



The Origins of Bone Tool Technologies

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Jarod M. Hutson · Alejandro García-Moreno · Elisabeth S. Noack
Elaine Turner · Aritza Villaluenga · Sabine Gaudzinski-Windheuser

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THE ORIGINS OF BONE TOOL TECHNOLOGIES: AN INTRODUCTION

Tool use is one of the hallmarks of what makes us human. This defining behaviour is fostered by our high fidelity social learning environment and unique process of cumulative cultural evolution. From the Stone Age to the Digital Revolution, the human narrative has been written in the technologies we developed to meet the challenges of everyday life. How our ancestors accomplished increasingly complex tasks reflected the skills and materials available at the time, and as technology developed in complexity, so too did their lives. For over two million years of the human lineage, stone and bone tools preserve the only record of our technological heritage and capacity for innovation. Studying the origins and development of these technologies plays a vital role in retracing our evolutionary footsteps toward becoming human.

The use of intentionally modified stone tools may extend back to more than three million years ago in East Africa (Harmand et al., 2015) and persisted in some parts of the world until historic times. These tools began as simple stone flakes and hammerstones used to butcher animal carcasses (Semaw et al., 1997, 2003; Semaw, 2000; McPherron et al., 2010), followed by the addition of stone handaxes, and later flourished into a wide array of technological and cultural traditions that serve as a record of humanity's cumulative process of behavioural evolution.

The use of bone tools followed a slightly different trajectory, first appearing during the Oldowan period as early as 2.1 million years ago in East Africa

(Backwell and d'Errico, 2004) and slightly later at two million years ago in southern Africa (Backwell and d'Errico, 2001, 2008). The East African tools consisted of large mammal long bone shaft fragments intentionally shaped by knapping and a few complete bones used as hammers. In contrast, the bone implements from southern Africa were not deliberately modified to aid in butchery activities, but rather used in termite foraging, digging for tubers, processing fruits and other tasks (d'Errico and Backwell, 2009). The use of these early bone tools appears to have been infrequent and expedient before largely disappearing from the archaeological record of the ensuing Acheulean and Middle Stone Age in Africa.

Rare examples of bifaces made from elephant bones are known from several locations scattered across Europe and the Levant (see Zutovski and Barkai, 2016), but these tools date to the end of the Lower Palaeolithic (500-250 ka) and are unlikely to be technologically descendent from similar, yet much earlier, bone tools from East Africa. At roughly the same time and in the same areas of Europe and the Levant, hominins began using antlers and limb bones of large mammals in the manufacture and maintenance of lithic tools (Roberts and Parfitt, 1999; Goren-Inbar, 2011; Blasco et al., 2013; Julien et al., 2015; van Kolfschoten et al., 2015; Moigne et al., 2016). Commonly known as retouchers (*retouchoirs* in French) or percussors (*percuteurs*), these bone tools display characteristic pits and scores



Figure 1 Participants of the “Retouching the Palaeolithic” conference at Schloss Herrenhausen in Hannover, Germany, October 2015.

indicative of use in shaping lithic tools (see Patou-Mathis, 2002); lithic fragments often embedded in the pits and scores attest to their various functions related to stone tool manufacture (Mallye et al., 2012; Tartar, 2012; Bello et al., 2013). The use of bone retouchers in various forms continued uninterrupted until stone was abandoned in favour of metal as a raw material for tools (see Taute, 1965; Schibler, 2013; Vitezović, 2013).

Bone retouchers and percussors are particularly intriguing, as they incorporate elements of both bone and stone tool technology. As stone is a more durable raw material that can withstand the effects of burial over the course of many millennia, our understanding of specific stone tool technologies and associated human behaviours is far advanced beyond that of tools made of bone and other osseous raw materials. The origin of bone tool use lagged behind that of stone tools; in a similar fashion, the initial recognition of and subsequent appreciation for Palaeolithic bone tool technology has been somewhat delayed (e.g., Dupont, 1871; Daleau, 1884; Henri-Martin,

1906, 1907). A renewed interest in bone tool technology has arisen over the past decades (e.g., Chase, 1990; Vincent, 1993; Patou-Mathis, 2002; Mallye et al., 2012; Mozota, 2012; Blasco et al., 2013; Jéquier et al. 2013; Abrams et al., 2014; Daujeard et al., 2014; van Kolfschoten et al., 2015), and we now recognize that the production of bone tools spans much of human prehistory, and their forms are as varied as their inferred functions.

It is the relatively abrupt appearance of bone retouchers and similar osseous tools coupled with their sustained use across a wide geographic area that justifies their position at the dawning of bone tool technology. The root of this technology lies in the circumstances under which prehistoric humans ceased to consider bone as a sterile by-product of the hunting and butchery process and began to recognize bone’s technological utility for the manufacture and maintenance of lithic tools. While the designation of a singular, oldest bone tool will be subject to periodic revision, the enduring significance of this origin story is one of technological

innovation and adaptation – the propensity and talent for creating tools to solve new and old problems in different ways. Bone retouchers emerged at a time of broad technological upheaval, when the bifaces that record the final stages of the Lower Palaeolithic gave way to a mosaic of prepared core, flake-based technologies across Africa and Eurasia. This rapid period of innovation was driven by the interplay between various biological, social, and environmental factors (see Elias, 2012), and identifying these internal and external forces through the archaeological record provides a framework to evaluate the adaptive significance of bone retouchers. These contexts are of immeasurable value for understanding how the emergence and development of bone tool technology influenced human subsistence and other socio-economic adaptations across space and time.

To explore these behavioural and cultural facets to the use of bone retouchers and similar tools, a scientific workshop was organized around the title, “Retouching the Palaeolithic: Becoming Human and

the Origins of Bone Tool Technology”. The event took place in October 2015 at Schloss Herrenhausen in Hannover, Germany (Figure 1), with generous financial support provided by the Volkswagen Foundation’s “Symposia and Summer Schools Initiative”. This volume is a product of the exchange of ideas at that workshop and brings together a diverse array of perspectives on bone tools use spanning across Europe and the Levant, from the Lower Palaeolithic to the Neolithic. In part, this work aims to build on the influential volume edited by Marylène Patou-Mathis in 2002, “*Retouchoirs, compresseurs, perceurs... Os à impressions et à éraillures*”, which has served as the reference manual for bone retouchers and other similar tools. The goal of this current volume is to reach a wider audience and move beyond the physical attributes of the bone tools themselves toward a deeper understanding of the behavioural implications behind the development of various bone tool technologies. With this synthesis, we add an important dimension to the ways in which tool use defines what it means to be human.

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KEYNOTE PAPER

IAIN DAVIDSON

TOUCHING LANGUAGE ORIGINS AGAIN: HOW WORKED BONE SHAPED OUR UNDERSTANDING

Abstract

In 1986 Bill Noble and I began to talk to each other about the origins of language. We articulated the importance of bone tools as the best marker of the imposition of form on artefacts. Some people have said that such an indication of mental representation of form can only follow from the emergence of language. I will review the arguments we produced then and show some of the evidence that strengthened our belief that they were important. I will then put them in the context of the vastly expanded knowledge of the archaeology of modern human behaviour over the last 30 years. Some of the arguments have been ignored, others have been overtaken by new finds, but the theoretical position also raised questions that have not been adequately answered. I will conclude by emphasising the importance of bone tools for understanding that theory and discussing some of the ways in which the theoretical position has moved on. Insights from studying bone tools opened up understanding of modern human cognition but we need more complex models of cognitive evolution.

Initial arguments

When Bill Noble and I began to look at areas of overlap between his interests as a psychologist of perception, particularly hearing, and my interests in the archaeology of fisher-gatherer-hunter peoples in Europe and Australia, we found that there was a fruitful intellectual area to explore in the question of language origins. Prior to our collaboration there had been much work concentrating on syntax as the important defining element of language, given the salience of Chomsky's linguistics in the 1960s (Holloway, 1969), on the anatomical conditions for speech production in humans and Neanderthals (Lieberman, 1984), on the features of the brain that might identify the language capabilities of early hominins (Falk, 1980; Holloway, 1983) and

on the possible archaeological signatures (Isaac, 1976; Marshack, 1976; White, 1985). There was also an active engagement with primate communication in the laboratory (Terrace, 1979; Premack and Premack, 1983; Gardner and Gardner, 1985; Savage-Rumbaugh et al., 1986), but less-so in the wild (Marler and Mitani, 1988), and arguments by comparison with stages of human infant language acquisition (Parker and Gibson, 1979; Wynn, 1979).

Our project was to identify the impact of language on the human mind – what I would now call cognition – which was Noble's primary contribution, and how language could be identified through the products of the archaeological record, which was

RETOUCHING TOOLS FROM THE POST-PALAEOLITHIC PERIOD IN SOUTHEAST EUROPE

Abstract

One of the earliest confirmed uses of osseous raw materials was for retouching, sharpening and repairing stone tools, dating from the Lower Palaeolithic and throughout the Pleistocene period. Considerable changes to subsistence strategies, technology, and overall lifeways occurred among European hunter-gatherer communities during the Holocene. In turn, the role of retouching tools was also modified. Although less common, retouching tools were still present among the Mesolithic and Neolithic communities across Europe. This paper provides an overview of the available evidence for the presence of retouching tools in the Mesolithic and Neolithic, focussing on southeast Europe. Their technological traits, distribution, functions and their significance within Mesolithic and Neolithic societies will be discussed.

Keywords

Mesolithic; Neolithic; Southeast Europe; Bone technology; Retouching tools

Introduction

Retouchers are artefacts used for retouching, repairing and/or sharpening stone tools. They may be made out of different materials, including bone, antler or teeth, and may be used in their natural form or modified (Patou-Mathis and Schwab, 2002). Retouchers can be easily distinguished from other tools by the specific use traces, usually consisting of one or several zones of use with small punctiform pits and/or parallel linear marks on the distal ends of their surfaces. Use traces are often dense and overlapping, creating small, localized surfaces of damage on the bones (Leonardi, 1979; Averbouh, 2000; Patou-Mathis and Schwab, 2002; Schwab, 2002; Valensi,

2002; Karavanić and Šokec, 2003; Mallye et al., 2012; David and Sørensen, 2016). Although these characteristic marks are clearly the result of stone working, different types of stone working tools (e.g., punches, pressure flakers, hammers, retouching tools) cannot always be easily distinguished.

Retouching tools are one of the earliest types of artefacts made from osseous materials, and some of the earliest recognized bone tools (e.g., Henri-Martin, 1906, 1908; Siret, 1925). A great deal of attention has been paid to the occurrence of osseous retouching tools during different stages of the Palaeolithic and their importance for studying early

stages of technology (e.g., Chase, 1990). However, their study is often neglected during later periods, particularly from the Holocene. One of the reasons may be the fact that, for a very long time, most of the studies of osseous industries from later prehistoric periods focused mainly on morphology and on typological classification based on forms. Furthermore, retouching tools may have been overlooked in those sites where faunal remains were not carefully collected, not thoroughly analysed, or where studies of osseous industries were restricted to formal tools. Therefore, it is reasonable to expect that the quantity and diversity of such finds, as well as their geographical and chronological distribution, will increase with future analyses.

The Holocene period brought on important changes among European hunter-gatherer commu-

nities, in subsistence practices, lifeways, and also technology (see Bailey and Spikins, 2008, and references therein). As flint industries changed, so too did other associated technologies, including retouching tools. As a general trend, they became less common over the course of the Holocene. Although they were *ad hoc* tools to a certain extent, they often display more careful manufacture, more formal shapes and evidence of longer use lives. Overall, they were still a relatively rare group of “tool-making tools” (Chase, 1990), i.e., tools used exclusively for the production and maintenance of other tools.

In this paper, I offer a short overview of the retouching tools of the Mesolithic and the Neolithic periods, with special focus on the region of southeast Europe (Figure 1). Their role in daily activities and craft production will be discussed.

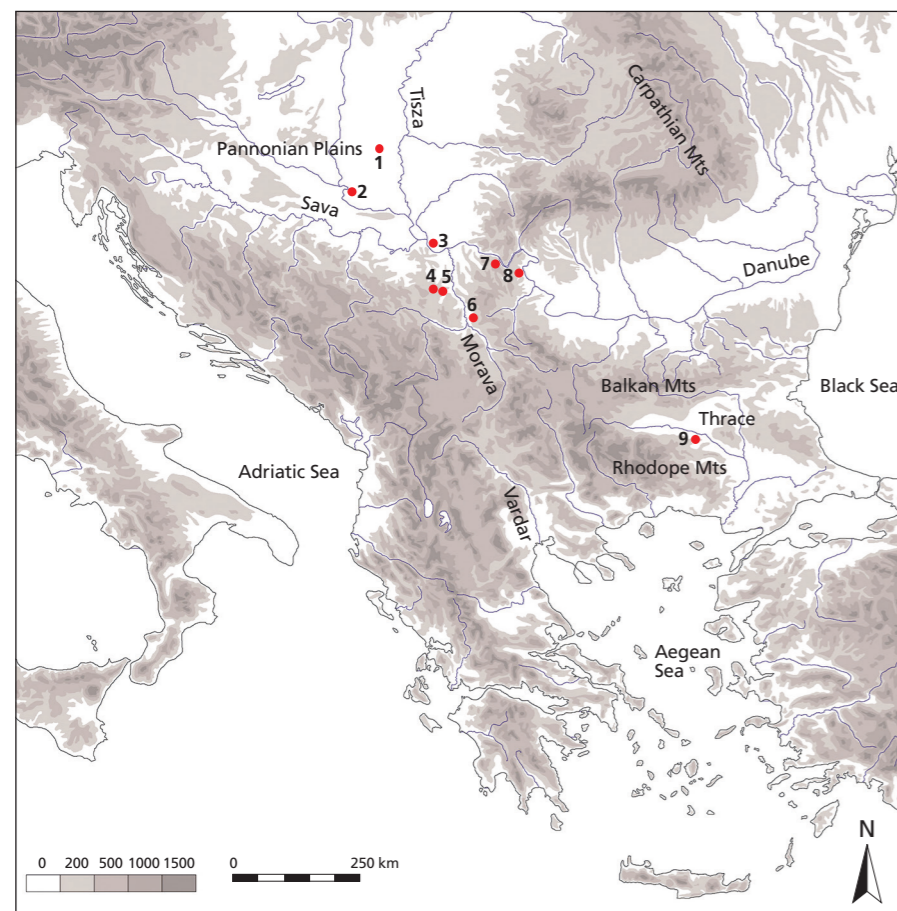


Figure 1 Sites from southeast Europe mentioned in the text: 1. Ludaš-Budžak; 2. Donja Branjevina; 3. Starčevo-Grad; 4. Grivac; 5. Divostin; 6. Drenovac; 7. Vlasac; 8. Kula; 9. Nova Nadezhda.

Retouching tools in the Mesolithic

Mesolithic in the Iron Gates

The Iron Gates region is a part of the Danube valley, today forming the border between Serbia and Romania, where several sites dated to the Mesolithic were discovered: Lepenski Vir, Vlasac, Padina, Hajdučka Vodenica, Schela Cladovei, Ostrovul Corbului, Ostrovul Banului, Icoana and others (Bonsall, 2008; see also Radovanović, 1996, and references therein). These Mesolithic communities practiced fishing and large game hunting, and their material culture included lithic and osseous tools, weapons and non-utilitarian items, such as ornamented stones and sculptures (Srejović and Letica, 1978; see also Radovanović, 1996, and references therein). Unfortunately, most of the finds were collected during rescue excavation projects from the 1960s-1980s, when faunal material was hand-collected, sometimes in haste, and not all of it was thoroughly examined. Furthermore, the taphonomic conditions for bone survival were unfavourable at some of the sites, so the quantity and the preservation of bone artefacts are sometimes very poor (e.g., at Kula; Vitezović, 2011b; see also Radovanović, 1996, and references therein).

The chipped stone industry included artefacts made from quartz, quartzite, silicate rocks, obsidian, flint and chalcedony (Radovanović, 1981), with quartz and quartzite particularly abundant at some of the sites (e.g., at Kula; Sladić, 1986, 2007; see also Radovanović, 1996, and references therein). Retouched tools included end and side scrapers, retouched flakes, burins, retouched blades, perforators, awls, retouched bladelets and geometric microliths, among others (Radovanović, 1981, 1996). The abundance of retouched tools varied from site to site and over time. For example, at Răzvrata they comprised only 1.6% of the total chipped stone assemblage, at Vlasac between 5.0% and 6.6% in different horizons, 15.0-23.0% at Padina and 16.0-31.9% at Ostrovul Banului (Radovanović, 1996:233).

Osseous industries included a large number of antler tools, mainly implements with working edges

used for cutting/chopping (chisels, wedges, axes or mattocks), and various hammers, scrapers, burnishers, pointed tools and weapons (projectile points and harpoons). Retouching tools are recognized from at least two sites. During the 1970s excavations at the site of Vlasac on the Serbian side of the Danube River, a large bone assemblage of almost 4000 artefacts was recovered and analysed mainly from a typological viewpoint (Srejović and Letica, 1978). Although the original report does not mention retouching tools, they can be recognized by specific use wear traces. These include one antler beam artefact with incised net decoration over its surface that was probably also used as a scraper or burnisher (Srejović and Letica, 1978:plate LXXVI) and perhaps a few other antler implements interpreted as cutting or percussion tools.

Two poorly reserved retouching tools were uncovered at Kula, another site on the Serbian side of the Danube (Vitezović, 2011b). One retoucher was made from a red deer (*Cervus elaphus*) antler tine segment. The base was simply cut or broken off and it has traces of scraping and whittling on its mesial side. The working tip is heavily worn and has deep, parallel incisions and grooves. The second tool is also made from red deer antler tine (Figure 2). The basal part has traces of grooving from the cut-and-break method used to detach the antler blank. The natural tip of the tine was preserved at the distal end and it was probably used as a punch. Deep, parallel grooves and incisions are visible over the entire distal and mesial portions. These traces are compatible with use as a retouching tool (Leonardi, 1979; Averbouh, 2000; Patou-Mathis and Schwab, 2002; Valensi, 2002; Karavanić and Šokec, 2003; Schwab, 2003; Mallye et al., 2012).

Vlasac and Kula have low numbers of retouched tools (Sladić, 1986, 2007; Radovanović, 1996), but this may be connected with preservation issues, recovery methods or differences in the character of the excavated portion of the site (such as activity areas). The circumstances of site occupation may be relevant, as it is not clear whether these settlements were occupied year-round and by all members of the community. The absence of retouchers at sites



Figure 2 a) Retouching tool from the site of Kula, Mesolithic; b) Detail.

on the Romanian side of the Danube (Beldiman, 2007) may also be explained by these factors.

Mesolithic in Europe

Rich Mesolithic assemblages from northern and eastern Europe also yielded different osseous tools related to stone working. Retouching tools were reported from several sites of the Butovo culture, in

the Volga-Oka region in Russia, such as Ozerki 5, Okaemovo 5, Ivanovskoe 7 and Stanovoe 4 (Zhilin, 2013, 2014). These tools were made from diverse raw materials: bear canines, beaver mandible fragments and incisors, different long bones, ribs and antlers. Bone retouchers, such as a rib segment of a large ungulate from Ivanovskoe 7, were not intentionally shaped, but simply selected from among broken pieces of bone. Unmodified bear canines

were also used, generally displaying heavy damage from use as both intermediary tools and in direct retouching. These bear canines were relatively numerous at Ozerki 5, for example, where 13 such tools were discovered (Zhilin, 2013, 2014). Antler retouching tools are known from Stanovoe 4, made from a diversity of antler segments modified mainly by scraping, and one has traces of being repaired (Zhilin, 2014). Retouching tools made of beaver incisors from Ivanovskoe 7 and Stanovoe 4 were reworked several times and used for different purposes; their final function was for pressure flaking (Zhilin, 2014).

Rare finds of possible retouching tools were reported from other sites in the Baltic region (David and Pelegrin, 2009). Mesolithic sites in present-day Denmark and adjacent areas also yielded a number of osseous tools used in indirect and pressure lithic reduction. Most were made from red deer antler, but elk (*Alces alces*) antler and bone were also used. Four possible types of tools were identified: pectoral pressure sticks, punch tools, shoulder/elbow pressure sticks and lever pressure sticks (David and Sørensen, 2016).

Recent studies of the Mesolithic sites in the Adriatic region suggest that osseous retouching tools were used in these communities as well. For example, the site of Vlakno on the island of Dugi otok in Croatia yielded a relatively rich osseous industry, with a few antler tines possibly used for retouching flint (Radović et al., 2016).

Retouching tools in the Early Neolithic

Starčevo culture

The first farming communities in the central Balkans and south Pannonian plain are attributed to the Starčevo culture (roughly 6200-5500 BC; see Whittle et al., 2002), part of the Starčevo-Körös-Criș cultural complex. Numerous portable finds were uncovered from several dozen settlement sites that have been excavated up until the present day.

The chipped stone industry included the following retouched artefacts in varying abundances at different sites: retouched flakes, retouched blades (sometimes quite long), perforators, side scrapers,

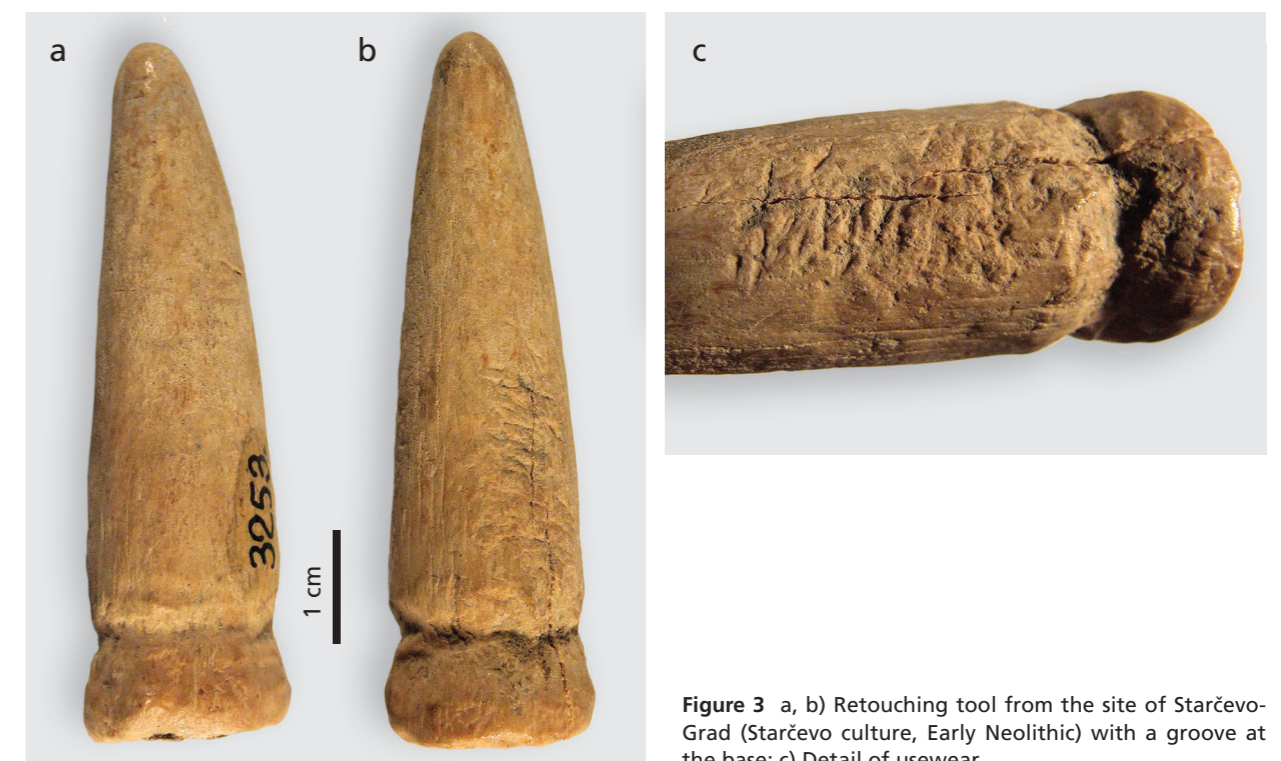


Figure 3 a, b) Retouching tool from the site of Starčevo-Grad (Starčevo culture, Early Neolithic) with a groove at the base; c) Detail of usewear.

end scrapers and double side scrapers (see Šarić, 2014, and references therein). The osseous industry was relatively abundant, and included mainly small tools used in diverse crafts (awls, needles, spatulae, scrapers, chisels, etc.), heavy-duty tools (axes, adzes, percussion tools), hunting gear (projectile points and rare fishhooks) and jewellery (pendants, beads, bracelets, buckles). Bone was the predominant raw material, followed by red deer and more rarely roe deer (*Capreolus capreolus*) antlers, with occasional use of teeth and mollusc shells (Vitezović, 2011a). Most of the bone tool assemblages were collected during excavations carried out in the early and mid-20th century, and the faunal remains were not collected uniformly and carefully. Although some assemblages include several hundred tools

and technical pieces, at most sites there are only a few well-preserved tools now stored in various museum collections.

Artefacts identified as retouchers/pressure-flaking tools were noted at seven sites: the eponymous site of Starčevo-Grad, Donja Branjevina and Ludaš-Budžak, located in Vojvodina, on the Pannonian Plain; and at Anište-Bresnica, Grivac, Divostin and Drenovac, situated in Pomoravlje, central Serbia (Vitezović, 2007, 2011a, 2013a, 2013b).

STARČEVO-GRAD Two tools with characteristic use traces were identified. The first is made from a small red deer antler tine. It has a blunt tip and its use traces consist of deep, dense notches and incisions. Its base features a deep groove, perhaps used for



Figure 4 a) Retouching tool from the site of Starčevo-Grad (Starčevo culture, Early Neolithic), made from roe deer antler; b) Detail of usewear.



Figure 5 Retouching tool from the site of Donja Branjevina (Starčevo culture, Early Neolithic) from red deer antler tine.

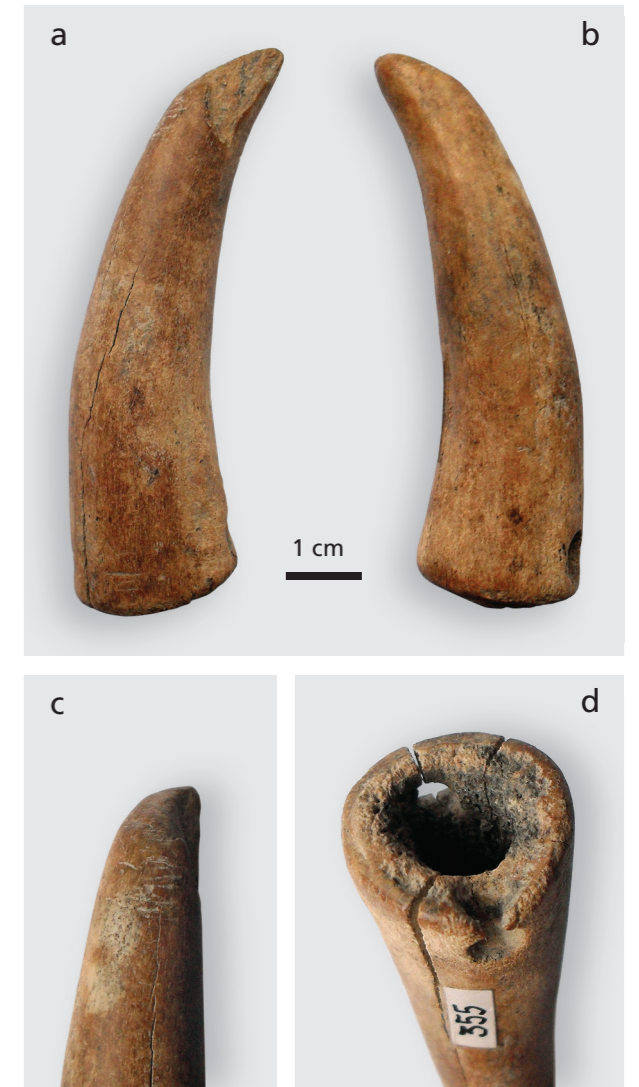


Figure 6 a, b) Retouching tool from the site of Donja Branjevina (Starčevo culture, Early Neolithic); c) Detail of distal end; d) Detail of the perforations at the base.

attaching the tool (Figure 3). The second artefact was made from a roe deer antler segment, which consisted of the beam with a crown and one tine. The entire tine is covered by dense, deep, parallel incisions and grooves from use (Figure 4).

DONJA BRANJEVINA Three retouching tools were identified, all made from red deer antler tines. Two have their natural tine tips transformed into small, rounded surfaces (ca. 5 mm in diameter), blunt and worn from use (Figure 5). Fine traces of cutting related to manufacture can be observed at the proximal ends, and most of the naturally rough outer

surfaces of the antlers were smoothed by scraping with a flint tool. Traces of use, visible on the distal portions of both tools, consist of partially overlapping, short and deep furrows, grooves and incisions, oriented perpendicular to the long axis of the tool.

The third tool was carefully made from the tip of a small antler tine (Figure 6). The base was carefully cut and the spongy tissue partially carved out. Nearly the entire outer surface was smoothed. The tool had perforations at the base, 4-5 mm in diameter – one entirely preserved, another broken and a third perforation was started, but remained un-



Figure 7 a) Retouching tool from the site of Ludaš-Budžak (Starčevo culture, Early Neolithic); b, c) Detail of the usewear at the distal end.

finished. The active end is partially damaged; nevertheless, its end has been modified into a semi-circular surface. Deep and dense lines, incisions and grooves, perpendicular to the long axis of the tool, are visible at the distal end. Perforations were probably made so that the artefact could be attached to a belt or otherwise carried on the body. The broken perforation likely resulted from such use.

LUDAŠ-BUDŽAK One retouching tool was discovered, made from a red deer antler tine tip (Figure 7). The base was cut off and the entire surface is covered by dense use traces. In the distal portion of the tool, several zones exhibit overlapping grooves and diagonal incisions. The tip was modified into a

circular surface and covered with dense lines and incisions.

ANIŠTE-BRESNICA One retouching tool was discovered, made from a red deer antler tine (Figure 8). The basal portion was cut off and the distal surface was smoothed by scraping with a fine chipped stone tool. The distal end was shaped into a small circular surface, and the entire distal portion of the tool is covered with deep, dense incisions and grooves.

DIVOSTIN A rich antler industry discovered at the site of Divostin included four retouching tools, all made from red deer antlers. Three tools were made from tines; the natural tips were shaped into a small



Figure 8 a, b) Retouching tool from the site of Anište-Bresnica (Starčevo culture, Early Neolithic); c, d) Detail of use; e) Detail of manufacture traces.

circular surface on two specimens, while the third object has a damaged tip that was previously modified by cutting. Traces of use are very intense on all specimens and consist of dense, deep incisions and grooves. The fourth artefact is a hammer made from the modified base of a shed red deer antler (Figure 9). The natural base was used as a hammer-like working surface, and the beam was thinned for use as a handle. The natural base of the antler was also modified (or possibly repaired) by removing small flakes prior to or during use as a hammering surface. The opposite end was not preserved. After the tool broke or became blunt, the handle was secondarily used for the manufacture of chipped stone artefacts; dense, deep, short incisions and furrows are visible on its surface.

GRIVAC Two retouching tools were identified, both made from small tine fragments of red deer antlers. The natural tips were modified into a circular surface

on both tools (Figure 10). On the first tool, the tip was cut off by grooving and cutting; on the second, two flakes were removed from two sides by direct percussion. The outer surface of the first tool was also scraped with a flint tool. Apart from damage on the tip, the distal ends are entirely covered with incisions and grooves. One of the retouchers was discovered in an excavation unit associated with a pit dwelling and was possibly abandoned at the place where it was used.

DRENOVAC Two small antler tines were used as retouchers but only minimally modified. The first has traces of cutting at the base from gradual thinning with a flint tool; the natural antler tip was modified into a small circular surface by cutting. Its entire mesial and distal parts are covered with dense, somewhat irregular, short incisions and grooves, thus, forming a zone of damage caused by intensive use (Figure 11). The tip is blunt and damaged from use.



Figure 9 a, b) Hammer modified into retouching tool, from the site of Divostin (Starčevo culture, Early Neolithic); c) Detail of usewear.

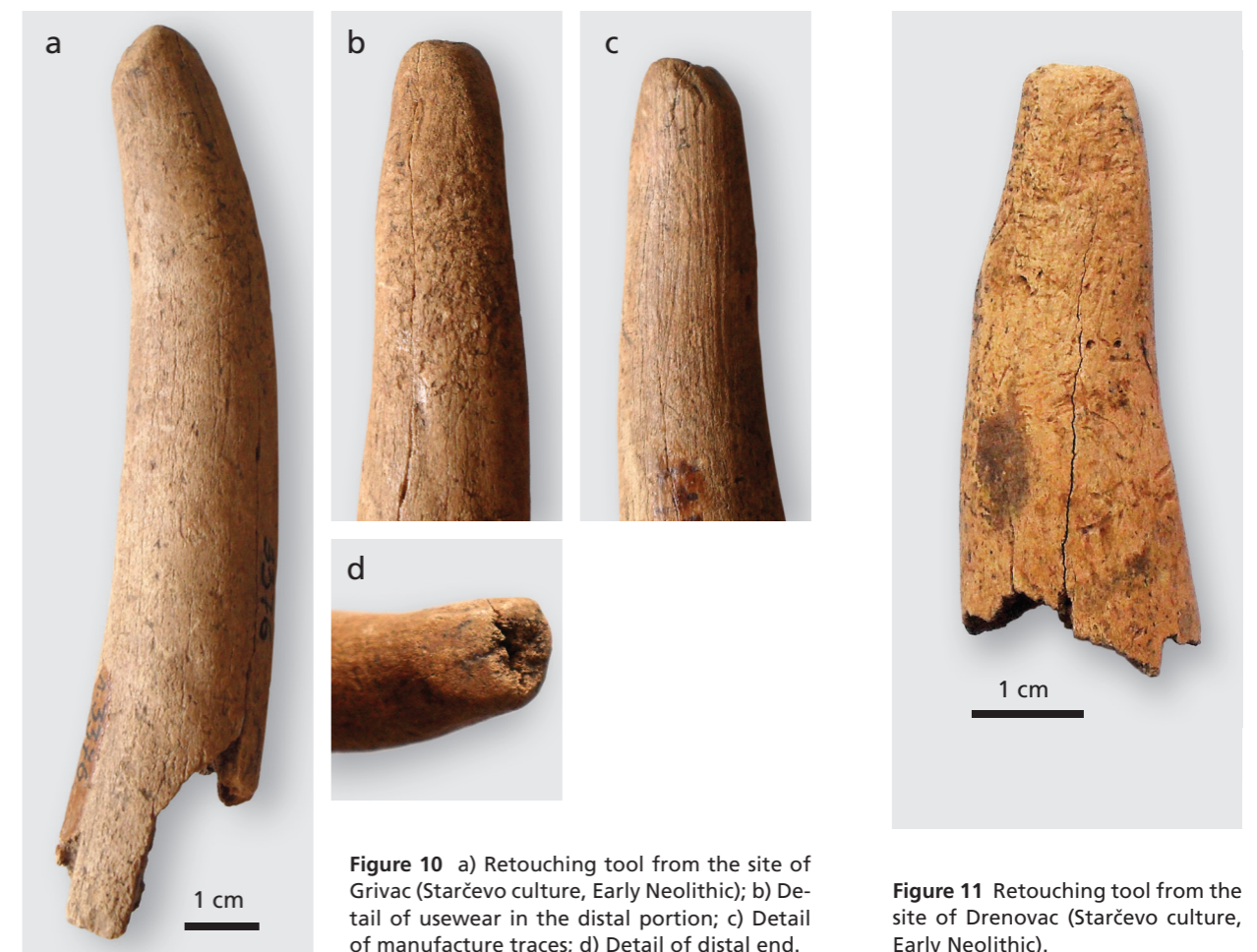


Figure 10 a) Retouching tool from the site of Grivac (Starčevo culture, Early Neolithic); b) Detail of usewear in the distal portion; c) Detail of manufacture traces; d) Detail of distal end.

Figure 11 Retouching tool from the site of Drenovac (Starčevo culture, Early Neolithic).

The second retoucher is not completely preserved, but numerous incisions and grooves from use are visible on the distal part.

Karanovo I culture

The first farming communities in the Eastern Balkans, present-day Bulgaria, are labelled the Karanovo I culture (see Boyadzhiev, 2009, and references therein). The chipped stone industry is marked by macroblade technology, in particular by the presence of blades with high retouching, sometimes of considerable dimensions, and also by irregular blades, retouched flakes and perforators (see Gatsov and Nedelcheva, 2009, and references therein). As for the bone industry, the problem of sample bias is evident – faunal remains from most of the older excavations were not carefully collected nor examined for possible traces of manufacture and use. At

present, only a few bone assemblages have been analysed in great detail, including Ovčarovo (Zidarov, 2014), Karanovo (Lang, 2005) and Yabalkovo (Guedeli, 2014), but no retouching tools were identified at any of these sites.

The recently excavated site of Nova Nadezhda, however, yielded possible tools related to retouching activities. The site is situated in eastern Thrace near the town of Khaskovo, Bulgaria, and was excavated as part of a rescue project in 2013-2014. Excavations revealed Early Neolithic settlement structures (houses, pits, ditches), several graves and archaeological remains from later periods (Bacvarov et al., 2014, 2015). In addition to numerous ceramic finds, many lithic and osseous artefacts were also uncovered.

The osseous industry from the Early Neolithic at Nova Nadezhda is relatively rich and includes some characteristic techno-types for this period, such as



Figure 12 a) Hammer with traces of being use as retouching tool from the site of Nova Nadezhda (Karanovo I culture, Early Neolithic); b) Detail of usewear.

awls, needles, spoons, chisels, etc. Animal bone was the predominant raw material, followed by red and fallow deer (*Dama dama*) antlers, teeth and shells. In general, antler was poorly preserved, but did serve as the raw material for a number of small punching tools, scrapers and burnishers. One finely made but badly preserved specimen was discovered within the Early Neolithic ditch at Nova Nadezhda. This small hammer tool was completely smoothed and burnished and was made from a beam segment of either a red or fallow deer antler. It has traces of use that may be interpreted as retouching marks: deep, perpendicular incisions and punctiform pits creating clusters of heavy damage on the surface (Figure 12). Another interesting find is a fallow deer antler pedicle, discovered below a Chalcolithic structure, but most likely belonging to disturbed Early Neolithic layers. This implement includes no traces of manufacture, but preserves dense traces of use in the form of short, deep incisions and grooves on its surface (Figure 13). It was most likely used as an anvil or support.

Retouching tools in the Late Neolithic

Vinča culture

The Vinča culture represents the Late Neolithic/Early Chalcolithic culture in the central Balkans and south Pannonian region (present-day Serbia, Oltenia and Transylvania in Romania, eastern parts of Croatia and Bosnia and Herzegovina), covering the time span between 5400 and 4500/4450 cal BC (Borić, 2009; Tasić et al., 2015).

The Vinča culture is characterized by developed craft production (Tringham and Krstić, 1990), with rich lithic and osseous industries. Chipped stone industries are generally abundant and included both local raw materials and imported obsidian. Retouched tools, including flakes, blades, scrapers, etc., were present in varying abundances at different sites and over time (Kaczanowska and Kozłowski, 1990; Antonović and Šarić, 2011). Osseous assemblages mainly included tools for diverse crafts: awls,

needles, massive pointed tools, spatulae, scrapers, chisels, axes, hammers and other percussion tools. Hunting and fishing gear (harpoons, fishhooks) and jewellery (bracelets, pendants, appliqués) were made mainly from domestic animal bones, red and roe deer antlers, boar tusks and mollusc shells, including imported *Spondylus* (Bačkalov, 1979; Lyneis; 1988, Russell, 1990; Vitezović, 2007, 2013a).

Retouching tools were rare, identified at only two sites thus far: Selevac and Drenovac, both in the Pomoravlje region of Serbia. At Selevac, at least four

tools have been identified as pressure flakers (Russell, 1990), three made from antler and one from a rib segment. All have been shaped into a broad, blunt point, and the area beneath the tips show clusters of characteristic scars. Several other artefacts have unclear or poorly preserved micro-wear, but are likely to have been used for pressure flaking, including three lozenge-shaped pieces of antler.

Two retouching tools were discovered within the Starčevo culture layers at Drenovac. Another retouching tool made from a large red deer antler tine



Figure 13 a) Antler pedicle with traces of use, probably as an anvil for retouching, from the site of Nova Nadezhda (Early Neolithic); b) Detail usewear.

likely belongs to the Vinča culture layers (Vitezović, 2007). Its tip is damaged, but several deep, overlapping horizontal grooves from use are visible on the distal end.

Neolithic in Europe

Retouching tools have been reported from a few Neolithic sites in central and western Europe.

In Hungary, the Late Neolithic site of Aszód Papi yielded a very rich osseous industry, including 90 pieces used as intermediate punches or pressure flakers. All were made from red deer antlers, except for three made from roe deer antlers (Tóth, 2013). From the Pre-Cucuteni site of Târgu Frumos in Romania, three pieces made from red deer antler segments were probably used for retouching stone (Vornicu, 2013).

A total of 29 antler retouching tools were also reported from Chalain 4 in France (Maigrot, 2003). All were all made from elongated segments of red deer antler tines modified by abrasion, except for one roe deer crown and one basal segment. They were used both for retouching by compression and by percussion. In fact, careful microscopic examination at high magnifications allowed Maigrot (2003) to distinguish 15 percussion and 14 retouching tools. Some of these tools were re-utilized, originally functioning as cutting/chopping tools or “sleeves” for hafting stone axes.

Finally, the most interesting and probably the most recent of these finds comes from the equipment carried by the mummy, known as Ötzi, discovered in the Ötztal Alps on the border between Austria and Italy. Amongst other possessions, he carried one tool made from a section of a stripped lime tree branch, which was cut off at one end and sharpened at the other. An antler rod, 6.1 cm long, was hammered into the core of the branch, so the total tool length was 11.9 cm, although the antler spike stuck out no more than 4 mm. The distal end of the antler had also been hardened by firing. The tool was easily sharpened like a pencil when the antler tip became blunt from use (Spindler, 1995; Fleckinger and Steiner, 2000). This tool, with its bark

haft, is a unique find in prehistoric Europe, and provides insight into how these tools were used during the Neolithic and earlier times.

Chalcolithic bone industries from European contexts are insufficiently studied; therefore, the presence or absence of retouching tools cannot be adequately assessed. In southeast Europe, retouching tools are absent from carefully collected and thoroughly analysed assemblages, such as from the site of Bubanj in Serbia (personal observation) and from Chalcolithic layers at Karanovo in Bulgaria (Lang, 2005). However, as mentioned earlier, sample bias may be a contributing factor to this apparent absence.

Discussion

The evidence for osseous retouching tools in the Mesolithic period is relatively sparse. To date, such tools have been reported from northeastern Europe and from the Iron Gates region. However, studies of the material from recent excavations (Radović, et al., 2016), as well as re-examinations from older excavations (David and Sørensen, 2016), show that the distribution and overall quantity of osseous tools used in stone working are much higher than the current results suggest. Although the relatively small number of known retouching tools does not allow for generalizations, some trends can be noted. The predominant raw material is antler, followed by teeth and the occasional use of the other skeletal elements. The retouchers are also rarely unworked, *ad hoc* artefacts, but rather intentionally shaped tools. Furthermore, they were used for longer periods and sometimes even re-worked and repaired.

The preference for antlers continues into the Neolithic period. In the Starčevo culture, except for one roe deer antler tool from the Starčevo site, all artefacts were made from red deer antler segments. The possible use of fallow deer antlers is also noted in the Thrace region. Tine tips were preferred, although other antler segments may be encountered. The natural tips of the tines are usually shaped into smaller circular or elliptical surfaces, and sometimes

entire tools were smoothed by scraping and burnishing. In most cases, the tools resemble small punches made from truncated antler tines. It is possible that some of the punches were also used for retouching, but the characteristic use traces were not preserved or the retouchers were used for too short a time for the traces to be visible.

The retouchers in the Vinča culture are mainly modified antler tines as well, similar to small punching tools. Additional retouching tools may be unidentified, either because the assemblages were not examined carefully or the use traces were not well preserved.

If we arrange retouchers from Starčevo sites along an imaginary manufacturing continuum (*sensu* Choyke, 1997, 2001; Choyke and Schibler, 2007), they cover a wide range, from minimally modified tools to carefully made pieces involving considerable investments in time and labour. Strictly *ad hoc* objects are absent, but broken antler tools were sometimes secondarily used as retouchers (e.g., the broken hammer from Divostin; see **Figure 9**). The manufacture of most of the tools was planned – they were made in a uniform way from strictly chosen raw material. Some of the specimens are very well crafted, particularly the piece from Donja Branjevina (see **Figure 6**), with its carefully cut basal part and basal perforations. Traces of repair can also be observed on this particular tool. After one of the perforations broke, another one was started but not finished; perhaps the remaining perforation was sufficient or the distal end broke off and the tool became unusable. This tool and another example from Starčevo were probably portable (see **Figure 3**) – they could have been worn attached to the belt, at hand and ready for use. Such carefully made examples have not been discovered in Vinča culture assemblages thus far. However, the Vinča retouching tools discovered were planned and worked artefacts, not simple *ad hoc* tools.

Examples from the Neolithic sites in Switzerland display similar patterns: antler was the preferred raw material, strictly *ad hoc* tools were not noted and there are a few carefully shaped examples that were likely worn on a belt.

Extended use lives, as well as considerable time and labour investments, suggest these tools held some importance in craft production. The possibility that some of these tools were worn visibly argues in favour of the idea that the skill these tools implied were valued (Choyke and Schibler, 2007). However, the available data does not allow any further generalizations regarding their exact position within the organisation of production. Were they used frequently or only occasionally? Were retouchers made from osseous raw materials rare or common? What was their relation to retouching tools made from stone materials? These questions remain unanswered.

Most Neolithic retouching tools were used for a long time, sometimes even repaired. Preserved use traces suggest that they were used for both percussion and pressure flaking. Detailed microscopic examination of the retouching tools from Chalain 4 demonstrated both functions were equally represented (Maigrot, 2003). Examined under low magnification, use traces on the pieces from the Starčevo culture can be roughly divided into two groups: 1) incisions and grooves, perpendicular or diagonal to the long axis of the tool, located around the small circular working end; and 2) use areas consisting of dense concentrations of incisions, grooves and furrows, located across the surfaces, especially in the distal portion. These different types of damage suggest two modes of use: for percussion and pressure flaking. Some of the tools were used in both ways, but some have preserved just one type of use trace (Vitezović, 2011a).

Conclusion

Flint-knapping represented a valued skill, not just for early humans, but also throughout the entire prehistoric period. Knowledge of flint-knapping itself was valued, and the resulting artefacts, with their investments in labour and time, could have been objects of prestige (Sinclair, 1995, 1998; Hayden, 1998). Retouchers represent one of the most widespread tool types made from osseous raw materials,

covering a wide chronological and geographical distribution. They are also made from a wide range of raw materials, different tools include various levels of modification and their final shapes are variable.

The study of retouching tools, their first appearances, distribution, raw material choices, etc., is important for studying human technological behaviour. In the Holocene, when important changes occurred in most segments of life (e.g., subsistence practices, lifeways, worldviews), retouching tools also underwent certain changes that reflect transformations in overall technological practices. *Ad hoc* use of osseous remains declined, and more careful selection of raw materials is notable. In the eastern European Mesolithic, retouching tools were made from carnivore and beaver teeth, as well as antlers, while antler was the preferred raw material in most other Mesolithic and Neolithic communities. Unlike during the Palaeolithic period when all osseous raw materials were used, often without any selection (Leonardi, 1979; Leroy-Prost, 2002; Valensi, 2002; Schwab, 2003; Mozota, 2007; see also Patou-Mathis, 2002, and references therein), the predominance of antler is apparent in the Mesolithic and Neolithic. Antler is generally more resilient to shock and more convenient for use as a percussion tool (Billamboz, 1977; see also Christensen, 2004, and references therein); therefore, such a preferred raw material choice may be related to the less expedient character of these tools and their longer duration of use.

Over time, retouchers became planned tools, sometimes very skilfully made, with considerable time and labour invested in their manufacture. They were often used for a long time and repaired. Some retouching tools were even made publicly visible (possibly hanging from the belt), perhaps giving to their owner a certain status.

Future detailed examination of already recovered faunal remains or new excavations will certainly add to the quantity and morpho-typological diversity of retouching tools from the Holocene period. Judging from the currently available data, retouching tools gradually disappear from the Chalcolithic period in most parts of Europe, when the overall technology

underwent dramatic changes largely related to the introduction of metallurgy.

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This volume is a collection of papers from the conference titled "Retouching the Palaeolithic: Becoming Human and the Origins of Bone Tool Technology" held in October 2016 at Schloss Herrenhausen in Hannover, Germany. With major funding from the Volkswagen Foundation's Symposia and Summer School initiative, the conference brought together an international group of scientists from an array of research backgrounds to explore the origins and development of bone tool technologies in prehistory, specifically retouchers, compressors and percussors used in various lithic knapping activities. The diverse conference attendance generated an assortment of perspectives on bone tool use covering western Europe to the Levant, from the Lower Palaeolithic to Neolithic times. Collectively, these papers provide an overview on how the integration of bone tools with other Palaeolithic technologies influenced human subsistence and other socio-economic behaviours over time and space. In the end, this volume is not just about bone tools. Rather, this compilation is intended to stimulate broader ideas on technology and innovation, for the ability and desire to create new tools truly lies at the core of what makes us human.

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