendant from the same site has a triangular notch cut in the crown (Fig. 12:14). A similar elk tooth pendant with a triangular notch has been also found in the Neolithic VII burial at Tamula (Jaanits 1954: fig. 12:5; Kriiska *et al.* 2007: fig. 8; Jonuks 2009:92). Tõnno Jonuks (2009:111) considers it possible that cutting elk incisors in this way was meant to leave an impression of the sharp canines of a carnivore. But at the same time, elk incisors were the most widespread pendants in North Europe, including Estonia, and evidently elk had a significant position in the mythology of that period (Jonuks 2009:108, 124, and references cited there). In such a context it does not seem very likely that the aim was to imitate a tooth from some other species. It is also possible that the aim might be to conflate the characteristics of two species (Alice Choyke – pers. comm.).

Tooth pendants do not occur among the finds from the Bronze Age fortified settlements. In the excavations of the Bronze Age sites of Asva and Ridala about ten teeth and canines have been recovered, but none of them is pierced or otherwise modified. Still, the bear canine found from Asva should be mentioned – it is the only skeletal part of bear from the

Fig. 14. Antler double buttons (1-4) and bone pins (5-13) from the Bronze Age site of Asva. (AI 4366: 132, 1591, 614; 3658: 500; 3799: 136, 39, 82; 4366: 1735; 3994: 604; 3307: 230; 3799: 78, 341; 3799: 351)

site and consequently it can be presumed that it is not an incidental object. It evidently possessed some meaning (for comparison it could be mentioned that one bear bone was found at the from Bronze Age site of Ridala and three, including one tooth, from the Neolithic site of Naakamäe (Paaver 1965, table 21); and the bear tooth pendant already mentioned from the Neolithic site of Loona). Thus, one may say that while tooth pendants are common among the Neolithic finds, they disappear by the end of the period, reappearing on Estonian sites only in the Viking Age. Using or not using tooth pendants could be related to changes in beliefs (e.g. Jonuks 2009:146).

Two small trapezoid plates made from boar tusks with two holes pierced in each were found at the Neolithic site of Loona (Fig. 12:10) – presumably they were sewn to garments, either as a means for fastening or a decoration; they may also have possessed some symbolic, magical or other meaning.

Some small tubular beads and pendants made from bird bones are also only found on Neolithic sites. Six tubular beads from bird bones have been found at Loona (Fig. 12:11) and one was found at Naakamäe. These beads were made from the radius of a medium-sized bird, the species of which could not be determined; in one case it could be established that the bird was a larger species, probably *Anseriformes*. Four bird bone pendants have been found at the Neolithic site of Naakamäe (Fig. 12:19) made from humeri of *Anatidae* while one pendant was made from the ulna of an *Anser* species.[4] Beads and pendants made from bird bones as well as bird figurines have been also found at other Neolithic sites. Such tubular beads are especially numerous in the middle Neolithic burials at Tamula. Their location in the graves suggests that they were decorations sewn onto garments (Jaanits 1957:92-93). Similar tubular beads have also been found at Ajvide in Gotland while bird bone pendants have been discovered at Zvejnieki in Latvia; most of these beads are made from the radius or ulna of waterfowl and the pendants are made from the humeri of medium-sized birds or small ducks (Mannermaa 2008a:209-210, fig. 7-8; 2008b:61). It has been suggested that waterfowl occupied an important place in Stone Age mythology; according to the Finno-Ugric *resp*. Arctic North-European creation myth, the world was born from mud brought up by a waterfowl or from waterfowl's egg (Jonuks 2009:88 ff. and references cited there).

As mentioned already, the site of Loona is particularly interesting because there two settlements are located one above the other – a stone grave was erected in the Late Bronze Age upon the site where a settlement had been in the Neolithic and which was probably still inhabited in the Early Bronze Age. A spade-headed bone pin, three trapezoidal bone pendants and two pierced bone discs were found in the area of the late Bronze Age stone grave

4 Identified by Teresa Tomek.

(Fig. 13:1-6; Luik 2007: fig. 10). It was possible to identify the material only for two of the artefacts: one disc-shaped plaque with a hole was made from an elk mandible (Fig. 13:6) and one trapezoidal pendant was made from elk antler (Fig. 13:4). The pin (Fig. 13:1), based on comparison with analogous finds, definitely dates to the Bronze Age (Lang 1992). The pierced bone discs may date to the Bronze Age although some similar artefacts are also found in Neolithic material in Latvia (Loze 1979:46, fig. 42). The pendants have parallels in Neolithic material from Lithuania, e.g. Kretuonas, where they were made from bone as well as from amber (Girininkas 1990: fig. 115:3, 4). Similar pendants also occur in Latvia among the finds of the Abora I settlement site, located in Lubāna Valley, and dated to the Neolithic (Loze 1979:46, fig. 43). Hence, the trapezoidal pendants may be, after all, finds from the earlier Neolithic settlement site. Here, two rib fragments from the Neolithic site of Naakamäe should also be mentioned – they may be fragments of a single artefact (Fig. 13:10). Although the artefact is not trapezoidal, one fragment has a hole in it suggesting it was used as a pendant while its sides display similar indentations to the pendants from Loona. A fragment of one other oblong pendant is known from Naakamäe (Fig. 13:9).

A small fragment of a pierced bone plate has been found at Loona (Fig. 13:7). A similar artefact came to light in a Bronze Age stone grave at Kurevere (Fig. 13:8). Thus, the plate may belong to the assemblage of finds from the Bronze Age grave. The plate from Kurevere, with more than 10 holes in it, has a diameter of about 50 mm. The fragment from Loona is small and its diameter and the number of holes is not known. Analogies to these plates can be found in Germany, e.g. at Wallersdorf and Lupberghöhle. These objects were made from human skull and are regarded by scholars as amulets. In terms of its size, the plate from Lupberghöhle is about the same as the plate from Kurevere (with a diameter of 58 mm), but the number of holes is considerably greater – 64 holes altogether. The bone plate from Wallersdorf has nine holes (Probst 1999:287-288).

A new group of Bronze Age artefacts consists of bone pins and antler double buttons, imitating foreign bronze objects (Fig. 14; Luik, Ots 2007; Luik, Lang in press). The introduction of bone pins may have been connected with a new style of dress which required pins for fastening. But their occurrence may also reflect the distribution of the ideologies and symbolic meanings connected with them on the eastern shore of the Baltic Sea, as well as the existence of a social group or rank whose requirements these artefacts met. Similar pins and double buttons (the latter sometimes also made of amber) occur also among the finds from Latvian and Lithuanian Bronze Age sites (Luik, Ots 2007; Luik, Maldre 2007:33-34, fig. 9, 31; Luik 2007:51-53, fig. 2-4; in press: fig. 16-18; and references cited there). Double buttons may reflect a sun cult, which was wide spread in Scandinavia and which presumably played an important role in Estonian Bronze Age religious practice as well (Jonuks 2005:90, 2009:191 ff.). The formation of the sun cult has been related to the spread of cultivation and in Estonia the connection of Bronze Age stone-cist graves with sun symbolism has been suggested (V. Lõugas 1996:101 ff.; Lang 2007:180-181; Luik, Ots 2007:133).

Alice Choyke (2008) has suggested that small items, designed for individual use – e.g. ornaments – were meant to be worn and thus were also displayed by their owners. They may have reflected differences in status, gender, age or profession. Among such items she mentions decorative pins made from bone and imitating copper pins which were characteristic for the Late Neolithic of Central Europe. Choyke accentuates that imitations seem to be primarily characteristic in periods when social changes were taking place and new territorial and/or social limits being shaped. In Central Europe, the end of the Neolithic marked a period when social structures became more hierarchical and complex, social differentiation increased, metalworking technology was introduced and together with it new materials, which could be related to high status (Choyke 2008: pl. 1:1a–b). On the eastern shore of the Baltic, including Saaremaa, the situation was similar in the Bronze Age, when social changes are indicated by the appearance of stone graves (as burial places for the elite) as well as fortified settlements.

Apparently the differences in the kinds of small personal items among archaeological finds from the Neolithic and the Bronze Age reflect the changes that were taking place in the beliefs and mythology, and social structures of the region.

Faunal remains and material used for making artefacts

The greater part of the animal bones in the faunal material from the Neolithic site of Naakamäe come from seal (the most numerous are the bones of harp seal, but ringed seal and grey seal are also represented: Lõugas 1997b: table 1). Wild boar bones are most numerous among the remains of terrestrial animals. At the Neolithic site of Loona, seal and wild boar bones are also numerous but the amount of fish bones is also remarkable (Lõugas 1997a: ta-

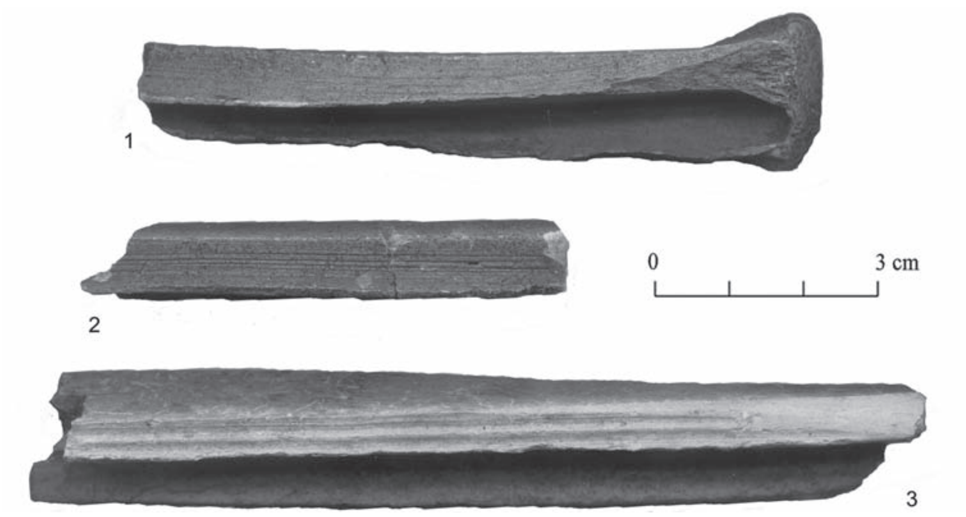


Fig. 15. Elk metapodial bones with working traces from the Neolithic site of Naakamäe. (AI 4211: 1090, 1079, 1091)

ble 2; 1997b: table 1). Fragments of fishing spears and harpoon heads among the finds suggest fishing and seal hunting were critical subsistence activities. At both sites, other species are represented by single bones, e.g. fox, marten, elk, bear, hare, beaver (Paaver 1965; Lõugas 1997a; Kriiska 2002:48). Some of the pig bones from Loona could have come from domesticated individuals (Paaver 1965; Lõugas *et al.* 1996:415-416, table 1). In the Bronze Age sites of Asva, Ridala and Kaali, the majority of the faunal remains comes from domestic animals: 58% at Asva and up to 78% at Ridala. Goat/sheep bones are most numerous, followed by cattle, pig and horse. Seal bones are also numerous, 39% at Asva and 19% at Ridala; terrestrial wild animals are represented by a few bones, about 3% at each site: e.g. elk, wild boar, bear, fox, marten, hare, beaver (Paaver 1965; Lõugas 1994; Lang 2007:110-111; Maldre 2008).

Changes in subsistence also influenced the choice of material used for making artefacts. The Neolithic artefacts are made from bones of wild animals. A large proportion of the bone artefacts consists of tooth pendants. The material from the Neolithic site of Loona contains a piece of elk antler with working traces although artefacts made from elk antler are very few. Artefacts were made from elk bones and elk incisors were used as pendants. Mainly elk long bones were used, especially metacarpal and metatarsal bones; a few artefacts were also made from elk femur, tibia and radius and in some cases elk mandible was also used. Compared with the number of elk bones in the unworked material, artefacts made from elk bone are relatively numerous. Besides a couple of auroch's incisors there may also be a fragment of auroch tibia with working traces on it from Loona – the identification is based on the thickness of the cortical bone. It is possible that some artefacts made from unidentifiable pieces of long bone also came from auroch. Seal bones were used quite often, and they also constitute the majority of the unworked faunal remains. Seal bones were mostly used for making awls and seal canines were used as pendants, they are particularly numerous in Loona. Wild boar bones and canines were also used for making artefacts while a few objects were made from marten, fox, roe deer and bird bones. The latter come from waterfowl (*Anseriformes, Anatidae*).

In the Bronze Age, artefacts were quite often made from elk antler (e.g. hoe blades or ard points, cheek-pieces, spoons, handles, double buttons: Luik 2011). Artefacts made from the bones of wild animals are few in number; still, awls produced from the rudimentary metapodials of elk should be mentioned. The relative frequency of elk among worked material is surely remarkable, but concerning antler it should be remembered that shed antlers were also used, not only those from hunted animals (Maldre 2008:271).

Bones of domestic animals were mainly used for making artefacts in the Bronze Age. For several artefact types, bones of small domestic animals, mainly goat/sheep, were also exploited. As mentioned already, goat/sheep bones are also most numerous among the faunal remains; the environmental conditions of the region particularly favoured goat and sheep breeding. Artefacts were also made from horse and cattle bones although artefacts definitely made from horse bones are still relatively few (Maldre, Luik 2009; Luik in press). It is remarkable that although seal bones are numerous among the faunal remains from the Bronze Age sites of Asva and Ridala, they were not used for making artefacts in this later period. At Neolithic settlements, skeletal elements of seal were used for making two artefact types – tooth pendants and awls. Canine pendants

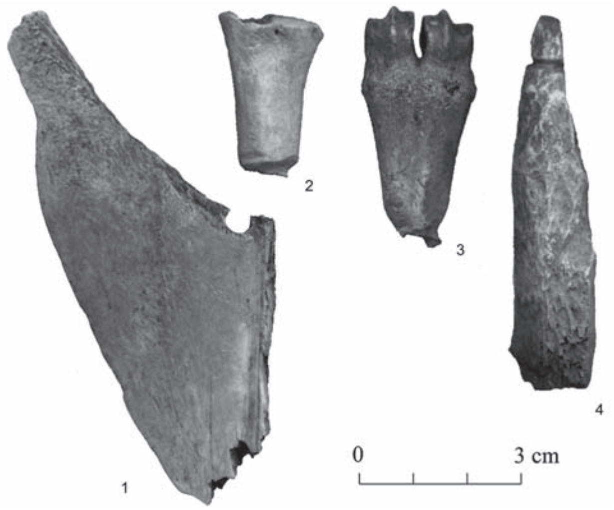


Fig. 16. Worked bone fragments from Bronze Age sites of Asva (1) and Ridala (2-4).
1 – scapula of elk or cattle, 2 – undetermined long bone, 3 – sheep metatarsus, 4 – long bone of large herbivore.
(AI 4366: 1944; 4261: 698, 582, 450)

do not occur in the Bronze Age material, which is probably connected with changes in beliefs. But as for awls, it seems that for making an awl of about the same size as the seal bone specimens in the Neolithic, goat/sheep metapodial bones were preferred in the Bronze Age.

Technologies used for making bone artefacts

Working traces can be observed on bone artefacts and bone and antler working debris both from the Neolithic and from the Bronze Age. Bone and antler working debris is more numerous at the Bronze Age sites of Asva and Ridala; at the Neolithic sites of Naakamäe and Loona, the amount of bone working refuse is quite modest. One reason for that is probably the different character of these sites: Naakamäe and Loona were small settlements where seal-hunting and fishing were the basic means of subsistence; Asva and Ridala were much larger fortified settlement sites where also crafts and trade were important occupations. The other reason may be that at the Neolithic sites of Naakamäe and Loona only a few artefacts were made from antler, but antler working refuse is more easily recognizable than bone working refuse which could easily remain unnoticed during excavations and go into the unworked faunal assemblage.

Bone artefacts can be generally divided into two groups: (1) artefacts for which a bone was chosen as having as suitable shape as possible with only slightly worked; (2) carefully worked artefacts, which were often made from the compact diaphysis of long bones.

Slightly worked artefacts include, both at the Neolithic and Bronze Age sites, awls for which bones with a suitable shape were chosen. In the Bronze Age, only the tip of the bone was slightly sharpened to make the awls produced on rudimentary metapodials and ulna of elk and horse (Luik in press: fig. 3). The other possibility was that a bone was broken spirally and one end was sharpened. Such artefacts include awls made from bird bones and rudimentary metapodials of seal in the Neolithic material and specimens from goat/sheep metapodials among the Bronze Age finds (Luik 2009: fig. 3).

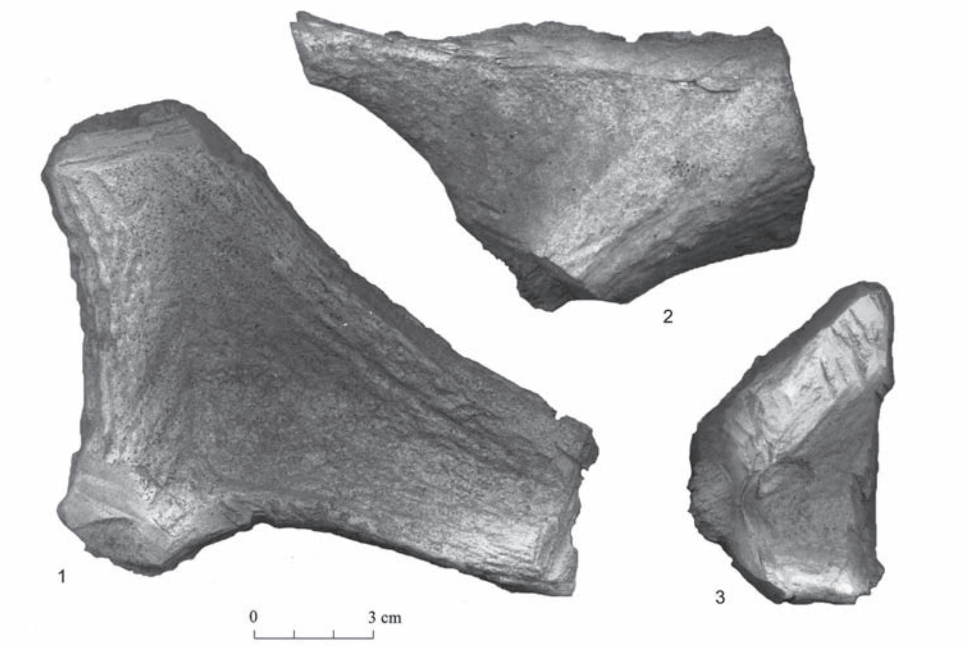


Fig. 17. Antler pieces with chopping traces from the Bronze Age site of Asva.
(AI 3307: 224, 114; 4366: 1409)

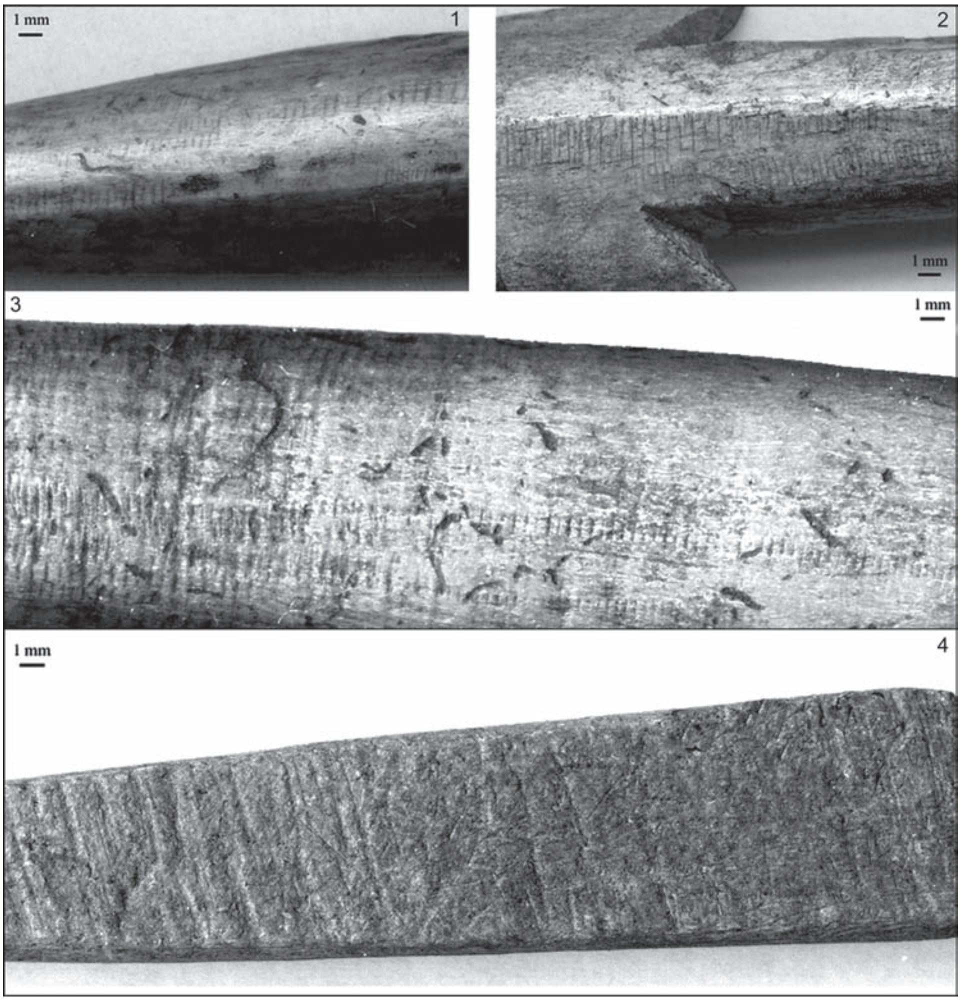


Fig. 18. Chatter-marks on bone arrowheads from the Bronze Age site of Asva (1-2) and on a cylinder-shaped blank from the Bronze Age site of Ridala (3); working traces on artefact fragment from the Neolithic site of Naakamäe (4). (AI 3994: 586; 3307: 296; 4261: 235; 4211: 357)

To make an artefact from the compacta of a diaphysis, the bone had to be cut into pieces first. For that purpose grooving was used: a groove was cut into a bone with a flint blade or sawn with a sharp-edged sandstone plate and then the bone was broken or split at the grooves. Grooving helped to avoid the bone breaking in the wrong place; the fracture could then be scraped with a flint blade or ground on a grinding-stone (Choyke 1997: 67). Among the material from the Neolithic sites of Naakamäe and Loona, fragments of split diaphyses can be found bearing the characteristic longitudinal working traces. Usually the bone was grooved into the medullary cavity, but sometimes the last part of the diaphysis was broken (Fig. 15; compare e.g. Christidou 2005: fig. 4, 10). Pieces of diaphysis produced by this method were used for making fishing spears, harpoons and, spearheads but also some awls. Grooving can also be observed on bone artefacts from the Bronze Age settlements of Ridala and Asva; grooving was used to produce longitudinal as well as transverse dissecting of bones (Fig. 16). Among the Bronze Age finds, arrowheads, some of the harpoon heads and decorative pins should be mentioned as artefacts that were made from long bone diaphyses.

Longitudinal splitting left similar grooving traces on Neolithic bone working refuse as well as on the compact part of the only piece of antler in the Neolithic finds. Bronze Age material contains more antler working refuse. Cutting up antler was performed by cutting or chopping around the compact part so that the spongiosa within the antler could then just be broken off (Fig. 17; Luik in press: fig. 19). Some of the antler fragments also bear traces of further working – removal of the rough antler surface was started and the antler was scraped thus producing facets (Luik in press: fig. 20). Chopping and cutting traces can be observed also on unfinished antler artefacts (Vassar 1955: pl. XXIII:7), as well as on tools where it was considered unnecessary to hide the manufacturing marks such as on the shafts of antler harpoon heads (e.g. Fig. 4:4) and ard points or hoes.

Chatter-marks represent a special type of working-trace on Bronze Age bone and antler artefacts in the Baltic countries. Among the finds from Asva and Ridala such traces can be found e.g. on bone arrowheads, harpoon heads, some ard points or hoes, etc. (Fig. 18:1-3; Luik 2006:138, fig. 6). Such chatter-marks can be seen on the surface of the replica of an arrowhead from Asva, made by Jaana Ratas and Jaak Mäll. In the course of their work they discovered that when cutting a rather hard material like bone powerfully and with steady force, the blade may begin to vibrate, thus leaving small transverse lines at equal intervals – chatter-marks – on the surface of bone. By the opinion of Ratas and Mäll the chatter-marks are probably the result of working the artefact surface with a flint blade, which has been inserted into some sort of handle (Luik 2006:138-140, fig. 7-8), but they may have appeared also in using a bronze tool (e.g. Cristiani, Alhaique 2005; Christidou 2008). On bone artefacts from Naakamäe and Loona, the Neolithic settlement sites on Saaremaa, working traces are not quite the same. Slightly more irregular transverse lines can be observed on the edge of a spearhead from Naakamäe and on another artefact fragment (Fig. 18:4).

Barbs of Neolithic fishing spears and Bronze Age arrowheads were made in different ways. Barbs of fishing spears (Fig. 3:1-10) were mostly cut with a sharp-edged flint or quartz tool, but in one case, a hole was drilled into the bone and then shaped into a barb (Fig. 3:13; compare e.g. Sidéra 2005: fig. 2). Barbs of the Bronze Age arrowheads (Fig. 5:1-3, 5-6) were probably made by abrading/sawing with small sandstone plates – this method was successfully used by Jaana Ratas and Jaak Mäll for making a replica of an arrowhead from Asva. First they tried to cut the barb into the bone but unsuccessfully – the barb broke (Luik 2006:141).

Holes were made in artefacts, a process requiring augers. In Bronze Age artefacts the holes are usually cylindrical (e.g. Figs 11:6; 14:10-13), drilled through the bone in one direction; biconical holes bored from two sides are common in Neolithic artefacts (Fig. 12). The same distinction – biconical holes typical of Neolithic artefacts and cylindrical holes characteristic of Bronze Age ones – can be also observed e.g. in amber artefacts from the Baltic countries (Ots 2006:29, 34, 74).

Conclusions

Artefact types which occurred both in the Neolithic and the Bronze Age were those connected with activities practised in the settlements in both periods such as seal hunting (harpoons) and hide and leather working, textile and basketry making (awls). But changes can be also observed in the shapes of tools connected with these activities, as well as in the materials used for making them. The choice of raw material is, in its turn, connected with subsistence and related possibilities of using certain raw materials: e.g. Neolithic awls from seal bone *vs* awls from domestic goat/sheep bones in the Bronze Age (Figs 6:1-4, 7:1-6). Concerning the choice of raw material, it seems that both in the Neolithic and the Bronze Age, the percentage of elk skeletal elements in the worked bone finds is considerably higher than in the unworked faunal remains. Evidently elk bone and antler were preferred as raw material due to their size and other properties. Seal bones were frequently used as raw material in the Neolithic when they constituted the majority of the bones in the unworked faunal assemblage. Although seal bones occupy an important place among the faunal remains in the Bronze Age settlements on Saaremaa as well, they were not used for making artefacts in that period.

New artefact types among the Bronze Age finds include objects connected with farming (e.g. hoe blades or ard points). Although the beginning of cultivation in Estonia has been dated to the Middle Neolithic, it was still not omnipresent in the Late Neolithic yet; it has been assumed that hunting and fishing were combined with small-scale animal husbandry and tillage. Cultivation became the main form of subsistence on Estonian coasts and islands only in the Late Bronze Age (Lang 2007:19, 95 ff.). The character of the settlements must also be taken into consideration – the Neolithic sites of Naakamäe and Loona were settlement sites of seal hunters and fishers; tools from these sites are mainly connected with related activities. Bone artefacts were also made, if necessary, in such seasonal settlements as indicated by bone working refuse and the unfinished artefacts found there.

So-called personal objects connected to various aspects of dress are completely different in the two periods. In the Neolithic they comprised mostly pendants, especially tooth pendants (Fig. 12) while in the Bronze Age, decorative pins and double buttons (Fig. 14) imitating foreign metal types, prevailed. Besides changes in the economy, shifts also evidently took place in social relations and beliefs, finding indirect expression in artefacts which, along with their obvious function of fastening and decorating clothes, probably possessed some symbolic meaning as well. Artefacts such as bridle cheekpieces and probably also the carefully finished handles and spoons or arrowheads used in warfare may also reflect the changes in social relations and lifestyles.

Acknowledgements

The study was funded by the Estonian Ministry of Education and Research (SF0130012s08), Estonian Science Foundation (grant no 6898) and the European Regional Development Fund of the European Union (Centre of Excellence in Cultural Theory). The authors also thank Teresa Tomek for identifying the bird bones, Liis Soon for translating the text, and Alice Choyke for revising the English text. We would like to thank Alice Choyke and Arkadiusz Marciniak for their comments on the preliminary version of the manuscript.

References

Abbreviations

AI – Archaeological collections of the Institute of History, Tallinn University

AI FK – Collection of photographs in the Archives of Institute of History, Tallinn University

Burenhult, G. 1991. *Arkeologi i Sverige 1. Fångstfolk och herdar,* Höganäs: Förlags AB Wiken.

Choyke, A.M. 1997. *The bone tool manufacturing continuum*, Anthropozoologica 25-26, 65-72.

Choyke, A.M. 2008. *Shifting meaning and value through imitation in the European Late Neolithic*. In: P.F. Biehl and J. Rassamakin (eds.) *Import and Imitation in Archaeology*, Schriften des Zentrums für Archäologie und Kulturgeschichte des Schwarzmeerraumes 11, Langenweissach: Verlag Beer and Began, 5-23.

Christidou, R. 2005. *Investigating technical and functional variability in the Neolithic bone tool assemblages of Eastern Macedonia (Northern Greece): Methods and preliminary results*. In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present. Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003*, Muinasaja teadus 15, Tallinn, 91-104.

Christidou, R. 2008. *An application of micro-wear analysis to bone experimentally worked using bronze tools*, Journal of Archaeological Science 35, 733-51.

Cristiani, E. and F. Alhaique 2005. *Flint vs. metal: the manufacture of bone tools at the Eneolithic site of Conelle di Arcevia (Central Italy)*. In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present. Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003,* Muinasaja teadus 15, Tallinn, 397-403.

Feustel, R. 1980. *Neolitische Gerberwerkzeuge aus Knochen*, Alt-Thüringen 17. Jahresschrift des Museums für Ur- und Frühgeschichte Thüringens, Weimar: Hermann Böhlaus Nachfolger, 7-18.

Girininkas, A. 1990. *Kretuonas. Vidurinysis ir vėlyvasis neolitas / Kriatuonas. Srednii i pozdnii neolit*, Lietuvos archeologija 7, Vilnius: Mokslas.

Grigalavičienė, E. 1995. *Žalvario ir ankstyvasis geležies amžius Lietuvoje*, Vilnius: Mokslo ir Enciklopedijų Leidykla.

Hásek, I. 1966. *Pravěké kostěné a parohové nástroje s ozubenou pracovní hranou,* Sborník Národního muzea v Praze / Acta Musei Nationalis Pragae. Series A – Historia XX(3), Praha: Orbis.

Indreko, R. 1939. *Asva linnus-asula*. In: H. Moora (ed.) *Muistse Eesti linnused. 1936.–1938. a. uurimiste tulemused*, Tartu: Õpetatud Eesti Selts, 17-52.

Jaanits, L. 1954. *Novye dannye po neolitu Pribaltiki,* Sovetskaya arheologiya XIX, 159-204.

Jaanits, L. 1957. *Neue Gräberfunde auf dem spätneolithischen Wohnplatz Tamula in Estland,* Suomen Muinaismuistoyhdistyksen Aikakauskirja 58, 80-100.

Jaanits, L., S. Laul, V. Lõugas and E. Tõnisson. 1982. *Eesti esiajalugu*, Tallinn: Eesti Raamat.

Janzon, G. 1974. *Gotlands Mellanneolitiska gravar*, Acta Universitatis Stockholmiensis 6, Stockholm: Almqvist & Wiksell.

Jonuks, T. 2005. *Principles of Estonian prehistoric religion: with special emphasis to soul beliefs*. In: V. Lang (ed.) *Culture and Material Culture. Papers from the first theoretical seminar of the Baltic archaeologists (BASE) held at the University of Tartu, Estonia, October 17th–19th, 2003*. Interarchaeologia 1, Tartu; Riga; Vilnius, 87-95.

Jonuks, T. 2009. *Eesti muinasusund*, Dissertationes archaeologiae Universitatis Tartuensis 2, Tartu: Tartu Ülikooli Kirjastus.

Jussila, T. and A. Kriiska. 2004. *Shore displacement chronology of the Estonian Stone Age,* Estonian Journal of Archaeology 8(1), 3-32.

Kriiska, A. 1997. *Kroodi ja Vihasoo III asula Eesti varaneoliitiliste kultuurirühmade kontekstis,* Journal of Estonian Archaeology 1, 7-25.

Kriiska, A. 2002. *Lääne-Eesti saarte asustamine ja püsielanikkonna kujunemine*. In: V. Lang (ed.) *Keskus–tagamaa–ääreala. Uurimusi asustushierarhia ja võimukeskuste kujunemisest Eestis*, Muinasaja teadus 11, Tallinn; Tartu, 29-60.

Kriiska, A., M. Lavento and J. Peets. 2005. *New AMS dates of the Neolithic and Bronze Age ceramics in Estonia: preliminary results and interpretations,* Estonian Journal of Archaeology 9(1), 3-31.

Kriiska, A., L. Lõugas, M. Lõhmus, K. Mannermaa and K. Johanson 2007. *New AMS dates from Estonian Stone Age burial sites*, Estonian Journal of Archaeology 11(2), 83-121.

Kriiska, A. and U. Saluäär. 2000. *Lemmetsa ja Malda neoliitilised asulakohad Audru jõe alamjooksul*. In: A. Vunk (ed.) *Pärnumaa ajalugu* 3. *Artiklite kogumik* 2, Pärnu, 8-38.

Lang, V. 1992. *Eesti labidaspeaga luunõelte dateerimisest*. In: L. Jaanits and V. Lang (eds.) *Stilus* 1. *Eesti Arheoloogiaseltsi Teated,* Tallinn, 8-32.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Estonian Archaeology 3, Tartu: Tartu University Press.

Lang, V. and A. Kriiska 2001. *Eesti esiaja periodiseering ja kronoloogia*, Journal of Estonian Archaeology 5(2), 83-109.

Lehmann, E. 1931. *Gezahnte Knochenwerkzeuge aus Mitteldeutschland*, Jahresschrift für die Vorgeschichte der Sächsisch-Thüringischen Länder XIX, 37-43.

Lõugas, L. 1994. *Subfossil vertebrate fauna of Asva site, Saaremaa. Mammals*. In: V. Lang (ed.) *Stilus 5. Eesti Arheoloogiaseltsi Teated*, Tallinn, 71-93.

Lõugas, L. 1996. *Stone Age fishing strategies in Estonia. What did they depend on?* Archeofauna 5, 101-9.

Lõugas, L. 1997a. *Post-Glacial Development of Vertebrate Fauna in Estonan Water Bodies. A Palaeozoological Study*, Dissertationes Biologicae Universitatis Tartuensis 32, Tartu: Tartu University Press.

Lõugas, L. 1997b. *Subfossil seal finds from archaeological coastal sites in Estonia, east part of the Baltic Sea*, Anthropozoologica 25-26, 699-706.

Lõugas, L. 2006. *Animals as subsistence and bone as raw material for settlers of prehistoric Zvejnieki*. In: L. Larsson and I. Zagorska (eds.) *Back to the Origin. New Research in the Mesolithic-Neolithic Zvejnieki Cemetery and Environment, Northern Latvia*, Acta Archaeologica Lundensia, Series in 8°, No. 52, Lund, 75-89.

Lõugas, L., K. Lidén and E. Nelson. 1996. *Resource utilisation along the Estonian coast during the Stone Age*. In: T. Hackens, S. Hicks, V. Lang and U. Miller (eds.) *Coastal Estonia: Recent Advances in Environmental and Cultural History*, PACT 51, Rixensart, 399-420.

Lõugas, V. 1996. *Kaali kraatriväljal Phaethonit otsimas*, Tallinn: Eesti Entsüklopeediakirjastus.

Loze, I. 1979. *Akmens laikmets Lubāna klānos*, Rīga: Zinātne.

Luik, H. 2006. *For hunting or for warfare? Bone arrowheads from Late Bronze Age fortified settlements in Eastern Baltic*, Estonian Journal of Archaeology 10(2), 132-49.

Luik, H. 2007. *Dazzling white. Bone artefacts in Bronze Age society – some preliminary thoughts from Estonia*. In: A. Merkevičius (ed.) *Colours of Archaeology. Material Culture and Society. Papers from the second theoretical seminar of the Baltic archaeologists (BASE) held in Padvaria, October 20–22, 2005*. Interarchaeologia 2, Vilnius-Helsinki-Riga-Tartu, 49-64.

Luik, H. 2009. *Skill, knowledge and memory. How to make a bone awl properly?* In: A. Šne and A. Vasks (eds.) *Memory, Society and Material Culture. 3rd Baltic Archaeological Seminar (BASE 3), Oct. 4.–7. 2007, Ventspils,* Interarchaeologia 3, Vilnius-Helsinki-Riga-Tartu, 45-58.

Luik, H. 2011. *Material, technology and meaning: antler artefacts and antler working on the eastern shore of the Baltic in the Late Bronze Age*, Estonian Journal of Archaeology 15(1), 32-55.

Luik, H. in press. *Luu- ja sarvetöötlemisest Läänemere idakaldal nooremal pronksiajal: sarnasused ja erinevused Eesti, Läti ja Leedu leiuaineses*, In: A. Kriiska, M. Lõhmus and K. Johanson (eds.) *Man, his Time and Space*, Muinasaja teadus, Tartu.

Luik, H. and V. Lang, 2010. *Scapular artefacts with serrated edges from fortified settlements of the Late Bronze Age in Estonia*, Archaeologia Baltica 13, 162-74.

Luik, H. and V. Lang, in press. *Bronze Age bone pins in the eastern Baltic – for fixing garments or signalling identity?* In: M. Lavento and M. Suhonen (eds.) *The changing Bronze Age in Fennoscandia and Around the Baltic Sea. Proceedings of the 11th Nordic (1st Nordic & Baltic) Bronze Age Symposium Held at the University of Helsinki, Finland, October 29-31, 2009,* Helsinki.

Luik, H. and L. Maldre. 2007. *Bronze Age bone artefacts from Narkūnai, Nevieriškė and Kereliai fortified settlements. Raw materials and manufacturing technology*, Archaeologia Lituana 8, 5-39.

Luik, H. and M. Ots. 2007. *Bronze Age double buttons in Estonia*, Estonian Journal of Archaeology 11(2), 122-40.

Maldre, L. 2008. *Karjakasvatusest Ridala pronksiaja asulas*, In: L. Jaanits, V. Lang and J. Peets (eds.) *Loodus, inimene ja tehnoloogia 2, Interdistsiplinaarseid uurimusi arheoloogias*, Muinasaja teadus 17, Tallinn, 263-76.

Maldre, L. and H. Luik. 2009. *Horse in Estonia in the Late Bronze Age: archaeozoological and archaeological data*, In: A. Bliujienė (ed.) *The Horse and Man in European Antiquity (Worldview, Burial Rites, and Military and Everyday Life)*, Archaeologia Baltica 11, 37-47.

Mannermaa, K. 2008a. *Birds and burials at Ajvide (Gotland, Sweden) and Zvejnieki (Latvia) about 8000-3900 BP*, Journal of Anthropological Archaeology 27(2), 201-25.

Mannermaa, K. 2008b. *The Archaeology of Wings. Birds and People in the Baltic Sea Region during Stone Age*, Academic dissertation. Helsinki: University of Helsinki.

Martinsson-Wallin, H. 2008. *Land and sea animal remains from Middle Neolithic Pitted Ware sites on Gotland Island in the Baltic Sea, Sweden*. In: G. Clark, F. Leach and S. O'Connor (eds.) *Islands of Inquiry. Colonisation, seafaring and the archaeology of maritime landscapes,* Terra Australis 29, The Australian National University Press, 171-83.

Northe, A. 2001. *Notched implements made of scapulae – still a problem*, In: A. M. Choyke and L. Bartosiewicz (eds.) *Crafting Bone: Skeletal Technologies through Time and Space. Proceedings of the 2nd Meeting of the (ICAZ) Worked Bone Research Group, Budapest, 31 August – 5 September 1999*, British Archaeological Reports, International Series 937, Oxford: Archaeopress, 179-84.

Ots, M. 2006. *Merevaiguleiud Baltimaade kivi- ja pronksiaja muististes*, MA thesis, Tallinn (Manuscript at the University of Tartu and at the Institute of History, Tallinn University).

Paaver, K. 1965. *Formirovanie teriofauny i izmenchivost' mlekopitaiushchikh Pribaltiki v golotsene.* Tartu: Akademia Nauk Estonskoi SSR, Institut zoologii i botaniki.

Probst, E. 1999. *Deutschland in der Bronzezeit. Bauern, Bronzegiesser und Burgherren zwischen Nordsee und Alpen*, München: Orbis.

Rimantienė, R. 1996a. *Šventosios 4-oji radimvietė*, Lietuvos Archeologija 14, 5-79.

Rimantienė, R. 1996b. *Šventosios 6-oji gyvenvietė*, Lietuvos Archeologija 14, 83-173.

Sidéra, I. 2005. *Technical data, typological data: a comparison*, In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.) *From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present. Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003,* Muinasaja teadus 15, Tallinn, 81-90.

Sørensen, M.L.S. 2000. *Gender Archaeology,* Cambridge: Polity Press.

Steppan, K. 2001. *Worked shoulder blades: technotypological analysis of Neolithic bone tools from Southwest Germany*. In: A. M. Choyke and L. Bartosiewicz (eds.) *Crafting Bone: Skeletal Technologies through Time and Space. Proceedings of the 2nd Meeting of the (ICAZ) Worked Bone Research Group, Budapest, 31 August – 5 September 1999*, British Archaeological Reports, International Series 937, Oxford: Archaeopress, 85-91.

Vasks, A. 1994. *Brikuļu nocietinātā apmetne. Lubāna zemiene vēlajā bronzas un dzelzs laikmetā (1000. g. pr. Kr. – 1000. g. pēc Kr.)*, Rīga: Preses Nams.

Vassar, A. 1955. *Ukreplennoe poselenie Asva na ostrove Saaremaa*, In: H. Moora and L. Jaanits (eds.) *Muistsed asulad ja linnused*, Arheoloogiline kogumik 1, Tallinn: Eesti Riiklik Kirjastus, 113-37.

Walter, D. and G. Möbes 1988. *Gerätschaften des Schlächters aus Siedlungsgruben der Aunjetitzer Kultur in Thüringen*, Ausgrabungen und Funde 33(5), 242-46.

Zagorska, I. 2000. *Seal mammal hunting strategy in the Eastern Baltic*, Lietuvos Archeologija 19, 275-85.

Florentina Oleniuc, Luminița Bejenaru

Preliminary Data Concerning the Manufacturing of Animal Raw Materials in the Chalcolithic Cucuteni *B* Settlement of Poduri-Dealul Ghindaru, Romania

The archaeological research of the Chalcolithic settlement of Poduri, belonged to the Cucuteni culture, aims to research subsistence practices including the manufacturing of animal raw materials as reflected by archaeozoological analyses. The animal remains studied in the present paper represent bone, antler, tooth and shell artefacts, belonging to phase *B* of the Cucuteni culture, recovered from the archaeological excavations carries out in 2007-2008.

Among the finds, bone and antler artefacts are quite numerous, but we also identified pieces made of teeth and shells. The discussed artefacts include tools, ornaments (pendants) and probably gaming pieces (knucklebones). The mammal species identified are both wild and domestic: red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa ferus*), aurochs (*Bos primigenius*), cattle (*Bos taurus*), sheep/goat (*Ovis aries/Capra hircus*) and pig (*Sus scrofa domesticus*).

The artefacts have been identified in different stages of manufacturing and also having different wear levels. Our study emphasizes an important diversity in the typology of artefacts and also in the anatomical and taxonomical selection of raw materials.

Key words: bone, antler and tooth artefacts, Chalcolithic, Cucuteni culture, Poduri-Dealul Ghindaru, Romania

Introduction

The Cucuteni culture appeared and spread in the Eastern Romania, evolving in three chronological phases (*A*, *A*-*B* and *B*), between 4,600-3,500 cal BC (Mantu 1998:166). Over 125 years of research several settlements have been excavated, some of them integrally, and several hundred habitations have been studied (Monah, Cucos 1985:101-103).

The *Tell* of Poduri-Dealul Ghindaru, Bacau county (Fig. 1), has the following position: 45º28ʾ953ʾʾ North latitude and 26º30ʾ029ʾʾ East longitude, with an absolute altitude of 429 m. The *Tell* is situated on a fragment of the terrace of 30 m on the right bank of the Tazlau Sarat river and it currently has a surface of around 1.2 ha. The high level of complexity of the stratigraphy was emphasized in the 28 archaeological excavations campaigns that have taken place so far. Levels were reported belonging to the Precucuteni and Cucuteni Chalcolithic cultures and to the

Fig. 1. Map showing the location of Poduri-Dealul Ghindaru *tell* in Eastern Romania

Bronze Age (Monah *et al*. 2003:33-42). The animal remains studied in the present paper represent bone, antler, tooth and shell artefacts, belonging to phase *B* of the Cucuteni Culture, recovered from the archaeological excavations carried out in 2007-2008. The artefacts were dated by the archaeologists according to the pottery (Monah *et al.* 2007:274-275; Dumitroaia *et al*. 2008:230-231). The artefacts (represented by tools and jewels) belonged to cultural complexes, as well as to *tell*'s layers. The cultural complexes of Cucuteni phase B level, represented by six dwellings (L1-L6), two clay's platforms (4 and 5), and several pits (4-6 and 8-12) revealed archaeological and archaeozoological materials.

Refuse bone assemblage

Out of the total of 16,643 faunal remains, identified in the level Cucuteni B of tell of Poduri, 9159 faunal remains (representing 55%) had been specific identifiable. This could be related to trampling and weathering and to the relatively slow sedimentation rates at the site. Of the 9159 faunal remains, 9121 belonged to mammals, 38 to other systematic classes (5 fish bones, 18 skeletal fragments of birds, 13 exoskeleton fragments of molluscs). Of the 9121 faunal remains of mammals, 154 belonged to a ritual deposition of dog and 8967 were assigned to different assemblage of level B Cucuteni of studied tell. Of the 8967 faunal remains of mammals, 8030 were assigned to domestic mammals (representing almost 89,55%) and 934 to the wild ones (10,45%). As the preliminary study (Bejenaru *et al*. 2009:225), the studied sample revealed the prevalence of cattle (38,64%) and sheep/goat remains (33,76%), followed by pig (15,63%) within domestic mammals. In the level B Cucuteni of tell of Poduri, the prevalence of faunal remains of deer (*Cervus elaphus*) (43,35%), followed by those of wild boar (*Sus scrofa ferus*) (36,71%), roe deer (*Capreolus capreolus*) (10,71%) and aurochs (*Bos primigenius*) (representing 9,71%) were found within the wild mammals faunal remains.

We mention that the animal remains were recovered only "by hand", without sieving of the sediment, which may have caused the loss of some small pieces. The faunal analysis was done in the Laboratory of Archaeozoology, "Alexandru Ioan Cuza" University of Iasi. The study methodology was specific to archaeozoology, mainly consisting of anatomical, taxonomical and taphonomical identifications, encoding and quantification of data (Udrescu *et al*. 1999:44,145).

Raw material selection

In the level B Cucuteni of *tell* of Poduri, 8967 faunistic remains belonged to mammals, only 116 had been manufactured in tools or jewels. The frequency of the species that have been selected as source for raw materials is different to those recorded in the refuse bone assemblage (Table 1). Of these, 53 faunistic worked remains (representing 45,68%) belonged to domestic mammals: 25 being attributed to sheep/goat (*Ovis aries/Capra hircus*), 15 to the pig (*Sus scrofa domesticus*) and 13 to cattle (*Bos taurus*). The domestic mammal's long, short bones and teeth provided animal raw material in manufacturing household objects and jewels. In comparison with studied sample, in the level A Cucuteni of tell of Poduri was found a tooth of dog (*Canis familiaris*) worked as pendant.

Sixty three faunal remains of wild fauna (hunted or gathered), representing 54,32%, provided animal raw material represented by valve's shell, antlers, long and short bones, as well as teeth, which had been used only in manufacturing of tools. Of the 62 faunal remains of wild mammals, 36 belonged to deer, 16 to roe-deer, 9 were assigned to the wild boar and one to the aurochs. The invertebrates were represented by a shell's valve, used as pendant.

The analysed animal raw material belonged only to adult individuals of domestic and wild mammals. Depending to the prevalence of mammal's skeletal elements used in manufacturing tools or jewels, in the level B of the tell of Poduri was recorded that 60% were produced from long bones (mostly metapodials, tibias, femurs, phalanges, radius, ulnas) and few from short bones (14%), antlers (12%), teeth (10%), ribs (4%). Over 60% of mammal's skeletal elements, used in processing of household objects were found in the dwellings, clay's platforms and Cucuteni B layer of the tell of Poduri. Less than 40% could be found in pits.

Typology and functions

The typology, the functionality and the degree of useness of the manufactured animal raw material, characteristic Cucuteni Culture area had been established according to the prehistoric bone industry studies (Beldiman 2007: 75-157). The tools made of long and short bones, teeth and antlers revealed their multi-tasks in Chalcolithic community and displayed in many types in shape and function (Choyke 2005:134).

The domestic animal raw material, found in the level Cucuteni B of the tell of Poduri revealed the preponderance in processing of sharpen tools as

Fig. 2. Smoothers and scrapers on cattle ribs

Fig. 3. Bored centrotarsus of cattle

oblique and straight tips (8,62%), needles (0,86%), awls (1,72%), cutting blades (3,44%) were useful in perforating the slaughtered domestic animal's hides as well as in weaving and spinning. On the second place ranked the rounded tools made of skeletal elements of domestic mammals, were used in removing grease, wood- processing, grinding the pottery, We found with preponderance smoothers (10,34%), scrapers (3,44%), chisels (6,89%), handles and weight (0,82%). A few skeletal elements of domestic mammals were manufactured as ritual objects (1,72%) and pendants (3,44%).

Bos taurus. Of the 3465 skeletal elements of cattle, 13 (representing 0,37%) had been manufactured in tools and less in pendants. Long and short bones of cattle provided animal raw material in manufacturing rectangular plates, tips, chiesels, smoothers, weight, handles and pendants. Two ribs of the cattle were flattened on the cranial-caudal surfaces and used as rectangular plates. These pieces weren't polished on their ends. If in the level Cucuteni A of the tell Poduri, the cattle's animal raw material used in manufacturing smoothers had been reprezented by the astragali polished on the cranial-caudal surfaces the, in the level B Cucuteni, where were found three ribs flattened also on the cranial-caudal surfaces, as well as in synchronous sample in Hungary. The scrapers were manufactured from two proximal fragments of metatarsus and another two distal fragments of metacarpus, which had been split and then flattened on the cranial-caudal surfaces and on the medio-lateral surfaces (Fig. 2). Three chiesels had been worked in the level Cucuteni B of the tell of Poduri from the diaphysis of the long bones and the cranial elements (lower jaw) of cattle. Both diaphysal fragments of the cattle's femurs had been split in small parts. On one edge of each piece, on the cranial surface, these were rounded and flattened. The cattle's mandible (gonion fragment) had been polished on the vestibular and on the lingual surfaces. A centrotarsus of an adult individual of the cattle had been perforated complete and unpolished on the longitudinal ax. The piece could be used as a weight, being hanged on the fishing net (Fig. 3). This is the first archaezoological evidence of a tool used in fishing, in the Cucuteni phase B area.

Fig. 4. Pointed pieces on sheep/goat long bones

A handle had beend manufactured from a complete fused proximal phalanx of cattle, which had been imcomplete perforated on the cranial surface. The whole is a big, central, unpolished. A complete fused medium phalanx of an adult individual of cattle had been perforated on the caudal surface and then slightly polished. The whole is small and centrated. The piece had been used as pendant.

Ovis aries/Capra hircus. Of the 3029 faunal remains belonging to sheep/goat, only 25 (representing 0,82%) had been used in manufacturing in tools and less in ritual objects and pendants. The animal material raw had been represented by long and short bones. The skeletal elements were used mainly as smmothers, tips, chiesels, ritual objects and pendants. The tips made of long bones were found in the this sample. There were identified two types of tips: oblique and straight. A unique piece for Cucuteni phase B area was found in the tell of Poduri. The proximal fragment of a metacarpus belonging to sheep/goat had been double-worked. In the middle of the proximal epiphysis of the metacarpus was found a central and polished perforation. On the half of the diaphysis, this metacarpus had been oblique split (from the medio to lateral suface) and then rounded flattened. The piece could be used in spinning and weaving by chalcolithic communities. Of the eight long bones of sheep/goat, six were manufactured from proximal fragments of ulnas as awls; another two of radius as tips. These pieces were intensly used (Fig. 4). Two proximal fragments of radius of sheep/goat had been central perforated only on the cranial surface a smal. The whole was slightly polished. The pieces could be used within the ritual ceremonies (Fig. 5). In comparison with level A, in the level B Cucuteni of the tell of Poduri were identified more astragali (7) of sheep/goat flattened on the medio-lateral surfaces. These knucklebones could be used in games or related to ritual ceremonies of future's prediction (Fig. 6). The chiesels were manufactured from two diaphysis of tibia of sheep/goat, which had been flattened on the cranial and caudal surfaces. Used as a chiesels might have been the diaphysis of a humerus and a femur as well as a lower jaw, which had been slightly polished. A calcaneus of of sheep/goat had been complete and centraland complete perforated on the medio-lateral surfaces. The piece could be used as a pendant.

Fig. 5. Bored radius of sheep/goat

Sus domesticus. Of the 1402 skeletal elements belonging to pig in the level B Cucuteni of the tell of

Fig. 6. Polished astragals of sheep/goat

Poduri, 15 (representing 1,06%) had been manufactured in tools and less as pendants. The cranial elements (lower jaws and teeth), long and short bones of pig had been used as animal raw material used in manufacturing of the smoothers, chiesels, cutting blades, needles awls and pendants. Two astragali of pig were flattened on the medio-lateral surfaces. The pig's knucklebones could be used in games or in ritual ceremonies related to future's prediction. A diaphysal fragment of a tibia belonging to pig had been split on the caudal surface, then rounded and flattened from the cranial to caudal surface.The piece had been intensly used as a chiesel. Four diaphysal fragments of fibula belonging to mature individuals of pig had the cranial and caudal surfaces flattened. These pieces could be used as spatulas (Fig. 7). Five tusks belonging to mature individuals of pig had been manufactured as cutting blades. The teeth had been broken on the longitudinal ax and then flattened from their top to base (Fig. 8). If in level A Cucuteni of the tell of Poduri, a tooth was used as pendants, in the studied sample, two proximal phalanges of pig had been manufactured in jewels. The phalanges had been in the first third as well as in the middle of the caudal surface perforated.

The wild mammals material raw revealed the prevalence in manufacturing of sharpen tools as: soft-hammers, planters, tips, awls, needles, cutting blades, which were used in plat cultivation, perforating the wild animal's hides. Less faunal remains belonging to wild mammals were manufactured as chiesel, scrapers, smoothers and spatulas , used in wood-processing, removing grease. A pendant made of one phalanx of roe-deer had been discovered in level Cucuteni B of the studied *tell.*

Cervus elaphus. Of the 359 faunal remains of deer, only 36 were manufactured only in tools (representing 10,02%). As animal raw materials prehistoric community used antlers as well as long and short bones. Only the deer's antler provided raw material for 16 soft-hammers, 8 planters and one handle; in association with long and short bones, the antler had been used in achieving of 8 tips and scrapers, six smoothers and a chiesel. A handle had been manufactured from a fragment of a deer's beam. The external surface of the beam was pearled, only it's edges had been polished. The content of the beam was slightly emptied. The soft –hammers (16), identified in the level B Cucuteni of the tell of Poduri had been manufactured from the brow- tine, beam and crow-tine of the deer. There were identified eight soft-hammers made from brow-tines, another five from the beam, and one from the deer's crow-tine. Two of the eight soft- hammers made of brow-tines had been calcinated, burnt and chopped (Fig. 9:a-b). Almost all the soft-hammers had been perforated and intensly used. Eight bay-tines of deer were intensly used as planters. These pieces were broken away from the beam and then each piece flattened and rounded on the top and on it's base. The tips were made of the diaphysis of the metapodials, and deer's ulnae. A part of the beam had been cut on the longitudinal axis, then both edges intensly flattened in the V shape. The external surface of the beam hadn't been polished. The diaphysis of two metatarsi of the deer were split along the internanonial ridge and then flattened mainly on the medio-lateral and less on the cranial-caudal sufaces. The metapodials were intensly used as tips. Six diaphysal fragments of ulna of the red-deer had been split on their caudal faces and slightly flattened

Fig. 7. Artefacts from pig bones (astragal and fibulae)

Fig. 8. Split lower canines of wild boar

Fig. 9. Artefacts from red deer antlers (a. pointed ended tine; b. soft-hammer)

to their proximal ends. These left long bones might be considered waste material in manufacturing tips. Six astragali and two fragments of deer's beam were manufactured as smoothers. In the level Cucuteni B of the tell of Poduri, the deer's astragali were flattened on the medio-lateral surfaces. Many black-burnt and cut-marks on the deer's astragali revealed their useness as gaming pieces or in ritual ceremonies, in analogy with the deposit of cattle and deer astragali found in the level A Cucuteni of the same *tell* (Bejenaru *et al.* 2010). Both deer's beam had been in half broken and then flattened only on the internal part; the external part of the deer's beam had been kept pearled. Eight proximal and distal ends of the deer's metatarsi were manufactured as scrapers. The pieces were split along the intercanonial ridge and then flattened on the cranio-caudal as well as on medio-lateral surfaces. One proximal fragment of a metatarsus had been black-burnt and another distal had a cut-mark. A distal fragment of a deer's metacarpus had been flattened on the cranio-caudal and on the medio-lateral surfaces. The piece had been black-burnt marks and had been used as a chiesel.

Capreolus capreolus. Of the 89 skeletal elemens belonging to roe-deer in the level B Cucuteni of the tell of Poduri, 16 had been manufactured in tools and less as pendants. The animal raw material of roe-deer was represented by long (mostly ulna and metapodals) and short bones. Seven distal fragments of roe-deer's metapodials, had been split and then flattened on the cranio-caudal and on the lateral surfaces in obtaining the awls (Fig. 10)..Two fragments of meta-

Fig. 10. Perforating tools from roe deer metapodium

Fig. 11. Bored shell of the painter's mussel (*Unio pictorum*)

carpus (one distal and another proximal) of the roe-deer, which had been split on the cranial face and then the intercanonial ridge polished and widened, represented the animal raw material in manufacturing needles. Two proximal fragments of a metacarpus and a metatarsus, belonging to roe-deer had been in V shape flatened: the first on the cranial and the second on the caudal surface, in manufacturing the tips. Four proximal fragments of ulna belonging to roe-deer had been intensly flattened on the cranial-caudal surfaces and used as spatulas; one of them had the active part broken. In the level B Cucuteni of the tell of Poduri had been identified a medium phalanx of roe-deer, manufactured as pendant. The piece had been complete perforated on the medio-lateral surfaces.

Sus scrofa ferus. Of the 304 skeletal elements belonging to wild boar in the level B Cucuteni of the tell Poduri, nine had been worked (representing 2,96%) in tools. Boar's animal raw material used in manufacturing process was represented by long bone and tusks. The faunal remains of wild boar were monstly manufactured as cutting blades, needles, smoothers and spatulae. There four tusks of wild boar were manufactured as cutting blades. The pieces were broken on the longitudinal ax and then flattened from the root to their top. Also, there was found a right-side, lower incisor of wild boar used as needle. Their manufacturing process is opposite than that used in boar's tusks. A diaphysis and two proximal fragments of wild boar's ulna had been flattened on the cranial-caudal surfaces. These pieces could be used as smoothers. A distal fragment of a fibula of wild boar had been slightly flattened. The piece could be used as a spatula.

Bos primigenius. In the level B Cucuteni of the tell Poduri was identified a long bone worked of aurochs (representing 1,31%) of the total of 76 identified. An astragalus of had been smoothed on the cranial-caudal surfaces. The piece was intensly used as smoother.

Unio pictorum. In the studied sample, there were identified faunal remains assigned to invertebrates. A shell valve, mostly entire had a central perforation on the longitudinal ax. The piece could be used as pendant (Fig. 11).

Conclusions

The examination of the artefacts from Cucuteni *B* level of Poduri-Dealul Ghindaru *tell* reveals different stages of manufacture and shows a diversity of products obtained by simple and laborious manufacturing methods. Raw material selection in this studied assemblage follows practical considerations mainly relating to material strength, shape and size. The artefacts have been identified in different stages of manufacturing and they also have different wear levels.

The mammalian bones attest to the concern of Chalcolithic community to produce mostly tools, which were used in weaving, removing grease, wood processing, pottery finishing and plant cultivation. Phalanges and long bones of domestic and wild mammals as well as the exoskeleton shell's fragments were raw materials in manufacturing of jewels and ritual objects.

Table 1. Frequency of refuse remains compared with artefacts
(NISP=number of identified specimens, N tools = number of tools)

Taxon	Refuse assemblage		Artefacts (Tools)	
	NISP	%	N tools	%
Domestic mammals	**8030**	**89,55**	**53**	**45,68**
Cattle (*Bos taurus*)	3452	38,64	13	11,20
Sheep/Goat (*Ovis aries/Capra hircus*)	3004	33,76	25	21,55
Pig *(Sus domesticus*)	1389	15,63	15	12,93
Wild mammals	**934**	**10,42**	**62**	**44,32**
Red deer (*Cervus elaphus*)	323	4	36	31,03
Roe deer (*Capreolus capreolus*)	73	0,99	16	13,79
Wild boar (*Sus scrofa ferus*)	295	3,39	9	7,75
Aurochs (*Bos primigenius*)	75	0,84	1	0,86
Shell *(Unio pictorum)*	**7**	**0,02**	**1**	0,86
Total	**16527**	**100**	**116**	**100**

Acknowledgements

We wish to thank archaeologists Dr. Dan Monah (Archaeological Institute of Iasi) and Dr. Gheorghe Dumitroaia (International Centre of Cucuteni Culture Research, Piatra Neamt) for providing us with the animal remains they excavated and important data used in this study.

This study was supported by the Romanian research programs CNCSIS-BD 304/2008-2010, and CNCSIS - PN II Idei_2116/2008.

References

Bejenaru, L., C. Oleniuc and S. Stanc 2009. *A faunal assemblage from the Chalcolithic settlement of Poduri-Dealul Ghindaru (Bacau County). Preliminary data on subsistence patterns associated with Cucuteni-phase B level*, Analele stiintifice ale Universitatii “Alexandru Ioan Cuza’ din Iasi, Biologie animala LV, 223-8.

Bejenaru, L., D. Monah and G. Bodi 2010. *A deposit of astragali at the Copper Age tell of Poduri-Dealul Ghindaru, Romania*, Antiquity, Project Gallery, 084/323, http://www.antiquity.ac.uk/projgall/bejenaru323/

Dumitroaia, Gh., R. Munteanu, C. Preoteasa, D. Garvăn, L. Uță, D. Nicola and D. Monah 2008. *Poduri, com. Poduri, jud. Bacău. Punct: Dealul Ghindaru*, *Cronica Cercetărilor Arheologice din România. Campania 2006*, 230-231.

Mantu, C.M. 1998. *Cultura Cucuteni: evoluție, cronologie, legături*, Piatra Neamt: Editura Constantin Matasa.

Monah, D. and St. Cucoş 1985. *Aşezările culturii Cucuteni din Romania*, Iaşi: Editura Junimea.

Monah, D., Gh. Dumitroaia, F. Monah, C. Preuteasa, R. Munteanu and D. Nicola 2003. *Poduri-Dealul Ghindaru. O troie in Subcarpatii Moldovei*, Piatra-Neamt: Editura Constantin Matasa.

Monah, D., Gh. Dumitroaia, R. Munteanu, C. Preoteasa, D. Garvăn, L. Uță and D. Nicola 2007. *Poduri, com. Poduri, jud. Bacău. Punct: Dealul Ghindaru*, *Cronica Cercetărilor Arheologice din România. Campania 2006*, 274-275.

Udrescu, M., L. Bejenaru and C. Hriscu 1999. *Introducere in arheozoologie*, Iasi: Editura Corson.

Manuel Altamirano García

Bone industry from the Bronze Age in Central Iberia. The Settlement of La Motilla Del Azuer

A total of 331 worked bone items, dating to the Bronze Age (2200-1350 cal. BC), have been recovered from the archaeological site of *La Motilla del Azuer* (Daimiel, Spain), where several archaeological seasons were undertaken between 1974 and 1986, were restarted in 2000 and are still in progress.

In this paper, we aim to organize and study the worked bone items establishing a typology that takes into account morphological and morphometrical criteria, as well as the raw material from which bone tools were made. An anatomical study has also been carried out, in which sheep or goat tibia and metapodia and pig fibula predominated, mainly for use as points. A wider variety of bones has been noted among the ornament types, such as bird bones for tubular beads or pendants made from wild boar tusk. Ivory is also used to make V-perforated buttons and bracelets.

Key words: recent prehistory, Bronze Age, Iberian Peninsula, Motilla del Azuer, worked bone

I. The archaeological site of La Motilla Del Azuer

The Bronze Age site of La Mancha (2200-1350 cal. BC) – an area located in central Spain – is characterized by two types of settlements: those located on high hills with fortifications and natural protection, and others known as *motillas*. The *motillas* are artificial mounds (4-10 m in height) produced by the destruction of concentric lines of fortification and located in low areas or river basins. They are distributed regularly every 4-5 km and are related to the management and control of different economic resources (Nájera 1984; Nájera, Molina 2004a).

All the bones discussed in the present article originate from the Bronze Age settlement of *La Motilla del Azuer,* a site located near the city of Daimiel (Ciudad Real)[1]. The Department of Prehistory and Archaeology of the University of Granada began systematic excavations in 1974, followed by fourteen archeological seasons of excavation and restoration which still continue today. Thanks to this fieldwork, it can be stated that the fortified settlement had a complex system of fortification with a central tower surrounded by several lines of walls (Fig. 1). There is evidence of a small settlement and its necropolis surrounding the fortification (Nájera, Molina 2004b).

The fortification is 40 m in diameter and is divided into three main areas (Fig. 2): a central quadrangular stone tower with 7 m high walls; a big open area or court (patio), trapezoidal in form (inside which there

[1] This research has been carried out within the framework of the Investigation Project HUM2006-11296/HIST of the Spanish Ministry for Education and Culture. We would like to thank the Consejería de Cultura de la Junta de Comunidades de Castilla-La Mancha for financing the field and laboratory work carried out at La Motilla del Azuer. The present study is the result of a final research project for a Master in "Archaeology and Territory" of the Department of Prehistory and Archaeology of the University of Granada (Spain).

Fig. 1. The archaeological site of La Motilla del Azuer (Dept. of Prehistory and Archaeology. Univ. of Granada / M.A. Blanco)

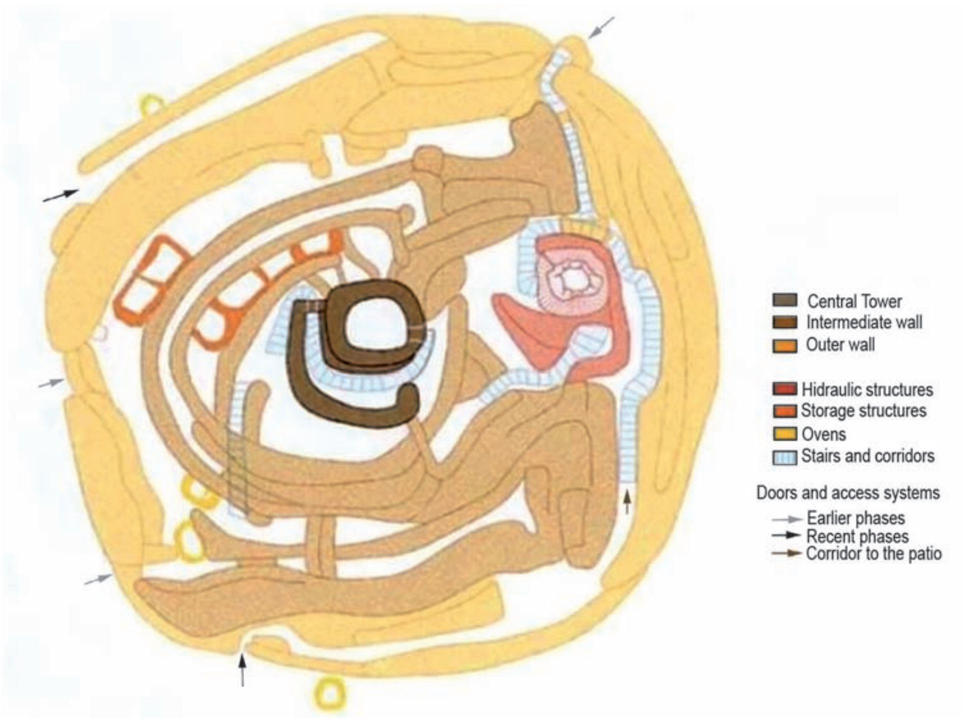


Fig. 2. Different areas and structures of the fortified settlement of La Motilla del Azuer (Dept. of Prehistory and Archaeology. Univ. of Granada)

is a well to obtain underground water, which is 16 m deep); and finally, two concentric spaces separated by a wall with an inner and an outer part. The inner part has been used for different purposes which have changed over time, such as a pen for animals and for storing cereals. In the outer part several ovens and rectangular store pits for cereals have been discovered (Molina *et al.* 2005).

The settlement area is located around the fortification, with a number of areas to carry out different activities as well as oval and rectangular dwellings with stone foundations and organic walls (wood and mud). The necropolis is located within the settlement area which was the common pattern in the Bronze Age on the Iberian Peninsula. The funerary ritual consisted of inhumation (Fig. 3), with the bodies being placed in a flexed position inside pits, sometimes covered with stonework or slabs, which appear either near dwellings walls or next to the outer line of fortification. Children were buried in either pits or pottery vessels. Funerary goods were usually poor and scarce (Nájera *et al*. 2006:151).

Fig. 3. Adult burial (Dept. of Prehistory and Archaeology. Univ. of Granada)

II. The worked bone

Throughout the systematic excavations carried out on the archaeological site of La Motilla del Azuer between 1974-1986 and 2000-2005, a total of 283 objects made from hard animal tissues have been documented. This worked bone collection is analysed in the present paper. A single item discovered in 2008 has also been included to complete the typology.

a) raw material analysis

A predominance of bone used as a raw material for manufacturing objects has been observed, followed a long way behind by deer antler, ovicaprid (sheep/goat) and cattle horns, mollusc shells, and, finally, ivory.

Animal species identification has been a complex task. This is because a large percentage of tools were substantially modified during the manufacturing process and subsequent use (Fig. 4). In addition a large number of elements have not been optimally preserved - they are heavily fragmented or altered by the action of postdepositional processes.

It has been possible however to identify a total of 92 artefacts, amongst which we have observed a predominance of domestic rather than wild animals This predominance is associated with the abundant presence of livestock, as reflected by faunal studies (Driesch, Boessneck 1980).

Anatomical study has allowed us to identify the type of bone from which the tools were manufactured (Fig. 5) with a success rate of 51%. Most items documented in the excavation between 1974 and 1986 had already been identified in previous stud-

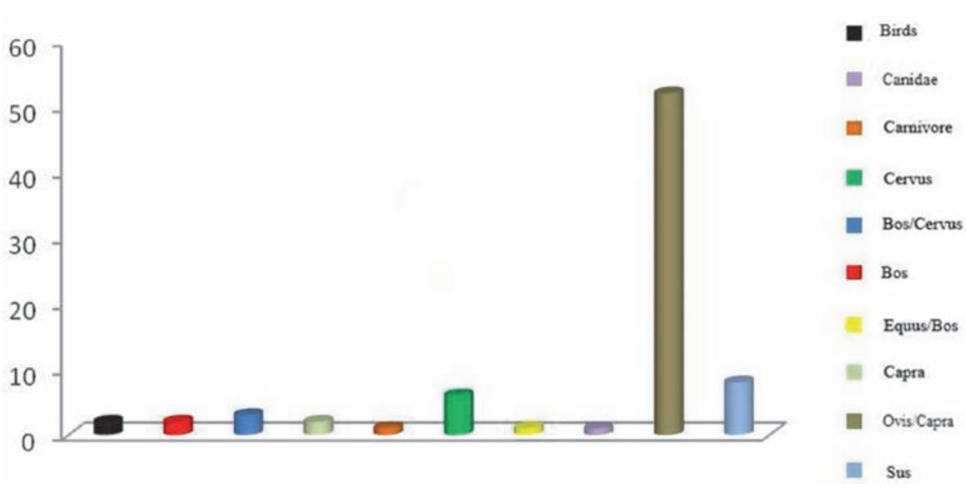


Fig. 4. Animal species identification

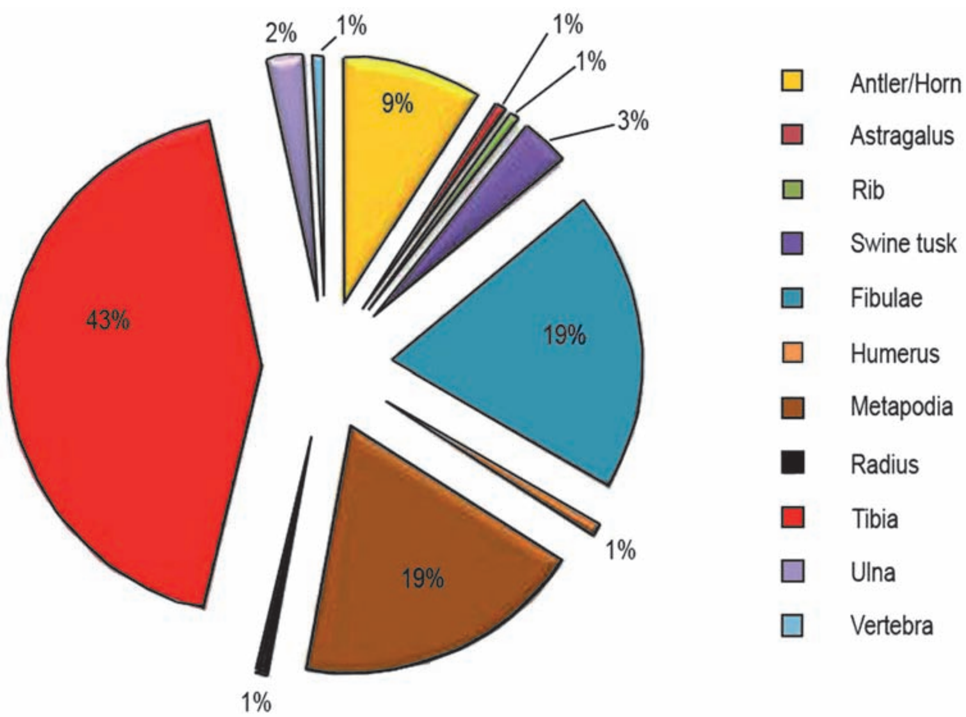


Fig. 5. Bone identification

ies to this work (Driesch, Boessneck 1980). There is a remarkable predominance of long bones from which the bone elements have been manufactured, especially for development of medium and large size artefacts.

Ovicaprid skeletons are undoubtedly the most important for manufacturing a large number of objects, especially the bones from their limbs, such as the tibia, metapodia (metacarpals and metatarsals), radius, fibula and ulna, which have the right length and hardness to make resistant artefacts. Goat horn-cores (*Capra hircus*) also show cut marks and their proximal part is faceted so that they could be prepared for a particular function, perhaps for use as handles.

The use of deer antlers (*Cervus elaphus*) is also relatively common in the manufacture of short compact points, and these were very frequently, chosen for the manufacture of arrowheads. Swine fibulae (*Sus domesticus/Sus scrofa*) is another bone that was used systematically to manufacture awls with very specific morphological features, preserving the proximal epiphysis and a flat distal section. The use of wild boar tusks (*Sus scrofa*) has also been observed for the production of ornaments such as pendants.

As regards the other species documented, there are isolated elements which did not appear with significant frequency within the studied group - some of them have special features. Two artefacts of interest were a very stylized pointed item from a dog fibula (*Canis familiaris*) found in a funerary context, and a fibula of an undetermined carnivorous animal whose function could have been needle-related.

b) the typological study

The typological study has been organized taking into account morphological and functional criteria for ornaments only. Some aspects related to the raw material have also been taken into account as there is a clear relationship between the desired tool and the bone chosen to obtain it.

The result is the establishment of two groups, tools and ornaments. These are divided into subgroups, types and subtypes. The subgroups are organized, in turn, according to the morphology of the active or distal end: pointed and bevelled edges. Within these subgroups we have identified a number of types that obey morphological criteria, in which several subtypes have been distinguished taking into consideration the kind of bone from which they have been manufactured.

The typology is reflected in the following outline:

I) TOOLS
- I.1. POINTS:
  - I.1.1. Epiphyseal base: *Tibia*; *Metapodia; Fibula*; *Ulna.*
  - I.1.2. Non-epiphyseal base: *Splinter*; *Shaft.*
  - I.1.3. Bipoints.
  - I.1.4. Arrowheads.
  - I.1.5. Undetermined.

I.2. BEVELLED
I.2.1. Double Bevelled.
I.3. UNDETERMINED
II) ORNAMENTS
II.1. BEADS
II.1.1. Discoidal.
II.1.2. Tubular.
II.2. PENDANTS
II.2.1. Wild boar tusk.
II.2.2. Perforated plate.
II.2.3. Decorated.
II.3. BUTTONS
II.3.1. V-Perforated.
II.4. BRACELETS
II.5. SEPARATORS
III) OTHERS
III.1 FRAGMENTS

c) bone artefacts: description and technological aspects

Tools:

Points make up the most abundant group. It includes all the bone elements whose main feature is having one pointed active end. It is possible to differentiate between those with a proximal end that retains the natural bone epiphysis, and those in which the proximal end has been completely modified.

Epiphyseal-base points (I.1.1), are defined as such because they preserve the natural bone epiphysis completely or with only slight modifications (López Padilla 1992:14). Other scholars have dubbed them “pointe à epiphyse” (Voruz 1982), “punzón de base articular” (Rodanés 1987), or “poinçon pris sur os ayant conservé une epiphyse entière” (Camps-Fabrer *et al.* 1990).

Within this group we have been able to make a clear division between those which have been made from bones with a medullary cavity, tibia and metapodia, and those without a medullary cavity, fibula and ulna.

The first category is characterized by the presence of a very marked medullary canal, with perpendicular and oblique traces to the longitudinal axis of the object. This indicated a manufacturing process which involved sawing the bone longitudinally (tibia of ovicaprids generally), creating a bevel, then smoothing the medullary cavity edges to make them uniform and providing a sharpened distal end (Fig. 6:1,2).

Metapodia, however, receive two different treatments. An oblique cut on the distal end was made to obtain a bevel that was fashioned by abrasion to create a pointed end (Fig. 6:3). Alternatively, a longitudinal groove was created along the bone shaft providing two halves with the corresponding half of epiphysis (Fig. 8:3). Only one item has been manufactured on a radius, using direct percussion to fracture the bone and remove one of the epiphysis (Fig. 8:4).

Except for two items, most pointed tools did not receive an overly careful treatment to their surface, with a polish that in some cases surpasses the metaphysis of the bones, affecting the lower side of the epiphysis (condyles), which can be observed in two cases, D-16.379 and D-4.650 (Fig. 8:1,2). This one (D-4.650) has a smooth, shiny and highly polished surface, though it has been affected by postdepositional processes, it is the only case in which treatment shows a clear polish, having eliminated the macroscopic traces of manufacture.

On the other hand, epiphyseal-base items manufactured with bones without a medullary cavity: fibula and ulna, most swine bones (domestic or wild) and some from ovicaprids (sheep/goat). The first group of tools (fibula) has a very characteristic morphology, preserving the natural proximal epiphysis and eliminating the distal one -which receives fine grain abrasion to achieve a sharp edge with a circular section. (Fig. 6:5, 8:6). It is possible to observe a general polish in the distal-mesial and distal parts of all these types of tools, together with many longitudinal traces on both top and bottom faces that could be directly related to the specific function that was given to them. However, there is one case of a fibula which, in contrast with previous ones, preserves the natural distal epiphysis, showing the sharpest end in the proximun.

Within this group, we must point out two pieces whose formal features make them special. First, an object manufactured from a dog fibula (D-10.113; Fig. 8:5) – extremely thin and elongated, whose dimensions are 102 mm in length, 3 mm wide and 2 mm thick. This object has a finish which has been completed with care, with the added interesting fact of having been documented in a funerary context (grave 1). Its formal attributes suggest a kind of element whose function could be clothing-related, such as a pin, but we can not test this hypothesis until use-wear analysis and contextual studies have been carried out in depth in future work.

The other element (D-10.245), manufactured from the fibula of a carnivore, has much smaller dimensions, a length of 48 mm, 1 mm wide and 0.4 mm thick. Its morphology resembles that of a pin or needle used in textile work, which should also be contrasted with use-wear analysis and experimentation. The head is not marked and does not present any evidence of drilling, having eliminated almost

Fig. 6. 1: transversal marks produced by the longitudinal sawing of a sheep tibia; 2, 3: epiphyseal base points made from sheep tibia and metapodia; 4, 5: epiphyseal base points made from ulna and fibula

entirely the natural form of bone used as the raw material (Fig. 8:7).

Three pointed items have been made from ulna, using very similar manufacturing processes. It is relatively easy to obtain one pointed end with this type of bone due to their natural morphology, provided they are from skeletons of young specimens whose bone has not yet fused with the radius. The natural proximal end is normally preserved, removing the distal end and wearing down the surface to obtain a short point, which is highly resistant thanks to the bone´s compactness (Fig. 6:4).

The next group is composed of those pointed elements without an epiphyseal base (I.1.2). In this group it is possible to distinguish two types. In the first group bone splinters are the most abundant and

Fig. 7. 1: point artefact made from a bone splinter; 2: bipoint; 3: arrowhead; 4: pendant made from wild boar tusk; 5: bevelled artefact: a) upper face, b) lateral view; 6: tubular bead

are morphologically defined as a narrow, irregular portion of long bone shaft that has not been modified but has been worn down on one of the ends forming a tip, while there is no evidence of any modification to the rest of the tool. In some cases, traces of the medullary canal and many edges which provide the bone with a totally irregular profile have been observed (Fig. 7:1). Their dimensions are more or less constant, with a maximum length of between 40-70 mm, a maximum width of 3-10 mm and a maximum thickness of 1-3 mm.

In the second group a type also lacking an epiphyseal base makes up a set, very small in number but with an impeccable finish. They are compact portions of long bone shaft whose surface has been smoothed carefully by fine grain abrasion so they become polished and have the desired shape. Very resistant items are created using this method. Unlike splinters, their shape has been carefully formed with a flat or slightly circular base at the proximal end, and a square section around the stem except for the distal part, which tends to be circular (Fig. 8:8).

Continuing with pointed objects, we now turn to analyse bipoints (I.1.3), a really interesting category, of which there are nine examples. In the typological specifications developed by French studies (Camps-Fabrer *et al.* 1990), these kinds of picks are defined (type 15) as a device whose surface is completely or partially treated, with both ends pointed can be symmetrical or asymmetrical in shape.

As the name bipoints suggests, they have a morphology in which both the distal and the proximal ends (if in this case we can use this distinction), are sharp and fairly regular. They have a plane or plane-

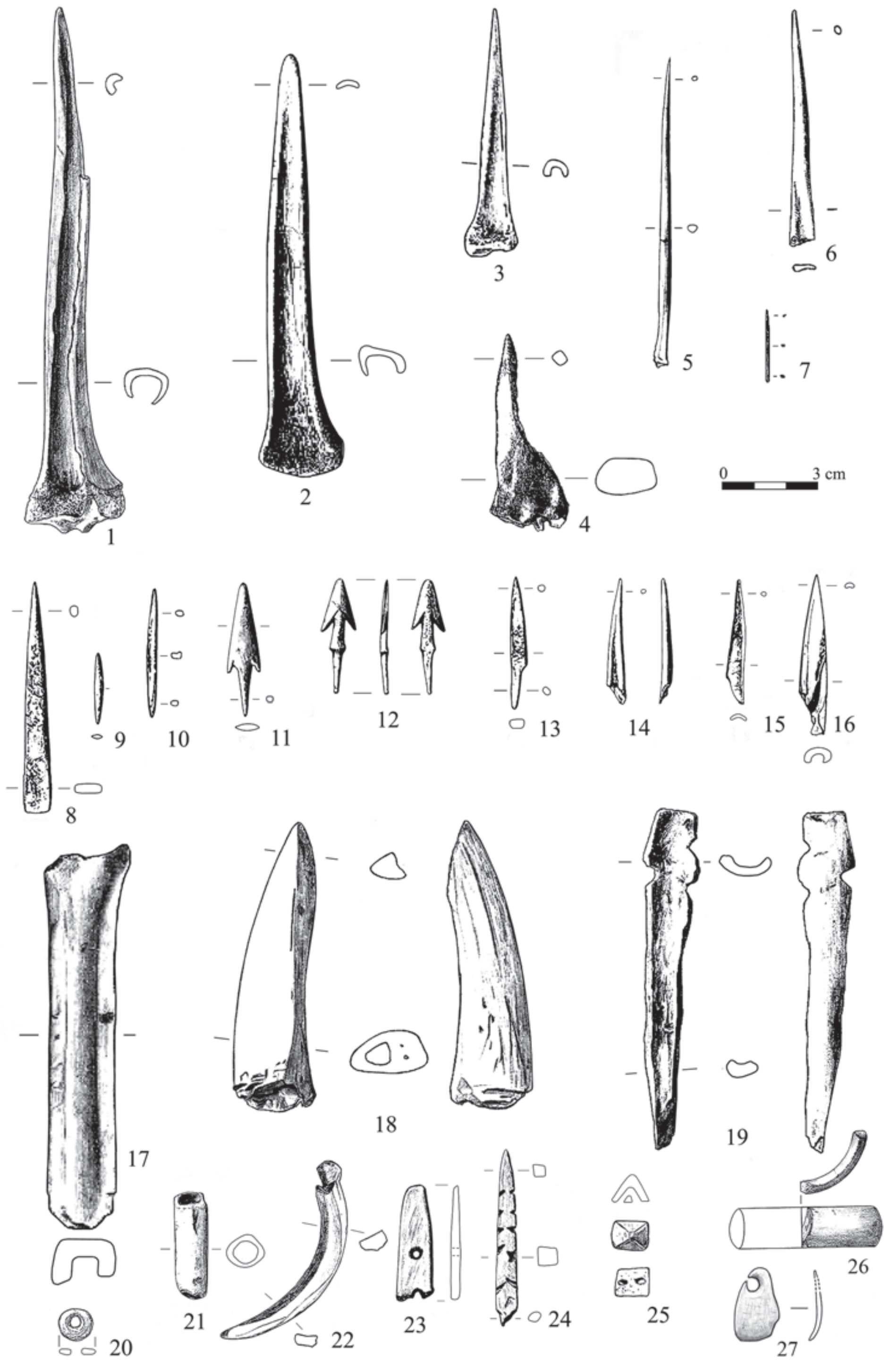


Fig. 8.
1-7: pointed artifacts I;
8-16: pointed artifacts II;
17-19: undetermined artefacts;
20-27: ornaments

convex section on both sides, although on some of them there is slight proof of the medullary canal that gives a concave section on the inner face. With regards to their size, they range from 63-75 mm in length, with a width of between 5-6 mm and a thickness of between 3-5 mm (Fig. 7:2; 8:9; 8:10).

We can observe a very careful treatment of their surfaces, which, together with marks on some of them on their mesial part, could be related to personal use, perhaps as hair or clothing pins, although this must be verified with use-wear studies.

Arrowheads (I.1.4) are undoubtedly very striking and beautiful type of artefacts, whose manufacture using bone as a raw material is a phenomenon that, while it has been present in previous stages, definitely seems to be of great importance within Bronze Age societies on the Iberian Peninsula. Registered in ever greater numbers on archaeological sites, they have a formal diversity much higher than metal arrowheads (Fernández 1998:169; López Padilla 2001:253).

In the development of the archaeological seasons at La Motilla del Azuer, a total of five completed arrowheads have been recorded four of which are unfinished. Five new arrowheads have been documented between 2006 and 2009, but they will be studied in future work.

The main problem we had when studying these elements has been the fact that some of these are located in the Archaeological Museum of Ciudad Real (D-10.120 and D-30.015, documented in the excavation campaigns of 1976 and 1981, respectively), so they have only been studied through drawings and photographs. One of these objects (D-10.120: Fig. 8:11) shows a morphology that is defined by a triangular shaped blade with two barbs and stem (tang), but it is not possible to say more, for now, about the treatment of their surfaces, the raw material or the manufacturing process. Moreover, there is another arrowhead (D-34.199) that is unfinished and that seems to be of a different type to that described above, but unfortunately it is fractured.

Five other arrowheads were discovered between 2000 and 2005 - three of these are unfinished. These are elements with two barbs skillfully manufactured from bone or deer antler (Fig. 7:3, 8:12, 8:13). We find good parallels in others *motillas* in the eastern area of La Mancha (Peñuela I), and the more eastern settlements of Argar Culture (Cabezo Redondo) (Najera *et al.* 1979:36).

To finish with the pointed objects group, a total of sixty-one pieces originally belonging to different types of devices have been grouped together. They were defined as indeterminate points (I.1.5), distal and distal-mesial portions whose common characteristic is having a sharpened end and a proximal fracture that does not allow them to be included in any of the types defined above (Fig. 8:14-16).

Only one object has been able to be defined as part of this subgroup of bevelled elements (I.2). This is a fragment of antler (D-25.019-2), possibly deer, whose active end has been bevelled on both sides, providing a double bevelled edge (Billamboz 1977), with a straight or perpendicular edge to the tool axis for use as a chisel (Salvatierra 1982:154). Its upper and lower face has been treated very sparingly by means of abrasion, while we can observe the spongy tissue on both right and left sides (Fig. 7:5a,b).

The last group within all the tools (I.3) is composed of all those bone elements whose special morphology does not fit into any of the parameters that define the types outlined above, and in the absence of use-wear studies we have not assigned them for the time being (Fig. 8:17-19). There are eighteen pieces in total, such as a cattle horncores, with several traces and cuts at its base, a goat horncores, which has a blunt tip and transverse traces on its base, a vertebra with some cuts and strong thermal alteration, and an astragalus with a central perforation.

Ornaments:

The key feature that separates this group from tools, apart from its morphological features, is that none of them is directly involved in the production process of other goods, leading many researchers to define them as non-productive elements (López Padilla 2001), except that they can be traded. Moreover, their main function is that of personal ornaments, to be displayed, being in some cases authentic elements of prestige, and can be worn continuously without being held, although some exceptions could be made (Pascual Benito 1993:87; Salvatierra 1980:44). They are, therefore, items created with an utilitarian end being symbolic in nature and for personal use, intended primarily to maintain and reproduce the ideology of a particular group (Barciela 2004:559).

Firstly, the beads documented in the Motilla del Azuer can be divided into two very distinct types, both in terms of morphology and of the raw material used for their production: discoidal and tubular.

We have documented a total of twelve discoidal beads (II.1.1) and, as their name implies, they are disc-shaped and are made from shell, possibly from bivalve molluscs which have not been identified at the present time. Their diameter does not exceed 15 mm in any case, and they have a perforation that in many cases is slightly off the central axis of the piece (Fig. 8:20).

Secondly, we find a group of nine tubular beads (II.1.2) of different sizes and whose diameter varies with the size of the bone used for their manufacture (Fig. 7:6; 8:21). These tubular beads are manufactured through cutting transversally the diaphysis of long bones, possibly metapodia, emptying the medullary canal and polishing the bead edges with a fine-grained abrasive. At least one specimen was manufactured using a bird bone, with extremely thin cortical walls and whose diaphysis is naturally hollow. On the other hand, items to be highlighted are a tubular bead made not from bone but from shell, the tubular shell of *dentalium*, a marine scaphopod mollusc, having been used in this case.

Pendants are defined as those elements which can be considered as personal ornaments that can be adapted to allow them to be suspended using a leather cord or vegetable fibre, with a perforation or a marked head. First, we found three wild boar tusks (*Sus scrofa*) that received different finish in their manufacture (II.2.1). On one of them (Fig.7:4; 8:22) the outer surface has been polished and some longitudinal cuts have been made on the inner surface, creating a sort of enlarged or marked head on the tusk´s natural proximal extremity to allow it to be used as a pendant. This object was documented during the excavation process together with another wild boar tusk, but this one does not seem to have been modified.

The other two tusks were also found together on the site and there is no evidence of cutting or polishing of the surface of their faces, although some notches with a deep V-profile can be observed on the distal end in order to attach some kind of string to suspend it.

Moreover, there is a small piece of shell (II.2.2), perhaps marine given its morphological characteristics, with a perforation near the edge made with the rotational movement of a sharp object from the outside toward the inside (Fig. 8:27).

Second, the only decorated element (II.2.3), has a pointed end and a square section, with deep incisions and oblique angles on all sides (Fig. 8:24). The proximal end, however, shows a section that tends to be circular and, although it is fragmented, might have been a kind of marked head to allow its use as a pendant. However, due to this fragmentation of the proximal end, it could be any other type of personal ornament, which could only be determined more accurately with use-wear analyses.

During the excavation season in summer 2008, the only V-perforated button that has been discovered in La Motilla del Azuer was documented in area 5, and was recovered by flotation of the sediment (Fig. 8:25). It is a small piece of ivory whose manufacturing process is similar to that observed in other V-perforated buttons (II.3.1) with similar chronologies, cutting/sawing a piece of ivory which was later scraped to obtain the desired shape, then polished with fine grain to obtain a smooth and shiny surface, and at whose base two conical section perforations of a millimetre in diameter were made (Mérida 1997:8). According to different typological studies about V-perforated buttons (Fonseca 1988; Uscatescu 1992), it would correspond to the prismatic type with rectangular base. Its dimensions are 11 mm for its longest side and 8 mm for the shortest, with a height of 8 mm, showing a worn vertex whether due to the manufacturing process or because of constant rubbing which it has suffered while it was in use. This button has been preserved very well, with no apparent signs of exfoliation or other postdepositional alterations, besides being able to observe the nutrient foramen in both its base and top.

Continuing with ivory, two more fragments have been documented, surely belonging to bracelets (II.4). One of them is exhibited at the Archaeological Museum of Ciudad Real, and it is a fragment (D-15.063) of an ivory bracelet, with a wide semilenticular section and a diameter of about 6 cm (Fig. 8:26). The other object is probably another piece of bracelet, with a wide flat section from a slice of ivory, as it clearly shows the grid that can be observed on its surface.

Only a single piece of bone has been defined as a separator (II.5), an object whose function would have been to separate the threads that held the beads on the various necklace threads (Carrasco *et al.* 2009:10). It is a fragmented piece 44 mm in length and 12 mm wide of a flat and slightly curved section of bone, and whose end has a rounded shape. Its upper surface tends to be convex, with plenty of oblique traces resulting from a fine grain abrasive, while the lower surface has a slightly concave morphology. Two circular perforations of 4 mm in diameter were made during the manufacturing process (Fig. 8:23).

Finally, items defined as “others” (III), a group in which we have included all the elements that in the absence of a distal and/or proximal end, we are not able to assign them to any group or particular type (fragments). They belong to a set of seventy-eight pieces. These fragments, mostly mesial-parts, show in many cases the presence of the medullary canal, possibly indicating cutting a long bone longitudinally. In this group, other skeletal remains which have been notably damaged by different postdepositional processes have also been included.

III. Conclusions

1. There is a general pattern that can be observed in the manufacture of the objects which reflects the intention of investing the minimum possible amount of work to obtain the final product, as in other contexts of the same chronology (López Padilla 1992, 1994, 2001; Fonseca 1985, 1988). This is a significant aspect for most of the items documented on La Motilla del Azuer, where a large percentage of the bone tools have only undergone minimal transformation from the original bone, which retains some of its distinctive anatomical features (diaphysis, medullary canal, condyles, epiphysis etc.).

2. On the other hand, there is another group of bone objects which are completely different to the group described above. These are characterized by the importance of investing time in their manufacture, with a fine polish and a good finish for both their

shape and surfaces. Perhaps a more personal usage of these objects emerges from this observation, mostly in the case of ornaments, except for the arrowheads and some other tools defined as non-epiphyseal base points. In general, these objects have a finish which has been obtained very carefully, changing significantly the natural morphology of the selected bone to obtain the desired shape and polishing the surfaces with fine grain to remove all traces of manufacture and to achieve a very smooth surface.

3. The animal species that have been identified in their use for the manufacture of the artefacts show there is a existence of a close relationship with species documented in the faunal analysis (Driesch, Boessneck 1980). This analysis showed that a large percentage of domestic species belonged to the livestock of the settlement – where animal husbandry also constituted an important basis for subsistence. The most common bones selected to manufacture tools were usually those belonging to domestic animals such as sheep, goats and pigs, and - in much smaller quantity – the raw material provided by wildlife such as deer, wild boar and birds.

4. There is a clear relationship between the type of tool and the type of bone from which it was made, given that the same manufacturing processes were observed for the same type of bone. This could lead us to consider standardisation, at least for some of the types of tools that have been defined. The selection of those bones from front or rear limbs is striking, especially sheep/goat tibia and metapodia and swine fibula, bones which were systematically used to manufacture most of the artefacts.

5. Evidence of the use of elephant ivory is widely found since times before the beginning of the Bronze Age (Pascual Benito 1993, 1995), appearing as a raw material for the first time in Chalcolithic contexts and increasing its presence with the Campaniforme (the Bell Beaker). It has been documented in contexts of the second millennium BC in the Iberian Peninsula, with an important increase in its demand as the archaeological record shows, such as the slices of ivory found in some archaeological sites (Fonseca 1985; López Padilla 2001). The use of ivory and its relative abundance in these contexts reveals the existence of trade with the Argaric area (South East of Iberia), where the ivory from North Africa would arrive (Molina *et al.* 1979; Nájera 1984; Najera *et al.* 1981). However, recent research raises the possibility of an influx of Asian ivory via the Mediterranean Sea, as was proposed at the 'Elephant Ivory in the Iberian Peninsula and the Mediterranean Congress' (held in Alicante in November 2008). However, Bronze Age ivory documented in the region of La Mancha mostly belongs to African elephants (*Loxodonta africana*) as indicated by the analysis that has been carried out.

6. Technological processes have not been addressed in depth in this article. The manufacturing process of some of the typological groups has been determined through the use-wear analyses. Thus, it was found that the epiphyseal base points made from sheep tibia have deep oblique marks over the diaphysis of the bone, made by sawing or cutting longitudinally the diaphysis, although in most cases these traces have been removed using coarse and fine grain abrasives. Another technological procedure that has been documented is the transversal cut of the diaphysis of long bones, usually metapodia (metacarpals or metatarsals), softening the edges through abrasion and eliminating the spongy bone so that it is hollow to make tubular beads. Flexion and percussion could have been used in the manufacture of some tools, specifically for epiphyseal base points made from swine fibula and ulna, retaining only the distal epiphysis (fibula) or the proximal epiphysis (ulna), eliminating the other epiphysis by one of the two previous procedures and employing abrasives to obtain the point. Finally, perforation has been clearly observed in discoidal beads made from mollusc shells.

7. Finally, we should mention that all the worked bones documented on the archaeological site of La Motilla del Azuer, are closely related - in shape, technology and the raw material employed in their manufacture -to other bone artifacts from Bronze Age contexts in the regions of La Mancha and Levante (Fonseca 1985; López Padilla 1992, 1998) and also the Argaric area (although the number of bone artefacts here is usually smaller).

References

Barciela, V. 2004. *Los elementos de adorno sobre soporte malacológico del Cerro del Cuchillo: una aproximación tecnológica*, In: Hernández Alcaráz, L. and Hernández Pérez, M. (eds.) *En Tierras valencianas y zonas limítrofes,* Ayuntamiento de Villena: Instituto alicantino de Cultura Juan Gil-Albert, 559-65.

Billamboz, A. 1977. *Industrie du bois de cerf en Franche-Compté au Néolithique et au debut de l´Age du Bronze,* Gallia Préhistorie 20(1), 93-176.

Camps-Fabrer, H., D. Ramseyer and D. Stordeur 1990. *Poinçons, pointes, poignards et aiguilles*, In: H. Camps-Fabrer (ed.) *Fiches typologiques de l´industrie osseuse* *prehistorique, Cahier III*, Université de Provence: Aix-en-Provence.

Carrasco Rus, J., J.A. Pachón Romero and J. Gámiz Jiménez 2009. *Los separadores de hileras de collar en la prehistoria peninsular. Un estudio crítico*, Antiqvitas 21, 5-70.

Driesch, A. von den and J. Boessneck 1980. *Die Motillas von Azuer und Los Palacios (Prov. Ciudad Real). Untersuchung der Tierknochenfunde*, Studien über frühe Tierknochenfunde von der Iberischen Halbinsel 7, 84-121.

Fernández, C. 1998. *Las puntas de flecha de hueso en la Prehistoria Reciente del País Vasco y Navarra, dentro del contexto pirenaico y peninsular*, In: *En el final de la Prehistoria: ocho estudios sobre protohistoria de Cantabria. Actas de la II Reunión sobre Arte Esquemático Abstracto. Santander, diciembre de 1996*, Santander, 157-82.

Fonseca Ferrandis, R. 1985. *Utillaje y objetos de adorno óseos del Bronce de La Mancha*, Cuadernos de Prehistoria y Arqueología 11-12 (1984-1985), 47-55.

Fonseca Ferrandis, R. 1988. *Botones de marfil de perforación en "V" del Cerro de la Encantada (Granátula de Calatrava, Ciudad Real)*, In: *Actas del I Congreso de Historia de Castilla-La Mancha, vol. III. Pueblos y culturas prehistóricas y protohistóricas* 2, 161-8.

López Padilla, J.A. 1992. *A propósito de algunos objetos de hueso y marfil de la Mola d´Agres (Agres, Alicante)*, Alberri: Quaderns d'investigacio del centre d'estudis contestants 5, 9-26.

López Padilla, J.A.1994. Industria ósea, In: M.S. Hernández, J.L. Simón and J.A. López (eds.) Agua y Poder. El Cerro del Cuchillo (Almansa, Albacete), Patrimonio Histórico-Arqueología Castilla-La Mancha 9, Toledo, 176-84.

López Padilla, J.A. 1998. *La industria ósea*, In: Mª Jesús de Pedro Michó (ed.) *La Lloma de Betxí (Paterna, Valencia). Un poblado de la Edad del Bronce*, Alicante: Diputación Provincial de Alicante, 223-7.

López Padilla, J.A. 2001. *El trabajo del hueso, asta y marfil*, In: *Y acumularon tesoros. Mil años de Historia en nuestras tierras: Valencia, Murcia, Castellón, Alicante, Barcelona*, Caja de Ahorros del Mediterráneo, Alicante, 247-57.

Mérida González, V. 1997. *Manufacturing process of V-Perforated ivory buttons*, In: L. A. Hannus, L. Rossum and R.P. Winham (ed.) *Proceedings of the 1993 Bone Modification Conference, Hot Springs, South Dakota*, Archeology Laboratory, Augustana College, Occasional Publication 1, 1-11.

Molina, F., T. Nájera and P. Aguayo 1979. *La Motilla del Azuer (Daimiel, Ciudad Real). Campaña de 1979*, Cuadernos de Prehistoria de la Universidad de Granada 4, 265-94.

Molina, F., T. Nájera, G. Aranda, M. Sánchez and M. Haro 2005. *Recent fieldwork at the Bronze Age fortified site of Motilla del Azuer (Daimiel, Spain)*, Antiquity 79(306).

Nájera Colino, T. 1984. *La Edad del Bronce en La Mancha Occidental*, Tesis Doctorales de la Universidad de Granada 458, Granada.

Nájera, T. and F. Molina 2004a. *Excavaciones en la Motilla del Azuer (Daimiel, Ciudad Real). 2000-2001*, Investigaciones Arqueológicas en Castilla-La Mancha 1996-2002, Toledo: Consejería de Educación y Cultura, JCCM, 35-48.

Nájera, T. and F. Molina 2004b. *Las Motillas. Un modelo de asentamiento con fortificación central en la llanura de la Mancha*, In: Mª. R. García and J. Morales (eds.) *La Península Ibérica en el II Milenio A.C.: poblados y fortificaciones*, Colección Humanidades 77, Cuenca: Ediciones Universidad Castilla-La Mancha, 173-215.

Nájera, T., F. Molina, P. Aguayo and G. Martínez 1981. *La Motilla del Azuer (Daimiel, Ciudad Real). Campaña de 1981*, Cuadernos de Prehistoria de la Universidad de Granada 6, 293-307.

Nájera, T., F. Molina, F. de la Torre, P. Aguayo and L. Sáez 1979. *La Motilla del Azuer (Daimiel, Ciudad Real). Campaña de 1976*, Noticiario Arqueológico Hispánico 6, 19-50.

Nájera, T., F. Molina, M. Sánchez and G. Aranda 2006. *Un enterramiento Infantil singular en el yacimiento de la Edad del Bronce de la Motilla del Azuer (Daimiel, Ciudad Real*), Trabajos de Prehistoria 63, 148-56.

Pascual Benito, J. L. 1993. *El hueso trabajado y los adornos*, Saguntum 26, 83-98.

Pascual Benito, J. L. 1995. *Origen y significado del marfil durante el Horizonte Campaniforme y los inicios de la Edad del Bronce en el País Valenciano*, Saguntum 29(1), 19-31.

Rodanés Vicente, J.Mª. 1987. *La industria ósea prehistórica en el Valle del Ebro: Neolítico-Edad del Bronce*, Diputación General de Aragón.

Salvatierra Cuenca, V. 1980. *Estudio del material óseo de las Cuevas de la Carigüela y la Ventana (Píñar, Granada)*, Cuadernos de Prehistoria de la Universidad de Granada 5, 35-80.

Salvatierra Cuenca, V. 1982. *El hueso trabajado en Granada (Del Neolítico al Bronce)*, Tesis Doctorales de la Universidad de Granada, Granada.

Uscatescu, A. 1992. *Los botones de perforación en "V" en la Península Ibérica y las Baleares durante la Edad de los Metales*, Madrid: Foro.

Voruz, J.L. 1982. *Typologie analytique d´industries osseuses néolithiques*, In: H. Camps-Fabrer (ed.) *L´Industrie en os et bois de cervidé durant le Néolithique et l´Age des Métaux I. Deuxième reunión du Groupe de Travail nº3 sur l´industrie de l´os préhistorique, C.N.R.S*, París, 77-105.

Justyna Baron

Ritual contexts of animal bone deposits from the Roman Iron Age settlement at Magnice, SW Poland

Despite numerous ideas and tools applied, including presumptions that in many instances, ritual or any action does not affect any perceptible change of material culture and that the latter does not reflect socio-cultural phenomena in a direct and objective way, there are two main criteria of distinguishing remains of ritual activities: unusuality of a given find and/or its context.

The paper presents the initial results of studies on animal bone deposits recorded in the Roman period settlement at Magnice near Wrocław which in my opinion are remains of rituals performed within the settlement area and being thus an integral part of its inhabitants' everyday life. For the sake of the study I applied a functional definition of ritual which I understand as a process including its performative and communicative aspects regarded as symbolical-expressive behaviour mode in communicating and consolidating certain social relations.

I applied the criteria of structured deposits proposed by L. K. Horwitz and T. Węgrzynowicz including: the presence of whole, unbutchered animals or articulated portions of animals, the presence of very young or very old animals, a selection of specific parts, an abundance of one sex and/or a particular taxon, the presence of rare taxa, association with human remains and/or grave goods.

Key words: animal bones, deposits, settlement, Roman Iron Age, SW Poland

Introduction

The last two decades have demonstrated an increased interest in ritual and religion studies. As a result he traditional division of sacred and profane areas of human activity has been rejected. Ritual (including, for example, such aspects as storage patterns, diet, refuse management and technology) are seen as part of daily life and not as being separated from domestic life. T. Insoll argues that the archeology of religion can encompass all aspects of material culture: "all can be influenced by religion. They are today, why not in the past?" (Insoll 2004:22).

Methods

In this study I applied a functional definition of ritual. I understand ritual as a process including both performative and communicative aspects which is regarded as a symbolical-expressive behaviour mode used to communicate and consolidate particular social relations. Ritual activity and collective activity in particular, "communicates something about social relations, often in a relatively dramatic or formal manner" (Wuthnow 1987:109). The characteristics of ritual understood in this way, include formalism,

Fig. 1. Overall excavation plan of the site

traditionalism, invariance, rule governance, sacral symbolism and performance – recalling the definition by C. Bell (1992:94). However, as R. Rappaport argues, the use of symbols is not a necessary component of rituals (2007:55).

How do archaeologists regard and study ritual? The main departure point in recent studies is an assumption on the inseparability of the ritual/religious and mundane spheres (Brück 1999; Kiriakidis 2007) Ideas and methodological tools from the history of religion, anthropology, sociology, cognitive sciences, performance and so on have been incorporated. The new interest in ritual and the conceptual world has been represented in numerous publications representing various theoretical perspectives ranging from the purely theoretical (e.g. Garwood *et al*. 1989); descriptive and explanatory views (e.g. Kossack 1999; Podborský 2006; Beilke-Voigt 2007) as well as combined theoretical and material based approach (e.g. Biehl, Bertemes 2001; Kaul 1998; Bradley 2005; Kaliff 2007).

Despite the numerous ideas and tools applied, including presumptions that in many instances, action does not affect any perceptible change of material culture and that the latter does not reflect socio-cultural phenomena in a direct and objective way, there are two main criteria for distinguishing the remains of ritual activities: the unusuality of a given find and/or its context. Bone remains belong frequently to the most abundant archaeological evidence yielded by excavations. In studying ritual activities based on bone evidence, context is essential however this can be misleading as well (e.g. Kiriakidis 2007:18).

The paper aims to present and interpret several bone deposits discovered at a Roman period settlement in Magnice near Wrocław. On the basis of criteria developed by L.K. Horwitz (1987) and T. Węgrzynowicz (1982) presented below, the finds are believed to be the remains of rituals performed at the settlement.

As many scholars note the identification, analysis and interpretation of bone material is carried out in order to understand features of subsistence, consumption and economic organisation – mostly from a processual perspective (e.g. Crabtree 2004:62). This approach has been criticised as reductive even compared to modern attitudes to animals which often go far beyond the economical considerations or may represent mixed– economic and non-economic use (for further bibliography on this issue see e.g. Crabtree 2004; Lauwerier 2004).

However even archaeologists focusing strictly on consumption and economy in animal use come across animal bone sets that are considered as deposits. Depending on their contexts, they are interpreted as offerings made for dead members of a group, the remains of foundation/closure sacrifices or religious feasts (in Polish literature e.g. Węgrzynowicz 1982; Andrałojć 1986, 1992; Makiewicz 1987). The frequent association of food – meat in this case – with ritual makes it a difficult task to distinguish ritual activities involving food from daily meat use.

What makes the bone deposits different from common food debris? L.K. Horwitz (1987 after Kansa, Campbell 2004) mentions such criteria as: the presence of whole, unbutchered animals or articulated portions of animals, the presence of very young or very old animals, a selection of specific parts, an abundance of one sex and/or a particular taxon, the presence of rare taxa, association with human remains and grave goods. According to T. Węgrzynowicz, the criteria of the ritual nature of deposits include the unusuality of the features, traces of structured and deliberate deposition, lack of any practical aspects in killing and deposition of animals, selection both on taxon and body part level (1982:20-21). In other words, the deposits are distinguished on the basis of the nature and context of their deposition or their association with other archaeological remains of an unusual or religious nature. Obviously any of these characteristics can often be attributed to non-ritual behaviour, however the co-incidence of some of them may indicate ritual activities of various kinds.

The site

As it was mentioned above, the paper presents the initial results of studies on animal bone deposits discovered at a Roman Iron Age settlement at Magnice near Wrocław. The site at Magnice is located 1km northwest from the contemporary village of Magnice, 5 km south from Wrocław (SW Poland). Rescue excavations were carried out in advance of construction works associated with a planned bypass (Fig. 1). The excavation was performed in 2007 and covered an area of 1.1 ha which produced 330 pits most of which were dated to the Roman period (in this case from the second half of the first century up to the second half of the fourth century). The pits show typical settlement features such as pit houses, storage pits, fireplaces, post holes, pottery kilns and wells (Baron *et al*. 2011).

One main point of interest is the spatial organisation of the settlement. There are at least three groups of pit and semi-pit buildings surrounding an empty square in which only common features such as wells

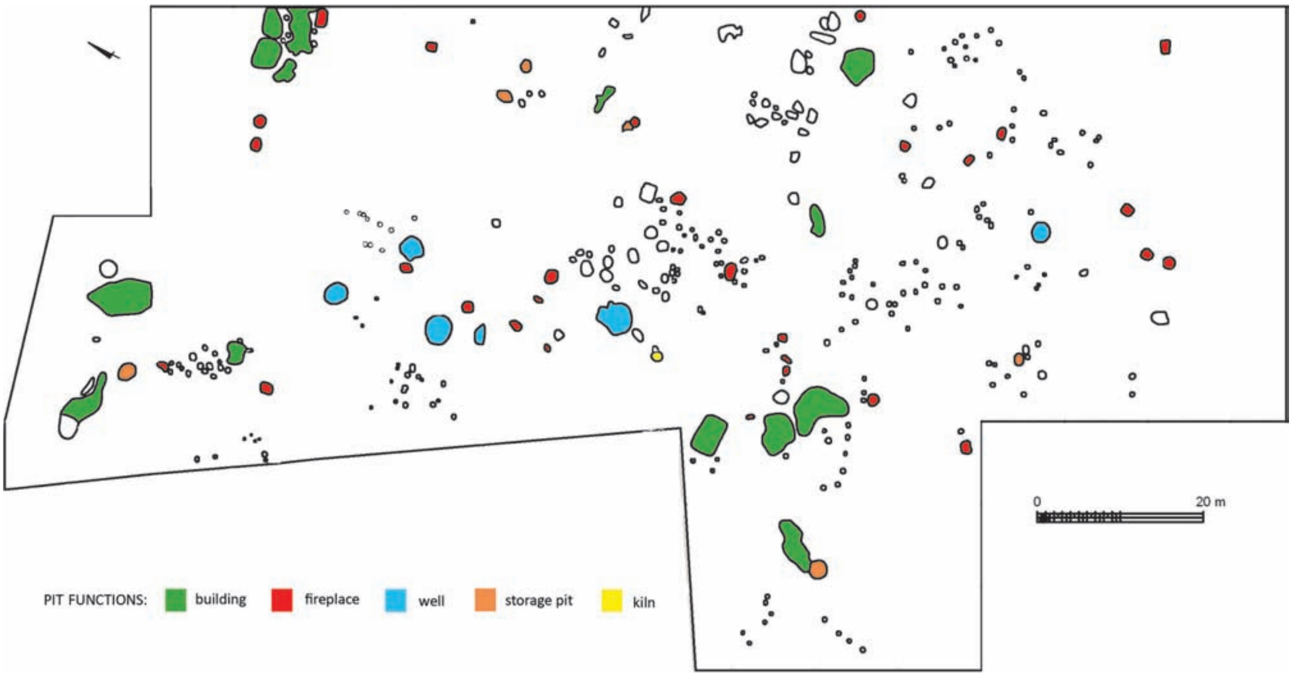


Fig. 2. Functional division of excavated pits

or fireplaces were situated (Fig. 2). The pit houses in each cluster were not of the same chronology and thus they are not remains of farmsteads consisting of several buildings but instead they reflect constant and long lasting settlement tradition. Such bonds with the area might have resulted from a fact that a large "industrial" settlement with dozens of lime kilns, bloomeries and ore-roasting pits was discovered just about 200 hundred meters northwest from the discussed site.

In course of the excavations 4738 animal bones and teeth were recovered, mainly from storage pits and wells, that were apparently re-used for rubbish disposal. Most of the remains represent a high degree of fragmentation and come from domestic animals (97,85%) among which cattle bones prevailed (47,52%), followed by pigs (32,31%), small ruminants (8,6%), horses (7,87%) and dogs (3,67%). One bone belonged to a cat (Fig. 3). In the case of cattle, pig and small ruminants all parts of the skeleton were identified (Romanow 2011).

In the pits situated in what may be called the common space of the settlement, several bone deposits were discovered (Fig. 4).

Two horse skulls without mandibles were found: one in a shallow pit house and one in a well. In both cases they were recorded in the bottom layers of the pits while in the well, apart from the skull, one quern stone was recovered. Both skulls belonged to individuals aged 5-6. The skull from the house was arranged upside down (Fig. 5).

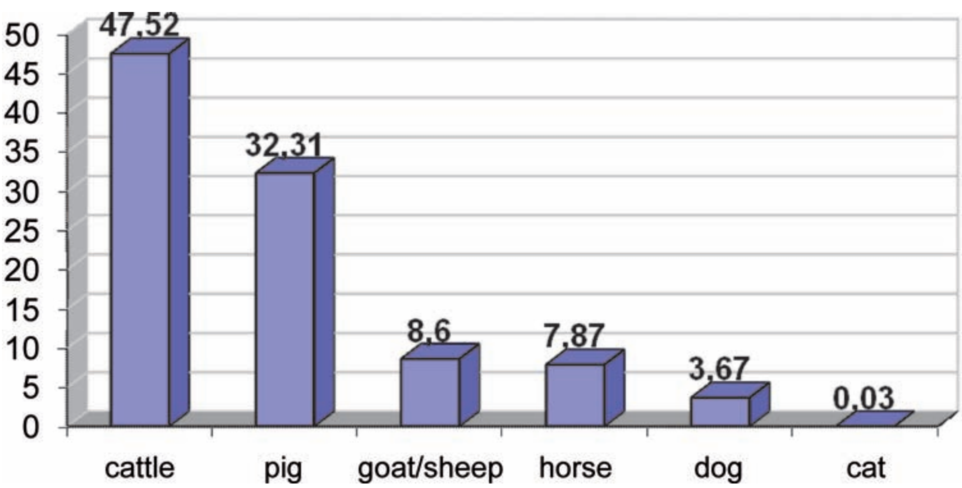


Fig. 3. Percentages of the domestic animal remains (after Romanow 2011)

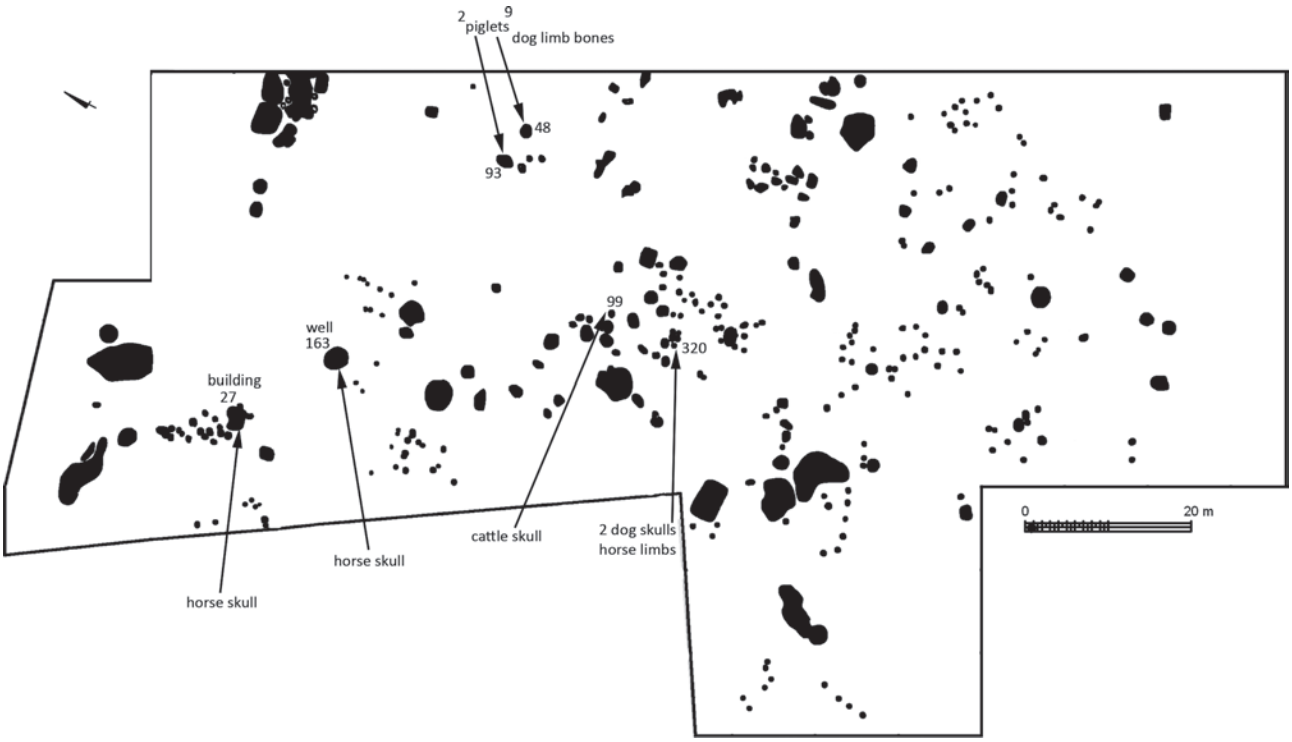


Fig. 4. Distribution of the bone deposits within the site area

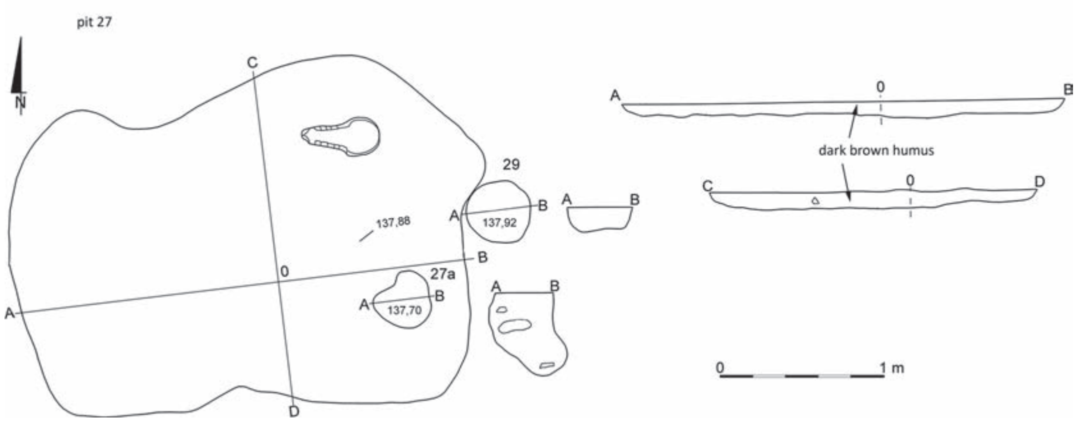


Fig. 5. Horse skull in pit 27. Photo: J. Baron

Fig. 6. Sections of the pits containing piglet skeletons. Photo: J. Baron

In the pits situated in the central part of the settlement a cattle skull (including mandible and fragments of cervical vertebrae) and two dog skulls (both from individuals aged 5-6) and horse limbs were found.

In two relatively deep pits, determined previously as having been dug for storage purposes, the complete skeletons of 11 piglets (at least 2 individuals in pit 93 and 9 in 48) were recovered. In one case (pit 48) these were accompanied by dog limb bones. Bone distribution within the narrow and deep pits suggest they were thrown rather than carefully deposited (Fig. 6). No anatomical order was noticed which rather excludes 'a burial' of dead animals resulting from their natural death (e.g. caused by a disease).

Discussion

If we apply the criteria of structured deposits proposed by L.K. Horwitz and T. Węgrzynowicz, these pits seem to contain remains relating to various ritual activities performed at the site.

1. The presence of whole, unbutchered animals or articulated portions of animals.

An overall comparison of animal bone fragmentation in the mentioned pits and the site in general shows that the deposit pits contained a higher number of complete animal bones. Relatively speedy deposition in the pits protected the bones from weather, trampling and scavenging animals as happens in the case of household refuse. On the other hand, if they are waste these complete bones demonstrated completely various consumption model (they were not crushed for marrow for instance). Taphonomic analysis carried out proved that none of these bones bore butchering marks.

2. Selection of specific parts of animal body.

The bones from these pits contained skulls and limbs, only the piglet skeletons were complete. One interesting question is where are the elements of post cranial skeletons (comp. table 1)? Usually bone deposits contain skulls and limbs which are considered as non meat parts offered during or after feasts and ritual meat consumption.

3. Selection of a particular and rare taxa.

Among the animal bones considered as remains of ritual activities, pigs, horses, cattle and dogs predominate. These start in the Mesolithic with recorded dog burials (e.g. Larsson 1990 with further references) and horse bones deposits from the Bronze Age onwards. Also at many sites beginning from the Bronze Age, the majority of bones of these animals (dogs and horses) are relatively rare in comparison with the occurrence of the bones of cattle and sheep for instance. Moreover, they are very often found together. Dogs and pigs, present in ritual context at Magnice are commonly interpreted as the most frequent type of offered animals (e.g. Choyke *et al.* 2004; Galik 2004; Hamilakis, Konsolaki 2004).

In the early Iron Age and Roman period dogs are seen as being traditionally associated with the healing and protection of humans. This is shown both by finds of dog skeletons in offering shafts and pits at the settlements and by dog figurines (e.g. de Grossi Mazzorin, Minniti 2004; Woodward, Woodward 2004:77-79). The latter authors in their paper on Romano-British urban centres argue that the shafts containing dog bones are often situated in the central parts of the sites (Woodward, Woodward 2004:78). Similar functions for such deposits has been proposed in the Polish literature by authors who argue the dogs buried at settlement space were guardians of humans or foundation sacrifices (Makiewicz 1987; Węgrzynowicz 1982:249; Andrałojć 1986, 1992).

Horses are considered to play a special role for whole Indo-European world. Horse sacrifice starting from Indian *Aśvamedha* is seen as being necessary to keep the cosmic balance (e.g. Puhvel 1978). The echoes of this sacrifice can be easily observed both in archaeological and ethnological evidence and there is extensive bibliography (e.g. in Węgrzynowicz 1982, 241).

The deposits from Magnice may be thus interpreted as the remains of ritual activities which, were incorporated into the daily life of the site inhabitants based on their spatial distribution.

What kind of rituals were performed at the discussed site?

Based on the distribution of the deposits I believe they reflect at least several types of rituals.

I would like to start with foundation sacrifices. As anthropologists argue, building rituals belong to the activities which reflect the transformation of nature into culture and wild into tamed. Many scholars demonstrate that rituals constitute an inherent essence of technology and thus cannot be separate from daily life activities (Bajburin 1990:62; Bradley 2005). This is ritual what endows an object with meaning and, finally, connects it with an area of senses which are comprehensible for a given community. Foundation offerings, recognised as the material remains of building rituals, are recorded worldwide in various cultural traditions. Despite the enormous variety of the symbols and procedures offering the basic sense of the rite remains the same. The offering values the space, distinguishes the area of highest sacral significance, purifies it and allows to initiate the construction. Thus erection of a house is directly connected with the offering that was made. The horse skull in one of the pit house is a typical example of such offering. Similarly arranged horse skulls are known for instance from the Roman period settlement dated to the 3rd cent. at Feddersen Wierde in Germany (Haarnagel 1979:226).

Another type of ritual reflected in archaeological evidence are the closing rituals which were performed for example when changing the some pit functions. Unbroken quern stones and animal skulls found in the bottom layers of wells have been interpreted as offerings made to close or change the pit function from a well to a rubbish pit. The presence of complete quern stones in deep pits such as wells and storage pits is known from many prehistoric sites (por. Malmer 2002:41; Bradley 2005:130). Horse skulls in deep wells are also interpreted as the remains of regularly deposited offerings. In this case we are not dealing with wells but rather sacrifice shafts. The site of Kasterbrunnen in Lower Saxony, despite its later chronology, might be a good example of such a shaft. In the deep pit, selected parts of animal bodies including horse skulls and limbs were found (Müller-Wille 1972:180). On the other hand, analyses done for some Scandinavian sites from the early Iron Age demonstrated that the remains of horse skeletons are mostly discovered at sites of relatively higher status or/and ritual character (Petersson 2006, Fig. 18)

In the case of the Magnice site, the well was just filled after making the deposit, and there was no stratigraphical evidence of the pit remaining open. The fact that the horse skull was found together with a quern stone at the bottom of the well seems to support the idea of closing offerings.

Finally, there were rituals performed in the open common area which are reflected in the presence of pits containing cattle and dog skulls and limbs and piglet skeletons. There are several possible interpretations, however obviously the bones (both selected parts and complete skeletons) were deposited deliberately in small pits and thus are preserved much better than rest of the bone collection from the site. In case of piglets one cannot exclude a deposition of complete animal bodies. No bones from the deposits bear traces of cutting and crushing while dog skulls, as they have no mandibles, must have been deposited after the soft tissue had been removed. Skull and limbs deposits are very often interpreted as the remains of feasts including ritual feasts. Feasts are events essentially constituted by the communal consumption of food and/or drink which is entirely different from everyday domestic meals including food preparation, consumption, social and spatial context in which foods were consumed. Common feasting, highly ritualized and initiated on various occasions are seen as being essential in creating relationships – from alliances and the manifestation of prestige to the confirmation of marriages and compensation for transgressions (Hayden 2001:30). According to B. Hayden, the archaeological evidence for feasts include both the food remains and the various distinctive types of vessels localised among others in the central community spaces (2001:table 2.1).

It has been argued that "for most farming societies, meat was an expensive commodity to produce and the offering a part of the animal's body operates as a purification ritual and represents the consumption of a valuable commodity as an experience shared with powers the offer was dedicated to. Thus, the sacrifice is often connected with feasting, when the animals were consumed. In my opinion the deposits of complete skulls or limb bones reflect very meaningful feasts because there are many crushed skull bones at the site but only some of them were deposited in a deliberately way" (Hamilakis, Konsolaki 2004:145).

The example of Magnice site demonstrates not only animal bones as ritual consumption remains but also shows animals being situated within a much wider ritually constructed view of the world.

Table 1. Body part representation for each major taxon (after Romanow 2011)

	CATTLE	PIG	SHEEP/ GOAT	HORSE	DOG
pedicle	39	-	6	-	-
skull	285	250	23	162	49
maxilla	23	40	1	1	6
mandible	189	68	23	18	11
teeth	191	56	26	44	15
vertebrae	144	119	15	-	5
sacrum	2	6	-	-	-
ribs	124	237	43	1	1
scapula	95	39	8	8	4
humerus	50	40	16	1	8
radius	55	23	10	2	3
ulna	8	15	-	1	2
carpal bones	9	21	1	-	-
metacarpus	47	2	1	8	-

	CATTLE	PIG	SHEEP/ GOAT	HORSE	DOG
pelvis	39	21	6	1	-
femur	34	39	12	1	2
patella	1	1	-	-	
tibia	70	40	27	4	9
fibula	-	10	-	-	5
tarsus	23	14	4	8	-
metatarsus	36	1	6	3	-
metapodium	111	42	63	1	5
phalangae	44	17	2	4	-
total	**1619**	**1101**	**293**	**268**	**125**

References

Andrałojć, M. 1986. *Pochówki psów w pradziejach Europy Środkowej*, Inowrocław.

Andrałojć, M. 1992. *Rola psa w obrzędowości pradziejowych społeczeństw Europy Środkowej*, In: M. Kwapiński and H. Paner (eds.) *Wierzenia przedchrześcijańskie na ziemiach polskich*, Gdańsk: Muzeum Archeologiczne, 98-110.

Bajburin, A.K. 1990. *W sprawie opisu struktury słowiańskiego rytuału budowniczego*, Polska Sztuka Ludowa – Konteksty 3, 62-7.

Baron, J., Czyż, P., Ibragimow, K., Sikora, E. and Stolarczyk, T. 2011. *Wyniki ratowniczych badań archeologicznych wielokulturowego stanowiska nr 8 w Magnicach, gmina Kobierzyce, województwo dolnośląskie*, In: J. Baron (ed.) *Wielokulturowe stanowisko nr 8 w Magnicach, gm. Kobierzyce, woj. dolnośląskie, Archeologiczne Zeszyty Autostradowe*, z. 11, *Badania na autostradzie A4*, cz. IX, Wrocław: Instytut Archeologii i Etnologii PAN, Uniwersytet Wrocławski, s. 7-144.

Beilke-Voigt, I. 2007. *Das „Opfer" im archäologischen Befund. Studien zu den sog. Bauopfern, kultischen Niederlungen und Bestattungen in ur- and frühgeschichtlichen Siedlungen Norddeutschlands and Dänemarks*, Berliner Archäologische Forschungen 4, Rahden/Westf.: Marie Leidorf.

Biehl, P.F. and Bertemes F. (eds.) 2001. *The Archaeology of Cult and Religion*, Budapest: Archaeolingua.

Bell, C. 1992. *Ritual Theory, Ritual Practice*, New York-Oxford: Oxford University Press.

Bradley, R. 2005. *Ritual and Domestic Life in Prehistoric Europe*, London and New York: Routledge.

Brück, J. 1999. *Ritual and Rationality: Some Problems of Interpretation in European Archaeology*, European Journal of Archaeology 2(3), 313-44.

Crabtree, P. 2004. *Ritual feasting in the Irish Iron Age: re-examining the fauna from Dún Ailine in light of contemporary archaeological theory*, In: S. Jones O'Day, W. Van Neer and A. Ervynck (eds.) *Behaviour Behind Bones. The zooarchaeology of ritual, religion and identity. Proceedings of the 9th Conference of the International Council of Archaeolozoology, Durham, August 2002*, Oxford: Oxbow Books, 62-5.

Garwood, P., D. Jennings, R. Skeates and J. Toms 1989. *Sacred and Profane, Proceedings at the Conference on Archaeology, Ritual and Religion* (Oxford University Committee for Archaeology Monograph 32), Oxford: Institute of Archaeology.

Grossi Mazorin, J. d. and C. Minniti 2004. *Dog Sacrifice in the Ancient World: A Ritual Passage?* In: L.M. Snyder and E.A. Moore (eds.) *Dogs and People in Social, Working, Economic of Symbolic Interaction, Proceedings of the 9th Conference of the International Council of Archaeolozoology, Durham, August 2002*, Oxford: Oxbow Books, 62-6.

Haarnagel, W. 1979. *Die Grabung Feddersen Wierde. Methode, Hausbau, Siedlungs- und Wirtschaftsformen sowie Sozialstruktur*, Band II, Textband, Wiesbaden: Steiner.

Hamilakis, Y. and E. Konsolaki 2004. *Pigs for the gods: burnt animal sacrifices as embodied rituals at Mycenaean sanctuary*, Oxford Journal of Archaeology 23(2), 135-51.

Hayden, B. 2001. *Fabulous Feast. A Prolegomenon to the Importance of Feasting*, In: M. Dietler and B. Hayden (eds.) *Feasts. Archaeological and Ethnographic Perspectives on Food, Politics and Power*, Washington and London: Smithsonian Institute Press, 23-64.

Horwitz, L.K. 1987. *Animal offerings from two Middle Bronze Age tombs*, Israel Exploration Journal 37, 251-55.

Insoll, T. 2004. *Archaeology, Ritual, Religion,* London and New York: Routledge.

Kaliff, A. 2007. *Fire, Water, Heaven and Earth. Ritual practice and cosmology in ancient Scandinavia: An Indo-European perspectiv*e, Stockholm: Riksantikvarieämbetet.

Kansa, S.W. and S. Campbell. 2004. *Feasting with the dead? – a ritual bone deposit at Domuztepe, south eastern Turkey (c. 5550 cal BC)*, In: S. Jones O'Day, W. Van Neer and A. Ervynck (eds.) *Behaviour Behind Bones. The zooarchaeology of ritual, religion and identity. Proceedings of the 9th Conference of the International Council of Archaeolozoology, Durham, August 2002*, Oxford: Oxbow Books, 2-13.

Kaul, F. 1998. *Bronzealderens religion. Studier af den nordiske bronzealders ikonografi*, København: Det Kongelige Nordiske Oldskriftselskab.

Kiriakidis, E. (ed.) 2007. *The Archaeology of Ritual* (*Cotsen Advanced Seminars* 3). California: University of California, Los Angeles, Cotsen Institute of Archaeology.

Kossack, G. 1999. *Religiöses Denken in dinglicher und bildlicher Überlieferung Alteuropas aus der Spätbronze- und frühen Eisenzeit (9-6. Jahrhundert v. Chr. Geb.)*, München: Verlag den Bayerischen Akademie der Wissenschaften.

Larsson, L. 1990. *Dogs in Fraction – Symbols in Action*, In: P.M. Vermeersch and P.V. Peer (eds.) *Contributions to the Mesolithic in Europe*, Leuven: Leuven University Press, 153-60.

Lauwerier, R.C.G.M. 2004. *The economic and non-economic animal: Roman depositions and offerings*, In: S. Jones O'Day, W. Van Neer and A. Ervynck (eds.) *Behaviour Behind Bones. The zooarchaeology of ritual, religion and identity. Proceedings of the 9th Conference of the International Council of Archaeolozoology, Durham, August 2002*, Oxford: Oxbow Books, 66-72.

Makiewicz, T. 1987. *Znaczenie sakralne tzw. „pochówków psów" na terenie środkowoeuropejskiego Barbaricum*, Folia Praehistorica Posnaniensia 2, 239-77.

Malmer, M. 2002. *The Neolithic of South Sweden. TRB, GRK and STR*, Stockholm: Royal Swedish Academy of Letters, History & Antiquities.

Müller-Wille, M. 1972. *Pferdegrab und Pferdeopfer im frühen Mittelalter*, Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek 20/21, 1970/71, 119-248.

Petersson, M. 2006. *Djurhallning Och Betesdrift: Djur, Människor Och Landskap I Västra Östergötland Under Yngre Bronsålder Och Alder Järnålder*, Uppsala: Uppsala Universitet.

Podborský, V. 2006. *Náboženství Pravěkých Evropanů. Die Religion der Ureuropäer. The Religion of the prehistoric Europeans,* Brno: Ústav archeologie a muzeologie FF MU.

Puhvel, J. 1978. *Victimal Hierarchies in Indo-European Animal Sacrifice*, The American Journal of Philology 99(3), 354-362

Rappaport, R. 2007. *Rytuał i religia w rozwoju ludzkości*, Kraków: Nomos.

Romanow, M. 2011. *Zwierzęcy materiał kostny z osady w Magnicach, stan. 8, gm. Kobierzyce*, In: J. Baron (ed.) *Wielokulturowe stanowisko nr 8 w Magnicach, gm. Kobierzyce, woj. dolnośląskie, Archeologiczne Zeszyty Autostradowe*, z. 11, *Badania na autostradzie A4*, cz. IX, Wrocław: Instytut Archeologii i Etnologii PAN, Uniwersytet Wrocławski, 151-9.

Węgrzynowicz, T. 1982. *Szczątki zwierzęce jako wyraz wierzeń w czasach ciałopalenia zwłok,* Warszawa: Państwowe Muzeum Archeologiczne.

Wuthnow, R. 1987. *Meaning and Moral Order: Explorations in Cultural Analysis*, Berkeley and Los Angeles: University of California Press.

Felix Lang

Activity not Profession. Considerations about Bone Working in Roman Times

The paper deals with the professions in which bone workers were engaged in Roman times. The considerations are concerned only with professional crafting not with bone working undertaken as home work or for mere subsistence. The archaeological evidence will be interpreted based on written sources. This leads to certain implications for archaeological terminology of bone crafting. Usually craftsmen working in bone are regarded implicitly or explicitly as specialists dealing with this raw material only.

However, due to written sources specialization in terms of the product was usual. The same worker carried out everything necessary to produce a certain object. Based on that, a different perspective is necessary for the interpretation of archaeological evidence of bone working. It is more likely that a craftsmen or a workshop was working in different raw materials than different workmen specialized in certain raw materials collaborating with each other.

I suppose that the usual model of Roman craftsmanship is influenced too strongly by modern methods of analyses based on raw material. We should rather use the ancient terminology of professions than one constructed by the division of the material in archaeological investigation. Clearly, there are many bone working activities in Roman times but this does not implicate that the profession of bone working existed. And this is the explanation why written and pictorial sources about this craft are almost lacking in Roman times.

Key words: specialization, craftsmanship, written sources, raw material usage

The paper deals with the professions in which bone workers were engaged in Roman times. The considerations are only concerned with professional crafting not with bone working undertaken as home work or for mere subsistence (cf. Schlesier 1981; Obmann 1997:85-86; Moosbauer 1999:219-220). The archaeological evidence will be interpreted based on written sources. This leads to certain implications for archaeological terminology of bone crafting.

General view of Roman bone working

Usually craftsmen working in bone are regarded implicitly or explicitly as specialists dealing with this raw material only (cf. Mikler 1997:113-114; Obmann 1997:84-87; Rothenhöfer 2005:184-185; Polfer 2008:37, Fig. 1). Written and pictorial sources about this craft are almost lacking in Roman times (Gostenčnik 2005:295). Just the *eborarii* (workers in ivory) are known. Therefore Jürgen Obmann (1997:84-85) suggested that, at least in Rome, bone workers were summed up by this term. Due to an inscription found in Rome (CIL VI 33885) they were joined into a *collegium* with *citriarii* (workers in citrus wood): "Im Zusammenschluß der beiden Handwerkszweige der eborarii und citriarii verdeut-

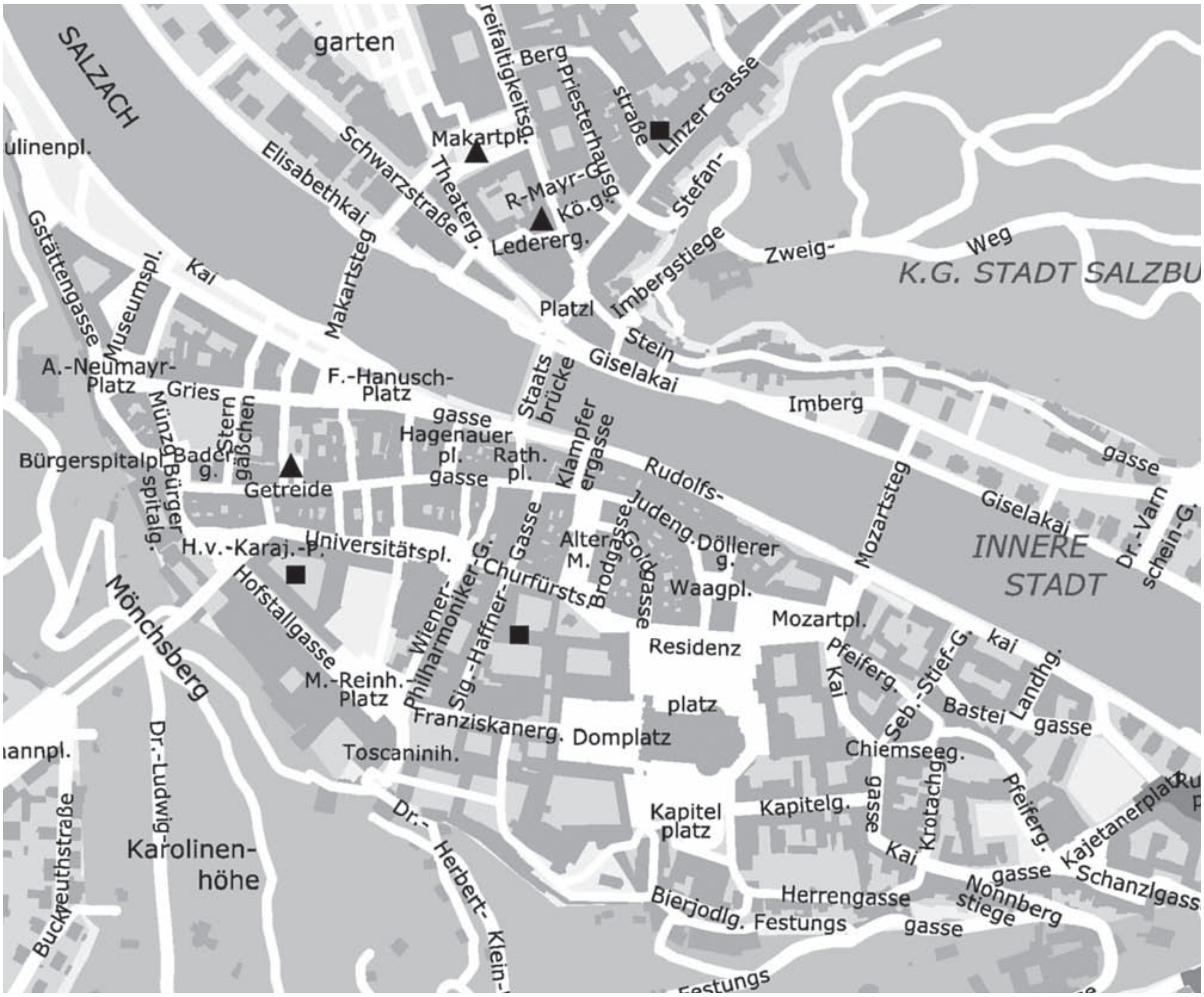


Fig. 1. *Iuvavum* – Salzburg: ▲ areas of depositing bone refuse including half fabrics of antler handles; ■ workshop areas with bone and iron working activities

lichen sich auch gemeinsame Fertigungstechniken vor allem in der Verarbeitung luxuriöser Werkstoffe. Ineinander verzahnte Arbeitsvorgänge, bei denen zwar unterschiedliche Materialien verwendet, jedoch an einem Werkstück zusammengebaut wurden, lassen eine getrennte endgültige Montage unwahrscheinlich werden" (Obmann 1997:85; also Mikler 1997:114).

However it is highly suspicious that the *eborarii* and *citriarii* mentioned in the inscription are indeed craftsmen, because the added term *negotiatores* is normally not used for workers but high scale merchants (Kornemann 1899:397-399; Behrends 1981:143 fn. 6; Kneißl 1983:73; Schlippschuh 1987:4-7; Frezouls 1991:59-60; Richardson 1992:346; Andreau 2000:783-785). Therefore it is quite possible that this people traded with these raw materials, not worked with them.

Truly there are *eborarii* known who are clearly identified as craftsmen by terms like *faber* or *opifex*. However, there is no connection with *citriarii* (Lang 2008b). Additionally there is no proof that these *eborarii* also worked in 'normal' bone not just in ivory (cf. Mikler 1997:113-114). Therefore it is quite improbable that this professional term covered all bone working activities.

The written evidence for professional terms of craftsmanship

There are quite a lot of investigations of professional terms in antiquity based on written sources (e.g. Petrikovits 1981a; Petrikovits 1981b; Frezouls 1991; Harris 2001; Ruffing 2008). Thereby craftsmen are named either after their product or the material they dealt with (Ruffing 2008:109). Looking at

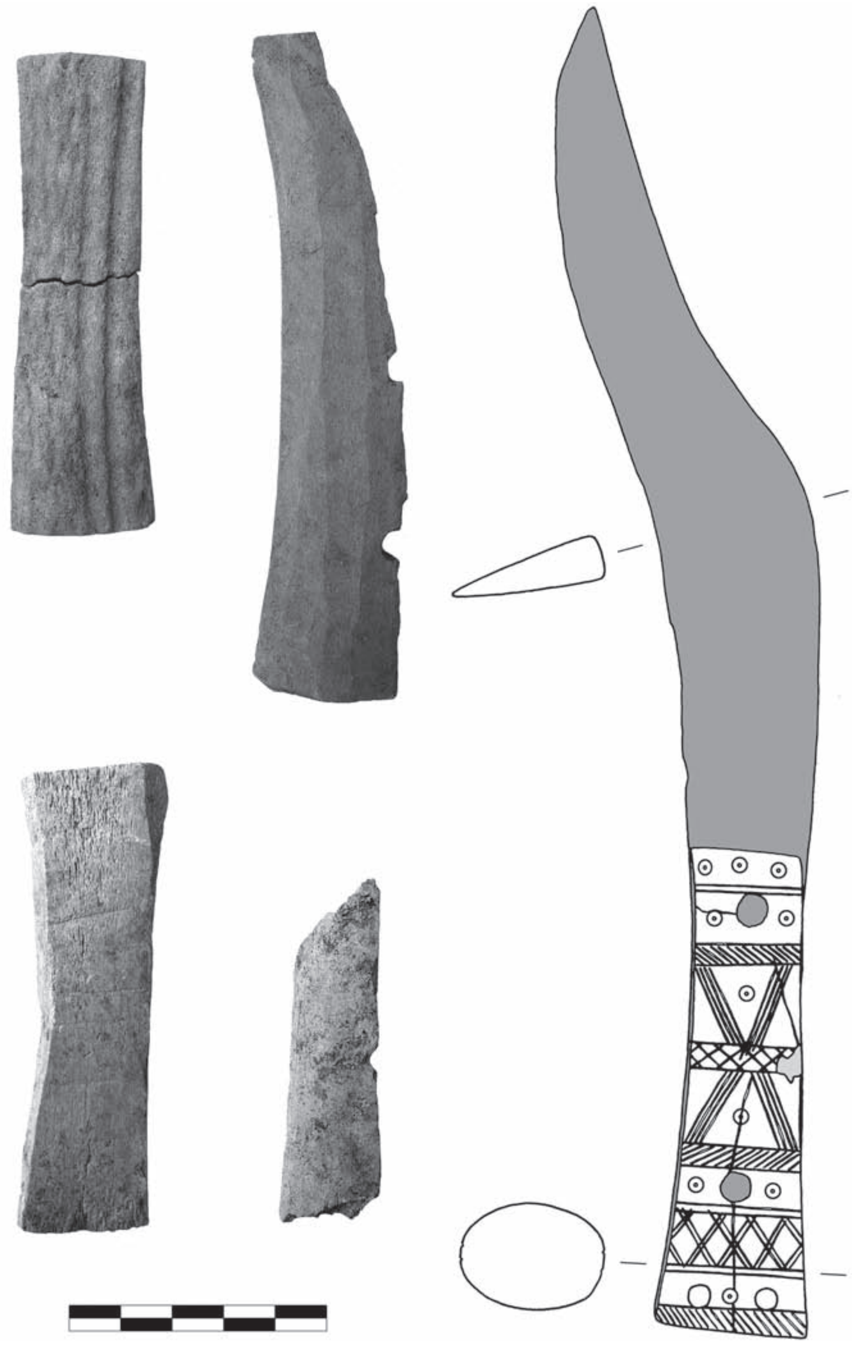


Fig. 2. Half fabrics of antler handles and a finished knife from *Iuvavum* – Salzburg

the professions "… it is crucial to make a distinction between two types of specialization, horizontal and vertical" (Harris 2001:70):

• Horizontal specialization means that the craftsman is specialized in terms of the product. The same worker carries out everything that is necessary to make it.

• Vertical specialization means that the craftsman is specialized in terms of the work. The product is made based on division of labour by different craftsmen.

In antiquity horizontal specialization was usual (Harris 2001:71; cf. Ruffing 2008:108-109). There are indications of vertical specialization but they are sparse. One major exception to this general rule is building (especially public one), where a number of professions are working under the direction of architects. Also the textile industry shows a large degree of specialization. In large workshops a kind of vertical organisation can also be assumed and even tested (Petrikovits 1981:72-73; Harris 2001:71; Ruffing 2008:212-214, 370-371, 374-375).

A passage by Demosthenes is very enlightening for this case (orationes 27. 9-10):

"My father, men of the jury, left two factories, both doing a large business. One was a sword-manufactory, employing thirty-two or thirty-three slaves, most of them worth five or six minae each and none worth less than three minae. From these my father received

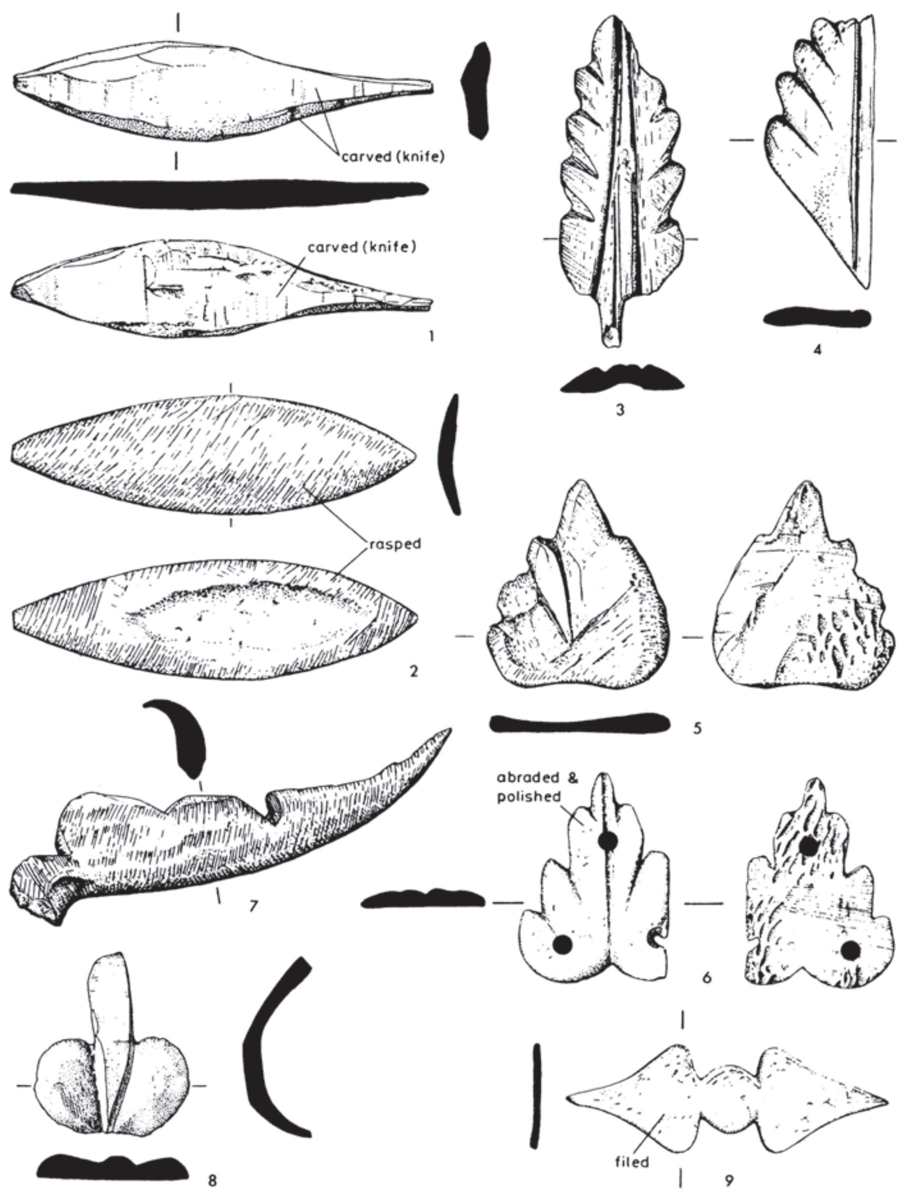


Fig. 3. Waste pieces from Colchester probably intended as applied ornament on wooden furniture; after Crummy 1981:279, Fig. 1

a clear income of thirty minae each year. The other was a sofa-manufactory, employing twenty slaves given to my father as security for a debt of forty minae. … Besides this, he left ivory and iron, used in the factory, and wood for sofas, worth about eighty minae; and gall and copper, which he had bought for seventy minae" (translated by A.T. Murray).

In the first manufactory/workshop also knives could have been produced. Anyhow, the important fact is; even though the workshops possessed by Demosthenes' father are quite big, there is no differentiation of the workers employed in them. Additionally different raw materials have been used (Harris 2001:71, 81-82; Schneider 2008:12).

Implications for archaeological terminology of bone crafting

Based on that, a different perspective is necessary for the interpretation of the archaeological evidence of bone working. It is more likely that a craftsmen or a workshop was working in different raw materials than different workmen specialized in certain raw materials collaborating with each other (cf. Prévot 2008:227). Let me show this by some examples:

In *Iuvavum*/Salzburg bone working has been determined at some places also connected with iron working (Fig. 1). According to the bone half fabrics handles for knives (Fig. 2) and maybe other implements have been produced there (Lang 2008a; Lang and Knauseder 2008). This does not indicate workshops of bone carvers but workshops of smiths where also

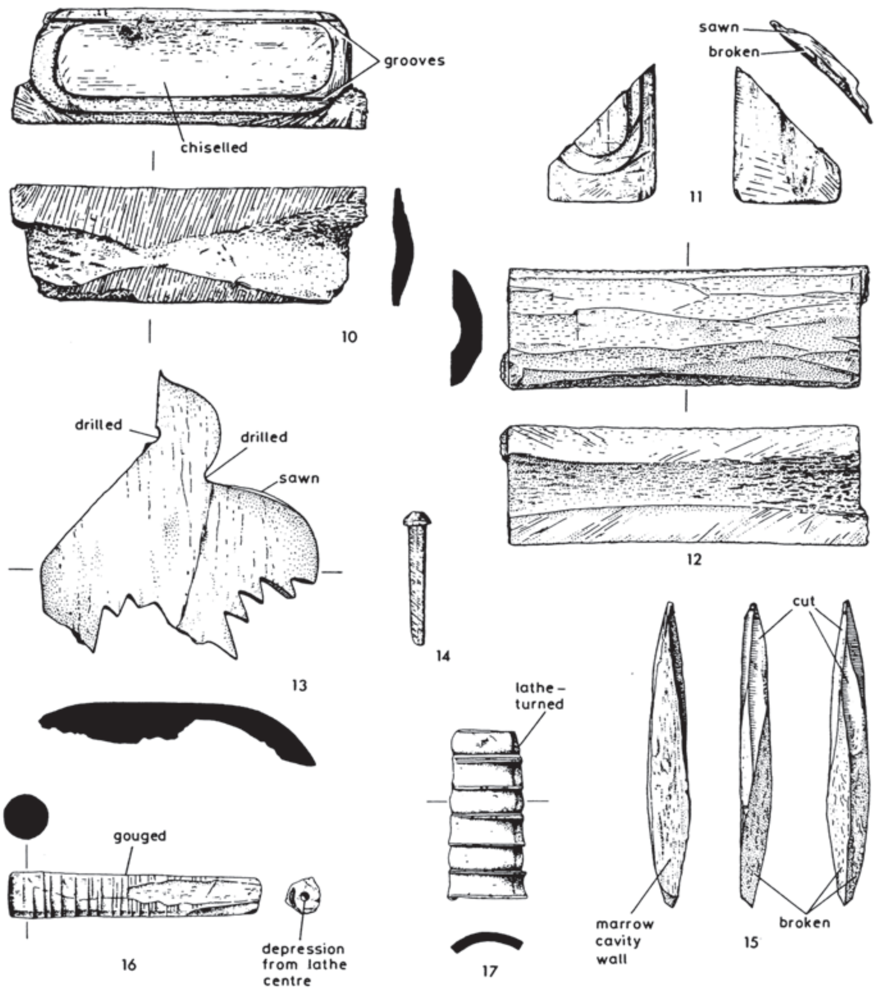


Fig. 4. Waste pieces from Colchester probably intended as applied ornament on wooden furniture; after Crummy 1981:281, Fig. 2

the handles have been made (cf. Crummy 2001:101-102). They were possibly specialized in knife making but this can not be attested due to the lack of evidence concerning the range of produced iron objects.

In Colchester waste pieces (Fig. 3 and 4) have been found probably intended as applied ornament on wooden furniture (Crummy 1981; MacGregor 1985:45, Figs. 29:h-j; Crummy 2001:99). Quite likely this as well as debris from the production of hinges of bone in Limoges (Vallet 1994) and bone refuse from a workshop in Amiens (Thuet 2008:41) indicates a workshop of a furniture maker.

This does not mean that it is impossible that bone was the only raw material a craftsman dealt with. Especially hairpins are predominantly made of this material (cf. Riha 1990:96-97; Deschler-Erb 1998:159). Therefore it could have been the only one. This could be the case in Alexandria in Egypt. There half fabrics of bone have been found in a house dating from the 5th to the beginning of the 7th c. AD interpreted as production waste of pins, needles, styluses or something similar (Rodziewicz 1998:143-146, Fig. 12-15). Quite likely there was a pin maker, because so called bone needles are most likely hairpins and bone styluses have been made just until the 1st c. AD, at least in the north-western provinces (Gostenčnik 2005:42, 102-103). Also in *Samarobriva*/Amiens there are two workshops dating 70 to 90 AD (maybe until 130 AD) and from the mid of the 2nd to the mid of the 3rd c. AD that seem to be specialized in the production of bone hairpins (Thuet 2008:38-41; Fig. 5).

Again in Alexandria in a filling of the 6th c. AD there have been found mostly by-products from the elaboration of pyxides and spindle-whorls or so-called tesserae, which in my opinion could be refuse from the production of bottoms or lids of pyxides (Rodziewicz 1998:146-147, Fig. 16-17). This could be a workshop specialized in bone pyxides, although maybe also wooden ones have been produced (cf. Pugsley 2001:113-115). Actually it is possible that further objects have been made; therefore this could be a turner's workshop.

Of course it is possible that the archaeological evidence indicates vertical specialization. In Gloucester 1,709 pieces of bone box veneer of the late 4th to early 5th c. AD have been found. "The absence of raw material, partially-worked pieces, or offcuts suggests that this was the workshop of a craftsman

Fig. 5. Workshop debris from the production of bone hairpins from *Samarobriva*/Amiens; after Thuet 2008:41, Fig. 5

Fig. 6. Workshop of a knife maker in Amsterdam, 18th c.; after Rijkelijkhuizen 2009:423, Fig. 10 right

in wood, who bought in the veneer pieces from a bone-worker" (Crummy 2001:100; also Hassal and Rhodes 1974:72-73 fig. 28.36). Also in *Flavia Solva*, as suggested quite optimistically by myself, handles of antler have possibly been made in a different place than the iron-knives they were destined for (Lang 2008c).

To postulate this careful contextual analysis is necessary. These examples could indicate this kind of specialization but it is not certain. In both cases just a part of the whole area is excavated (cf. Hassal and Rhodes 1974:26-30, Fig. 4). Therefore it is possible that the bone working took place just nearby. Anyhow, if the bone objects really have been made by a different craftsman, it is impossible to say if he was a specialized bone carver or another furniture resp. knife maker with a surplus of bone raw material.

Comparison with the mediaeval age

As known from written sources of mediaeval age Britain crossbow nuts have not been made by workshops specialized in bone but from those that produced the whole crossbow (MacGregor 1985:160-161; MacGregor 1991:367-368). Ralph Röber suggests for southern Germany that turners normally working in wood for special cases also used bone and antler. Also comb makers used different raw materials for their products. Just rosary and dice makers seem to work in bone only (Röber 1995:929-933). Even in the 18th c. it was quite common, as known from Amsterdam, that a knife maker produced the bone handles by himself (Rijkelijkhuizen 2009:423, Fig. 10 right; Fig. 6).

Conclusion

I suppose that the usual model of Roman craftsmanship is influenced too strongly by modern methods of investigation based on the raw material. More likely is a definition of different crafts in relation to the products. Therefore it is quite probable that a craftsman or a workshop worked with different materials. This should be reflected in the archaeological record. What we need are careful contextual analyses. There is of course a problem concerning the survival of different materials. For bone working the strongest association exists with wood working (cf. Obmann 1997:85). Objects of wood are normally not represented in the archaeological record. Iron working is somehow better to recognize through architectural remains as ovens and waste products as slag, but it is quite often impossible to determine which products have been produced in an iron workshop. Further professional specialization in terms of the product does not exclude that a craftsman occasionally made other products (cf. Burford 1985:118-121).

Anyway, we should rather use the ancient terminology of professions than one constructed by the division of the material in archaeological investigation. Clearly, there are many bone working activities in Roman times but this does not implicate that the profession of bone working existed. And this is the explanation why written and pictorial sources about this craft are almost lacking in Roman times.

References

Andreau, J. 2000. *Negotiator*, Der Neue Pauly 8, Stuttgart and Weimar, 783-85.

Behrends, O. 1981. *Die Rechtsformen des römischen Handwerks*, In: H. Jankuhn, W. Janssen, R. Schmidt-Wiegand and H. Tiefenbach (eds.) *Das Handwerk in vor- und frühgeschichtlicher Zeit 1. Historische und rechtshistorische Beiträge und Untersuchungen zur Frühgeschichte der Gilde*, Göttingen: Akademie der Wissenschaften, 141-203.

Burford, A. 1985. *Künstler und Handwerker in Griechenland und Rom*, Kulturgeschichte der antiken Welt 24. Mainz: Philipp von Zabern.

Crummy, N. 1981. *Bone-working in Colchester*, Britannia 12, 277-85.

Crummy, N. 2001. *Bone-working in Roman Britain: a model for itinerant craftsmen?* In: M. Polfer (ed.) *L'artisanat romaine: evolutions, continuités et ruptures (Italie et provinces occidentals). Actes du 2e colloque d'Erpeldange 26-28 octobre 2001*, Monographies Instrumentum 20, Montagnac: M. Mergoil, 97-109.

Deschler-Erb, S. 1998. *Römische Beinartefakte aus Augusta Raurica. Rohmaterial, Technologie, Typologie und Chronologie 1. Text und Tafeln*, Forschungen in Augst 27, Augst: Römermuseum.

Frezouls, E. 1991. *Les noms de métiers dans l'épigraphie de la Gaule et de la Germanie romaines*, Ktema 16, 33-72.

Gostenčnik, K. 2005. *Die Beinfunde vom Magdalensberg*, Archäologische Forschungen zu den Grabungen auf dem Magdalensberg 15, Klagenfurt: Verlag des Landesmuseums für Kärnten.

Harris, E.M. 2001. *Workshop, Marketplace and Household. The Nature of Technical Specialization in Classical Athens and Its Influence on Economy and Society*, In: P. Cartledge, E.E. Cohen and L. Foxhall (eds.) *Money, Labour and Land. Approaches to the Economies of Ancient Greece*, London and New York: Routledge, 67-99.

Hassal, M. and J. Rhodes. 1974. *Excavations at the Market Hall, Gloucester 1966-7*, Transactions of the Bristol and Gloucestershire Archaeological Society 93, 15-100.

Kneißl, P. 1983. *Mercator – Negotiator. Römische Geschäftsleute und die Terminologie ihrer Berufe*, Münstersche Beiträge zur antiken Handelsgeschichte 2(1), 73-90.

Kornemann, E. 1899. *Collegium, Pauly's Realencyclopädie der Classischen Altertumswissenschaft* 4, Stuttgart: J. B. Metzlerscher Verlag, 380-480.

Lang, F. 2008a. *L'artisanat du bois de cerf à Iuvavum/Salzbourg, Autriche. Les manches de couteau*, In: I. Bertrand (ed.) *Le travail de l'os, du bois de cerf et de la corne a l'époque romain: un artisanat en marge? Actes de la table ronde instrumentum, Chauvigny (Vienne, F), 8-9 décembre 2005*, Monographies Instrumentum 34, Montagnac: M. Mergoil, 335-42.

Lang, F. 2008b. *eborarii* und *citriarii*. *Bemerkungen zu zwei Berufsbezeichnungen in römischer Zeit*, Diomedes. Schriftenreihe des Fachbereiches Altertumswissenschaften, Alte Geschichte, Altertumskunde und Mykenologie der Universität Salzburg, NF 4, 47-55.

Lang, F. 2008c. *Zur Herstellung von Messergriffschalen aus Geweih in Flavia Solva. Internationaler Kongress CRAFTS 2007 – Handwerk und Gesellschaft in den römischen Provinzen, Universität Zürich (Schweiz), 1. März – 3. März 2007*, Zeitschrift für Schweizerische Archäologie und Kunstgeschichte 65, 133-6.

Lang, F. and K. Knauseder 2008. *Überlegungen zum so genannten Handwerkerviertel von Iuvavum/Salzburg*, In: C. Franek, S. Lamm, T. Neuhauser, B. Porod and K. Zöhrer (eds.) *THIASOS. Festschrift für Erwin Pochmarski zum 65. Geburtstag*, Wien: Phoibos, 559-65.

MacGregor, A. 1985. *Bone, Antler, Ivory and Horn. The technology of Skeletal Materials since the Roman Period*. London & Sydney: Barnes & Noble.

MacGregor, A. 1991. *Antler, Bone and Horn*, In: J. Blair and N. Ramsey (eds.) *English Medieval Industries: Craftsmen, Techniques, Products*, London: The Hambledon Press, 355-78.

Mikler, H. 1997. *Die römischen Funde aus Bein im Landesmuseum Main*, Monographies instrumentum 1. Montagnac: M. Mergoil.

Moosbauer, G. 1999. *Handwerk und Gewerbe in den ländlichen Siedlungen Raetiens vom 1. bis zum 4. Jahrhundert nach Christus*, In: M. Polfer (ed.) *Artisanat et productions artisanales en milieu rural dans les provinces du nord-ouest de l'Empire romain. Actes du colloque d'Erpeldange, mars 1999*, Monographies Instrumentum 9, Montagnac: M. Mergoil, 217-234.

Obmann, J. 1997. *Die römische Funde aus Bein von Nida-Heddernheim*, Schriften des Frankfurter Museums für Vor- und Frühgeschichte 13. Bonn: Habelt.

Petrikovits, H.v. 1981a. *Die Spezialisierung des römischen Handwerks*, In: H. Jankuhn, W. Janssen, R. Schmidt-Wiegand and H. Tiefenbach (eds.) *Das Handwerk in vor- und frühgeschichtlicher Zeit 1. Historische und rechtshistorische Beiträge und Untersuchungen zur Frühgeschichte der Gilde*, Göttingen: Akademie der Wissenschaften, 63-132.

Petrikovits, H.v. 1981b. *Die Spezialisierung des römischen Handwerks 2 (Spätantike)*, Zeitschrift für Papyrologie und Epigraphik 43, 285-306.

Polfer, M. 2008. *Zur Rolle des städtischen Handwerks in der Wirtschaft der römischen Provinz Gallia Belgica auf der Grundlage der archäologischen, epigraphischen und ikonographischen Quellen. Internationaler Kongress CRAFTS 2007 – Handwerk und Gesellschaft in den römischen Provinzen, Universität Zürich (Schweiz), 1. März – 3. März 2007*, Zeitschrift für Schweizerische Archäologie und Kunstgeschichte 65, 37-42.

Prévot, P. 2008. *État des connaissances sur la production de l'os à Orange (Vaucluse, F). Étude et comparaison des ateliers du travail de l'os*, In: I. Bertrand (ed.) *Le travail de l'os, du bois de cerf et de la corne a l'époque romain: un artisanat en marge? Actes de la table ronde instrumentum, Chauvigny (Vienne, F), 8-9 décembre 2005*, Monographies Instrumentum 34, Montagnac: M. Mergoil, 195-229.

Pugsley, P. 2001. *Trends in Roman domestic woodwork; bright ideas and dead ends*, In: M. Polfer (ed.) *L'artisanat romaine: evolutions, continuités et ruptures (Italie et provinces occidentals), Actes du 2e colloque d'Erpeldange 26-28 octobre 2001*, Monographies Instrumentum 20, Montagnac: M. Mergoil, 111-6.

Richardson, L. 1992. *A new topographical Dictionary of ancient Rome*. Baltimore: The Johns Hopkins University Press.

Riha, E. 1990. *Der römische Schmuck aus Augst und Kaiseraugst*, Forschungen in Augst 10. Augst: Römermuseum.

Rijkelijkhuizen, M. 2009. *Whales, Walruses, and Elephants: Artisans in Ivory, Baleen, and Other Skeletal Materials in Seventeenth- and Eighteenth-Century Amsterdam*, International Journal of Historical Archaeology 13, 409-29.

Röber, R. 1995. *Zur Verarbeitung von Knochen und Geweih im mittelalterlichen Südwestdeutschland*, Fundberichte aus Baden-Württemberg 20, 885-944.

Rodziewicz, E. 1998. *Archaeological evidence of bone and ivory carvings in Alexandria*, In: J.-Y. Empereur (ed.) *Commerce et Artisanat dans l'Alexandrie Hellénistique et Romaine. Actes du colloque d'Athènes, 11-12 décembre 1988*, Bulletin de Correspondance Hellénique, Suppl. 33, Athen: Ecole Française d'Athènes, 135-58.

Rothenhöfer, P. 2005. *Die Wirtschaftsstrukturen im südlichen Niedergermanien. Untersuchungen zur Entwicklung eines Wirtschaftsraumes an der Peripherie des Imperium Romanum*, Kölner Studien zur Archäologie der römischen Provinzen 7, Rahden/Westf.: Verlag Marie Leidorf.

Ruffing, K. 2008. *Die berufliche Spezialisierung in Handel und Handwerk. Untersuchungen zu ihrer Entwicklung und zu ihren Bedingungen in der römischen Kaiserzeit im östlichen Mittelmeerraum auf der Grundlage griechischer Inschriften und Papyri*, Pharos. Studien zur griechisch-römischen Antike 24, Rahden/Westf.: Verlag Marie Leidorf.

Schlesier, E. 1981. *Ethnologische Aspekte zu den Begriffen 'Handwerk' und 'Handwerker'*, In: H. Jankuhn, W. Janssen, R. Schmidt-Wiegand and H. Tiefenbach (eds.) *Das Handwerk in vor- und frühgeschichtlicher Zeit 1. Historische und rechtshistorische Beiträge und Untersuchungen zur Frühgeschichte der Gilde*, Göttingen: Akademie der Wissenschaften, 9-35.

Schlippschuh, O. 1987. *Die Händler im römischen Kaiserreich in Gallien, Germanien und den Donauprovinzen Rätien, Noricum und Pannonien*. Amsterdam: Hakkert.

Schneider, H. 2008. *Das römische Handwerk in althistorischer Sicht. Internationaler Kongress CRAFTS 2007 – Handwerk und Gesellschaft in den römischen Provinzen, Universität Zürich (Schweiz), 1. März – 3. März 2007,* Zeitschrift für Schweizerische Archäologie und Kunstgeschichte 65, 11-6.

Thuet, A. 2008. *Le trevail de l'os dans l'antique Samarobriva (Amines, F): première approche*, In: I. Bertrand (ed.) *Le travail de l'os, du bois de cerf et de la corne a l'époque romain: un artisanat en marge? Actes de la table ronde instrumentum, Chauvigny (Vienne, F), 8-9 décembre 2005*, Monographies Instrumentum 34, Montagnac: M. Mergoil, 35-45.

Vallet, C. 1994. *Les indices d'un atelier gallo-romain de fabrication de charnières en os à Augustoritum*, Travaux d'Archéologie Limousine 14, 105-13.

Magdalena Konczewska

Bone, horn and antler working in medieval Wrocław

Medieval bone, horn and antler items excavated in Wrocław include toilet and textile combs, playing pieces, beads, buttons, buckles, knife handles, pins, saddle fittings, crossbow-nuts, needles, styli, sledge runners, skates and many other objects.

The remains of workshops and concentrations of waste material were discovered at more than ten archaeological sites in Wrocław dated between the 13th to the 15th centuries.

The aim of this paper is an attempt of comparison of the results of archaeological excavations with written sources and a state of the location of places producing the wares from bone, horn and antler as well as determination of the raw material preferences and sources of supply in raw material.

Key words: bone, horn, antler, medieval Wrocław, workshop

During the Middle Ages, a wide range of artefacts were made of skeletal materials (Fig. 1). Medieval bone, horn and antler items excavated in Wrocław include – but are not limited to – the following: toilet and textile combs, playing pieces (dice, counters, and chessmen), beads, buttons, buckles, knife handles, pins, saddle fittings, crossbow nuts, needles, styli, sledge runners, and skates (Jaworski 1990; 1995:145-154; 1999:70-92; 2007: 511-522; Wiśniewski 1993:319-337; Wiśniewski, Tymciów, Łaciuk 1994:379-381; Jastrzębski 1999:89-99; 2004: 245-267; Wachowski 1999:184, Fig. 1:4; Konczewska 2010a:245-252, Fig. 164, 166).

It is worth emphasizing that the raw materials used by Wrocław's late-medieval craftsmen were not determined on a purely arbitrary or expedient basis. Rather, these artisans intentionally selected sources of raw material according to task, and one may perceive a particular focus on cattle metapodial bones, cattle horn and occasionally antler. They rarely used bones of other species of animals (Jaworski 1998:73-81; 1999:71-88). Moreover, their industries were defined in terms of the products they produced, rather than the raw materials they consumed. Thus, the combmaker made combs of bone, horn, wood and antler (MacGregor 2001:367). The choice of material was determined by the taste, preferences, and means of the consumer. Progressive urbanisation and limited forest access played a certain role in moving away from antler as a major raw material (Ulbricht 1984:73; MacGregor 2001:366-367). With this in mind, it is significant that in Wrocław the quantity of bone artefacts always seems to have surpassed the number of antler articles. For instance, only 20% of the all faunal items discovered in early medieval Ostrów Tumski were made of antler (Jaworski 1990:19, 22).

Bone and horn were available as by-products of meat consumption, and of the skinner's and tanner's trades. Thus, to the late-medieval craftsmen, bone was potentially a more accessible raw material than antler (see Müller 1992; Gręzak, Kurach 1996). Cattle bone was preferred for its year-round availability, for its (probable) low price, and for its aesthetic and physical properties: colour, shape, size and thickness (Krysiak 1987:230; Jaworski 1998:81-84). In particular, cattle metapodials, (both metatarsus and metacarpus) were used in the manufacture of a wide range of objects, including combs, beads, buttons, and dice. In addition, cattle horn (the ke-

Fig. 1. Late medieval artefacts from Wrocław: a – cattle bone and horn waste, Szewska Street, b – bone waste from bead making, Łaciarska Street, c – bone combs, Szewska/Uniwersytecka Street, d – bone/antler buckle, Szewska/Uniwersytecka Street

ratinous sheath itself) was suitable for the production of combs, but our knowledge of hornworking is confounded by the material's poor survival potential under normal burial conditions.

The development of medieval Wrocław as complicated and multipart urban structure is the subject of detailed studies of both archaeologists and historians[1]. Large-scale excavations in the Old Town provide valuable material for understanding the material culture of the inhabitants of Wroclaw and enable identification of the possible location of workshops, including those involved in the processing of bone, horn and antler.

The remains of workshops and concentrations of waste material were discovered at more than ten archaeological sites in Wrocław, dated between the 13th and 15th centuries (Jaworski 2007:511-512, 519, Fig. 4, 521-522). This evidence appears in the form of detached horncores with traces of sheath-removal, lower limb bones (generally of cattle, and particularly discarded proximal and distal ends of metapodials), by-products, semi-manufactures, and unfinished wares. The results of archaeological excavations were compared with written sources (Tab.1, Fig. 2, 3). It is difficult to identify in the historical records the craftsmen who may have carried out this sort of work, and for that reason archaeological studies are very important. According to documentary and archaeological evidences the workshops of combmakers, needlemakers, rosary and dicemakers

[1] Results of the archaeological research on medieval Wrocław are published cyclically in the *Wratislavia Antiqua* series.

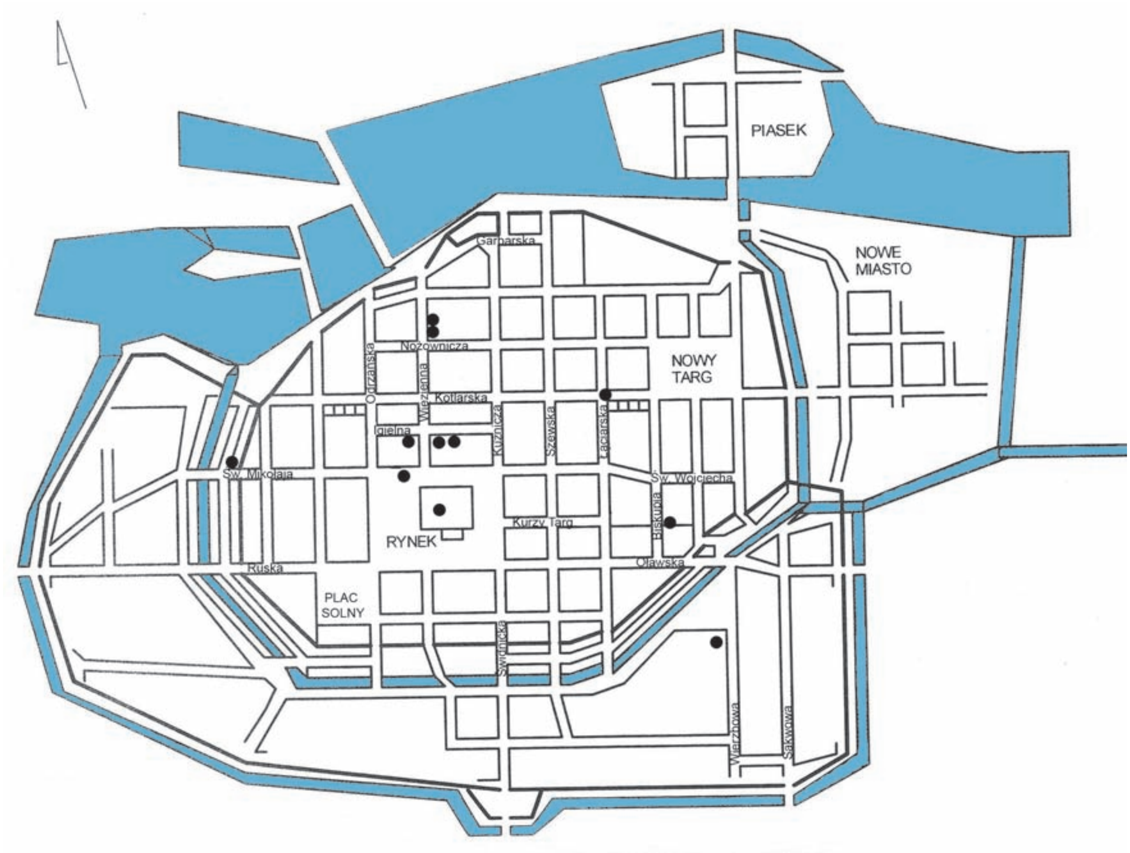


Fig. 2. Plan of Wrocław. Archaeological sites at which bone, horn and antler waste were found, and interpreted by K. Jaworski as workshops (after Jaworski 2007)

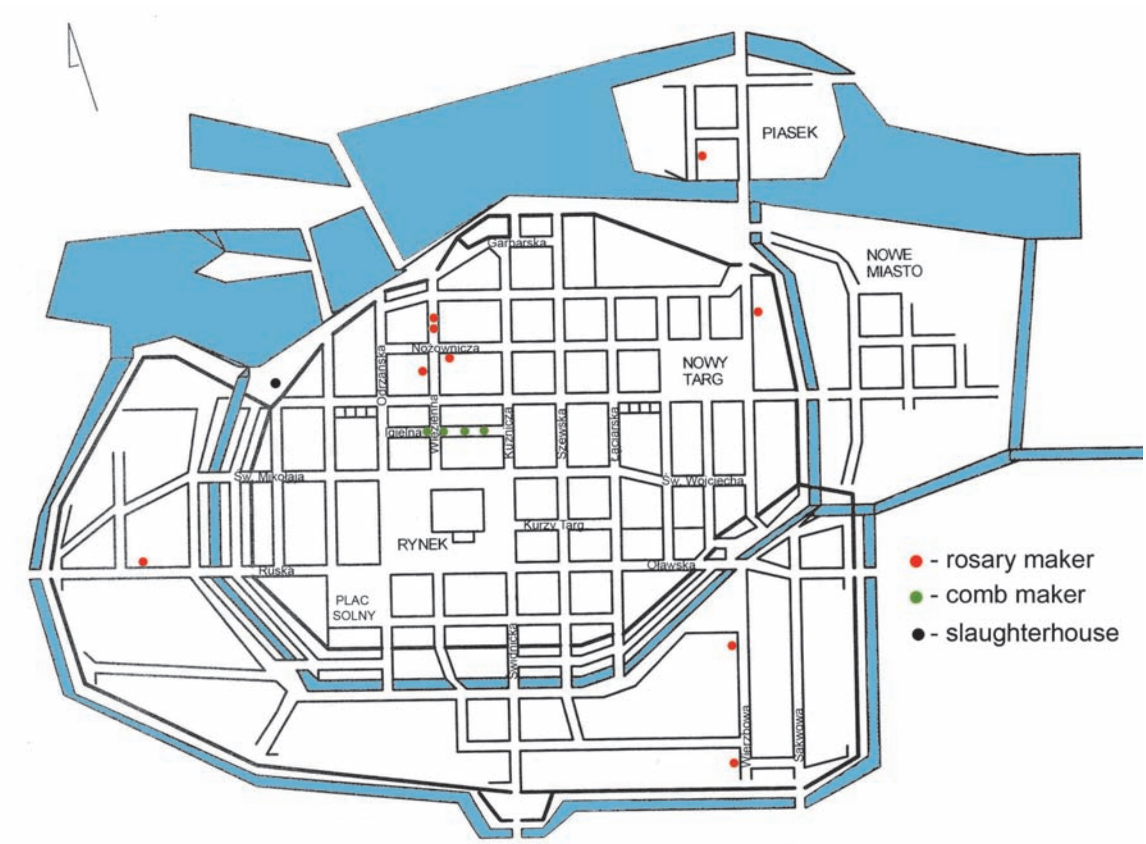


Fig. 3. Plan of Wrocław. Historically attested locations of comb and rosary-makers in 1403 (after Goliński 1997)

were located in the Butcher's Quarter, in the area to the north of the Market Square (Rynek), and its north-western part (Jaworski 2007). Bone, horn and antler could also be used by a range of other professions, including crossbow-makers, turners, belt-makers, saddlers, cutlers, and joiners. A list of lower-class tax payers working in Wrocław in the year 1403 mentions: 4 combmakers, 9 rosarymakers (paternosterer), 21 needlemakers, 60 cutlers, 7 saddlers, 33 belt-makers, 4 turners, 3 crossbow-makers, and 9 joiners (Goliński 1997:370-380; 477-480, maps 26-30).

At 6-8 Sukiennice (the Cloth Hall) two pits (no 12, 13) dated to the half of the 13th and 13/14th centuries were interpreted by explorers as workshops. Their chief outputs appear to have been dice and (probably) textile combs. The 1,500 artefacts recovered in this pits and in their neighbourhood included bone waste from dice-making, as well as semi-manufactures, unfinished and completed dice. Also present were a lead-filled first *Bos* phalanx, and several fragmentary textile combs (Wiśniewski 1993:325, 332, 337; Wiśniewski *et al.* 1994:379-381). In the younger pits – no 13, implements identified included a stone plate and stone polisher (Wiśniewski 1993: 325, 337, Fig. 12:7-9). The oldest documentary reference to Wrocław's Cloth Hall dates to 1242. Archaeological investigation in the middle of the Market Square indicates that initially the Cloth Hall simply consisted of a number of temporary wooden structures. These served as the main market, and were accompanied by workshops producing dice and other goods (see above). The brick-built Cloth Hall was constructed in the second half of the 13th century (Goliński1991:19-25; 1997:24).

A quantity of cattle scapulae, semi-manufactures, and bone-working debris (over 1,800 bones in total) were found in the north-western part of the Market Square. These have been interpreted as saddle fittings, and associated with the workshops of saddlers. Tellingly, the stalls of saddlers in this area are recorded in written sources from the 14th century (Goliński 1997:25; Jastrzębski 1999:89-90, 96-99; Jaworski 2007:517-518).

A certain amount of handles, horn- and bone-working waste uncovered at Nicolaus Street and dated between the 14th and 15th centuries should presumably be connected with cutlers (Tab. 1). In England, the medieval Cutlers' Company of London included not only the cutlers who assembled and marketed the finished products, but also blade smiths, sheathers, and – most importantly for us – hafters. These last made handles of every material, combining work in bone, horn and ivory with metalwork (McGregor 2001:367).

Large quantities of cattle bone and horn waste (130 metapodials and 148 horncores) come from cultural layers and rubbish pits discovered at 18 Igielna (Needle Street). It is interesting that any unfinished articles and semi-manufactures were noted. Four textile combs and one double-sided toilet comb were excavated from the site, as well as four playing pieces made of sheep/goat phalanges. Krzysztof Jaworski supposes that this site housed a workshop to produce combs. Interestingly, on the basis of archival documents medieval Igielna Street was inhabited by combmakers as well as producers of needles and needle-cases (Goliński 1990: 268; Jaworski 2002:213-214).

At 14 Igielna, 47 fragments of bone and horn waste had accumulated in the oldest stratigraphic layers, associated with a wooden construction dated to the beginning of the 14th century. Most of the waste fragments relate to the production of toilet combs, but the manufacture of dice and beads was also evidenced (Buśko *et al.* 1996:261-275). At 8 Igielna, a collection of antler blanks which have been drilled with holes attests to the production of prayer beads (Piekalski 1991:151).

Waste material at Biskupia Street shows evidence of the production of dice and rosaries in vicinity of this area (Borkowski, Gierczak 1995:221-227; Jaworski 2007:518-519), while, according to Krzysztof Jaworski (1999:92), at 10-11 Więzienna there were probably three workshops active in the production of toilet combs (one existed in the 2nd half of the 13th century and the second — in 14th century) and rosary beads (in 15th century). It is thus notable that from this area come two horn double-sided simple (i.e. one-piece) combs (Jaworski 1999: Fig. 22). Such finds are very rare, as keratinous objects rapidly decay in the soil. Finally, a certain quantity of bone and horn waste material was also discovered in cultural layers during the excavations under the pavement of the Szewska and Łaciarska Streets (Konczewska 2010b:265-267, 378-380).

The oldest evidence of the craftsman's activity in Wrocław come from the 1st half of the 13th century (6-8 Sukiennice and 8 Igielna), and the youngest from 15th century (10-11 Więzienna, 3 Wierzbowa, as well as Mikołaja and Biskupia Streets). Archaeological studies confirm the presence of workshops specializing in the processing of bone, horn and antler in the places mentioned in written sources from the 14th and early 15th century. Chronology of the discovered artifacts indicates that some of them existed much earlier – in the 13th century, what may suggest long-duration of workshops in discussed area. Probably their location were influenced by neighborhood of slaughterhouses and butcher stalls, which were the main source of raw material supply for craftsmen. The range of products manufactured in Wrocław does not differ from other well-known urban centers of the Western Europe. This is probably due to the standardization of production in this cultural tradition.

The oldest and most complete list of the guild's organizations in Wrocław are *iura omnium mechanicorum et operariorum ciuitati Wratizlauie* dating back to around the year 1300, and contained in a wider statute book known as the charters of Wrocław craft (Goliński 1991:62-63). The first references to the needle-case makers – the producers of bone, antler and wood containers designed to hold needles – occur in this register. Mateusz Goliński suggests that at the time of this edition of the guild's act, the term needle-case makers also encompassed combmakers and manufacturers of a range of other articles: the styli used in writing on wax tablets, knife and tool handles, pins, playing pieces, and pendants (Goliński 1991:98-99). Presumably then, the production of needle-cases and combs had a pedigree as part of one of the oldest of the craft specialisms involving the processing of bone, horn and antler. The evidence for bone, horn and antler working at the Nowy Targ (New Market) between the 12th century and the first half of the 13th is testimony to domestic handicraft (producing toggles, pins, sledge runners, skates, and simple combs) and to the manufacture of items by and for the use of craftsmen of other specialities (e.g. awls, needles, and handles). In the late Middle Ages, producers of needle-cases were recorded together with combmakers, and their workshops were located in the present Igielna (Needle Street). In 1390, this street appears in historical sources as Nadelnergasse (Needle Street), and in 1398 as Kemmergasse (Comb Street) (Goliński 1990:268, 1997:373, tab. 47, 53). On the basis of archival documents, such as the 1389 and 1420 lists of guilds we know that combmakers and needlemakers organized themselves as parts of a single guild (Fig. 4), while in 1420 both professions are mentioned together with rosary-makers (paternosterer), wire-makers, hook and eye-makers and melters of tin (Goliński1997:462, Tab. 120). We should also remember the importance of domestic handicraft, which in 13th-15th century Wrocław, was responsible for the production of sledges, skates, toggles, pins and other simple articles, according to the maker's own needs.

Fig. 4. Coffin cartouche of the comb, rosary and needlemaker's guild from Wrocław, 1603 (after Marcisz 2002)

Table. 1. Late medieval archeological sites in Wrocław with evidence for bone, horn and antler processing

Archeological site	Waste			Unfinished product	Profile of the manufacture	Chronology
	Bone	Horn	Antler			
North-western part of the Market Square	+	+	+	+	Linings, toilet combs, playing pieces	The end of the 13th – 14th
Więzienna 10-11 (Prison Street)	+	+	–	+	Toilet combs Rosary beads	The second half of the 13th 14th 15th
Sukiennice 6-8 (Cloth Hall Street)	+	+	?	+	Dice, textile combs	The half of the 13th and 13/14th
Igielna 18 (Needle Street)	+	+	–	–	Combs?	The second half of the 13th – the first half of the 14th

Igielna 8	–	–	+	–	Rosary beads	The first half of the 13^{th}
Igielna 14	+	+	?	–	Toilet combs, rosary beads, dice	The beginning of the 14^{th}
Mikołaja 23 (Nicolaus Street)	+	+	–	–	Processing of cattle horn sheath	14^{th}-$14/15^{th}$
Mikołaja 24	+	+	–	–	Knife handle Rosary beads	14^{th}-$14/15^{th}$ 15^{th}
Mikołaja 25	+	+	–	–	Processing of cattle horn sheath	15^{th}
Mikołaja 26	+	+	–	–	Rosary beads, dice	15-$15/16^{th}$
Biskupia (Episcopal Street)	+	–	–	–	Dice, rosary beads	15^{th} – the beginning of the 16^{th}
Kotlarska (Coppersmith Street)	+	?	?	+	Textile combs	13^{th} (?)
Wierzbowa 3 (Willow Street)	+	–	+	–	Rosary beads?	14-15^{th}

References

Borkowski, T. and P. Gierczak 1995. *W kwestii produkcji różańców i kości do gry w późnośredniowiecznym Wrocławiu*, Kwartalnik Historii Kultury Materialnej 43(2), 221-7.

Buśko, C., M. Chorowska and J. Piekalski 1996. *Średniowieczna działka mieszczańska przy ulicy Igielnej 14 we Wrocławiu*, Śląskie Sprawozdania Archeologiczne 37, 261-75.

Goliński, M. 1990. *Topografia zawodowa Starego Miasta we Wrocławiu w XIII w.*, Śląski Kwartalnik Historyczny 45(3), 257-76.

Goliński, M. 1991. *Podstawy gospodarcze mieszczaństwa wrocławskiego w XIII w.*, Historia 85, Acta Universitatis Wratislaviensis 1333, Wrocław.

Goliński, M. 1997. *Socjotopografia późnośredniowiecznego Wrocławia (przestrzeń – podatnicy – rzemiosło),* Historia 134, Acta Universitatis Wratislaviensis 2010, Wrocław: Uniwersytet Wrocławski.

Grężak, A. and B. Kurach 1996. *Konsumpcja mięsa w średniowieczu oraz w czasach nowożytnych na terenie obecnych ziem Polski w świetle danych archeologicznych*, Archeologia Polski 41(1-2), 139-67.

Jastrzębski, A. 1999. *Produkcja rogownicza na wrocławskim rynku w 2 poł. XIII i w XIV wieku*, In: M. Ježek and J. Klápště (eds.) *Mediaevalia Archaeologica* 1, 89-99.

Jastrzębski, A. 2004. *Wybrane aspekty życia codziennego w średniowiecznym Wrocławiu na podstawie wyrobów kościanych i rogowych*, In: J. Piekalski and K. Wachowski (eds.) *Wrocław na przełomie średniowiecza i czasów nowożytnych. Materialne przejawy życia codziennego,* Wratislavia Antiqua 6, Wrocław: Uniwersytet Wrocławski, 245-67.

Jaworski, K. 1990. *Wyroby z kości i poroża w kulturze wczesnośredniowiecznego Ostrowa Tumskiego we Wrocławiu*, Wrocław-Warszawa: Volumen.

Jaworski, K. 1995. *Wytwórczość kościanych i rogowych przedmiotów w późnośredniowiecznym Wrocławiu*, In: K. Wachowski (ed.) *Kultura średniowiecznego Śląska i Czech. Miasto*, Wrocław: Uniwersytet Wrocławski, 145-54.

Jaworski, K. 1998. *Wytwórczość rogownicza we Wrocławiu przed i po XIII-wiecznym przełomie*, In: K. Wachowski (ed.) *Kultura średniowiecznego Śląska i Czech. „Rewolucja" XIII wieku*, Wrocław: Uniwersytet Wrocławski, 73-86.

Jaworski, K. 1999. *Ślady obróbki surowca kościanego i rogowego*, In: C. Buśko and J. Piekalski (eds.) *Ze studiów nad życiem codziennym w średniowiecznym mieście. Parcele przy ul. Więziennej 10-11 we Wrocławiu*, Wratislavia Antiqua 1, Wrocław: Uniwersytet Wrocławski, 70-92.

Jaworski, K. 2002. *Działka mieszczańska Rynek 50 – Igielna 18. Pracownie rogownicze*, In: J. Piekalski (ed.) *Rynek wrocławski w świetle badań archeologicznych, cz. II*, Wratislavia Antiqua 5, Wrocław: Uniwersytet Wrocławski, 213-35.

Jaworski, K. 2007. *Rzemieślnicza obróbka surowca kościanego i rogowego w późnośredniowiecznym Wrocławiu,* Archaeologia historica 32, 511-25.

Konczewska, M. 2010. *Kultura materialna publicznej przestrzeni miasta w świetle zabytków ruchomych. Rozrywka*, In: J. Piekalski and K. Wachowski (eds.) *Ulice średniowiecznego Wrocławia*, Wratislavia Antiqua 11, Wrocław: Uniwersytet Wrocławski, 245-56.

Konczewska, M. 2010. *Kultura materialna publicznej przestrzeni miasta w świetle zabytków ruchomych. Odpady po produkcji rogowniczej*, In: J. Piekalski and K. Wachowski (eds.) *Ulice średniowiecznego Wrocławia*, Wratislavia Antiqua 11, Wrocław: Uniwersytet Wrocławski, 265-7.

Krysiak, K. 1987. *Anatomia zwierząt*, t. 1, Warszawa: Państwowe Wydawnictwo Naukowe.

MacGregor, A. 2001. *Bone, Horn and Antler*, In: J. Blair and N. Ramsey (eds.) *English Medieval Industries: Craftsmen, Techniques, Products*, London: Hambledon Press, 355-78.

Marcisz, B. 2002. *Cechowe pieczęcie i tłoki pieczętne*, In: M. Korżel-Kraśna (ed.) *Zabytki cechów śląskich*, Wrocław: Muzeum Narodowe, 9-145.

Müller, H. 1992. *Archaeozoological research on vertebrates in central Europe with special reference to the Medieval period*, International Journal of Osteoarchaeology 2, 311-24.

Piekalski J. 1991. *Przyczynek do kwestii spożycia i dystrybucji mięsa w średniowiecznym Wrocławiu*, Kwartalnik Historii Kultury Materialnej 39(2), 139-52.

Ulbricht I., 1984. *Die Verarbeitung von Knochen, Geweih und Horn im mittelalterlichen Schleswig*, Ausgrabungen in Schleswig: Berichte und Studien 3, Neumünster.

Wachowski, K. 1999. *Militaria*, In: C. Buśko and J. Piekalski (eds.) *Ze studiów nad życiem codziennym w średniowiecznym mieście. Parcele przy ul. Więziennej 10-11 we Wrocławiu*, Wratislavia Antiqua 1, Wrocław: Uniwersytet Wrocławski, 183-6.

Wiśniewski, Z. 1993. *Rezultaty ratowniczych badań archeologicznych na starym Mieście we Wrocławiu przy ulicy Sukiennice*, Śląskie Sprawozdania Archeologiczne 34, 319-37.

Wiśniewski, Z., Tymciów, W. and A. Łaciuk 1994. *Sprawozdanie z drugiego etapu badań ratowniczych przy ul. Sukiennice 5-8 we Wrocławiu*, Śląskie Sprawozdania Archeologiczne 35, 379-81.

Kamilla Pawłowska

The remains of a late medieval workshop in Inowroclaw (Kuyavia, Poland): horncores, antlers and bones

Worked animal bone constitutes one type of archaeological relic—alongside pottery, postconsumption animal bones, toothed saw blades, and lathe discs—recovered from site 19 in Inowrocław (Kuyavia Lake District, central Poland).

Site 19 is a piece of land belonging to a convent which contains some wooden buildings. The Franciscan nuns made the land available to the townspeople in the Late Middle Ages. Around the wooden buildings were found numerous signs of workshop activity, in the form of worked fragments of horncore, antler, and bone (n=347). Worked elements are classified into three categories, depending on whether they belong to the primary, secondary, or tertiary stage of the manufacturing process. Craft materials, semi-finished products, unfinished products, and finished products are all present. Products were prepared on-site, from the preliminary processing of material to the final stage of production, as exemplified by the diverse elements of facings and combs present. In most cases (about 60%), the elements of all three groups are waste. The analysed bone material represents the remnants of a late medieval workshop. The profile of the workshop indicates that mostly horncores (which dominate in the material) and antlers were worked on. The elements are derived mainly from goats, cattle, and red deer.

Most of the approximately 350 worked horncores, antlers, and bone fragments came from domestic mammals (60%, n=218), with about 30% (n=96) coming from wild mammals and 10% from fish (n=1), mammals (n=32).

Key words: zooarchaeology, worked bone, workshop, Late Middle Ages, Kuyavia, Poland

Introduction and purpose of study

Inowrocław is located in the Kuyavia Lake District, central Poland (Fig. 1). Archaeological research in this locality has identified a number of sites, and of particular interest is that known as site 19. This is located on Klasztorny Square, an area which between the 13th and 19th centuries belonged to a Franciscan convent.

Under the direction of Marcin Wozniak, excavations at this site discovered the architectural remains of the Franciscan convent, a medieval church, and, to the west of these (on land owned by the convent, but which may have been made available to the townspeople in the Late Middle Ages; Wozniak, pers. com.), a range of wooden buildings. Numerous indications of workshop activity were identified in the area around the wooden buildings; the evidence comes primarily in the form of worked fragments and waste of horncore, antler, and bone.

Systematic overview of the material will be presented in separate paper.

The main purpose of this paper is to answer the question of whether they were produced in the analyzed site and what was the profile of the workshop. This paper also describes differences in the production of objects made from antlers and objects made from long bones, and also attempts to identify the technological process employed and to reconstruct the tools used.

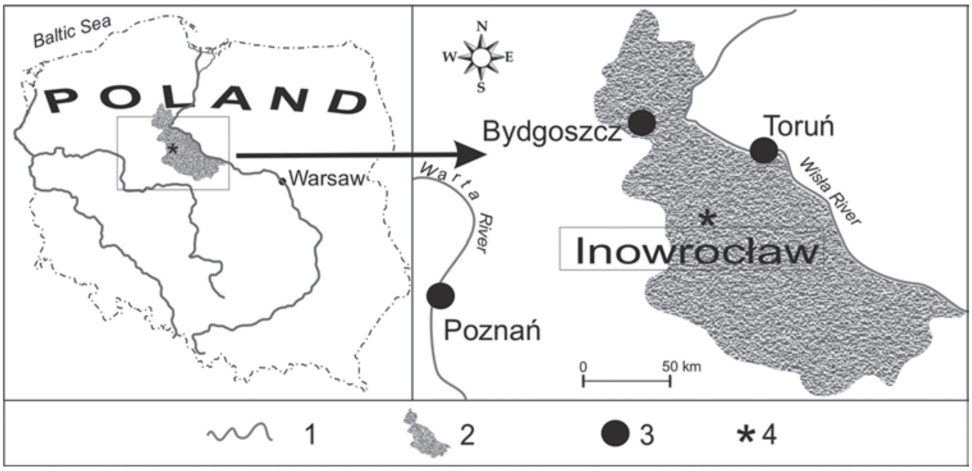


Fig. 1. Map of Poland showing location of site. 1 – main rivers, 2 – range of Kuyavia Lake District, 3 – main cities, 4 – Inowrocław site

Material

Alongside pottery and artefacts such as saw blades and the discs from lathes, animal bone constitutes a significant component of the finds assemblage. In total, about 7,800 animal bones were recovered, though this includes material relating to the consumption of food, as well as that which clearly evidences manufacturing. This paper is concerned with the latter group.

There are approximately 350 fragments of worked horncore, antler, and bone, and most of this material comes from domestic mammals (60%, n=218). Wild mammals account for 30% (n=96). The elements are derived mainly from goats (*Capra hircus)* (n=88), cattle (*Bos taurus*) (n=84), and red deer (*Cervus elaphus*) (n=69) (each constituting about 20% of the remains) (Fig. 2). Bones from other animals (n=73) – such as sheep (*Ovis aries*), horse (*Equus caballus*), moose (*Alces alces*), pig (*Sus domestica*), roe deer (*Capreolus capreolus*), bear (*Ursus sp.*), and aurochs (*Bos primigenius*) – occurred in smaller proportions.

Anatomically, the elements consist primarily of horncores (n=125), antlers (n=90), metatarsals (n=56), and metacarpals (n=22). Other elements (n=54) – such as scapulae, ribs, phalanges, radii, tibiae, femora, teeth, skull bones, and mandibles – are found with frequencies between 0.3% and 3% (Fig. 3).

Taphonomic evidence indicates that food remains were also used in craft: there are cuts and chops marks on the surfaces of certain elements (17% of the total material). The left horncore of an aurochs (in which

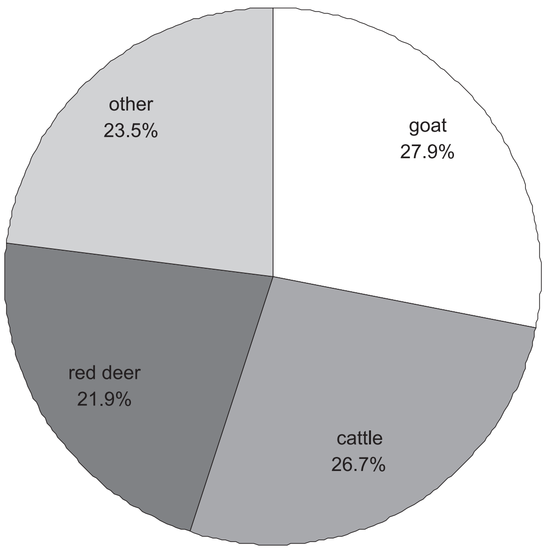


Fig. 2. Taxonomic distribution of bones by NISP (n=314)

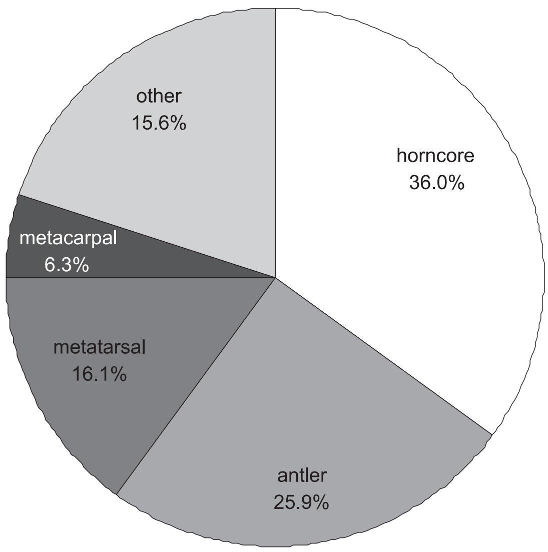


Fig. 3. Anatomical distribution of bones by NISP (n=347)

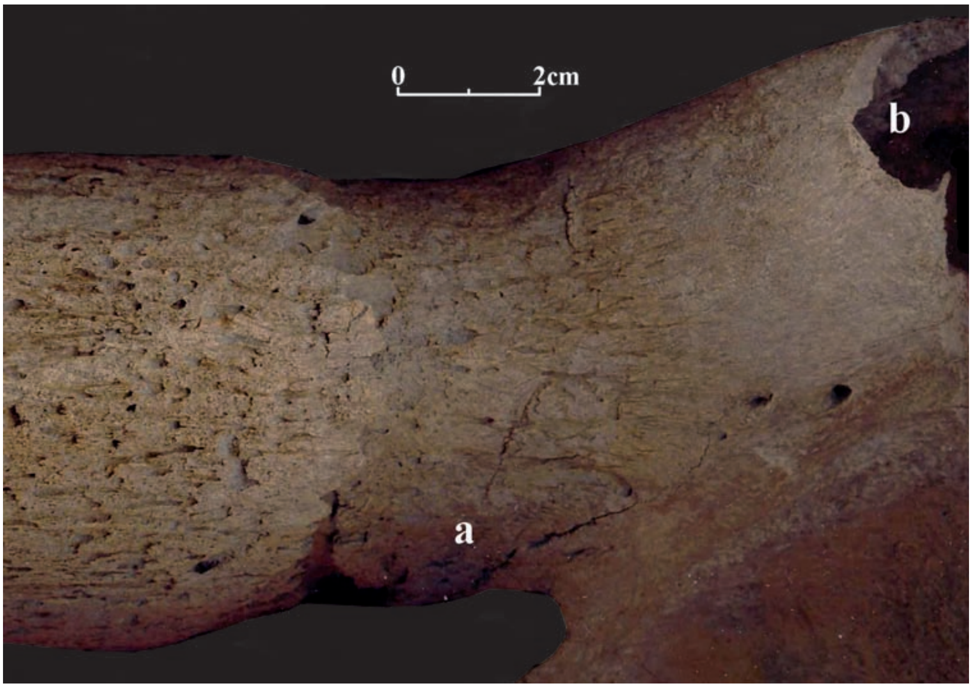


Fig. 4. Horncore of an aurochs with marks of skinning (a) and chopping (b).
Photo K. Pawłowska

Fig. 5. Preworked material for crafting. Metatarsal of cattle. Photo K. Pawłowska

Fig. 6. Semi- finished product of knuckle bone. Photo K. Pawłowska

Fig. 7. Pottery comb. Photo K. Pawłowska

Fig. 8. Textile comb. Photo K. Pawłowska

Fig. 9. Toggle button for clothing. Photo K. Pawłowska

a fragment of the frontal bone is retained) provides a nice example of an element bearing visible indications of anthropogenic intervention. The horncore features two types of anthropogenic mark: chopmarks, and cuts related to skinning (Fig. 4a and 4b).

Spatial analysis of the worked-bone findspots failed to reveal concentrations of any one category of find (*e.g.* raw materials, semi-manufactures, complete products, or waste) as the spatial organization of the workshop on this site.

Stages of the manufacturing process

The majority of bone-, antler-, and horn-working debris is easily characterised according to a tripartite classification in which waste may relate to the primary, secondary, or tertiary phases of the manufacturing process (a distinction developed from chaîne opératoire analysis of lithics, and applied by Niall Sharples in his analysis of antler waste from Bornais, South Uist; see also Ashby 2005). These phases can be described as follows:

• The primary stage is represented in the archaeological record by large pieces of bone or antler in which gross morphology is still clear, but which bear visible marks of chopping, cutting, or sawing. This waste represents the preliminary processing of unworked material into smaller, workable pieces.

• The secondary stage may be recognized by the presence of half-worked or discarded blanks. Antler may be stripped of all porous core material, while longbones may be split longitudinally into segments. At this stage, preworked pieces begin their transformation into finished artefacts or components (e.g. the connecting plates or billets of composite combs).

• The tertiary stage of manufacture includes the final phases of production, such as the cutting of comb teeth, decoration, and riveting together of components. The elements are finished by trimming and smoothing.

Results

The remains from the Inowrocław site may be sorted into the following groups, corresponding to the three stages of manufacture outlined above:

a) those bone, horn, or antler elements that represent raw materials intended for use in craft, but which were subsequently unworked (though some examples may have been preworked) (Fig. 5);

b) the semi-manufactures and unfinished products produced using the above materials (such as the knuckle bone in figure 6 and textile combs – Fig. 8). Debris was found from first and second groups.

Some products in studied material may be readily assigned to one of the following classes of objects, as categorized by Lasota-Moskalewska (1997) with modifications:

• Decorative objects (*e.g.* beads)

• Tools (*e.g.* pottery combs – Fig. 7)

• Domestic equipment (*e.g.* handles and bipartite ‘facings’ to cover knife handle

• Items associated with dress/ appearance (*e.g.* combs, toggles or buttons for clothing – Fig. 9)

• Items connected with entertainment (*e.g.* whistles? pipes?)

The analysed elements in material, in most cases (about 60%) are waste (for example: goat and sheep horncores with their ends cut off; branching segments and coronets from red deer antlers; proximal and distal ends of cattle metacarpals and metatarsals; defective facings and clothing toggles; unfinished or discarded pieces of textile combs) (Fig. 10).

Of the remains of raw materials suitable for working (bone, antler, and horn) horn is the most well represented (in the form of horncores). It is interesting that in the finds material there are neither products made from horn (such as combs), nor any evidence that this material was used for making glue, despite the fact that two ways are recorded for separating the

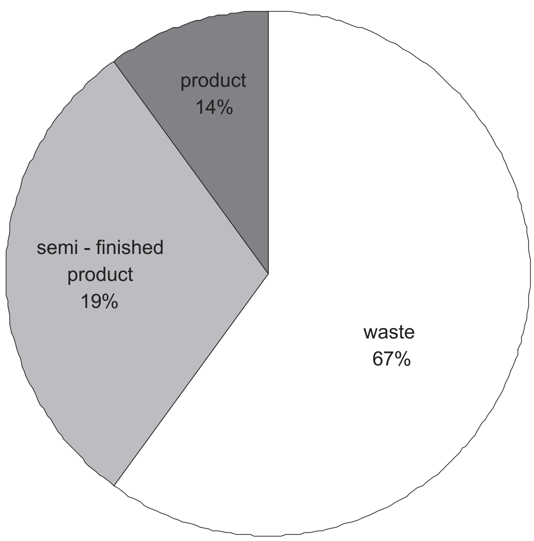


Fig. 10. Typological distribution of modified animal bones by NISP (n=342)

Fig. 11. Cattle horncore with marks of separating the sheath by extraction (central part). Photo K. Pawłowska

Fig. 12. Cattle horncore with marks of separating the sheath by cutting off the ends. Photo K. Pawłowska

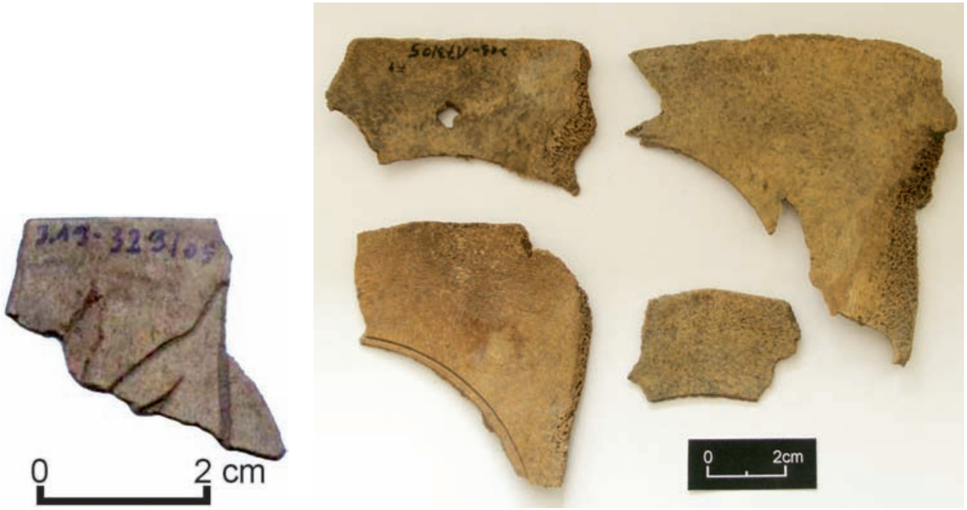


Fig. 13. Fragment of facing (left side) and waste of facing (right side, four pieces). Photo K. Pawłowska

sheath from the horncore – by extraction (Fig. 11) and by cutting off the ends (Fig. 12). It is associated with very rare cases the preserve of horn on the archaeological sites. Only a few tertiary-phase items (those regarded as finished) can be recognised; these are clothing toggles, a comb, and perforated phalanges).

There is evidence to suggest that all stages of manufacture – from preliminary processing of material to the final stages of production – took place on-site. This is particularly clear in the material related to the production of ‘facings’, for which primary, secondary, and tertiary stages of manufacture are evidenced (Fig. 13: a-b). According to Jastrzębski (1999), the production of facings from scapulae begins with the trimming of the spinous process. This is followed by tracing and incising, using knives, chisels, and compasses. The use of compasses is indicated by semicircular marks left on waste from the Inowrocław site. However, the character of edges of semicircular marks suggests that the bone fragment was first incised and then snapped off. The procedure was thus similar to that evidenced in the second half of the 13th century and in the 14th century in the market in Wrocław (Jastrzębski 1999).

Examination of the material from Inowrocław also allowed the identification of several stages of comb manufacture (the process undertaken in medieval Poland is well understood; see Cnotliwy 1973). Once again, elements belonging to primary, secondary, and tertiary phased were recovered. The primary stage is represented in the form of pre-worked raw material (cut lengths of antler), while there is diverse evidence for the secondary stage of manufacture: pieces of antler preworked with groove and splinter technique; antler plates for which the porous core material has been removed; and semi-finished products such as composite comb plates formed from hard outer layer of antler (*substantia compacta)* (Fig. 14). In the tertiary stage, there are some final products – the riveted comb elements (Fig. 15).

The degree of preservation and processing of the material allows differences to be inferred in the production of objects made from antlers and objects made from long bones.

Horn cores which display the marks of different methods of separating the sheath have been described above. The base and tip of horn cores are preserved in various lengths. The horn core was cut from the skull using a thick saw, what left cut marks

Fig. 14. Semi- finished product of comb.
Photo K. Pawłowska

2 mm wide (cattle) or 1.6 mm wide (goats). Some of them have been preserved together with the frontal bone, on which marks from breaking off the horn core were found.

In most cases, there are marks on the surfaces of long bones and antlers, which allow identification of the technological process and reconstruction of the tools used.

Shafts of cattle metacarpal and metatarsal bones, as well as of horse radii, were used as raw material in the production process. Both ends were cut off, and then the bone shaft was cut along the long axis. The ends are waste material and were cut off completely or partially and then broken off. Subsequently, the shaft was divided into smaller fragments by cutting. The next step of bone-working consisted of cutting the bone, polishing and making holes. In other cases, only one of the bone ends (proximal or distal) was cut off, and the shaft surface was unilaterally or bilaterally planed. Elements with a cut-off proximal end whose shaft has been planed to a polygonal form were also found (dimensions of the sides of the polygon: 10 mm / 6.4 mm / 7.4 mm / 4.8 mm / 11.5 mm / 6 mm / 8.5 mm / 6.8 mm). Bones were cut with a saw, as evidenced by the marks of width 1.8 mm, parallel to the surface intersection. A plane was used to smooth the bones.

The bones were either well or poorly softened during working, which can be determined in each case based on the absence or presence of notches on surfaces.

The technique of working pig metacarpals and metatarsals consisted of planning the proximal end using a knife, and making a hole in the shaft using a thick drill of diameter 4.3-6.7 mm.

In assessing the usefulness of particular parts of the antler for manufacturing the relevant objects, the craftspeople chose the main beam and pedicle. Other parts of antlers (the branching segments and coronets) were discarded as wastes.

The pedicles of the antlers were cut off with a thick saw, a process which left wide marks (width

Fig. 15. Final products- the comb.
Photo K. Pawłowska

1.7 mm). The dimensions correspond with marks described in Gdańsk (0.1-0.2 cm) (Cnotliwy 1973). The process of pedicle-working consisted of planning with a knife, smoothing and drilling holes. This process is consistent with the technique described by Cnotliwy (1958) – using antler handles for placing a knife's tang.

The basic raw material for the craftsman was a cervid main beam. From this part of the antler, blocks were cut. A thick saw was used, which left cut marks of width 1.7 mm. The dimension corresponds to that found in Gdańsk (0.1-0.2 cm) (Cnotliwy 1973). In a further stage, the blocks were divided into quarter-beam segments for the production of combs. Long antler plates (up to 21 cm) were obtained by incising grooves in antlers with a knife. This precise and efficient technique – known from the castle in Dobra Nowogardzka (13^{th}-14^{th} centuries) according to Cnotliwy (1973) – was used to soften the raw material. Such plates were used for making comb facings. Further processing of these antler-shaped pieces consisted of removing the porous core material, planning and trimming, smoothing, making holes and ornaments.

Conclusions

The analysed bone material, saw blades, and lathe discs that were found at site 19 in Inowrocław represent the remains of a late medieval workshop. The profile of the workshop indicates that the chief raw materials to be worked were horn (derived primarily from goats and cattle) and antler (from red deer). While hornworking or antlerworking are identified in many assemblages from different site, both of them from one archaeological site are relatively rare.

The characteristics of the analysed material – in particular the large quantity of waste material, unfinished products, and damaged products – allow it to be broadly characterised as waste. It is possible that some of the material may represent imperfect artistry on the part of the person who worked the material. Explain the presence of several finished objects poses anopen- ended question. Excavation of urban sites in Inowrocław (late medieval) has produced evidence for all aspects of crafts, from gathering and processing of raw materials to produce of semi-finished products and the finished products. Combs were the most complex product in the last category. A wide range of crafts contained the boneworking, hornworking and antlerworking which are rare. Mainly antlerworking and boneworking (Hilczerówna 1961; Cnotliwy 1956, 1958; Rębkowski 1996, 1997) developed in medieval (since the middle of the 10th century) Poland which was related to urban development and increase exchanges in the local market (Cnotliwy 1956).

References

Ashby, S. 2005. *Craft and Industries: Bone, antler and horn-working*, In: C.A. Spall and N.J. Toop (eds.) *Blue Bridge Lane & Fishergate House, York Report on Excavations, July 2000 to July 2002*, online: http://archaeologicalplanningconsultancy.co.uk/mono/001.

Cnotliwy, E. 1956. *Z badań nad rzemiosłem zajmującym się obróbką rogu i kości na Pomorzu Zachodnim we wczesnym średniowieczu*, Materiały Zachodniopomorskie II, 151-79.

Cnotliwy, E. 1958. *Wczesnośredniowieczne przedmioty z rogu i kości z Wolina ze stan. 4*, Materiały Zachodniopomorskie IV, 195-229.

Cnotliwy, E. 1973. *Rzemiosło rogownicze na Pomorzu wczesnośredniowiecznym*, Wrocław-Warszawa-Kraków-Gdańsk: Ossolineum.

Hilczerówna, Z. 1961. *Rogownictwo gdańskie w X-XIV wieku*, In: J. Kamińska (ed.) *Gdańsk wczesnośredniowieczny* IV, Gdańsk: Gdańskie Towarzystwo Naukowe, 41-144.

Jastrzębski, A. 1999. *Produkcja rogownicza na wrocławskim rynku w 2 poł. XIII i w XIV wieku*, Mediaevalia Archaeologica 1, 89-99.

Lasota-Moskalewska, A. 1997. *Podstawy archeozoologii*, Warszawa: Państwowe Wydawnictwo Naukowe.

Rębkowski, M. 1996. *Wyroby z rogu i kości, bursztynu, kamienia, szkła oraz gliny*, In: M. Rębkowski (ed.) *Archeologia średniowiecznego Kołobrzegu* I, Kołobrzeg: Instytut Archeologii i Etnologii Polskiej Akademii Nauk, 337-44.

Rębkowski M. 1997. *Zabytki bursztynowe, szklane, kamienne, rogowe i kościane oraz inne wyroby wykonane z gliny*, In: M. Rębkowski (ed.) *Archeologia średniowiecznego Kołobrzegu* II, Kołobrzeg: Instytut Archeologii i Etnologii Polskiej Akademii Nauk, 235-42.

Authors' Adresses

Irina Adriana Achim
"Vasile Pârvan" Archaeological Institute of the Romanian Academy,
11 Henri Coandă St., Sector 1 010667 Bucharest
Romania
achimirina@yahoo.com

Manuel Altamirano García
Departamento de Prehistoria y Arqueología, Universidad de Granada
Facultad de Filosofía y Letras
Campus de Cartuja s/n.
18070 Granada
Spain
toumai@correo.ugr.es

Esteban Álvarez-Fernández
Departamento de Prehistoria, Facultad de Geografía e Historia, Universidad de Salamanca,
C. Cerrada de Serranos S/N
37002 Salamanca
Spain
epanik@usal.es

Steven P. Ashby
Department of Archaeology, University of York, Kings Manor
York YO1 7EP
UK
steve.ashby@york.ac.uk

Emilio Aura Tortosa
Departament de Prehistòria i Arqueologia
Universitat de València, Avda. Blasco Ibañez, 28
E-46001 València
Spain
emilio.aura@uv.es

Aline Averbouh
CNRS, TRACES
Maison de la recherché, université Toulouse 2
5, allées A. Machado
F-31058 Toulouse cedex 9
France
averbouh@univ-tlse2.fr

Bárbara Avezuela Aristu
Laboratorio de Estudios Paleolíticos, Departamento de Prehistoria y Arqueología
Facultad de Geografía e Historia, Universidad Nacional de Educación a Distancia,
Ciudad Universitaria. Senda del Rey, 7
E-28040 Madrid
Spain
barbara@bec.uned.es

Justyna Baron
Instytut Archeologii Uniwersytetu Wrocławskiego
ul. Szewska 48
50-139 Wrocław
Poland
justyna.baron@gmail.com

Luminița Bejenaru
"Alexandru Ioan Cuza" University, Faculty of Biology, Bd. Carol, nr. 20 A
700506, Iasi
Romania
lumib@uaic.ro

Corneliu Beldiman
"Dimitrie Cantemir" Christian University, Faculty of History
176 Splaiul Unirii, Sector 4
040042 Bucharest 53
Romania
cbeldiman58@yahoo.com

Marcin Diakowski
Instytut Archeologii Uniwersytetu Wrocławskiego
ul. Szewska 48
50-139 Wrocław
Poland
m.diakowski@gmail.com

Erika Gál
Archaeological Institute of the Hungarian Academy of Sciences
1014 Budapest, Úri u. 49
Hungary
gal_erika@yahoo.com

Jesús Jordá Pardo
Laboratorio de Estudios Paleolíticos, Departamento de Prehistoria y Arqueología
Facultad de Geografía e Historia, Universidad Nacional de Educación a Distancia
Ciudad Universitaria. Senda del Rey, 7
E-28040 Madrid
Spain
jjorda@geo.uned.es

Magdalena Konczewska
Instytut Archeologii Uniwersytetu Wrocławskiego
ul. Szewska 48
50-139 Wrocław
Poland
magdalena.konczewska.@archeo.uni.wroc.pl

Bernadeta Kufel-Diakowska
Instytut Archeologii Uniwersytetu Wrocławskiego
ul. Szewska 48
50-139 Wrocław
Poland
bernadeta.kufel@gmail.com

Hans Christian Küchelmann
Knochenarbeit
Konsul-Smidt-Straße 30
D-28217 Bremen
Germany
info@knochenarbeit.de
http://www.knochenarbeit.de

Felix Lang
University of Salzburg, Archaeology
Residenzplatz 1
A-5020 Salzburg
Austria
felix.lang@sbg.ac.at

Heidi Luik
Institute of History, Tallinn University
Rüütli 6, 10130 Tallinn
Estonia
heidi.luik@mail.ee

Liina Maldre
Institute of History, Tallinn University
Rüütli 6, 10130 Tallinn
Estonia
liina.maldre@mail.ee

Benjamin Marquebielle
Laboratoire TRACES UMR5608
Université de Toulouse 2 le Mirail
Maison de la Recherche Bât 26
5, allée Antonio Machado
31058 Toulouse Cedex 9
France
benja.mar@wanadoo.fr

Peggy Morgenstern
Eichenstraße 5
13156 Berlin
Germany
peggy_morgenstern@web.de

Florentina Oleniuc
"Alexandru Ioan Cuza" University, Faculty of Biology,
Bd. Carol, nr. 20 A
700506, Iasi
Romania
carmen_oleniuc@yahoo.com

Mirja Ots
Institute of History, Tallinn University
Rüütli 6, 10130 Tallinn
Estonia
mirja.ots@mail.ee

Kamilla Pawłowska
Institute of Geology, Faculty of Geographical and Geological Sciences
Adam Mickiewicz University
ul. Maków Polnych 16
61-606 Poznań
Poland
koka@amu.edu.pl

Jean-Marc Pétillon
CNRS, TRACES
Maison de la recherché, université Toulouse 2
5, allées A. Machado, F-31058 Toulouse cedex 9
France
petillon@univ-tlse2.fr

Stefan Pratsch
Wollestraße 4
D-14482 Postdam
Germany
stefan.pratsch@teltow-flaeming.de

Marloes Rijkelijkhuizen
University of Amsterdam
Amsterdam Archaeological Centre
Turfdraagsterpad 9
1012 XT Amsterdam
The Netherlands
marloesrijkelijkhuizen@hotmail.com

Viorica Rusu-Bolindeț
National History Museum of Transylvania, 2 Constantin Daicoviciu St.
400020 Cluj-Napoca, Cluj County
Romania
viorusu1@yahoo.com

Elisabeth A. Stone
Department of Anthropology
MSC01-1040, Anthropology 1
University of New Mexico
Albuquerque, NM 87131
USA
elisabethastone@gmail.com

Katrin Struckmeyer
Lower Saxony Institute for Historical Coastal Research
Viktoriastr. 26/28
26382 Wilhelmshaven
Germany
struckmeyer@nihk.de

Diana-Maria Sztancs
"Lucian Blaga" University, Sibiu, Doctoral Program
Romania
beldiana22@yahoo.com

Selena Vitezović
Archaeological Institute
Kneza Mihaila 35/IV
11 000 Beograd
Serbia
selenavitezovic@gmail.com