International Conference on Use-Wear Analysis

USE-WEAR 2012

Edited by

João Marreiros,
Nuno Bicho and
Juan F. Gibaja

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Cambridge Scholars Publishing

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This book first published 2014

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-4438-6816-7
ISBN (13): 978-1-4438-6816-7

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INTRODUCTION

Prehistoric tools and implements are one of the most important resources for the study of early technology among human populations. Since Semenov's pioneer work on functional interpretations during the last decade experimental tests as well as macro and microwear analyses have been used as important methods to recognize diagnostic evidence of prehistoric human technology.

From these studies, different types of wear traces on tool surfaces were recognized (e.g., hunting projectile traces, residue analysis), and such diversity led to the development of new or different methodological and technological developments. It is a source of diverse information, which is necessary to solve both local and global problems, from the identification of functions of individual tools to the reconstruction of prehistoric economic systems. Thus, during the last decade use-wear analysis has focused on different approaches to study archaeological data.

Despite technological and functional perspectives on use-wear studies, archaeologists use these data to infer about broad topics and interpret prehistoric living activities, and, therefore, socio-cultural transformations within and between those populations. Recently, use-wear research led to the discussion and interpretations on new subjects. Topics such as the onset and expansion of the first farmers from the Near East to Europe, the diversity within lithic technological facies in Southwestern French Middle Palaeolithic, Early hunting techniques in Middle Stone Age of South Africa, and characterization of site function in Palaeolithic and Mesolithic contexts have been scrutinized by use-wear analysts.

With these ideas and facts in mind, we organized the International Conference on Use-Wear Analysis 2012 (Use-Wear 2012), held at the University of Algarve, Faro, October 10, 11 and 12th 2012. Since the last use-wear international meeting in Verona (2005), "Prehistoric Technology, 40 Years Later: Functional Studies and the Russian Legacy", many projects and data have been developed. Our goal was to provide a perfect setup to present ongoing projects and a forum for archaeologists to present and discuss the latest research on nature and timing of functional, technological and palaeoethnographic data.

During the Use-Wear 2012 meeting contributions included all different use-wear approaches, such as theory and method, archaeological artefacts, and residue analysis.

As a result of this conference is this volume, focusing on topics from methodological, geographic and chronological perspectives, and includes chapters covering different topics: methods (Part I: Methods), technology (Part II: Projectile technology and Part III: Bone technology), Early Stone Age, Middle Palaeolithic/Middle Stone Age, Upper Palaeolithic and Mesolithic cultures (Part IV: Hunter-Gatherers), Neolithic to the Iron Age (Part V).

PART I:

METHODS

CHAPTER ONE

A SPECIALIZED OCCUPATION DESPITE APPEARANCES: FUNCTION OF THE BUHOT LATE GLACIAL SITE (CALLEVILLE, NORTH-WESTERN FRANCE)

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Abstract

This paper summarizes the use-wear analysis of flint artefacts of the Buhot site. This site is located at Calleville in the north-west of France. It is attributed to the Pleistocene-Holocene transition. During this period in the Paris Basin, Northern France and Southern England, many sites are recognized as "belloisian" sites, "long blades" or "bruised blades" assemblages. They are interpreted as specialized in the production of long blades. According to the current hypotheses, these blades may have been produced for the processing of game killed in the surrounding area. At the Buhot site, the production is similar but the better illustration of domestic tools and projectile points suggests a wider range of activities. The use-wear analysis of a large sample of lithic remains (1409 artefacts) selected amongst retouched and unmodified blanks, allows a better understanding of the site function. Despite appearances, this site could be a short-term occupation focused on the first phases of game processing. Even if other activities did take place at the site, they seem to be marginal as much by their representativeness, as by the blanks involved.

Keywords: Pleistocene-Holocene transition, use-wear analysis, flint artifacts, site function.

1. Introduction

Functional analysis of the sites attributed to the Pleistocene-Holocene transition in the North of France is scarce and limited to the understanding of the function of bruised blades (Fagnart and Plisson 1997). This analysis constitutes the first approach on a large sample of lithic artefacts allowing the reconstruction of past activities. This work falls within the framework of Ph.D. dissertation research, focusing on the use and management of flint implements, site function and socio-economic organization of hunter-gatherers during the Pleistocene-Holocene transition in North-western France. During this period, at c.10000 BP, in the Paris Basin, Northern France and Southern England, the record of human activities seems to be essentially related to specialized sites. Most of them are located near good raw material sources. They are characterized by: (1) long blade production, (2) a frequent deficit in long and regular blades suggesting a circulation of the blanks, (3) a scarcity of points and retouched tools, and (4) a presence of bruised blades, sometimes in large numbers. These sites are known as “belloisian sites”, “long blade” or “bruised blade” assemblages. They were first recognized as flint procurement and knapping sites from which long blades are generally taken away (Fagnart 1988; Bodu and Valentin 1992). However, the presence of fauna and activity areas on several sites suggests a more complicated situation. According to the current hypothesis, some belloisian sites could be short time settlements located "near both the kill sites and the good flint raw material sources" (Bodu et al. 2011, 247). At these camps, cutting tools may have been produced for the processing of game killed in the surrounding area (Valentin 2008; Bodu et al. 2011). The cultural identity of these functionally oriented sites is not clear due to the specialization of these sites and the scarcity of the cultural indicators. Belloisian sites are now considered as specialized Laborian/Epi-Laborian and Ahrensburgian/Epi-Ahrensburgian occupations (Valentin 2008; Fagnart 2009).

The techno-economical study shows that the Buhot site is dated to the Pleistocene-Holocene transition (Biard and Hinguant 2011). The technical and economical characteristics of the production is characteristic of the Belloisian production (good raw material, use of soft hammerstone, careful shaping of the blocs, production of long straight and regular blades, circulation of the blanks, and the presence of bruised blades) but this site differs on various levels. Contrary to Belloisian sites the bladelet production is better represented. Indeed, at the Buhot site, bladelets and blades are produced in equal proportions. These products were produced and transformed into projectile points, which are well represented. Finally, the good representation of retouched tools suggests that a wide range of activities has been carried out. The Buhot constitutes one of the unique sites of the Pleistocene-Holocene transition on which "Belloisian like" long blade production is associated with a rich tool kit (projectile points and retouched tools). Therefore, it was considered as a potential residential site (Valentin 2008).

2. The Buhot site

The Buhot site is located in the Eure département in North-western France (Fig. 1). The open-air site was excavated ten years ago by M. Biard and S. Hinguant before highway roadwork (Biard and Hinguant 2011). Organic material is not preserved. A total of 5000 lithic artefacts were recovered. According to M. Biard and S. Hinguant, the distribution pattern of the lithic remains reveals the presence of two scatters, separated by a hearth (ibid.; Fig. 1). Although there has been a large number of refittings, few of them show connections between pieces from the two scatters. Therefore, it is hard to know if this site results from a single or a quick succession of human occupations (ibid.).

All flint varieties are local and available within a 5 km radius around the site. The aim of this flint production is to provide regular blades and bladelets. A non-quantified part of the blade production was taken away and at least 14 blades have been brought in to the site (ibid.).

The retouched tools are well-represented in comparison with the Belloisian sites. End scrapers (n=35) and burins (n=20) dominate the retouched tools. Amongst these retouched tools, only a part of the scrapers were made on regular blades. During the technological analysis several unmodified elements were identified as used elements. According to the size of the edge damage, and their distribution, some elements were qualified as bruised (nb=4), splintered (nb=13) or with used edges (nb=19).

A total of 52 projectile points were found. The majority of them were made by oblique and concave truncation. These points are common in Epi-Arhensburgian sites such as Gramsbergen, Oudehaske in Northern Netherlands (Johansen and Stapert 1998), or in the long blade sites of Uxbridge (Lewis 1991) and Launde (Cooper 2006). It could indicate an affiliation with the Epi-Ahrensburgian tradition (Biard and Hinguant 2011) as proposed by J.-P. Fagnart for the Belloisian sites of the Somme Valley in

Northern France (Fagnart 2009). Amongst the uncovered projectile points, there are two Malaurie points, which are usually found in Laborian contexts. This could indicate more southern influences (Biard and Hinguant 2011).

M. Biard and S. Hinguant considered the Buhot site as a short-term occupation because of the limited number of artefacts uncovered and the rather low structuration of the site (Biard and Hinguant 2011).

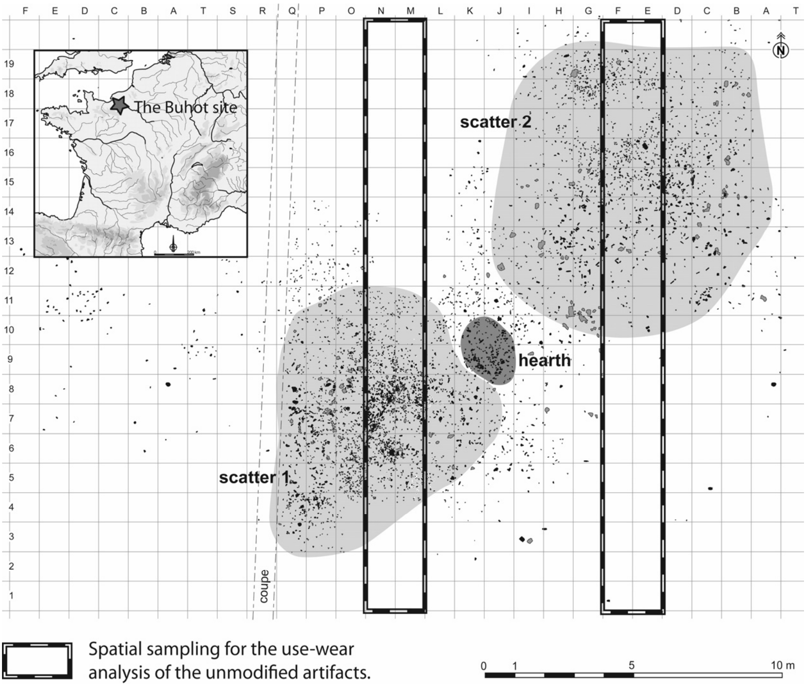

Fig. 1: Location of the Buhot site (CAD: L. Quesnel), distribution of the lithic artifact (Biard and Hinguant, 2011) and use-wear analysis sampling for unmodified elements.

3. Low use ratio

Functional analysis has been realized on 1409 pieces. All the retouched tools (n=85) and edge damage artefacts (n=35) identified during the technological study were examined. To avoid a subjective selection, all the unmodified blanks, except for the chips (n=1154), from a large spatial sample (Fig. 1). Finally the sampling was completed by 135 pieces coming from the refitting process to understand the aim of the production and to look at the function of the blades brought on the site. The results of this additional sampling are limited and will not be detailed in this paper. Due to the lack of time and the need for unwieldy experimentations for each projectile type, projectile points have not yet been analyzed. Nevertheless, an experimental program focused on the functioning of late glacial projectile points will be set up soon. The present functional analysis used low and high magnifications according to the methodological protocols defined by S. A. Semenov (1964) and L. H. Keeley (1980). Post-depositional surface modifications are in most cases limited to a microscopic soil sheen and the presence of bright spots.

Within the entire sample, only 93 implements exhibit use traces. It represents 139 used zones (UZ). Amongst the 93 used elements, 31 are retouched tools, 33 were qualified as used during the technological analysis and only 29 were found on unmodified pieces during the use-wear analysis. Amongst the 1257 elements from the spatial sample (which included retouched tools and edge damage artefacts), only 29 elements show used traces (2.3%). A lot of regular blades do not exhibit any use-wear. Furthermore, various uses are frequent but different uses are hardly ever combined and recycling evidences are extremely rare. All these observations support the idea that the Buhot site was a short term occupation.

4. Rather restricted activities

Regarding the number of UZ within the entire sample, butchery (44 UZ) is the main activity. Long, straight, regular unmodified blades were used. The traces (Fig. 2, a, b) are located along the distal or proximal half of the blank. This distribution could indicate the importance of the extremity during use. These long blades could have been very efficient in such tasks. These tools may have been easily held during tasks that require a lot of strength, such as dismemberment. Hide working (22 UZ) has been observed on 14 end scrapers and 6 unmodified implements. Skin processing is almost limited to a scraping motion. Only 4 UZ on unmodified edges are attributed to cutting motion. The states of the hide are principally wet or fresh (Fig. 2, c, d) but 4 end scrapers exhibit extensive edge rounding with matt polish and craters in them and are attributed to dry hide scraping. The scarcity of the cutting motion and the clear dominance of wet or fresh hide scraping suggest that in the Buhot site, hide working tools are mainly involved in the first phases of the technical process. At the Buhot site, 32 pieces display edge damages attributed to a percussive motion. Bruised edges occur on irregular blades or crests, sometimes on large flakes. These pieces are associated with the earliest reduction of the cores (large flakes, crests, irregular blades). According to the distribution, cross-section, size and shape of the edge scaring and to the presence or absence of abrasion, striations, cracking or incipient cones along the edges it was possible to distinguish two main functions. Most tools are attributed to percussive motion on mineral material (Fig. 2, h). As proposed by H. Plisson and J.-P. Fagnart for the bruised artefacts of Belloisians sites in the Somme Valley, these tools, may have been used for maintaining the soft hammerstones (Fagnart and Plisson 1997). Nevertheless, contrary to bruised edges at these sites, this type of bruising at the Buhot site never exhibits rounding. The experimentations carried out suggest that bruised pieces may have been used for preparing core overhangs (Jacquier, in press, in progress). As in other contemporaneous sites (Surmely 2003; Naudinot 2010), many blade butts exhibit percussion traces predating the extractions of the blades (Fig. 2, l) and which could be evidence for the core's overhang preparation. Five bruised elements show different edge damages characterized by bending fractures (Fig. 2, g). These marks result from the percussion of hard organic material such as bone, antler or wood. No microwear was observed so it is difficult to define the worked material. Scraping unspecified bone material involves only 4 burins and a burin spall (used before the extraction). No cutting, boring or grooving was observed. The UZ represents the facets (Fig. 2, i). These tools may have been used for shaping or sharpening bone tools. The scraping and grooving of mineral material involve 5 elements. Traces are similar from tool to tool and indicate that the mineral was hard and abrasive (Fig. 2, j, k). No residue was observed. For the scraping motion, unmodified edges and blade butts were used. For the grooving motion, a natural point and the angle of a bending fracture were used. No production in mineral matter was found during the excavation. So it is difficult to know whether the scraping and grooving of mineral material was to transform a surface or to grind mineral material to a powder. Just one piece shows use traces clearly related to plant work. It is a burin used on the two facets. The distribution of the use marks indicates a negative rake cutting with the ventral face as a contact face (Fig. 2, e, f).

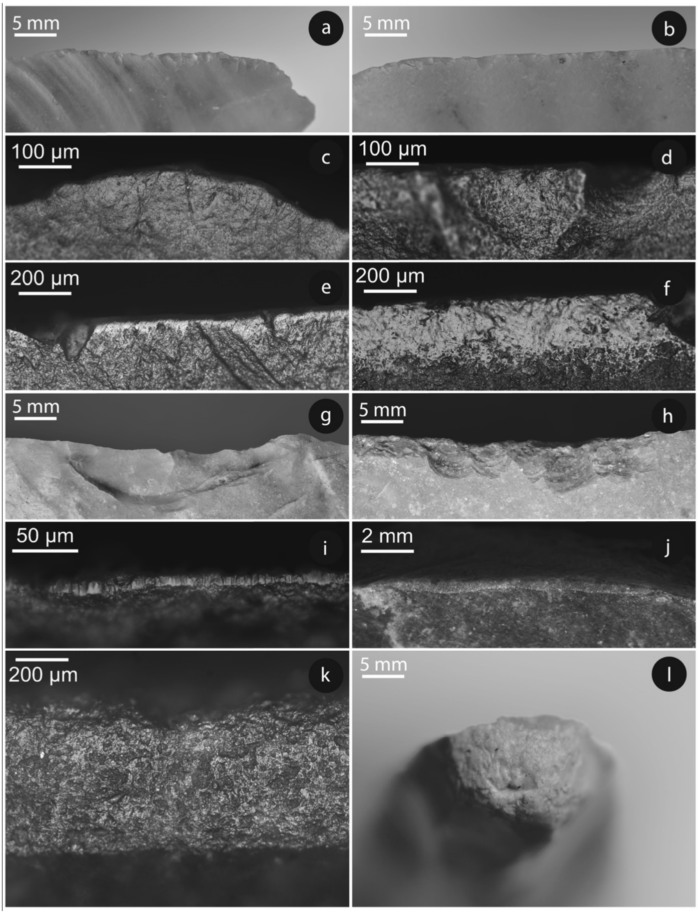

Fig. 2: Macro and micro-photographs.
[a] and [b]: macro-traces attributed to butchering activities (photograph [a] taken on blade n°1, fig. 3) ; [c] and [d]: taken on the front of scraper n°8, fig. 3, scraping wet/fresh hide. [c]: ventral face as a contact face and [d] retouched face as a leading surface, note the way the polish goes inside the depressions ; [e] and [f]: burin n°7 fig. 3, scraping plant. [e]: ventral face as a contact face. [f]: facet of the burin as a leading surface ; [g]: taken on blade n°5, fig. 3, percussion on hard organic material ; [h]: percussion on hard mineral material ; [i]: scraping bone material with a burin facet ; [j]: photograph taken on flake n°11, fig.3, bevel created in scraping hard abrasive mineral matter ; [k]: micro-wear observed on the macroscopic bevel on flake n°11 fig.3 ; [l]: blade butt with percussion traces indicating a preparation of the core overhang in a percussive motion.

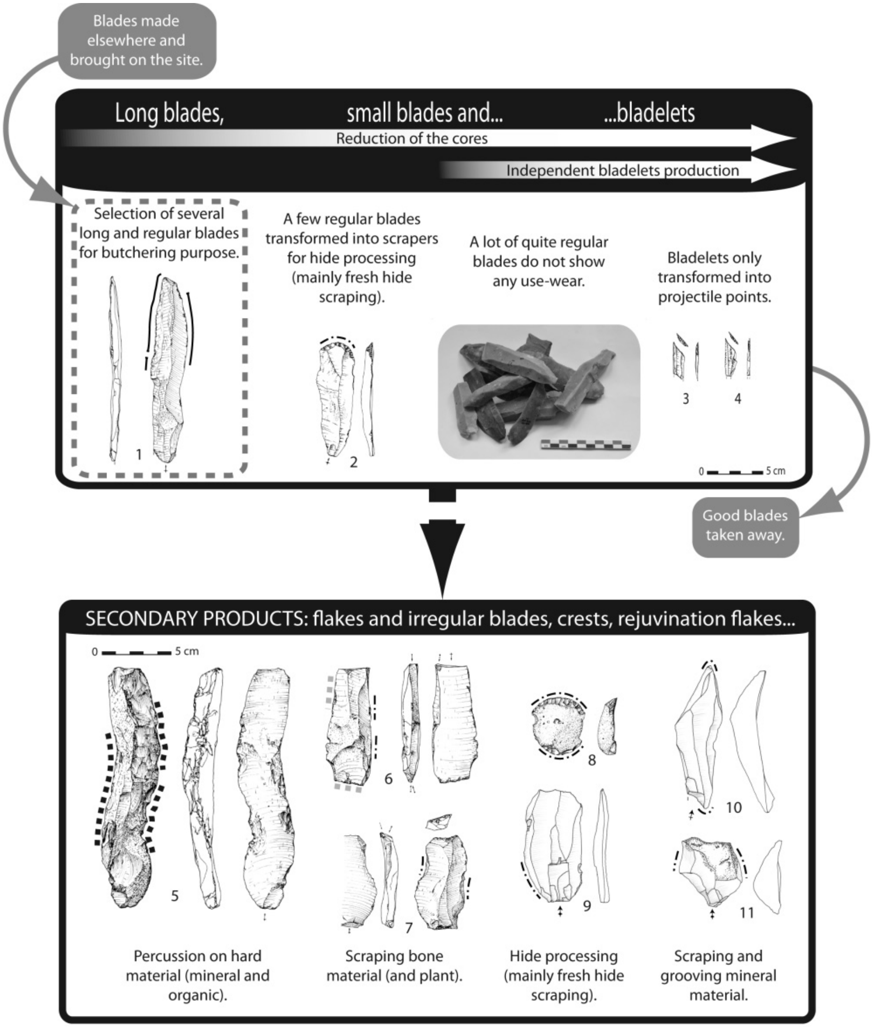

Fig. 3: A differential use according to the type of blanks (drawings 1 to 8, Biard and Hinguant, 2011).

5. And specialized blanks

The aim of the production is to provide straight and regular blades and bladelets. The production of blanks and especially the long blades is very demanding and requires skilled craftsmen. Techno-functional analysis shows that amongst the blades produced at the site, the longest and more regular were used for butchering (Fig. 3). Imported blades seem to be used only for these tasks. Several regular blades produced at the site were also retouched into scrapers for skin processing. Amongst the full sample, no unmodified bladelets show use marks. So it seems that bladelets were transformed into projectile points. Bone material working, plant scraping, mineral scraping and grooving, percussion on mineral or hard organic material and the main part of the hide working tools were carried out with secondary products like flakes and irregular blades or even crests and rejuvenation flakes. The differential use of tools according to the type of blanks (Fig. 3) could indicate that, at this site, the first attempt of lithic production is to provide blanks for hunting and the first phases of game processing.

6. Conclusion

In such a background where most of the sites are considered as specialized occupations oriented toward the production of long blades for deferred uses, the good representation of tools and projectile points suggests the Buhot site to be a residential camp with diversified activities. However, this use-wear analysis shows that the Buhot site remains specialized in nature. The activities performed are rather limited and some of them seem to be only partially done at the site. The segmentation of the *chaîne operatoire* is particularly visible in hide processing and maybe in the bone working. The specialization of the site is perceptible through the specialization of the most demanding blanks in the butchering of game. The low ratio of used artefacts and the scarcity of multiple uses and recycling suggest that this site was occupied for only a short duration. The Buhot site could be interpreted as a short term occupation related to the first phases of game processing and preparing for the hunt.

This work shows the importance of use wear study to the interpretation of site function and the risk incurred in using typological arguments for such a question.

Acknowledgements

I would like to thank M. Biard and S. Hinguant for allowing me to study this site. I wish to thank H. Pioffet, N. Naudinot and K. Donnart for their rereading of the text and L. Quesnel for the illustration.

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CHAPTER TWO

USE-WEAR CHARACTERIZATION THROUGH CONFOCAL LASER MICROSCOPY: THE CASE OF WILD VS DOMESTIC CEREAL HARVESTING POLISH

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Abstract

Many problems have arisen over the description and characterization of polished surfaces, which are described in terms of visual appearance. As a contribution to solve this problem, we propose to measure use-wear polish through confocal laser microscopy. This technique is used to discriminate between wild vs. domestic cereal harvesting polish. Wild cereals must be harvested before the complete maturation of the plant, while domestic cereals are harvested ripe. This difference in the degree in humidity when harvesting provokes differences in the characteristics of the use-wear polish. Achieving this discrimination is important to

understand the process of cereal domestication in the Near East. The discriminant function which distinguishes both types of use-wear polishes is used to classify four archaeological sickle elements from Late PPNB, Middle PPNB, PPNA and Natufian archaeological levels.

Keywords: Neolithic, agriculture, cereal harvesting, Natufian, PPNA, PPNB, Near East.

1. Introduction

Visual characterization allows a first approach to the characteristics of harvesting polish. However, many problems have arisen over the description and characterization of polished surfaces, which are described in terms of visual appearance (Vaughan 1985, 29; Mansur-Franchomme 1983b, 223). As they are not expressed in a quantitative form, the criteria for the identification of different polishes present a certain level of subjectivity, which thus has an effect on the level of reliability of the interpretations. The need to quantify use polish was evident to the first use-wear researchers (Keeley 1980, 62-63). Different methods have previously been used to attempt a quantification of use-wear polish, such as interferometry (Dumont 1982), image analysis (Grace et al. 1987; Vila and Gallart 1993; González Urquijo and Ibáñez 2003) or atomic force microscopy (Kimball et al. 1995). During the last decade laser confocal microscopy has proved to be an accurate and easy-to-use technique for use-wear quantification (Evans and Donahue 2008; Stevens et al. 2010; Evans and Macdonald 2011).

This paper contributes to the topic of use-wear quantification. We use confocal laser microscopy in order to quantitatively discriminate wild vs. domestic harvesting use-wear polish. This discrimination is important in order to shed light on the process of cereal domestication. The invention of agriculture is one of the most important cultural achievements of humankind. In the Near East, the last hunter-gatherers began to make their first agricultural experiments in the tenth millennium BC, domesticating several species of cereals and legumes. Growing wild cereals led to their domestication through the selection of traits in what is known as the domestication syndrome (Brown et al. 2009).

We are aware that harvesting with sickles played a major role in cereal domestication. Harvesting would have caused the progressive unconscious selection of mutant individuals among the population of wild cereals leading to domestication (Hillman and Davis 1999). Wild cereals must be harvested before the complete maturation of the plant to avoid the loss of grain because of the fragile characteristics of the basal rachis of the seeds.

On the contrary, domestic cereals are harvested ripe. This difference in the level of humidity when harvesting causes differences in the characteristics of the use-wear polish. Use-wear polish from harvesting domestic cereals is flatter and more abraded than the polish produced by cutting wild cereals (Figs. 2-1 and 2-2) (Unger-Hamilton 1991; Anderson 1991). Thus, a precise discrimination of the wild versus domestic harvesting use-wear traces and the intermediate steps would result in a better understanding of the domestication process, as it would allow us to locate in time and space the different steps of the domestication process across the Near East.

Visual characterization allows a first approach to the characteristics of harvesting polish, but it is a limited method for discriminating wild versus domestic harvesting use-wear polish as well as the intermediate steps. This precise discrimination should be determined and demonstrated through quantitative methods. During the last decade laser confocal microscopy has proved to be an accurate and easy-to-use technique for use-wear quantification (i.e. Evans and Donahue 2008). For this analysis, we have used a Sensofar confocal microscope in the CD6 Laboratory at the Universitat Politecnica de Catalunya (Terrassa, Spain).

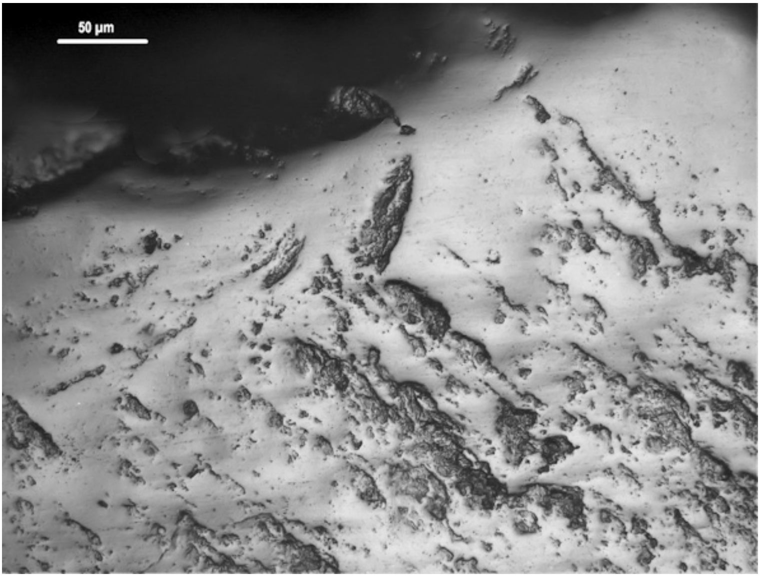

Figure 1. Use-wear polish from harvesting wild cereals *(Triticum dicoccoides* and *Hordeum spontaneum)*, during 4 hours, 200X.

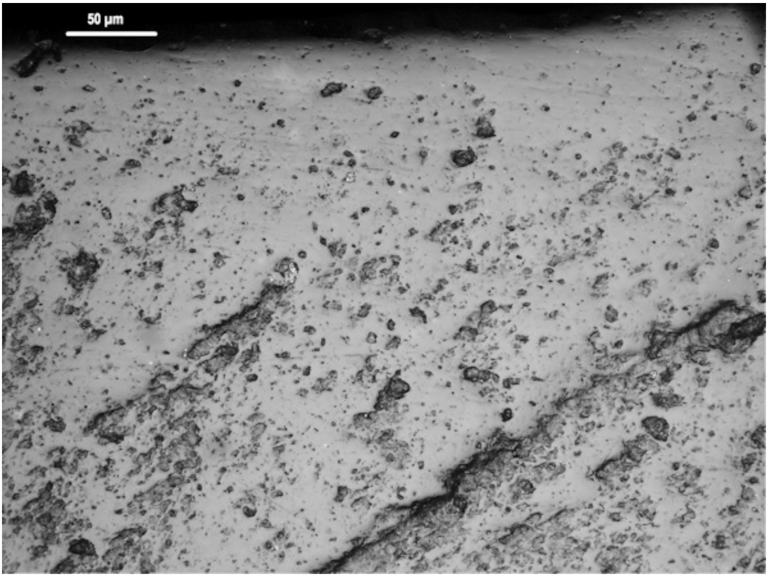

Figure 2. Use-wear polish from harvesting domestic cereal *(Triticum spelta)*, during 7 hours, 200X.

2. Materials and methods

This is the first step in an ongoing research program. For the moment, the use-wear polish taken from 8 sickle elements has been measured. Four of them were experimental tools, which were used for harvesting wild (n=2) and domestic cereals (n=2). The other four elements were recovered in archaeological sites (see below). Experiments of wild cereal harvesting were carried out at the Jabel el Arab (Syria), in 2009 and 2010. Stands of Triticum dicoccoides and Hordeum spontaneum were collected at the beginning of May, when the grain was already formed, but the plants were still not completely mature. The experiments of harvesting domestic cereals were carried out in Zureda (Asturias) in September 1993. We used these experimental tools to obtain a discriminant function, which could allow us to distinguish use-wear polishes from both types of tasks. The archaeological sickle elements were found in the sites of Tell Mureybet (Ibáñez 2008) (one sickle element from the Natufian levels and another from the PPNA levels) and Tell Halula (Molist 2001) (one from the Mid PPNB levels and the other from the Late PPNB levels). Both sites are located in the Middle Euphrates (Syria). The archaeological sickle elements came from four main successive phases in the process of cereal domestication, dated to between the end of the 11th and the 8th millennium BC.

The archaeological and experimental tools were cleaned with soapy water. Later, they were observed under a microscope, in order to detect the appropriate areas to be measured. Several areas of harvesting polish of around 650x500 microns were measured on each tool with the confocal microscope at 200 magnifications. The Sensomap software, from Digital Surf, was used for processing and measuring the sampled surfaces. From these, two or three sub-samples of 250x200 microns were chosen. As the topographic measures were affected by the lack of horizontality of the sampled surface under the microscope and by the irregularity of the original flint surface, we corrected the measured surface column by column, in order to obtain a flat surface in which the main irregularities were corrected and texture could be adequately quantified.

Different parameters of texture measurement were tested for the subsamples, choosing those which offered significant discriminant capacity between the use-wear polish from wild and domestic harvesting tools. The more discriminating parameters were related to measurements of height, such as Sa., the mean height of the surface, and Sq., the root mean square height. The software allows furrow sorting of the surface. Using a threshold for selecting all the furrows (100%) we chose the parameter of the mean depth of furrows. Finally, the software may display the power spectrum density plot (horizontal method), which measures the waviness or periodicity of the surface. From the psd we chose the parameter of amplitude. Thus, four parameters were used: Sa., Sq., mean depth of furrows, and amplitude of the power spectrum density plot. Canonical discriminant statistics were used, from the SPSS statistic package, in order to obtain the discriminant function from both types of traces and to calculate the distance between the four archaeological tools and the experimental ones.

3. Results

The discriminant function analysis allows the consistent discrimination between the subsamples of use-wear polish resulting from harvesting wild/green cereals and those resulting from harvesting domestic/ripe ones. The test correctly classified 82% of the subsamples.

We proceeded to compare the results of the subsamples of wild and domestic cereal polishes with the archaeological tools. For this, we included the subsamples obtained from each archaeological tool one by one in the discriminant function analysis. We observed that the Late PPNB sickle element is classified near the experimental tool used for harvesting domestic cereals (Fig. 2-3).

The Middle PPNB sickle element is classified at a similar distance from both types of experimental tools, though slightly nearer the experimental tool used for harvesting domestic cereals (Fig. 2-4).

The PPNA sickle element is classified nearer the experimental tool used for harvesting wild cereals (Fig. 2-5). The Natufian sickle element is classified very near the experimental tool used for harvesting domestic cereals (Fig. 2-6).

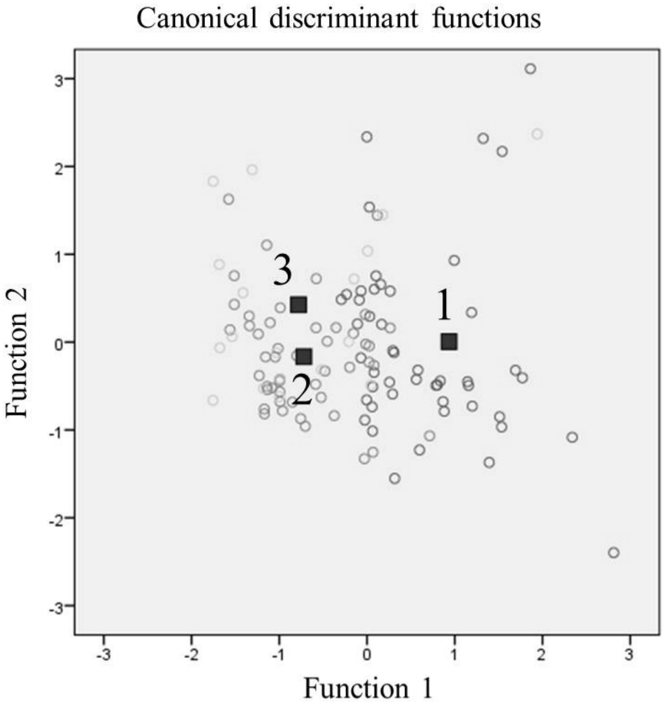

Figure 3. Canonical discriminant functions of wild harvesting (1), domestic harvesting (2) and Late PPNB (3) subsamples of use-wear polish from sickle elements.

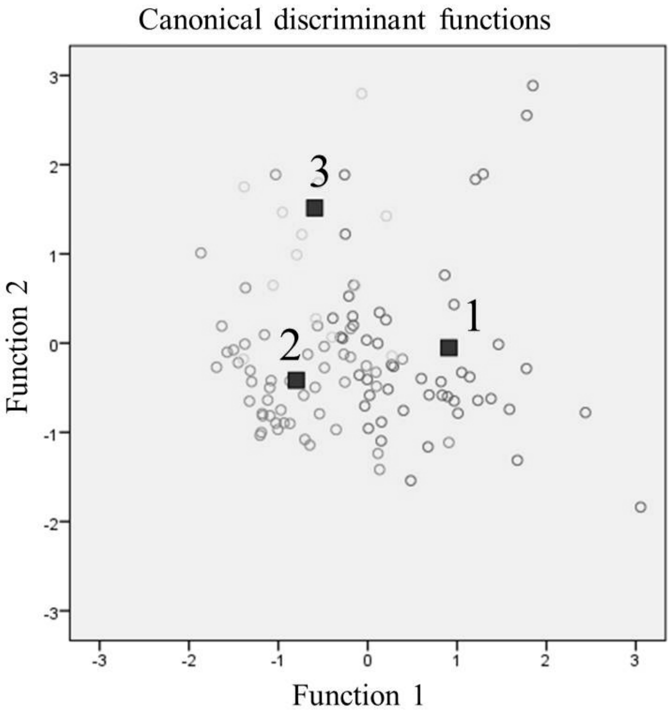

Figure 4. Canonical discriminant functions of wild harvesting (1), domestic harvesting (2) and Middle PPNB (3) subsamples of use-wear polish from sickle elements.

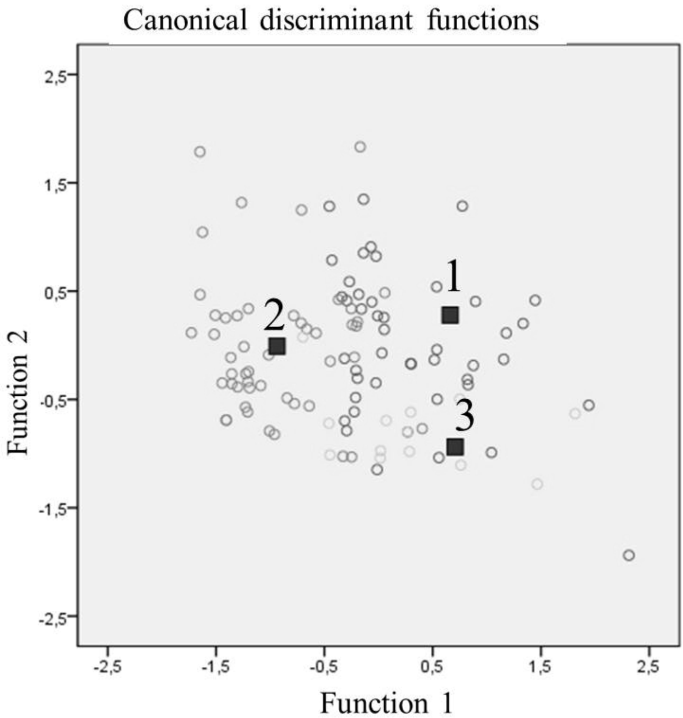

Figure 5. Canonical discriminant functions of wild harvesting (1), domestic harvesting (2) and PPNA (3) subsamples of use-wear polish from sickle elements.

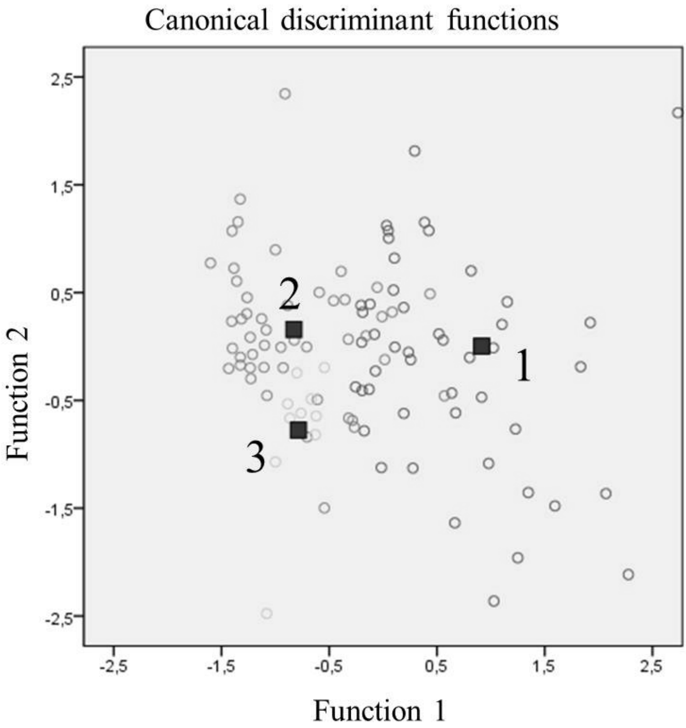

Figure 6. Canonical discriminant functions of wild harvesting (1), domestic harvesting (2) and Natufian (3) subsamples of use-wear polish from sickle elements.

4. Discussion

The discrimination of the sickle elements used for harvesting wild cereals from those used for cutting domestic cereals is statistically significant. These results suggest that the quantitative distinction of both types of traces can be achieved consistently. However, it is necessary to take into account other variables which could affect the reliability of this inference, such as the degree of development of the polish, the cutting height or the flint of which the tools were made, to cite just the more relevant ones.

The study of the archaeological tools has resulted in a classification of the sickle elements, which is coherent with what we expected. The Late PPNB element displays use-wear polish that is similar to the one present on the tool used for harvesting domestic cereal. The polish on the Mid PPNB tool is between the wild and the domestic cereal harvesting experimental tools and the PPNA one resembles the polish on the wild cereal harvesting experimental tool. This classification corresponds adequately with the archaeobotanical data, as the PPNA cereals of Mureybet are morphologically wild (Willcox 2008), while the first domestic cereals in the Middle Euphrates appear in the Mid PPNB levels at Tell Halula and became fully established in the Late PPNB levels (Willcox et al. 2009). These are promising results, suggesting that this method of polish quantification characterizes the process of cereal domestication. However, it is necessary to stress that the archaeological sample is still too small to establish final conclusions. If the study of a larger sample of archaeological tools offers data that are consistent with our preliminary analysis, this method of harvesting polish quantification could be used in other Near East sites to obtain a more detailed picture of the cereal domestication process. The identification of the use-wear polish on the Natufian sickle element with the experimental tool for harvesting domestic cereal should also be considered as preliminary and tentative, as further analyses are needed to confirm this trend.

Acknowledgements

We are grateful to Ferran Laguarta from the CD6 Laboratory at the Universitat Politecnica de Catalunya (Terrassa, Spain) for his help in using confocal laser microscopy. Research is sponsored by the Spanish Ministry of Economy and Competitiveness (Grants HAR2011-21545-C02-01 and HAR2011-29486) and by the Spanish Institute of Cultural Heritage (Excavations Abroad), Ministry of Culture.

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CHAPTER THREE

GLOSSY TOOLS: INNOVATIONS IN THE METHOD OF INTERPRETATION OF USE-WEAR PRODUCED BY PLANT PROCESSING

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Abstract

This work presents an attempt to read wear traces generated by working plants, in particular siliceous plants like cereals, reeds and other herbaceous plants, starting from the methodological basis created by various scholars, and integrating those with new variables. A targeted experimental activity is at the base of this project, along with the analysis of the different stages of trace formation over time and the isolation of the features of each of the latter. Moreover, the tool surface is divided into three distinct areas and scrutinised as a single unit. This new reading mode allows the achievement of more data, useful to the interpretation, avoiding possible evaluation mistakes especially in the case of not highly developed wear. For a more accurate description of the trace, I used the particular definition "tends to" in order to define a polish exhibiting not fully developed features but that seems to tend towards a determined morphology. This methodology worked very well in the analysis of wear generated by reeds, which are characterized by a quick and clear development. However, good results were also achieved in the analysis of tools used to process wild cereals. This work demonstrates the importance of variable distribution in the recognition of wear trace, also allowing for speculation about the time of use of a tool.

Keywords: Wear traces by plants, new reading mode, innovation, wild cereals

1. Introduction

Experiments related to plant processing (Anderson-Gerfaud 1988; Gassin 1993; Jensen 1994; Van Gijn 2010) have led to the identification of peculiar characteristics concerning the use-wear related to the cutting of many different types of plants. Accurate studies have been carried out on wear traces produced by siliceous plants (Jensen 1994; Clemente and Gibaja 1998; Ibanez et al. 2008; Van Gijn 2010). The morphological features on which many scholars have based the definition and assignment of a specific trace are usually texture, topography, brightness and weave. The recognition of the trace is based on the study and combination of these morphological features.

2. Methods and materials

During the work for my MA research (D'Errico 2011), I have focused my study on the analysis of use-wear produced by the processing of both domestic and wild cereals, reeds, siliceous grasses and woody plants in order to reconstruct the exploitation of plants in the sites of Masseria Candelaro (Puglia, Italy) and Çayönü (Anatolia, Turkey). The utilized stone tools, all made of flint, included both objects exhibiting use-wear related to cutting actions which lasted for several hours and those used for a period of more limited time. The various stages of the formation of each wear trace have been accurately analysed from a diachronic point of view. The surfaces of the tools have been divided as follows: Edge area (outermost zone more in contact with the worked material), Inner edge area (intermediate zone, strictly close to the edge) and Inner surface area (innermost area of the surface).

This method of investigation seems to be particularly effective, especially when compared with wear traces in their early stage of development. Reading difficulties in archaeology are due both to the state of conservation of the instrument and especially to the impossibility in many cases to assign a specific instrument to the material worked if the characteristics of the trace appear to be poorly developed. Poorly developed traces can lead to erroneous assignments because the characteristics, if not fully developed and recognized, can lead to various interpretations. Furthermore, I introduced the definition of “tending” (for example, smooth or flat) to define a stage where the polish does not present both a fully developed texture and topography, but tends towards to a determinate morphology. To show the capabilities of this method of interpretation, I have analyzed the evolution of the wear trace due to the cutting of reeds.

3. Results

In the case of tools, after two hours of use for cutting reeds (Phragmites australis) a band of poorly developed polish appears in the Edge area. By moving slightly to the Inner edge area, this band is lost in favour of the particular smooth polish which is only present on high points of the surface with a reticular weave, while on the inner surface area can only be seen a widespread brightness without changes in the surface.

After five hours of usage there is an accentuation of the characteristics of polish in the Edge area that still presents itself as smooth and flat. However, this is with a much more tightened weave, while in the Inner edge area is still present a reticular weave with smoother high points which now goes to affect even the marginally lower areas. On the inner surface area can be found only a diffused brightness.

After six hours of usage the trace shows itself as highly developed in the Edge area with a smooth texture and with very accentuated characteristics but without creating a compact and continuous band of polish like cereals. In the Inner edge area the presence of reticular weave with very rounded high points and the lower parts of the surface only slightly affected by the polish remains constant, while on the Inner surface area in addition to a diffused brightness can be noticed a minimal rounding of the high points.

The main feature of the polish caused by the cutting of reeds is the overall smoothing (with different characteristics) of both the Edge area and the Inner edge area, which can be easily distinguished from the remaining surface, which instead appears rough. This particular morphology of the polish from reeds allows it to be distinguished from that due to the cut of cereals, which especially in the early stages can appear very similar. In the case of tools used for two hours, for example, we noticed substantial differences that may lead to a correct interpretation in an archaeological environment in which the artefacts are generally used for very long time.

Even after this short period of time the polish from cereals presents smoother and flatter characteristics and more tightened weave than that from reeds. Even if in both cases there is not a compact and continuous band of polish, the polish by cereals presents a more intrusive band of polish formation. The polish does not only affect the immediate Edge area and the Inner edge area.

A further interesting comparison is between wear traces from reeds and siliceous grasses. After six hours of usage, polish from siliceous grasses presents smoother and flatter characteristics and tighter weave than those from reeds.

Furthermore, the observation of the distribution of wear traces shows as in the case of reeds, how the use-wear is always more present on the high points of the surface in the Edge area and degrades more quickly in the Inner edge area. Compared to the ones associated to the cutting of siliceous plants this tends to dent in much lesser way the more internal areas of the surface.

4. Discussion

On the basis of the results of this study, I was also able to distinguish the distinctive characteristics of the wear traces caused by the exclusive cutting of wild cereals. The texture of the polish from wild cereals is similar, only in the edge area, to that originated by the processing of domestic cereals, while, in the Inner edge area, only a slight rounding of the high points of the surface can be noticed. Besides, traces left by wild cereals' processing generally show all the characteristics of a less developed type of polish. This difference could be caused by the different quantity of water present in the stems of wild and domestic cereals. The farmers did not have a constant supply of water and wild cereals are more prone to stress caused by aridity while the latter had more frequent access to water.

5. Conclusion

Although still in a pioneering phase, the study of the distribution of use-wear in the various areas of the surface can be extremely important in the experimental study on the formation of wear traces related to the cutting of plants and gives important clues for the interpretation of archaeological chipped stones. To improve and test the functionality of this method of investigation divided into areas there is a need to plan experiments with the objective of recognizing the main features of wear traces in the diachronic sense, taking into consideration a large sample of plants that could have been exploited in activities related to subsistence or for other purposes. These experimental replicas should form a collection for comparison linked to the development of wear traces over time. This approach in some cases could lead to the identification, in the archaeological context, both the processed material and, especially, the period of use of the instrument. This fact is of great significance for the reconstruction of the activities related to the collection of plants and the more or less intensive exploitation of resources.

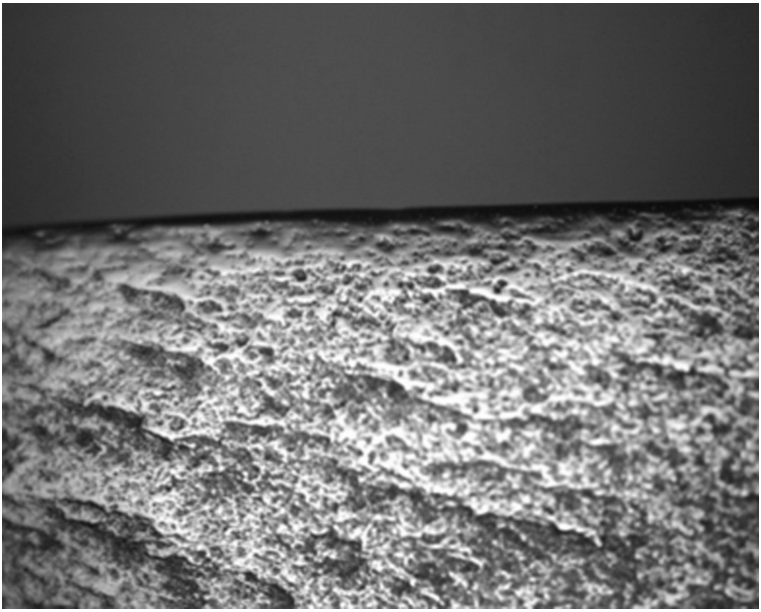

Fig 1. Experimental trace due to two hours of cutting reeds Edge area 10x

Fig 2. Experimental trace due to two hours of cutting reeds Inner-edge area 10x

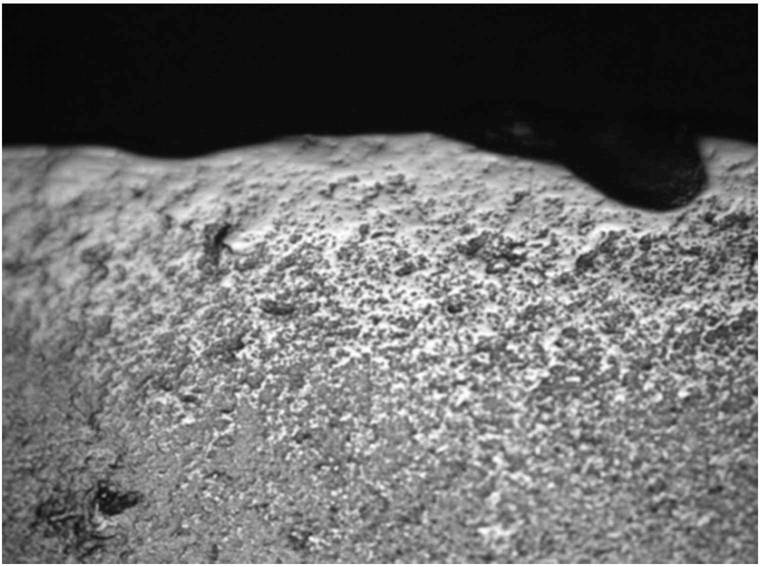

Fig 3. Experimental trace due to five hours of cutting reeds Edge area 10x

Fig 4. Experimental trace due to five hours of cutting reeds Inner-edge area 10x

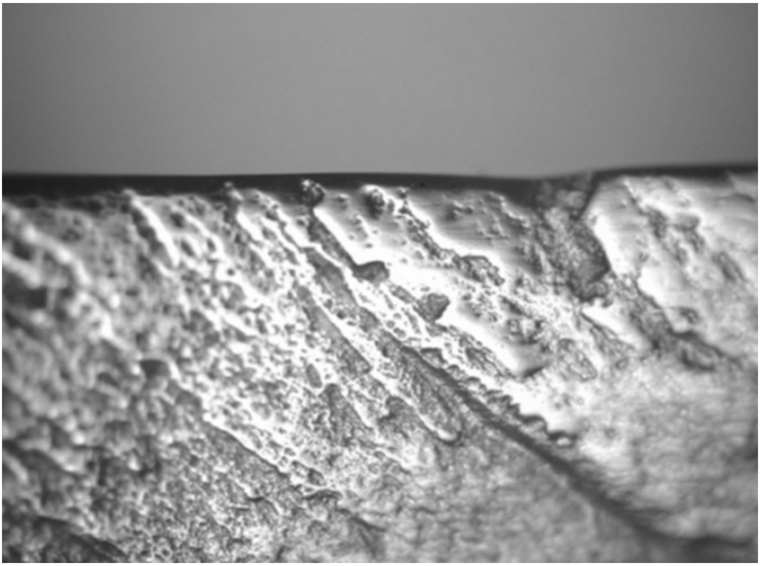

Fig 5. Experimental trace due to six hours of cutting reeds Edge area 10x

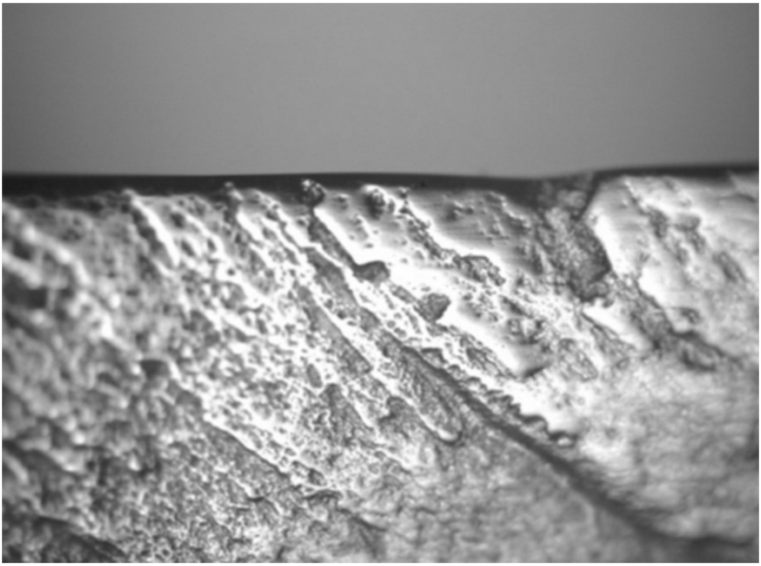

Fig 6. Experimental trace due to six hours of cutting reeds Inner-.edge area 10x

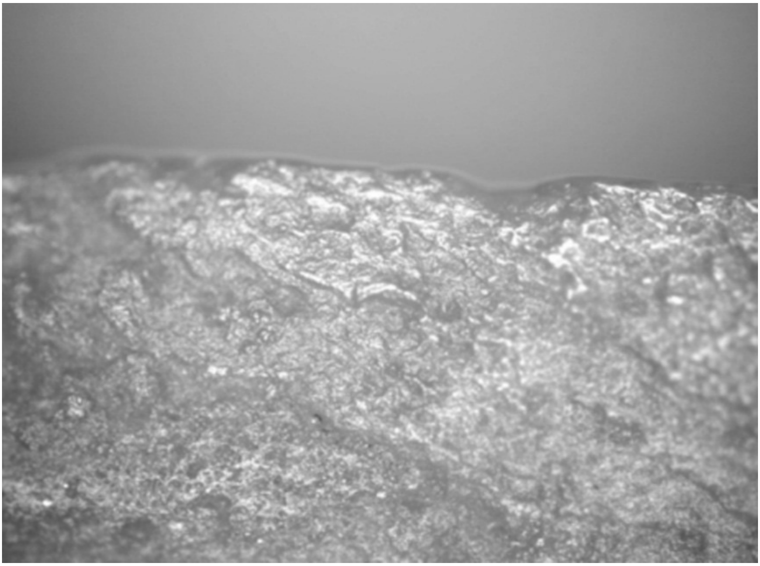

Fig 7. Archaeological trace from Çayönü (Turkey). Tool used to cut wild cereals

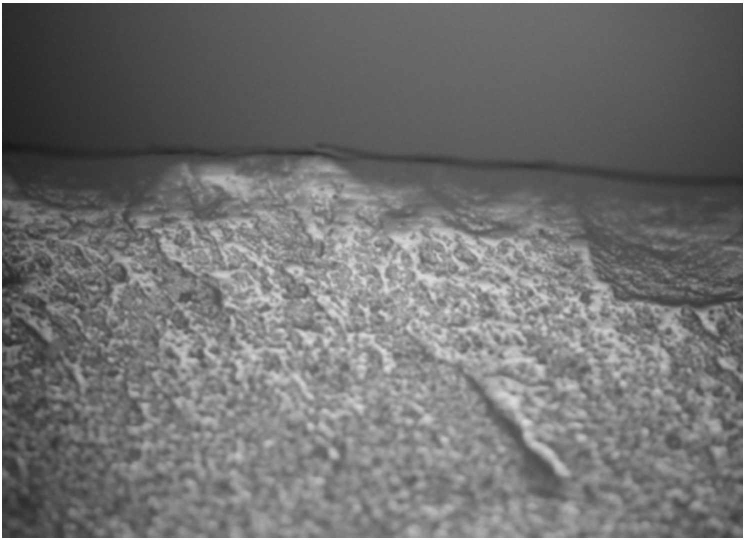

Fig 8. Archaeological trace from Çayönü (Turkey). Tool used to cut domestic cereals

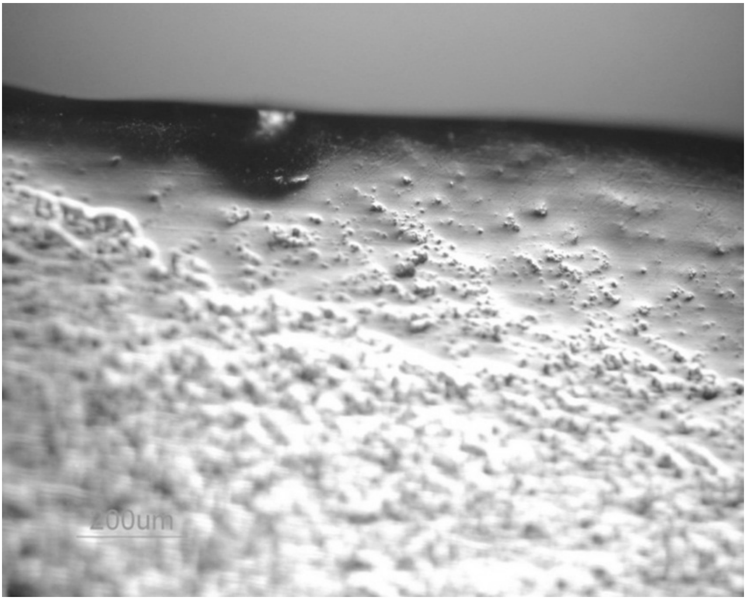

Fig 9. Experimental trace due to six hours of cutting siliceous grasses Edge area

Tab 1. Description of the wear traces due to two hours of cutting reeds

Reeds	**Edge area**	**Inner edge area**	**Inner surface area**
2 hours of use Band of polish: 0,5 mm	Edge slightly rounded. The high points of the surface are smooth while the polish is being formed in the lower parts	Reticular weave with →smooth appearance	Presence of diffused brightness without relevant changes of the surface

Tab 2 Description of the wear traces due to five hours of cutting reeds

Reeds	**Edge area**	**Inner edge area**	**Inner surface area**
5 hours of use Band of polish: 1,06 mm	The polishing is more smooth and flat. No compact band of polish	Reticular weave. The smooth appearance marginally interest also the lower zones	Presence of diffused brightness without relevant changes of the surface

Tab 3. Description of the wear traces due to six hours of cutting reeds

Reeds	**Edge area**	**Inner edge area**	**Inner surface area**
6 hours of use Band of polish: 1,06 mm	The band of polish is very compact. The smooth and flat appearance is strongly marked and associated to heavy edge rounding	Reticular weave. The smooth appearance, very pronounced on the high points, marginally interest even the lower zones.	Presence of diffused brightness with minimal rounding of the highest points of the surface

Acknowledgements

Special thanks to Dr Natalia Skakun for having made available for this study the experimental tools used for the Wenner Gren project “Developing a FTIR Spectra collection for interpreting residues of the Prehistoric activities”.

Special thanks to Prof. Avi Ghoper and Prof. Shahal Abbo for having made available for my study, the experimental materials concerning the cutting of wild cereals.

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CHAPTER FOUR

TURNING THE WHEEL ON LITHIC FUNCTIONALITY

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Abstract

Lithic analysis is one of the most important disciplines in prehistoric archaeology, and during the last 200 years archaeologists have been trying to extract the most information possible through technological, typological and functional analysis on stone tools. In this paper, we will focus on functional analysis, presenting a critical view on how use-wear studies have been performed. Experimental studies have been recurrently used as the most reliable method to get use-wear traces that are similar to those found in archaeological artefacts after they have been used in different actions and used materials. However, critical and sceptical debates have pointed out that such replications might be too subjective, especially as several key variables are not controlled. Therefore, results are sometimes seen as problematic or inadequate.

Based on this debate, we suggest in this paper a new experimental design based on controlled conditions, where each key variable can be identified, quantified and analyzed. We believe this new approach can help functional analysis to become an even more important tool for the inference of past human behaviour.

Keywords: Experimental program; controlled test, use-wear analysis; mechanical device

1. Introduction

The main goal of artefact analysis is to infer about the social, cultural and technological patterns of past human populations, to recognize types that can be used as temporal and regional markers and to infer their use. During the last decades, techno-typological studies have been complemented by use-wear analysis in order to reconstruct human past technology and behaviour (Gibaja 2007; Longo et al. 2005). Functional inferences are based on experiments assumed to mimic past daily activities (e.g. Hardy 1998). Wear traces observed in experimental tools are used as reference data and compared against those found in the archaeological record. When both lab and archaeological assemblages are similar, archaeologists believe they have found the possible activity performed, and the material used in the past (Keely 1980; Moss 1983; Odell and Odell-Vereecken 1980; Vaughan 1985). This apparently simple correlation has constantly faced several constraints. Perhaps the most critical one is the fact that some traces can be obtained by more than one activity (e.g. worked material, movement, working time, etc.). Some researchers argue that many wear traces cannot be associated with confidence to one specific task or material and, thus, many of them discard this method as a reliable tool to understand past human behaviour (Grace 1996; Keeley 1974; Shea & Klenck 1993).

The modern relation between function and tools came from works such as those of Leroi-Gourhan (1945), who named artefacts based on their morphology and on ethnographic proxies. This idea was used to create some of the type-lists for Palaeolithic assemblages (Sonneville-Bordes & Perrot 1954, 1955, 1956; Bordes 1961). At the same time in the world, use-wear investigation appeared in the early 1930s from the Marxist perspective of Soviet archaeology, which used tools as a fundamental proxy to understand the evolution of societies (Phillips 1988). In the West, this approach was rapidly divorced from its ideological underpinnings, and became widely adopted (Semenov 1964) embedded in the processualist, middle-range and scientific approaches–the fundamental pillars of present archaeological research. Since then, the understanding of tools has received important contributions from other disciplines such as ethno-archaeology (González et al. 1999), experimental archaeology and primatology (Carvalho et al. 2008, 2009; Scott et al. 2006; Haslam et al. 2009).

In the beginning, use-wear researchers approached methodology, terminology, features and goals of the experimental programs along with the presentation of preliminary results (Anderson et al. 1993; Ibáñez and Gonzalez 2003; Longo et al. 2005; Gibaja 2007). Special attention was given to retouched tools (Moss 1983; Plisson 1985; Gassin 1996; Ibáñez and González 1996; Bicho and Gibaja 2006; Gibaja and Palomo 2004; Igreja 2005) but the ongoing research widely accepted that non-retouched blanks were not only used for a multiplicity of tasks (Gibaja 2006; Igreja et al. 2007; Marreiros 2009), but also that some chipping present along the edges was not related to intentional retouch, but rather with post-depositional processes or with the contact of the artefact against hard materials (Evans & Donahue 2005; Sala 1986; Stevens et al. 2010). This demanded the clarification of the term tool. Presently it is commonly accepted that the word tool should be applied to any artefact that was used as a device, beyond those existing in the body, in order to increase the influence applied to someone or something, and which gives a mechanical and/or mental advantage that eases the accomplishment of an objective, whether or not it was retouched. This designation should be distinct from a retouched tool, which should be applied only to those implements that show intended modification, whether with use-wear traces or not. Moreover, it has been shown that the retouched area was not always actively used on other materials, but rather used to haft the artefact (Gibaja 2003). Recently, functional analysis stepped beyond the interpretation of artefacts per se and embraced wider (and eventually more interesting) questions related to past human behaviour in its cultural, social, economical and adaptive senses (González and Ibáñez 1994; Gassin 1996; Ibáñez and González 1996; Gibaja 2002). But, is the present state of the art of use-wear methods solid enough for such a step forward or does it has important gaps that need urgent solutions?

2. Functional analysis

As mentioned above, functional analysis is based on systematic experimentation, a basic principle of the scientific method. This means that the experiments can be replicated with the same results, and that the convergence of results is what makes it valid. This is important because, since it is often related to a humanistic perspective, this approach can be an important way to bring archaeology closer to other sciences–those that are considered more accurate. The experimental programs performed in functional analysis assume to mimic human actions (Ascher 1961), where the final results are defined by the relation between the presence of different forms of macro- and microwear traces: the absence and intensity of types of edge damage, polish and chipping driven from the combination of different agents such as tools, movements, worked materials, human bio-mechanics and physics (pressure, speed, etc.) (Ibáñez & González 1996). In the case of tools, significant variations can come from the surface area of the artefact making contact with the worked material, the edge and working angle, the raw material in which the tool was manufactured, and the presence, absence or type of retouch. Among the different types of tasks one can consider are cutting, scraping, drilling, stabbing, polishing or cracking. The working materials can be divided into animal (fat, meat, hide, scales, tendon, spine, bone, horn, antler and ivory), vegetable (root, trunk, branch, twig, stalk, bole, haulm, hard fruit, soft fruit and leaf) and geologic (water, rocks and minerals). The types of movements one can consider include unidirectional (all towards the back or all towards the front), bidirectional (backward and forward movements), twisting, spinning, impacting, percussion, erratic, or some combination thereof. In the case of human bio-mechanics, the situation gets even more complicated, since past human species had body proportions and abilities that cannot be directly replicated by modern humans. Finally, adding to all these elements, one must add physical agents such as the duration of tool use, attrition between the materials, applied pressure, speed of the movements, degree of strength used, and the physical and chemical post-depositional actions over the artefacts. All of these are seen as key variables that might interact at the same time.

The plethora of publications on use-wear methods, whether resulting from lab experiments or archaeological interpretations, have not always reached consensus. This is due to three major causes: (1) entropy might have damaged the tools, leading to the misinterpretation of the use-wear marks; (2) after a certain point of its use, the edge gets damaged in such a way that the traces from completely different activities may overlap with each other; or (3) because during the lab experiments not all variables were controlled with enough accuracy, resulting in the construction of biased reference collections. As an extreme example of the last case, one may ask if, for instance, the edge damage produced during lab experiments on unretouched chert flakes over the hide of a European 21st Century farm cow can be used as a reliable proxy to infer the use of basalt unretouched flakes found around a rhinoceros dated from 1.7 Myr in Africa, that could be the result of the activity performed by Homo habilis, Homo ergaster, Australopithecus (Paranthropus) robustus or Australopithecus (P.) boisei?

3. Turning the wheel

Due to the existence of a variety of results that have generated little consensus among researchers, namely those in which similar or identical wear traces are obtained through different activities, researchers tend to hold one of two perspectives: those who are sympathetic with functional analysis and accept the great majority of the results that come from this line of research (probably sometimes with too much optimism and little criticism) and those who are sceptical and disbelieve all or almost all these results. There is no doubt that these are the extreme points of a line where the most fruitful position to solve the problems in hand lies somewhere in the middle. But, where is that midpoint? To help find that answer, we have to search where functional analysis and use-wear interpretations receive more consensuses. In our opinion one of them is the recognition, interpretation and replication of artefacts that were used as projectile points and tips (Fischer et al. 1984; Lazuén 2012; Lombard 2005; Hutching 2011; Iovita et al. in press; Pargeter 2011; Pétillon et al. 2011; Plisson & Beyries 1988; Sano 2009; Villa et al. 2009; Wilkins et al. 2012). Why? We believe that this has to do with the fact that the number of key variables is highly controlled. Usually the analysis focuses on one morph-type (point or tip), often with low morphological variation, and on which measurements are usually taken (with increasingly accurate methods such as 3D scanning or contour morphology over digital photography) before shooting, which is replicated often with the raw material of the same source from that used to manufacture the archaeological ones. The artefact is then projected one time, in a single direction, at a controlled speed and distance against a target whose characteristics, position and angle are also controlled. The projectile can hit areas with different stiffness, such as hide and flesh or hide and bone, but, since the shots are done one at a time, the projectile and the target are analyzed, which means that this variable is also controlled. So, what do we need to do to increase the accuracy of use-wear analysis and make people from the second group change sides? We believe that the answer lies in the creation of experimental protocols that will be (1) so tight in the control of each key variable that the following replication will generate statistically identical results; (2) that results will be different right after one of the variables is changed; (3) that such control will retrieve normal linear regression results on the formation of edge damage in actions that are nonlinear in time or pressure; (4) that the results will form clusters related to activity and material used; and (5) clusters can exactly show the window when the overlaps occur.

So, how can such improvements be done effectively? We believe that, at this point of research, with traces resulting from the physical actions between the artefact and worked materials, this goal can only be achieved through mechanical devices (and not human action) that would have the ability to be limited to physics, bring almost absolute control over a known list of variables specifically implied in each experiment and for which all critical variables would be controlled and measured in real-time during the test. These devices would intentionally exclude other variables such as those related to human biomechanics that are consistently and unconsciously added to any manmade movement as the result of millions of years of evolution, namely uniquely human tool use.

Recently, our team from the University of Algarve developed a prototype dedicated to produce wear traces in a controlled laboratory environment through mechanical movements. Our preliminary experiments seem to show success in both the control and the acquisition of real-time data from several crucial key variables. Detailed results are presently in preparation for publication elsewhere (Pereira et al. in preparation).

Other experiments are ongoing and include an examination of variation among worked materials, raw materials and tool morph-types, both retouched and not-retouched.

Since use-wear analysis is based on the physical results obtained between the contact of at least two different materials and shapes, the systematic application of mechanical devices can remove from this equation all the input from human evolution and leave only the physical action to be measured. After mechanical experiments retrieve a considerable and consistent quantity of data it will be possible to (a) clear up or at least narrow down the blurred area of overlapping traces and associate with confidence the lab results with the archaeological observations, and (b) understand how much of human evolution input exists in order to counteract the physical difficulties. In other words, to assess how dexterity works to accomplish a task in order to increase efficiency and reduce energy consumption and risk.

Acknowledgements

This research has been founded by the Fundação para a Ciência e a Tecnologia through the post-doc. grant of Telmo Pereira (SFRH / BPD / 73598 / 2010) and the Ph.D. grant of João Marreiros (SFRH / BD / 65301 / 2009).

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CHAPTER FIVE

EXPERIMENTAL PROGRAM FOR THE DETECTION OF USE WEAR IN QUARTZITE

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Abstract

This paper presents preliminary results obtained from a series of butchery and woodworking experiments aimed at identifying use-wear traces on quartzite. Sequential SEM observation of wear on tool edges allowed us to document slight development and conservation of wear features. Wear results mostly from the essentially fragile behaviour of quartz grains, which tend to fracture with applied effort, generating a loss of microrelief. Our results demonstrate the potential of establishing experimental wear patterns on quartzite objects, which aid interpretation of features observed on archaeological materials.

Keywords: Quartzite, experimental program, Scanning Electron Microscopy.

1. Introduction

The paucity of experimental studies of use-wear on quartzite tools constrains the study of quartzite archaeological assemblages. Previous studies have demonstrated the difficulties encountered when comparing use-wear traces produced on flint with those on quartzite, and have shown that both types of rocks have their own wear characteristics (Beyries 1982; Plisson 1985; Mansur and Alonso 1990; Utrilla and Mazo 1996).

At a macroscopic level, the surface topography of quartzite is irregular which seems to explain why use-wear develops on much smaller and discontinuous areas than on other rocks such as flint (Clemente 1997; Mansur 1999; Gibaja et al. 2002, Ollé 2003; Vergès 2003; Leipus and Mansur 2007). A further problem noted is the loss of traces accumulated during the first moments of use due to destruction of microrelief caused by microflaking of the edge. This destruction is produced during the first stage of fracture with a loss of crystals caused by attrition. At the second stage of edge stabilization fracture decreases and the presence of friction phenomena rises (Ollé 2003).

The present study aims to present the results of a preliminary experimental program devoted to the monitoring of wear formation on experimental quartzite tools.

2. Materials and methods

Eight experimental tools were used in this study: 4 were used for woodworking and 4 were used in butchery processes. The butchery tools comprised 2 large shaped tools (handaxes) (CSAC1-CSAC2), and 2 medium-sized flakes (CSAC4-CSAC5). Wood working tools consisted of 2 large shaped tools (handaxe (CSAM2) and cleaver (CSAM4)), and 2 medium-sized flakes (CSAM3-CSAM5) (Table 5-1). As the experimental program was conceived to aid future study of the Acheulean assemblage from Santa Ana cave (Cáceres, Spain), all replicas were made from local quartzite slabs (Ordovician Armorican, from Salor Valley). The choice and combination of tool types respond to specific questions posed by a preliminary use-wear study of the assemblage (Ollé et al. this volume).

The program included sequential experiments, which aimed to monitor wear process during the actions performed (Ollé and Vergés 2008). Choice of activities was restricted to butchery and woodworking to begin with as these are activities commonly assumed to be related with Acheulean large cutting tools (Clark and Haynes 1969; Clark 1975; Jones 1981; Villa 1990;

Schick and Toth 1993; Ashton and McNabb 1994; Mitchell 1995; Domínguez-Rodrígo et al. 2001; Ollé 2003).

In order to control variables, we grouped actions into a limited number of categories (Table 5-1). Butchery activities (Ovis aries and Cervus elaphus) included skinning, disarticulation and defleshing. Although all experiments were planned to be sequential, to date only 2 cases (CSAC1 and CSAC5) have been observed through two stages of use. Woodworking consisted of cutting, scraping and planing fresh Holm oak (Quercus ilex) branches.

Experimental tools were analysed under the SEM (JEOL JSM-6400), a technique of analysis that offers some advantages with respect to conventional light optical microscopy, essentially in terms of image resolution, depth of field and the potential of associated elementary microanalysis (EDS) (Ollé 2003; Vergès 2003).

To accurately observe deformations on tool surfaces caused by use, we followed a cleaning procedure proposed by Ollé and Vergès (2008). For SEM observation we made high-resolution moulds of tool edges using the dental silicone Provil® novo Light (Heraeus Kulzer, Inc.). For casts or replicas we used a bicomponent polyurethane rapid setting resin (Feropur PR-55, Synthesia Española S.A.). Replicas allow us to record the morphological features of the fresh cutting edge and thus compare a given point of the edge before and after use.

Edge visualization was carried out by locating points of interest defined by areas where use-wear traces were observable. These points were systematically recorded by taking images at different magnifications (50, 100, 250, 500 and 1000x), after which they were located on the fresh edge of the replica. These series of micrographs were crucial in order to properly locate points of interest, record the distribution of traces, and analyse minute details of features individualized at different magnifications. In some cases, we were able to take images of the same point of the edge and thus note the development of microrelief at three different stages: before use and after two episodes of use.

Experimental variables						Edge features			
Ref	Worked Material	Actions	Motion	α of work	Time	α edge	Edge shaping	Prof. Del.	Hor. Del.
CSA C1	Skin, subcutaneous tissues	Skinning	Uni. Long.	90°	30´ +30´	70°	Cfg.	Inc (str)	1a
CSA C2	Meat, joints, tendons, bone	Disarticulation	Uni. Trans.	90°	15´	65°	Cfg.	inc	cx
CSA C4	Meat	Defleshing	Uni. Long.	75°	15´	40°	ncfg.	str	cx
CSA C5	Bone, meat	Evisceration, rib cutting and meat cutting	Uni. Long.	90°	20´ +20´	30°	ncfg.	str	cx

CSA M2	Fresh wood	Chopping	Uni. Trans.	45°	15´	65°	cfg.	sin	1a
CSA M3			Uni. Trans.	45°	15´	70°	ncfg.	sin	sin
CSA M4		Scraping	Uni. Trans.	60°	20´	60°	ncfg.	sin	cx
CSA M5		Cutting	Uni. Long.	75°	15´	55°	ncfg.	sin	cx

Tab. 1: Experimental Protocol variables and edge features: reference; worked material; action; direction of motion (unidirectional –Uni-, longitudinal -Long-, transverse -Trans-); angle of work; time: angle edge; edge shaping (shaped -shp- and not sdhaped –nshp-); profile delineation (straight –str-, incurved -inc-, sinuous –sin-); horizontal delineation (convex -cx-, sinuous -sin-, uniangular -1a-).

3. Results

3.1. Butchery processes

After 15 minutes of cutting meat (CSAC4) minor microrelief modifications were observed along the active edge (64 mm) of the tool that are restricted to the crystals close to the edge, and do not extend towards the inner area of the tool surface. A slight microfracture and slight smoothing of the crystal ridges can be observed.

During disarticulation (CSAC2) the point of the tool broke, which involved the loss of any previous modification, as well as making it impossible to compare the same points on the edge before and after rupture.

The skinning activity (CSAC1) produced continuous wear of crystals close to the edge that was particularly developed on the dorsal face that had sustained greater contact with the worked material. Deformations observed after 30 and 60 minutes of use include edge rounding (Fig. 1 B-C), friction features in the form of linear grooves, and a slight polish from plastic deformation. Microfracture of crystal ridges and loss of material are evident, and sometimes the only feature recorded (Fig. 5-1 E-F).

Evisceration, disarticulation of ribs and meat cutting (CSAC5), produced deformations that are distributed along the active edge, but which are more intense at the distal end. Crystal microfracture close to the edge became more intense as time of use increased, leading to more rounded ridges and smoothed surfaces after four minutes of use (Fig. 5-2 B-C).

In those cases where two stages of use are documented, the same wear pattern can be observed. After the first period of use almost no visible deformation, and only a loss of material due to the fracture of crystals close to the edge, can be observed. When use is extended, crystal ridges begin to round off and some friction features appear (Fig. 5-1 F). In the case of the tool that was subjected to harder contact material (CSAC5, cutting ribs), fractures are dominant during the entire process (Fig. 5-2) and plastic deformation, although visible during the second period of use is poorly developed.

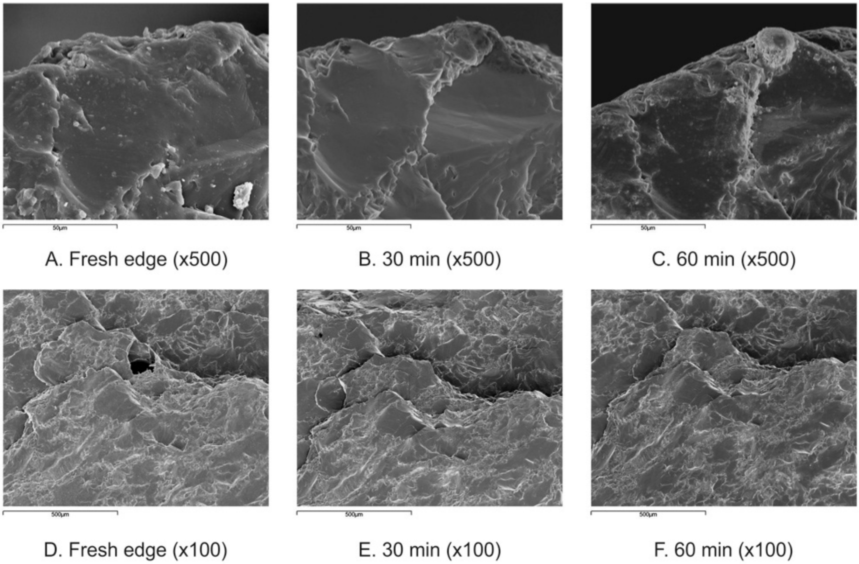


Fig 1: CSAC1. Skinning action, 2 stages of use (30 minutes +30 minutes). A: Fresh edge of control point 1. B: after 30minutes use; rounded edge and loss of material. C: after 60 minutes use, edge rounding, smoothing and initial polish. D: Fresh edge occ̦f control point 2. E: after 30 minutes use, quartz crystals microfracture. F: after 60 minutes use, loss of material because of intense quartz crystals micro-fracture and initial surface regularisation.

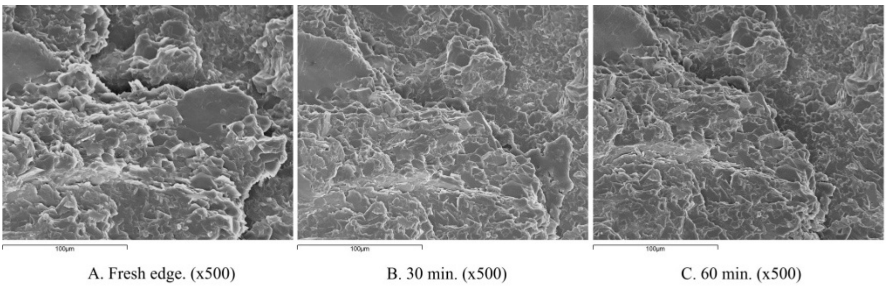
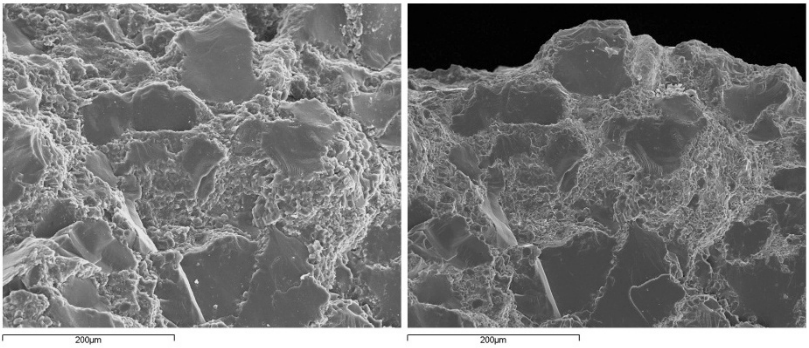


Fig 2: CSAC5. Evisceration, rib cutting and meat cutting actions, 2 stages of use (20 minutes +20 minutes) A: Fresh edge. B: after 30minutes use, loss of material due to crystal microfracture and slight smoothing of the surface. C: after 60 minutes use, accentuation of the loss of the quartz crystals and smoothing, with no clear wear features visible.

3.2. Fresh wood working

During the first 3 minutes of striking (in an axe-like manner) (CSAM2-CSAM3), both pieces used were fractured and their points showed heavy chipping. After a few minutes of use, the edge began to stabilize and smoothing and slight rounding of crystals closer to the edge were visible.

During wood scraping (CSAM4), wear developed continuously along the used edge. A great loss of material due to the microfracture of crystals close to the edge was observed. Crystal ridges became rounded and the surface smoothed. In many cases, an incipient polishing and rounding of the stabilized active edge occurred after fracture (Fig. 5-3).



A. Fresh edge. (X500) B. 15 min. (X500)

Fig 3: CSAM4. Fresh wood scrapping action. A: Fresh edge. B: after 15 minutes use. Intensive microfracture of the quartz crystals of edge (clearly transverse oriented), surface smoothening and marked edge rounding.

Finally, wood-cutting (CSAM5) resulted in very slight deformations that are restricted to the microfracture of crystals close to the edge and distributed intermittently along the first third of the tool, smoothing of the surface, and the beginning of edge rounding.

4. Discussion and conclusions

In this study we have presented a methodological procedure that includes sequential experiments and microscopic analysis based on observations at different magnifications using scanning electron microscopy. Although the preparation process of samples is more demanding than with traditional optical microscopes, the SEM offers significant advantages over traditional optical microscopes, especially in terms of magnification power, image resolution and depth of field.

The experimental program allowed a preliminary approach to the development of wear induced by butchery and woodworking activities on a set of tools made of a specific variety of quartzite. In order to evaluate precisely the effects of use on the experimental tool edges, monitoring of the wear process from the fresh edge (for which replicas were used) through different stages of use is considered crucial. This procedure has reinforced the idea that functional studies of raw materials other than flint are possible, although not all raw materials offer the same potential to identify actions undertaken and materials worked.

Wear features discernable from butchery actions are very weak and appear only on the rim of the edge, whereas they are more developed and extended in woodworking actions. But forceful actions produce more edge microfracturing that causes the loss of portions of the edge (and so, loss of wear features). This can explain why longitudinal motions on soft materials tend to leave wear features along the entire edge and transversal motions on harder materials leave main microfractures (that make a detailed comparison between fresh and used edges difficult to do).

Quartzite crystallographic properties explain the essentially fragile behaviour of this rock when submitted to force. The continuous fracture of its quartz crystals obstructs both the appearance and the conservation of wear features (striations, plastic deformations…). Nevertheless, the two-time sequential experiments have shown how this low intensity process of wear includes a first stage of fracture that involves abrasion of crystal ridges, after which there is a stage of edge stabilization when plastic deformation (rounding, polish…) begins to appear.

This study is a methodological approach for the analysis of large shaped quartzite tools. As well as the need to extend the experimental program by the inclusion of a wider range of activities, other surface modifications such as those produced by postdepositional processes must be considered in future research.

Acknowledgements

We would like to thank all our colleagues from the *Eauipo Primeros Pobladores de Extremadura*, as well as the institutions that supported research in the Calerizo de Cáceres. This study was developed in the framework the MICINN project CGL2009-12703-C03-02 and the

AGAUR projects 2009SGR-188 and 2009PBR-00033. We also thank Antonio Rodriguez and Lucía Bermejo for making corrections and Norah Moloney for her assistance with the English version of the manuscript.

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CHAPTER SIX

MICRO-RESIDUES ON STONE TOOLS: MORPHOLOGICAL ANALYSIS, INTERPRETATION AND CHALLENGES

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Abstract

Here we present an overview of the challenges and the advances made to the morphological analysis of micro-residues recorded on archaeological stone tools. We suggest that through continued (blind and other) testing, and the development of techniques and approaches, the field has overcome many initial obstacles.

Keywords: Micro-residues, morphological analysis, stone tools

Introduction

Micro-residue analysis was a contested method for the reconstruction of tool use (Grace, 1996; Smith and Wilson, 2001, and see the debate in Fullagar et al, 1996), but with rigorous testing doubt has been lessened. Here we present a brief overview of progress and future challenges.

ML developed the 'multi-stranded approach', which also includes quantification and statistical testing. Before we continue, we illustrate this approach with a short-case study. Examining and interpreting any archaeological material in isolation may lead to inadequate/unreliable strands of evidence (cf. Wylie, 1989). In the multi-stranded approach, single residue occurrences are interpreted to the best of the analyst's abilities, and functional interpretations are based on the larger dataset recorded on a tool and/or a representative sample of (morphologically similar) artefacts. The latter specifically tests for repetitive patterning that, if present, can counter arguments for the accidental presence of residue types. For example, on 53 backed artefacts from a narrow archaeological context, a total of 1825 individual residue occurrences were recorded (Lombard, 2007, 2008, 2011). The distribution of animal type micro-residues prevailed on the sharp, unretouched sides; plant remains were most abundant on the backed sides (Figure 1). Using additional strands of evidence, including the distribution of wear traces and fractures, ML inferred that most of the backed tools were used to tip hafted hunting weapons (Lombard, 2007, 2008, 2011).

Accuracy of morphological identification

Regardless of artefact type (lithics, pottery, bone), few scholars would deem morphological analyses in archaeology 100% accurate. A margin of interpretative error is generally understood as a result of the tightness (or not) of definitions, analysts' perceptions of a 'category/type', their experience, and the nature/condition of the materials. This is also true for micro-residues on stone tools, and blind tests do not have 100% success rates (Lombard and Wadley, 2007; Monnier et al., 2012; Wadley et al., 2004). Difficulties and ambiguities regarding the morphological recognition of micro-residues on stone tools are often highlighted. For example, some plant and animal remains share morphological properties when observed at specific angles, magnifications and/or light conditions (Lombard and Wadley, 2007). Decayed and contaminant micro-residues can also resemble something they are not (Haslam, 2006b; Langejans, 2009), and not all remains are as 'diagnostic' as initially thought (e.g. Crowther, 2009).

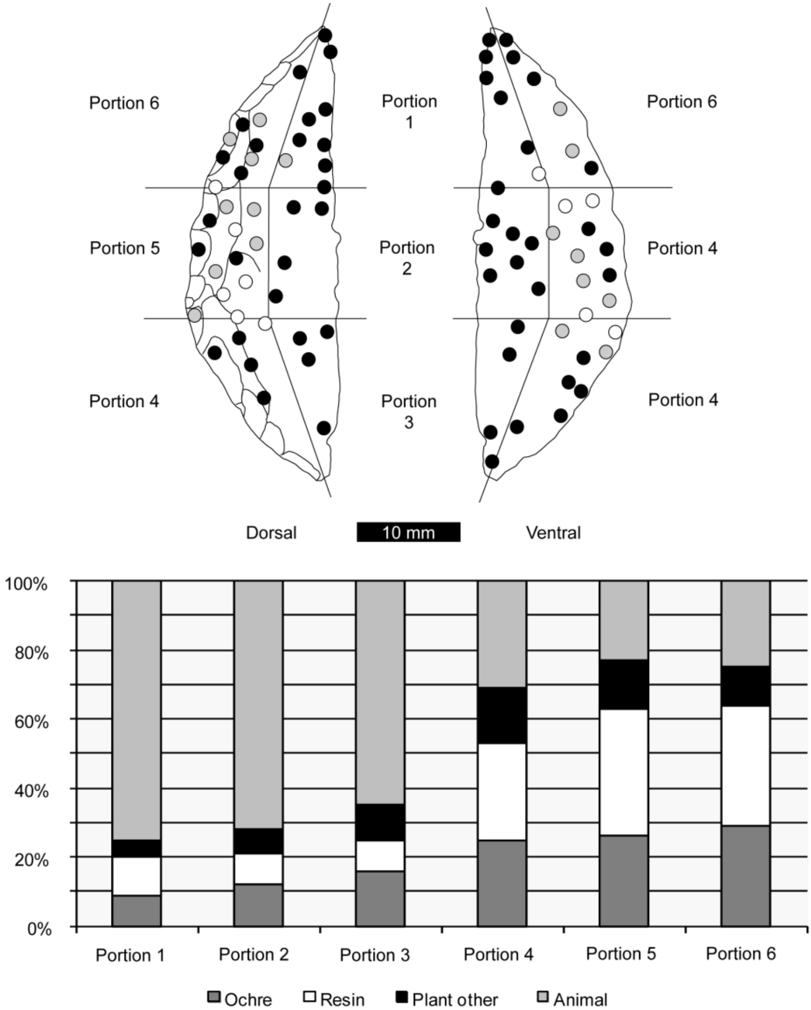

Fig 1: An example of a multi-stranded residue study. The top of image represents a simplified residue distribution map for a Middle Stone Age stone segment from Sibudu Cave, South Africa (adapted from Lombard, 2008, Fig. 3). The segment is divided in 6 portions and here the general residue groups are indicated by the following symbols: black circle = animal type remains (muscle tissue, bone, collagen, blood and hair); open circle = plant type remains (plant tissue/fibers, starch); grey circle = ochre and resin micro-residues. The lower part of the figure is a graph with the combined and quantified results of an assemblage of segments (n

= 53) (from Lombard, 2007; Lombard, 2008). Note that plant remains, ochre and resin are most abundant on portions with steep retouch (the backed side, portions 4-6). Animal type remains are dominant on the sharp edged portions 1-3. Lombard (2008, 2007) interpreted these patterns as evidence for the hafting of most segments using mixed ochre and resin adhesives, and their use as hunting weapons.

Thus, a method of generating and cross-checking against experimental and ethnographic comparative collections, recording observations under different angles, magnifications and lighting conditions, applying statistical tests when the data allows, as well as cautious 'best-fit' functional or hafting interpretation can be followed to produce convincing reconstructions of use and/or hafting. Conducting experiments also builds experience regarding the diverseguises that materials can adopt when observed microscopically (Crowther, 2009; Lombard and Wadley, 2007).

Based on this approach, the reliability of micro-residue identifications is demonstrated by blind tests. An experienced analyst, working from 3D samples, achieved an average success rate of 82% over four tests (Lombard and Wadley, 2007; Wadley et al., 2004), and even minimally trained novices, using 2D photographic material, obtained an average success rate of 75% (Monnier et al., 2012). Depending on the research question, it is good-practice to report on unidentified micro-residues, the range of observed contaminant micro-residues and unidentified/uncertain functional assessments (e.g. Langejans, 2011, 2012; Monnier et al., 2012; Robertson, 2011).

New approaches to resolve issues in morphological interpretation are able to address specific issues. For example, the successful application of SEM to differentiate deciduous wood from bone and coniferous wood by Monnier and colleagues (2012) is an important methodological contribution. Further conventional blind-testing, aimed at isolating problem areas, may increase the reliability of identifications. Some answers also come from bio-chemical approaches (e.g. Charrié-Duhaut et al., in 2013; Langejans, 2007; Lombard 2014; Pawlik and Thissen, 2011), but as a result of still poorly understood processes of diagenesis, the destructive methods and the often minuscule remains, these approaches might not be suitable for all contexts. Long-term actualistic decay experiments may assist in resolving some of these issues. Techniques are, however, being improved as we write, and the future will no doubt see a flurry of archaeological residue results, tested, supported and/or refined by a range of bio-chemical approaches.

3. Preservation

Site taphonomy is an important aspect, and understanding the circumstances under which different types of micro-residues (e.g. bone, plant fibres and starch) escape decay helps to interpret ancient remains (see the discussion in Fullagar et al., 1996). Although experiments have demonstrated that residues survive on some artefacts, preservation depends on the local circumstances, including climate and soil conditions (e.g. Barton, 2009; Langejans, 2010; Lu, 2006). Artefacts from stable, dry and sheltered sites are generally promising for micro-residue studies, whereas those from unstable open-air sites might be less suitable (Langejans, 2010). Additional long-term preservation experiments that test different residues on diverse rock types, and in different environmental contexts could lead to more detailed preservation predictions than what is available today.

4. Contamination and age

Not only may use-related residues have disappeared from artefacts, non use-related residues can stick to artefacts, hampering reliable interpretations of an artefact's function. Hence, reworked and deflated sites, and cleaned and extensively handled samples are less than ideal (cf. Langejans, 2013, 2011; Robertson, 2006), and a good understanding of the curation history is key to sample selection. Experimental work and the application of rigorous lab and recording protocols allow us to recognise contaminants. For example, through scrutinising soil and dust samples (cf. Crowther et al. 2014Loy and Barton, 2006; Wadley and Lombard, 2007), and by applying the multi-stranded approach (cf. Hardy and Garufi, 1998; Wadley and Lombard, 2007). Other experiments demonstrate that contaminants display random distribution patterns on artefact surfaces and are less concentrated in deposits and frequencies than use-related residues (Barton et al., 1998; Langejans, 2011; Williamson, 2006). Recently, micro-residues have been directly dated (Zarrillo et al., 2008), although direct dates do not exclude the possibility of ancient contamination.

5. Bringing the strands together: sample size and type, and method

Sample selection includes decisions about research questions, sample types, contexts and sizes. Sample size, especially, has been critiqued as often not being representative. Although there are examples of studies with small samples, it is mismatch between the research question and the collected data that give unreliable reconstructions (Haslam, 2006a, 2009). Broad assessments of tool types and time periods require large diachronic samples, but single objects can be studied in their own right if they are the focus of a project (Haslam, 2009).

The morphological identification and assessment of the authenticity of micro-residues are only part of an analysis. The interpretation of micro-residues is also based on the assemblage of artefacts and remains and their contexts; in a similar vein, micro-residue types alone are seldom claimed to be representative of specific actions (cf. Haslam, 2009 and see Table 1 in Robertson, 2011). Use-related micro-residues usually co-occur in specific combinations, and they often have repeated associations with micro-wear or macro-fracture traces (e.g. Barton et al., 1998; Fullagar, 2006; Hardy and Svoboda, 2009; Lombard, 2011; Loy et al., 1992; Robertson, 2011). On morphologically similar artefacts, from tightly defined archaeological contexts, use-related micro-residues may display recurring distribution patterns (e.g. Lombard and Wadley, 2007; Wadley and Lombard, 2007). Not only do contaminants have random distribution patterns, they also generally lack repeated association with other micro-residue types or use-traces (e.g. Barton et al., 1998; Robertson et al., 2009; Rots and Williamson, 2004). By analysing distribution patterns, accidental residues and contaminants, interpretative errors can be statistically assessed. This approach allows analysts to build cables of evidence (cf. Wylie, 1989), based on sets of mutually strengthening and constraining data consisting of:

- The identification of micro-residue types and suites, to the best of their abilities, experience and equipment;
- The patterns of micro-residue distributions on artefact surfaces; The number of micro-residue occurrences per type (and when appropriate according to tool morphology);
- The relationship between micro-residues, use-wear, macro-fractures and tool morphology;
- Exclusion of outliers (e.g. contaminant and incidental micro-residues).

Quantification is time-consuming, but by quantifying micro-residue types relative to their distribution on a stone artefact, null hypotheses can be statistically tested (Langejans, 2011; Lombard, 2005, 2007). Although difficult and perhaps even impossible it might prove opportune to improve and standardise the quantification of micro-remains so that the outcomes of different studies can be more easily compared.

With this brief review we demonstrated how the cumulative efforts of many researchers have addressed important issues that influence the feasibility of micro-residue analysis on stone tools. Particularly the results of blind tests are encouraging; because they stress that most micro-residues can be identified accurately using the morphological approach, even by relative novices. Challenges, however, remain – and as research lines develop, new challenges will emerge, but so will innovative techniques. It cannot be questioned that micro-residue analysis and the subsequent use, hafting and behavioural interpretations, especially when coupled with pertinent research questions, have provided rare and detailed glimpses into ancient lives that cannot be obtained in any other way. Further development and new techniques can only bode well for our future understanding of prehistoric peoples and their technologies.

Acknowledgements

The work of Marlize Lombard is supported by the African Origins Platform of the National Research Foundation (NRF) of South Africa. Geeske Langejans's research is funded with a Veni grant by the Netherlands Organisationfor Scientific Research (NWO). Any opinions expressed in this paper are, however, those of the authors and not the NRF and NWO.

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CHAPTER SEVEN

MANAGEMENT OF HEATED BLADELETS IN THE SOUTHERN CHASSEY CULTURE: USE-WEAR ANALYSIS AND EFFICIENCY TEST

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Abstract

Our study focuses on the management of a special production, which was the object of a mass dissemination in southern Chassey Culture–the bladelets knapped by pressure on bedoulian heated flint. Use-wear analysis shows us they were principally used with their raw edges for cutting soft material from animals. Because productions for other uses are generally not heated, we wondered if the heat treatment is related to the use. A butcher craftsman used bladelets from heated and not heated flint during a blind-test and designated the heated one as the most effective in almost 80% of cases. Then, we developed a sharpness tester which showed us that heat treatment allows an increase in efficiency.

Keywords: Neolithic, Southern Chassey culture, heated flint, Efficiency test, Butchering activities

1. Introduction

During the Neolithic, profound changes in the socio-economic structures are perceivable through the intensity of exchange and increasingly crafty production of tools, particularly with regard to the complexity of chaînes opératoires of lithic materials (Binder and Perlès 1990). This is illustrated here with the example of Southern Chassey culture (late fifth–mid fourth millennium BC) since that is when the phenomenon was taking up the greatest extent in the geographical area concerned. In this context, one of the raw materials which was the subject of a remarkable diffusion is the edoulian flint from the Lower Cretaceous in Vaucluse (Fig. 1). This flint is often found in high quantity in the Southern Chassey culture assemblages in Provence, the Rhône Valley, Languedoc, Midi-Pyrénées, and also beyond the Southern Chassey culture area: Catalonia, Northern Italy and Switzerland (Léa 2005). All sites of this geographical area were dependent on exchange networks for making tools. The two main productions are, from the old Chassey culture, blades knapped by pressure or indirect percussion on producer sites and imported on consumer sites as finished blanks, and in parallel from the classic Chassey culture, the preparation of preforms and their heat treatment on producer sites for knapping bladelets by pressure on consumer sites (Léa 2004).

Use-wear analyses show there are differences in the management of each production (Gassin 1996). It schematically appears that blades of unheated flint were often retouched and had long management while bladelets knapped after heat treatment were used for a shorter period of time. These bladelets were often unretouched and used for cutting soft animal material but could also be retouched/recycled for multiple uses (Gassin 1999). It was, therefore, proposed that these bladelets had no functional pattern, but the cores could be managed as reserves of multipurpose blanks (Gassin et al. 2006). However, use-wear analysis on the Southern Chassey culture is relatively rare compared to the number of consumer sites known and this hypothesis has been formulated from the observation of tool management in the sole site of Fontbrégoua. It is thus convenient to check this hypothesis on a larger corpus of sites, and try to see to what extent the production of knapped bladelets after heat treatment could correspond to a particular functional purpose: cutting soft animal material.

To deal with that question we used two research avenues. The first one concerns the peculiarity of these blanks that are knapped from a block of heated flint. It aims to understand the importance of heat treatment and its impact on a functional point of view. To do this, after some laboratory tests, the effectiveness of the bladelets was assessed by an artisan butcher in a blind test. The second research axis used archeological material. It aims to synthesize the functional data collected from the six sites in the corpus to bring out similarities and differences in the management of bladelets knapped after heat treatment, and try to understand the reasons.

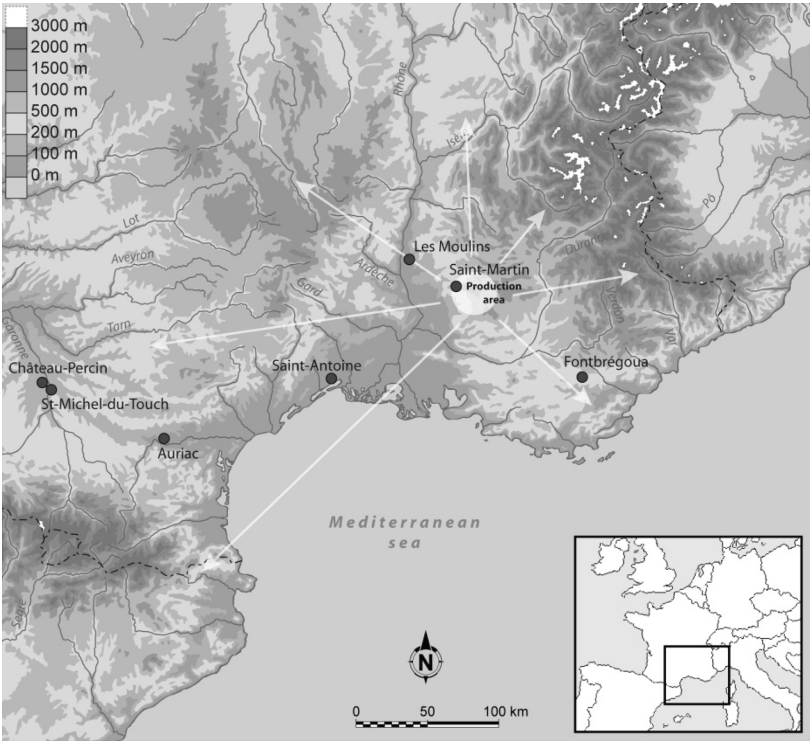

Fig 1: map of Southern France and position of the sites

2. Knowledge of heated Bedoulian flint

2.1. Hypotheses about the use of heat treatment

We look at the purpose of heat treatment and its close association with a particular production: the knapping of bladelets by pressure. Until now, prehistorians agree that heat treatment facilitates knapping by pressure. However, it turns out that the Bedoulian flint has intrinsic qualities that enable the technique of pressure even if it is not pre-heated. It is possible that other motivations could have led prehistoric communities to use heat treatment. In the course of the evolution of production techniques during the Southern Chassey culture, the use of heat treatment is increasingly frequent, and we intend to find out the benefit for the consumer to import heated preforms. Thus, our approach not only reaches aspects of production, but also of the functional aspect and the management of bladelets knapped from heated flint.

2.2. Mechanical properties' modification and sharper bladelets

Since 2009, the results obtained in the frame of the ANR ProMiTraSil project have allowed some progress on the issue. We can now state that heat treatment reorganizes the porosity of the flint (Roque-Rosell et al. 2011), and in parallel, new linkages (Si-O-Si) are formed during dehydration (Schmitt et al. 2012). The consequence of these changes is a modification of the mechanical properties of stone and a different fracture path. Indeed, the fractures formed after heat treatment appear shiny to the naked eye and it is through this contrast between shiny and matt fractures that has allowed identification of heat treatment in the Chassey culture context. All these aspects (hardness, toughness, roughness, edge micromorphology) are specifically discussed within the context of a doctoral thesis (Torchy 2013). As is the case in modern cutlery, we can consider that the surface roughness and the condition of the cutting edge are two factors that have a big effect on sharpness. Inspired by the tests covered by ISO8442.5, a personally adapted test bench has been developed to objectively quantify the sharpness of flint bladelets by measuring the pressure needed to cut a silicone sample, and then a nylon string. Initial tests have shown that bladelets knapped after heating are sharper (Torchy in Lea et al. 2012).

3. Butchering experiments

These experiments have two aspects. Firstly, they aim to verify the effectiveness of the heated bladelets compared to unheated bladelets. Secondly, they are targeting the replication of referential use-wear on bladelets which were used briefly, and which can, therefore, be reasoned only by micro-scars.

3.1. Bladelets from heated flint are more efficient

Laboratory tests have shown that bladelets knapped after heat treatment are sharper (Torchy 2013). These tests should, however, be confirmed by a realistic approach: an efficiency test on an animal carcass.

Bruno, artisan butcher, has agreed to participate in a blind-test and use these bladelets for cutting meat, fat and tendons (Fig. 2). He was given 42 hafted bladelets (Fig. 3) in pairs, with the same angulations, to gain his opinion on their efficiency. During this series of tests, one observer reported information concerning the butcher's opinion on the table. During the session, 21 tests involved a pair of one heated and one unheated bladelet. According to the butcher's opinion, these tests were classified into five categories and presented in the following histogram (Fig. 4). It appears that the heated bladelet was rated as more effective than the non-heated bladelet in 16 out of 21 tests (76.2%).

This session of experiments shows that heat treatment helps to improve the efficiency of flint bladelets for cutting soft animal materials. Even if the increase in sharpness is not always very strong, it is noticeable in most cases by a craftsman, which shows us that it is not negligible. However, we must ask whether this improvement alone justifies the use of heat treatment that required great technical investment from producers. We must, therefore, cross the data concerning these experiments with the study of the management of these bladelets in the Chassey context, and particularly the proportion of bladelets with traces of butchery.

3.2. What are the diagnostic criteria?

After the efficiency tests, a series of experiments were conducted in order to get a repository of bladelets that were used briefly. The objective is to isolate diagnostic criteria to recognize the butchering tools by trying to reason only by micro-scars, since, on the archaeological material, the other traces (polish, striation, edge rounding) are often not obvious or even absent. For this repository, 28 Bedoulian flint bladelets (9 unheated and 19 knapped after heating) were used. Given the fragility of flint bladelets, gestures of cutting were rather delicate avoiding possible contact with bones yet ensuring effective work.

Following these experiments, the qualities that we can consider as diagnostic are the absence of polish or rounding, irregular distribution of micro-scars along the edge (often more in the distal part) which are mostly oblique and /or with burination across the ends (Fig. 5). However, the bladelets that did not have any contact with bones do not have these criteria. Therefore, when we are confronted with the archeological material, the proportion of bladelets we think is involved in butchery is minimum and we should try to reach a conclusion from it.

Fig 2: blind-test in progress

Fig 3: bladelets used for the blind-test

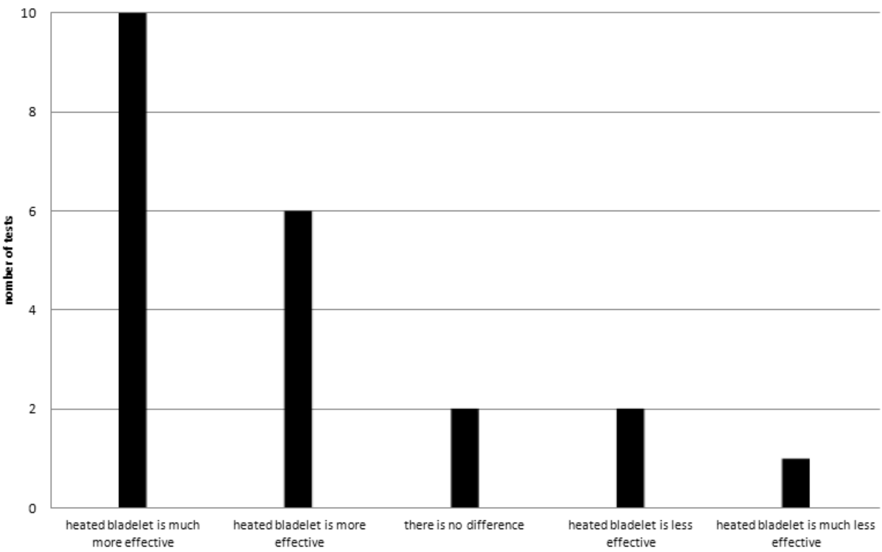

Fig 4: butcher's opinion according to the heat treatment

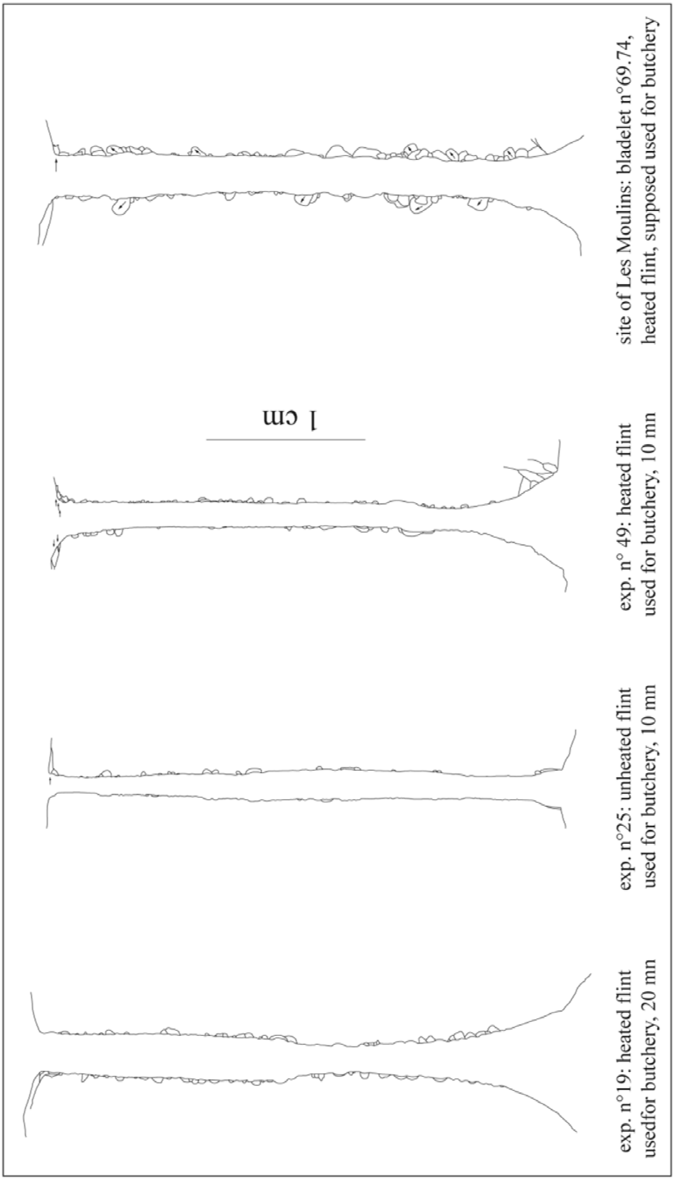

Fig 5: micro-scars on experimental and archeological bladelets

4. Management of bladelets knapped after heat treatment

4.1. Variability factors in the proportion of bladelets assigned to butchery

According to the selected site there is a high variability in the proportion of blade(let)s knapped after heating and allocated to butchery activities (Fig. 6). For the sites of Saint-Michel-du-Touch, Saint-Antoine (recent phase) and Saint-Martin, the figure is over 70%, while it varies between 18 and 37% in the other three sites. This does not seem related to an underrepresentation of this activity and we should try to consider other factors that may have influenced these proportions.

In view of the composition of assemblages, two other scenarios are possible. In case 2 (the sites of Auriac and Château Percin), the proportions of unheated Bedoulian flint and local materials are extremely low. Therefore, the heated Bedoulian flint was used for all activities. The management of the flint in the site shows that the assemblage is not made according to functional needs, but to its integration into networks, which resembles the site of Fontbregoua where these bladelets are multi-purpose (Gassin et al. 2006).

In case 3 (the site of Les Moulins), the assemblage is more heterogeneous and the unheated flint is well represented. But when we focus on the blanks knapped after heating, several productions are perceivable: bladelets knapped on the site and blades probably imported as a finished product. Thus, these two productions may not have had the same functional purpose and we should try to understand their management in parallel with unheated flint. This is why we should consider the size of the blanks.

4.2. Heat treatment as criteria to select butchering tools

In most Chassey culture sites, bladelets are associated with heat treatment while blades are knapped from unheated flint. It is, therefore, not possible to separate size and heat treatment in the study of tool management. However, there is a schematic view because we can also find unheated bladelets as in the site of Lattes (Léa 2004).

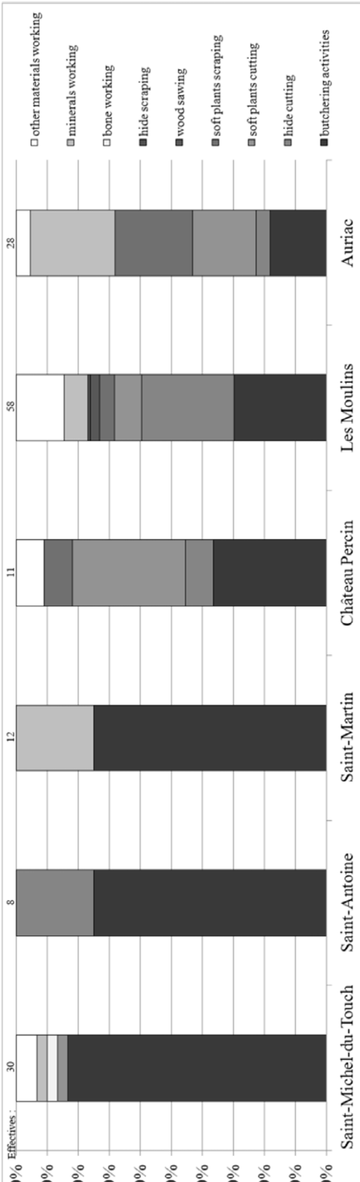

Fig 6: proportion of heated bladelets assigned to butchery and other activities

The site of Les Moulins offers the possibility for separating size and heat treatment because the representation of the size of pieces in the scatter graphs shows that there is a wide overlap area between heated and unheated flint (Fig. 7). This graph indicates that the choice of the tool is based on different criteria depending on the activity. Thus, for cutting soft plants, the choice fell on the width of the blank probably for hafting issues, anyway if it is heated or unheated flint. For butchering activities, heat treatment seems to have guided the choice. Because only one unheated bladelet was used for this activity while the same sizes were also available in that raw material. Therefore, heat treatment is a determining factor on the choice of blanks.

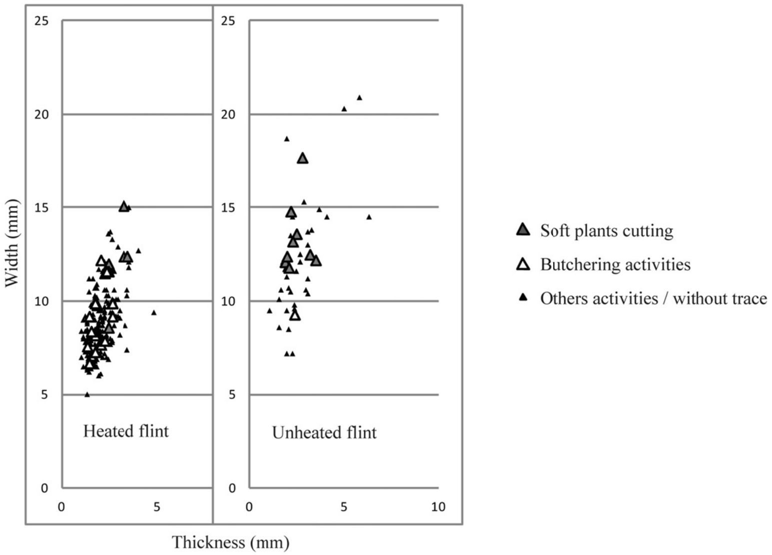

Fig 7: scattergraphs of the size of blade(let)s on the site of Les Moulins, and selection of soft plants cutting and butchering tools

5. Conclusion

Laboratory tests and the blind-test with the artisan butcher have shown that bladelets are sharper when they are knapped after heat treatment. However, the study of management strategy indicates these bladelets are used differently depending on the site. When the consumer site is equipped with a heterogeneous assemblage, heat treatment appears to be a determining factor for the selection of butchering tools. When, conversely, the assemblage is unbalanced, which is related to the convenience of supply for a production or the difficulty for another, the tool management is organized accordingly.

If the link between heat treatment and butchery seems to be demonstrated, this does not prove it was a motivation for the original use. This shows these bladelets were preferred for butchering activities. The motivations for the use of heat treatment on flint and the reasons for the success of these productions may be different, that is, considering several geographical areas as well as the classic and recent periods. It would, therefore, be appropriate to study several corpuses of sites separately in different places and periods, bearing in mind that the transition from old to classic Chassey culture is the key that can explain the origin of the use of that technology.

This management strategy shows that the craftsman made a choice among available blanks depending on the task. However, available blanks are an outcome of the integration of the site in such and such exchange networks. Thus, a site like Auriac could perhaps more easily supply heated flint from the networks and these bladelets were used for different purposes at the expense of local raw materials (Fig. 7-8). It shows that the functional needs can have influence on the constitution of assemblages, but the integration of the site in the networks may be a limit factor.

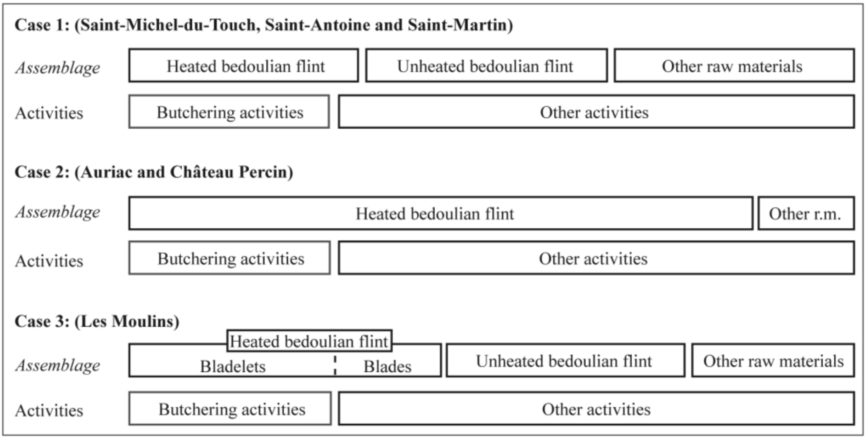

Fig 8: three different examples of management according to the constitution of *assemblage*

Acknowledgements

I would like to thank Bruno for his participation to the blind-test, and I am indebted to the programme ANR-09-BLAN-0324-01 ProMiTraSil for financial support of the laboratory tests.

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CHAPTER EIGHT

ORNAMENTS AND USE-WEAR ANALYSIS: METHODS OF STUDY APPLIED TO THE ADAÏMA NECROPOLISES

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Abstract

The corpus of ornaments from Adaïma necropolises comprises 378 pieces of finery including 5085 beads. The study combines the methods of funerary archaeology and use-wear analysis to determine the function of these artefacts. We are dealing with different raw materials: shells, bones, minerals, rocks, and "artificial materials" such as faience or terracotta. The composition of ornaments shows a large variability. This implies differences both in crafting techniques and uses. This paper presents the method applied to study a sample issued from the corpus. The methodology applied includes observation, description and recording in a database. Then, we need experiments to highlight the nature of the traces observed. In the first stage, the experimental part is didactical. It will be followed by methodical experimentation for which protocol is in progress.

Keywords: Ornaments, use-wear, Predynastic period, Egypt, methodology.

1. Introduction

Our work relates to the study of finery in a funerary context from Adaïma site (Upper Egypt) during the fourth millennium BC. It consists of a systematic analysis of ornaments, from the acquisition of the raw material to the use and the ultimate deposit in the grave. The site of Adaïma is located 8 km south of the modern town of Esna and was occupied during the fourth millennium BC, from Nagada IC (3700 BC) to the end of the third dynasty (2600 BC). The excellent preservation of the Eastern necropolis and the multidisciplinary approaches–combining archaeology and biological anthropology–implemented during the excavations offer ideal conditions for the study of ornaments in a funerary context. The first analyses of the funeral practices and grave goods highlighted strong differences from one tomb to another, particularly regarding finery (Duchesne et al. 2003). Indeed, the composition of ornaments, colours and associated raw materials showed wide variability.

The corpus of ornaments comprises 378 pieces of finery composed of 5085 beads. The ornaments were found in 187 graves. Fifty different raw materials and different shapes were used for the beads. Different shapes in 50 different raw materials were used for the beads. Hard animal materials were used for beads and ring-bracelets. Shells were simply perforated; bones and ivory were used for rings and combs, or transformed to make different beads. Rocks and minerals were shaped in different ways to make beads: Pebbles were simply perforated or further transformed to make ring-beads or figurative pendants. Artificial raw materials, faience and terracotta were used to manufacture different beads such as cylindrical or barrel-shaped beads. Copper was used to create ring-bracelets. Beads were essentially linked together to create necklaces, bracelets for anklets or wristbands. Addressing these artefacts in a systematic way, one has to deal with several mediums. The methods of analysis allowing the understanding of ornament artefacts have considerably evolved recently. The functional aspects based on the contexts of discovery and trace analysis are now added to more classical studies (e.g. Bonnardin 2006).

Technical and social implications can be deduced from the study of ornaments. Here we focus on the meaning of this artefact in a funeral deposit. A couple of methodologies are used. On one hand, methods of funerary archaeology allow a reconstruction of the consecutive gestures that took place during funerals. On the other hand, trace analysis is a tool to assess firstly the technical manufacture used, and secondly whether the jewels were new or had been worn before their deposit at the time of burial. This is of some importance in addressing the function of ornaments within the funerary ritual.

2. Use-wear analysis of ornaments from Adaïma

A sample of 482 beads belonging to 127 different ornaments was analyzed. Observations were made with a digital microscope (Dino-Lite) with a magnification capability of 20 to 230. An observation sheet was made to record the location of stigmata observed, on both sides numbered S1 and S2, and on both profiles of the object, numbered P1 and P2 (Fig. 1). Observation at a macroscopic scale (Sidera and Legrand 2006) was executed in most cases. Beads were observed at a magnification of about 50. Observation at a magnification of 200 was rarely executed.

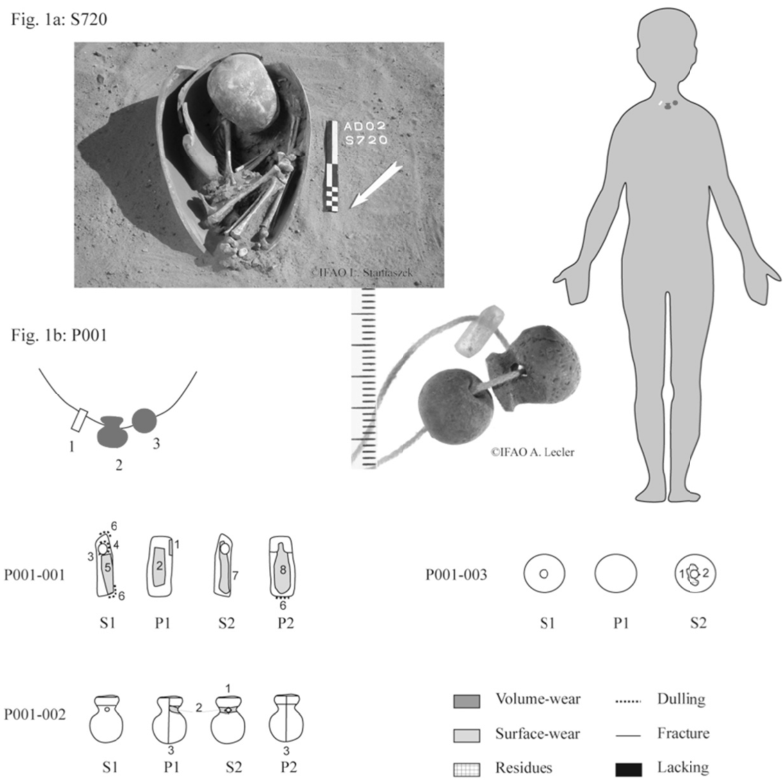


Fig 1: Example study

Our methodology can be illustrated by the burial S 720 (Fig. 1), which was a burial-jar containing a child aged 1-4 years dating from Naqada IIIA1-IIIA2 period. At the time of his funeral, the child wore a necklace with 3 beads: An oblong pendant in rock crystal, a "nw-jar" shaped pendant, and a spherical faience bead (Fig. 1).

3. Record and analysis

The data were recorded in a database grouped by different criteria. Burial was identified in the database by the number given during the excavations (e.g. S720). The description of each structure was recorded in the database as well as the number of individuals buried and the accompanying items; in the current example, only the burial-jar and the necklace. Each ornament was recognized by its study number (P001). For each bead, the number of the ornament was followed by a number according to its position on the necklace reconstructed during the excavations (P001-001, P001-002, P001-003). Beads were described using different criteria such as height, typology, raw material, colour, kind and dimension of perforation. The number identified the computer records and graphic records of each stigma on the beads. Stigmas were those conventionally listed in studies from use-wear analysis (Table 8-1). We have referred particularly to the research on bone technology by I. Sidera and A. Legrand (2006) as well as S. Bonnardin (2009). The main categories of observed traces were firstly volume-wear: Smoothing, chip, removal negative, fracture and notch; secondly there was surface-wear: Striation, polishing, and discoloration. Additionally, residues such as “baking-bed” and leftover links could sometimes be observed. Both are less conventional. “Discoloration” and “baking-bed” are typical of faience beads, a raw material that is not often studied in macrowear analysis. “Discoloration” means change in colour, a colour lightening. “Baking bed” is to be understood as a residue that is put on the surface of beads during the firing. Indeed, beads are laid on a surface of sand or ash, from which residues attach to the surface during the efflorescence process.

The organization and position of these traces were recorded graphically and in the database, as well as other details about the stigma, such as morphologies, extent and organization (Table 8-1). The bead P001-001 stigma 1 was a surface-wear. It had striations; the extent of which was moderate in the proximal part of P1. These striations were parallel to each other and in a V-profile, and were perpendicular to the bead length. Different striations were recorded in this piece and smoothing was observed around the perforation and at the edges of the bead. Striations are probably due to the manufacturing process and smoothing due to the wear. The bead P001-002 stigma 1 was a volume-wear with unifacial and bilateral notches. P001-002 stigma 2 was ochre-coloured, and stigma 3 was a bifacial fracture probably due to firing. In P001-003, a residue of the baking-bed was observed around the perforation on S2, as well as a little notch.

Criteria	Details
Study number of stigma	Number on the drawing
Kind	Surface-wear, volume-wear or residues
Stigma	smoothing, chips, removal negative, fracture, notch, striations, polishing, discoloration, “baking bed” and leftover links
Localization	Study number of bead
Localization 2	P1, S1, P2, S2
Morphology	U-shape, V-shape
Direction	Longitudinal or perpendicular
Organization	Parallel, alone
Position	Unifacial, unilateral, bifacial, bilateral
Extent	Covering, moderate, marginal
Incidence	Raze, steep
Continuity	Continue, discontinue
Observation	Additional observations

Tab. 1 : Criteria of database, stigma

The database allows the implementation of multi-scale analysis: from the location of finery in the tomb, the identification of each component of adornment, and to stigma based on microwear analysis. The aim is to highlight the types of beads–shape and material–that would be subject to specific stigma during the manufacturing or use process.

For example, the statistical analyses highlighted that notching was mainly present on the Nerita and Polinice shells and on the long beads fabricated from artificial material (Fig. 2). To determine whether these traces were the result of fabrication or the use process, they were compared to our own experimentation results and to other published results (D’Errico et al. 1993; Taborin 1993).

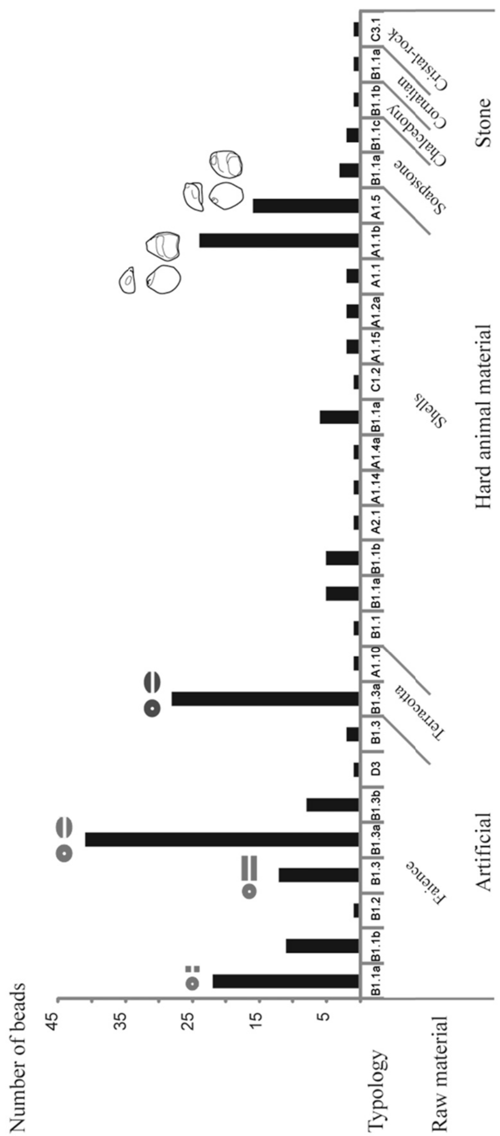


Fig 2 : Statistical analysis, notches (blue = faïence/ red = terracotta/ white = shell)

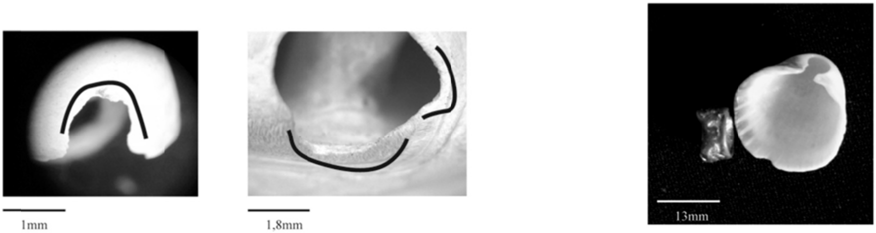
4. From didactical to methodical experiments

As M. Christensen (1999) advised, we started with didactic experiments. Thereafter, they will be followed by systematic experiments. The aim of the first didactic experiments undertaken is to understand if stigma could be derived from fabrication or use.

For six months, I wore an ankle bracelet composed of seven beads, including a shell. The beads were linked together close to the ankle. The pressure between the ankle and the link created a notch on the labrum of the shell and on the other metal ring-beads. Subsequently a notch was observed on the labrum of the shell, as seen on the archaeological pieces (Fig. 3). After statistical analysis, it was noted that notches also commonly appeared on the faience and terracotta beads, especially the long beads (Fig. 2). Barrel and cylindrical shapes were moulded in air-hardening paste and drilled with a copper point. A little piece of paste was attached to the tip of the copper point, and the ends of the beads were torn during the removal of the point, creating the notches. The notches were bilateral and unifacial alternately. The same position was observed on archaeological tubular pieces. Notches, in this case, seem to be manufacturing traces (Fig. 4).

This first experimental approach is now followed by a methodical experimentation phase where more criteria are controlled. Criteria are the raw material, the technique of perforation, the nature of the link, the way of linking and the time of use.

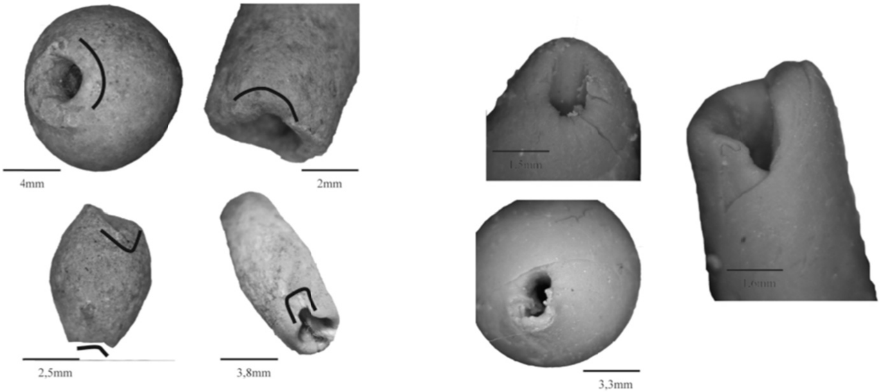
The goal of this second phase is to reconstruct replicas of the pieces of finery found in the graves, and wear them at the ankle, wrist, or around the neck, depending on their situation of discovery. Afterwards, for each bead, a description is made with the same analytical scale as the archaeological material. Those experimentations are in progress, and it will be several months before results are available. We started using shells according to species found on the site (Nerita, Polonice, Collumbella…). The perforation technique is now mastered; it is hammering or grinding (Fancis 1989). It therefore remains for us to essentially test the mode of suspension, the kind of link and traces left by the use of fineries in a given time. Thus, a bracelet made of four shells Nassarius columbella simply suspended with a link was worn on the left wrist during one month. The main feature of the wear is the disappearance of technical traces and the smoothing around the hole, but no notch was created on the labrum (Fig. 5).



Archaeological pieces

Experimental pieces

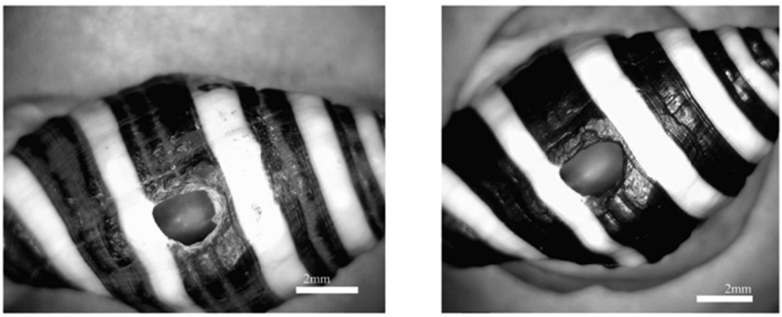
Fig 3 : Notches on shell



Archaeological pieces

Experimental pieces

Fig 4 : Notches on molded beads



Before use

After use

Experiment 26

Fig 5 : the disappearance of technical traces

5. Conclusion

Thus, database and statistical analyses have made focused experiments possible. We need to choose by focusing on one from the wide variability of artefacts. However, a considerable number of modes of wear on different parts of the body, as well as other constraints on the beads, like links and methods of stringing, must be taken into account, which further increases the number of potential experiments. Systematic experimentation is the only solution to disclose the use of objects before their deposit in the grave; but it is long-term task. Coupled with funerary analysis, this will determine which objects were used before their deposit in the grave and will highlight the meaning of such ornaments during life and after death. In the case of burial S720, the child wore the ornament at the time of his burial. It was put on the body during the preparation for burial. Stigma observed on each bead shows many technical traces, which were not erased by wear. It can be inferred that the object had been little worn, or not at all. Taking into account the age of the child–1-4 years–it is possible that the object belonged to him before his death, or was manufactured at the time of the funeral. No other child in the same necropolis was found wearing the same ornament. This clearly suggests an individualized object with identity and funerary meaning.

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CHAPTER NINE

"CEREAL POLISH": DIAGNOSIS, CHALLENGE OR CONFUSION

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Abstract

Prehistoric sickle inserts are considered to be one of the most easily recognizable artefacts (even to the naked eye) owing to the shiny cereal polish usually covering parallel or oblique parts of the sickle inserts. However, microscopic observation of both experimental and archaeological implements reveals a great variety of features of the polish itself and the accompanying striations, edge smoothing and scarring and the post-depositional alterations/modifications, which together makes a very complicated and complex picture for reading and for reliable/unambiguous interpretation. An interesting aspect of the debate is an attempt to reliably distinguish between cereal polish resulting from reaping/harvesting or threshing. This paper includes additional information on the problem of combining empirical data from the Balkans and the southern Levant.

Keywords: Cereal polish, comet-shaped depression, sickle, tribulum

1. Introduction

At the outset I should like to say that my interest and work in the domain of prehistoric agricultural toolkits is closely linked and further stimulated by my participation in the EARTH project directed by Prof. P. Anderson (CEPAM-Nice). A brief synopsis of my work on prehistoric agriculture is presented in three separate contributions to monographs that have been prepared for publication by Team 2 of the EARTH project.

There is one crucial problem, which inherently and repeatedly arises in the context of the "cereal polish" discussion. This is the still unresolved problem concerning the differentiation of use-wear traces caused by different processing of cereals–harvesting, threshing, ground straw cutting, etc. One cause of the ambiguity in our reading of use-wear traces is the interpretation of the comet-shaped features that have long been considered as an indicator of sickle use-wear–by the St. Petersburg school: Prof. Korobkova and her research group (Korobkova 1996), as well as N. Skakun (Skakun 1992, 295; 1994, 297). Subsequently, these features were attributed instead to tribulum, inserts by P. Anderson and team (Anderson 1994; Anderson and Inizan 1994; Anderson et al. 2004; Chabot 2002). At the first Semenov Congress at St. Petersburg in 2000 I put the matter precisely: if it is reasonable to distinguish and consider the comet-shaped features as a discriminatory characteristic attributable to some unique microwear complex, to what must we attribute these comet-like features–to sickle inserts or to threshing sledge inserts? I also showed at this congress systematic differences between sickle and *tribulum* microtraces (Gurova 2001, Figs. 11, 12). After years of study of Bulgarian and north-western Anatolian prehistoric assemblages and agricultural toolkits, my own opinion is that we are dealing with a feature that appears frequently on cereal treating artefacts–I have seen and recorded many unambiguous sickle inserts from Neolithic, Chalcolithic and Bronze Age assemblages from the above-mentioned regions and documented some comet-like depressions (Gurova 2005a, b; 2008a, b; 2011a, b). The comet-shaped aspect, but combined with different microtopography and polish texture, is very common and diagnostic on *tribulum* inserts I have observed on both ethnographic and archaeological implements (Gurova 2001, 2006, 2011c). The opportunity to work with material from the southern Levant (collections of Canaanean blades from Israel) was a real challenge, enriching my experience and empirical data with convincing observations in favor of this conclusion. The picture of cereal polish became more complex and enigmatic with the demonstration in Verona of the variability of polishes attested on Neolithic sickles from Spain and the reasoning of the investigators about the plausible factors provoking the ambiguous abrasive aspect of the cereal polish (Ibáñez et al. 2008, Fig. 9).

In the following pages I will present the evidence, challenges and confusion alongside my intention to investigate more systematically the repeatedly approached but still insufficiently resolved problem of cereal polish.

2. Sickle cereal polish

There is a large corpus of well-documented archaeological evidence of sickle use and variability in Bulgarian prehistory. Everyone should feel fortunate in being able to work in the area where emblematic prehistoric agricultural tools such as the famous Karanovo sickles were discovered (Georgiev 1958).

At the very beginning of the Early Neolithic, manifested at sites such as Chavdar, Samovodene and Kovachevo, and during the Karanovo I period at the eponymous tell (first half of the VI mill BC), sickle inserts are numerous and show considerable morpho-typological variability. Almost all pieces have an angular shiny cereal polish (from slightly oblique to diagonal) that indicates the oblique insertion of the flint inserts into a curved antler handle–the most characteristic trait of the "Karanovo type" sickle. Sickle-blades with parallel lateral polish are rare. During the Neolithic there is no evidence of standardization of the sickle inserts: they consist of unretouched and variably retouched blades (rarely flakes) 2-5 cm in length and 1-3 cm in width. In spite of their stylistic variability, handle fragments can reliably identify sickles or typical micro use-wear of their flint inserts (Fig. 1: A).

The abundance of sickle inserts and their exhaustive use suggests that farming activities were well developed. This development continued during the Chalcolithic period (V mill BC) when the same "Karanovo type" of composite sickle was used, but probably made with wooden hafts, because there are no antler handles preserved from this period. Sickle inserts became more standardized in their morpho-metrical parameters, normally made on fragmented regular blades (with or without retouch) and tools on blades. Rather, this standardization results from the fact that new technology of blade production, based on high quality flints from northeastern Bulgaria, took place in the V mill. BC cal (Fig. 1: B) (Gurova 2005b, 2011, a, b; Skakun 1994, 2006).

Its end is marked by a typological innovation among flint assemblages consisting of different denticulates (appearing sporadically in the Late Chalcolithic) which from the beginning of the Bronze Age (IV mill. BC) became a characteristic feature of the flint industry and could be considered as "diagnostic tools" for this period (Gurova 2008a). The process has been interpreted as a shift in sickle morphology and mode of use; however, in terms of the microwear patterns, the same characteristics of sickle/cereal polish are observed–smooth and bright with many differently shaped pits and depressions and very often with pronounced linear striations (Fig. 1: C).

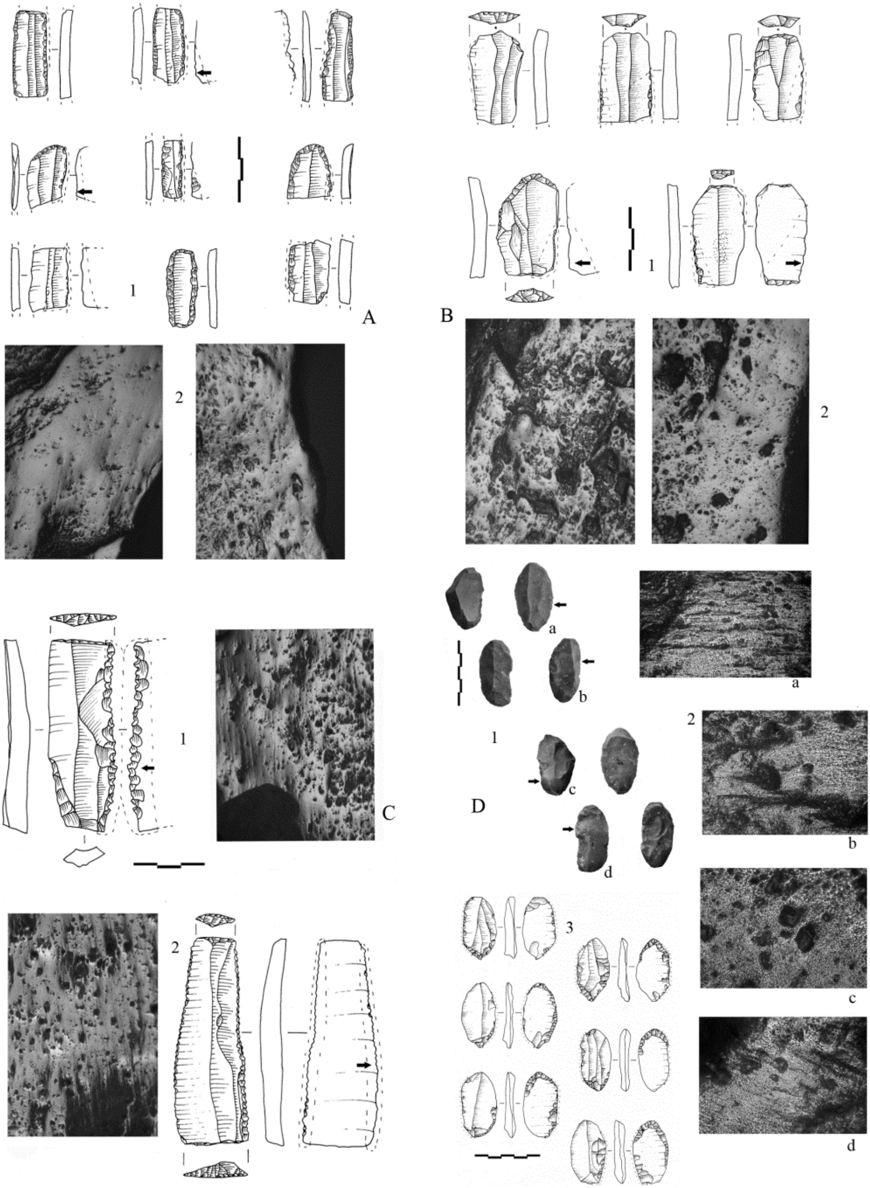

Fig 1. A – artefacts (1) and microphotographs (2) of cereal polish of sickle inserts from the Early Neolithic site of Yabalkovo; B – artefacts (1) and microphotographs

(2) of cereal polish of sickle inserts from the Chalcolithic tell of Karnobat; C – denticulates used as sickles and microphotographs of cereal polish of the Bronze Age sites Aul Kaya(1) and Lepitsa (2); D – 1: ethnographic *tribulum* inserts from Bulgaria (a, b, d) and Cyprus (c); 2 (a-d): microphotographs of cereal polish; 3 : ethnographic *tribulum* inserts from Bulgaria, private collection. The arrows mark points of taken photographs on sickles and *tribulum* inserts (x100). A-C – cereal polish of sickle inserts; D – cereal polish of *tribulum* inserts. Photos and drawings by M. Gurova.

3. Thus far, what is diagnostic, challenging and confusing?

Without doubt well-developed cereal polishes on archaeological pieces are diagnostic; the challenge lies in reproducing such a typical and diagnostic polish. There are, of course, examples of very successful and convincingly documented reproduction (Anderson 1999; Unger-Hamilton 1999). My experimentation was short and unsatisfactory, but provoked some unavoidable confusion.

After harvesting for 3.30 h with a sickle of "Karanovo type", made by me in France years ago with Grand Pressigny flint insertions, I observed on a distal insert the beginnings of polish that could not be described as "cereal", only as initial "SI rich soft material" polish. The same result was demonstrated by Astruc after experimental harvesting with obsidian and flint sickle inserts (before Astruc et al. 2012, Fig. 6).

The confusion lies in the fact that if the cereal polish is not fully developed, its diagnostic features are not sufficiently recognizable and there is a real possibility that we will misread and misinterpreted it: *ergo*– some (many?) sickle inserts may not be recognized in the early stage of use.

4. Sickles blades versus *tribulum* inserts

The biggest source of confusion nevertheless is to establish reliable criteria for distinguishing cereal polishes (and accompanying striations) of sickle inserts from those of *tribulum* inserts. This is fundamental problem in use-wear studies.

The first ethnoarchaeological approach to the *tribulum* as an element of traditional agricultural equipment in Bulgaria, Ukraine and Moldova was done by N. Skakun in the 1970s and 1980s. In her numerous publications she presents a diachronic picture of Neolithic and Chalcolithic agriculture in Bulgaria, emphasizing in particular the distinction between sickle and *tribulum* inserts. The problems with this database consist in the fact that the presented materials (many of them coming from the multilayer

Chalcolithic tells of Durankulak and Goliamo Delchevo) are not stratigraphically or contextually related. The categories of tools are presented grosso modo or with percentage data that do not allow simple statistical considerations and ratios to be made (Gurova 2007). The *tribulum* inserts are classified as standardized blade segments, but their illustrations are quite equivocal: sometimes they are sickle-blade-like (Skakun 1999 Fig. 21.7; 2006, Figs. 9. 1-20 and 21, 10, 11); sometimes they are tools on (blade-like) elongated flakes (Skakun 2006, Fig. 26.1-4, 7 and 17.1-4). The most confusing are 6 drawings of artefacts that are totally different morphologically and typologically, identified in the figure captions as sickle inserts and in the text as tribulum inserts, but in fact it seems that the first row contains 3 sickle, the second–3 *tribulum* inserts (Skakun 1994, Fig. 4d). Even worse is the situation with microwear documentation: one picture (most probably a sickle insert) is published once as such (Skakun 1992, Fig. 9a), but another time as *tribulum* inserts (Skakun 1993, Fig. 5). The microphotographs by themselves are not diagnostic and readable (see Skakun 1992, Fig. 9b-c; 1994, Fig. 4a-c; 1999, Fig. 21.8; 2006 Fig. 42). From this deeply confusing picture, there is no convincing proof that Chalcolithic fragmented blades from Bulgaria were used as *tribulum* inserts: all the illustrated and described blades (with angular polishes) seem to be traditional sickle inserts.

In my long-lasting research on prehistoric Bulgarian agricultural toolkits I have never observed (fragmented) blades *sensu stricto*, morphologically identical to sickle inserts, which I would attribute to the *tribulum* inserts' category. If it were possible to distinguish and recognize such a well-documented category from clear stratigraphic contexts in Skakun's studies, it would be very interesting and deserving of real discussion.

My approach to the problem of the identification of prehistoric *tribulum* inserts is based on two empirical levels: the detailed study of ethnographic implements, and the comparison of, and reliable distinction between tribulum and sickle inserts coming from certain prehistoric contexts.

Tribulum flints from Bulgaria, both ethnographic and prehistoric, have a distinctive elongated ovoid shape obtained by intentional retouch (a particular technological approach resulting in characteristic ventral retouching of the lateral and distal transverse part) (Fig. 9-1, d) (Gurova 2001, Figs. 4-8; Gurova 2011c, Fig. 7). It is not always evident if they are made on blades or elongated flakes. Uni- and bilateral utilisation is attested.

Archaeological *tribulum* inserts can be recognized because of their strong similarity to ethnographic examples in morphology and shape and especially in microscopic wear features (Gurova 2001, Figs. 9-11; Gurova 2011c, Figs. 8/2 and 10). The use-wear complex is very distinctive. The working edges are strongly bifacially smoothed and rounded. The texture of the polish is rough and opaque, partially abraded, and with many (including comet-shaped) depressions. It is worth emphasizing here that careful use-wear and morphological analysis of ethnographic tribulum inserts allow unambiguous distinctions to be made between tribulum and sickle inserts, both having cereal polishes. In Bulgaria, rectangular blade fragments are not attested as *tribulum* elements. No traces of bitumen as an adhesive material for fixing both sickle blades and *tribulum* inserts have been ever discovered on the archaeological implements from Bulgaria.

Currently, a series of certain, stratigraphically documented, prehistoric tribulum inserts from Bulgaria comes from the excavations of the multilayer tell site of Drama–Merdžumekja, where the sequence (Karanovo V and VI) belongs to the Chalcolithic and begins c. 4900 BC (Lichardus et al. 2001). The artefacts identified as tribulum inserts comprise 12 typological tools, coming from both strata and other locations. This material is presented in detail in a chapter of the EARTH project monograph (a picture can be seen in Gurova 2011, Fig. 8/2).

Re-examination of the "cereal polish" problem came about from a new interpretation of Levantine Canaanean blades (very large, regular flint blades) not as sickle inserts, but as tribulum inserts. This new interpretation was presented in several articles based on interdisciplinary research including experimentation combined with use-wear, tribological and phytolith analyses made by a team led by P. Anderson (Anderson 2003; Anderson, Inizan 1994; Anderson, Chabot, 2004; Anderson et al. 2004; Anderson et al. 2006; Chabot 2002; Chabot, Eid, 2003, 2007). The study by this team comprised Canaanean blades from northern Mesopotamia (Syria and Iraq) and south-east Anatolia (Turkey), and also included a small number of artefacts from Uvda Valley in Negev, Israel: a Canaanean type of blade and a series of 30 backed blades (macro lunates) interpreted by the specialists as tribulum inserts on the basis of comet-shaped grooves, shallow pits and scratches.

Inevitably, questions arose about additional work and functional interpretation of the north Levantine (Israel border region) Canaanean blade assemblages, which had not been subject to a detailed microwear study.

My interest in this problem was first provoked by a presentation by Uzi Avner at one of the EARTH project meetings. In 2010 I was awarded a Fellowship to conduct research at the Albright Institute (AIAR) in Jerusalem. There I attempted to update my knowledge of Israeli threshing sledges in their ethnographic and archaeological contexts, starting with Internet data and ending with visits to major Israeli museums. For precisely one month, thanks to the generous help of my Israeli colleagues, I was engaged in a microwear study of some Canaanean blade collections (Gurova 2011c, Figs. 13-21). My study is based on 268 artefacts (most of them Canaanean blades and tools), 194 (72%) possessing traces of use, and 151 (77%) revealing sickle (in my opinion) cereal polishes.

Because the Uvda material is critical to my argument, it is worth focusing on and illustrating the artefacts from Uvda that were previously studied by P. Anderson and published as tribulum inserts (Avner et al. 2003, 467-70; Anderson et al. 2004, Fig.11) (Fig. 9-2, a2). Flints were collected during the surveys led by U. Avner (Avner 2002). My use-wear expertise of morpho-metrical parameters of the artefacts (particularly macro lunates), distribution and micro features of polishes and detailed microphoto documentation led me to conclude that artefacts from Uvda (including the blades) are not attributable to tribulum inserts, but some of them are undoubtedly sickle inserts (Gurova 2011c) (Fig. 9-2, b). The photos from the Spanish team paper revealing the variability/diversity of "cereal polish" on archaeological sickle blades illustrate just how subjective are the definitions and axiomatic assessments of the microwear features (Fig. 9-2, a3). The results of P. Anderson's team regarding the use of some series of Canaanean blades from the northern Levant as tribulum inserts are rigorously debated and it is probable that the blades studied and published by P. Anderson et al., after being used as sickles, were reused as *tribulum* elements. That may be a reasonable explanation of their mixed, and quite ambiguous and confusing (in my view) microwear traces. According to the published data this explanation is quite possible for certain series of Near Eastern blades studied by P. Anderson and J. Chabot (Anderson, Inizan 1994, Figs. 4-6; Chabot, Eid 2007, Figs. 6-9, 17-19).

I have observed variability in Canaanean blades that were used as sickles and for other plant cutting, and for other functions, but I did not see among the samples studied any artefact that I would regard as a tribulum insert, either morphologically or in terms of microwear traces.

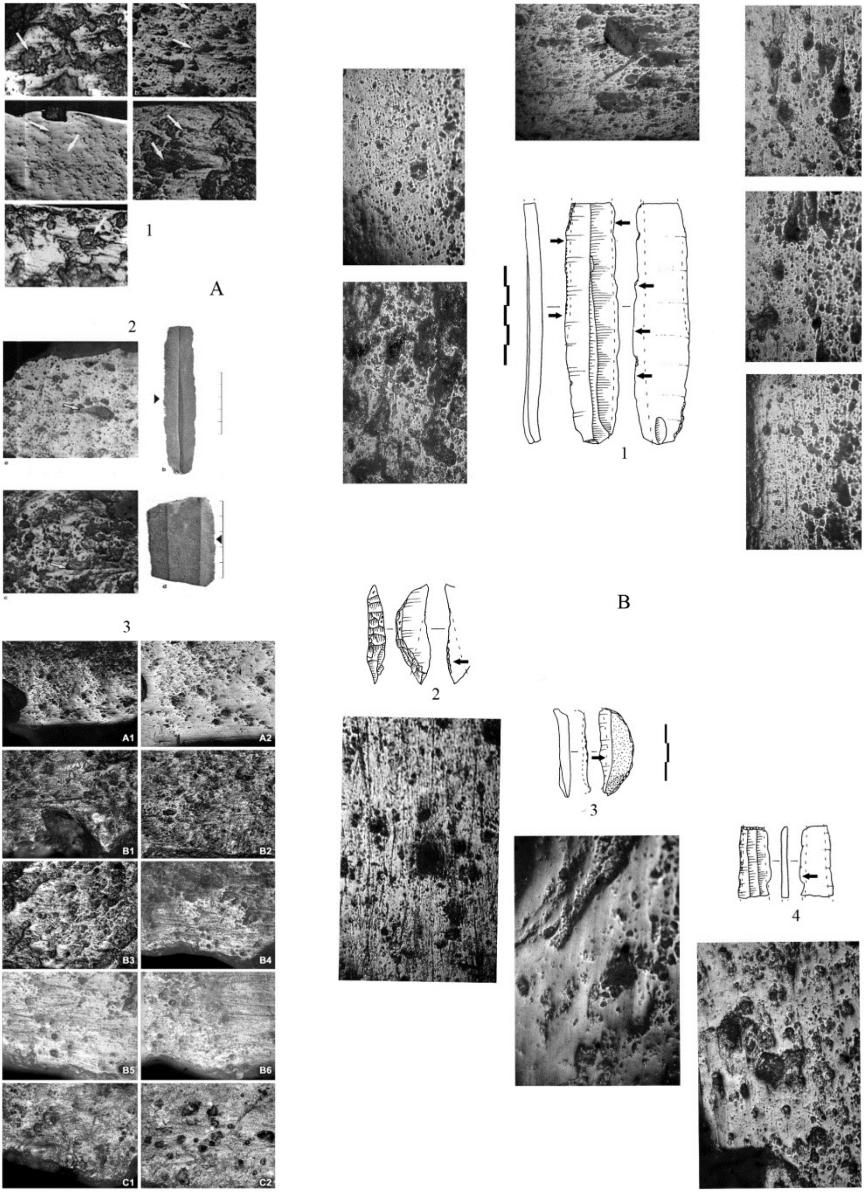

Fig 2. A – variability of Si (cereal polish): 1 – sickle and *tribulum* polish (according to Anderson et al 2004, fig. 4); 2 – Canaanean blades used as *tribulum*

inserts (according to Anderson et al 2004, fig. 11); 3 – sickle gloss (A1-B6) and abrasive polish (C1-C2) (according to Ibáñes et al, 2008, fig. 9); B –artefacts from Uvda valley (Negev, Israel): 1 – Canaanean blade used as a sickle and corresponding microphotographs; 2 – 4 large segments and truncated blade used as sickle inserts and corresponding microphotographs. The arrows mark points at which photographs were taken (x100). Photos and drawings by M. Gurova.

There are no arguments for definitive conclusions on how to distinguish sickle from tribulum inserts, because there is no panacea in looking for clarity and unambiguity of microtraces of use. Attempts to reveal the meaning of use-wear patterns (cereal polish for example) and to identify its reliable parameters can only be successful if we approach the problem taking into account the following factors: the archaeological context, the morphological and technical patterns of the artefacts studied, their intra- and inter-site stylistic repertoire, ethnoarchaeological evidence (if available), experimental replicas, and the absence of an anticipated model/hypothesis for functional definition. It is useful to keep in mind the reflections of S. Rosen (1997) who is not a use-wear analyst, but who succeeded in observing and defining the complexity as well as the evident and potential pitfalls of the “sickle problem”.

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CHAPTER TEN

TEN YEARS OF USE-WEAR ANALYSIS OF EARLY NEOLITHIC MACROLITHIC TOOLS FROM NORTH-WESTERN EUROPE: LIMITS AND CONTRIBUTION

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Abstract

After a brief synthesis of ten years of functional study of the first Neolithic macrolithic tools in north-western Europe, we propose a critical discussion on the progress and limits of this approach. A complete technological study was made possible by a permanent feedback between methodological improvements of use-wear analysis and the multiplication of archaeological applications. The co-development of raw material, typology, manufacture and use-wear approaches has created the conditions for a real integrative technological study of macrolithic tools. This has avoided some mistaken interpretations of the functioning and biography of querns, polishers and other macrolithic tools in the Linienbandkeramik and Villeneuve-Saint-Germain technical system of north-western Europe. We insist on the main parameters that particularly affect the functional interpretation of macrolithic tools, compared to other types of tools. The nature, granulometry and cohesion of the raw material can distort our perception of use-wear traces. The under- or over-estimation of some transformed matters induced by use-wear analysis can sometimes be attenuated by a more global perception of tools' technical characteristics.

We finally discuss how the intensity of use, plurifunctionality and reuses have particular consequences for the functional interpretation of macrolithic tools.

Keywords: Macrolithic tools, grinding and abrading activities, early Neolithic, north-western Europe.

1. Introduction

The use-wear analysis of macrolithic tools has been enriched this last ten years by several studies on the emergence of cereal consumption in the Near East (Dubreuil 2004), on the Neolithic development in north-western Europe (Hamon 2006, 2008; Verbaas & Van Gijn 2008) and on the first metallurgist's cultures of the Iberian Peninsula (Delgado-Raack et al. 2009; Risch 2002). They cover a wide range of raw material (sandstones, basalts and granites), experimental tests and use-wear characterization, compared and tested through different collective papers (Adams et al. 2009; Hamon and Plisson 2008).

For the early Neolithic of north-western Europe, the co-development of an integrated raw material, typo-technological and use-wear analysis on macrolithic tools was conducted in order to complete our perception of the technical system and economy of the Linienbandkeramik (5100-4900 BC) and the following Blicquy-Villeneuve-Saint-Germain (4900-4700 BC) cultures as the first Neolithic cultures of the Paris Basin and southern Belgium. Our work has avoided some mistaken interpretations of the functioning and biography of querns, polishers and other handstones (Hamon 2003a & b, 2006, 2009). The permanent feedback between use-wear analysis improvements and archaeological tool studies has now created the condition for a self-criticism of the real progress and limits of this integrated approach.

2. Context and assemblages

The strong identity of the LBK and VSG people has often been underlined, due to the apparent homogeneity of their material culture over hundreds of kilometers. Most of the material comes from lateral refuse pits located along house walls, allowing multiscalar and multidisciplinary approaches of subsistence activities and economical organization. Four hundred and eighty tools from nineteen early Neolithic settlement sites in the Paris Basin and Hesbaye have been sampled for use-wear analysis out of a total number of 1710 macrolithic tools (Fig. 1).

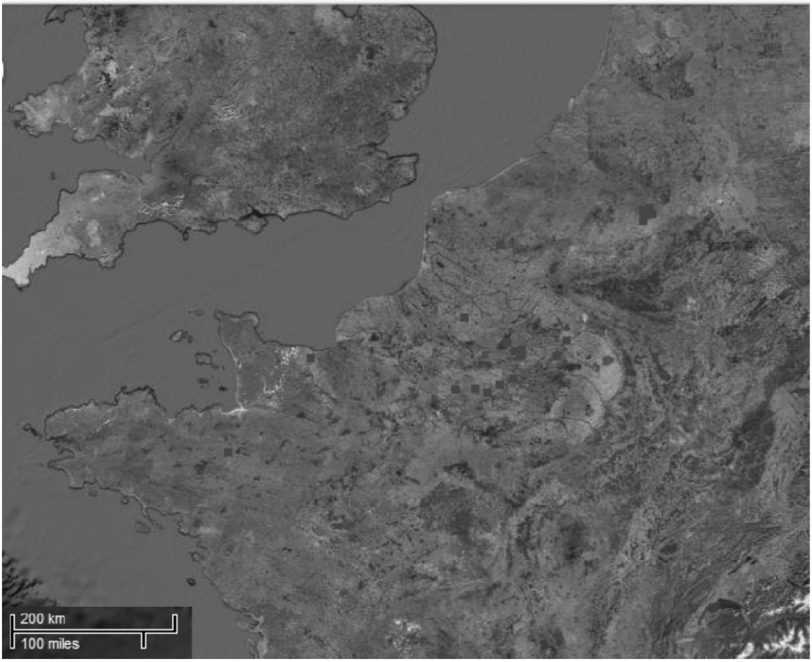

Fig 1 Map of the localization of the studied Lbk and VSG sites

The sampling represents 28% of the total assemblage (Table 10-1). It is quite representative of the average composition of the archaeological assemblages, except for percussion tools for which a specific methodology and experimental referential needs to be built. Querns and grinders constitute half of the assemblage, with 248 tools, mainly dominated by grinders. 20 grinding slabs and “broyons” have also been examined, together with 46 friction tools and 119 abrading and polishing tools. Among each category of tool, the sampling was then based on several criteria, in particular a good preservation of the raw material (a low rate of alteration and high cohesiveness), the integrity of the tools (as far as possible complete tools) and macroscopic use-wear traces.

Our study has contributed together with flint and bone tools to identify a wide range of activities, especially focusing on plant processing for food preparation, stone and shell shaping for tools or ornament production and on animal matter transformation (leather, meat, bone, etc.).

	Berry au Bac - la Croix Maigret	Bucy le Long - la fosselle	Bucy le Long - le Fond du Petit Marais	Cuiry les Chaudardes - les Fontinettes	Trosly Breuil - les Obeaux	Bucy le Long - la Fosse Tounise	Jablines - la Pente de Croupeton	Saint Denis - rue du Landy	Betton - Pluvignon	Chelles - ZAC Tuileries	Colombelles - le Lazarro	Loison sous Lens	Maurecourt - la Croix de Choisy	Ocquerre - la Rocluche	Remicourt - En Bia Flo	Fexhe - le Haut Clocher	Oleye	Darion	Waremmes Longchamps	TOTAL
querns				1	12			5				5	1	6	10	2	5	1	2	**50**
grinders				10	17	1	15	2	8		8	2	14	9	10	2	10	5	11	**124**
grinding fragments	4	5	8	1	43	9	3								1					**74**
grinding slab									1				1		2	2	3		1	**10**
broyon	1			1	2		1				1			4			1			**11**
hammerstones		1				1														**2**
hammers											4									**4**
lower polishers		1	1						1	1	1		1	3	3	1	1		1	**15**
hand abraders			1		4				6		2		1	2	5		7		3	**31**
grooved abrader				28		1			1		3		2	6	3	4	3			**51**
polisher fragment	5	8			5	4														**22**

handstones	4			3	3	1	3			4	11		6	4	3				1	**43**
smoother										1	2									**3**
undetermined		5			30	2	1				2			1						**41**
Total sample	**14**	**20**	**10**	**44**	**116**	**19**	**23**	**7**	**17**	**6**	**34**	**7**	**26**	**35**	**37**	**11**	**30**	**6**	**19**	**481**
Total site	41	220	36	131	75	42	53	8	136	10	209	24	166	68	**86**	28	132	150	95	1710

Tab.1. Sampling of macrolithic tools on 19 Lbk and VSG sites from north-western Europe for use-wear analysis; see the representativity of this sampling among the global assemblage of each site

3. Results

From all tool types considered, 46.4 % of the studied tools processed various plants, less than 16.3% are animal matter and 20% mineral matter. 13.3% are of undetermined uses and 3.5% have had multiple uses (Table 2). Hard animal and mineral matter have been processed by the most numerous categories of tools, showing that macrolithic tools are involved in a wide range of tasks and chaines operatoires, including food production and tools manufacturing.

Not surprisingly, 65% of the grinding tools are involved in cereal processing. But most astonishing is their use at 14% for mineral matters, among which colourings (1.2%), and soft minerals (3.6%) finally constitute a small part of the assemblage. The grinding and crushing of temper for ceramic production could explain this high rate of mineral processing, and so does the 4.8% of animal matter grinding which could also be involved in food production.

The main use of polishers and abraders for the processing of hard animal and mineral matters hides a high rate of undetermined matters transformed (21%). Most of these polishers have been involved in the production of bone tools, ornaments and polished stone tools. Their role in the technical system is directly related to the spread of "polishing" techniques as symbols of new technical habits.

Much more complex seems to be the use of handstones, as no less than 6 families of transformed matter have been interpreted, including cereals (16.6%), skin (19.4%), hard (19.4%) and soft (5.5%) mineral matters and ochre (2.8%). This diversity echoes the morphological variability of this category of tools, and the high rate of multiple uses (8.3%).

This use-wear analysis demonstrates the central role of macrolithic tools in a wide range of activities. Food processing seems well represented through cereal and bone grinding. Polishers and abraders are clearly designed for the production of bone and stone tools. Skin treatment also requires macrolithic tools, and so does ceramic technology through the processing of temper and burnishes. Colouring processing and ornament manufacturing finally conclude the long list of activities involving macrolithic tools. Far from a monolithic vision of macrolithic tools involved in food preparation, our work has completely renewed the perception of their role in the technical system.

	cereals	wood	other plants	hard animal matter	skin	fresh skin + mineral matter	mineral matter	hard mineral matter	soft mineral matter	ochre	cereals then skin	cereals + mineral matter	cereals + ochre	hard mineral matter + other mineral matter	mineral + other plants	undetermined	TOTAL
querns	28		3	1			8	1	1	2		2		1		3	**50**
grinders	85			4			7	2	4	1	1	6		1		16	**127**
grinding fragments	51		2	7			6		4				1			3	**74**
grinding slab				1			4	1	2							1	**9**
broyons	2		6				1		1							1	**11**
hammerstones	1			1												1	**3**
hammers				2												2	**4**
polishers	2	1	1	7			2	1	1							6	**21**
lower polishers				5			3	3								1	**12**

hand abraders				15			5	2	5					2		6	**35**
grooved abraders				7			1	2	3							6	**19**
polisher fragment				3			1										**4**
handstones	6		6	7	3	7	2	1	3	1					1	6	**44**
smoothers				1			1									1	**3**
undetermined	17		2	4			2		8	1				1		8	**43**
Total	**192**	**1**	**20**	**65**	**3**	**7**	**42**	**13**	**32**	**5**	**1**	**8**	**1**	**5**	**1**	**61**	**459**
%	**41,8 %**	**0,2 %**	**4,4 %**	**14,2 %**	**0,7 %**	**1,5 %**	**9,2 %**	**2,8 %**	**7,0 %**	**1,1 %**	**0,2 %**	**1,7 %**	**0,2 %**	**1,1 %**	**0,2 %**	**13,3 %**	

Tab. 2. Functional interpretation by categories of tools and transformed matters for the whole studied assemblage

4. Interpretation and limits

The strong reliability of these general results hides a more complex reality, when getting into the details of our perception of the cycles of uses, of the limits of use-wear analysis and of the representativity of the sampling. For macrolithic tools, the quality and conservation of the raw material, the duration of the activities or the complexity of the cycles of use can be of particular importance. Consequently, the identification of the transformed matter can be then over- or underestimated.

First of all, the quality and properties of raw material can impact directly on the aspect of use-wear and the possibility of its functional interpretation. If high cohesive sandstone used for grinding and percussing tools generally presents well-developed use-wear traces, some other varieties of sandstones are more difficult to analyze. Especially, low cohesive sandstones have deliberately been chosen for half of the LBK and VSG grooved abraders to enhance their abrasiveness (Fig. 2). But this has largely restrained the possibilities of their functional analysis: the quartz and feldspath grains wearing use disappeared during the shaping and sharpening operations. Only a good strategy of sampling has allowed some results, by working on a series of tools from a large geographical area so as to get a chance to analyze more cohesive and well-preserved raw materials. Of major concern are also the rejuvenation sequences of grinding surfaces: as completely part of querns and grinders' life cycles, these operations destroy partly or completely the active surfaces. Working on freshly rejuvenated surfaces can be favourable to find single use surfaces, whereas a more global overview of the biography of the tools can be approached on more intensely used surfaces.

Secondly, bone and lithic tools share the poor traceological signature of soft plant and animal matter processing. We face here a general problem of the unequal intensity and development of the traces, which must be kept in mind when interpreting our assemblages. It is all the more true for the study of macrolithic tools, characterized by high amplitudes in the durations of use (from several minutes to tens of years). Our experiments have shown the low speed of use-wear formation for soft plant grinding, and strong differences among vegetal matters. Well recognized on half of the "broyons", plant grinding has only been recognized on 2% of the querns and grinders. The processing of plants and cereals on the same querns could explain this distortion: as the duration and intensity of cereal grinding is more important, the corresponding use-wear could have hidden lighter traces created by soft plant grinding. Combined optical and residues' analysis can help limit these distortions, but not completely avoid them because of the unequal preservation of residues. Especially in our context, poor results have been obtained through phytoliths' analysis to complete our perception of plant processing (Hamon et al. 2011). Finally, the low degree of specialization of plant processing tools is a key point that must be integrated in the functional interpretations.

Fig 2. Abrader from Ocquerre La Rocluche (Seine et Marne, France) in low cohesive sandstone with aspect of the used surfaces and grains (after Hamon 2009)

The third important question to be raised especially for macrolithic tools is their plurifunctionality. Together with the long duration of use of certain tool types, the life cycles and biographies of tools can strongly affect their functional interpretation. Far from the establishment of functional typologies, we must keep in mind that only the main and/or last uses of the tools can be approached by use-wear analysis. The low degree of morphological differentiation of certain categories of tools can find a direct translation in the wide range of transformed matter. Linienbandkeramik handstones are the best example: they share more or less the same morphological characteristics but are used for the largest range of actions and matter transformed. The fact that half of the plurifunctional tools are concerned with cereal grinding, also shows that the tools involved in this activity are not as specialized as previously admitted. Secondary uses and reuses can sometimes be identified only through use-wear analysis. Despite the presence of ochre residues on some LBK querns of Hesbaye, use-wear analysis made it possible to propose a principal use for cereal processing, and a secondary use for ochre grinding (Fig. 3). This confirms that use-wear analysis is of main importance, even when residues are visible macroscopically.

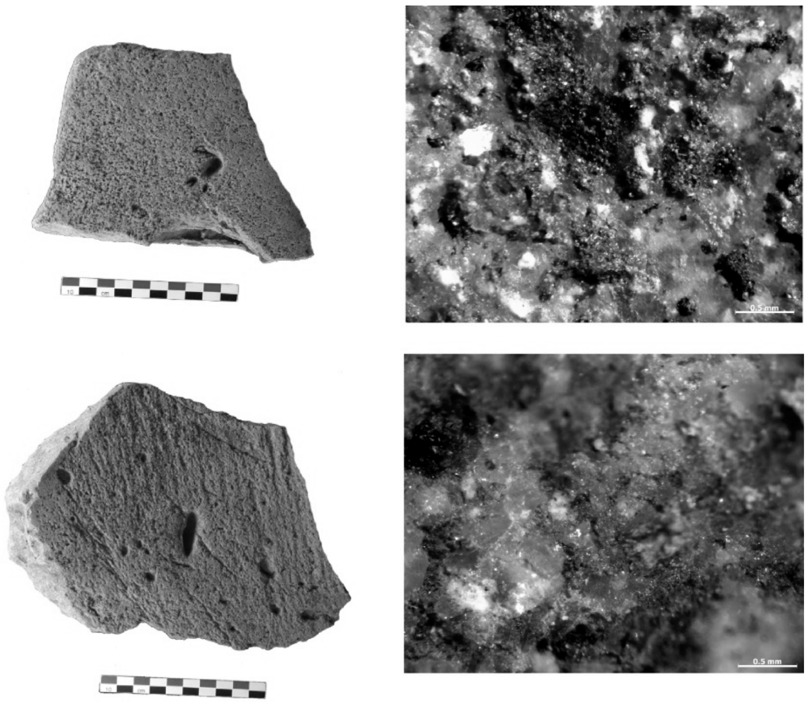

Fig 3. Fragments of querns and grinders from Remicourt En bia Flo (Hesbaye, Belgium), used for cereal grinding and then reused for the processing of red coloring matter (Hamon 2007)

5. Conclusion

The functional analysis of macrolithic tools from the first Neolithic of north-western Europe has permitted a deconstruction of old functional typologies, associating querns to cereal transformation and polishers to stone axe shaping. The rebuilding of a more accurate functional synthesis clearly shows that macrolithic tools were highly involved in food preparation as well as tools, ceramic and ornament production. Tracking stages of use and plurifunctionality through use-wear analysis has improved our global understanding of the macrolithic tools' biography in their socio-economic context.

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CHAPTER ELEVEN

THE EFFECTS OF CLEANING ON SURFACE ROUGHNESS: EVALUATING SAMPLE PREPARATION USING USE-WEAR QUANTIFICATION

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Abstract

Recently there has been a proliferation of new use-wear methods that quantify functional traces on stone tools. Many of these methods focus on the quantification of surface roughness, measuring topographic features at small scales to understand variation in surface texture created by varying contact materials. One promising technique uses the LEXT laser scanning confocal microscope (LSCM) to characterize surface texture. This paper will present the results of measurements taken with a LSCM to understand the effects of various cleaning methods on surface roughness. Currently, there is little consensus within the field of use-wear on how to adequately clean samples prior to analysis. The high resolution images and surface measurements produced by LSCM make this technique uniquely qualified to address this problem. Experimental tools were subjected to three levels of cleaning to test whether chemical cleaning erodes stone tool surfaces. The tools were cleaned with alcohol, then soap and water, and finally chemical cleaning with potassium hydroxide (10%) and hydrochloric acid (10%). The results from this study contribute to the standardization of sample preparation and highlight the applications of LSCM for further use-wear studies.

Keywords: Use-wear quantification, cleaning, sample preparation, laser scanning confocal microscopy.

1. Introduction

Over several decades the development of use-wear analysis methods has examined the applications of different microscopy techniques to interpret stone tool function. The multitude of different approaches to use-wear analysis has resulted in little standardization within the practice of data collection. The inherent qualitative aspects of light microscopy for polish identification to determine contact material has led to a move towards the collection of quantitative data. Quantitative data allows for greater comparability of results and can contribute to the identification of surface textures undetectable by visual methods. Recently there has been a proliferation of new use-wear methods that quantify functional traces on stone tools (e.g. Anderson, et al., 2006, Evans and Donahue, 2008, Faulks, et al., 2011, Stemp, et al., 2009, Stemp, et al., 2012). Many of these methods focus on the quantification of surface roughness, measuring topographic features at small scales to understand variation in surface texture created by varying contact materials. One promising technique of use-wear quantification uses laser scanning confocal microscopy (LSCM) to characterize surface texture. This paper presents the results of measurements taken with the Olympus LEXT OLS4000 laser scanning confocal microscope to understand the effects of various cleaning methods on surface roughness. The aims of this study are to 1) test whether different commonly used cleaning protocols affect surface roughness measurements, and 2) present the visual effects of different cleaning protocols on a worn lithic tool surface.

Although artifact cleaning occurs prior to all use-wear studies, there is little consensus between use-wear analysts on how to adequately clean samples. When reported, cleaning protocols include cleaning with alcohol, soap and water, and chemical cleaning. There has been some discussion as to whether chemical cleaning impacts the surface of chert artifacts (see Vaughan, 1985), however it has not been systematically explored. The high resolution images and surface measurements produced by LSCM make it uniquely qualified to contribute to this discussion. In this research, experimental tools were subjected to three levels of cleaning; the tools were cleaned with alcohol, then soap and water, and finally chemical cleaning with potassium hydroxide (10%) and hydrochloric acid (10%). The results from this study contribute to the standardization of sample preparation and highlight the applications of the laser scanning confocal microscopy for further use-wear studies.

2. Methods

2.1 Experiments

For this study, a set of experimental tools with well-developed use-wear traces was chosen. These tools were selected from a set used during harvesting experiments, organized and directed by Dr. Patricia Anderson. The experiments took place over five days, with three days dedicated to cutting the wheat, one to threshing, and one to winnowing the grain. The harvesting field was located outside the town of St. Vallier de Thiey, France, and was planted with einkorn wheat (*Triticum monococcum*). The experimental sickle used for harvesting was modeled after an archaeological piece from the Natufian period. The sickle was armed with six chert geometric microliths (Negev chert) and was used for approximately 12,000 strokes (400 minutes). Two microlith inserts from the sickle were chosen to test differences in cleaning protocols.

2.2 Microscopic Analysis

The use of laser scanning confocal microscope (LSCM) in becoming increasingly popular in studies of lithic use-wear quantification (e.g. Evans and Donahue, 2008, Evans and Macdonald, 2011, Giusca, et al., 2012, Stemp and Chung, 2011, Stemp, et al., 2012). LSCM has the ability to characterize surface texture through constructing 3D models of surface features (Figure 1). This produces quantitative measurements of surface roughness, useful for distinguishing polish from different contact materials. Previous research has shown that useful parameters for characterizing worn lithic surface texture include average roughness (*Sa*) and root-mean-square of average roughness (*Sq*). For this study we used an Olympus LEXT OLS4000 LSCM. The planar resolution that can be achieved with this system is 0.12 μm and up to 10 nm vertical resolution. Magnification depends on the objective lens used and the highest magnification objective is 100x (0.8 NA), which allows magnifications of 2000x to be achieved (Evans and Macdonald, 2011). The Olympus LEXT system combines the LSCM with a standard light microscope system. This feature allows it to be used with the familiarity of a conventional reflected microscope either alone or at the same time as LSCM (Evans and Macdonald, 2011).

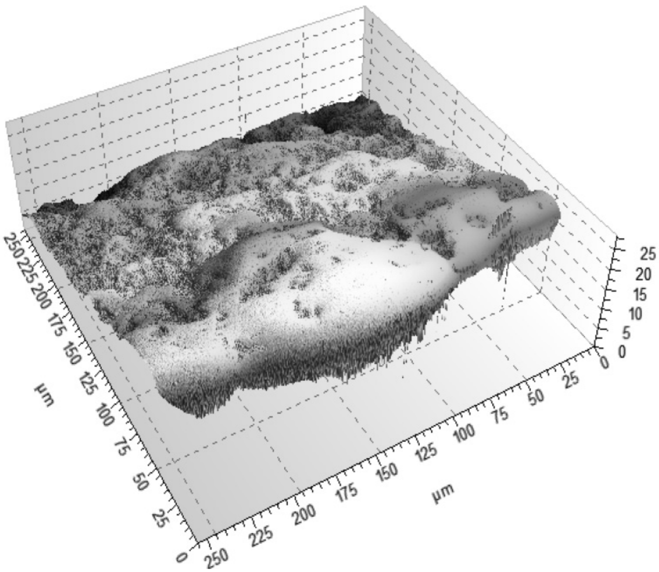

Fig 1: Three-dimensional image produced by LSCSM of tool #1's surface.

As mentioned above, two sickle inserts were chosen for analysis. In the first stage of the analysis, the lithics were cleaned with methyl alcohol and technical wipes, minimizing the transfer of residue from the cloth to the artifact. Once the pieces were cleaned they were scanned with the LSCM using the 20x objective and 50x objective respectively. For the second stage, the lithics were cleaned with warm water and a mild detergent (nutratek) while being lightly brushed with a soft bristled tooth brush. After cleaning they were once again scanned with the LSCM in the same location and at the same magnification. During the final stage of the analysis the lithics were subjected to chemical cleaning (as outlined by Keeley, 1980). First they were soaked in a bath of 10% potassium hydroxide (KOH) for 10 minutes to remove organic deposits. Following this cleaning, the lithics were soaked in 10% hydrochloric acid (HCl) for 10 minutes to remove any mineral deposits. Then they were bathed in clean water to remove any remaining chemical traces. Scans were taken of the microliths after the final cleaning stage at the same magnification and location as the first two cleaning stages. Thus, the lithics were subjected to increasingly invasive cleaning techniques during each stage of analysis.

For each tool, five sampling areas of 30 μm x 30 μm were selected for measurement from the polished surface of the lithic. The same five areas were scanned at each stage to ensure the measurements were reflecting changes in cleaning technique and not differences in surface topography. An average roughness measurement (*Sa*) was recorded for each area using Mountains Map software. The results of the five scans per tool were averaged to generate a mean average roughness for each tool at each stage of cleaning.

3. Results

The overall results of the study indicate that alcohol cleaning is not sufficient for either visual interpretation of use-wear (Figures 2 and 3) or for use-wear quantification. The data summarized in Figure 4 shows that surface measurements of average roughness for tool #1 cleaned with alcohol has a high variance. For tool #2, the piece has a high variance and a high average roughness measurement (Figure 5). This is likely due to the presence of greases (which have a smooth texture) and of particulate matter (which is rough) creating a highly variable surface. This interpretation is further corroborated with the visual assessment of the images, where grease and other particles can be clearly seen on the surface (Figures 2 and 3). Cleaning with a detergent removed the grease and much of the particulate residue, resulting in measurements with lower variance for both tools. For tool #2, the mean roughness for the tool cleaned with detergent was significantly lower than the mean roughness of just alcohol cleaning. Finally, the surfaces cleaned with the acid and alkali method appears free from small particulate matter. Thus, the texture variation is reduced considerably in the surface roughness measurement of the chemically cleaned pieces. This is particularly evident in tool #1 where there is a clear reduction in the variance of the surface roughness between the surface cleaned with nutratek and the surface cleaned with chemicals. It is interesting to note there is little difference in mean surface roughness between the cleaning with detergent and cleaning with chemicals for tool #2 suggesting that the soap cleaning was sufficient for this particular tool.

This research shows that differences in cleaning practices do have an effect on measured surface texture. In addition, visual differences can be seen among the three cleaning stages, with visible grease and particles on the tools cleaned only with alcohol. This highlights sample preparation as an important area of methodological research for use-wear analysis. To ensure only surface texture is measured, we would recommend acid/alkali cleaning prior to imaging for metrological purposes. Clear differences in the measurements between detergent cleaning and chemical cleaning in tool #1 suggest that chemicals are needed to remove all adhering materials from the lithic surface. However, for visual assessment the tools cleaned with soap and water provided adequate cleaning if chemical facilities are not available.

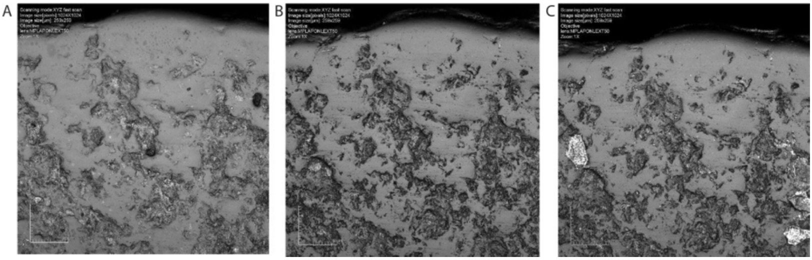

Fig 2: Cleaning stages on tool #1. A, cleaning with alcohol wipe; B, cleaning with soap (nutratek) and water; C, cleaning with 10% KOH and 10% HCl.

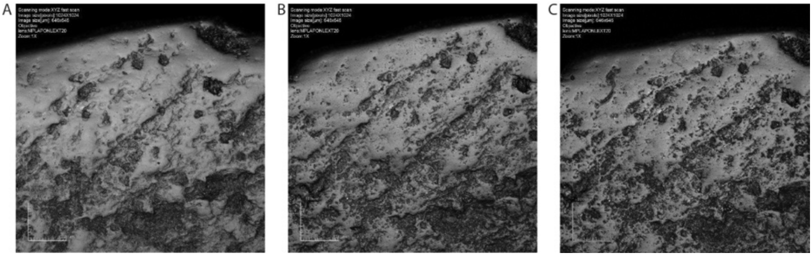

Fig 3: Cleaning stages on tool #2. A, cleaning with alcohol wipe; B, cleaning with soap (nutratek) and water; C, cleaning with 10% KOH and 10% HCl.

4. Discussion

Further research will continue to explore the application of laser scanning confocal microscopy for lithic use-wear analysis and the standardization of sample preparation protocols. This current study will be expanded to include the effect of ultrasonic baths and acetone for artifact cleaning. A program for the measurement of lithic surfaces to distinguish different contact materials is ongoing. The continued use of quantitative microscopy will greatly contribute to the standardization of lithic use-wear analysis, increasing the comparability of results among researchers.

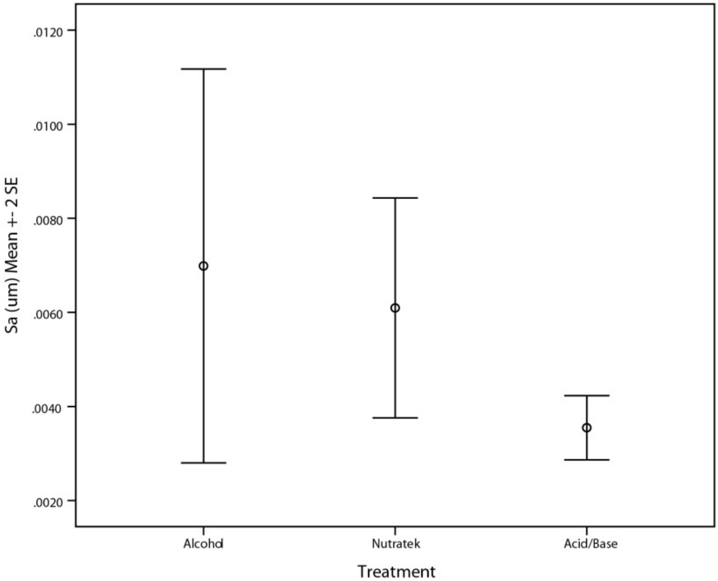

Fig 4: Mean average roughness (*Sa*) of each cleaning treatment with 2± SE for tool #1

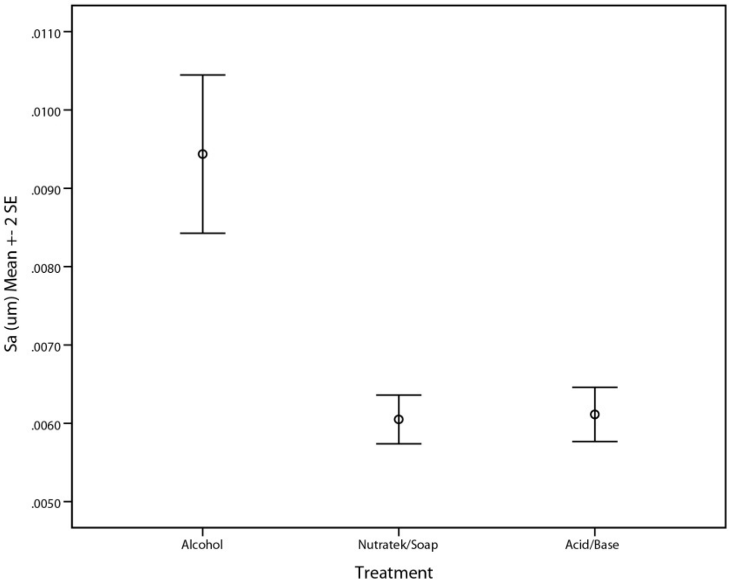

Fig 5: Mean average roughness (*Sa*) of each cleaning treatment with 2± SE for tool #2

Acknowledgements

Thank you to National Physical Laboratory, UK for use of the LEXT and on-going collaboration. DM would like to thank Patricia Anderson for graciously inviting her to be part of the experimental harvesting work during the summer of 2011. DM was supported by the University of Toronto, School of Graduate Studies Travel Grant.

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CHAPTER TWELVE

USE-WEAR ANALYSIS ON QUARTZ AND QUARTZITE TOOLS

METHODOLOGY AND APPLICATION: COUDOULOUS I (MIDI-PYRÉNÉES, FRANCE)

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Abstract

The aim of this work is to contribute to the development of a use-wear analysis methodological framework on quartz and quartzite industries. After illustrating the main steps of the analysis, a small part is dedicated to archaeological application on a specimen from the site of Coudulous I (France).

The difference lies in the different structure of quartz and quartzite, and in their response to mechanical stress.

To understand the behaviour of quartz subjected to mechanical forces originated by its use on various materials (wood, horn, bone and meat), it is essential to create a comparative collection established by the experimental protocol and obtained from a series of tests by controlled parameters.

This preliminary step is essential in order to comprehend and identify use-wear traces on archaeological material, which will be compared by analogy with the experimental ones.

In the study of use-wear traces, tribochemistry provides us with the guidelines to understand their formation.

This discipline, in fact, studies the interaction with surfaces in motion and contact with each other or with a third body. The application of the tribological model to the use-wear traces of quartz and quartzite identified through structured series of experiments has proven very effective for the interpretation of the archaeological evidence.

Keywords: Use-wear analysis; methodology; quartz; tribology

1. Introduction

Quartz is the constituent mineral of polycrystalline rocks, and it is represented by many different varieties, depending on geological origin, for instance, filonian and hyaline quartz (Fig. 1). Its physicochemical properties (hardness and insolubility) provide it with a great resistance. On the other hand, quartzite is a metamorphic rock, mainly composed of quartz, which can be associated with other minerals. Both quartz and quartzite were largely exploited during the Palaeolithic period as raw materials, in particular in contexts where flint or other materials, were not available, although there are recorded findings of tools made of quartz from sites located in areas where flint sources where accessible. This is the case of the French site of Coudoulous I where, within layer 4, several quartz and flint tools were found in association with numerous bison (Bison priscus) faunal remains (J. Jaubert et al. 2005). In Europe, the major areas rich in quartz formations are located across the French-Cantabrian zone and Portugal. Even though quartz industries are very well represented these are still poorly examined from a functional point of view, due to the long and laborious phases of the study, and in particular the difficulties related to the interpretation of the wear on this specific material.

2. Methodology

For a correct archaeological interpretation, it is important to carefully examine the behaviours of quartz through experimentation. Without a scanning electron microscope (SEM), which is useful to quicken and improve the analysis, a metallographic microscope equipped with reflected light and a differential interference contrast system (DIC) can be used (Igreja De Araujo 2009).

The main difficulty in interpreting quartz lies in the fact that, under a microscope, its natural surface is characterized by traces, originated by the formation processes of the crystal (Fig. 2); to these latter, in the case of archaeological implements, all the possible traces also left by post-depositional events have to be considered.

Fig 1: experimental quartz flake

Fig 2: example of pre-use evidence on a crystal surface

To this end, experimentation was carried out to recreate the rubbing between the artefacts and the other hard tools within the archaeological sediment; as a post-depositional event certainly occurred. Two flakes of equal size were rubbed against each other for 1 hour. The result is a very strong abrasion that completely destroyed the crystal's morphology, leaving several crystal portions still intact. This specific abrasion can occur in any point of the flake surface and does not produce polish or rounding of the crystal's edge. If strong and repeated over time it can give indications on the movement direction (Fig. 3).

Fig 3: crystal surface completely destroyed with two small portion still intact

During the experimental phase it is imperative to analyze the object under a microscope, although it may appear to be a time consuming and demanding process.

Using a metallographic microscope it is useful to make a mould of the entire surface (both ventral and dorsal) with a two-component silicon (Provil Novo Light Fast), in order to obtain a negative cast of each of the crystals composing the surface matrix, and to reduce their reflectivity.

Once the experimental activity is concluded, the sample must be cleaned at first with water and then with demineralized water in an ultrasonic bath; if dealing with fatty worked materials it may be necessary to perform a mild chemical washing to eliminate the residues. Once the sample is dried it is possible to apply the silicon along the edge (including at least 1.5/2 cm of the surface) to obtain a cast of the edge after its use (Fig. 4).

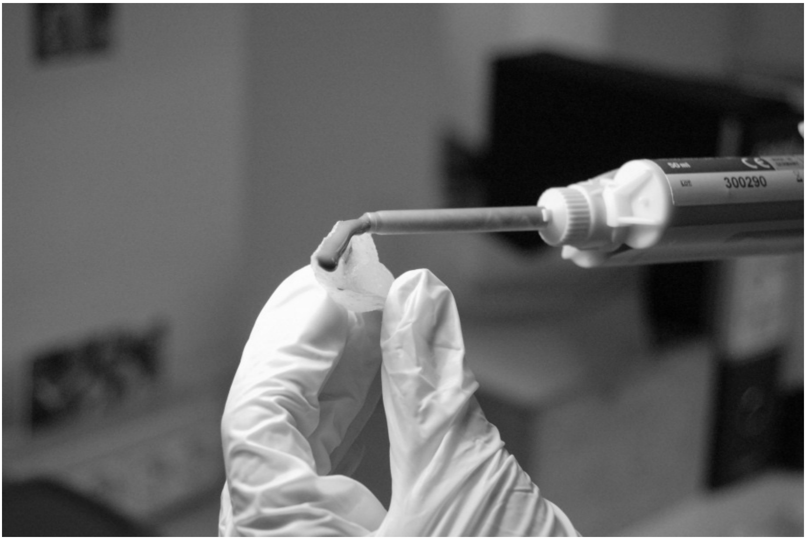

Fig 4: cast of the edge made with Provil

During the microscopic examination, it is advised to have both pre- and post-use silicon casts on the microscope's stage. This will allow the crystals that we are comparing to be perfectly lined up (Fig. 5). Thus, the comparison between the crystals will be immediate and it will ease the recognition of modifications in the surface before and after use (Fig. 6).

Although long and demanding, this step sharply reduces possible errors in recognition during the experimental stage.

Both on the archaeological and experimental materials, it is worth taking note (through a sketch of the object) of the point where the trace was identified. It is important to remember this step because wear on quartz has to be searched for on each crystal of the ventral and dorsal surfaces (not only along the edge) of the tool. Knowing the correct location of the traces aids thinking about the possible use of the tool and also reduces the analysis time in case you want to see the same traces later.

Having a good experimental use-wear comparison collection is essential to achieve a more accurate archaeological interpretation.

Finally, once diagnosed, it is useful to enter the information related to the analyzed use-wear in a database, including a description of the topography, texture, colour, direction and morphology, depending on whether these are abrasions, polishing or striations.

Fig 5: pre and post-use casts on the microscope’s stage

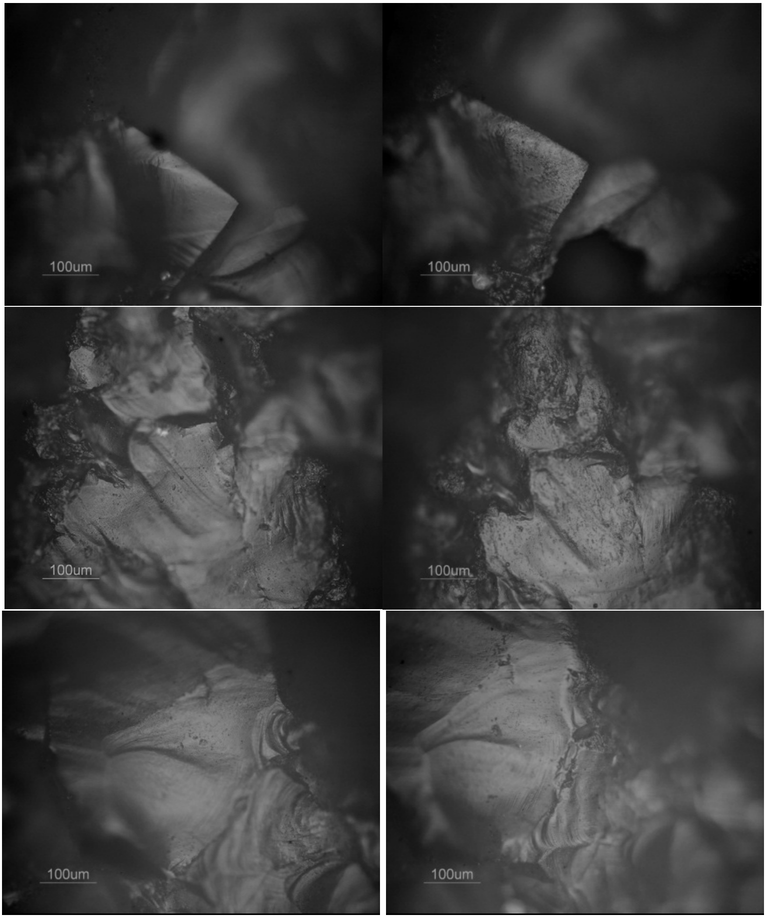

Fig 6 (a-f): examples of experimental wear associated to butchering, scraping of dry skin and cutting of dry wood follows. Fig 6 a,c,e: pre-use ; Fig 6 b,d,f: post-use

3. Application

To understand the ways in which use-wear is produced on quartz and all materials, we must refer to the discipline that studies the interaction of surfaces in motion and in contact with each other or with a third component: tribology (Bartùli 2008) (Fig. 7).

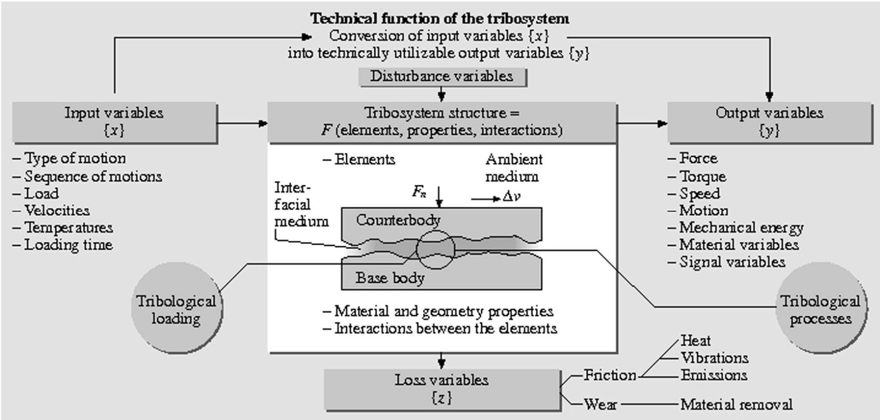

Fig 7: tribological system

When quartz comes into contact with the processed material, molecular interactions are established between the two materials. These latter interactions create bonds that break due to the activities carried out (cutting, scraping). In particular, motion produces heat, which breaks the bonds previously created detaching material from both surfaces (adhesive wear).

If the mechanical stress continues, the more protruding surface portions break and, both at a macro and microscopic level fractures on the crystals are evident (fatigue wear). The materials that detach during both the mechanism of adhesive and fatigue wear originate abrasive wear, which produces traces such as abrasions and striations.

Once the abrasion decreases, the process of accumulation (tribochemical mechanisms) begins. Layers of the amorphous substance, along with the oxides present in the mineral, compact themselves due to the chemical interactions favoured by water (present in all materials). The result is a polishing effect always located in the cavities produced by the abrasion and often along the edges of the crystals (Venditti 2011).

An accurate experimental protocol allows, through the analysis of the archaeological material, the obtaining of important information about the nature of the investigated site, and the activities carried out by its inhabitants.

It is important to highlight that the experimental work has also led to the identification of the type of track that cannot be found on archaeological material.

As opposed to fresh meat, which produces a characteristic and unequivocal trace, working the thick layer of subcutaneous fat during skinning, makes the surface of the crystals smooth and very bright. This is completely different when compared to the same crystals before use, characterized by a darker colour and covered with micro residues (Fig. 8) (Venditti 2011).

Therefore, on the archaeological material, with the absence of a comparison with the pre-use features of the crystals, it is difficult to distinguish between traces produced by butchering and wear related to skinning activities.

Butchering activity was recognized on a specimen from the Palaeolithic site of Coudoulous I (Quercy, France) thanks to this experimentation.

This carstic hole, joining the Lot and Célé rivers, was used by Neanderthals as a bison trap between the end of the spring and the beginning of the summer during the middle Palaeolithic period. (J. Jaubert et al. 2005). Traces of fresh meat are present on 80% of the analyzed specimens (Fig. 9) even if traces of wood and dry skin are also present.

The location of the traces on the tool was very useful to reconstruct its employment.

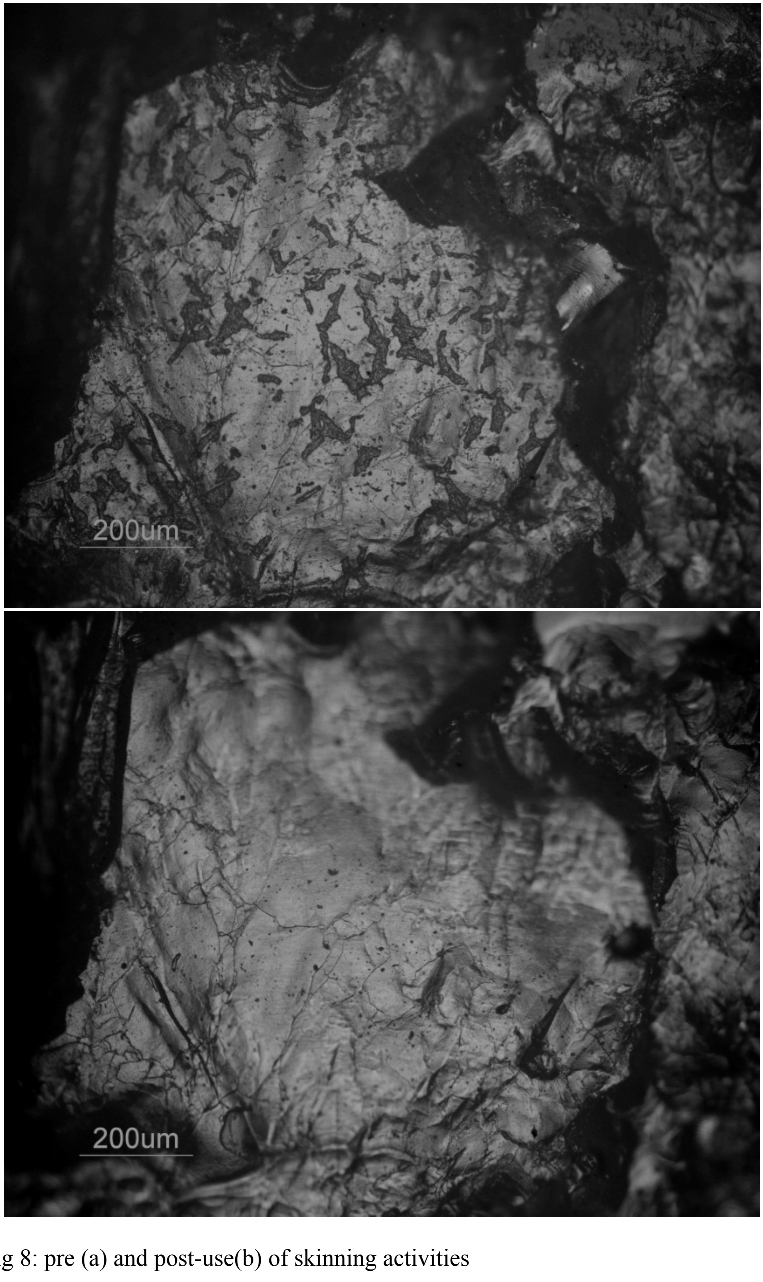

Fig 8: pre (a) and post-use(b) of skinning activities

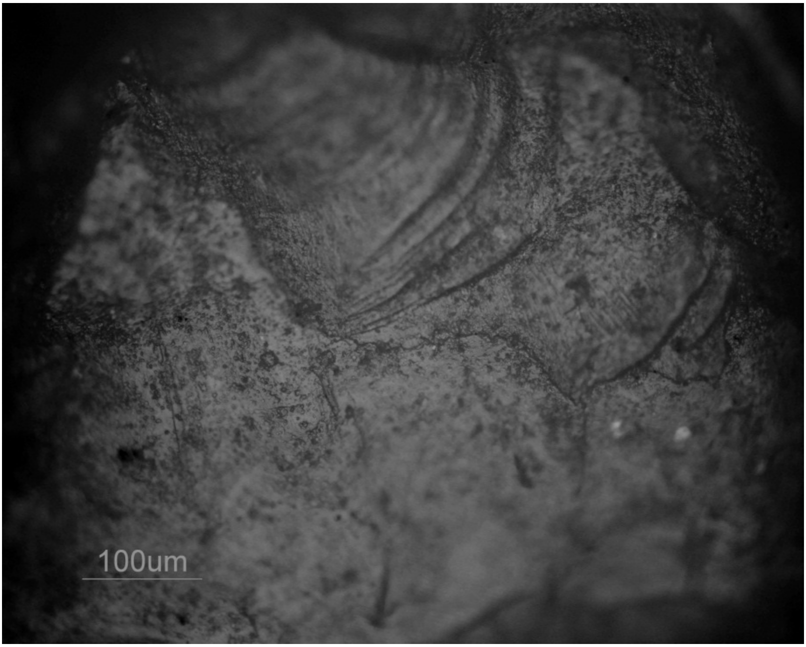

Fig 9: example of archaeological track associated with butchering on the tool Cs 79 ext c4n4 5110

Although we do not have traceological evidence of handling, a back knife could instead have been held thanks to a skin support. Traces on the central part of the tool attributable to contact with dry skin should prove this. (Venditti 2011; Lemorini-Venditti in press). The use-wear analysis of Coudoulous I quartz tools was essential to recreate the activities carried out at the site. Flint tools, although present, were very damaged and altered by the desilification process due to the continuous passage of water in the carstic setting.

In these environmental conditions, the physic features of quartz and quartzite tools have allowed to overtake the alterations preserving their use-wear. Even if well preserved, on some of these objects we have observed some strong abrasions due to a post-depositional process, according with experimental data (Fig. 10).

In conclusion, without a specific analysis on the quartz tools, it would not have been possible to make any functional reconstruction of the lithic implements and, more generally, of the nature of the site.

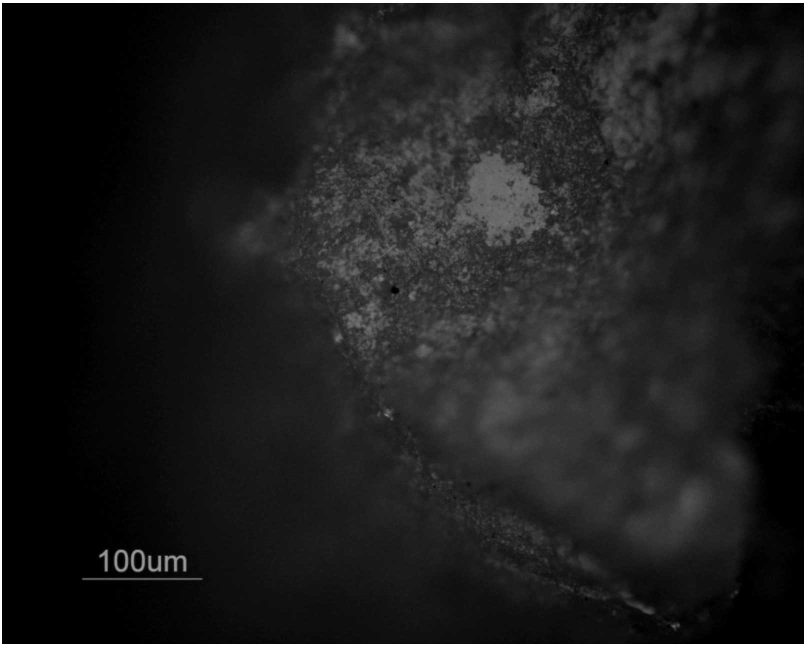

Fig 10: example of bright spot on the archaeological tool Cou J 4 2006

Acknowledgements

I would like to thank Jacques Jaubert for the opportunity given me to undertake the study on quartz and for making the lithic artefacts available. Also, I would like to thank Cristina Lemorini for her availability and patience, with which she has followed me during these last years.

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PART II:

HUNTER-GATHERERS

CHAPTER THIRTEEN

NEW FUNCTIONAL DATA CONCERNING MIDDLE PALAEOLITHIC BIFACES FROM SOUTHWESTERN AND NORTHERN FRANCE

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Abstract

Bifaces appear at different moments in several regions of Western Europe during the Middle Palaeolithic. In order to understand why various human groups produced these tools, it is instructive to investigate how they were used. In light of the rarity of use-wear studies involving bifaces, new analyses concerning these artefacts recovered from sites in Southwest and Northern France were carried out using a collection of experimental bifaces. A predominantly low-power approach was adopted given the paucity of micro-polishes. Macro- and micro-traces connected to butchery were often observed on cordiform and triangular bifaces whose convergent edges could be repeatedly resharpened suggesting significant use-lives. Less frequent oval bifaces exhibit scarring on their distal transverse edges referable to chopping medium hard materials, while percussion marks observed on the edges and surfaces of several other examples, suggest that bifaces were also probably used as retouchers. Finally, a combination of intense macro- and micro-traces were sometimes observed on surfaces and are likely the product of repetitive friction involving an abrasive material with a mineral component whose precise origin could not be determined.

Keywords: Bifaces, Middle Palaeolithic, butchery, hammerstones, reduction

1. Background, objectives and data set

Late Middle Palaeolithic stone tool industries in Western Europe portray significant variability connected to a combination of economic, environmental, functional and cultural influences (e.g. Binford 1973; Bordes and Sonneville-Bordes 1970; Rolland 1981). This diversity is partly expressed in the presence or absence of bifaces in particular industries together with their different morpho-technological characteristics (e.g. Depaepe 2007; Soressi 2002). Furthermore, identifying the function(s) of these artefacts plays an important role in helping decipher why different Middle Palaeolithic human groups may have produced bifaces (technological convergence vs. cultural connections). Although it remains difficult to shed light on possible social or symbolic roles, technological studies have shown bifaces to be highly mobile and curated tools, which occasionally served as cores (e.g. Faivre 2006; Geneste 1985; Turq 2000). The few available use-wear analyses concerning these artefact types have highlighted a variety of uses suggesting that they may in fact represent multi-functional tools (for a synthesis see Claud 2008) whose precise function(s) still requires further clarification. With this in mind, a new use-wear analysis focused on bifaces from final Middle Palaeolithic assemblages was conducted with the aim of (1) obtaining new data on modes of use, (2) elucidating connections between morphology, tool reduction and these modes, as well as (3) identifying similarities and differences in these aspects between different assemblages.

This study comprised 92 bifaces from seven sites in Southwest and Northern France (Table 13-1). Although most are cordiform bifaces with convergent edges, triangular bifaces from Saint-Amand and oval bifaces with a transverse edge from La Graulet and La Conne de Bergerac were also included. These bifaces portray different reduction stages ranging from freshly shaped to heavily recycled examples with irregular removals or notches.

site	**location**	**site type**	**datations (ka BP)**	**references**	**nb of pieces studied / total**	**use-wear interpretations**				
						butchery	chopping medium hard material	hard mineral percussion		friction with an abrasive material
								edges	surfaces	
Bayonne-Prissé	Pyrénées Atlantiques	open-air site		Colonge *et al.*, in prep	6 / 6	2			2	2
Chez-Pinaud (06 / 07)	Charente-Maritime	rockshelter	39 ± 3	Airvaux, 2004, Jaubert *et al.*, 2008	48 / 48	18		4	4	9
Combe Brune 2	Dordogne	open-air site		Brenet *et al.*, 2008	3 / 3	1				
Fonseigner (Dsup)	Dordogne	open-air site	50,2 ± 5,3	Geneste, 1985, Valladas *et al.*, 1987	3 / 3	2				
La Conne de Bergerac	Dordogne	open-air site		Brenet, in prep.	5 / 5	2	1 ?			
La Graulet	Dordogne	open-air site		Brenet, in prep.	5 / 5		2			
Saint-Amand-les-Eaux	Nord	open-air site	49,2 ± 3,34	Feray, in prep.	22 / 80	3			10	9
total					92	*28*	*2 (+ 1?)*	*20*		*20*

Tab. 1. Details of sites studied and use-wear interpretations.

2. Methods

All bifaces were studied from a technological, morphological and functional point of view. Given that micro-polishes are rarely preserved on Lower and Middle Palaeolithic artefacts, a predominantly low-power approach was adopted (binocular microscope at 10 to 30x) to describe macrowear edge damage (scarring and rounding) in conjunction with a metallographic microscope when micro-traces were preserved (Chez-Pinaud, Fonseigner, Bayonne-Prissé). A reference collection of experimental bifaces was created in order to better characterize edge damage which has been shown to vary as a function of the active area (e.g. retouched or not) (Claud 2008, 2012; Claud et al. 2009)

3. Results and discussion

3.1. Edge wear

The most frequent use-wear traces result from cutting soft to medium hard materials most likely connected to butchery practices (Fig. 1, Table 1). This characteristic bifacial scarring whose morphology is discontinuous, oblique, triangular or semicircular and associated with step terminations is similar to that observed on bifaces used in butchery experiments. Polishes, when present, indicate the processing of meat or more abrasive materials such as skin or sinews. This mode of use was identified amongst both cordiform and triangular bifaces in different stages of reduction but which all retained a sharp lateral edge associated with a cutting tip.

Two oval bifaces from La Graulet exhibit large, semicircular bending scars on their distal edge. While indicative of chopping medium hard materials such as wood, the absence of polish precludes specifying the exact material worked (Fig. 2). Damage is similar to that observed on experimental bifaces used to fell trees and differs significantly from that referable to dismembering carcasses by percussion or breaking bones.

Seven heavily reduced bifaces (notched or having irregular removals) from Chez-Pinaud and Saint-Amand show unifacial damage on their lateral edge(s) along with crushing resulting from a transverse motion involving a hard mineral material. While working this type of material is plausible, such alterations are more likely to have a technological origin. Use-wear traces are often overlain by removals connected to recycling or reshaping and microscopic observations show no use polish. Deep striations similar to those produced by a hard-hammer during retouch are present and could result from edge preparation by abrasion.

The last type of edge wear combines intense bifacial damage with crushing (Fig. 3). Present on four resharpened or heavily reduced bifaces from Chez-Pinaud, this damage is tied to percussion with a hard mineral material and can have several different origins:

- non-use related actions in the form of intentional edge crushing designed to create a prehensile area or the use of the biface for indirect percussion (e.g. as a wedge). These are however unlikely given the location of the percussion traces and the bifaces' morphology coupled with the absence of other active areas.
- traces with an active origin due, for example, to crushing/grinding mineral or other materials on an anvil or the shaping and maintenance of hammerstones. However, experimental bifaces used in these activities demonstrate incongruent use-wear traces combined with low edge efficiency. With that said, a second hypothesis remains possible; bifaces could themselves have been used as hammerstones. Comparative experiments have shown that scarring and crushing on archaeological examples correspond well to those observed on experimental bifaces used to retouch denticulates (Claud 2008; Claud et al. 2010; Thiébaut et al. 2010). Moreover, comparable “V” shaped cross-sections of notches resulting from the experimental use of a hammerstone with a dihedral edge have been observed on archaeological denticulates (Airvaux 2004; Thiébaut 2005).

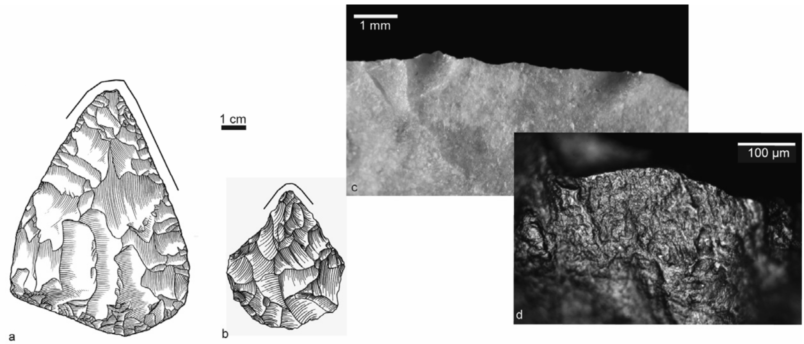

Fig. 1. Cordiform bifaces from Chez-Pinaud used for butchery and resulting macro- (c: scarring) and micro-wear traces (d: meat cutting polish) (drawings S. Pasty and F. Brenet).

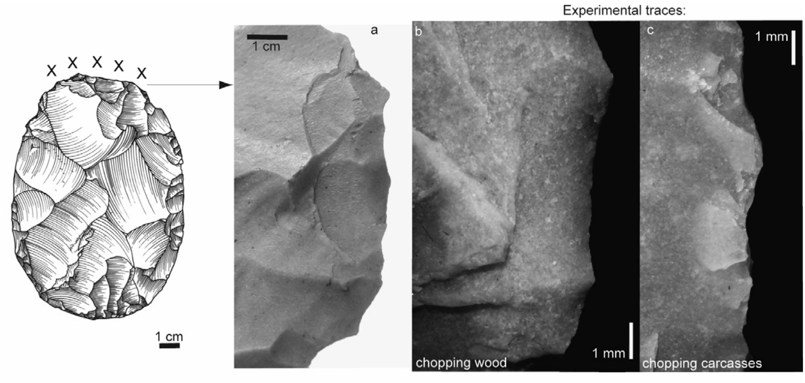

Fig. 2. Oval biface from La Graulet used to chop medium-hard material and scarring observed on archaeological and experimental bifaces used to chop wood and dismembering carcasses (drawings F. Brenet).

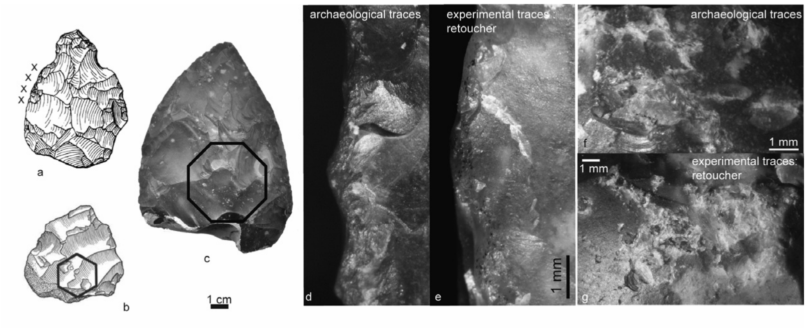

Fig. 3. Bifaces from Chez-Pinaud (a, b, drawings J. Airvaux and S. Pasty) and Saint-Amand (c, photo J. Lantoine) probably used as retouchers and traces observed on archaeological and experimental bifaces.

Activities	Modes of use	Nb of active areas
Butchery	Cutting (meat, hide, sinews)	12
	Chopping (dismemberment)	5
	Scraping (cleaning bones)	3
Hide processing	Cutting	2
	Scraping	2
	Piercing	2
Woodworking	Sawing	10
	Scraping	27
	Choping and splitting	17
	Piercing	2
Other	Processing plants	2
	Bone and antler working	3
	Mineral working (e.g. pigments)	2
	Spearpoints	2
	Digging	4
	Curation, transport	5
	total	*100*

Tab. 2. Experiments using bifaces. The majority were carried out as part of a collective research project (*Des Traces et des Hommes*, Thiébaut *et al.* 2009). Additional experiments were conducted in order to draw direct comparisons with archaeological traces of percussion and friction. Bifaces were hand-held, 'wrapped' or secured within a wooden haft (especially for chopping). Different biface morphologies were tested: cordiform, triangular and oval.

3.2. Surface wear-traces

A first type of use-wear trace comprises impact cracks and ripples on either convex or flat surfaces together with ridge scarring and crushing due to percussion with a hard mineral material (Fig. 3). These traces were observed on a mesio-proximal area of 16 bifaces and the surface of 5 bifacial thinning flakes. While present on bifaces in several different reduction stages at the other sites, all the bifaces from Chez-Pinaud exhibiting this type of trace were heavily reduced and mostly irregular. Several hypotheses may explain the presence of percussion traces.

The use of bifaces as anvils is unlikely given their small size and convex or irregular surfaces. Employing bifaces as hammerstones for indirect percussion is possible; however our experiments have shown that wear-traces on these experimental bifaces are generally in the middle of the biface and more diffuse.

The crushing of mineral or organic material with bifaces on an anvil is possible; however these types of use leave less detectable traces. The distribution and character of the use-wear traces on experimental bifaces used as retouchers are comparable with those observed on archaeological examples (Claud et al. 2010, Thiébaut et al. 2010), making this final hypothesis the most plausible.

Finally, 20 bifaces portrayed a second type of surface trace, which coexists on several examples with traces of butchery and/or percussion. This type of trace is also present on 10 bifacial thinning flakes, which was in place prior to their removal from the biface. These substantial use-wear traces consist of rounded ridges, subparallel striations, pits and a flat micro-topography. Striations on either one or both faces are almost always parallel to the biface's longitudinal axis or a lateral edge. While their original distribution is difficult to determine on most examples as they are often overlain by subsequent removals or retouch, they cover almost the entire surface of others.

The aspect of these traces undoubtedly indicates a mechanical origin likely due to persistent friction involving an abrasive material with a mineral component. The recurrent orientation of the striations, the fact that they are often intersected by negatives of later removals and are absent on other tools or flakes effectively excludes their being due to post-depositional surface modifications. Numerous alternative hypotheses have been suggested to account for this rubbing, several of which we have tested experimentally:

1. Surface abrasion connected to shaping or resharpening;
2. Prehension (hafting, “wrapping”–Rots 2010);
3. Handling, curation, cleaning or wiping the biface;
4. Employing the abrasive properties of the ridges to work different materials (pigments, hides with pigments or the edges of stone tools or hammerstones).

Unfortunately, none of these hypotheses could be confirmed experimentally as the morphology, distribution and orientation of the traces were not compatible with the archaeological examples making new experiments necessary to determine their origin.

No hafting traces were observed, however these tend to be faint and easily removed by post-depositional surface modifications (Rots 2010). Nonetheless, hafting cannot be excluded especially for bifaces used in chopping motions.

4. Conclusion

Overall, butchery appears to be the dominant activity involving bifaces having convergent edges (triangular or cordiform). The presence of use-wear traces on bifaces in different reduction stages indicates these types of tools were designed to function over significant periods of time. Bifaces were also probably used as retouchers in their final stages of reduction alongside their more prevalent use in butchery. A parallel can be drawn with what little functional data is available concerning Acheulean bifaces that also often carry traces of butchery and surface impact cracks (e.g. Keeley 1980; Mitchell 1998). The transverse edge of the occasional oval biface was used to chop medium hard materials, perhaps wood. Finally, further comparative studies are required to tease out the functional opposition between bifaces with convergent versus transverse edges.

The fact that identical uses (butchery knives and hammers) were revealed among artefacts from different Middle Palaeolithic industries with bifaces suggests that some of the morphological differences may be tied to distinct cultural traditions. Moreover, butchery and possibly wood chopping could correspond to the acquisition of animal and plant materials, perhaps carried out at specialised sites. Finally, the production of bifaces could represent a shared solution adopted by several different populations to specific land use patterns and mobility strategies.

Acknowledgements

Many thanks go to the various excavation directors who permitted me to study their collections and to the collective research project *Des Traces et des Hommes* for the experimental work. I am also grateful to Brad Gravina for helping edit the text.

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Tabl. 2. Experiments using bifaces. The majority were carried out as part of a collective research project (*Des Traces et des Hommes*, Thiébaut *et al.* 2009). Additional experiments were conducted in order to draw direct comparisons with archaeological traces of percussion and friction. Bifaces were hand-held, 'wrapped' or secured within a wooden haft (especially for chopping). Different biface morphologies were tested: cordiform, triangular and oval.

CHAPTER FOURTEEN

USE OF MIDDLE PALAEOLITHIC TOOLS IN SAN QUIRCE (ALAR DEL REY, PALENCIA, SPAIN)

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Abstract

This paper presents the results of the functional analysis of the Middle Palaeolithic stone assemblages from the 2009 excavation at the San Quirce site in Palencia (Spain). The main raw material used for tools manufacturing was a local quartzite available on the Pisuerga river terraces. Massive and flake tools were manufactured, with sharp denticulate edges used in different productive activities (they mainly used unretouched flake blanks), primarily related to the exploitation of plants, animal substances and, to a lesser extent, mineral resources (hammerstones for lithic knapping). Resharpened edges have been also detected through the analysis of micro-flake elements.

Keywords: Middle Palaeolithic, Quartzite, Productive activities and tools.

1. Introduction

San Quirce is a Middle Palaeolithic site located between Herrera de Pisuerga and Alar del Rey, southwest of the San Quirce Río Pisuerga municipality (Fig. 1). Eight terrace levels (Arnaiz 1996) have been identified in the middle section of the Pisuerga River (Alar del Rey-Osorno). The site is situated on the river terrace (+20-25 m). The 2009 excavation focused on Sector I of the site (+24.5 m, absolute altitude 860.5 m).

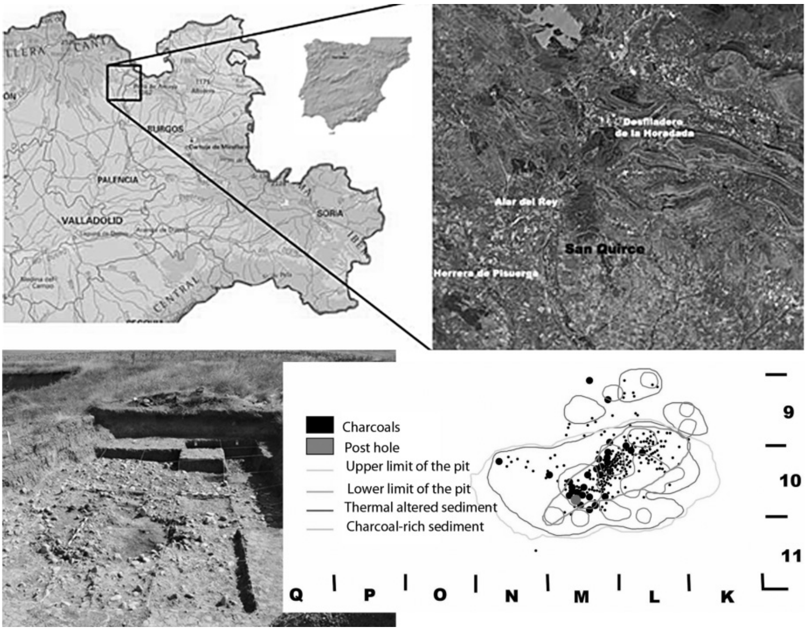

Fig. 1: Location map and view plan of the San Quirce excavation.

The 2009 excavation in Sector I differentiated three archaeologically fertile levels on the terrace channel (surface, colluvium and floodplain). The stratigraphic profile consists of a 30-40 cm layer (Level 1 from top to bottom), composed of mixed sand and clay, with a large amount of blackish organic matter. A 30 cm deep colluvium (Level 2) was deposited on the level below, after an important chronological hiatus and after a process of erosion. In this level there is not in-situ materials. Level 3 (40 cm deep) is part of a floodplain facies consisting of clay and silt layers.

The archaeological level is part of the 5-20 cm deep yellow silt layer, 20 cm above the channel and 5-10 cm below the colluvium (Terradillos 2010).

Only the material recovered from the San Quirce deposit during the 2009 dig was analyzed. Several structures were identified (Fig. 1) and 362 lithic items were found on Level 3 in a 49 m² area, yielding a provisional density of approximately 8 items per m². All of these items appeared in situ, many in an upright position. Features of this assemblage were the predominant usage of quartzite (83.1%) and a major representation of PB (68.8%) and natural bases (10.4%). Among the flake tools there is a significant presence of denticulates (78.6%). The San Quirce lithic assemblage can be ascribed to Mode 3 but it should be regarded as a type of Mode 3 characterized by the particular circumstances of this assemblage (Terradillos 2010).

2. Material and methods

A methodology for the analysis of heterogeneous rocks such as quartzite has been previously developed by Clemente-Conte (1997), Clemente-Conte and Gibaja (2009), Leipus and Mansur (2007) and Mansur (1999).

The analysed material from San Quirce Level 3 consisted of 328 lithic remains, 86% (282) of which were of quartzite, 37 identified as quartz and only 9 in flint. The latter are composed of very small fragments. The largest fragment measured 17 mm, with a mean of no more than 1 cm. The flints were poorly preserved, with a deep patina due to the desilicification of this raw material. None of these flint items appear to have been used as working tools however, in two cases, flint items have been classified as NAM (Non-analyzable material) due to the specifically poor preservationn of their surfaces. The same was true for the only quartz item classified in this group, which was heavily worn. Thirteen quartzite items complete the NAM group.

No traces of use have been identified over a sample of 242 lithic remains (73.7%). This group included pebbles (hammerstones and mannuports), fragments and flakes of all sizes. Of the remaining assemblage ten remains were classified as having possible use (PO), 26 tools with probable use (PR) and 28 with certain use (SG) (Clemente-Conte 1997). Analysis of the 54 detected working tools found that nearly 70% of them (n=37) were used to exploit plant resources, while 13 tools (24%) were used on soft animal resources and 3 hammerstones may have been used to produce stone tools.

3. Exploitation of animal resources

The majority of the 13 used tools were manufactured on flake and/or flake fragment, with a straight edge and acute angle, which is quite effective for cutting (Fig. 2: 3-5 and Fig. 3: 1-3). Knapped pebbles were used as tools only in two cases (Fig. 2:1-2), along with a small flake that is probably a resharpening flake (see below) (Fig. 4). The flakes used to cut soft animal matter tend to have a straight edge in both section and plan, with an average angle of 35°. In some cases use-wear traces are quite clear due to intense utilization. None of the materials used for butchering were shaped by retouch, apart from the massive tools employed for meat processing. Generally, instruments were used employing only one of the sharp edges. Edge fractures are the results of these activities. Only one specimen (J5-281) had two edges–straight and distal–with evidence of having been used to cut soft material of animal origin on both sides.

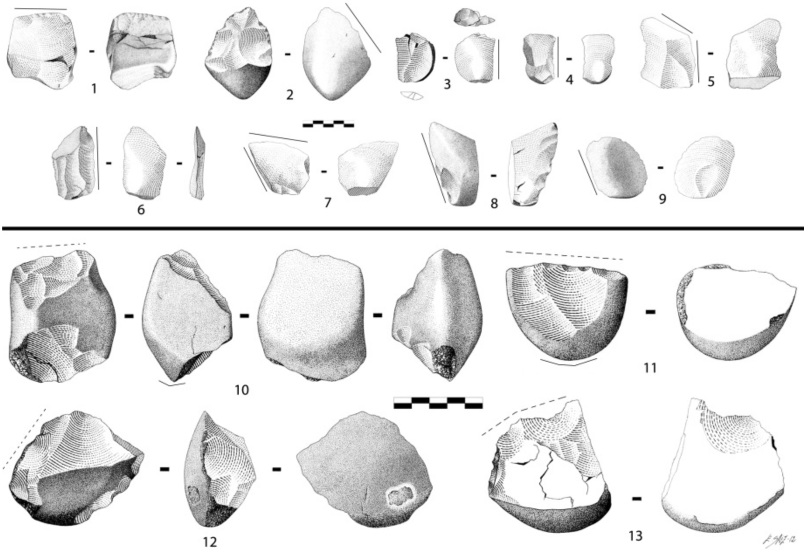

Fig. 2: Selection of the lithic assemblage of San Quirce: 1: L8-66; 2: K5-136; 3: I8-95; 4: L3-257; 5: J5-281; 6: H13-183; 7: J5-290; 8: J12-96; 9: J12-98; 10: J9-15; 11: J5-289; 12: I10-8; 13: J4-316. 1-5, tools on edge and quartzite flakes used to process animals; 6-9, quartzite flakes used for woodworking; 10-13, quartzite pebble tools with two active edges, used to scrape and crush plant matter. Drawings by E. Saiz.

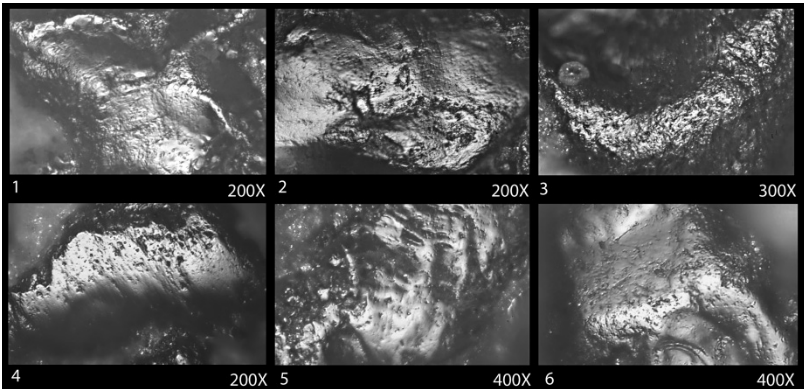

Fig. 3: Use-wear traces documented on the surface of tools used to work soft animal materials (meat/hide) (1 to 3) and medium-hard vegetal material (wood) (4 to 6).

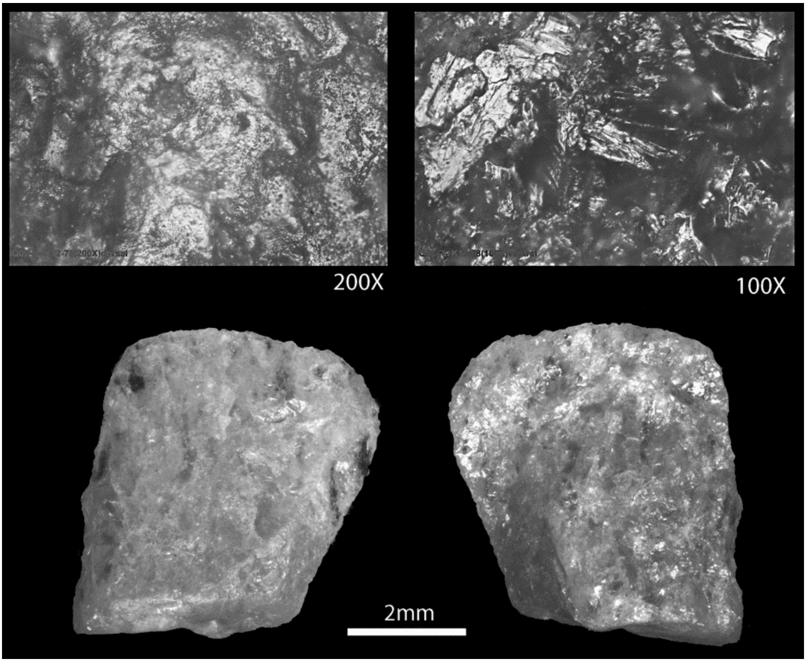

Fig. 4: Resharpening micro-flake used to work soft-medium animal materials, probably hide. Note that crystals on the ventral face (right) are fresh, while there is a micro-polish and rounding on the dorsal face (left) due to the previous use.

4. Woodwork

There were 22 documented lithic remains linked to woodworking (Fig. 2: 6-9, Fig 3: 3-6). Only one, an elongated quartzite flake (K6-171), shows traces of use on two edges: the left edge in a longitudinal cutting action, and the right transversal edge in a longitudinal action. The lithic remains classified as wood-working tools included a small quartz flake from the reshapening edge. Most of the woodworking-related tools were used for scraping/planning activities (12), four were used for cutting/thinning wood with a longitudinal-crosswise action, and five blades were used for cutting/sawing wood. In most cases, the wood was worked while still fresh and/or green. For cutting actions, relatively long flakes were chosen, with angles from flat to semiabrupt (maximum 50°), while for transversal planning/scraping actions, the angles are more varied, from 35º for scraping the wood fibres, to 70° for planing and polishing the surfaces.

5. Tools with 60º edges

These working tools were made from quartzite pebbles (Figs. 5 and 6). The selected pebbles were probably originally medium-sized (6 to 8 cm on the longest axis), with at least one long and flat face. This face was used to remove two or three flakes by percussion, in order to produce a roughly 60° edge. Only one of the analysed tools shows a working angle of 80° (H11- 28), while the others measure between 50º to 70º (averaging 63º). This was the main working edge of the tool. These edges were used for the same activity, a planing movement on a medium-hard substance. In addition, the opposite (distal) edge was also often used for pounding undetermined medium-hard materials. This action was probably performed by placing the worked material on a hard surface as a base. Traces of both types of activity were documented on eight tools, while in three cases only one action was realized: in one case (G9-124) only the planing action was detected, while in the others only the pounding-crushing activity was found (J4-312 and J6-326). Nevertheless, the latter are fragmentary tools possibly from a resharpened edge (?).

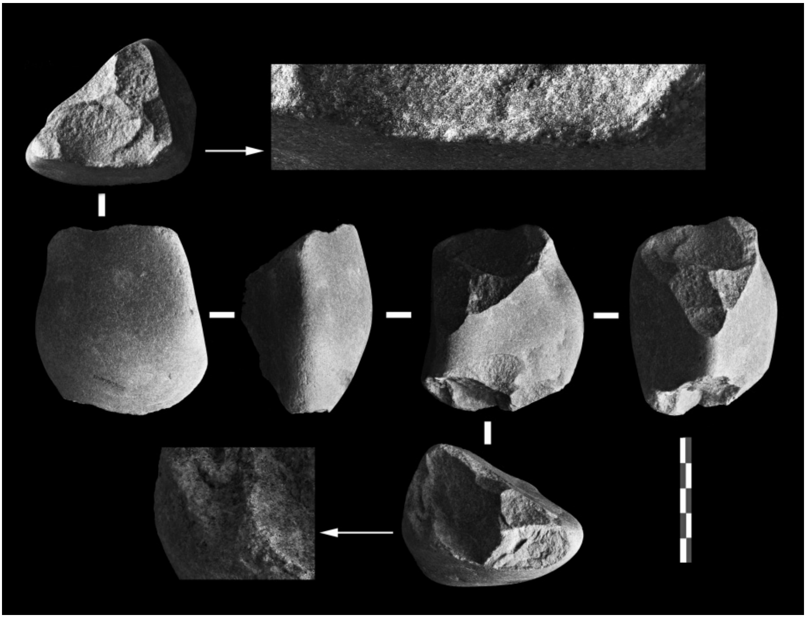

Fig. 5: View of pebble quartzite tool. Two areas were probably used for the same production process (scraping/pounding).

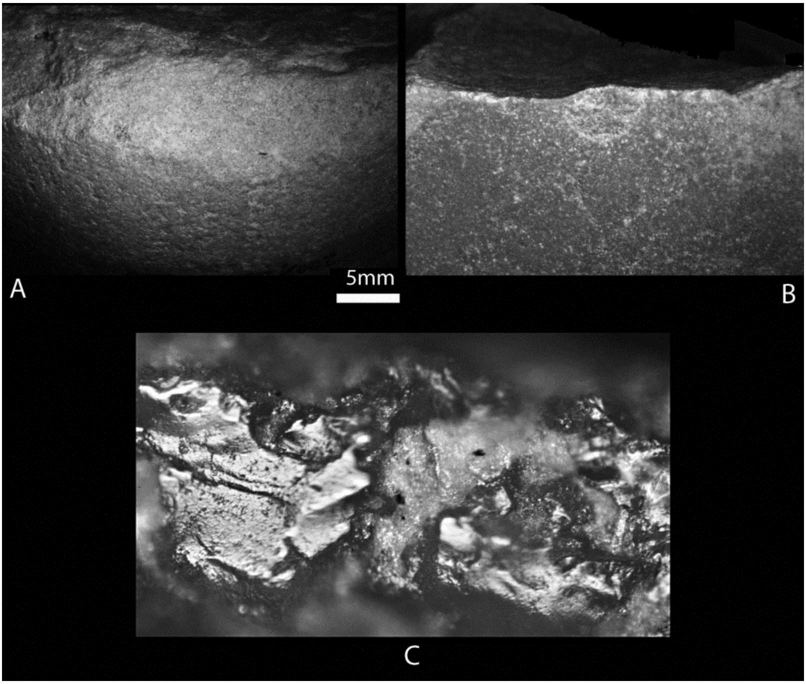

Figure 6: Macro and micro wears detected on a pebble tool, with double active zone. Micro-polish produced by a scraping activity (macro photo top right).

6. Discussion/conclusion

The functional analysis of the lithic remains from San Quirce offers unusual results, contributing new data to the understanding of the technological behaviour of the prehistoric societies of this chronological period, encouraging researchers to apply the same methodology to other industries. However, it must be remembered that the conservation and post-excavation damage of material often affects this type of assemblage. San Quirce lithic materials are thus a sort of exception in the sense as they show a good state of preservation.

The inhabitants of San Quirce intensely exploited quartzite pebbles collected from the surrounding river terraces in order to manufacture a broad series of tools to process different types of natural resources in a variety of production processes. They mainly used untouched flake blanks, obtained through percussion of quartzite pebbles. Both sharp flakes and massive tools were used.

Edges resharpened by retouch have been identified previously at other Middle Palaeolithic sites, but always through the observations of the retouch sequences on the artefact (Bourguignon 2001; Navazo and Díez 2008; Ríos 2008; Lazuén in this volume). In this case detection is based on the analysis of micro-flakes (or waste materials) from the retouch process used to sharpen the edges. It is curious to note the preference for resharpening dulled edges instead of using the edge of a fresh tool, in a site that has abundant and good quality raw materials. However, retouching activities to shape and/or maintain tools was uncommon at San Quirce. Perhaps the effectiveness of these tools led them to this habit.

Acknowledgements

This paper is part of the project BU028A09 entitled The Pleistocene in the Duero Basin I: Geomorphology, geochronology and technology of major prehistoric evidence in the Pisuerga River valley - 2009-2011. Education Department, Junta de Castilla y León. Marcos Terradillos Bernal has been a scholarship holder of “Cátedra Atapuerca”. The authors acknowledge the comments made by the anonymous referee, which have improved our original text.

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CHAPTER FIFTEEN

FLINT WORKSHOP OR HABITAT? TECHNOLOGICAL AND FUNCTIONAL APPROACHES TOWARDS THE INTERPRETATION OF SITE FUNCTION IN BERGERAC REGION EARLY AURIGNACIAN

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Abstract

The function of Early Aurignacian open-air sites from Bergerac region is discussed here. Previous interpretations emphasized the flint workshop function but recent excavations have challenged this view. Technological, spatial and use-wear analyses show that the Aurignacian occupation of the region was far more complex than previously thought, including flint workshops, habitats and activity areas. This settlement model is particular to the regional Aurignacian but has some similarities with the Chatelperronian occupation model.

Keywords: Aurignacian, Lithic Technology, Use Wear, Flint Workshop, Open Air Site

1. Introduction

The changes in land use are an important issue regarding the Middle to Upper Palaeolithic transition and the replacement of Neanderthals. Although Neanderthal spatial use has been analyzed intensely in the last 20 years, we have scarce information on the land use strategies developed by Modern Humans during the Aurignacian.

The Bergerac region is situated in the middle banks of the Dordogne River, in an area without karstic formations where Palaeolithic habitat has always been found in open-air sites. One of the most striking features of this area is the richness of excellent quality of flint (Fernandes et al. 2012). Archaeological work initiated in the XIX century but systematic excavations started in the second half of the XX century (Bordes 1970; Boëda 1996; Chadelle 2000; Guichard 1976; Ortega et al. 1999; Tixier 1991). In 2004 a rescue archaeology made by the INRAP discovered and excavated in extension more than 16 sites with chronologies ranging from Lower Palaeolithic to Magdalenian.

This region constitutes an important referent for analyzing land use changes between Middle and Upper Palaeolithic for many reasons: it has many recently excavated late Middle Palaeolithic, Chatelperronian and Aurignacian sites; many of these occupations represent more or less repeated occupation events with good spatial information; and finally because technological and use-wear information, albeit preliminary, is available for many of these sites.

The objective of this paper is to present the technological, functional and spatial information for several Early Aurignacian sites from Bergerac region (Vieux Coutets-VC-, Barbas III-BBIII, Garris II-GII, La Graulet VI-GRVI- and Cantalouette II-CII), discuss site function, the role of these occupations from a supra-regional point of view, and present some of the differences and similitudes with previous (Mousterian and Chatelperronian) settlement systems.

2. Aurignacian open-air settlement in Bergerac region

The traditional interpretation of open-air settlement in Bergerac region viewed these occupations as flint-workshops to exploit flint outcrops for exportation to habitat sites in the near (karstic) valleys (Demars 1994). This interpretation was based on the richness of the flint outcrop, on the abundance of flint-knapping remains, on the few quantities of retouched tools, on the apparent absence of structured habitat and finally on the regular

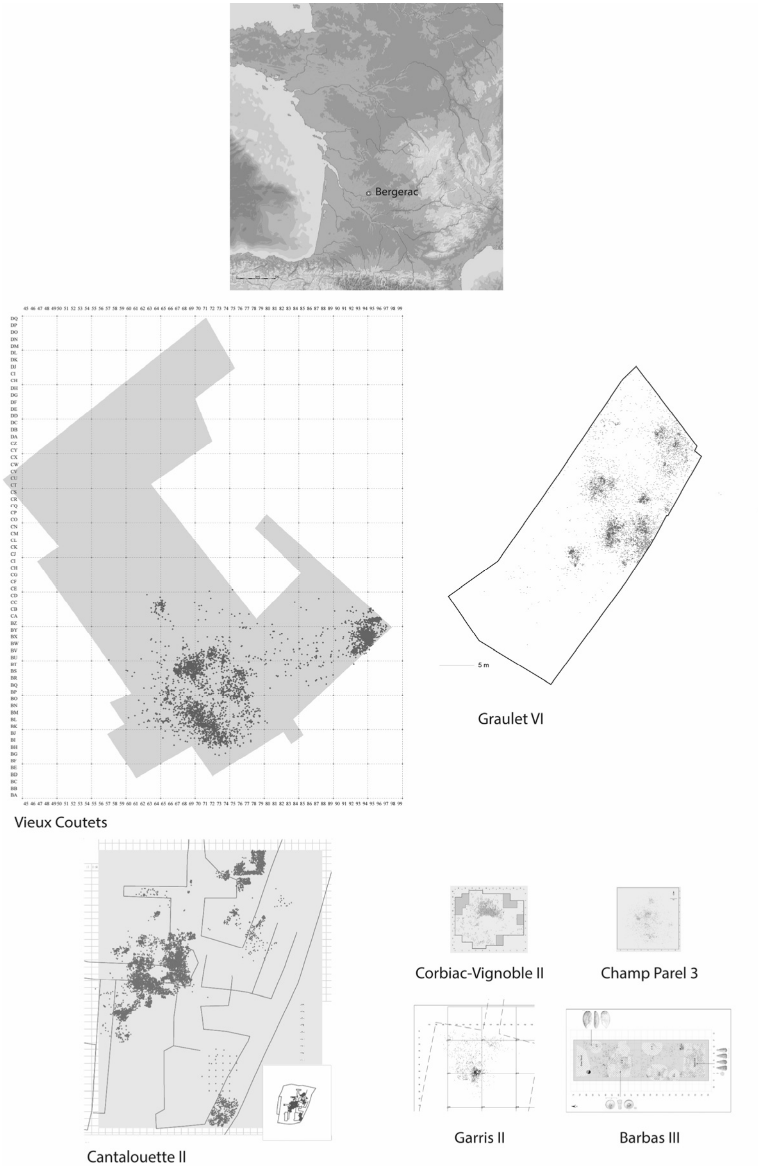

Fig 1. Map of localization, plan lithic scatters of different Aurignacian sites of Bergerac region. Cham Parel 3 adapted from Chadelle 2000 and Corbiac-Vignoble II from Bordes 2002

presence of Bergerac flint in almost all Upper Palaeolithic cave sites found eastwards. Although this interpretation has been partially challenged by new excavations, e.g. Barbas (Teyssandier 2000; Ortega et al. 2006), there are two sites (Corbiac-Vignoble and Champ-Parel) that are still interpreted as mere flint workshops (Bordes 2002; Chadelle 2000). This interpretation is, in our opinion, biased by the limited extension of the excavation surface, which rarely reaches 80 m^2, by the absence of organic remains and by the poor preservation of structures (e.g. fireplaces). We must add to these problems the lack of use-wear analyses. In any case it seems, from a technological point of view, that some of these concentrations are indeed strongly related with knapping activities.

The extensive excavations made by the INRAP in four new Aurignacian sites (VC, CII, GII, GRVI) plus BBIII excavation (Ortega et al 2006), and the subsequent analysis of lithic assemblages, including use-wear analyses, offer new elements for the interpretation of Aurignacian settlement systematics.

2.1. Barbas III

This site was excavated in the 1960s by Guichard and in the 1990s by Boëda and Ortega (Boëda et al. 1996; Ortega et al. 1999). It has a long stratigraphy with Mousterian, Chatelperronian and Early Aurignacian levels. 120 m^2 were excavated and 2500 artefacts (>2cm) were recovered. A clear spatial structuration, with at least 9 defined concentrations, has been described (Ortega et al. 2006). Lithic technology is characterized by different blade productions (big, medium and bladelet), each one having its particular raw material selection criteria and technical procedures.

A total of 53 pieces, including retouched and unretouched tools, were analyzed (5 complete big flakes, 6 fragments, 8 bladelets, 5 burins, 24 end scrapers, 3 carinated end scrapers and 2 retouched blades). Use-wear results showed that unretouched big blades were used for different activities (cutting and scraping), probably in the first stages of wood and bone/antler work. These activities were quite intense and occasionally included edge re-sharpening. After use, big blades were stored maybe for future tasks. Fragments of these big blades were used in more varied activities such as hide scraping, skinning, butchery, bone/antler scraping and cutting or ochre powdering. Burins were used to scrape, cut and engrave osseous materials. End scrapers show two types of utilization, those with convex edges were used to scrape hide; those made on cortical blades with straighter fronts were used to scrape bone and antler. Any one of the carinated end scrapers has use traces. Finally, retouched blades showed different uses as bone cutting and scraping.

In Barbas III, although knapping activities were important, the evidence of a structured space of work, the development of different activities (e.g. bone work, hide processing), tool storage, or symbolic behaviour pointed to a more complex site-function with mixed activities and uses (Ortega et al. 2006).

2.2. Cantaloutte II

This site was excavated in 2003-2004 by L. Bourguignon (Bourguignon et al. 2004, 2008). It is located in a doline between a Middle Palaeolithic and a Solutrean occupation. It was excavated over 1800 m^2 and 9500 artefacts (>2 cm) were recovered. Spatial distribution shows some distinct concentrations, basically knapping positions and dump-off areas. Technological analysis shows that the main activity is the production of blades and flakes for exportation. Retouched tools are very rare but some retouched blades and end scrapers were recovered. There is also some evidence of symbolic behaviour (Ortega et al. in prep.). Only 19 pieces were analyzed and 13 of them show slightly developed traces probably related with clay elimination from the surface of flint blocs and organic hammer preparation. This evidence suggests that the lithic assemblage from Cantalouette II was formed by successive episodes of flint knapping.

2.3. Vieux Coutets

The site was excavated in 2004 by I. Ortega (Bourguignon et al. 2004; Griggoleto et al. 2008) and it is located less than 700 m from CII and 1500 m from BBIII sites. Three main occupation episodes have been identified, including Mousterian, Chatelperronian and Aurignacian. It was excavated in an area of 1500 m^2 and 9710 artefacts (>2 cm) were recovered. Spatial distribution of lithic remains shows a big concentration in the South, divided into three locus with clear separations between them, plus one small knapping post situated NW and another locus situated NE. Technological analysis shows the importance of blade, bladelet (prismatic and carinated cores) and flake productions. Retouched tools are relatively abundant (4.55% of total) with many end scrapers, retouched blades, burins, etc.

In total 49 pieces have been analyzed (13 carinated end scrapers, 3 end scrapers, 3 Aurignacian blades, 3 truncated pieces, 2 burins, 2 side scrapers, 2 retouched bladelets, 1 denticulate, 1 backed blade, 1 cleaver like piece, 16 non-retouched blades and 3 non-retouched bladelets). 28

pieces showed some kind of use in 34 active zones. The majority of the work involves the scraping of different materials, bone/antler, wood, hide and minerals (79.4%). Other activities such as cutting, butchery or projectile use are also present but in a lesser extent.

Three of the 13 carinated end scrapers show use-wear related to wood scraping (Fig. 2, b). These pieces have regular fronts and have been exploited as cores after use and probably before resulting in a sort of combined core-tool. This information contrasts with the data obtained in other sites such as Barbas III (Ortega et al. 2006), Brassempouy (Rios-Garaizar 2004) or Mitoc Malul Galben (Jardón 1993).

On the other hand, the simple end scrapers and one of the Aurignacian blades were used in hide processing while truncated pieces are related to bone/antler working. This association between tools and activities is similar to that identified in Barbas III.

The scarcity of butchery traces, the variability of activities, involving "artisanal" activities such as hide processing or bone/antler/wood tool making, the technological features and the structured spatial distribution suggest a domestic status for Vieux Coutets Aurignacian occupation.

2.4. Garris II

The site was excavated in 2004 by I. Ortega and L. Bourguignon (Bourguignon et al. 2004). Mousterian and Aurignacian occupations have been identified. A total of 355 m^2 was excavated and 2345 artefacts (>2 cm) were recovered. Spatial distribution shows a clear pattern with a central area where the majority of cores and by-products are located interpreted as a dump off of knapping debris, and to concentrations situated NW and NE with scattered materials in between.

A total of 41 pieces, of which 22 are retouched, have been analyzed. Only 27 pieces presented use-wear making a total of 39 active zones. Identified activities are mainly related with hide working (dry hide traces and hard mineral-ochre-scraping–Figure 2, a). Other materials such as bone, antler, wood and soft mineral have also been worked but to a lesser extent. We have also identified four pieces with impacts related to their use as weapon tips and two pieces with butchery traces. 25% of the active zones remain unidentified due to poor conservation of traces or low intensity of developed activities. Few of these activities have been identified in the dump off area; the NW area has many pieces related with hide working and the NE area has the projectiles, and pieces used in butchery and to process skin.

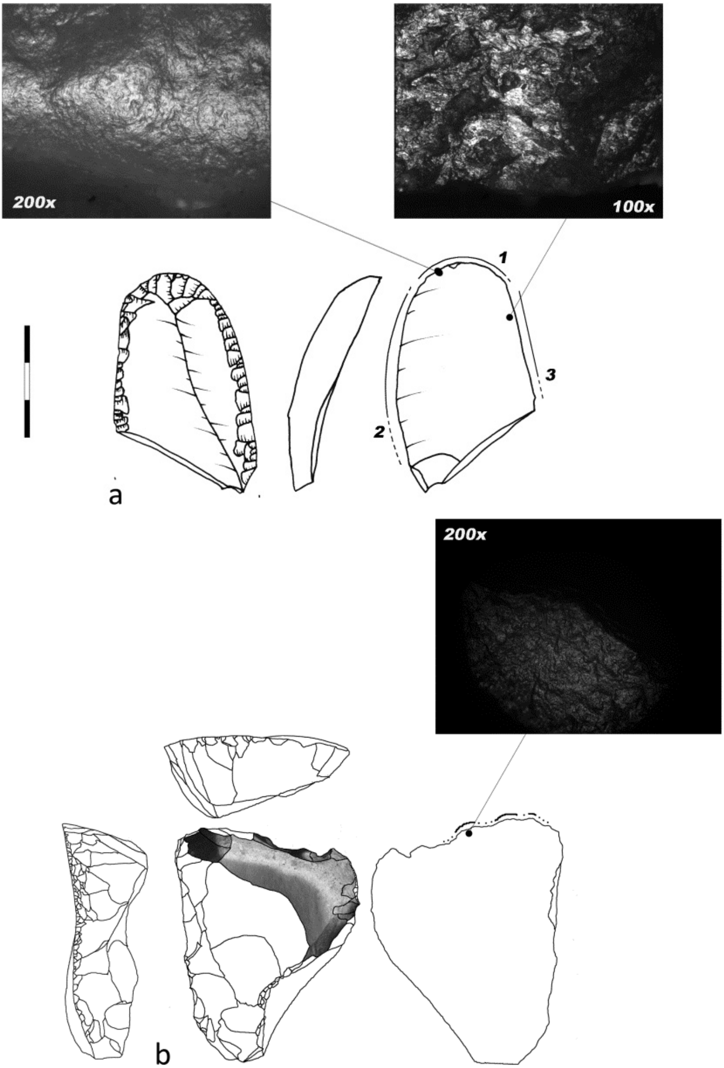

Fig 2. A; Used end-scraper from Garrris II: 1: Dry hide scraping; 2: Dry Hide cutting; 3: Ochre scraping. B: Carinated end scraper from Vieux Coutets, used for wood scraping.

This distribution and the nature of the identified clusters suggest that knapping activity is the most intense activity developed at the site, creating an enormous amount of refuse, which was accumulated in a single concentration. In addition to the knapping activities there is evidence of carcass processing in the NE concentration and ochre aided hide processing in the NW one. This defines a flint workshop with complementary activities.

2.5. Graulet VI

This site was excavated on the left bank of the Dordogne River over around 2500 m^2. It shows spatial structuration with at least one fireplace dated by TL to 39.500±2550 and 36.000±1900 BP (Viellevigne et al. 2008). Technological and typological composition suggests that it was used as a temporary camp. At the moment no use-wear has been made on this collection.

3. Discussion

Extensive rescue excavation developed in Bergerac region has revealed an intense occupation of the region during the Aurignacian. Bearing in mind that the probable chronological span of this period is around 7000 years, and compared with other periods as Gravettian, Solutrean or Magdalenian, it shows a high density of occupations. The different results obtained (lithic technology, use-wear and spatial distribution) evidence an important variability of occupations revealing complex settlement (if these sites are almost synchronic) or important differences of settlement strategies during the Aurignacian. There are sites that can be described as flint workshops (e.g. CII) but others, such as Corbiac-Vignoble 2 and Champ Parel 3, excavated in small extension, resemble some discrete aggregations of material present in other sites as GII (Zone S) or VC (Zone NE), and can be part of more complex and intense occupations.

Use-wear analyses have revealed a high variety of activities which enrich and complicate the view of the Bergerac region as a simple flint extraction and processing area. We have strong evidence of hide processing, wood/bone/antler tool manufacture, weapon repair, butchery, etc. in three of the sites (BIII, VC and GII). Spatial information, albeit incomplete, shows the structuration of activity areas. There is also other evidence of complex behaviour as the big blade storage of Barbas III, or the presence of engraved flint fragments or pendants in two sites (BIII and CII). From a supra-regional perspective the Bergerac region played different roles related not only with raw material exploitation and transport but also with the exploitation of other resources (e.g. game), and probably the open-air habitat was more intense in this region than previously thought.

The Mousterian occupation of the region is clearly different. In sites such as CII, for example, there is evidence of repeated occupation of the same space during a considerable time span (Bourguingnon et al. 2008) while other sites such as Combe Brune 1 can be interpreted as small temporal habitats, but there are neither intensive workshops nor complex habitats as at VC or BIII. These differences have been also seen in raw material transport and in the link between Bergerac and neighbouring regions (Bourguignon et al. 2006).

On the other hand, the Chatelperronian record is more similar to the Aurignacian, and sites such as Canaule II have been interpreted as flint workshops for Chatelperron point production (Bachellerie et al. 2007), but others, as VC, also present other activities and some spatial structuration (Griggoleto et al. 2008).

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CHAPTER SIXTEEN

THE CAMP OF UPPER PALAEOLITHIC HUNTERS IN TARGOWISKO 10 (S POLAND)

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Abstract

This paper presents the results of use-wear analysis of a flint inventory from the Late Glacial open-air site Targowisko 10, located ca. 30 km east of Cracow, S Poland. The site represents a temporary camp of Upper Palaeolithic hunters from the 15th millennium BP, whose activities were related to hunting horse and reindeer, as well as obtaining local flint from the nearby outcrop. A few concentrations of stone artefacts associated with the reduction of flint nodules and 5 hearths were discovered at the site within a clear spatial structure. The Palaeolithic assemblage consists of 4708 stone artefacts, mostly made of flint, and the remains of steppe-tundra animals: horse and reindeer. Based on spatial analysis of flint tools of particular function, unused artefacts and refitted objects we determined activities performed at the site and spots, where tools and wastes had been discarded. Clear spatial distribution of the structures and intensively worn tools enabled us to draw conclusions about the function of the site, to reconstruct its spatial organisation and the sequence of performed tasks.

Keywords: Upper Palaeolithic, use-wear analysis, intra site analysis

1. Targowisko 10, S Poland

The Late Glacial open-air site Targowisko 10 is located in S Poland, ca. 30 km east of Kraków, on the left bank of the Raba river, tributary of Vistula (Wilczyński 2009). According to the dating of the charcoal samples, this material is associated with a settlement of Upper Palaeolithic hunters from the 15th millennium BP. Archaeological material was found within an area of over 400 square metres. It forms a visible living horizon, within which there are concentrations of stone artefacts and 5 fireplaces. All the artefacts were deposited at approximately the same depth. The Palaeolithic assemblage consists of more than 4700 artefacts mostly made of flint, including 38 cores, 593 flakes, 821 blades, 66 tools and chips, debris and other small pieces (Table 1). Most of the flint materials processed on the site are local. This especially applies to the Cretaceous erratic flint and brown chocolate flint. Apart from flint there is also one core and also some blades made of radiolarite, as well as 46 obsidian flakes and blades, imported from Slovakia. The animal remains are very badly preserved and only tooth enamel has survived. Teeth and teeth fragments of horse and reindeer were found mainly in the southern part of the site. However, in spite of the state of the bone material, the site in Targowisko is exceptional among other sites located south-east of Vistula, where the entire bone material had been lost due to the specific geological conditions.

2. Stone assemblage–problems with taxonomic classification

At this stage of the research, it is impossible to identify the cultural affiliation of the described material. The tool assemblage, due to the presence of short, massive backed blades, is typical of the Epigravettian tradition and similar to the assemblages from Slovakian sites, e.g. Kašov I (Novák 2006). The numerous obsidian products discovered at this site seem to confirm this attribution. We could also observe some similarities with the Mezirichian assemblages from the Middle Dnieper basin (Nuzhnyi 2006). But the assemblage under study differs considerably in terms of raw materials, stone processing techniques and tool inventory from other Epigravettian sites known from southern Poland (Wilczyński 2006, 2007). The technological process and core shapes are more similar to the Magdalenian culture, where we observe an advanced development of double-platform core processing. Furthermore, the dating of the site to 15th millennium BP does not provide any further clues. This is because the time of occupation of this site corresponds to the first stage of the colonization of the Polish lands by the groups of Magdalenian people, and is almost contemporary with the occupation of the Maszycka Cave (Kozłowski et al. 1993, 2012).

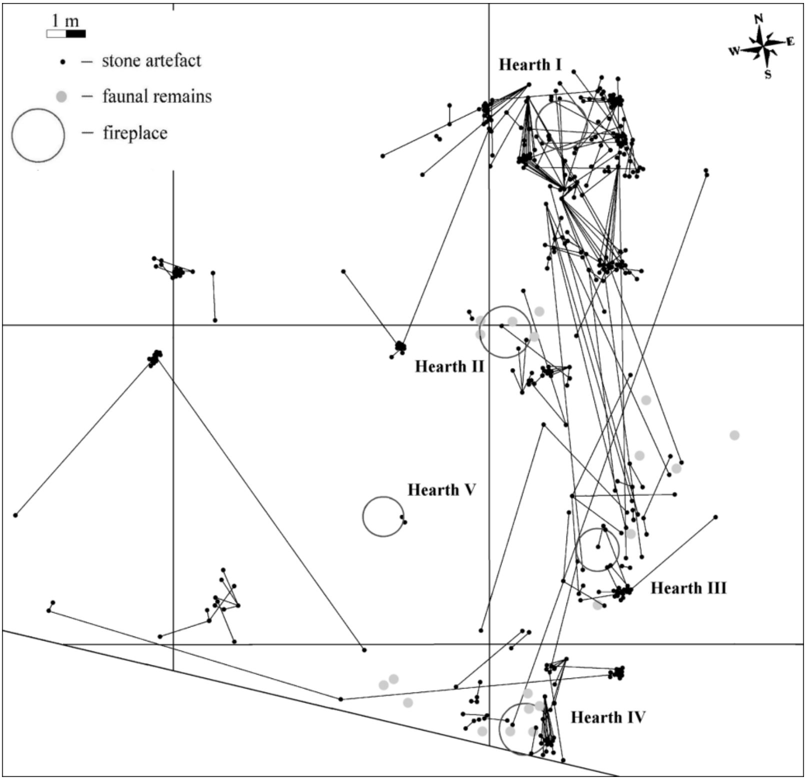

Figure 1. Targowisko 10, S Poland. Spatial distribution of finds, hearths and refitting (after Wilczyński 2009, supplemented)

3. Materials processed at the site

According to the analysis based on the location of fireplaces and the spatial distribution of artefacts, there are clearly visible zones of activity, but related mostly to the processing of individual lumps of stone and probably carcass processing. The study proved the site had been a short-term base camp with a clear spatial structure. We decided to do microwear analysis to find out more about activities carried out at the site including such activities which are not reflected in obtained evidence.

Based on morpho-metric and technological criteria we selected 193 specimens, tools and artefacts with morphological and morphometric characteristics of the probable tools, including blades without retouching and specimens with macroscopically visible use scars. In the group of blades, elements of refitted blocks are included as well to get information about blank selection and raw material economy. Among almost 200 examined artefacts, 67 specimens have clearly visible, mostly intensive traces of use (Table 16-1).

Type	∑	Analysed	Used	Hide	Soft animal tissue	Hard material	Plant	Other/ unident.
Scrapers	27	24	19	16	-	2	-	1
Burins	11	11	9	-	-	2	2	5
Trancated and backed blades	13	13	4	2	1	-	1	-
Retouched blades	8	2	-	-	-	-	-	-
Retouched flakes	4	4	2	-	-	-	-	2
Notched tools	1	-	-	-	-	-	-	-
Unidentified tools	2	-	-	-	-	-	-	-
∑ (tools)	66	61	34	18	1	4	3	8
Cores	38	2	-	-	-	-	-	-
Blades	821	121 (mostly refitted pieces)	29	11	4	2	4	8
Flakes	593	9	2	-	-	-	-	2
Wastes	3126	5 (burin spalls)	2	-	-	-	-	2
∑ (others)	4578	137	33	11	4	2	4	12
∑	4708	198	67	29	5	6	7	20

Tab. 1. Inventory and used artefacts from Targowisko 10, S Poland

Almost 50% of discarded artefacts with traces of work were hide processing tools, used to scrape fresh hide. All scrapers are heavily worn, suggesting relatively long use or rather very intensive work (Fig. 2, a-d). No tools are used to perforate hide and leather and it is not associated

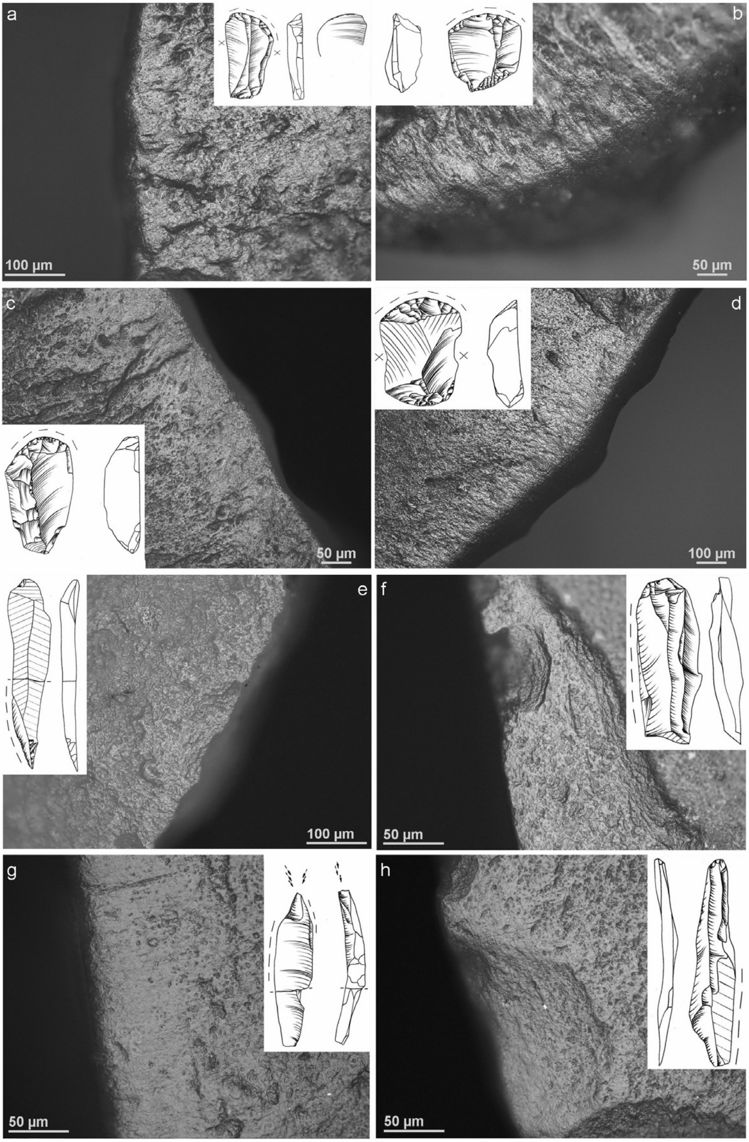

Figure 2. Microwear traces on: a-d – scrapers used for hide processing, e-f – blades used for processing soft animal tissue, g-h – burin and blade used for plant processing (Photography B. Kufel-Diakowska)

with poor identification of this activity on the basis of microtraces. There are also no morphological perforators or becks. We should accept that they took up only the initial preparation of hide at the camp or they used unpreserved bone tools for advanced hide treatment.

Less numerous are knives used for processing soft animal tissue (butchering and slicing meat), although it is known that such tools are difficult to detect (Fig. 2, e-f). Use-wear traces specific to processing meat and meat/bone were distinguished on 4 blades and 1 truncated blade.

Only 6 specimens bear traces that may be associated with hard materials, like bone and antler. These tools were used for various tasks, e.g. scraping or engraving, and one burin was used for chopping hard material. A low number of tools for hard animal tissue suggests that no production of weapon or hafts was carried out at the site. Some specimens may have been used to repair various items, others to obtain food (chopping bones for marrow).

Only a small number of morphologically different artefacts which bear traces of scraping, cutting and whittling (Fig. 2, g-h) is related with plant and wood processing. Some of them may have played a role as universal personal knives for processing plant or soft animal material, as they reveal mixed traces, which are difficult to interpret.

4. Spatial distribution of activities

The second step in this study was the spatial analysis of used and unused flint tools. We examined where tools and waste products from flint core reduction were abandoned, then distinguished activity zones within the site and finally tried to figure out the site function, spatial organization and sequence of performed tasks.

From the technological point of view, we dealt with a single episode of habitation and refitted objects unambiguously showing that the whole technological process had been carried out at the site (Wilczyński 2009). Artefacts with traces of use were discarded within the area of biggest flint scatters. But from the functional point of view, worn tools represent only a few, selected activities (the skinning and processing of fresh hide, as well as butchering), characteristic for a highly specialised group of hunters.

What is very interesting, both from microwear and technological studies, is that we can draw similar conclusions on the sequence of particular tasks performed at the site. We distinguished 3 activity zones, which reflect the chronological sequence of the site use (Fig. 3). Zone 1 was the place where hunted game had been brought. In the vicinity of fireplace IV, there are tools for processing soft animal tissue and (blade) tools, which had contact with bone. It should be noted that this place does not correspond exactly with the distribution of animal remains.

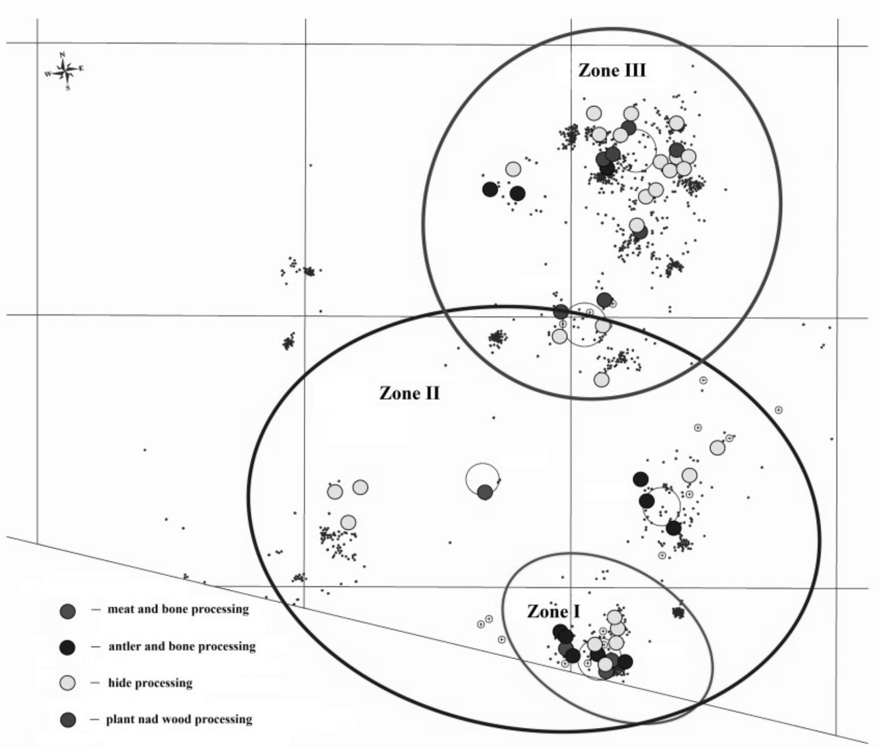

Figure 3. Targowisko 10, S Poland. Activity zones

After the initial treatment of animal carcasses, including skinning and butchering, skins and bones were subjected to further processing. These activities were done partly in the same place and in zone 2–around fireplaces II, III and V. Zone 2 occupied a larger area, because it was associated with hide processing–the activity which was, apart from flint raw material acquisition, one of the main goals of the expedition.

In zone 3, near fireplace I, tools worn as a result of processing animals were repaired. Activities included replacing used hide scrapers in hafts and probably the repairing of damaged hunting weapons. Only in this area did we find a lot of highly worn scrapers and also relatively numerous tools with traces of wood/plant working (blades and burins). Here, a few backed blades were also found, but without any impact traces. Finally, the distribution of finds in this area, within zone 1 is the most clearly visible and only partially disturbed. Therefore, we believe that zone 3 was the last place used by the group of hunters, where they were sitting and carrying out their activities.

5. Conclusions

There is no single central fireplace around which various activities were performed within different distances from the fire, as in the hypothetical model of a Palaeolithic hunters' camp (Leesch et al. 2010) and at the sites, where activities and long-term occupation are confirmed by microwear analysis (Moss 1983, 133-144; Symens 1986; Sano 2012). Instead, we have a situation that may be interpreted in two ways. In the first scenario, there are various activities shifting from one zone to another. The act of moving was accompanied at the same time by the act of firing a new fireplace. This option is possible, if we assume that the camp was inhabited only by a very small group of hunters.

In the second scenario, the spatial organization of the site was a result of the separation, from the very beginning, of a few activity zones of different function, where several groups of people undertook different activities, like butchering, skinning and repairing stone tools. In this option, the group of hunters was much larger than in the first variant. However, in our opinion, the clear artefact distribution around the fireplace I seems to confirm that this was the last place used by the hunters and therefore the group was not large, but numbered only a few members.

The first scenario is also more probable if we look at the explicit purpose of the expedition. The lack of certain tools such as perforators and the presence of a large number of tools for fresh hide processing suggests that the main aim of the trip, apart from acquisition of good quality blanks, was to obtain hides. This assumption is also confirmed by the small number of tools for working bone, antler and wood. These activities were not associated with the production of organic items, but those, which had been found, were only expedient tools. Moreover, hide processing tools, which are not part of refitted blocks, are heavily worn and bear hafting traces. These data prove that the hunters prepared their expedition carefully. Some tools, especially hide scrapers have been brought to the camp in the form of hafted tools.

As already mentioned, it is difficult to determine the taxonomic affiliation of the assemblage. Magdalenian character may be confirmed by the preparation of a specialized toolkit for particular tasks, as well as a fairly high rate of hafted tools. From this point of view the group seems to be a logistically well organized hunting group, typical for the Magdalenian tradition. Secondly, there are not many discarded elements of hunting weapons. A few backed blades found at the site bear no impact traces, but traces of unskilled production (e.g. one backed blade preserved in three parts broke as the result of using too much force while retouching; see also Šajnerová-Dušková, 2007, 53). A hunting weapon could have been made from bone and not survived. In this context, stone artefacts left at the site do not represent the full range of activities. Unfortunately, ambiguities in typology, technology and raw material economy still exist and do not allow the resolution of this problem.

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CHAPTER SEVENTEEN

THE CONTRIBUTION OF TRACEOLOGY AND LITHIC TECHNOLOGY IN THE STUDY OF THE SOCIO-ECONOMIC CAPSIAN OF SHM-1 (HERGLA, TUNISIA)

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Abstract

This article focuses on the traceological analysis of the lithic industry from the first five occupational levels at the Capsian site of SHM-1 (Hergla, Tunisia). The study is based on an approach that includes technical, economic and spatial data. The lithic tool is entirely studied, from the supply of raw materials to use and abandonment. Lithic techno-complexes of SHM-1 are characterized by the production of flakes on local raw materials using simple methods of knapping, and by the production of bladelets on imported good-quality siliceous and limestone material, with an elaborate knapping model. Traceological observation has revealed that lithic tools were used for the processing of a wide range of materials, such as bone, wood, shells and hide.

Keywords: North Africa, Capsian, Lithic industry, Technology,

Functional analysis.

1. Introduction

The evidence of the Epipalaeolithic and Neolithic periods in Eastern Maghreb is quite limited, due to the discontinuity of field research from the late 1970s. The lack of recent investigations has prevented the possibility of having a chrono-stratigraphic sequence and reliable information on palaeoenvironments related to the occupations of Early and Middle Holocene communities. The Capsian culture was recognized for the first time in 1909 thanks to the excavation at the site of El Mekta, near Gafsa, in southern Tunisia (De Morgan 1909). It has been successively defined, on the basis of lithic industries, as an Epipalaeolithic North African culture, occupying the inland eastern Maghreb between ca. 10000 and 7000 millennium cal BP (cf. Rahmani 2004; Lubell 2005). Technological and typological studies have allowed the highlighting of the existence of two different facies, Typical Capsian and Upper Capsian. Nevertheless, the Capsian chronology and its evolution are still poorly defined; likewise, the socio-economic system and the organization of habitat, as well as the management of space and environment, remain to be clarified. Finally, the role of Epipalaeolithic groups for the development of the local Neolithic productive economy is still unclear. In this context, the excavation at SHM-1 (Hergla), a coastal eastern Tunisian site discovered in 1954 by E. G. Gobert, has produced new data and new insights for the Capsian culture during the 9th and 8th millennium cal BP. The number of new elements unearthed at SHM-1 contributes to enhance the debate on the final phases of the Capsian and on the Neolithic transition in the Central Mediterranean and Eastern Maghreb. The extensive excavation of the open-air site of SHM-1 has detected a succession of living floors associated with dwelling structures. Spatial and technological analysis of recovered artefacts and ecofacts (pottery, lithic and bone industry, faunal and malacological remains, etc.) provided valuable information on the economic strategies and on the technical system developed by Capsian communities.

2. SHM-1

SHM-1 is located on the western border of the southern basin of the Halk el Menjel sebkha-lagoon, on top of an aeolian dune of approximately 4 metres above the bottom of the current sebkha (Fig. 1). The site presents a complex stratigraphy typical of North African open-air Capsian and Neolithic occupations (locally named *rammadiyat* or *escargotières*). First investigated in the 1970s by M. Harbi-Riahi and J. Zoughlami (Riahi and Zoughlami 1971; Zoughlami 2013), SHM-1 was the object of a large-scale excavation, based on a multidisciplinary approach, launched in 2002 by an Italian-Tunisian team. The exploration of SHM-1 was conducted adopting a specific field and data recording protocol based on a Geographical Information System (GIS). New extensive trenches and stratigraphic excavations have allowed the detection of seven main occupational levels, each one composed of structural remains (Mulazzani et al. 2013). The whole stratigraphic sequence was dated through a series of 26 radiocarbon determinations obtained on Cerastoderma glaucum shells, ostrich eggshells and faunal bioapatite, assigning the occupations of the site from the beginning of the 9th to the first half of the 8th millennium cal BP (Saliège et al. 2013)

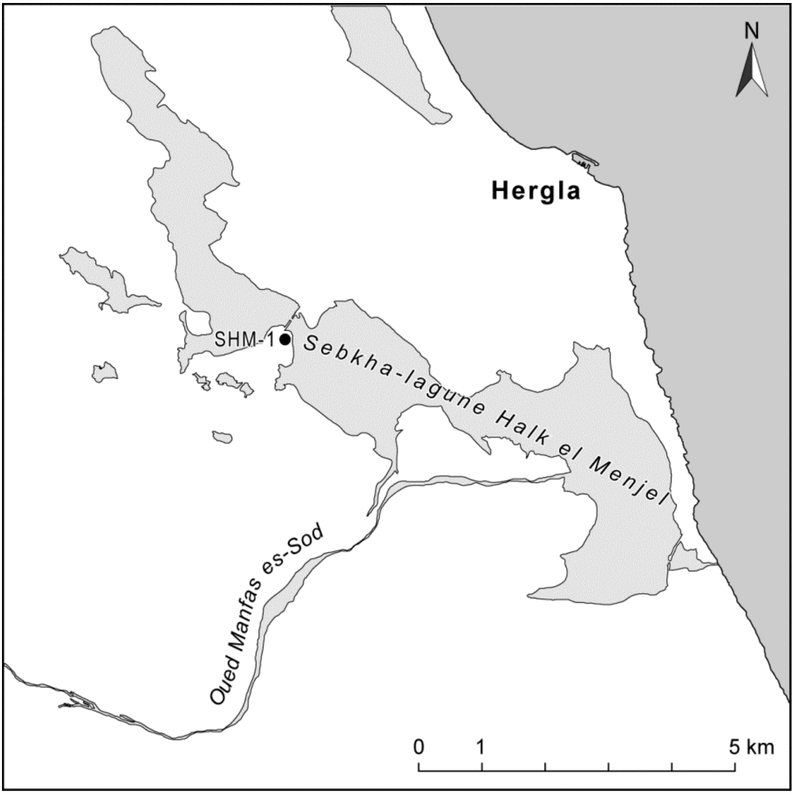


Fig. 1. Location of the site of SHM-1

Faunal analyses revealed a subsistence economy based on hunting, gathering and fishing (Aouadi et al. 2013; Mannino and Mazzanti 2013; Vorenger 2013). No remains belonging to domestic faunas have been recognized within the assemblage. Bovidae are the main mammal remains represented, in addition to the remains of species attesting to an open environment, such as giraffe or rhinoceros. Vast amounts of *Cerastoderma glaucum* shells and ichthyological remains indicate the exploitation of the lagoon and coastal systems.

The analysis of the different classes of artefacts from SHM-1 (bone industry, ceramics, lithic industry, etc.) has been conducted relying on techno-functional protocol in order to detect the *chaînes opératoires* of material culture production as well as their purposes. Following a brief presentation of the main technological characteristics of the lithic débitage, we focus in this paper on the functional analysis carried out on chipped stone-tools from the first five occupational layers (1 to 5) detected on site.

3. Chipped stone implements at SHM-1: raw material procurement, technology and function

3.1. Lithic raw materials

At SHM-1, different raw materials of various origins were acquired and knapped to manufacture stone implements. The most common is limestone, of several varieties, which makes up 57% of the lithic assemblage being studied here, followed by flint (37%) and other rocks, such as sandstone (4%) or petrified wood and obsidian, representing the remaining 2%. The heterogeneous coarse-grained limestone, beige to light brown, is of local origin (Table 1). This sedimentary rock is attested around the site in the nodule form of medium to large size. The fine-grained limestone, the flint and the petrified wood were acquired, in a secondary position, about 50-70 km west of the site, along the fluvial deposits of the Oued Marguellil and Oued Zeroud. Senonian flint, originating from Gafsa, ca. 200 km south of Hergla, constitutes a very good-quality raw material, probably imported to the site through an indirect procurement as preformed blanks (Belhouchet et al. 2013). Obsidian is attested by only a few specimens imported to the site from the fifth occupational level onwards, proving nevertheless a débitage in situ of this rare and exogenous material. PIXE and EDS-SEM analyses on all the obsidians recorded at SHM-1 confirmed its origin from the island of Pantelleria, about 70 km east of Cap Bon (Mulazzani et al. 2010).

Raw materials	Limestone	Flint	Sandstone	Petrified wood	Obsidian	Indeter	Total
Number	6752	4397	511	33	11	53	11757
%	(57,4%)	(37,4%)	(4,34%)	(0,3%)	(0,11%)	(0,45%)	

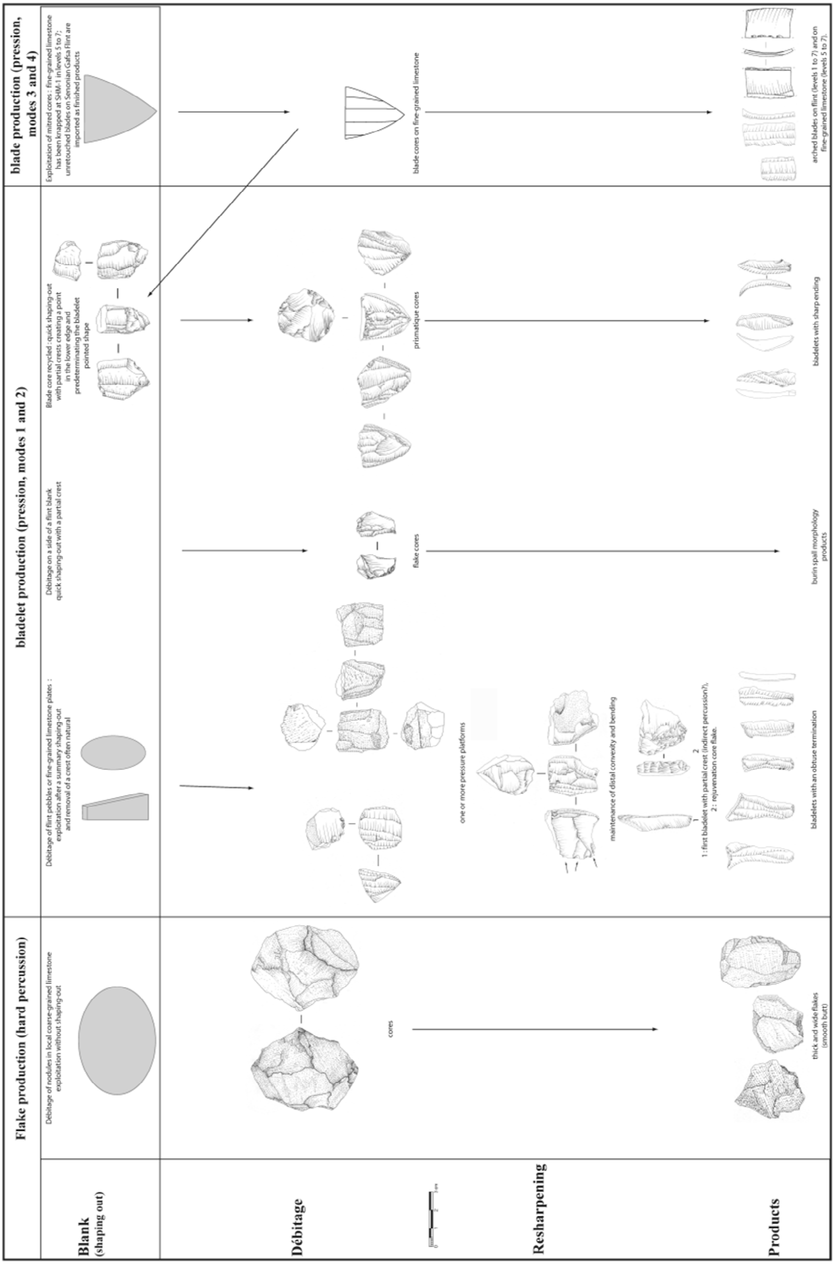
Tab 1. Distribution (numbers and %) of different types of raw materials exploited at all occupational levels (after: Belhouchet and al. 2013).

3.2. Technological systems used to produce implements

The study of the lithic techno-complex of SHM-1 has enabled the detection of several *chaînes opératoires*, as well as a true raw material economy, strictly related to their quality and availability (Fig. 2). Knapping was directed towards the production of bladelets and, marginally, of flakes. The former were obtained by pressure (modes 1 to 3, and to 4 since layer 5, according to to the classification of the different pressure modes of J. Pelegrin 2012) and, more rarely, by indirect percussion. Such bladelets, produced on flint and fine-grained limestone, consisted of regular pieces with standardized dimensions (20 mm of medium length). Shaping was standardized and determined by the necessity of minimizing the waste while maximizing the exploitation of the cores, given the very small dimensions of the cobble stones. The flakes were obtained through an expedient knapping procedure, by hard and possibly soft organic percussion on the local limestone. These pieces were shaped for the production of processing equipment, such as end-scrapers, side-scrapers or retouched flakes in different degrees, notches and denticulates. In contrast, bladelets were fashioned to obtain armatures, mainly backed bladelets and geometric microliths. One of the most noticeable characteristics of the lithic assemblage at SHM-1 is the abundance of notches and denticulates followed by backed bladelets and finally by geometric microliths.

Fig. 2. (next page) Reconstruction of the main *chaînes opératoires* exploited for the lithic débitage at SHM-1. (After: Belhouchet et al. 2013)

Reconstruction of the different chaînes opératoires of the lithic industry at SHM-1



3.3. What were the tools used for?

Macro and microscope analysis were carried out on 497 lithic tools from SHM-1 (Fig. 3 and Fig. 4). The assemblage is composed of the whole amount of retouched tools belonging to the first four levels and a sample (ca. 50%) of the tools belonging to level 5. Such an assemblage was intentionally not selected following specific criteria and encompasses the totality of tool types detected on site. The study has been conducted using a Wild Heerburgg binocular with 15X-75X magnification and a Nikon metallographic microscope allowing 100X-500X magnification. The combination of both kinds of magnification has enabled the observation of a series of modifications (rounding, striations, scarring and micropolish), allowing a determination of the nature of the materials worked using the different implements and the movements made during the processing (Keeley 1980; Plisson 1985, 1991; Vaughan 1985; Philibert 1991; Gassin 1996). Experimental results ought to be considered for an accurate interpretation of the use-wear analysis on archaeological artefacts. Therefore, the lithic sample from SHM-1 was systematically compared with experimental data obtained from distinct rocks, such as flint, limestone and sandstone. The results obtained show that 96 pieces (19.4%) exhibit use-wear marks, while 203 (40.8%) did not display any (macro or micro) use-wear; 198 pieces (39.8%) were not classified given the absence of diagnostic criteria to define if any kind of use was present. This group included pieces with light smoothing or mechanic effects. However, the results showed significant variations in the use of tools according to the different raw materials. Flint tools constitute the main category displaying use-wear traces (73%), while the percentages of limestone or sandstone pieces presenting use-wear marks are much lower (respectively 22% and 5%). The type of rock therefore constitutes a direct factor in choosing tools used during manufacture.

Functional analysis has shown that most tools were used for the processing of animal substances (hide and bone) or as projectiles, and fewer were used for butchering or for the processing of vegetables and mineral matter. On the other hand, for a not insignificant group of tools, the substance worked cannot be determined precisely, apart from its hardness.

The two basic actions are represented in the different occupational levels of SHM-1, but unevenly, due to the nature of the worked material. The scraping work affects 77% of active edges of several tools, which were used for the processing of animal substances. One sixth of the edges were worn by cutting actions and the majority of these by butchering. Only one tool was used to perforate dry wood matter.

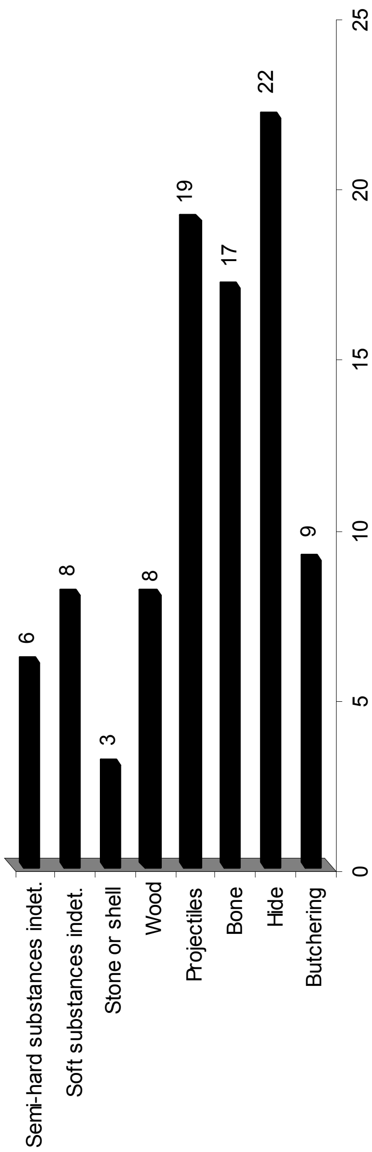


Figure 3. Results of use-wear analysis of the lithic tools (number of use area) of levels 1 to 4, and partially of level 5.

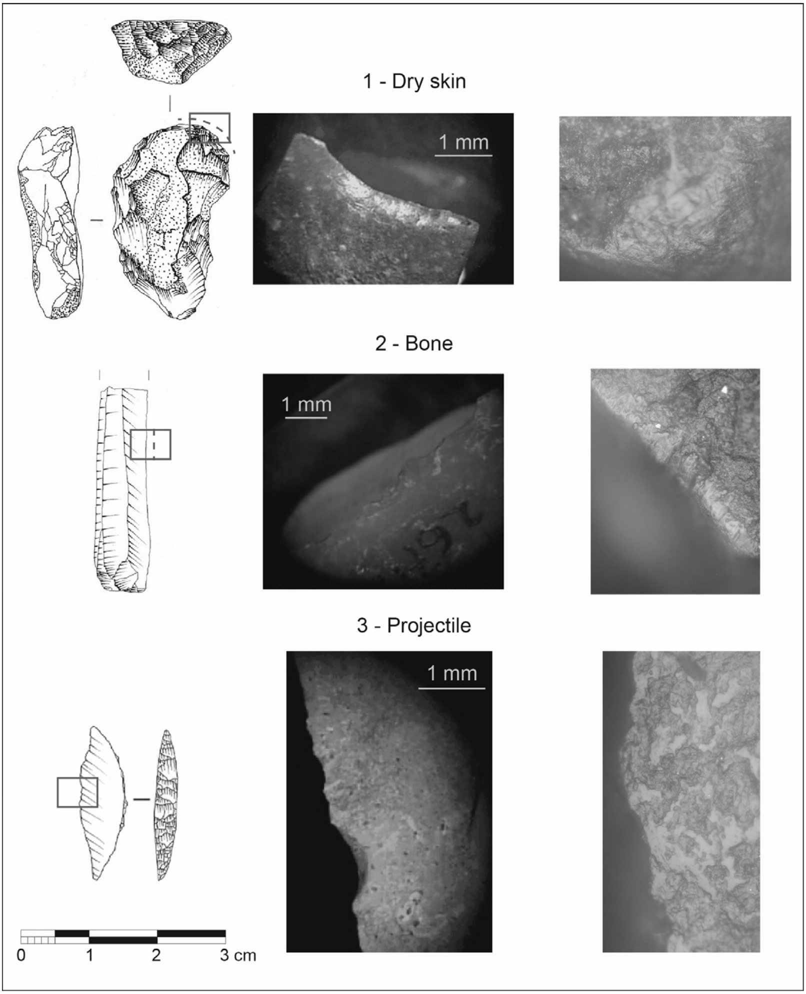


Figure 4. Tools from SHM-1: 1) end-scraper used to scrape dry hide: this activity generates edge punctures and a strong rounding with micropolished areas; 2) bladelets used to scrape dry bone with crude edge 3) lunar scarring due to impact and polish caused by use of the segment as a barb elements. (Macroscopic photographs at 35x; microscopic photographs at 200x).

We can resume the results obtained from the analyzed tools of the five levels as follow:

Three retouched bladelets, two notched flakes, two notched bladelets, one denticulated flake and one perforator were used for butchering. These tools have very sharp straight or convex edges (25°-35°), and show use-wear on their unretouched edges.

Of the tools used for hide working, only one notched flake with sharp edge (20°-30°) was used for cutting. In contrast, hide scraping was performed using a larger series of tools, namely five end-scrapers, two retouched flakes, two retouched bladelets, five notched flakes, four notched bladelets and one denticulated flake with steeper edges (40°-60°), ideal for working an abrasive substance such as dry hide. Two retouched bladelets show on their unretouched edges use-wear produced by fresh hide scraping. One geometric (trapeze) must have been used on a very abrasive substance (hide).

Bone processing is well documented at the site. Dry bone scraping involved a wide range of tools (one burin, one notched bladelet, two denticulated bladelets, three notched flakes, two retouched fragments, two retouched flakes, one retouched bladelet and one *Mèche de forêt*). In contrast, only one denticulated bladelet was used to cut bones. Two retouched bladelets and one denticulated flake were used to work fresh bones. The extension of the marks, robustness and wear of the edges suggest that they were probably used for a transformation activity such as smoothing, scraping, grooving and sawing the bone. Bone manufacture was probably made at the site, at least for a portion of the assemblage, although wastes, blanks or drafts have not been identified (Mulazzani and Sidéra 2012).

The quantity of weapon elements depends on the occupational levels of SHM-1. They are rare in the first four levels and their number seems to increase from the fifth level onwards. Most weaponry elements are intact; some of them are fragmented, due to their use as projectile points (distal bending fracture) or barbs. A use-wear analysis of 77 diverse weapon elements (trapezes, segments, triangles and a few points) have shown 19 microliths with use traces served as projectile weapon elements, either in the form of barb elements or as perforating elements. On the whole, approximately 27% of the microliths present use traces. This type of artefact, used as a projectile, is very common in Mesolithic sites in France (Khedhaier 2003; Valdeyron et al. 2012) or in Epipalaeolithic sites in the Iberian Peninsula (Rodriguez Rodriguez 1993).

We have documented traces of perforating motion on one retouched fragment, used probably on woody plants, and two end-scrapers, two notched flakes and three retouched bladelets used for scraping, perhaps dry wood.

Finally, three pieces, namely a side-scraper, a notched bladelet, and the unretouched edge of a bladelet, must have been used on a very abrasive substance and/or a very hard one (stone or shell).

4. Conclusion

The multidisciplinary approach applied at SHM-1 provides new insights, albeit partial and provisional, into the techno-economic system and the way of life of the Capsian communities living on the eastern Maghreb coast. The present study focused on the procurement, technology and function of the lithic assemblage. The data obtained are unique, as to date practically nothing is known about the tool-kit used by the Capsian communities. Functional analysis performed on the tool-kit from the first four occupational levels and a sample of level 5 of the site shows the diversity of activities that took place at the site itself. The analysis has shown that several areas of activity can be identified: together with hunting and butchering, the evidence attests different sorts of manufactures related to the processing of hard substances and the treatment of hides. The activities detected on site would likely be related to a permanent occupation, perhaps interrupted by short abandonment phases, as revealed by malacological and micromorphological studies (Eddargach and Wattez 2013; Mannino and Mazzani 2013).

On a broader perspective, in order to enhance our perception of the techno-economic organization of Capsian communities, we should analyze complementary or converging data from similar occupations; it would be necessary to compare the results of traceological lithic assemblage at SHM-1 with functional data of contemporaneous regional Epipalaeolithic and early Neolithic sites. Nevertheless, several issues limit the comparison of the SHM-1 lithic techno-complex. The available archaeological data on North African Epipalaeolithic or early Neolithic lithic collections are rarely based on a technological approach, and the traceological analyses are totally lacking. Furthermore, some of the excavated sites were investigated in the first half of the twentieth century; the obvious difference in field methods, not based on the standard protocols applied more recently, limits somewhat the chrono-stratigraphic information available. However, it is possible to make some comparisons with the newly studied collections of the old excavations at Kaf That El Ghar (Bouzouggar 2006) or El Zafrin (Gibaja et al. 2012). Unfortunately, the scanty amount of lithic tools at both sites makes some percentage-based attempt of comparison simply in vain; the available data permits only very general observations to be tested in the future.

J. F. Gibaja et al. (2012) identify at El Zafrin (Chafarinas Islands, Spain) a simple knapping process resulting in numerous flakes that were turned into end-scrapers, denticulates and notches. Backed bladelets are numerous but, unlike at SHM-1, the geometrics consist of triangular pieces and, to a lesser extent, of trapezes.

The site of El Zafrin is characterized by the predominance of butchering work and hide work. The main difference with SHM-1 is the scarcity of worked bone matter and the small use of armatures as projectiles.

To conclude, the functional analysis carried out on the lithic tools from the first five occupational levels of SHM-1 allowed the detection of some of the main activities performed at this Capsian coastal site. The ongoing analysis of the two last occupational levels will allow for the proposing of a diachronic reconstruction of the activities practiced along all the sequence and detecting a potential transformation during the Neolithic transition, between the 9th and the first half of the 8th millennium cal BP.

Acknowledgements

We would like to thank Valentina Azzarà and Nadia Mohsni for the revision of English language of the original manuscript. We are very grateful to the Restoration Laboratory of Ksar Said (Tunisia), which kindly provided us with the reflection microscope used for the present study.

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CHAPTER EIGHTEEN

TYPOLOGY VERSUS FUNCTION: TECHNOLOGICAL AND MICROWEAR STUDY OF POINTS FROM A FEDERMESSER SITE AT LUBRZA (WESTERN POLAND)

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Abstract

Knowledge of the Federmesser Culture is the weakest of all the Late Glacial techno-complexes in the territory of Poland. This is due to relatively few sites attributed to that unit, and the large degree of diversity of those assemblages. Presently, there are three kinds of assemblages

showing affiliations to the Arched Backed technocomplex in Poland. There are unclear genesis and unclear criteria to distinguish them (Kabaciński, Sobkowiak-Tabaka 2010). The site under discussion–Lubrza 4 is a new Federmesser Culture location, discovered during rescue excavations carried out in 2005 and 2008 along the A2 highway connecting Warsaw and Berlin.

The purpose of the current paper is to present the results of functional studies of a specific technological and functional behaviour related to the production and utility of backed points recorded at the site–the most distinctive tool of the Federmesser Culture.

1. The site

Site 42 at Lubrza is located in Western Poland, in the young moraine landscape characterized by a large number of moraine hills and glacial troughs dated to the Late Glacial times related to the melted waters of the last glacier and buried by dead-ice supplied by water in newly emerged lakes (Fig. 1). Due to numerous glacial lakes the area is called Łagów Lake District (Kondracki 2009). The peninsula where the site was recorded stays above the basin of one such lake that was continuously filled with biogenic and mineral sediments from the beginning of Late Glacial (Kabaciński, Sobkowiak-Tabaka 2010). The Federmesser settlement is the oldest episode of occupation of that area. In the same place several hundred years later a Swiderian Culture camp existed and Mesolithic groups settled in that place during the Holocene. A final stage of settling took place as an Early Medieval village (Kabaciński, Sobkowiak-Tabaka 2011).

In the central and south-eastern part of the two hectares of the excavated area seven concentrations of flint artefacts were recorded with over 10.000 lithics in total. Two of those concentrations are related to the Federmesser unit while the remaining five are to Swiderian and the Mesolithic occupation (Fig. 2).

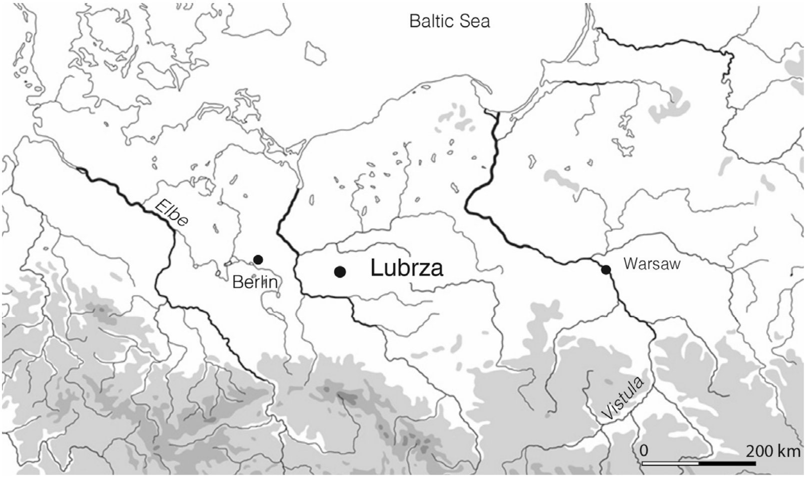


Fig. 1. Lubrza, site 42. Location of the site.

Fig. 2. Lubrza, site 42. Hypsometric map of the site with location of Late Palaeolithic and Mesolithic concentrations (1 – Federmesser Culture concentrations, 2 – Swiderian Culture concentrations, 3 – Mesolithic concentration; drawing M. Sip and P. Szejnoga).

2. Federmesser Culture occupation

The presence of Federmesser people at the site produced 3184 lithics that are related to 2 separate concentrations. Technological and typological analyses show functional differences between two concentrations. The first one (concentration 1) seems to be a domestic assemblage while the second (concentration 5) is a workshop. As detailed characteristics of flint assemblages are already published elsewhere (Kabaciński, Sobkowiak-Tabaka 2010, 2011), we present below only a short description of concentration 1–crucial for this study.

The assemblage belonging to concentration 1 comprises 2877 artefacts recorded within the area of ca. 110 square metres (Fig. 3). The assemblage was made of erratic Baltic cretaceous flint. The basic core type is a single platform core for blades. Other core types–such as cores with changed orientation for flakes and blades–are also present. One hundred and ten retouched tools were found of which burins (22 pieces; Fig. 4), end scrapers (16 tools; Fig. 4) and backed forms (19 specimens; Fig. 5) are the most numerous. The structure of the assemblage–both technological and typological–suggests we are dealing with a domestic assemblage produced for the everyday needs of the site inhabitants.

Certainly the most characteristic tools are backed points and backed blades. Other than forms with straight or arched backs, often recorded in high frequencies in inventories of western Poland (i.e. Siedlnica 17–Burdukiewicz 1974), there are also common large points with straight or arched backed sides, formed with a steep retouch. In three cases a backed retouch is also present on the other side of the tool forming a kind of tang. Double-backed points (Fig. 5: 19) are morphologically close to Kremser points according to W. Taute (1963). By other authors that kind of tool is classified as a groover (Kozłowski 1972) or just as a backed piece (Schild 1975). However, the most intriguing are by far the forms called shouldered backed points (Fig. 5: 14, 16, 18). Up to now there are no similar pieces in the Polish Federmesser-like assemblages. On the other hand similar tools are often present at North-Western European sites like Rekem (De Bie, Caspar 2000, Pl. 71.24), or relatively close pieces described as couteau à dos retouché at Belloy-sur–Somme or Le Marais (Fagnart 1997).

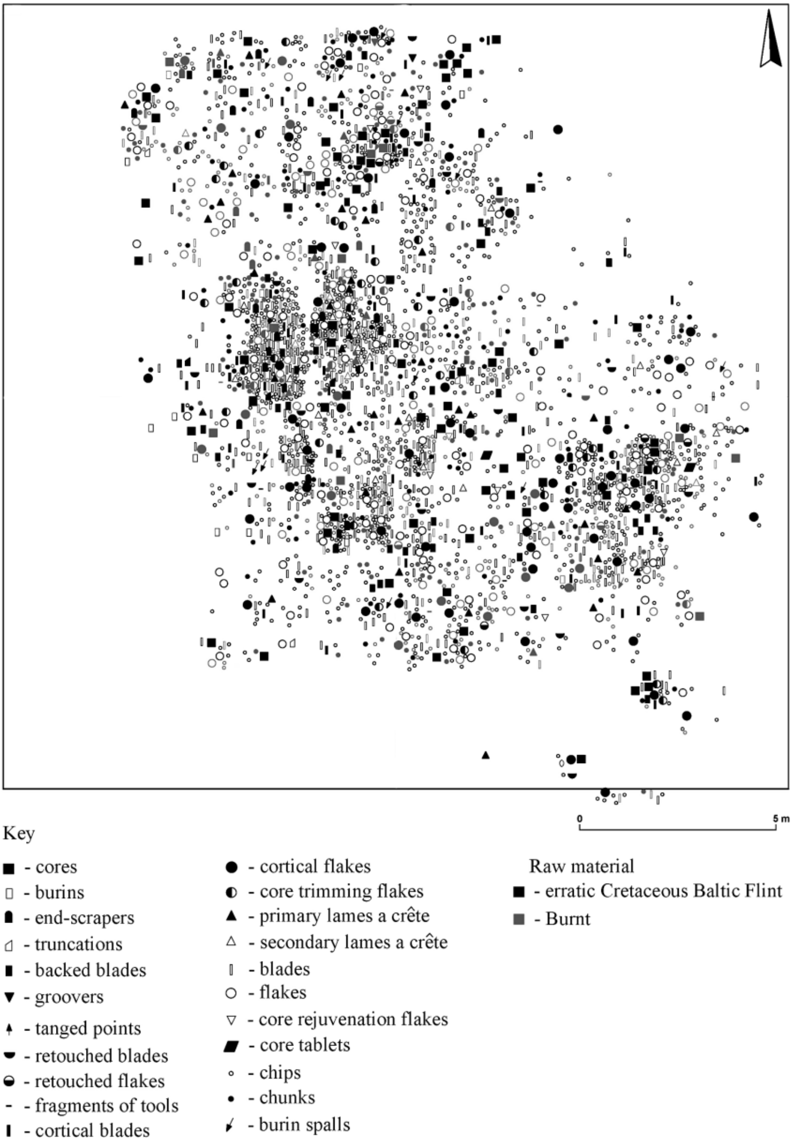


Fig. 3. Lubrza, site 42. Concentration 1 – spatial distribution of artifacts (Drawing P. Szejnoga).

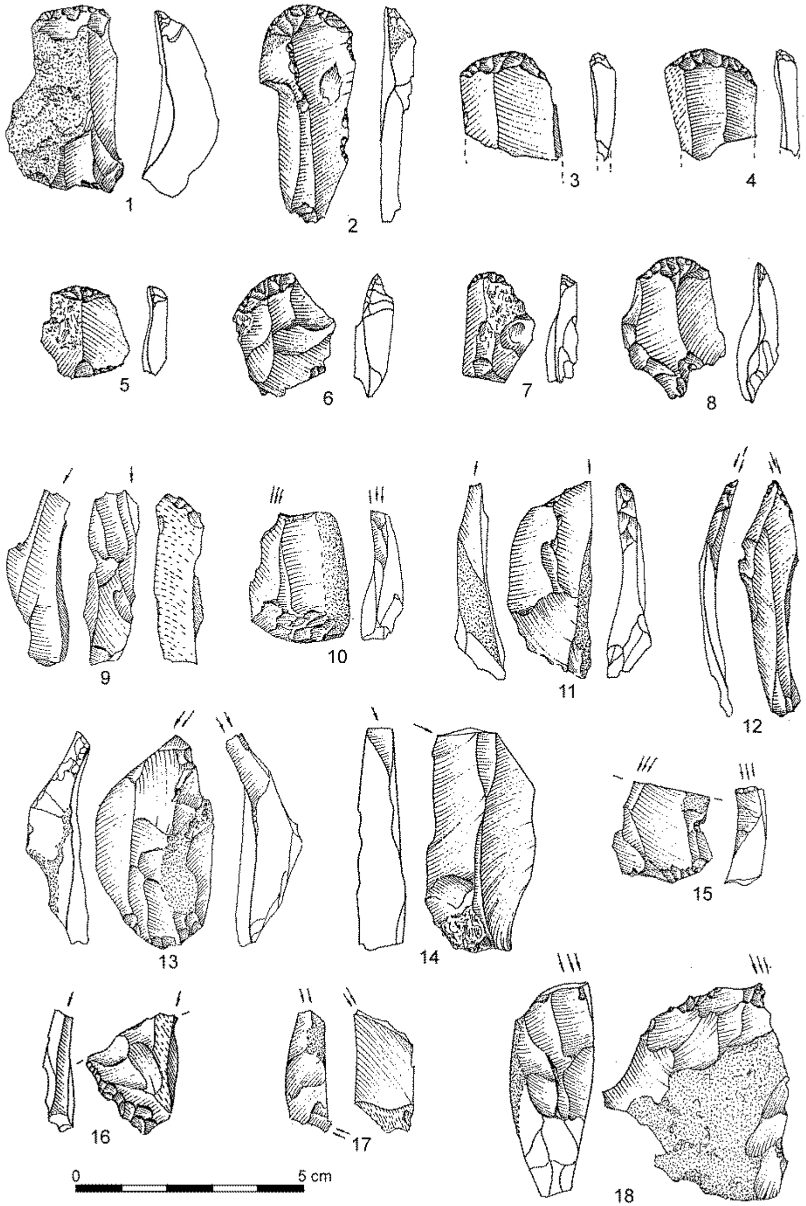


Fig. 4. Lubrza, site 42. Concentration 1: 1-8 – end-scrapers; 9-18 – burins (drawing J. Sawicka).

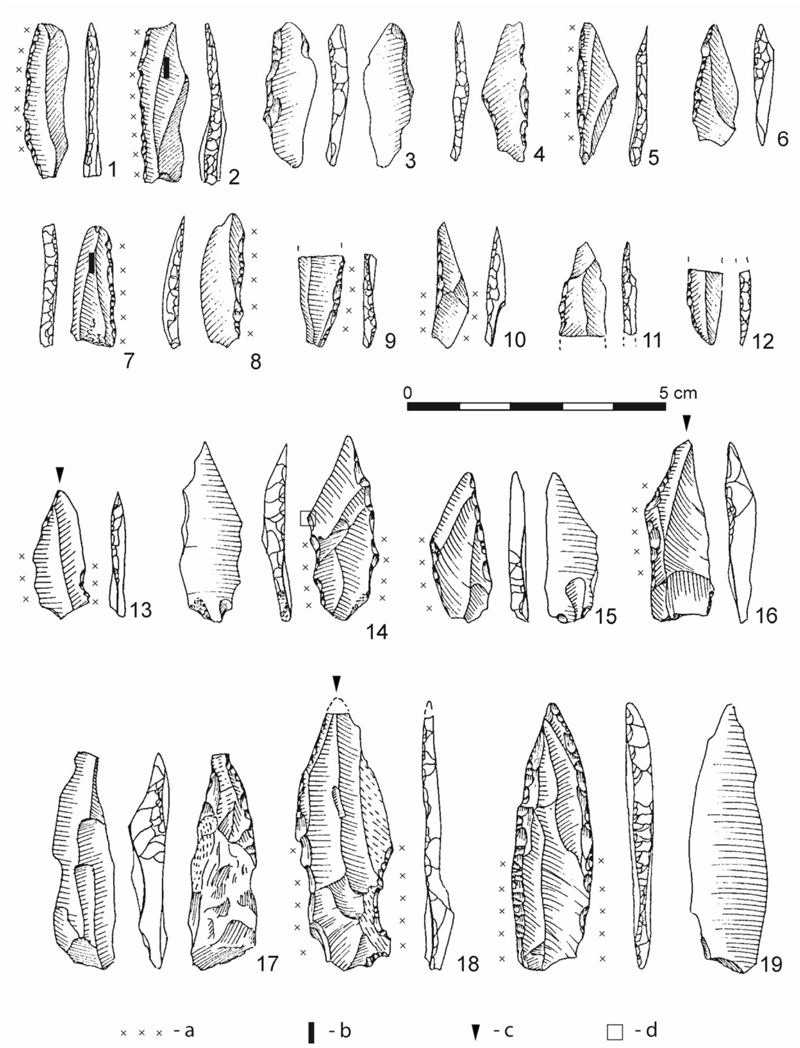


Fig. 5. Lubrza, site 42. Concentration 1: Backed pieces (drawing J. Sawicka). a – hafting traces; b – MILT traces; c – tip breakage; d – photo.

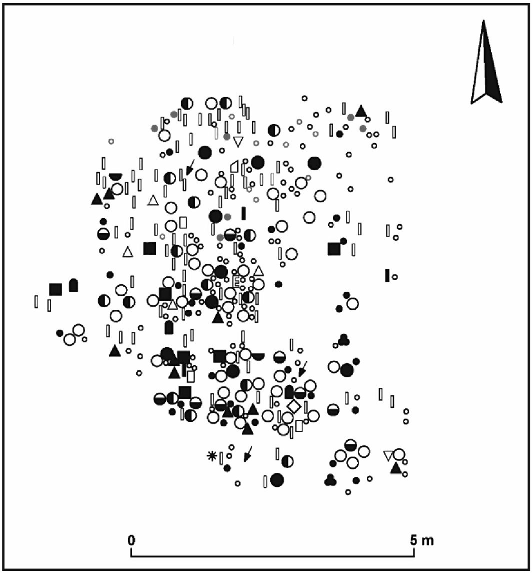
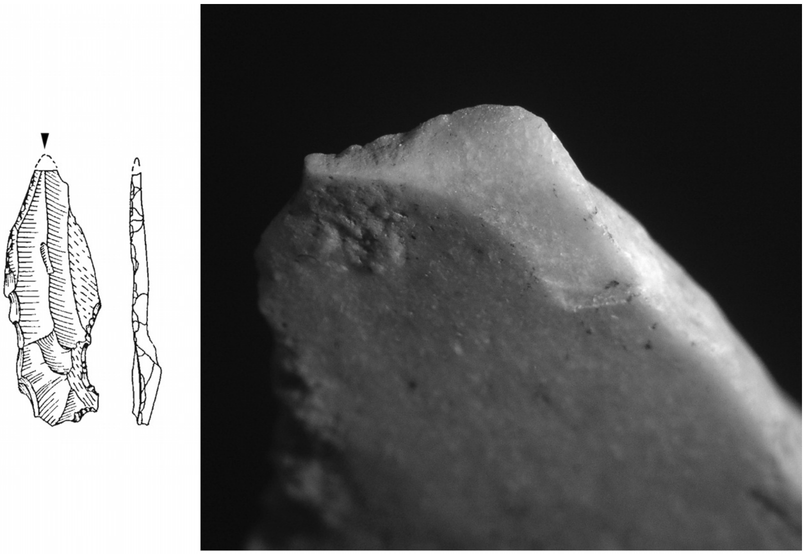


Fig. 6. Lubrza, site 42. Concentration 1. MILT traces.



15 x

Fig. 7. Lubrza, site 42. Concentration 1. Burin-like fracture.

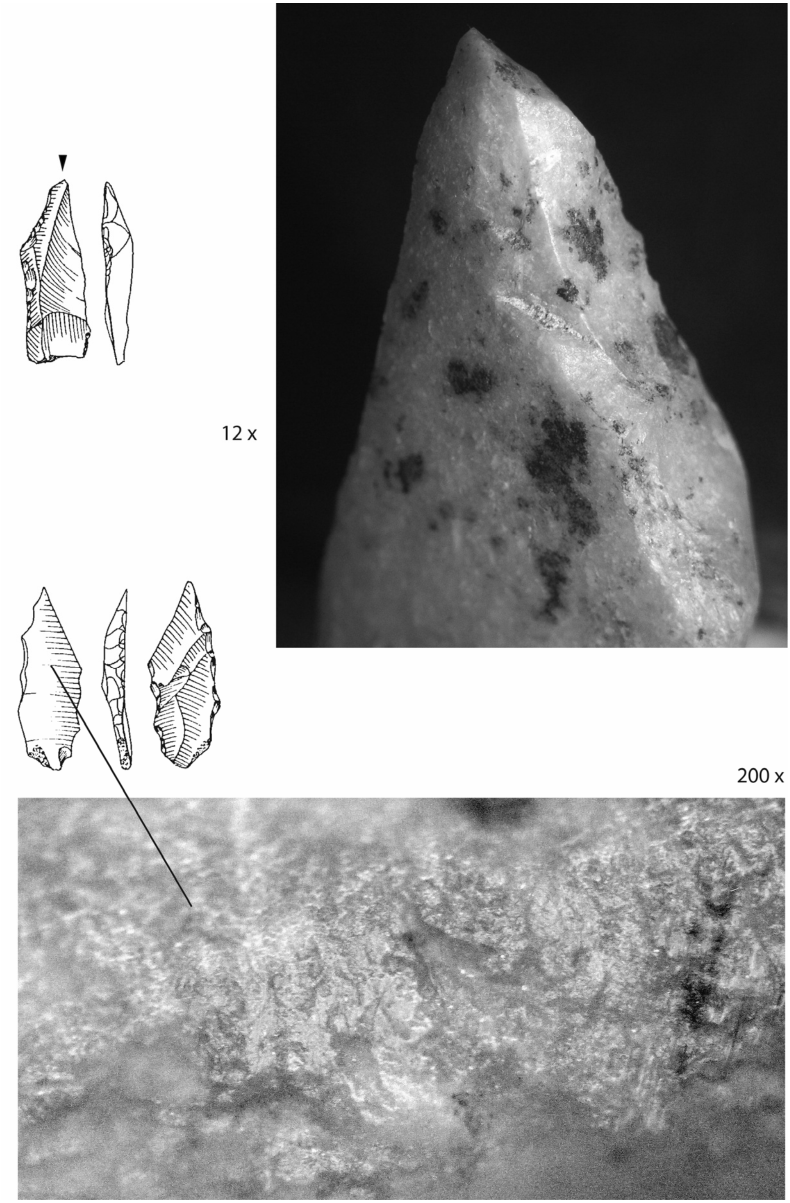


Fig. 8. Lubrza, site 42. Concentration 1. Upper photo – tip breakage; lower photo – hafting traces.

The affiliation of that assemblage to the Federmesser techno-complex is likely. Inventories of similar technological character were discovered at Nowa Wieś (Burdukiewicz, Furmanek 2008), Całowanie (layer III) or Rydno IV/57 (Schild 1975) - Pawłów (Libera et al. 2005; 2008), Trzebca II/63 (Kobusiewicz 1964). However it is difficult to find a direct close analogy to Polish assemblages of Witowian, Tarnowian or Federmesser. The Western European inventories of Rekem (De Bie & Caspar 2000), Belloy-sur-Somme and Le Marais (Fagnart 1997) and especially Bad Breisig (Grimm 2004) seem to provide important analogies.

There has been no direct dating of the site up to now but traditionally settlements of Federmesser culture are related to the Allerød oscillation (see for instance Taute 1963; Schild 1975) aspect that is confirmed by radiocarbon dates from Polish sites at Caowanie (Schild et al. 1999), Witów (Chmielewska 1961) and lately Rotnowo (Galiński 2007).

3. Functional analysis

The subject of functional analysis included all backed pieces and backed points recorded at the site within concentration 1 (19 specimens). A relatively good state of preservation of tools (a lack of patina and limited other post-depositional tracers) allowed the carrying out of macro- and microscopic observations. Macroscopic observations based on the Low Power Magnification method described by Semenov (1964) and Tringham et al. (1977) and in this case stereoscopic microscope with magnifications from 6.3x to 57x was applied. On the other hand a High Power Magnification approach, proposed by Keeley (1980) and later developed by others (e.g. Moss 1983; Plisson 1985) was used for microscopic observations using a metallographic microscope with magnifications ranging from 100x to 500x.

Summarized results of observations are shown in Table 18-1. This comprises descriptions of traces and diagnostic transformations of tool edges and surfaces in respect of their possible function (elements of weapon). The question was posed in the case when the interpretation raised some doubts. In Table 18-1 drawings of artefacts with traces of use are noted.

tool type	used/ unus -ed	Destroy-ed tip	MI LT	hafting traces	demages	remarks
backed point	yes	yes	no	yes	no	Fig. 5:18; Fig. 9
backed point	yes	no	no	yes	broken basal part	Fig. 5:19
backed point	yes	yes	no	yes	no	Fig. 5:15
backed point	no	no	no	no	no	burnt, Fig. 5:17
backed point	yes	yes	no	yes	no	Fig. 5:14; Fig. 10, bottom
backed point	yes	yes	no	yes	yes	Fig. 5:16; Fig. 10, top
backed point	no	no	no	no	no	burnt, Fig. 5:6
backed point	yes	yes	no	yes	broken basal part	Fig. 5:13
backed point	yes	no	no	yes	yes	Fig. 5:10
backed point	no	no	no	no	no	Fig. 5:3
backed point	no	no	no	no	no	Fig. 5:4
backed point	yes	no	no	yes	yes	Fig. 5:5
backed point	yes	no	no	yes	no	Fig. 5:8
backed point	yes?	no	no	no	yes	Fig. 5:11
backed point	no	no	no	no	no	Fig. 5:12
backed blade	yes	yes	yes	yes	no	Fig. 5:2; Fig. 8, top
backed blade	yes	yes	yes	yes	yes	Fig. 5:7; Fig. 8, bottom
backed blade	yes?	no	no	yes	yes	Fig. 5:9
backed blade	yes?	no	no	yes	no	Fig. 5:1

Tab. 1. Lubrza, site 42. Concentration 1. Results of functional analysis of backed pieces and backed points.

4. Discussion

The analysis reveals the presence of use-wear traces on 11 tools and in the case of another 3 there is a high possibility they were used as well. Diagnostic features (Fischer et al. 1984) such as tip damage in the form of burin (Fig. 5, 16, 18) and spin-off fractures (Fig. 5: 13) as well as broken basal ends (Fig. 5: 13, 19) were registered. In two cases microscopic impact linear traces (MILT) are visible (Fig. 5: 2, 14, Fig. 6).

Transformations and the location of hafting traces evidently indicate that more massive forms of backed specimens were fit centrally as points (Fig. 5: 13-16, 18-19). Smaller tools, especially backed blades, were elements of hunting weapons and served as inserts and barbs (Fig. 5: 1-2, 5, 7-11). Certainly analyzed pieces were placed into the shaft in different ways and at least in two cases they were inserted obliquely (Plisson 2005, 186; Fig. 5: 15-16).

The lack of comparative functional studies of Federmesser sites at a close distance to the Lubrza site moves us ca. 800 kilometers west to the Belgian Rekem site. That extensive site covered sixteen separate Federmesser occupations and hundreds of backed pieces were recorded at this site. Smaller (slender) pieces from Rekem were interpreted as elements of projectile components while wider and larger tools served as butchering knifes (De Bie and Caspar 2000). Considering here the presented results, there is a basic difference between Rekem and Lubrza from afunctional point of view. At Lubrza all backed pieces–no matter their size–served as projectile components and none show traces of any kind of secondary utilization as knifes, as is similar to another distant site–Rietberg in Westphalia (Sano 2012). Perhaps that is a result of the much smaller size of the Lubrza site where only two concentrations were recorded. However those differences most probably reflect different functions of both sites. Rekem is a stable, multi-seasonal Federmesser occupation where a variety of activities were undertaken. On the other site, Lubrza is perhaps a case of a short-term task-oriented occupation and it is difficult to define its specific activity. One of the explanations could be the extraction of red ore from the soil which might be suggested by the presence of red colorant on artefacts from both concentrations and a presence of heavy-duty tools in concentration 5. However, the nature of the observed recolouring needs to be studied in detail before we are certain of the presence of red colorant procurement at the site. Intensive traces of hunting activities recorded on tools from concentration 1 suggest the necessity for acquiring food during other activities which would functionally connect both concentrations. On the other hand the typological differentiation of backed pieces found in concentration 1, and different ways of their hafting prove the presence of a variety of hunting tools and perhaps also a variety of hunting strategies.

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CHAPTER NINETEEN

USE-WEAR ANALYSIS OF A SET OF GEOMETRIC PROJECTILS FROM THE MESOLITHIC CONTEXT OF COCINA CAVE (EASTERN SPAIN)

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Abstract

In this paper we present the preliminary results of the functional analysis of a set of geometric tools (mainly trapezes and triangles) from the Mesolithic layers of the Cocina Cave (Valencia region, Eastern Spain). This site has a long stratigraphic sequence that includes late Mesolithic and Early Neolithic levels. A recent revision of the lithic assemblage from a selected pit (E1) provided the basis for the study of the dynamics of lithic techno-typology from the first levels of the sequence (middle of the IX millennium cal BP) until the end of the Mesolithic period (dated around the middle of VIII millennium cal BP). Use-wear analysis provided data on the degree of use, and the relation between hafting and shape. This information allows us to explain some hypotheses for understanding the change mechanisms that operated in lithic style and their translation in chronocultural terms.

Keywords: Cueva de la Cocina, Mesolithic, Microliths, Geometric tools, Use-wear, Lithic style

1. Mesolithic geometric tools' context in Cocina cave (Valencia, Eastern Spain)

Cocina Cave is a singular site located in Valencia region, in the municipality of Dos Aguas. The cave is situated in a bend into the ravine known as "Barranco de la Ventana" (La Canal valley), in one of the last mountain ranges between the plains area of the Jucar river and the Mediterranean (Fig. 1). The site was discovered and excavated during the 1940s by L. Pericot (1945) and later (in the 1970s) by J. Fortea (1973). The great interest of this research was recognized after the publication of Fortea's book about the Epipalaeolithic complexes of the Mediterranean Coast of the Iberian Peninsula. Since then, Cocina Cave has reached an international relevance in relation with the characterization of the last Mesolithic assemblages in the Western Mediterranean (Geometric Mesolithic) (Fig. 2). The cave shows a long stratigraphy with several levels corresponding to the final Mesolithic, Neolithic and Bronze Age. Recently, in the framework of the ANR project directed by P. Allard "The last hunter-gatherers of Western Europe" we have obtained the first radiocarbon dates for the Mesolithic levels of Cocina from single animal bones with anthropic marks (Fig. 2). Results indicate that the Mesolithic period began about 8500 cal BP and lasted, at least until, 7700 cal BP.

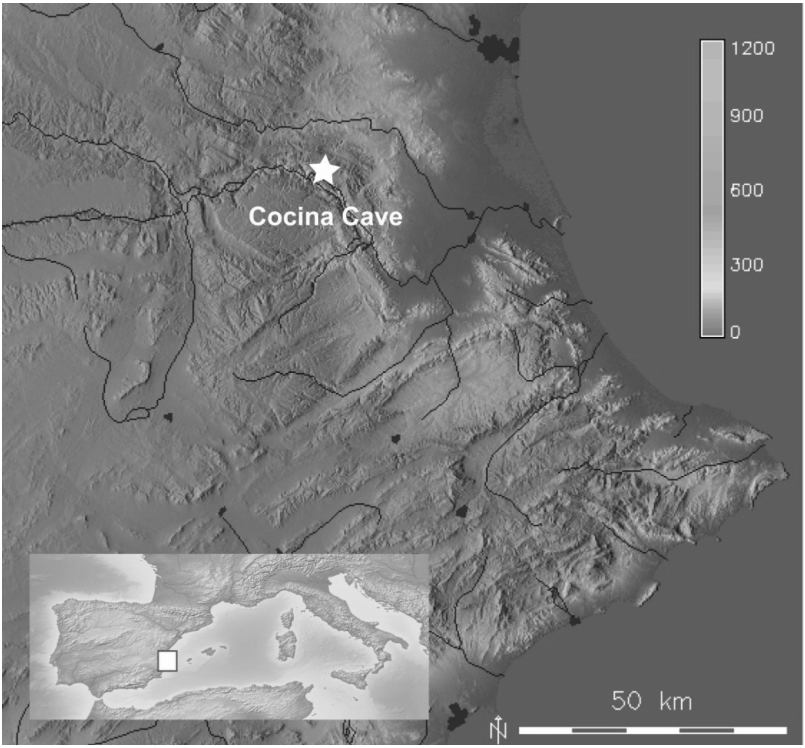

Figure 1. Geographical framework of Cocina cave (eastern Spain).

Geometric tools (trapezes and triangles) represent the main objective of knapping bladelet production. Across Western Europe we observe how the Mesolithic industries present similar patterns in the techniques and methods employed. Cocina Cave provides a good example of this type of industry, with an impressive lithic assemblage that has been recovered during different excavation campaigns. Unfortunately only a small part has been studied (E1 pit, excavated in 1945). Other materials from pits excavated in 1941, 1942 and 1943, together with the work effectuated in the 1970s by Fortea remains unpublished. All these materials are actually curated in the Museum of Prehistory of Valencia.

The aim of our study is to analyse Cocina Cave's old collections by means of use-wear analysis, in order to reach a better understanding of the functionality of these instruments and their relation to the technological and cultural trends. Use-wear or microwear analysis represents a suitable

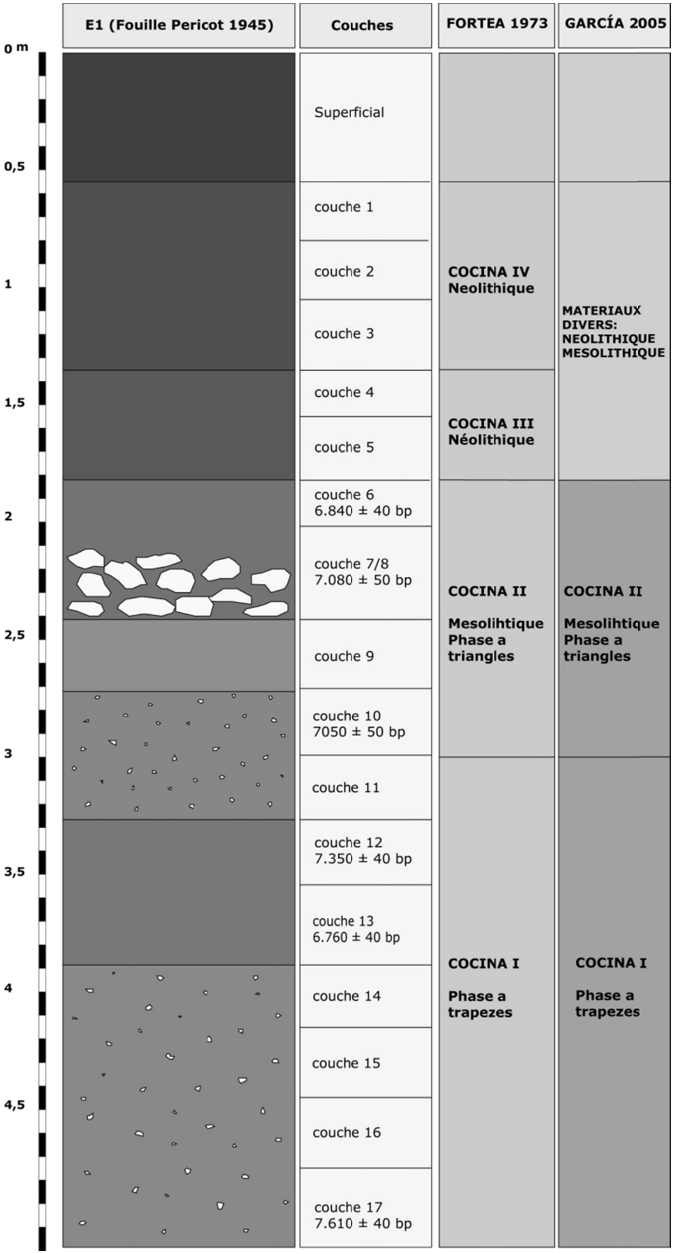

Figure 2. Schematic stratigraphy of Cocina cave.

technique for the reconstruction of prehistoric economic processes, allowing the identification of the functional patterns of the prehistoric artefacts. Moreover, in the case of microlithic tools, we can count on a long history of experimentation and analyses. Since the pioneer work of Odell and Odell-Vereeken (1980) and Fischer, Vemming and Rasmussen (1984), a large number of studies have approached the problematic of microlith functionality and hafting modalities in different chronological and cultural contexts. Even if, due to the high-number of variables involved in projectile impact dynamics, it is still difficult to propose a detailed reconstruction of both hafting and functional aspects, based on the analysis of recurrent fracture and scarring patterns we are able to describe a general trend of the use of this type of instrument.

2. Materials and methods

A sample of geometric tools from the Mesolithic phases, mainly trapezes (n°110), followed by triangles (n=23) and rare segments (n=3), has been submitted to use-wear analysis in order to clarify some aspects related to the management of the lithic resources at Cocina Cave. All the materials proceed from from Mesolithic phases (Cocina I and II). This is just a small part when compared to the overall number of geometric tools present at the Cocina Cave (more than a thousand). The selected materials, however, represent a good example of the types of microliths recovered at the site. All the materials have been analysed both through stereoscopic microscope (Leica MZ16A, 20x-40x), to examine the macrowear (notches, rounding of the edges, etc.), and transmitted light microscopy (Olympus BHMU, 50x-600x) (Odell and Odell-Vereeken 1980), to study the micro-wear (striations, micro-polish, etc.) (Semenov 1964; González and Ibáñez 1994). However, due to the scarce conservation of the lithic surfaces, strongly affected by mechanical and chemical weathering, most of the observations have been realized at a macroscopic scale. Mechanical weathering resulted in a diffuse polishing and rounding of the surfaces, while chemical weathering resulted in the formation of patinas and other changes in the petrographic and mineralogical composition of chert.

3. Results and discussion

60.3% of the sample shows macroscopic wear that could be related to use. Of those, 75% have been produced as a consequence of the employment of the geometric tools as hunting weapons, while the remaining instruments show more doubtful traces. Following the work of

Fischer (1990), Gassin (1991), Gibaja and Palomo (2004), Cristiani (2009), Martínez (2009) and more recently Yaroshevich et al. (2010), Pargeter (2011) and Petillon et al. (2011) we were able to differentiate a number of different types of fractures, often in reciprocal association between them: a) impact burination; b) step-terminating bending fractures; c) spin-off fractures; d) edge scarring and/or rounding.

a) Impact burination is the more common fracture among the studied sample (45.1%). Even if some authors do not always consider them as diagnostic features of projectile impact (Fischer et al. 2004; Pargeter 2011), the high occurrence of this type of fracture, that appears always in the same position (on one of two the tips of the trapezes, along one of the ridges of the surface) and with the same directionality (with an oblique direction in respect of the axis of the instrument), suggests that those features were produced by human utilization and not because of trampling or flaking activities (Fig. 3, a-c). It is remarkable that the majority of the burin-like fractures show rather reduced dimensions, with a length frequently smaller than 5 mm. Considering the position, the extension and the diagonal directionality of the burin-like fractures, it seems plausible to think that those instruments were used as points or as lateral inserts in composed hunting weapons. In both cases, a large part of the instruments would be protected by the haft and the resin preventing most of the edges from damage. A test of this hypothesis may explicate why projectile impacts would only produce such tiny fractures on the tips of the instruments.

b) Step-termination bending fractures (38.1%) also represent a relevant percentage of the assemblage. Those pieces with this type of wear show a large variability in size and orientation: observed from very small bending fractures that barely damage the tool tip to invasive scars that could remove more than half of the instrument. Directionality also varies from perpendicular to oblique in respect of the axis of the tool (Fig. 3, d, e2). In these cases the interpretation of the use-wear is more controversial. Some of the observed fractures which are very invasive, with a perpendicular orientation in respect to the tool axis, seem to suggest that the tool has been used as a point. Other instruments, that show only tiny bending fractures with diagonal orientation, appear to have been used as barbs.

c) Spin-off fractures (6.3%), usually considered the most diagnostic wear of projectile impacts, mainly appear in association with the two previous types of fractures, both impact burination and step-termination bending fractures. Among Cocina geometric tools spin-off are mainly represented by a series of consecutive tiny fractures and scars all around the used tip (Fig 3, a).

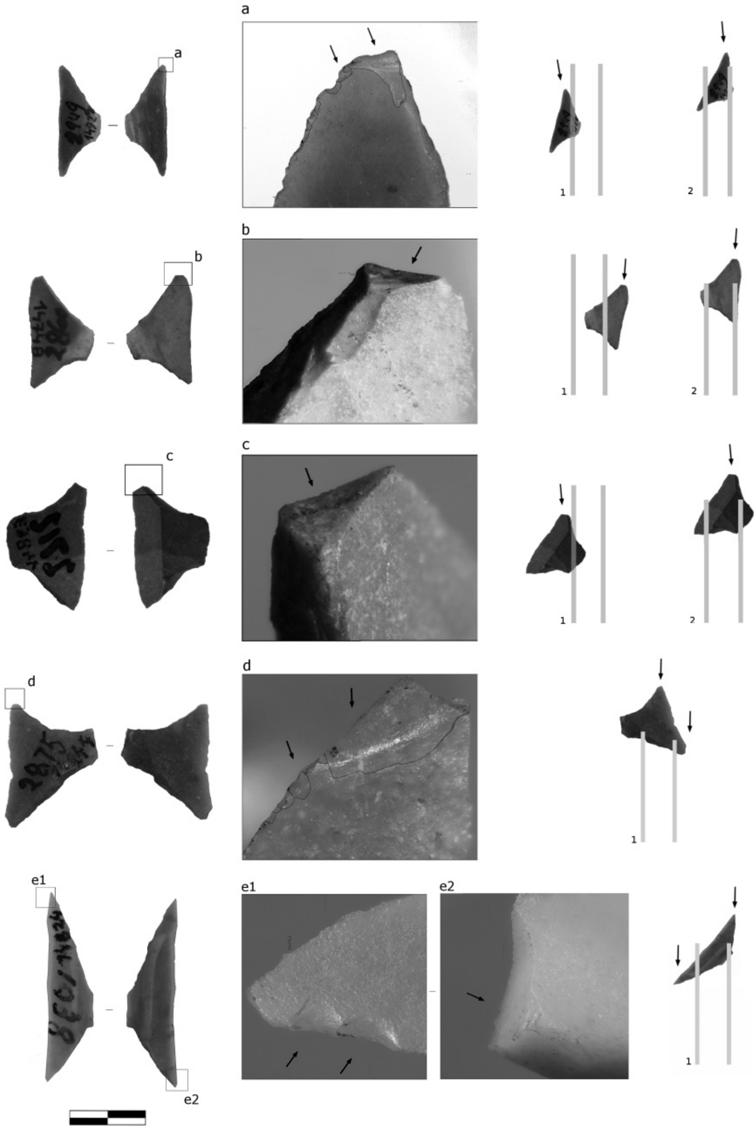

Figure 3. Selected use-wear traces from Cocina cave geometric tools. a-c) Impact burination. See how the burin-like fractures run along the dorsal ridges; d) Bending step fracture; in photo a) and d) see how larger fractures are associated to tiny spin-off fractures. 1-2) Hypothetical functional and hafting reconstruction of the tools.

d) Edge scarring and/or rounding have been also observed (10.5%), usually in association with the other fracture types (Fig. 3, e1). We associate this type of wear with the penetration of the instrument inside the target. However, this type of trace alone could not be considered a diagnostic of a projectile impact, as trampling or other post-depositional could produce similar traces.

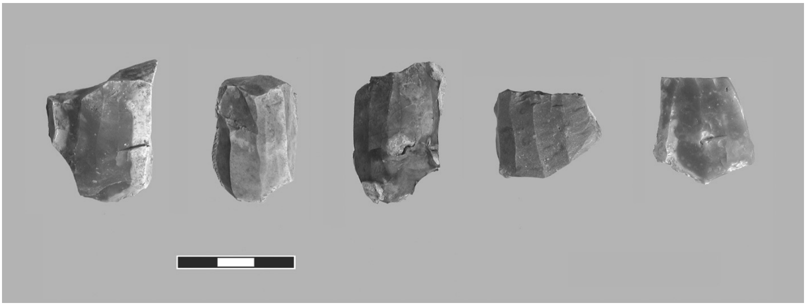

Figure 4. Bladelet cores from Cocina cave (size in cm).

4. Conclusion

The lithic assemblages of the final Mesolithic complex are marked by a high frequency of blade production that shows common features in the techniques and methods employed, over a great territory. The regular sharp and small size of the blades suggests the possibility of the use of a pressure technique as has been recognized in other late Mesolithic assemblages (Castlenovian) across the western Mediterranean (southern Italy and France) (Binder et al. 2012; Allard et al. in press; Perrin et al. in press). In these complexes, the most regular bladelets are selected for the production of geometric tools. Our preliminary study demonstrated that at Cocina Cave microlithic geometric tools were mainly employed as projectile weapons. Those instruments show a great standardization both technologically and functionally. Other activities that have sometimes been associated with those types of instruments, e.g. hide boring or scraping, butchering, cutting wild or domestic plants, etc. (Longo & Isotta 2005; Attenbrowa, Robertson & Hiscock 2008), have not been observed, nor even occasionally. Anyhow, a detailed microscopic study of micro-polish traces has not been possible due to scarce surface conservation.

In our opinion, the production of microlithic tools was directed toward the manufacturing of composite hunting weapons. The modalities of use and hafting also appear to be quite standardized. Both impact burinations and step termination bending fractures show common features in the localization, extension and directionality of the fractures. On the basis of those results we hypothesize two main different modalities of employment: 1) as barbs or 2) as points. However, it is important to remark that it is very difficult to discern the exact form of hafting used only on the basis of macro-fractures' analysis. The analysis of micro-features, as MILTs or polishes, is also necessary.

Acknowledgements

Laboratory analyses were supported by the project HAR2012-33111 "MESO COCINA: los últimos caza-recolectores y el paradigma de la neolitización en el mediterráneo occidental)" of the University of Valencia and the Museo de Prehistoria de Valencia. The ANR project directed by P. Allard "The last hunter-gatherers of Western Europe" supported the C14 dataset.

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CHAPTER TWENTY

LATE MESOLITHIC NOTCHED BLADES FROM WESTERN EUROPE AND NORTH AFRICA: TECHNOLOGICAL AND FUNCTIONAL VARIABILITY

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Abstract

During the 7th and 6th millenniums BC, major changes occurred over a widespread area in the lithic industries of the late Mesolithic. We focused our research on notched blades and bladelets knapped by pressure or indirect percussion. We managed to define this technical process by showing that these notches result from voluntary retouch, with variability in retouch modes and in uses (different operating processes and worked materials). It is a simple technical concept, connected to the recurring mode of operation, but with varied functional purposes that comes out as a result of this survey carried out in France, Belgium, Spain, Morocco and Tunisia.

Keywords: Notched blades, late Mesolithic, experiments, retouch, scraping tools

1. Introduction

A wide technical change occurred during the 7th millennium BC amongst the Mesolithic groups in a large part of Europe and North Africa. Large and regular flint bladelets, removed by pressure or indirect percussion, became the basis of the lithic industries. They were transformed by retouch to produce two main tool types: geometric arrowheads (trapezes) and notched bladelets. The chronology of the expansion of these industries during the 7th and 6th Millenniums BC suggests that there is a shift from Mediterranean to Northern Europe (Perrin et al. 2009). Without any functional analysis, different hypotheses were proposed to explain the production and use of these notched blades: blank tools used to scrape wooden sticks in order to shape arrow shafts, the notches being created by the work itself (Rozoy 1978); tasks correlated with an intensification of plant processing (Rahmani and Lubell 2012). We began to explore this question in France and Belgium, as part of collective projects associating technologists and use-wear analysts (Gassin et al. 2013; Gassin et al. in press; Gueret 2014). We recently enlarged our study with new sites in France, and with sites in Spain and Northern Africa, and we undertook a collective blind test in order to clarify our observation methods and our interpretation criteria.

2. Used notches: archaeological data set

We studied notched blades from 24 sites (Fig. 1), with a total of 175 used notched blades.

Notched blades are present in the majority of the late Mesolithic sites, but there are some exceptions, such as at the Castelnovian site of Châteauneuf-les-Martigues (Font des Pigeons). It is difficult to interpret differences in frequency, although we can suspect the existence of some functional variability amongst sites. For instance, notched blades represent

6% of the retouched tools at l'Essart (Marchand 2009), 31% at Dammartin-Marpain and 48% at Benàmer (Jover Maestre et al. 2012).

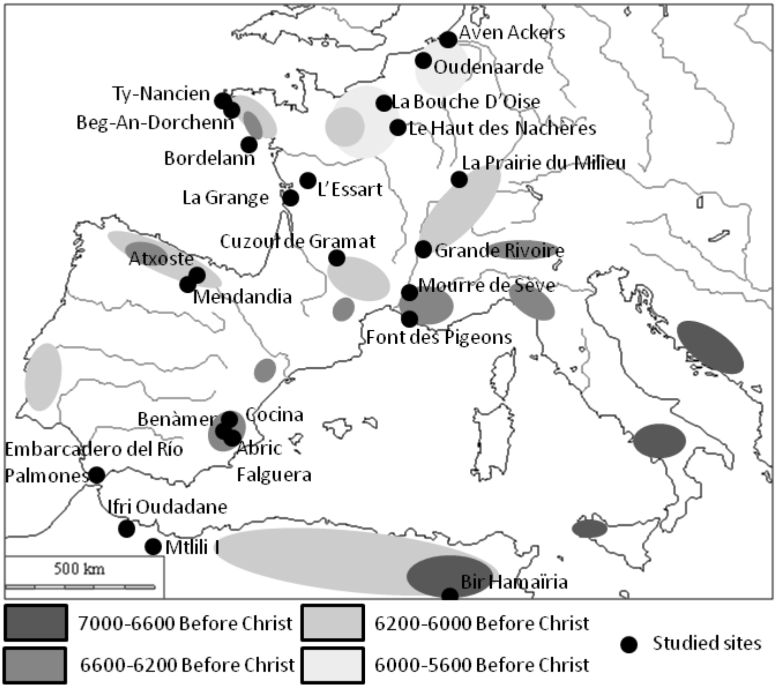

Fig. 1. Chronological stages of the spread of the blades and trapezes industries (from Perrin et alii, 2009).

Only a few notched flakes have been found (only one in Beg-an-Dorchenn, 4.2% of retouched tools of Benàmer). Notched or denticulated flakes are numerous at l'Essart, but most of them are Clactonian notches with a different shaping. These findings from l'Essart have not yet supported use-wear analysis, and the homogeneity of the layer is unknown. Notched blades are generally made on very regular blades. They are always on the dorsal face, except for a few blades from Cuzoul de Gramat. A large part of them only bears one or a few negatives in every notch; according to their morphology (no negative bulb, 90° fracture initiation), we interpret them as bending fractures, which can be produced when pressing the ventral face of the blade against a wooden cylinder. Less frequently, there is a superposition of negatives, which can result from the retouch against a harder wood or other material (hard animal matter or harder material); it is more difficult to interpret the retouch technique. There can only be one notch, two opposed notches, creating a strangled blade (very frequent only in some Spanish sites, like in Benàmer, with 18% of the retouched tools, or Cocina), or numerous notches on both sides (up to 13 on a Capsian blade from Bir Hamaïria). Notches are sometimes very deep, considerably reducing the width of the blades, and, when there is a shift between left and right notches, the blade becomes sinuous. Most of them are clearly delimited, but in some instances, it is difficult to distinguish between contiguous notches and irregular continuous retouch.

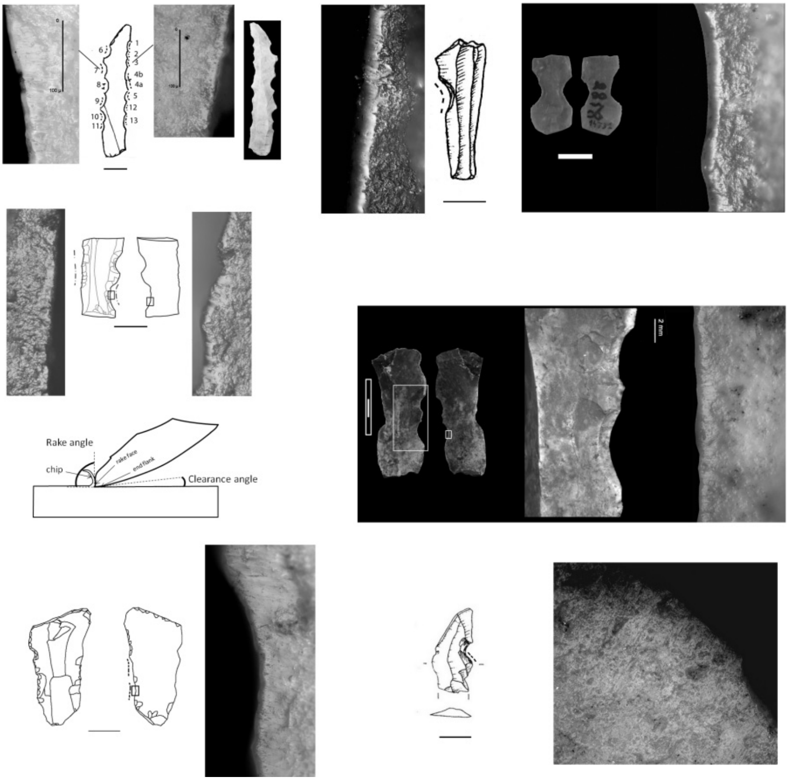

Fig. 2. Notched blades. 1: Bir Hamaïria (wood / plant?). 2: Benàmer (wood / bone?). 3: Cocina (bone?). 4: Cuzoul de Gramat (wood?). 5: Ifri Oudadane (bone?). 6: position of the tools during the work. 7: Beg-an-Dorchenn (plant?). 8: Beg-an-Dorchen (fibrous plant?). All microscope photographs taken at 200 x, excepted 2 (400 x). Scales in cm. All photographs on the ventral face.

3. Use-wear observations and interpretations

3.1 A single way of use

In the new sites of our corpus, we found the same use as in the previously studied samples. The used zones are always the concave part of the notches. Edge damage is very limited or absent (see infra). The polish is always dissymmetric, with a bevel on the ventral face, characterized by a compact domed polish: on the retouched dorsal face, the polish is sometimes weaker, sometimes compact and shiny. This dissymmetry results from a negative rake-cutting of different materials. The end flank is always the ventral face; the dorsal face is the rake face, with a rake angle near 90° (Fig. 2-6).

3.2 Voluntariness of the retouch

The scars shaping the notches cannot, according to our experiments, result from the scraping process itself. A scraping motion with the ventral face as a rake face would produce similar notches, but a different distribution of use polishes (the bevel would be on the dorsal retouched face). A positive rake scraping motion, with a blank blade presenting initially an acute edge angle, and the ventral face as end flank, produces damage scars which only partially match the patterns observed on archaeological tools. Scraping soft wood produces short bifacial scars; scraping hard wood, during intensive work, produces large bending fractures, most of them on the dorsal face, but this edge damage does not create regular notches. Only a few blades (those with irregular retouch) in our Mesolithic corpus could match this use process. So, we think that the notches are the result of a voluntary retouch, creating a very short concave active zone with a robust straight angle edge.

3.3 Different worked materials

Some notches bear on the dorsal face a bright smooth polish, and on the ventral face either an invasive pitted and striated polish or a smooth polish with few striations; they could have been used to work certain plant materials. On other notches, polish on the ventral face is limited to a band along the edge, creating a domed bevel, with some striations. On the retouched dorsal face, the polish is not very developed. These notches have probably been used to scrape wood or rigid plants. Some notches with a rather flat bevel on the ventral face, with some striations and microfractures, could have been used to scrape bone or antler. Different uses are associated in most sites, if there are enough analyzed tools to observe this diversity.

4. Discussion

It is often difficult to establish the exact nature of the worked material, because of the overlaps between use-wear traces. A collective blind test performed in Barcelona in October 2012 allowed greater care to be taken with our interpretations, as we saw some mistakes while interpreting experimental tools used to work wood. Our interpretative abilities are also limited by a short number of experiments with plant working. So we have to improve our knowledge basis with new experiments involving the use of notched blades to process plant materials.

We are sure now that these phenomena–retouching regular blades, via bending fracture or other retouch techniques in order to shape notches, used to scrape different materials–has some consistency, as we have found similar used notched blades in almost all studied sites from the late Mesolithic. The recurrent choice of regular blades, and the scarcity or absence of notched flakes or flakes with naturally straight angle edges used to scrape the same materials (but this is still to be demonstrated on a larger sample), point to a well-established technical tradition. However, we know that these notched blades are absent from Font des Pigeons–Châteauneuf-lès-Martigues; they are probably absent in other sites which are yet to be analysed, such as Lallo in the Rhône Valley. In the sites with notched blades, some differences can be seen: for instance, the strangled blades are numerous in Spanish sites only. What is the meaning of these differences? One difference could be stylistic/cultural (strangled blades?), and the other is maybe functional (Font-des-Pigeons?).

Making notches to scrape different materials does not need a high level of know-how, and has probably been invented independently in several places and times. For instance, a few notched blades used to scrape bone or silica rich plants are known in the Middle Neolithic of Southern France and Eastern of Spain; but it is not a systematic way of doing things, unlike the burins in the Chasséen of Southern France. Making direct notches on regular blades, as the dominant tools in the lithic industries, is quite different. Is it a distinctive feature of late Mesolithic, or is there some continuity with previous or later cultures? The lithic industries from earlier Mesolithic sites (early or middle Mesolithic, particularly Sauveterrian) comprise a few notched blades used to scrape bone or antler, wood or plants, as in Vionaz in Switzerland (Pignat and Plisson 2000), Fontfaurès, L'Abeurador, Balma Margineda in SouthWestern France (Philibert 2002), Le Sansonnet, Pey de Durance (Provence), Baume d'Ogens, Château d'Oex (Switzerland) (Khedhaier 2003), or in some "muescas y denticulados" sites from Spain like in Collado (Alicante). None have been found in Northern France and Belgium. Some early Neolithic sites, like Mendandia and Atxoste in the Basque country (Alday et al. 2012), and Peiro Signado in Languedoc (Philibert, this volume), show a few notched blades used to scrape different materials. However, we think that more similarities are needed to suspect some continuity or some heritage of a traditional way of doing things.

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CHAPTER TWENTY ONE

EXPERIMENTATION AND FUNCTIONAL ANALYSIS OF THE BACKED POINT TOOLS FROM THE CASTELLO'S SHELTER AT TERMINI IMERESE (PA, ITALY) PRESERVED FROM THE MUSEO DELLE ORIGINI (ROME)

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Abstract

This research focuses on the functional analysis of some of the flint backed point tools, from the site of the Castello's Shelter (PA, Italia), which could have been used as projectile points. The replication of the diagnostic projectile point tool impacts and their comparison with those identified in the archaeological record (Fig. 4) is the subject. The research methodology used in this study included the experimental reproduction of the backed points presenting distinct and clear impact evidence experimental with a diversity of hafting techniques, suggesting that the archaeological implements were likely used for hunting (javelin and arrow). Preliminarily, we can say that the functional analysis of some of the backed point tools from the Castello's Shelter, chronologically ascribable to the final Epigravettian, has led, based on their morphometry, to the identification of two distinct functional types of tool: one that could be linked to the use of the bow and one linked to the use of the atlatl.

Keywords: Riparo del Castello, Final Epigravettian, Functional Analysis, Projectile Impacts, Backed Point Tools.

1. The site and its prehistoric context

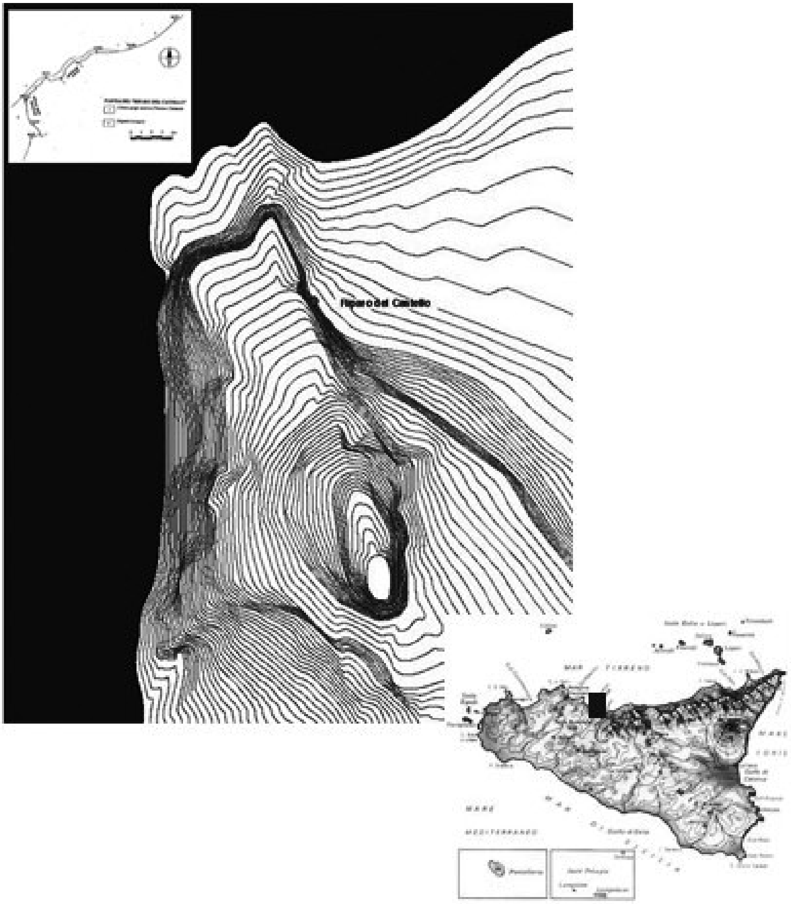

Fig. 1 Site location

The Castello's Shelter has been formed by an ancient shore line that is located on the eastern side of a Messinian formation composed of marly limestones whose lithologies derived from the "Dominio Imerese" formation. The shelter, today positioned in the city centre of Termini Imerese, lies at 40 m above sea level at a distance to the coast line of about 200 m (Fig. 1). It looks over a terraced plateau covered with Plio-Pleistocene gravel and clay deposits whose morphological structure is due to transgressive and regressive quaternary marine movements. These deposits are cut by the rivers S. Leonardo, Himera and Torto that in prehistoric times contributed to the formation of wetlands, behind the coast line, 50 m below the present sea level, hosting a rich biocenosis.

At the end of the late glacial a significant lowering of temperatures in Sicily is recognized in the Younger Dryas (Sprovieri et al. 2003). Initially the palaeo-floristic coverage seems to be predominantly open and steppic while, with the beginning of the Holocene, it emphasizes an increase of arboreous taxa associated with a decrease of the graminaceae (Sadori and Narcisi 2001). The palaeo-fauna in the Castello's Shelter is represented by species of temperate climate with continental characteristics with an asian-european origin. Cervus elaphus, Sus scrofa, Bos taurus primigenius, Equus hydruntinus are clearly the species most hunted. The hunting activity may have therefore been performed in the forest or in the mixed wood belt (wild boar and deer) and in open grassland or parkland areas (european ass and ure). The stratigraphy evidence of the archaeological deposit within the Castello's Shelter has suggested a different use of the site with an occupation time divided into long permanences alternated with shorter ones as a characteristic of hunter-gatherer groups with a wide mobility.

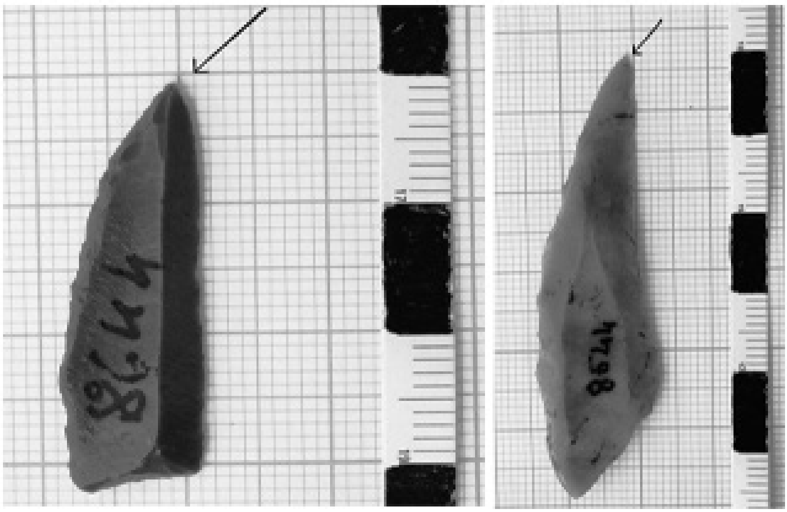

Fig. 2 Malaurie point / curved point

The entire lithic industry from the Castello's Shelter is composed of flint and quartzite even if the latter raw material is much less present in the archaeological record. Both raw materials, especially red Lias and yellow Trias flint nodules, can be found along the secondary deposits of the banks of the San Leonardo river; 1 km distance from the site. In the current state of the research we can assign the lithic industry of the Castello's Shelter to the typological record made of backed point tools (Fig. 2) and geometrics (triangle) with a strong presence of blade blanks seen in the sequence of Acqua Fitusa Cave lower level (cuts 5-3), San Teodoro Cave levels D and C and Acqua Fitusa Cave upper level (cuts 2-1) (Zampetti 1984-87). Some of the typological characteristics are in fact classifiable in the earliest phase of the Sicilian final Epigravettian attributable to a period between 14000 and 12000 years BP (Segre and Vigliardi 1983). At the same time other typical features, such as Malaurie points, that strongly characterize the final stages of the industry, would be classifiable instead to the next step of the final Epigravettian in Sicily.

2. Experimental Reports

A sampling grid was created during the experimentation, to document all the technical characteristics of each shot including the number of the experiment and its photo, the type of projectile and its diameter, the point type, the hafting configuration, the bonding mass, the number of shots executed, the average penetration, the average laceration, the average distance, the point fracture type, the integrity of the point, the type of carcass target, a notes' space and a incidents' one.

Both types of projectile (dart and arrow) had a good and sometimes excellent "killing power"; the backed points of these projectiles have reported, on being tested, very diagnostic impact fractures and the same associations (of fractures) to those found on the archaeological sample (Fig. 3).

Mostly of the impact fractures involved the proximal and mesial segment of the points and occurred to the hafting zone; they are principally distributed on the ventral face of the points as happens in the archaeological sample.

Only one burin shape impact fracture has been reported during the experimentation but has not compromised the functionality of the point.

The only snap fractures that should be read as diagnostic are probably those in association with the bending-step or bending-feather ones corresponding on the same point.

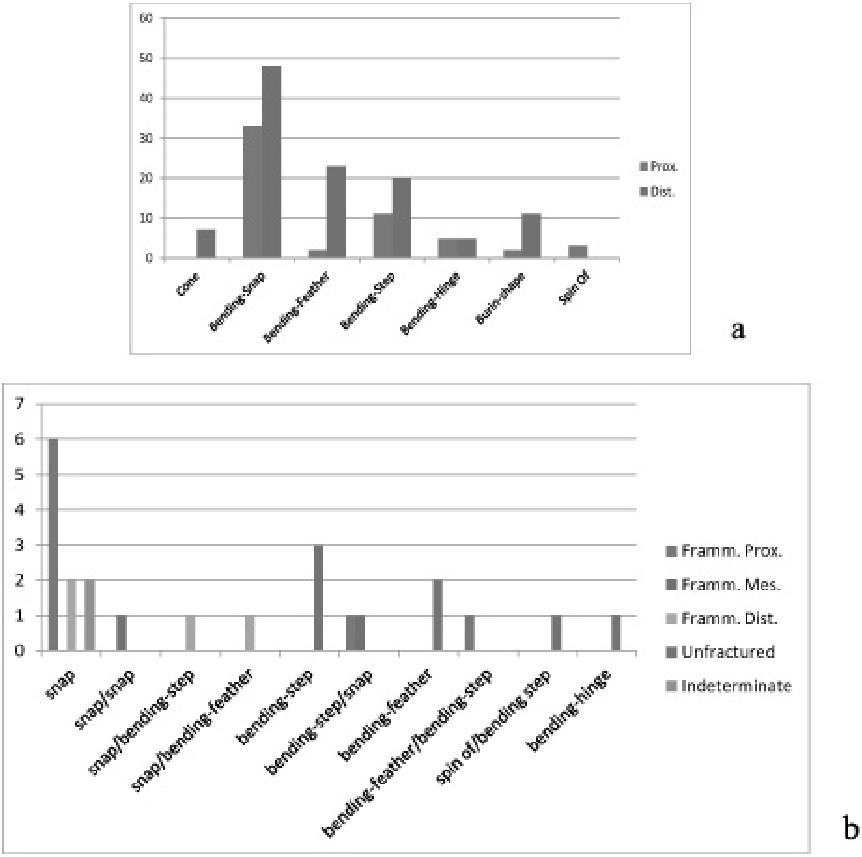

Fig. 3 a – impact fractures on the archaeological sample; b – impact fractures on the experimental sample

It is possible to hypothesize, according to the experimentation, that the nature of the Howieson's poort pointed tools, often curved or angled, would preclude the possibility of a multi-element hafting configuration but rather would indicate one suitable for a single element set in a longitudinal or transverse position; the hypothesis of a transverse hafting configuration is also confirmed by the position of some of the impact fractures, discovered whether on the archaeological sample or in the experimental one, which are distributed with an hardly orthogonal orientation to the axis of the point.

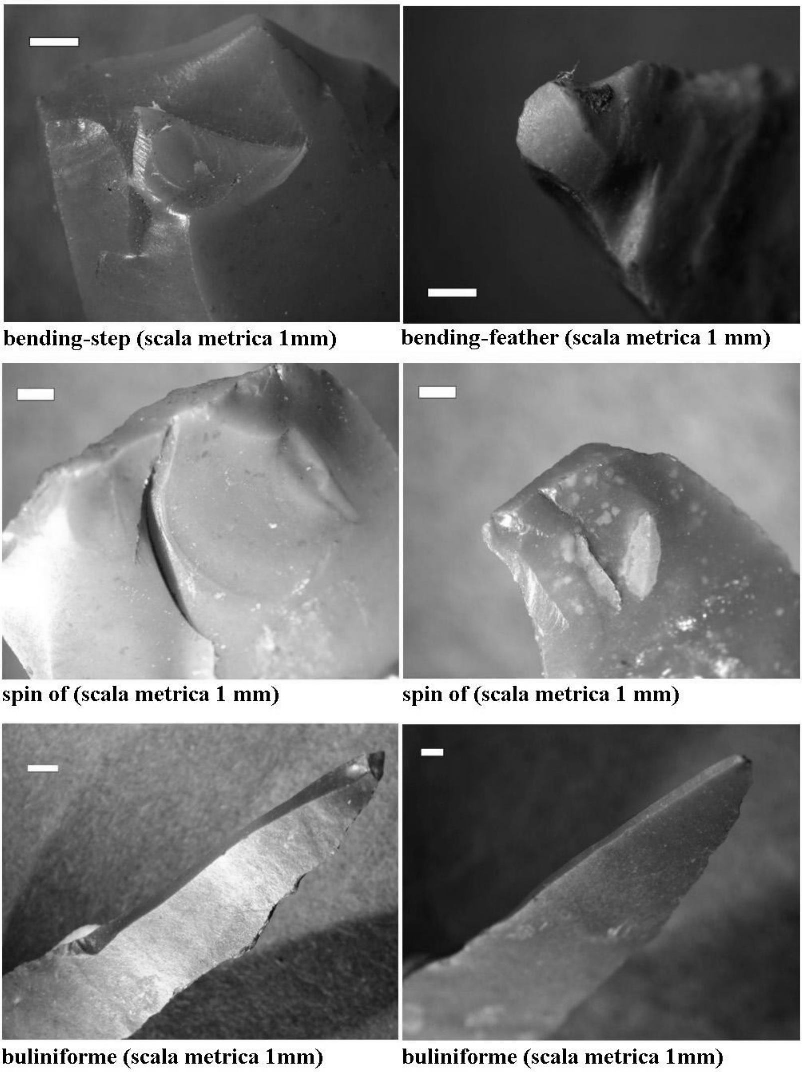

Fig. 4 Some of the impact fractures from the archaeological sample

The experimentation stage has demonstrated, especially when the points have small sizes, that the longitudinal hafting configuration is more efficient when it is associated with the use of bow and arrows while the transverse hafting configuration would be more suitable with the use of the atlatl and spears; in any case it is necessary to find the right metric balance between the wooden mounting support and the backed point tool.

3. Conclusions

Although there are no ethnographic comparisons proving the use of the atlatl integrated with the use of the bow in hunter-gatherer communities this study has suggested and analyzed both ballistic systems; in any case, the backed point tools taken into account may not be coeval. While the results of this experimentation have confirmed many of the assumptions in the bibliography, answered some questions and given some value to empirical considerations at the same time it has left some open questions needing further study in the experimental arena. However, the functional analysis of some of the backed points from the Castello's Shelter has led to the identification of two distinct functional types of tools, one could be linked to the use of the bow and one linked to the use of the atlatl. We still do not know if this dualistic choice has been coeval and how it has been forced to technological, ecological or cultural markers. In any case it is important to note that the two ballistic systems examined are the result of two different hunting strategies in relation to different approaches towards the prey and therefore it is hard to imagine them joined together in the same community of hunters-gatherers.

Acknowledgements

My heartiest thanks to Prof. Cristina Lemorini, Prof. Daniela Zampetti for helpful discussions and advices, my hearliest thanks to Dr Massimo Massussi for participating in the blind tests.

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CHAPTER TWENTY TWO

FUNCTIONAL ANALYSIS OF A MAGDALENIAN SITE FROM THE SPANISH NORTHERN MESETA: A CASE STUDY OF ENDSCRAPERS FROM LA PEÑA DE ESTEBANVELA (AYLLÓN, SEGOVIA)

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Abstract

Use-wear analysis techniques were applied to 160 end scrapers, selected from the lithic assemblage unearthed at La Peña de Estebanvela between 1999 and 2009. This functional study is aimed at assessing the use/function of this very typical Magdalenian tool type which is particularly abundant at the site. Use-wear analysis results indicate that end scrapers were mainly used for hide-working, but also for working harder materials, like wood, bone and antler.

Keywords: Spanish Meseta, Use-wear analysis, Magdalenian, Lithic industry, Endscraper.

1. The site

La Peña de Estebanvela is a large rockshelter, located to the southeast of the Duero river basin, 1085 m above sea level. An archaeological sequence, including Final Magdalenian (stratigraphic units (SUs) I and II), Upper Magdalenian (SUs III and IV) and possibly Middle Magdalenian (SUs V and VI), has been identified and dated to between 14000 and 11000 BP. The site features a rich lithic assemblage, along with ornaments such as shell beads and deer canine, and a bone industry dominated by needles, as well as a good number of decorated plaques. Hearth features were identified in SU II. Peña de Estebanvela is one of the few sites of inland Spain featuring a Magdalenian sequence that have been studied under a multidisciplinary approach.

The archaeological work carried out so far at Peña de Estebanvela focused mainly on the upper units. Thus, the majority of finds come from levels I, II and III. End scrapers exist in all six levels; all are made from flint (Cacho et al. 2006). Flint types are not yet well defined, as raw materials are currently being studied. Still, considering a generic classification based on colour, there is a certain diversity of shades. This does not necessarily mean different raw materials, as flint nodules often feature different shades. In broad terms, white flint is dominant, with two other good quality, fine-textured flint types standing out as well: a translucent brown coloured flint and a greenish flint. Level III features a concentration of nodules of the latter, which appears to be a raw material reserve.

2. Use-wear marks

2.1. Methodology

All samples, either experimental or archaeological, should be cleaned prior to examination under the microscope. Cleaning procedures should never damage the samples. Tools were immersed in a 10% HCl solution for 3 minutes, followed by immersion in a similar solution of potassium hydroxide (KOH) for the same amount of time. Before and during examination, the surface of tools should be cleaned with a 50% acetone-alcohol solution to remove grease and other residues resulting from artefact handling (Plisson 1985). Any remains of the cleaning solutions must then be neutralized by means of successive immersions in abundant deionised water in an ultrasonic cleaner.

Use-wear analyses were conducted using two different optical pieces of equipment: a Leica type Wild M3C stereo microscope and a Leitz DMRX transmitted/reflected light microscope with magnifications from 50 to 400x, featuring Nomarski interference contrast (DIC), which provides a resolution comparable to electron microscopy (Pignat and Plisson 2000), and can be connected to a digital camera. In both cases, ZoomBrowser EX 6.51 and Helicon-Focus 5.0 software were used, the latter for correcting depth of field problems.

2.2. Use-wear analysis

Due to the huge amount of lithics found at La Peña de Estebanvela (in excess of 50000), a meaningful set of tools from the 1999 through 2009 field seasons was selected for the use-wear analysis of end scrapers, by means of a random sample of size n (n=160), using Microsoft Excel ©. A column was used for the acronyms of all tools. Next, a random number was assigned to each tool, using Microsoft Excel's "RAND" function, which returns uniformly distributed random numbers between 0 and 1. Tools were then sorted by the assigned random numbers and the 160 end scrapers with the highest numbers were selected. The bulk of the sample comes from levels I, II and III, as the older levels (IV, V and VI) feature a much smaller excavated area and scarce lithic remains, which is a major constraint for diachronic studies.

Table 23-1 shows an overview of use-wear marks identified in the study sample. It is important to stress that nearly half of the collection (41.7%) does show traces of use. Level IV features the highest percentage, but the study sample is rather small. Levels I and III stand out at 57.9% and 51% respectively. Level II, on the contrary, shows a lesser amount of used tools, down to a little less than a third of the sample, due to the higher incidence of soil abrasion. We should also stress that 3 tools from level III and 1 from level II showed very clear technological marks only, which led us to consider them as cores and not tools, as we shall discuss further on. Finally, 44 tools, slightly more than one quarter of the sample (27.5%), showed no marks of any kind, either use-wear, technological or alteration marks.

LEVELS	WITH USE-WEAR MARKS	WITHOUT ANY MARKS	ONLY TECHNOLOGICAL MARKS	SOIL POLISH	TOTAL
I	22 (57,9%)	9 (23,6%)	-	7 (18,4%)	**38**
II	22 (31,9%)	26 (37,6%)	1 (1,4%)	20 (28,9%)	**69**
III	24 (51%)	9 (19.1%)	3 (6.3%)	11 (23.4%)	**47**
IV	3 (100%)	-	-	-	**3**
V	-	-	-	-	**-**
VI	-	-	-	3 (100%)	**3**
TOTAL	**71 (41.7%)**	**44 (27.5%)**	**4 (2,5%)**	**41 (25.6%)**	**160**

Table 1: Overview of marks by levels

2.3. Level I

More than half of the tool sample from Level I (57.9%) shows traces of use, whereas the remainder does not show any type of marks (23.6%) or only shows soil abrasion (18.4%). The most common tools with marks are end scrapers on flake, immediately followed by those on blade. On the contrary, we could not point out any type of function neither on distal ends nor on thumbnail end scrapers or end scraper-truncations.

As far as worked materials are concerned, hide-working is the main activity, at 63.6 %, to which we must add 3 further tools with unclear hide-working marks and yet another one that also showed traces of work on some other hard material. This fully agrees with studies carried out at other sites (Collin and Jardón 1993). Thus, 77.2% of the end scraper study sample was used for hide-working. Most of the tools are made on flakes; the use of end scrapers on blade is residual, and these tools show traces of work on hard materials or on undetermined soft materials. This is surprising, as both types were proportional in the selected sample.

Striations and the distribution of use-wear marks on the ventral vs. dorsal surfaces are the more relevant data that can provide information on tool use (Mansur-Franchomme 1986). Actions identified in level I are mostly planing (40.9%), closely followed by scraping (31.8%). Both actions are very similar, the only difference being the inclination of the tool in relation to the worked material, that is, in a rubbing action there is more contact between the ventral surface and the worked material, at a low angle of some 30º, whereas when scraping both surfaces keep the same distance from the worked material, at roughly 90º (Gutiérrez Sáez 1996). It should nevertheless be stressed that there is a significant number of end scrapers with traces of use for which no specific action could be identified.

The average tool size ranges from 32.38 to 6.85 mm, all tools showing traces of hide-working. There is a single tool of larger size (40x40x9 mm), featuring traces of work both on hide and on hard material. The smallest tool, on the other hand, was used for working soft material, but a single case is not really meaningful. Thus, end scrapers used for hide-working feature lengths between these two tools, used on other materials. If we consider the dimensions of the distal ends only, we can see that the hardest materials are worked with the broader, more robust tools. Regarding height, there are no striking differences. The smaller end scraper, though, used on soft material, does feature an angle of larger proportions but, as already mentioned, being a single tool this is not a relevant issue.

2.4. Level II

The distribution of use-wear marks in this level is different from level I. The percentage of use-related end scrapers is lower and there is a larger number of tools without any kind of traces. On the other hand, this level features a higher incidence of soil abrasion (28.9%). We also identified, for the first time, a tool that shows technological marks only, and no use-wear marks. Distribution by tool types shows more diversity, which can be due to the larger sample size. Regarding typology, end scrapers on flake are predominant, nearing almost half of the sample (47.8%), while the thirteen end scrapers on blade only reach 18.8%.

Not unlike the first level, hide is also the more frequently worked material in level II, at 45.4% but reaching 54.4% if unclear cases are considered as well. Therefore, hide-working accounts for a little more than half the sample, while in the former level it reached up to nearly two-thirds. This is due to the higher presence of work on hard materials and wood (27.2%), and to the fact that 2 tools showed use-wear marks that could not be specifically identified.

Regarding worked materials, the situation is similar to the former level, with predominantly low angle actions, planing, and a minority of tools for which no specific motion could be identified. As far as the relation between tool dimensions and worked materials is concerned, higher lengths are related to hide (33.2 mm) and possibly hide (25.5 mm). Width ranges from 29 to 19 mm, lower values being related to hide. Broader tools (29 mm) were used on wood, even though they are not so much broader than those used on hide. Regarding the choice of distal ends for the different actions, there is, in broad terms, a certain uniformity concerning width (16.19 to 29 mm) and angle (60 to 70º).

2.5. Level III

Half of the tools from level III show function-related marks. The remainder are mostly tools that either show no marks or were unsuitable for use-wear analysis due to the high incidence of soil abrasion. Three end scrapers stand out in this level, showing traces of technical knapping gestures (percussion) but no traces of use. As in level I, the most common types are end scrapers on flake, followed by end scrapers on blade, the latter showing a higher incidence of use-wear marks.

In level III, hide-working is clearly dominant at 58.3%, a higher percentage than level II (Plate 23-1, a). Regarding other materials, there is evidence for the use of tools on wood and bone, but only on very limited terms, as usual. On the level III action table, scraping is the more frequent action, but barely more than planing. Nevertheless, specific actions could not be determined for a large number of tools. As to the relation between tool size and worked materials, most tools feature similar dimensions, the only exception being wood-working, for which much smaller tools were selected. Thicker tools were used on hard materials + hide and on soft materials. In broad terms, other values are rather uniform as far as working other materials is concerned.

2.6. Levels IV, V and VI

The excavated area in these levels so far is rather small, so the random sampling did not include any tools from level V. Three tools from level IV were selected for use-wear analysis, two of which show traces of hide-working; one was used for planing, and no action could be determined for the other. A third tool scraped soft material. As far as the oldest level in the sequence is concerned (level VI), the three tools selected for study had to be disregarded due to soil polish.

3. End scraper functionality

At Peña de Estebanvela, the use of end scrapers for hide-working clearly prevails over other activities. Table 23-2 shows the tool/use relationships in the different levels of the sequence. As we have mentioned before, some authors establish a distinction between fresh and dry hide. It is indeed possible to tell one from the other when working with experimental, good quality flint tools that have been used for longer periods. Still, due to differences in raw material quality and varying degrees of intensity resulting from working times, it is extremely difficult to establish that distinction on archaeological material.

WORKED MATERIALS	I	II	III	IV	TOTAL
Hide	14 (63,6%)	10 (45,4%)	14 (58,3%)	2 (66,66%)	**40 (56,3%)**
Hide?	3 (13,6%)	2 (9,1%)	1 (4,2%)	-	**6 (8,4%)**
Soft material	1 (4,5%)	2 (9,1%)	-	1 (33,33%)	**4 (5,6%)**
Hard material	2 (9,1%)	4 (18,2%)	-	-	**6 (2,8%)**
Wood	-	1 (4,5%)	1 (4,2%)	-	**2 (2,8%)**
Wood?	-	-	1 (4,2%)	-	**1 (1,4%)**
Bone	-	-	1 (4,2%)	-	**1 (1,4%)**
Hard material + hide	1 (4,5%)	-	1 (4,2%)	-	**2 (2,8%)**
Undetermined	1 (4,5%)	3 (13,6%)	5 (20,8%)	-	**9 (12,6%)**
TOTAL	**22 (30,9%)**	**22 (30,9%)**	**24 (33,8%)**	**3 (4,2%)**	**71 (100%)**

Table 2: Worked materials by levels

Amongst the Peña de Estebanvela lithic assemblage, and from 48 end scrapers related to hide-working, only 4 showed clear traces of work on dry hide: 2 from Level I, 1 from Level II and another from Level III. This does not necessarily mean that all the other end scrapers were used on fresh hide only, as use-wear marks were often faint, indicating a low intensity of use.

Another issue regarding this type of tools is the presence of ochre on the distal end (Audoin and Plisson 1982). Detection of this abrasive on tools from Estebanvela is not feasible either, due to the fact that sediment from the different levels has a reddish shade and it is often difficult to differentiate between sediment residues and the purposeful addition of ochre. Thus, only 5 distal ends featured clear evidence for the use of ochre.

Consequently, that difficulty in determining the presence of ochre on the end scrapers under study, as referred above, kept us from drawing conclusions and establishing a relationship between this material and hide-working. Nevertheless, this does not deny the use of ochre, which has been clearly established in other sites (Audouin y Plisson 1982; Philibert 1994).

The use of end scrapers on other materials is rather scarce. Working hard materials reaches up to 7% (Plate 23-1, b), while wood and other soft materials only reach 4.2% and 5.6%, respectively. Thus, the Peña de Estebanvela end scrapers show evidence for a range of activities consistent with results from other sites.

Finally, we ought to differentiate between the different working edges of end scrapers, particularly in the case of double tool types and of end scrapers on blade, which feature a greater diversity of potentially active parts. The location of working edges was determined on the basis of use-wear marks (polishes, striations, edge rounding and edge damage) identified on the different tool edges. Distal edges were, without a doubt, the choice working edges, and so it is at Peña de Estabanvela as well. Still, it is not uncommon to find other active parts located on the lateral edges of end scrapers, although to a lesser extent (Plisson 1985; Jardón 1990; González and Ibáñez 1994; Jardón and Sacchi 1994; Calvo 2004).

The Peña de Estebanvela end scrapers show a low degree of multiple use, which is only observed on 13 tools (18.3%). In level I, end scrapers featuring lateral uses are related to meat-working, whereas distal edges are related to hide-working. Using a sharp edge, located close to an end scraper's distal end with traces of hide, to work on meat or soft materials might indicate the elimination of thick residues from a hide's inner layer. Among the double end scrapers from this level, only one tool showed traces of use on the two ends, both on dry hide. The two end scrapers from level II feature the same type of activity, both on the distal and on the left lateral edges. Regarding end scrapers from level III that show traces of use on the lateral edges, one tool combines work on meat and hide on the right edge and hard material + hide on the distal edge, while the other tool only features an undetermined function on both active lateral edges.

As far as double end scrapers are concerned, a single tool shows use on wood, on both ends. In level IV, out of three analyzed tools, two show multiple marks, the first on hide and soft material and the second only on hide.

All of the above might indicate a specialized use of these tools, the distal edge being preferred, as the use of other edges is limited to a few particular cases (8 tools, 11.2%), in which the lateral edges were used for hide-working, to eliminate such residues as fat and meat; the identification of these materials is not always possible, especially in cases of low work intensity.

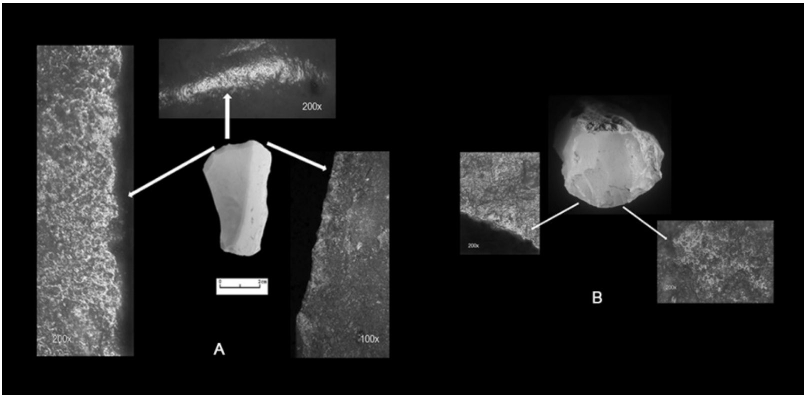

Fig 1. A: Endscraper with hide-working marks (ETV´2006/B15-C15/III/14/21 - Photo: I. Martín). B: Endscraper with hard material work marks (ETV´06/E9/III/8/4 - Photo: I.Martín)

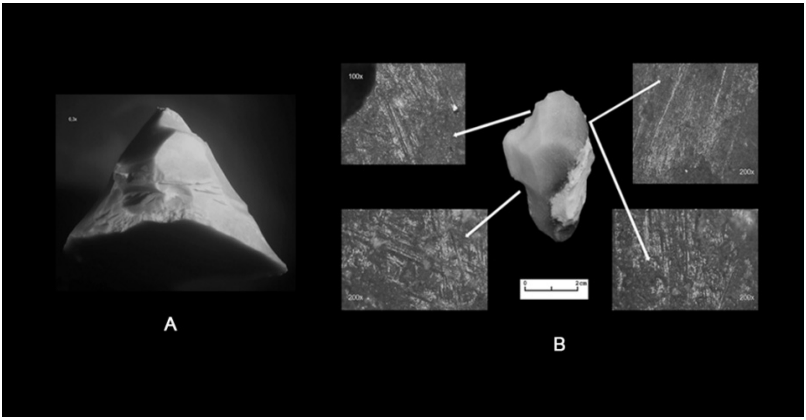

Fig 2. A: Endscraper without use-wear marks due to rejuvenation (ETV´07/H10/I/7/1238 - Photo: I.Martín). B: Tool with technological marks: percussion striations (ETV´03/E8/III/5/16 - Photo: I.Martín)

Despite the fact that the archaeological assemblage unearthed at Peña de Estebanvela features a high percentage of use, there is a significant number of end scrapers without use-wear marks. This issue has already been addressed by several authors. The functional study carried out at Cova Alonsé (Montes & Domingo 2013) is a recent example: 50 out of 75 artefacts did not show any use-wear marks. So, and even though we cannot rule out the possibility that some end scrapers may have been produced for future use but never actually used, everything else seems to indicate that tools were discarded shortly after their last resharpening (Hayden 1979, 14; Plisson 1985, 313), even if they do not feature a symmetrical wear that might contribute to establishing a unitary pattern.

4. Discussion

Several authors consider hide-working as the main activity when discussing end scraper use and this has also been confirmed in Peña de Estebanvela (Martín Lerma et al. 2008). Hide can be processed while still fresh, as well as dry and soaked. Thanks to ethnoarchaeology, hide-working has been well documented (Hayden 1993; Jardón 2000). On the other hand, experimental programmes have provided a record of marks resulting from different processes, even if determination is not always easy when it comes to hide and soft materials.

On the subject of hide-working, a few issues ought to be highlighted:

- End scrapers used on soft materials, which might be related to fleshing along with hide-working, could be included in the stage immediately following skinning. This stage would feature fleshing with initial scraping to eliminate the remains of meat and fat from hides, using either cutting implements or end scrapers. Five tools from Peña de Estebanvela show traces of work on meat on the distal ends and on four lateral edges; two of the edges also showed hide-working marks.

- Only 5 tools showed clear traces of work on dry hide. These tools could be included in different stages of the process, such as pseudo-tannage, shaving, tanning andsoftening. In any case, they are to be included in advanced stages of hide-working but do not bear enough evidence for establishing an angle of motion pattern.

The addition of ochre may also be included in different stages, as it might equally be related to pseudo-tannage, shaving and tanning, but to finishing tasks as well. Five end scrapers might have been used in any of these stages. Three of them show traces of hide and ochre on the distal end and a fourth one also on the lateral edge. One of the others is an end scraper on flake, featuring ochre residues associated with traces of work on hard materials, and the last tool does not show any use-wear marks. Both the use of ochre and dry hide working are usually associated, by several authors, with more stable settlements, as constant group mobility would increase the difficulty of such activities (Keeley 1988; Hayden 1993, 101).

5. Other functional aspects

Resharpening/rejuvenation: Working fleshy and greasy materials such as hide increases the rate at which the active parts of a tool wear out. Thus, frequent resharpening is required to recover the end scraper's functional abilities. The main criterion used to identify resharpening was the presence of use-wear polish cut by microflake scars caused by rejuvenation, on high zones of the distal edge (Ibañez Estévez and González Urquijo 1999). This was mainly observed on end scrapers on blade, from several levels; and also on one tool on a blade-like flake. Another criterion was the presence of stepped distal edges, resulting from successive retouch phases (Plate 23-2, a). In this case, end scrapers did not show any marks, either because any previous use marks were obliterated during rejuvenation, or because the tools were used for a short time only, not long enough to produce new marks.

Technological marks: a small group of 4 tools showed only technological marks, namely percussion blow striations (J. J. Ibañez et al. 1987). As these tools showed no traces of use, we have to address the possibility that these are in fact small bladelet cores, and not true end scrapers (Plate 23-2, b). On the other hand, out of 3 nucleiform end scrapers included in the sample, one from level III also featured clear hide-working marks.

Hafting: Most end scrapers used for hide-working were hafted, but hafting traces are hard to identify and to differentiate from technological marks. The presence of polish on high, not active areas may be an indication of hafting (Calvo 2002; Rots 2010). In Estebanvela level III, 3 end scrapers on flake show micro-polish from hard materials on the proximal end, which might indicate wood, or possibly bone/antler hafting; we cannot be more specific. Another criterion, such as the presence of tongue fractures on the ventral surfaces, is more widely documented in levels I and II. As end scrapers both on blade and on flake show hafting traces, no particular type or any standadrd length could be defined, as far as hafting is concerned.

Soil abrasion: This particular type of mark, on any archaeological material, is a common feature and a major obstacle for the identification of use-wear traces; sometimes, use-wear analysis is simply impossible. Should such marks be present on other parts of a tool, besides the active edges, we should consider that they result from alteration processes, and tools are therefore not suitable for a functional analysis. This does not necessarily mean that tools were not used, but the presence of alteration marks on top of use marks rules out any chance of indentifying a tool's function. At La Peña de Estebanvela 41 tools, 25.6% of the study sample, showed this type of problem, which is quite common in the use-wear study of archaeological assemblages.

6. Conclusions

The use-wear analysis of 160 end scrapers has shown the presence of use-wear marks in nearly half of the sample, mostly from levels I and III. Tools were mainly used for hide-working, but also on other materials, like wood, bone and antler, to a lesser extent. Data analysis led the authors to conclude that end scrapers from La Peña de Estabanvela were used in different stages of the process, from the initial cleaning of hides to remove the remains of meat and fat, to more advanced tasks, like using ochre for the final tanning. Interestingly, 4 tools showed only well defined technological marks, and must therefore be considered as cores, not tools.

Acknowledgements

We would like to thank the Junta de Castilla y León and the Consejo Superior de Investigaciones Científicas for their financial support to this research project (CyL-14-40.024.002.01). And we couldn't possibly close this paper without thanking Carmen Gutiérrez for her always helpful advice, Jesús Rodríguez for his collaboration in computer tasks pertaining to the random sample, Armando Lucena for the English translation, and the Departamento de Prehistoria y Arqueología de la Universidad Autónoma de Madrid for allowing us to use all the facilities of its Laboratory.

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CHAPTER TWENTY THREE

THE PROTO-AURIGNACIAN "KNIVES" OF THE RIPARO MOCHI (BALZI ROSSI, ITALY)

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Abstract

Based on current evidence, the base of Unit G of Riparo Mochi (Balzi Rossi, Italy), dating to around 37-36.5 ka BP (41.5 cal BP), is the oldest directly-dated Aurignacian assemblage in Italy. In this paper, the lithic assemblage coming from this layer has been functionally analyzed. From a technological perspective, the assemblage is mainly represented by a bladelet production made from non-local raw materials and by an elongated-flake production made from local flint. Regardless of this technological difference, the lithics have been used for tasks linked to the treatment of animal materials. In particular, besides retouched tools showing traces of hard materials (bone or antler), unretouched tools show traces related to butchering or cutting soft/medium material, such as meat and hide. According to the type and distribution of the macro and microwears, a possible reconstruction of the hafting technique is also suggested.

Keywords: Riparo Mochi; Balzi Rossi; ProtoAurignacian; Functional analysis; Bladelets

1. Introduction

The rockshelter of Mochi (or Riparo Mochi) is located in the Balzi Rossi area on the Ligurian coast, very close to the France-Italy border. The site was discovered in 1938 and excavated systematically during several seasons by A. C. Blanc and L. Cardini of the Istituto Italiano di Palaeontologia Umana (1941, 1942, 1949, 1959) and by A. Bietti (University of Rome) from 1996 to 2005 (a history of the site in Douka et al. 2011).

The Riparo Mochi shows a 10 metre-deep sequence from Middle to late Upper Palaeolithic. The analyzed lithic collection comes from the base of Unit G that provided proto Aurignacian archaeological evidence (Palma di Cesnola 1993; Broglio 1994, 1995; Mellars 2005). Recently, the base of layer G has been dated to around 37-36.5 ka BP (41.5 cal BP) (Douka et al. 2011); and thus, this is the oldest directly-dated Aurignacian assemblage in Italy.

2. The lithic sample and raw material

The lithic collection (Table 24-1 top) comes from the base of Unit G, that is to say a deposit of approximately 20-25 cm thick in an excavated area of about 15 square metres. The assemblage is made of 647 blanks among cores, blades, flakes and fragments (broken items that may be classified from a technological and/or typological perspective); 296 debris, (unbroken flakes of less than one cm in length); and 234 waste material, such as indeterminable fragments.

It was possible to determine the type of raw material on more than the 80% of the blanks (Grimaldi and Porraz, in prep.). Several types of French flint come from outcrops ranging from 15-20 to more than 150 kms from the site; Italian raw materials are characterized by Liguria jasper–the nearest outcrops are found at least 80-100 kms from the site–and in central Italy flints coming from outcrops at more than 200 kms from the site (all distances are calculated as the crow flies). Finally, a local flint, known as the "Ciotti" type, has been knapped on site.

French and Italian raw materials have been introduced to the site mainly as pre-formed cores in order to produce blades/bladelets. Flakes made on these raw materials are mainly related to the rejuvenation process of the cores and they may only rarely be interpreted as elongated sub-products of blade production. On the contrary, Ciotti flint was knapped in order to produce elongated, blade-like flakes through the unidirectional reduction sequence of local rounded pebbles .

	Functionally analyzed collection						
	Cores	**Blades**	**Flakes**	**Fragments**		**Debris**	**Waste**
France	1	93	33	8	**135**	33	20
Local	19	43	192	86	**340**	102	113
Italy	1	38	14	5	**58**	24	28
Indet.	2	61	32	19	**114**	137	73
	23	**235**	**271**	**118**	**647**	296	234

	Blades		**Flakes**		**Fragments**			
	N.	**%**	**N.**	**%**	**N.**	**%**	**N.**	**%**
France	32	34	1	3	0	0	**33**	24
Local	19	44	22	11	7	8	**48**	14
Italy	12	32	2	14	1	20	**15**	26
Indet.	1	2	1	3	0	0	**2**	2
	64	**27**	**26**	**10**	**8**	**7**	**98**	**15**

Tab 1 - (top) The proto Aurignacian lithic collection: blanks vs. raw material provenance. Debris and Waste material have not been included in the functional analysis. (bottom) The proto Aurignacian knives: blanks vs. raw material provenance.

		Longitudinal	**Indet.**	
Animal	**France**	23	2	**62**
	Local	26		
	Italy	11		
Indet.		19	17	**36**
		79	**19**	**98**

Tab.2. The proto Aurignacian knives: relationship between worked material, action and raw material provenance.

3. The functional analysis and study method

Almost the entire lithic collection found at the base of Unit G has been functionally analyzed. Interestingly, while retouched items such as side scrapers, end scrapers, and awls show traces related to animal hard materials (scraping or engraving bone/antler, see Fig. 1), most unretouched items show traces related to longitudinal actions on animal soft materials (meat and/or fresh hide). Several items have also been used for butchering activities. This paper will focus on these cutting tools that will be discussed under the name of "Knives".

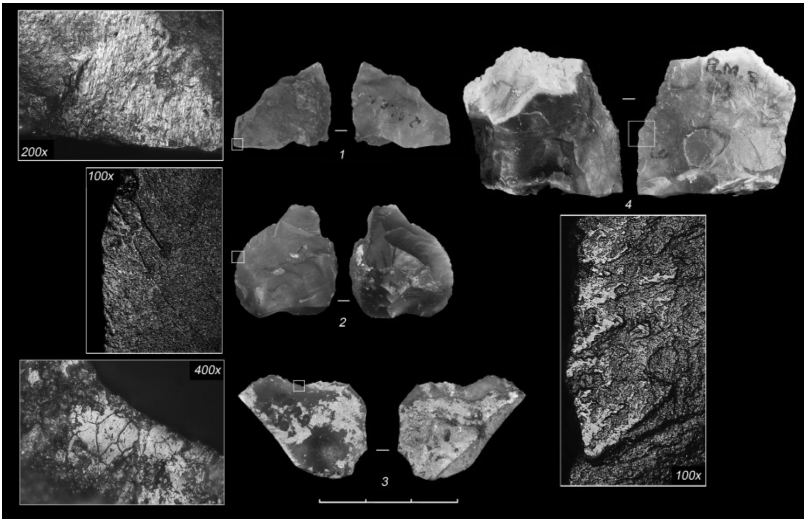

Fig. 1. The ProtoAurignacian (base of Unit G) of Riparo Mochi: use wears of engraving (1) and scraping (2-4) hard animal material (Photo: S.Grimaldi)

Knives were washed at the time of the excavation but their state of preservation is good. Their surfaces do not show concretions; only a light alteration due to fire is present on some blanks. In this study, lithics have been cleaned only with alcohol. Some of them also underwent a cleaning process with acetone in order to remove the ink that was protected by a varnish covering. Lithics have been analyzed through the Low and High Approach (following Semenov 1964 and, among others, van Der Dries and van Gijn 1997; Gonzalez Urquijo and Ibanez Estevez 1994). Technical devices are a binocular microscope Leica MZ 12.5 with magnification grades ranging between 8x and 100x and by a microscope Leica DM2500M with 50x, 100x, 200x, and 400x magnifications.

4. The “Knives”

The number of blanks recognized as Knives (Table 24-1 bottom) is 98: 64 out of 235 blades (27% of blades), 26 out of 271 elongated flakes (10% of the elongated flakes) and 8 out of 118 fragments (7% of the fragments). They represent 15% of the 647 functionally analyzed lithic items. It is worth mentioning that, as far as the local “Ciotti” flint is concerned, the truly elongated flakes–i.e. those showing a symmetrical, blade-like morphology–have been studied in the Blade category while elongated flakes with an irregular morphology have been classified in the Flake category.

Percentages are much more relevant if raw material provenance is concerned: knives made on French or Italian flint represent one-third of the blades made on these raw materials (34% and 32% respectively). Even more interestingly, knives represent 44% of the blade-like elongated flakes made on local Ciotti flint.

Dimensionally, knives show quite varied dimensions: from 6 to 35 mm in length (average 17.8); from 2 to 49 mm in width (average 13.1), and from 1 to 15 mm in thickness (average 3.1). The active edge angle is ranging from 20° to 60° with an average of 29 degrees.

Table 24-2 shows the relationship between worked material, action and raw material. Three main longitudinal actions have been observed: for butchering (Type B), for cutting meat (Type M) and, more rarely, hide (Type H). These actions should not be seen as independent ones; they could be interpreted as the results of several tasks involved in the same functional process, that is to say the treatment of animal tissues.

It was possible to define action and worked material with a good degree of confidence on 60 knives (61%); it was possible to define the longitudinal action on 19 knives out of 98 while only two knives provided evidence for animal tissues but no clear evidence of the action. Seventeen knives did not show any diagnostic use-wear; they have been classified among the Knives only because of the presence of hafting features (see below).

From a typological point of view (Table 24-3), 24 items show formal retouch morphologies such as Denticulates, Notches, Truncations; no clear distinction among types and raw materials is visible. Retouch is never encountered on the active edge and it seems to be much more related to the hafting technique.

	Backed tool	Denticulate	Notch	Retouched tool	Side-scraper	Truncation		Unretouched	
France	3	2	4		1	1	**11**	22	33
Local			3	2	1	2	**8**	40	48
Italy		1	1	2			**4**	11	15
Indet.	1						**1**	1	2
	4	**3**	**8**	**4**	**2**	**3**	**24**	74	98

Tab.3. The proto Aurignacian knives: retouched blanks vs. raw material provenance.

Knives are macroscopically (up to 50 magnifications) characterized by one–but some blades may have two–active edges and usually show sliced and/or bifacial scars (Fig. 2, a). Active edges show irregularly distributed scars with feather terminations in types B and M; type B and H show more developed–in the sense of distribution and intensity–scars while active edges of type M are better preserved.

Microscopically (from 100x to 400x), all types of active edges are characterized by the presence of a "greasy lustre" (Gijn 1990) usually concentrated close to the edge, and with a different level of distribution and brightness even on the same active edge (Fig. 2, b). Type B is also characterized by the presence of localized contacts with hard animal material (bone/antler). Type H shows a light rounding active edge which is often interrupted by scars with feather terminations, and a distribution of the polish which appears to be more concentrated on the edge; some striations may occur.

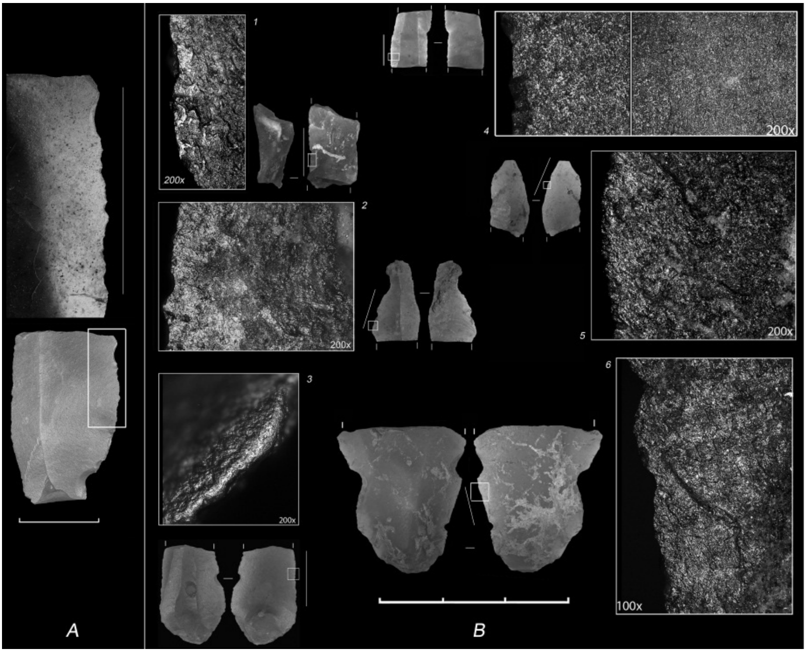

Fig.2. The ProtoAurignacian (base of Unit G) of Riparo Mochi: examples of Knives. Modification of the active edge (A); use wears of cutting soft animal tissues (B)(Photo:S.Grimaldi)

Macro and microwear traces are rarely observed on the entire length of the edge; that is to say that only a part of the edge of the tool is functionally active, the rest of it is usually related to the hafting technique. Then, functional and hafting traces may be sometimes superimposed in some spots of the active edge.

5. The haft

During the functional analysis, a recurrent presence of some features with no apparent relation with the active edge has been observed on the knives. The way that these features (hereafter named as "hafting features") are associated one to another and the pattern of their distribution all around the tool–together with the microscopic observation of use-wears–allowed a consideration of them as diagnostic elements for the identification of hafting techniques (see for instance, Rots 2010). In order to define these hafting features, the active edge of the knives is conventionally positioned on the upper left side of the tool (Fig. 3, a); consequently, the blanks are oriented regardless of the position of its technical characteristics such as the butt and upper or ventral surface. Hafting features are produced intentionally or mechanically: retouched edges, retouched notches, fractures and, only for flakes, the "debordant" lateral side are expected to be produced by humans during the production process of the tool in order to facilitate its insertion into the handle; on the contrary, impact scars, notches, and abrasions may be interpreted as mechanical alterations of the hafted edges produced during the use of the tool (Fig. 3, b).

The distribution of the hafting features observed in the 98 knives (Fig. 3, c) shows that: a) blades are always distally fractured; b) scars, abrasions, and more rarely, notches are always present on the fractured surface and this confirms that fractures have been made before use; c) retouched and unretouched notches are very often positioned in the proximal, non-active part of the active edge; d) the non-active edge–i.e., the hafted edge of the tool–is characterized by the random presence of many types of hafting features; in other words, no clear distribution pattern is recognizable. The main difference between blades and flakes is related to the presence among the flakes of unbroken items and of a "debordant" side.

From a microwear perspective, possible traces of the haft (Fig. 4) may be related with: a) the presence of striation in association with the retouched notches; b) bright spots, usually located close to or on the central ridges; c) oriented polish inside the retouched notches.

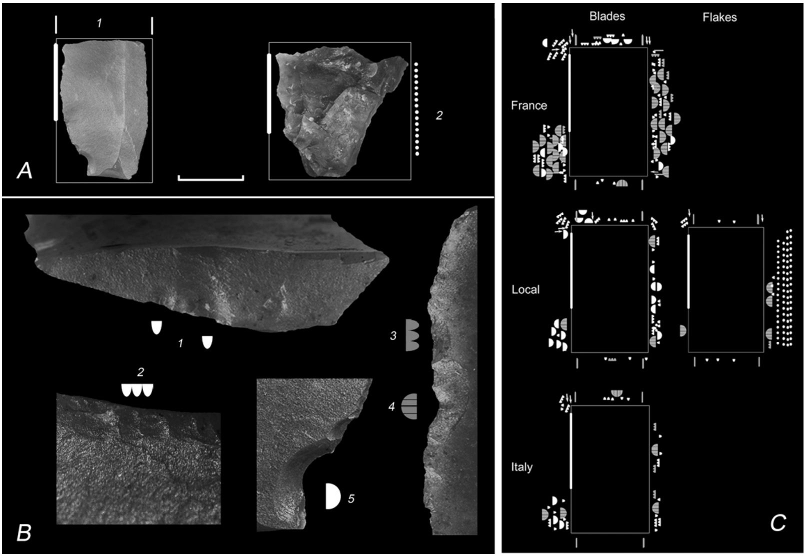

Fig. 3. Technological features are fractures (A1), “debordant” side of the flakes (A2), retouch (B3) and retouched notch (B4); mechanical features are scars (B1), abrasions (B2), and notches (B5). Distribution of the hafting features on the Riparo Mochi ProtoAurignacian (base of Unit G) Knives (C) (Photo:S.Grimaldi)

6. Experimental activity

In order to verify these observations, an experimental program was carried out. After several attempts in order to check different hafting methods, a pattern of macro and micro use-wears, similar to that described above, was provided by a hafting technique. A wooden shaft–but it could be made from hard animal material as well–is shaped in order to create a distal step (Fig. 5, a). The mesial part of an experimental blade made from grey flint of the "Biancone" geological formation (widespread in the Lessini Mountains, northeast Italy) was used as a knife (Fig. 5, c). Intentionally-made hafting features are the proximal and distal fracturation of the blade and the realization of a small retouched notch on the proximal part of the active edge. The distal fractured side of the knife will be placed against the step of the haft in order to fix the lithic. Then, lithic and shaft will be bound together with a string of sinew (Fig. 5, b). The active edge of the lithic is not parallel to the haft but shows an approximate 30 degrees of inclination. The presence of the retouched notch was very useful to avoid the cutting of the string against the cutting edge of the lithic. The hafted tool was used to cut fresh beef meat (about 10 minutes of work) and dry cow hide (about 3 minutes of work).

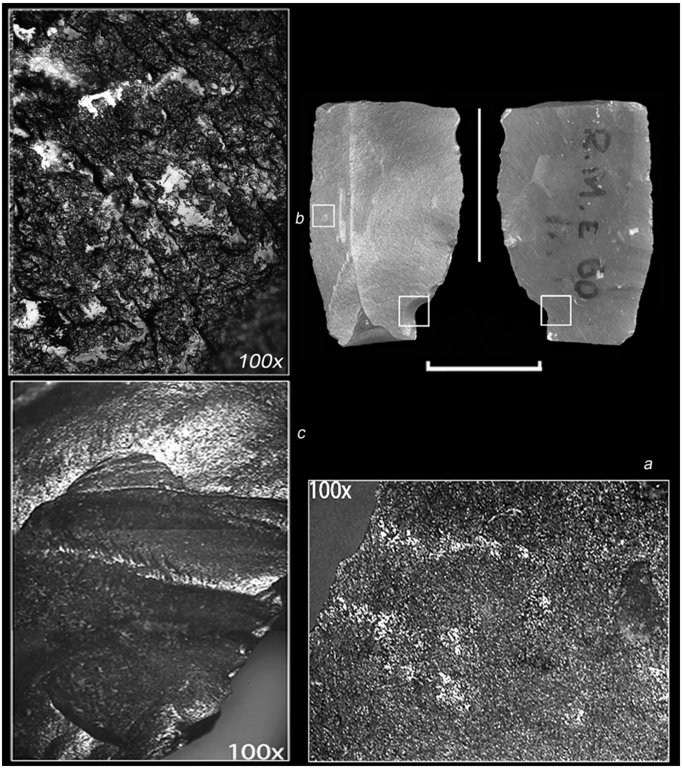

Fig. 4. The ProtoAurignacian (base of Unit G) of Riparo Mochi: use wears related to the hafting technique. a) striations on the ventral surface of a retouched notch; b) bright spots; c) oriented polish inside the retouched notch. (Photo: S.Grimaldi)

Macroscopically, the experimental activity produced alteration of the active edge, namely sliced and oriented scars (Fig. 6, a); microscopically, a polish formed along the cutting edge showing characteristics similar to those observed in type M of the Riparo Mochi knives (Fig. 6, b). The hafting technique–namely, the string of sinew–produced micro use-wear that may well be compared to those described for the archaeological knives (Fig. 6, c, d, e and compare with Fig. 4).

These experimental observations are just the first step of a program that will be developed in the near future.

Fig. 5. Experimental blade used as a knife (c), hypothetical reconstruction of the handle (a), and the hafted tool (b) (Photo:S.Grimaldi)

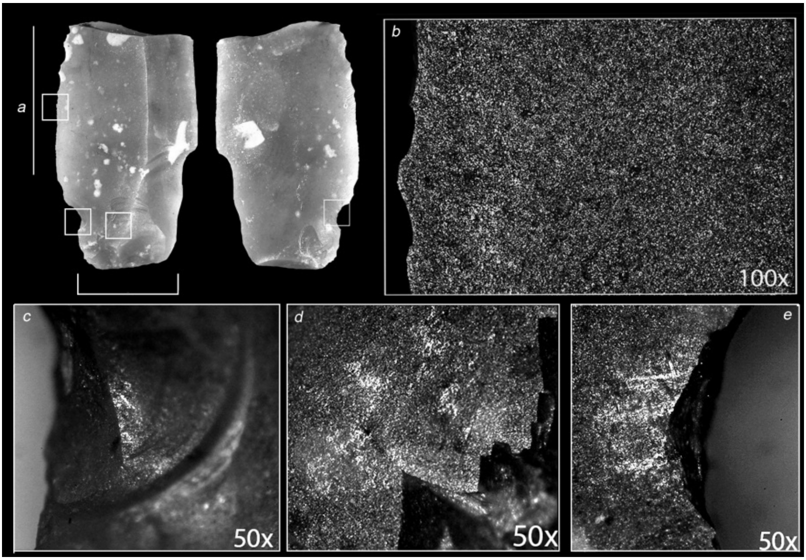

Fig. 6. Experimental use wears. The active edge with its macro modifications (a) and polish (b); the traces produced by the handle: inside the retouched notch (c), bright spot close to the central ridge (d), and striations associated to the retouched notch on the ventral surface of the blade (e) (Photo:S.Grimaldi).

7. Conclusion

The results of the functional analysis briefly presented here, have provided interesting data about the behaviour of the first Aurignacian human groups that inhabited Riparo Mochi.

First of all, it is worth mentioning that the scale of the excavation is small; even if it is recognized as a “site”, the Riparo Mochi is probably part of a wider area where the Protoaurignacian human groups could have been living. Accordingly, the Riparo Mochi could have been a spot where functionally specialized activities such as the treatment of animal bodies were carried out. The lithics showing traces of hard animal materials may be related to the reparation of bone/antler tools such as scrapers or projectiles.

Raw material provides another interesting item of information. Flakes made on local flint as well as blades/bladelets made on non-local raw materials have been used for the same functional purpose: among the former, truly elongated, one side “debordant” flakes have been selected; among the latter, length and width are not playing a relevant role in the selection of the blanks. It is possible to suggest that the technical objective of the lithic production was a blank much more suitable for a standardized hafting technique than for a specific functional purpose. The blades, with their standardized thickness and regularity of the edges, represent the best choice in this regard. Local flint is not suitable for blade production, and thus elongated flakes made on this raw material may sometimes represent a good substitute to the paucity of blades. In conclusion, raw material utilization is not indifferent to variations in raw material quality and abundance (but see Brantingham 2003) and procurement of stone is completely embedded within the mobility strategy; that is to say, raw material is procured only when encountered in the course of the "territorial mobility" or "long-term movements" (in the sense of Kelly 1992); rarely a result of specialized procurement forays such as by logistical task groups (Binford 1979) or a result of exchange systems between different local groups (but see Bietti and Negrino 2007).

Acknowledgments

I wish to thank those people who helped me in learning functional analysis: Sylvie Beyries for giving me the basic training, Hughes Plisson for his advices on microphotography techniques, and finally I am indebted with Ignacio Clemente Conte, my teacher, who patiently explained to me how to "dream" use wear. The town of Barcelona and the friends I met there during a 6-month training stage are now part of my life. The Department of Letter and Philosophy of Trento University authorized my stage abroad. Venue for the study was the *Laboratorio "Bagolini*" of Trento University (Italy) with its facilities. The *Soprintendenza per i Beni Archeologici della Liguria*, namely dott. Angiolo Del Lucchese, provided the permission for this study. Obviously, any mistake or weakness in this paper is mine.

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CHAPTER TWENTY FOUR

A MICROWEAR ANALYSIS OF HANDAXES FROM SANTA ANA CAVE (CÁCERES, EXTREMADURA, SPAIN)

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Abstract

The function of large cutting tools (LCT) is one of the most debated topics in Acheulian technology. However, little of the work published on archaeological materials has focused specifically on functional studies. Here we introduce the fundamentals of a methodological proposal based on SEM analyses and report the results of a preliminary use-wear study conducted on the lithic assemblage from the Santa Ana cave (Cáceres, Spain).

The surfaces of the analysed tools proved to be very well preserved. Discrete user-wear traces related to butchering activities were found, and wear features and their distribution allowed us to reconstruct the kinematics of the tools.

Keywords: Microwear, Acheulian, large cutting tools, SEM, Santa Ana

1. Introduction

Although the function of LCT is a recurring topic when dealing with Acheulian lithic assemblages, in fact little specific work has been done on functional analyses. While some interesting insights into functional aspects have been made from the perspective of the experimental evaluation of tool effectiveness, or based on ethnological comparisons as well as on simply technological deductions, the more direct approaches to this topic, namely use-wear and residue studies, have been scarcely applied to archaeological bifaces. This can be explained by several factors, the most important of which are those of a methodological nature. Several common features in Acheulian assemblages, such as the wide variability in raw materials (often including coarse-grained rocks), the large size of the tools, the intense edge retouch, or the various forms of postdepositional surface damage, seem to have restricted the applicability of microwear studies to their more characteristic classes of stone tools.

In this paper we present an archaeological case study aimed essentially at examining the feasibility of a microwear analysis on the Acheulian lithic assemblage of Santa Ana cave. We take advantage of this preliminary microwear study to introduce some methodological considerations regarding the functional analysis of LCT that have proved essential in achieving satisfactory results elsewhere.

Santa Ana cave is located in the western part of the Iberian Peninsula, in the karstic system known as El Calerizo de Cáceres (Extremadura). Systematic excavations in this area began in 2001, and have continued year-round without interruption up to today. So far, three test pits (one at the cave entrance and two inside the cave) and a corridor joining both areas have been excavated. The sedimentary succession has been described in the entrance area, and it is formed by 7 geological units numbered from bottom to top (Carbonell et al. 2005). Units 1, 2, 3 and 4 contain stone tools. Some bone remains without a clear stratigraphic context were also recovered. Unit 6 is a continuous stalagmitic formation sealing all the Pleistocene deposits and dated by U series at 130000 +/- 8000 BP. Unit 7 contains Holocene remains.

Acheulian technology is well represented in units 1 and 2, including both core and flake technology and LCTs (Carbonell et al 2005; Peña 2006; Aranda 2011). This assemblage is knapped mainly in quartzite, but other materials such as milky quartz and breccia are also present. All these lithic raw materials are available within a limited area around the site.

Among the heavy-duty tools, the handaxes and cleavers are well represented. The blanks of most of these tools are large flakes (for handaxes and cleavers), but also some tools were directly shaped on slabs (handaxes, picks, and some chopping tools). Regarding the shape of the morphotypes, the handaxes are mainly amygdaloids and elongated cordiforms (some of them showing prominent distal trihedrals), while the cleavers display convex or straight transverse edges.

This preliminary microwear study was conducted on a sample including three handaxes, two of them quartzite and one milky quartz, selected according to a macroscopic estimation of their good state of preservation.

2. Microscopic analysis methodology

The methodological approach we propose here aims to minimise some of the constraints commonly said to make difficult the use-wear analysis of Acheulian LCT, and follows what has proved effective in other Lower Palaeolithic assemblages (Márquez et al. 2001; Ollé 2003; Vergès 2003).

In order to record the different wear features stemming from the raw material of the tool, the actions undertaken, and materials worked, it was crucial that we employed sequential control of the experimental processes using a systematic scanning electron microscope (SEM) analysis (Ollé & Vergès 2008). In these type of experiments, several points on the active edge are documented at different magnifications before use and then at several successive intervals during the working process.

For the microscopic analysis, we used a JEOL JSM-6400 SEM and a FEI Quanta 600 ESEM, both with energy-dispersive X-ray analysis (EDX). The technical advantages of SEM observation with respect to conventional optical microscopes are the following: great field depth, the ability to work at high magnifications, high control and precision in the manoeuvrability of the samples, high image quality, and the possibility of chemically analysing the surface observed using EDAX. The gold coating of specimens necessary for high resolution imaging was effectively removed after analysis using a nitro-hydrochloric acid bath. The ESEM used in this study has the added advantage of a large specimen chamber, which can house samples up to 18 cm long without any mobility problems. When such a large chamber is not available, the problematic size of certain artefacts can be solved by means of high-resolution partial replicas. The replication technique followed in this study involved silicone-based dental impression materials (Provil® novo Light) to make moulds, and bicomponent rigid polyurethane resin (Synthesia corp.) to make casts.

3. Results

Firstly, it is important to point out that all the samples analysed showed an excellent state of surface preservation.

Secondly, and in terms or wear, both quartzite and quartz showed a similar pattern. These raw materials develop an attritional polish produced mainly through brittle behaviour. So, we basically found an abrasion of the quartz crystal edges on the surfaces of the tools, accompanied by some plastic deformation (compression) in the more exposed portions of the edge and the adjacent prominent points of the microrelief. In this case, this wear leads to quite significant edge dulling, progressively decreasing towards the interior of the face of the tool (the polish is easily identifiable in a 200 µm strip near the edge, and rarely extends beyond 500 µm). The flat crystal surfaces on the used edges show abundant linear features, mainly scratches in the form of lines of holes (formed from cracks caused by brittle fractures after material fatigue in the subsurface zone), but also some sleeks (linear plastic deformations) (Kamminga 1979; Knutsson 1988). The arrangement and some of the attributes of these linear features as well as the general distribution of the wear are the traits used to infer the tool's kinematics (type of motion, direction and working angle).

Aside from its morphological features, we can ascribe these deformations to use-wear and not to postdepositional processes because the inner parts of the tools, as well as some of the shaped edges, appear completely fresh, without any damage to the edges or to the surfaces of the quartz crystals.

The first piece we studied is a lanceolate handaxe shaped on a flake of fine-grained quartzite (Fig. 1). The bifacial retouch is mainly devoted to shaping the lateral edges. An abrupt cortical surface was preserved on the base and on the proximal half of the right lateral. Continuous use-wear was documented on the left edge, which is 160 mm long, convex in shape, and shows a straight profile. The edge angle measures 75-80º at the proximal and medial portions, and 50º at the tip. The distribution of the use-wear traces indicates a longitudinal unidirectional motion towards the base. These traits, combined with the presence of the abrupt preserved proximal zone, allow us to reconstruct a hypothetical manner of prehension. The appearance, intensity and combination of traits of the deformations fits with what we have reproduced experimentally when working on soft animal tissues, so we suggest that this handaxe was used for butchering activities such as skinning, dismembering and de-fleshing carcasses.

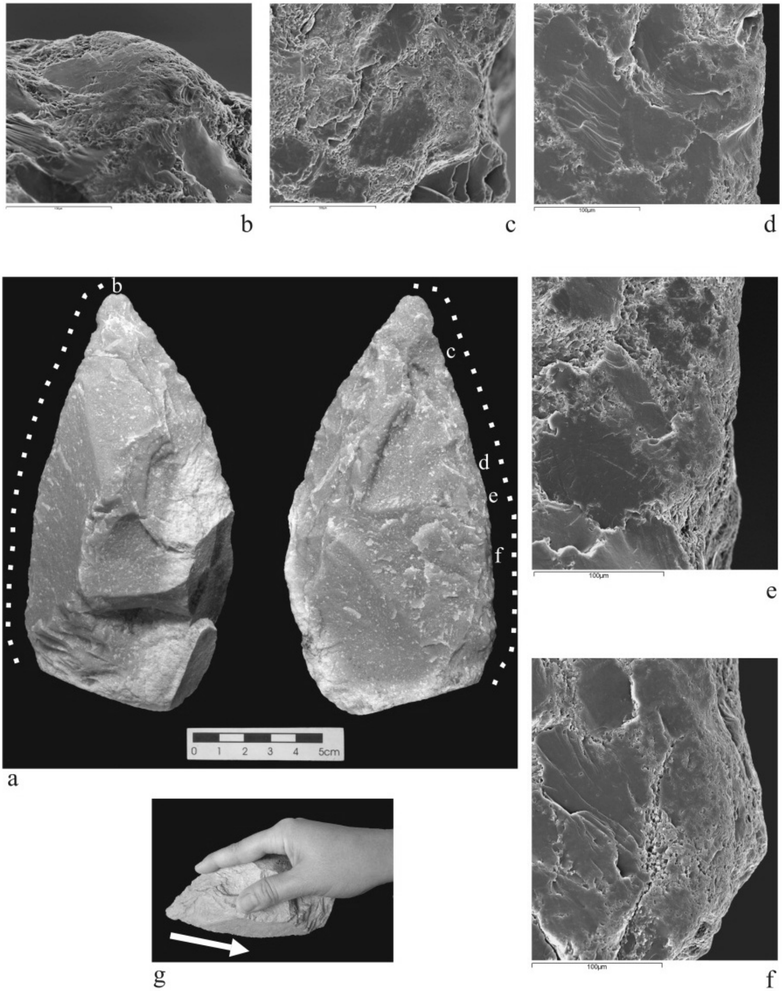

Figure 1. SA01, N2, J30-1 (158*78*34 mm). Artefact analysed under the conventional SEM, the tip directly on the original (because of an excavation fracture) and the rest by means of casts; a) Dorsal and ventral views of the quartzite handaxe (the dotted lines show the edge portions with use-wear traces; the white letters indicate the location of the images); b to f) Details under the SEM of the abrasion of the quartz crystal edges, initial plastic deformation leading to a smoothing of the surface, and some linear features. Note how in some points the wear led to a marked edge dulling (as in b or in f); g) Reconstruction of the prehension model after the distribution of the use-wear traces identified.

The second analysed artefact is an amygdaloid handaxe, made of a slightly more coarsely grained quartzite. Although the whole perimeter is affected by shaping, the proximal portion is quite abrupt. The right edge presents a huge alteration in the form of modern scars produced during recovery, which prevented us from conducting a microscopic analysis. In this case, use-wear was only recorded on the tip, which presents a convex dihedral measuring 50º. The traces are discontinuous and scarcely developed. There is some edge microfracture on the crystals, apparently produced by a transversal or oblique motion. The rest of the perimeter is absolutely fresh, and we can still observe some percussion traces produced by the hammerstone when the tool was shaped. On the whole, the traces recorded are too weak to infer any specific interpretation, but it could have been used for chopping actions making use of the convex distal edge.

The third artefact is an amygdaloid handaxe made of milky quartz (Fig. 2). The whole perimeter has been shaped by means of extensive bifacial retouch, leading to a continuous edge of 70/80º on the laterals and a slightly lower angle on the base. The right edge displays continuous use-wear, practically along all its length (130 mm). The edge is convex in shape and has a curved profile. The appearance of the deformations is quite similar to those observed on the quartzite, although more regular given the smoother microrelief and the bigger crystals in the case of quartz. The linear features are especially evident and recognizable. As in the first handaxe reported, the distribution of the deformations clearly indicates a longitudinal unidirectional motion. But, in this case, the direction of motion seems to have been inversed, towards the tip. This observation led us to infer a striking pattern of prehension, which has subsequently proved very effective for medium-sized handaxes. As for the other artefacts, the distribution and morphological features of the recorded deformations fit with what has been experimentally obtained after butchering activities. Some use-wear traces have been recorded on the opposite edge of this handaxe. In this case, they appear on isolated points and in a less developed stage. These deformations can be interpreted either as the product of occasional use of this left edge (with a similar angle but very sinuous) or as worn points that remained after hypothetical edge resharpening.

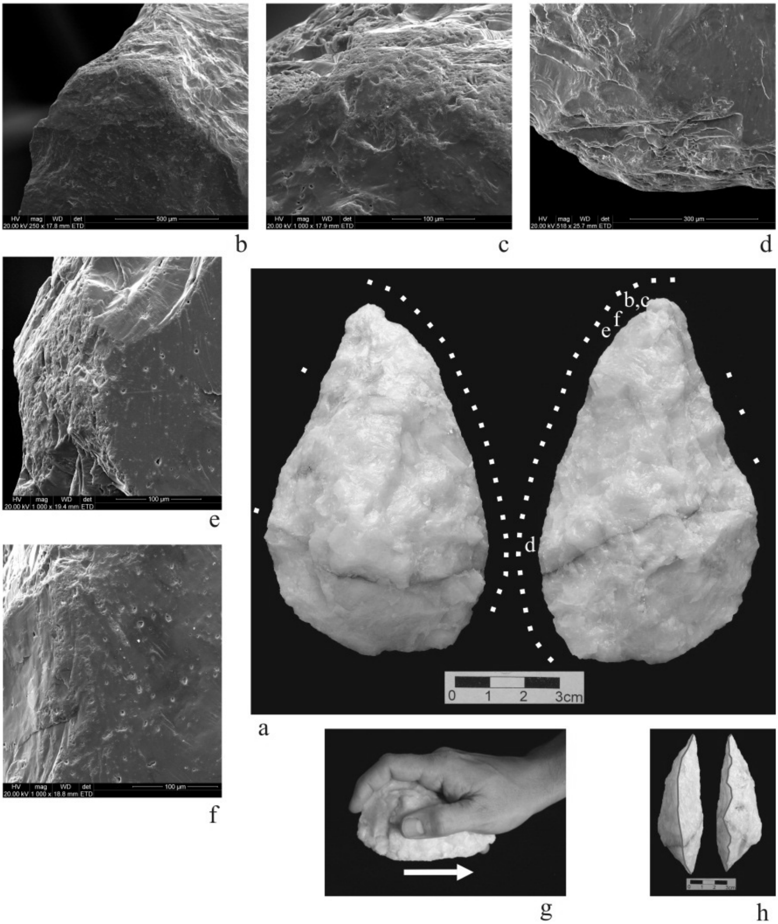

Figure 2. SA02, SI, R2135 (114*67*39 mm). Original artefact analysed under the ESEM equipment at high vacuum, with not need to resort to casts; a) Dorsal and ventral views of the milky quartz handaxe (the dotted lines show the edge portions with use-wear traces; the white letters indicate the location of the images); b) View of the worn edge at the handaxe tip; c) Detail of b at higher magnification to show the abrasion of the crystal edges and an initial smoothing produced by plastic deformation; d) Plastic deformation on a portion of the edge previously affected by microflaking; e) Dulled edge and parallel linear features on the crystal surfaces; f) Detail of a group of linear features from which we can infer type of motion and also direction; g) Reconstruction of the prehension model; h) Lateral profiles of the handaxe.

4. Conclusion

Some of the constraints commonly related with microwear studies on Acheulian lithic assemblages can be overcome by means of the methodological approach taken in this study. Nevertheless, to make functional inferences possible the materials must be in an excellent state of preservation, as in the case of the Santa Ana's assembladge.

With regard to our results, we were able to recognize the used edges and the tool-kinematics and to infer the generic action performed with each artefact. In at least two cases, the inferred use is closely related to butchering activities, but at the current stage of our research we would not dare to specify which phase of carcass processing these tools were used in.

In terms of general patterns of use identified, we observed that dihedral instead of trihedral edges proved to be the functional morphopotential units. Two of the handaxes were used by one of their long edges, by means of longitudinal unidirectional motions. Only the less pointed handaxe showed a probable chopping motion.

Acknowledgements

We would like to thank all our colleagues from the *Eauipo Primeros Pobladores de Extremadura*, as well as the institutions that supported research in the Calerizo de Cáceres. L.P. received a pre-doctoral research grant from Fundación Valhondo-Calaff. This work has been developed in the framework the Spanish MICINN project CGL2009-12703-C03-02 and the Catalan AGAUR projects 2009SGR-188 and 2009PBR-00033.

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CHAPTER TWENTY FIVE

STONE TOOL HAFTING IN THE MIDDLE PALAEOLITHIC AS VIEWED THROUGH THE MICROSCOPE

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Abstract

The results are presented of a wear analysis that was performed on samples of four Middle Palaeolithic sites in Western Europe. It is argued that tools were hafted from the early Middle Palaeolithic onwards. Armatures, butchering knives and woodworking tools were used while hafted. The choice to haft a stone tool appears to be influenced by a site's function.

Keywords: Use, hafting, wear traces, Middle Palaeolithic, spear points

1. Introduction

The importance of hafting for a reliable interpretation of archaeological assemblages has been recognised for some time (Ambrose, 2001, 2010, Keeley, 1982, Rots, 2003a). Over the last years, a methodology was developed that allows the identification of hafting wear on archaeological assemblages (Rots, 2002a, 2010a, Rots, et al., 2006). The method was applied to various European Middle (Rots, 2011, In press) and Upper Palaeolithic (Rots, 2002c, 2005) assemblages as well as to Northeast African Middle Stone Age assemblages (Rots and Van Peer, 2006, Rots, et al., 2011). In the meantime, also other results in relation with hafting were produced, mainly based on residue work on various assemblages (Hardy, 2004, Hardy, et al., 2001, Hardy and Moncel, 2011), or on specific selections of certain tool categories (i.e., microliths, stone points) (Lombard, 2005), or based on the occurrence of hafting residues (Boëda, 2008, Boëda, et al., 1996, Mazza, et al., 2006, Pawlik and Thissen, 2011). All these analyses have confirmed the existence of hafted stone tools (including points) in the Middle Palaeolithic and the Middle Stone Age (points and microliths only).

While results remain overall scarce, the examination of hafting has proven to contribute to basic insights in the existence of hafting and various hafting modes, and to an improved understanding of tool morphology and site function. Here, I will focus on the characteristics of the observed hafting traces and their patterning on four examined Western and Central European Middle Palaeolithic assemblages.

2. Methods

An Olympus binocular microscope SZX7 (magnifications 8-56x) and an Olympus BX51M incident-light microscope (50-500x, bright field) were used for the examination of wear traces. Identifications were based on an experimental reference collection consisting of over 600 experimental tools that were used for various tasks while hand-held or hafted in various arrangements. In addition, at least another 500 experimental pieces were available related to other processes, including different production techniques. Tools were cleaned with alcohol and/or acetone during the analysis.

The results on four Middle Palaeolithic sites are included: *Maastricht-Belvédère* (NL) (De Loecker, 2004, Roebroeks, 1989), *Biache-Saint-Vaast* (F) (Rots, 2013, Tuffreau and Sommé, 1988), *Bettencourt* (F) (Locht, 2002) and *Sesselfelsgrotte* (D) (Freund, 1998, Richter, 1997, Rots, 2009) (Table 1). Details on the exact site context and assemblage composition can be found in the above-mentioned publications. All sites are located in Western or Central Europe and they were selected based on their chronological position and importance. The aim was to get a first – not necessarily entirely representative – insight into the frequency of hafted tools in the Middle Palaeolithic period. In order to understand the regional and chronological variability of hafting, more sites will need to be included in the future.

The material selection responded to different research questions, pertinent for each of the assemblages included and therefore sample composition differs to some degree amongst them. For the site of *Bettencourt*, only a selection of the Levallois points was examined, for the three other sites, the samples were selected among all tool categories. The whole tool assemblage of *Maastricht-Belvédère* was included, but it was not yet entirely examined (52 of 103 tools).

Site	Level / area	Date	Nr of tools	Sample	%
Maastricht-Belvédère (NL)	Site K	250 ±20 ka (TL)	137	(52) 103	*(38)75*
Biache-St-Vaast (F)	Level IIa	175 ± 13 ka (TL) 253 +53/-37 ky (ESR)	722	157	*22*
Bettencourt (F)	N2b, Levallois points	Ca 75-85ka (TL-IRSL, pedostrat.)	128 (48)	27	*21*
Sesselfelsgrotte (D)	A06 & A08 mainly (G-complex)	Ca 41 ka (Keilmessergruppen)	1585	692	*44*

Table 1. Site details and selected samples.

3. Trace recognition and interpretation

Instead of dealing with each Middle Palaeolithic assemblage separately, the focus of this paper lies on the different kinds and patterns of traces that are observed, with a special focus on hafting wear. Data are presented per main tool use category. As previously discussed (Rots, 2008b, 2010a), tool use has an important impact on the formation of hafting traces. The hafting trace intensity largely depends on the worked material hardness, while the hafting trace pattern is mainly determined by use motion. It needs to be stressed that an identification of hafting is not based on one kind of key trace or key trace type. It relies on a combination of traces and an association of trace types, which are distributed in particular patterns over the stone tool (Rots, 2010a). No obvious occurrence of hafting adhesives was observed. Given that most tools had already undergone cleaning episodes before the functional analysis, this is not surprising.

On the whole, Middle Palaeolithic assemblages may present more post-depositional alterations in comparison to more recent assemblages. These alterations generally have a widespread and disorganised presence, facilitating their distinction, but they may also mimic use-wear distributions. This particularly concerns bright and smooth wood-like polishes. Confusion can be avoided by focussing on all trace types and by closely examining trace patterning and trace associations. While examinations under low and high magnification need to be combined at all times, the contribution of a low magnification analysis is particularly important for Middle Palaeolithic assemblages as it helps to ascertain trace causes and to avoid misunderstanding based on polish evidence alone.

4. Results

In general terms, the microwear analysis demonstrates an important focus on hunting and animal processing activities, even though the frequencies vary between the different sites. The main identified tool uses were spear points, butchering knives, woodworking tools and grooving tools, as is detailed below. Aside from these, some less important activities were also identified (e.g., some working of hard animal materials for instance Sesselfelsgrotte; a possible strike-a-light at Bettencourt). Further data regarding the different sites and the results of the functional analysis can be found in the following publications: (Rots, 2009, 2013, In press).

Hafted tools were frequent on all sites (Table 2). For some used pieces, no prehensile mode could be identified with reasonable certainty. It is likely that these pieces were used in the hand as it is more difficult to identify hand-held use with certainty in comparison to hafted implements. As a result, the percentages of hand-held tools should be considered as minimal estimates.

4.1. Spear Points

Wear traces on spear points have been extensively discussed by many researchers, but significant differences between researchers can be noticed. While the identification of some relies on one so-called diagnostic criterion only, which leads to very contestable results (Wilkins, et al., 2012), other analysts identify points based on a pattern of different diagnostic wear traces (Plisson and Beyries, 1998). I believe the latter position is a precondition for reliable identifications. Wear features created upon impact can occur on the tip, but the edges and proximal part are equally important. In order to be able to reliably argue that the observed wear features are created under projectile impact, all other possible causes need to be excluded first.

Site	Sample	Unused	%	Uncertain	%	Hand-held	%	Hafted	%	prehensile mode	%
Maastricht-Belvédère	52 (103)	11	*21*	12	*23*	10	*19*	15	*29*	4	*8*
Biache-St-Vaast	157	23	*14,5*	25	*16*	17	*11*	69	*44*	23	*14,5*
Bettencourt	27	5	*19*	2	*7*	3	*11*	17	*63*	0	*0*
Sesselfelsgrotte	292 (692)	56	*19*	47	*16*	19	*6,5*	110	*38*	60	*20,5*

Table 2. Functional results of each assemblages with frequencies per prehensile mode. Degrees of certainty within each category vary (see Rots In press for more details). (Note: for Maastricht-Belvédère, only 52 of the 103 available tools were yet examined; for Sesselfelsgrotte, 692 tools were screened under low magnification, 292 tools were examined in more detail)

In addition to wear criteria related to use, I advocate the inclusion of hafting wear. This needs to concern characteristic wear evidence as identified based on experimentation (Rots 2010) and it should not concern wear features that have no immediate alternative explanation or wear that could potentially be related to production. Reliable interpretations require a combined occurrence of different hafting wear features.

While the existence of hafted spear points in the Middle Palaeolithic used to be seriously contested, results from wear and residue studies have demonstrated their existence (Locht, 2002, Plisson and Beyries, 1998, Rots 2009, 2013). Spear points were identified in all four of the assemblages examined. Typologically, diverse categories are concerned, but morphologically, most spear points share among them a more or less symmetrical morphology.

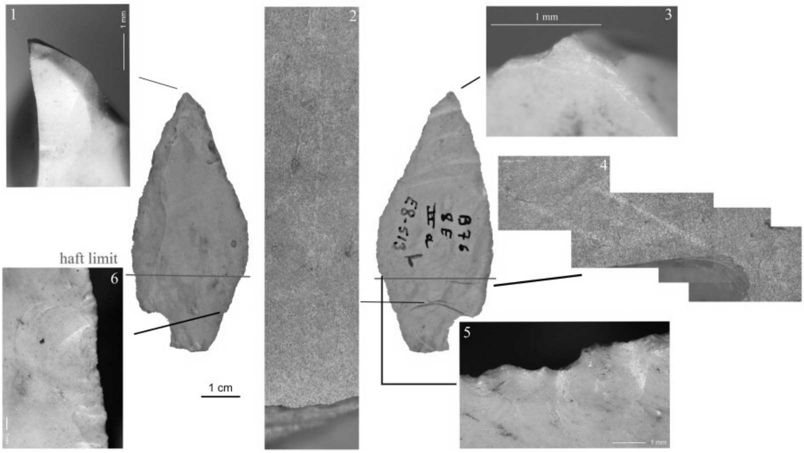

Fig 1. Spear point (E8-513; elongated Moustier point; Biache-St-Vaast): 1. Burination on the distal left point, initiated from distal extremity (16x); 2. Striation from counter-pressure, in the prolongation of the large scar on the ventral proximal surface (100x); 3. Small burination detached on the ventral distal left point (50x); 4. Impact striation associated with edge damage on the ventral medial left edge (100x); 5. Scarring evidence on haft boundary on the ventral medial right edge (16x); 6. Obliquely initiated, step-terminating hafting scarring on the dorsal proximal right edge (8x).

Points were identified based on the presence of a combination of wear features, including step-terminating bending fractures on the tip or step-terminating impact scars on the tip or lateral edges, preferentially in association with microscopic linear impact traces (MLIT's, (Moss, 1983b)) (Fig. 1-2). These impact scars can consist of scars with a bending initiation, burinations, combinations of these, or spin-offs associated with a tip fracture. In some cases, distal impact damage is combined with important proximal damage from the counter-pressure against the haft. It may consist of an actual fracture that is proximally initiated and step-terminating (not to be confused with proximal production-related damage) or step-terminating impact scarring from counter-pressure. Similar to direct impact damage, impact by counter-pressure is preferentially associated with MLIT's that support the cause of the scars. In no instance did the spear point identification rely on just one so-called diagnostic feature. When insufficient diagnostic criteria were observed in combination, the identification was marked as uncertain.

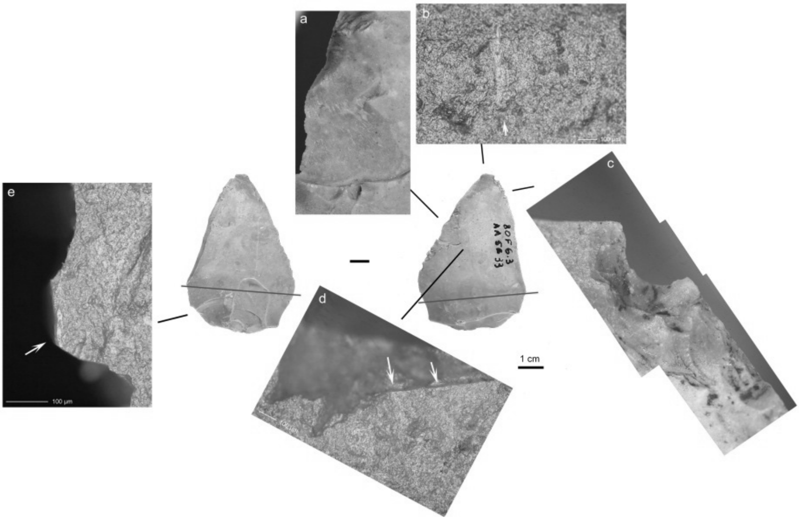

Fig 2. Spear point (AA56/33; Levallois point; Bettencourt): a. large step-terminating bending scar (8x); b. Impact striation in prolongation of tip fracture (MLIT) (100x); c. impact damage (25x); d. impact striations (MLIT) in prolongation of large impact scar (100x); 5. friction spot due to friction with scar flake detached within the haft (200x)

4.2. Butchering knives

Traces of meat cutting activities are not always as easy to distinguish due to the slow formation of meat polish. However, diagnostic scarring may form more rapidly. In the case of butchering activities, the knife's tip is often involved in the action, which facilitates identifications. As insertion in the animal may be quite forceful, small fractures are often visible on the tips that should not be confused with impact fractures from hunting activities. Aside from tip fractures (i.e., break through both surfaces more or less equally), scars (initiated on one face but detached on opposite face) are often concentrated around the tip. Often these scars show step-terminating terminations. It is clear that analyses that do not use sufficiently strict criteria for the identification of spear points will easily misinterpret these kinds of scars, especially when these analyses rely on the occurrence of one wear feature only (*contra* Wilkins et al. 2012).

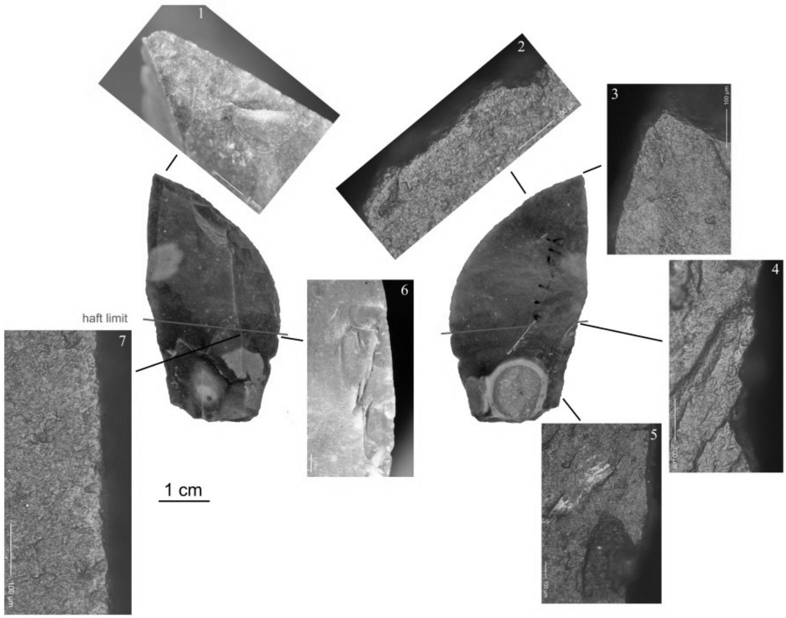

Fig 3. Butchering knife (B76 15Y IIa; convex side scraper; Biache-St-Vaast): 1. Small tip fracture with associated use damage on the dorsal distal right edge (16x); 2. Use-wear polish on the ventral distal right edge (200x); 3. Use-wear polish on the ventral distal right point (200x); 4. Bright spot on the ventral medial left edge associated with dorsal hafting scarring at haft boundary (200x); 5. Bright spot in striation associated with hafting scarring and hafting polish on the ventral most proximal left edge (100x); 6. Start of hafting damage around the haft boundary on the dorsal medial right edge (10x); 7. Hafting polish associated with rounding on the dorsal medial ridge (200x).

Use-wear traces were generally observed on one edge only, including the tip (if present) (Fig. 3). On converging implements (e.g. Levallois points), traces often occurred on a convex edge opposite to an unused straight or concave edge that remained unused. Use-wear traces generally consisted of sliced scars in an alternating pattern associated with a light meat-like polish.

Many butchering knives proved to be hafted, generally in a terminal hafting arrangement with a hafting boundary that is slightly oblique with regard to the tool's axis. The haft boundary was generally explicit and marked with larger, more prominent scars, associated with other wear features (e.g., bright spots, striations). Scars in the remainder of the hafted area remained more limited. In comparison to the used edge, the hafting scar pattern was more irregular, in size, morphology and distribution.

4.3. Wood percussion tools

Wood percussion tools were identified at Biache-St-Vaast and at Sesselfelsgrotte, aside from a possible example at Maastricht-Belvédère. It generally concerns adzes, so pieces hafted with one face down, perpendicular to the shaft's long axis or on a curved handle (Fig. 4). Only at Sesselfelsgrotte, pieces may also have been hafted as axe (see Rots 2009). As observed experimentally, wood percussion results in quite explicit hafting wear formation due to the important pressure that is exerted during use. In particular hafting boundaries are very explicit, while the hafted extremity may show damage from the counter-pressure against the haft (Rots, 2010a).

4.4. Wood planing tools / rabot

Within three of the analysed assemblages, a very particular tool category was observed. It concerns a more or less triangular implement of which the longest edge was used for wood planing. The used edge generally has a sharp angle, with various degrees of retouching. These pieces were used with their ventral face in contact with the wood, in a pushing motion away from the user. They are reminiscent of a *rabot*, and were probably used in a way similar to the Australian tula adzes (McCarthy, 1976, Rots, 2009). Possible functions would be sharpening spears or any other function requiring a comparable use motion.

The particular triangular tool morphology appeared quite recurrent throughout the different assemblages. While one wood plane was identified at *Bettencourt*, it did not correspond in characteristics to those observed on the other three sites. The reason is obviously that only Levallois points were examined for this site.

The wood planes were systematically hafted at the extremity of a handle and the haft boundary often appeared to be quite close to the used edge. In some cases, this proved to be the result of resharpening.

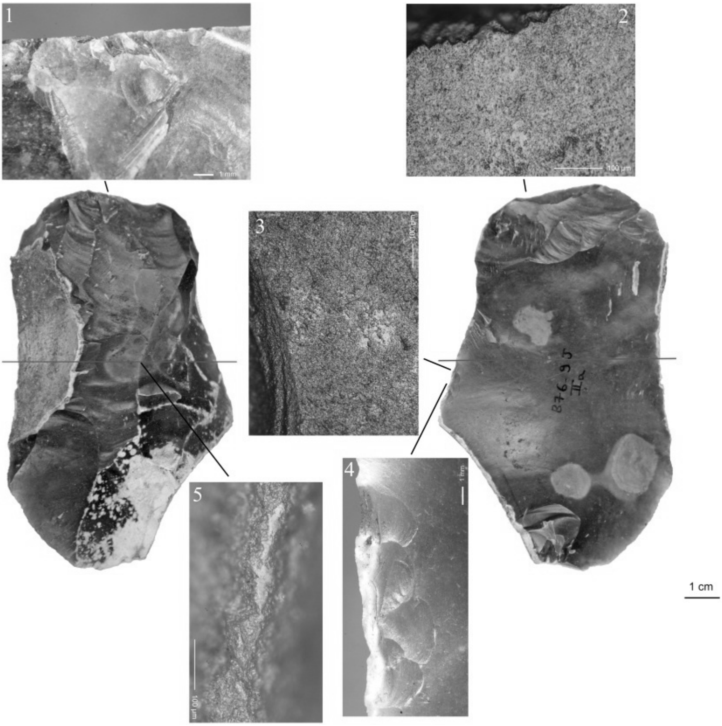

Fig 4. Wood percussion tool (B76 9J IIa 2; large flake, thinned distally; Biache-St-Vaast): 1. Edge damage on dorsal distal extremity (8x); 2. Use striation associated with minor wood use polish on the ventral distal extremity (200x); 3. Bright spot zone associated with edge damage on the ventral medial right edge (haft boundary) (100x); 4. Hafting edge damage on the ventral medial right edge (8x); 5. Bright spot on the haft limit on the dorsal medial ridge (200x).

5. Discussion

Based on the microscopic evidence, it is argued that hafted tools were present at all examined sites in variable quantities and with variable tool uses. Around 30-40 % of the analysed assemblage proved to show indications of hafting, at the exception of the somewhat biased tool sample of *Bettencourt* that resulted in a higher percentage of hafted tools.

The predominant function of each of these sites was determined, as well as the relation netween site function and the frequency and characteristics of hafting (Table 3). Since the analysis of *Maastricht-Belvédère* is still incomplete, and since only Levallois points were examined for the site of *Bettencourt*, attention is focussed on the remaining two sites. For *Biache-St-Vaast*, the use-wear analysis shows a clear focus on animal hunting and processing activities. At the same time, tools involved in these activities are quite systematically hafted, while tools engaged in other functions are only occasionally hafted. At *Sesselfelsgrotte*, a different pattern emerges. The site proved to have a more general purpose, with a strong focus on retooling activities. A lot of woodworking took place, next to various other grooving and scraping activities. Woodworking tools were used hafted quite systematically. By contrast, butchering knives were preferentially used in the hand. It leads one to suggest that the dominant function of a site has an important influence on the kinds of tools that were hafted. In this context, the rather important number of spear points at *Sesselfelsgrotte* could be partially linked to retooling instead of directly reflecting intense hunting activities around the site. This would also explain the low number of butchering knives relative to the number of spear points (see table 3).

6. Conclusion

The four included Middle Palaeolithic sites are very diverse in terms of location, age and characteristics, but the functional results nevertheless suggest that hafting does not simply increase in frequency over time; it is influenced by other factors, including site function. Task frequency and a site’s specialisation proved to determine whether stone tools prepared for a given function were hafted or not. Hafted tools did not simply appear at a given moment in time with knowledge on hafting being introduced as a package and being invariably applied to all tools used at a site; it is a far more complex phenomenon that needs to be studied in its own right.

Site	Sample	Subsistence				Tool manufacture							Uncertain
		Animal hunting	Animal proc.	Veget. proc.	*%*	Briquet	Wood percuss.	Wood working	Grooving / drilling	Scraping hide	Other scraping	*%*	Other cutting
Maastricht-Belvédère	52 (103)	2	4		***38***		1	1	3		2	***44***	3
Biache-St-Vaast	157	16 or 20	18		***44***		6	3	13		5	***31***	19
Bettencourt	27	7 or 9	8		***89***	1		1				***5***	
Sesselfels grotte	292 (692)	28	9		***27***		24	19	16	2 or 6	18 or 22	***60***	18

Table 3. Site function and predominant tool uses (not all use categories are represented) (percentage: relative to number of identified tool uses)

Acknowledgements

I am indebted to the *Fonds de la Recherche Scientifique* – FNRS and the *Fonds voor het Wetenschappelijk Onderzoek – Vlaanderen* (FWO) for their financial support of this research. I sincerely thank the following people for the permission to study the archaeological material: D. De Loecker, J.-L. Locht, J.-L. Marcy, L. Reisch, J. Richter, W. Roebroeks, A. Tuffreau and C. Züchner.

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CHAPTER TWENTY SIX

LITHIC TECHNOLOGY AND TOOL USE IN THE NORTH AMERICAN ARCHAIC: BRIDGING TECHNOLOGIES, PLANTS, AND ANIMALS

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Abstract

Koster is a well-known archaic period site in east central North America. Chipped and ground stone tools including a variety of formal and informal implements such as pestles, anvils and grinding stones were used throughout the Koster sequence with examples coming from some of the earliest levels (Early Archaic) dated to 10,000–8,000 years ago. It is often assumed that ground stone tools relate to an increased or different use of plants in the early Holocene, while chipped stone technologies are linked principally with processing and procuring animal resources. Both assumptions tie lithic technologies to subsistence. Our research addresses these assumptions about the North American Archaic through experimental and archaeological use-wear studies in order to better understand the extent of plant and animal processing in both subsistence and manufacturing domains.

Keywords: North American Archaic, use-wear, ground stone, chipped stone, plant domestication

1. Introduction

Aligning stone tools both chipped and ground, with the procurement and consumption of foodstuffs is a fundamental focus both in European (Juel Jensen 1994; Van Gijn 2010:51) and North American hunter-gatherer research (Bamforth and Bleed 1997; Odell 1996, 1998; Shott 1986). North American archaeologists have created images of past lifeways persistently focused on subsistence practices, which are often neatly divided along the lines of plant versus animal resources linked to ground versus chipped stone technology. For chipped stone, interpretive emphasis is typically placed on hunting technologies and animal processing. Ground stone, if considered at all, is relegated to processing plant foods including nuts, fruits, and presumably edible seeds. The functions of minimally or unmodified tools are often overlooked in North American hunter-gatherer studies. Furthermore, lithic technologies for non-subsistence pursuits such as manufacturing or ritual, have received little analytical attention. Our study has enabled us to explore the realities of activities involving plant and animal resources. We argue that a complete picture of lithic tool use must consider subsistence and manufacturing, plants and animals, and chipped and ground stone technologies.

We report results of a pilot use-wear study carried out on chipped and ground stone tools from the Koster site, a deeply stratified site located on a terrace along the east bank of the Illinois River ca. 80 km north of St. Louis, Missouri, where occupations span over 6,000 years. Our study (part of a larger project directed by Jane Buikstra and Tim Messner, and funded by the U. S. National Science Foundation) focuses on Horizon 11 at Koster, dated to ca. 9500 years ago, one of the earliest Archaic period occupations at the site (Wiant, et el. 2009). The larger project addresses changes in prehistoric peoples' use of plant resources and processing technologies in the Archaic period that may provide insight into the trajectory towards domestication in the lower Illinois River Valley (http://www.caa-archeology.org/CurrentPrelude.html, accessed January 10, 2013). This collaborative project draws together multiple lines of evidence including plant residues extracted from tool surfaces, studies of macrobotanical and faunal remains, phytolith analysis, and use-wear studies of selected chipped and ground stone tools. The use-wear study is designed to explore the roles stone tools played in processing both organic and inorganic resources with a focus on technology and plant utilization.

Initial starch and macrobotanical analyses demonstrate that Early Archaic peoples ate nuts, but did not harvest and process large masts, collected groundnut tubers, and to an uncertain extent collected small seeds including *Chenopodium* (goosefoot)and *Ambrosia trifida* (giant ragweed). *Rhus* (sumac) and *Gleditsia triacanthos* (honey locust) are represented but it is not clear to what extent these plants were consumed or consumable (Sidell and Asch 2012). Faunal data reveal an emphasis on small mammals, specifically squirrel and aquatic resources, fish and mussels, with deer utilized to a lesser extent (Boon and Neusius 2012). The study provided us with the opportunity to bring use-wear data to bear not only on questions of plant use in the Early Archaic at Koster, but also on the problem of archaeological interpretation of chipped and ground stone implements in plants and animal processing for both subsistence and manufacturing tasks.

2. Samples and Methods Used

We designed plant-focused wear experiments to provide referents for both chipped and ground implements (Fig. 1). For chipped stone, Pope used unmodified flakes hafted with antler handles to cut cattails and rushes and to scrape tubers. Ground stone experiments involved nut and seed processing, as well as manufacturing tasks and grinding ochre. Sievert paired the experimental ground stone tools into hand and nether stone combinations—hammers with anvils, pestles with mortars, and manos with metates, and recorded wear following methods pioneered by Adams (2002).

Archaeologists who participated in the Koster Horizon 11 excavations in the 1970s selected archaeological samples. Pope used a metallurgical microscope to analyze 31 chipped stone tools drawn from four Horizon 11 excavation squares having hearths. The chipped stone sample consisted primarily of minimally or unmodified flakes. Sievert used a stereomicroscope to analyze the ground stone sample of sixteen implements selected from hearths and other features across Horizon 11. Ground stone implements represent a range of morphologies from tools having been intentionally shaped through pecking and grinding, to others modified heavily through abrasive and percussive wear. Samples are small, and non-representative of lithic variability across the Horizon 11, but regardless have the potential to provide a window into Early Archaic tool function.

Fig. 1. Wear experiments. Cutting plants using hafted chert tool (left). Nut-cracking using quartzite hammer with limestone anvil (right).

3. Results

The use-wear data for the archaeological samples revealed a variety of contact materials. Traces on chipped stone indicate uses involving hide, wood, plants, bone or antler, and butchery. Both animal and plant processing tools are nearly equally represented in the analyzed sample. Unmodified debitage was used in both subsistence and manufacturing activities. Tools tentatively interpreted as subsistence-related comprise flakes, denticulates, and one biface. Tools identified as manufacturing-related also include unmodified or minimally modified debitage. Flake technology is predominant with only five tools exhibiting bifacial technology. For chipped stone, manufacturing tools are more frequent than those interpreted to be from subsistence activities and appear to have been used in both animal and plant processing tasks (Fig. 2).

The majority of the animal-processing tools were used to manufacture items out of hide and bone/antler. Plant working tools used for manufacturing are more easily interpreted than those used for subsistence tasks. The presence of weak polishes possibly from processing small mammals and fish could skew the interpretation in favor of manufacturing activities. Pope interpreted three flakes used in animal-related subsistence tasks involving butchery or meat processing. Five chipped stone tools have weak polishes that may have resulted from contact with either vegetal or animal fibers. It is currently not possible to distinguish which chipped stone tools were used to process plants intended for eating from those used for other purposes such as medicine or dye.

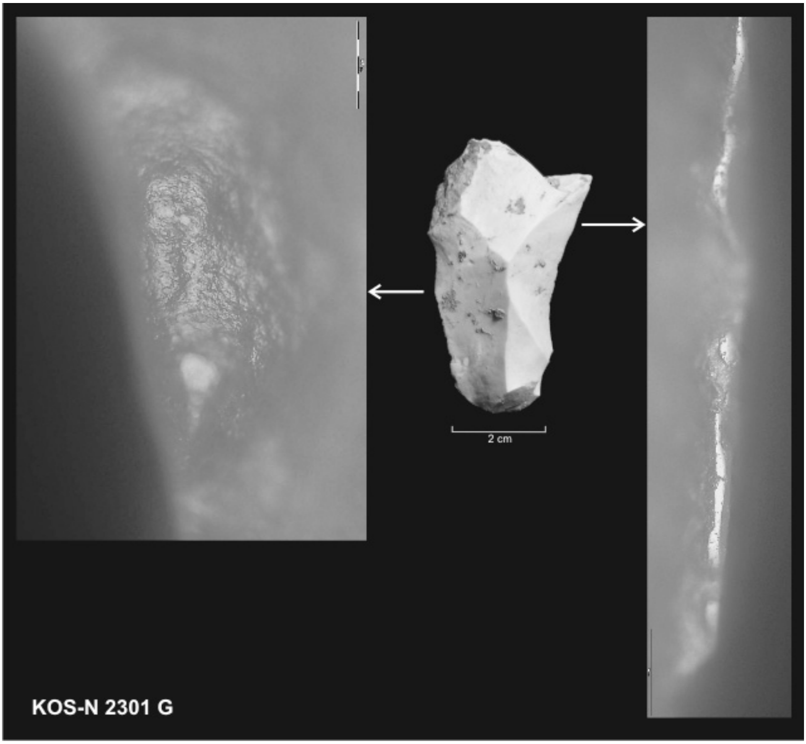

Fig. 2. Wear interpreted to result from contact with hide (left) and possibly siliceous plants (right). Artifact courtesy of the Illinois State Museum.

The ground stone implements are also largely informal, with four intentionally shaped into an axe, a disc, and two pestles. The remainder represents cobbles of diverse raw materials, drawn from glacially-deposited sources and modified by use. At least three of the tools are large and heavy enough to be non-portable, so were likely left on the prehistoric surface, perhaps to be used again at another time. These larger tools exhibit multiple functions with evidence for grinding and pounding. One shaped axe shows intensive damage from use. Hammerstone damage and anvil-related pitting are common among the ground stone tools, which were used to process a range of hard and soft materials consistent with use on stone, hide, ocher, starchy plants, and nuts. Ground stone subsistence-related tools likely include a shaped pestle and a deeply channeled mortar/metate (Fig. 3). Analysis of microfossils confirms the presence of plant starches on several larger grinding stones (Messner 2012).

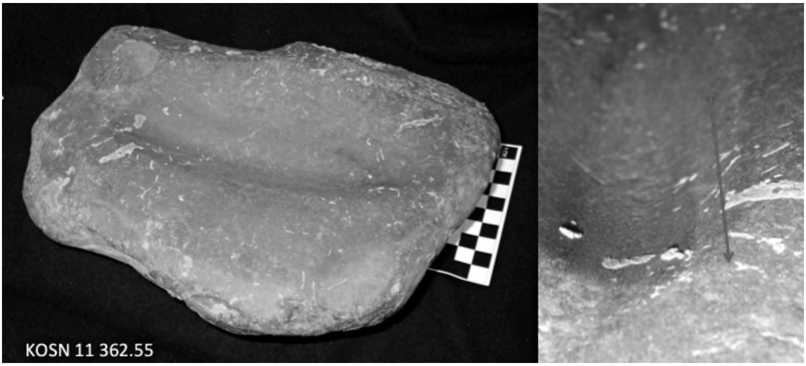

Fig. 3. Ground stone channel-basin metate (left) with heavy longitudinal wear from grinding soft materials (right).

4. Summary and Conclusions

Interpretations are complicated by the ambiguities presented in any use-wear study, including ambiguous traces and implements having multiple uses. Additional experiments should focus on processing small mammals, fish, seedy plants, and groundnuts. Further experimentation may help to clarify to what extent it will be possible to identify tools used to process meat fibers for food from those used to process plant fibers for food, or to differentiate plant fiber uses in subsistence from those used in manufacturing.

In summary, we learned that both chipped and ground stone tools were utilized in a range of activities that span subsistence and manufacturing domains. We demonstrate that both plant and animal materials were worked using both chipped and ground stone tools, and some tools were used on minerals as well. We assert that many lithic tools, especially the larger ground stone examples were used repeatedly for possibly unrelated tasks—at once to grind a new edge on an axe, followed by use as an anvil on which to crack nuts. Our small sample of chipped lithics was biased toward flakes; however, the few bifaces we analyzed showed uses in the manufacturing rather than subsistence realm. This goes counter to archived wisdom about the function of bifacial technology as primarily related to subsistence activity, with an emphasis on hunting.

These results challenge the emphasis in the archaeological study of the North American Archaic that has privileged animal-focused subsistence tasks and bifacial technologies over plant-focused activities, manufacturing tasks, and *ad hoc* technologies. While an increasing presence of ground stone technology in the Archaic period no doubt relates to foodways to a degree, manufacturing using ground stone may be just as important. Variation in the quantity and diversity of lithic items and uses at the different hearth spaces may signal the presence of groups that formed around shared activities or ‘like’ tasks that involved *ad hoc* tools as well as reusable heavy stones left in place for future needs. Use-wear-informed studies enable technology to be situated in relation to a range of activities centered at particular places, and have the potential to inform on the social contexts in which activities took place. Although our samples are small, the hearth-centered use-wear study suggests the possibility of relating specific activities to specific tool using strategies for both subsistence and manufacturing. It is also possible that plant-linked manufacturing activities preceded and contributed to plant husbandry, perhaps expanding the potential for plants to contribute to both diet and manufacturing.

We advocate bridging typological and interpretive divides common in archaeological practice, specifically those between chipped and ground stone, and between plants and animals. We hope that this integrated approach can bring archaeologists closer to the interactions between people, the places they occupied, and the technologies they developed and used.

Acknowledgements

We thank Jane Buikstra and Tim Messner for directing the Prelude to Plant Domestication project under NSF award no. 0822080. We thank Mike Wiant and Gail Anderson for selecting samples, and the Center for American Archaeology at Kampsville, Illinois for support. Anson Kritsch worked with Pope on chipped stone, while Brian McConnell, Sheree Sievert, and Gerald Ward assisted with ground stone experiments.

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CHAPTER TWENTY SEVEN

LITHIC USE-WEAR ANALYSIS FROM THE EARLY GRAVETTIAN OF VALE BOI (SOUTHWESTERN IBERIA)

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Abstract

The archaeological site of Vale Boi presents an important chronostratigraphic record for the entire Upper Palaeolithic sequence in this region. All three chrono-stratigraphic sequences at the site show horizontal beds with lithic remains associated with the Gravettian techno-complex. The Early Gravettian is dated from c.33 to c. 28 ka cal BP and represents the oldest evidence for this techno-complex in the Iberian Peninsula. In this paper we present results on the chert lithic use-wear analysis from the Early Gravettian occupation of the site. Different worked materials are documented, with special attention to backed projectile technology.

Keywords: Vale Boi, Early Gravettian, lithic use-wear analysis, projectile technology.

1. Introduction

The expansion of the Gravettian techno-complex in Eurasia represents one of the most important steps for the so-called techno-cultural polymorphism that characterizes all the Upper Palaeolithic sequence (Moreau 2012; Otte et al. 1996). During the last decades, the Gravettian sequence from Southern Iberia has been seen as a homogeneous period with no significant regional and diachronic changes (Villaverde et al. 1998; Straus 2005). Recently, the excavation of new sites and the revision of lithic industries of several important contexts, show that this idea is unlikely (Cortés et al. in press; Marreiros et al. in press; Peña 2012). The identification of regional (i.e. Vicentine Mediterranean technological facies) and diachronic settings is based on techno-typological variability and organization, which are associated with three main aspects: (1) different human ecological adaptation related to rapid climatic shifts; (2) techno-cultural and stylistic/ethnic differences between territories; and/or (3) functional specializations between and within regional sites (e.g. Fullola et al. 2007).

Use-wear studies might be essential to test functional aspects within and between sites, although few functional studies have been conducted to test Gravettian contexts from the Southern Iberian Peninsula. In this paper we focus on lithic use-wear analysis from the Early Gravettian of the archaeological site of Vale Boi (Southern Portugal). This paper shows wear traces associated with different types of worked materials with a predominance of woodworking and with special attention to projectile technology that regionally characterizes the Early Gravettian of Southern Iberia.

2. Archaeological site of Vale Boi (Cape St. Vicente, SW Portugal)

The site of Vale Boi (VB) represents one of the most important chronostratigraphic sequences for the Upper Palaeolithic record in Southwestern Iberia (Bicho et al. 2003, 2010). The site is located at the extreme south-southwestern Atlantic coast of Iberian Peninsula (Cape St. Vicente, Algarve). It is limited by a l0 metre high limestone outcrop (Fig. 1) on top of a slope, marked by a sequence of geological platforms resulting from the erosion of the limestone bedrock. Following this geological profile, three main areas were excavated during the last decades of research at the site: Rockshelter, Slope and Terrace. Horizontal beds with lithic materials associated with the Gravettian are documented in all areas, although with different conditions of preservation. In the Rockshelter, Early Gravettian assemblages are small when compared to other contexts at the locus, such as Solutrean or Magdalenian (Bicho et al. 2010). The Slope likely corresponds to midden deposits, from which Gravettian levels present numerous lithic and faunal remains. The Terrace presents the most complete sequence with Early Neolithic, Epipalaeolithic, Solutrean, Proto-Solutrean, Late Gravettian and Early Gravettian, and the excavation is yet to reach bedrock. There are three Gravettian levels (c. 27.29 and 32.5 ka cal BP – Bicho et al. in press) (Table 1), whose lithic assemblages are associated with backed technology (Marreiros et al. 2012).

Fig. 1. Location of the archaeological site of Vale Boi.

Area	Level	Phase	Lab.	Date	Material	Date calBP*	Notes
Terrace	2	Early Neolithic	Wk-17030	6036±39	Bone	6990-6785	
Terrace	2	Early Neolithic	OxA-13445	6042±34	Bone	6982-6791	
Terrace	2	Early Neolithic	Wk-17842	6095±40	Bone	7157-6807	
Terrace	2	Early Neolithic	Wk-13865	6018±34	Bone	6950-6752	
Terrace	2	Mesolithic	TO-12197	7500±90	Tooth, H. sapiens	8514-8056	
Shelter	Z1	Magdalenian	Wk-31088	15660±86	Tooth	19250-18606	
Slope	2	Solutrean	AA-63307	11840±280	Charcoal	14821-13131	
Slope	2	Solutrean	AA-63308	15710±320	Charcoal	19548-18115	
Terrace	3	Solutrean	Wk-13685	8,749±58	Charcoal	**	
Terrace	3	Solutrean	Wk-24761	8,886±30	Charcoal	**	
Terrace	3	Solutrean	AA-63305	8825±57	Charcoal	**	
Terrace	3	Solutrean	AA-63310	8696±54	Charcoal	**	
Terrace	3	Solutrean	Wk-36255	8664±25	Olea	**	
Terrace	3	Solutrean	Wk-36256	8737±25	Olea	**	
Shelter	B1	Solutrean	Wk-17840	20340±160	*Patella* sp.	24305-23380	Calcite
Shelter	B6	Solutrean	Wk-24765	18859±90	Charcoal	23233-22191	
Shelter	C1	Solutrean	Wk-24763	19533±92	Charcoal	23720-22684	
Shelter	C4	Solutrean	Wk-26800	20620±160	Charcoal	25045-24196	
Shelter	D2	Solutrean	Wk-26802	20570±158	Charcoal	25020-24119	
Slope	2	Solutrean	Wk-12131	17634±110	Bone	21405-20518	
Slope	2	Solutrean	Wk-12130	18410±165	Bone	22357-21505	Minimum Age
Shelter	D4	Gravettian?	Wk-26803	21859±186	*Patella* sp.	**	Calcite

Terrace	4	Gravettian	Wk-24762	24769±180	Charcoal	30211-29287	-
Terrace	4	Gravettian	Wk-31090	24549±165	Bone	29825-28608	Minimum age – small sample with low collagen yield
Terrace	4	Gravettian	Wk-32144	24,381±258	*Patella* sp.	29307-27981	Calcite
				23,613±240	*Patella* sp.	28440-26919	Aragonite
Slope	3	Gravettian	Wk-13686	22470±235	Bone	27844-26288	-
Slope	3	Gravettian	Wk-16414	23995±230	*Patella* sp.	28741-27650	Calcite
Slope	3	Gravettian	Wk-12132	24300±205	Charcoal	29522-28539	-
Slope	3	Gravettian	Wk-17841	24560±570	*Patella* sp.	30211-27743	Calcite
Terrace	5	Early Gravettian	Wk-31089	24183±161	Bone	**	Minimum age – small sample with low collagen yield
Terrace	5	Early Gravettian	OxA-25710	25050±100	*Patella* sp.	29565-28636	Calcite
Terrace	5	Early Gravettian	Wk-30677	25196±103 22,235±173	*Patella* sp.	29906-28620 **	Calcite Aragonite
Terrace	5	Early Gravettian	Wk-32145	25,181±293	*Pecten* sp.	30200-28600	Minimum age – burnt sample
Terrace	5	Early Gravettian	Wk-30679	25317±99 25390±255	*Patella* sp.	30141-29246 30331-28970	Calcite Aragonite
Terrace	5	Early Gravettian	Wk-26801	27720±370	Charcoal	**	-
Terrace	6	Early Gravettian	Wk-30678	25579±98	*Patella* sp.	30232-29487	Calcite
Terrace	6	Early Gravettian	Wk-35713	25930±122	*Pecten* sp.	30482-29599	-
Terrace	6	Early Gravettian	Wk-35714	25964±110	*Pecten* sp.	30570-29585	-
Terrace	6	Early Gravettian	Wk-35712	26026±114	*Nassarius* sp.	30590-29645	-
Terrace	6	Early Gravettian	Wk-30676	24318±90	*Patella* sp.	**	Calcite

				26353±284		31096-29740	Aragonite
Terrace	6	Early Gravettian	Wk-32147	27,141±365	*Acanthocardia* sp.	31502-30474	Aragonite
Terrace	6	Early Gravettian	Wk-32146	28,321±422	*Pecten* sp.	33070-31240	Calcite
Terrace	6	Early Gravettian	Wk-35717	28,012±192	*Arbutus* sp.	32875-31566	-
Shelter	D4	Early Gravettian	Wk-31087	28140±195	*Littorina obtusata*	32324-31253	Aragonite

*** Calibration with OxCal version 4.2 (Bronk Ramsey, 1995) with the IntCal09 curve (Reimer *et al*., 2009). Marine data (Delta-R 209±102) from Reimer et al, 2009.**
**** Non-calibrated results due do inversion, contamination or recrystallization of samples.**

Tab. 1 Radiometric ^{14}C dates for the Upper Pleistocene levels at Vale Boi.

3. Materials and methods

As mentioned above, although Gravettian lithic remains are present in all stratigraphic loci at the site, at this moment only the lithic Gravettian assemblages from the Slope area were analyzed for use-wear (Gibaja and Bicho 2006; Bicho and Gibaja 2004).

In this paper we focus on chert lithic assemblage from the Early Gravettian from the Terrace. From a technological perspective, the Early Gravettian of VB is characterized by flake and bladelet debitage, with the large absence of blade technology. Retouched tools are not numerous, and are mostly represented by end scrapers, side scrapers and splintered tools (Marreiros et al. 2012). One of the main aspects is related to backed elements, from which double backed and bipointed points are the most predominant morph-type within assemblage, and this has no parallel in other Gravettian contexts in Southern Iberia.

From the Early Gravettian lithic assemblage 90 lithic pieces including backed elements, other retouched tools (Table 2) and other pieces that show macroscopic evidence (naked eye and/or low magnification macroscope) of possible wear traces were selected. Use-wear analysis was carried out using low magnification, macroscope (Leica LED5000 SLI) and high magnification approach, stereomicroscope (Leica 2500M, 50-600x).

4. Results

Post-depositional alterations are one of the main problems in functional studies. During the analysis different alterations on tool surfaces were identified: soil lustre, burned tools and patina. This was also recognized from previous use-wear analysis in lithic assemblages from other excavation areas at Vale Boi (Gibaja and Bicho 2006).

Post-depositional alterations prevented the functional analysis of 41.11% (n=37) of the assemblage. From those with no visible post-depositional 25% (n=23) show no wear traces (Table 3). The other 33% (n=30) of analyzed tools, show a low diversity of wear traces, mainly associated with specific activities: mainly wood, dry hide, bone and several indeterminate materials (Table 3). Burins show no evidence of wear traces, and this seems to support the idea of being used as bladelet core-types (Marreiros et al. 2012).

Typology	Contexts C5	Macro and micro wear traces (N of pieces)
Burins	4	-
Endscrapers	4	3
Carinated endscraper	1	
Truncated pieces	2	1
Truncated and backed pieces	1	
Backed pieces	5	1
Bipointed and double backed points	13	5
Sidescraper	3	2
Denticulates	2	
Splintered tools	5	4
Notches	6	2
Undifferentiated retouched pieces		
Total	46	18

Table 2. Inventory of retouched tools and number of identified use-wear traces.

	No wear traces	Macro and micro wear traces*	Post-deposition alteration (unidentifiable)	Total
n	23	30	37	90
%	25,56%	33,33%	41,11%	100,00%
	retouched tools	unmodified edge		
n	16	14		30
%	53,33%	46,67%		100,00%

* Including DIF

Table 3. Results from the first phase of analysis.

From those tools with wear traces (i.e. macro and micro evidence) there is a balance between retouched tools and tools with no modified edges, 53% and 46% respectively. And those that had used unmodified edges are all flakes and no clear association between morphology and worked material.

Microwear results from unmodified flakes mainly show the presence of polish associated with wood and/or other vegetal material in pieces with an edge angle c. 30º. Polish and striations (when present) have longitudinal direction on the tool's edge surface, and this seems to indicate cutting activities (Fig. 2). Only one piece, from which the working edge have c. 40º, showing striations associated with scraping woody materials. This clear association between edge angle and working movement has already been reported elsewhere, and this seems to be clear from the results.

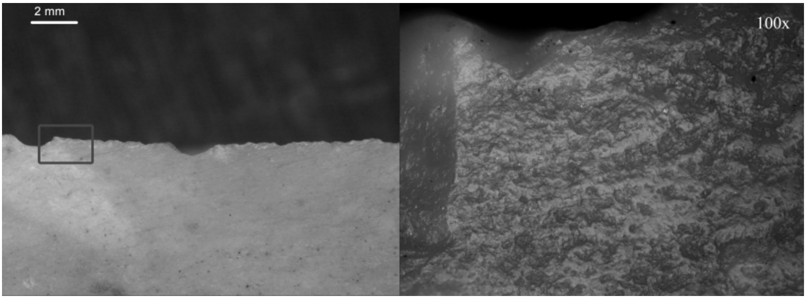

Fig. 2. Wood cutting.

Macro and microwear traces were identified in 46% of the retouched tool assemblage (Table 3). From those, end scrapers, splintered pieces and backed elements are the most important morph-types with wear traces. Functional analysis from end scrapers shows traces associated with scraping wood (Fig. 3). One side scraper shows polish and multi striations associated with dry hide treatment with ochre or other abrasive mineral (Fig. 4). One Truncation distal fragment shows at the ventral surface of the retouched area wear polish of hard material (bone or antler) (Fig. 5), not well developed, and maybe related to short time of use.

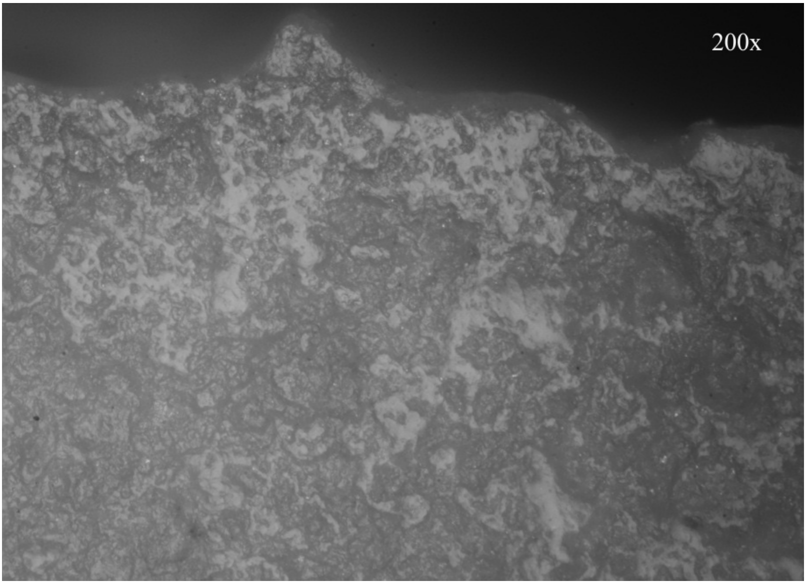

Fig. 3. Wood scrapping, endscraper.

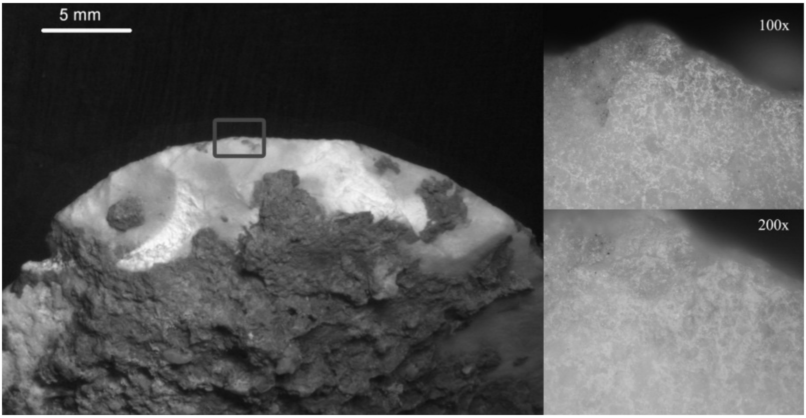

Fig. 4. Dry hide with abrasive material.

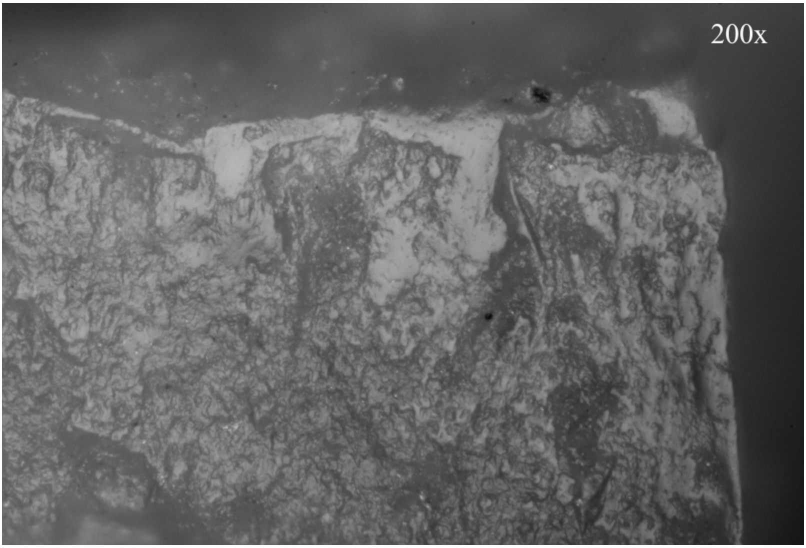

Fig. 5. Hard animal material (Bone or antler).

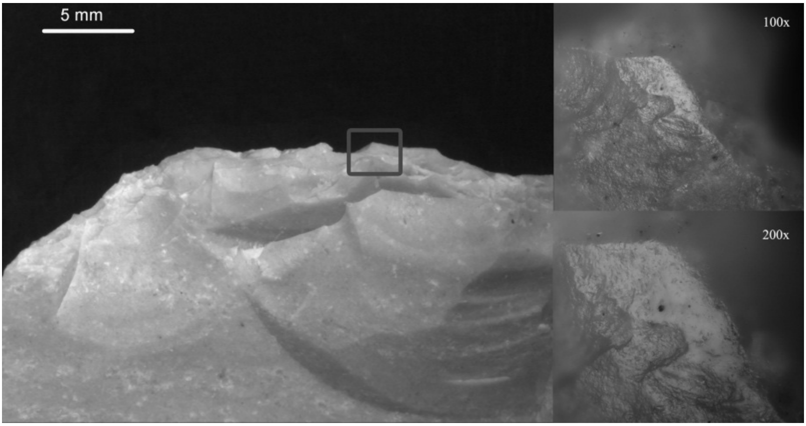

Fig. 6. Indeterminated hard material, splinteres piece.

Due to a steep working angle and consequent edge damage, microwear traces on splintered pieces are sometimes poorly preserved (REF). However, from our observations, splintered tools from the Gravettian of Vale Boi preserved macro and micro evidence. Macro observations show clear evidence of high working angle reported by bifacial and abrupt micro-fractures. Micro wear evidences show the preservation of wood working polish in some preserved interior fracture edges (Fig. 6).

One of the most interesting morph-types within the Early Gravettian lithic assemblage of Vale Boi is the backed technology (Bicho et al. in press, Marreiros et al. in press). From the technological perspective one of these morph-types is characterized by a slight twisted or curved section in the long axis, with no cortex and quadrangular cross-section (Marreiros et al. in press). Typologically these tools are defined as a point made on a rectilinear shaped bladelet, a bidirectional backed retouch in both edges, and pointed on both the distal and proximal tips (Fig. 7), even if this assemblage is too small (dimensions are 18.95 x 3.75 x 3.09 mm–Table 4).

Macroscopic observations show that 5 of the 13 tools are fractured by impact at their distal ends. Despite the low number of macroscopic breaks, the terminal fractures exhibit diagnostic impact fractures (DIF) such as burin shape or small sized grooves (spin-off) (<1mm) (Fig. 8). Some of the specimens have small 90 degree fractures. This is not diagnostic of their use as projectiles, since this type of fracture could be associated with knapping or trampling. As already mentioned, post-depositional alterations and chert of poor quality make difficult the preservation of certain micro traces, such as micropolish or longitudinal groove marks. Nevertheless, in three tools we observed the presence of polishing known as "mirror" or micropolish “G” (Fig. 8). The micropolish in projectiles is usually explained by friction, generated in the hafting area, by small chips coming from the pressure and the tool itself. Also, on the retouched edges of two of the backed tools micropolish was observed similar to traces produced by wood (Fig. 8), typically linked to the contact with the handle (Rots 2003). Three points exhibit the presence of an organic and/or adhesive material in their lateral edge (Fig. 8), however this should be tested in the future with more accurate analysis.

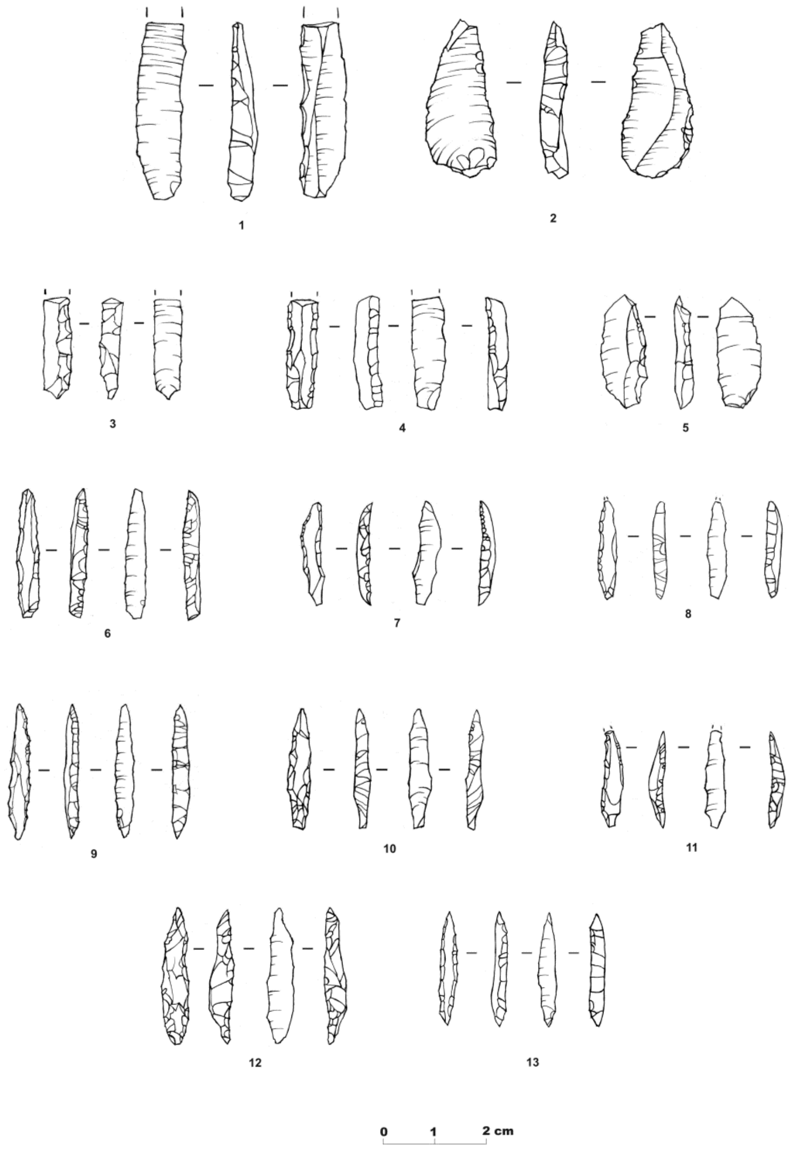

Fig. 7. The Gravettian Double backed and bipointed tools: 1 and 3. Backed bladelet; 2. Chalterperronian point; 4-13. Double backed and bipointed bladelets. (Drawings by Júlia Madeira)

		N	Minimum	Maximum	Mean	St. Deviation
Rockshelter						
	Length		22.03	26,19	23,89	2,115
	Width		3,85	4,89	4,32	0.527
	Thickness		2,97	3,87	3,553	0.505
	Valid N	3				
Terrace						
	Length		15,21	25,26	18,95	3,12
	Width		2,77	4,51	3,75	0,57
	Thickness		2,57	4,01	3,09	0,64
	Valid N	7				

Table 4. Morphometric analysis of the Double backed and bipointed points (mm).

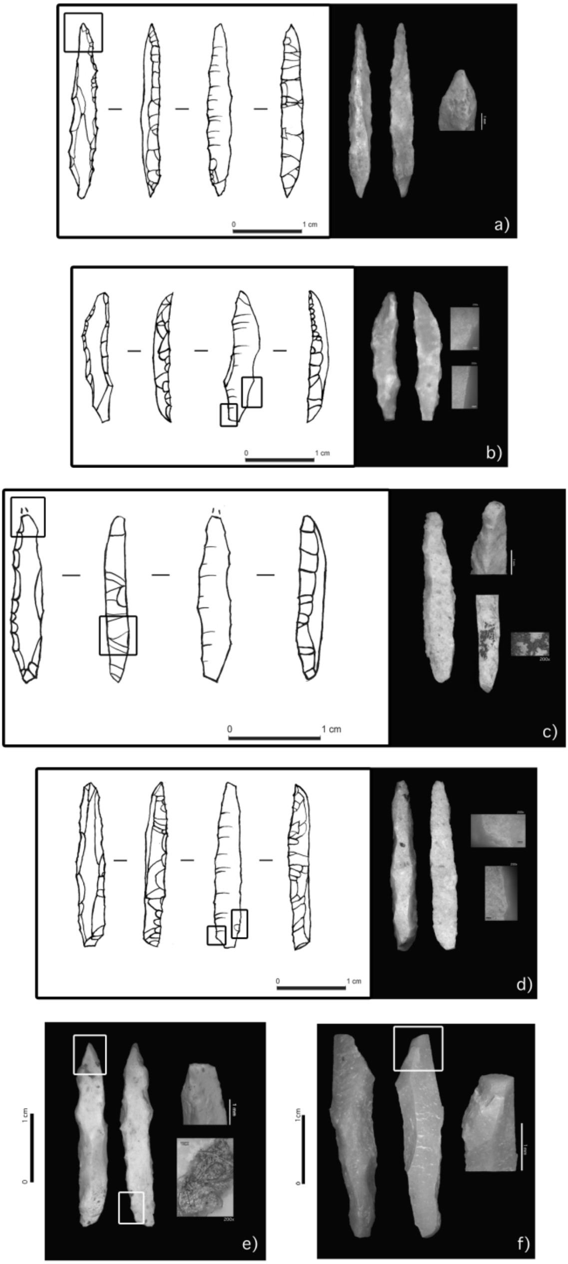
0
1 cm
a)
0
1 cm
b)
0
1 cm
200x
c)
0
1 cm
d)
0
1 cm
200x
e)
0
1 cm
f)

Fig. 8. (previous page) Diagnostic impact fractures. Burin-like impact scars (c, e and f), stepped or tongue-shaped towards the dorsal face (a). Use-wear traces from micropolish (b and d) and adhesive residue (c and e).

5. Discussion

Although preliminary, use-wear analysis of the chert lithic materials of Early Gravettian of the archeological site of Vale Boi as reported here, show interesting data. Results show clear evidence of three main tools with evidence of use: end scrapers, splintered pieces and bipointed double backed points. Polish and striations in end scrapers are associated with scraping woody materials, and in end scrapers with dry hide. From splintered pieces few examples of microwear evidence are preserved; however some interior edges show micro polish associated with wood. Edge damage and the bifacial distribution of micro fractures might show that these tools were used as a wedge for split and work wood. This type of work has also been reported for lithic materials of the Gravettian and Solutrean of Vale Boi and in other materials such as bone and anther (Gibaja & Bicho 2006). Bipointed double backed points mainly compose backed technology from the Early Gravettian of Vale Boi. The use of these tools as projectiles is indicated by the presence of DIF and microwear traces typically associated with hunting activities.

However this should be taken as a preliminary result and further research must focus on results from all the Gravettian sequence in order to test spatial organization and/or diachronic chances of human occupation at the site. Nevertheless, it is clear that functional analysis on materials from the Early Gravettian of Vale Boi seems to show that human occupation was very specialized, and probably woodworking is likely related to haft techniques for projectile technology.

6. Conclusion

Results presented should be taken as preliminary for the Gravettian sequence of the Terrace area from Vale Boi. However these results allowed the development of future research questions. Further studies should focus on assemblages from all three Gravettian horizontal beds and different site loci in order to test intra site and diachronic functional patterns, and compare the data results from other excavation areas previously published. Recently the archaeological site of Vale Boi, based on faunal remains from the Gravettian and Solutrean sequence (Manne et al. 2012), has been seen as a campsite used for the intensive exploitation of seasonal resources, and this may be reflected in different activities at the site during the Early Gravettian human occupation, with special attention to hunting activities, both associated with resource intensification. However this idea should be tested in the future, with functional analysis in lithic remains from the entire Gravettian sequence from all excavation areas, in order to check two fundamental questions: site functionality and intra-site spatial organization through time.

Acknowledgments

The authors acknowledge the FCT (Technological and Scientific Foundation, Portugal) for supporting the PhD grant and Vale Boi research project. Many thanks to all staff from Consejo Superior de Investigaciones Cientificas (CSIC, Catalonia) for proving all lab equipment.

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CHAPTER TWENTY EIGHT

INTEGRATED FUNCTIONAL STUDIES OF BADEGOULIAN LITHIC INDUSTRY: PRELIMINARY RESULTS OF LE PÉHAU (COIMÈRES, FRANCE)

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Abstract

An integrated, technological, petrological and functional approach applied to the Badegoulian lithic industry of Le Péhau site displays two distinctive tool strategies to perform two main activities: dry hide processing and osseous material working. We observe a raw material economy and a retouch modality specific to each working process.

The lithic tool structure is characterized by large retouched flakes with a huge resharpening and reduction potential over time, and as part of an original mobility context in which the whole flint set was carried over long distances.

Keywords: Badegoulian, lithic technology, use-wear analysis.

1. Introduction

The Badegoulian culture developed in France during the first part of the Late Glacial Maximum between 23.5 and 20.5 Ky cal BP (19.5-17.5 14C Ky BP). For a long time it was considered as a “lower” Magdalenian, and a “black sheep” within Upper Palaeolithic cultures due to the originality of its lithic industry. The varying amount of blades in the lithic assemblages is counterbalanced by flakes used as blanks for specific abundant diagnostic tools like raclettes and transverse burins.

The more recent work in Badegoulian lithic technology highlights a new techno-economic perspective. The latter explains the variability in flake debitage (Bracco et al. 2003) in terms of flexibility, as simple technical solutions (Cretin 2000). Through (1) the adaptability to local lithic resources, due to simple morphotechnic needs like thin or thick flakes, and (2) a ramification of the chaînes opératoires providing blanks (often blades) through mobile tool-kits, the Badegoulian lithic industry appears closely related to a “travel technology” and a foraging strategy (Ducasse 2012).

However the utilisation of Badegoulian lithic tools is not well known thus far. Only one use-wear study, on Cassegros level 10 (Vaughan 1985a), has been realised so far. We intend here, by the functional study of Le Péhau site, to shed a new light on the organisation of the Badegoulian lithic technical system.

2. Site Presentation

Le Péhau (Coimères, Gironde) is an open-air site located 7 km south of the town of Langon and the Garonne River, at 95 m.a.s.l. Situated on the Langon-Pau highway outline area, it was excavated in 2008 by the firm Palaeotime during a rescue archaeology operation.

The site is situated on a massive colluvial deposit originating from the erosion of the lower Pleistocene Garonne terrace. The acidity of the sandy-silty sedimentary context has not preserved the organic matter. The excavation yielded artefacts over 70 m², including lithic industry and elements of domestic structures. Although the site seems to have suffered some post depositional displacements or slidings, techno-economic consistency throughout and a relatively preserved spatial organisation lead to an interpretation of the site as one single Badegoulian settlement.

The lithic industry (3661 artefacts) is globally made up of flint (94%) with a supply of local quartzite (6%). Le Péhau’s industry, characterized by side scrapers (Fig. 1: 642), transverse burins (which correspond to edge-cores), thin flakes (Fig. 1: 780), and the absence of typical raclettes, in turn counterbalanced by thick retouched flakes (Fig. 2: 681, 722, 836+790), belongs to the Early Badegoulian (Ducasse 2010, 2012).

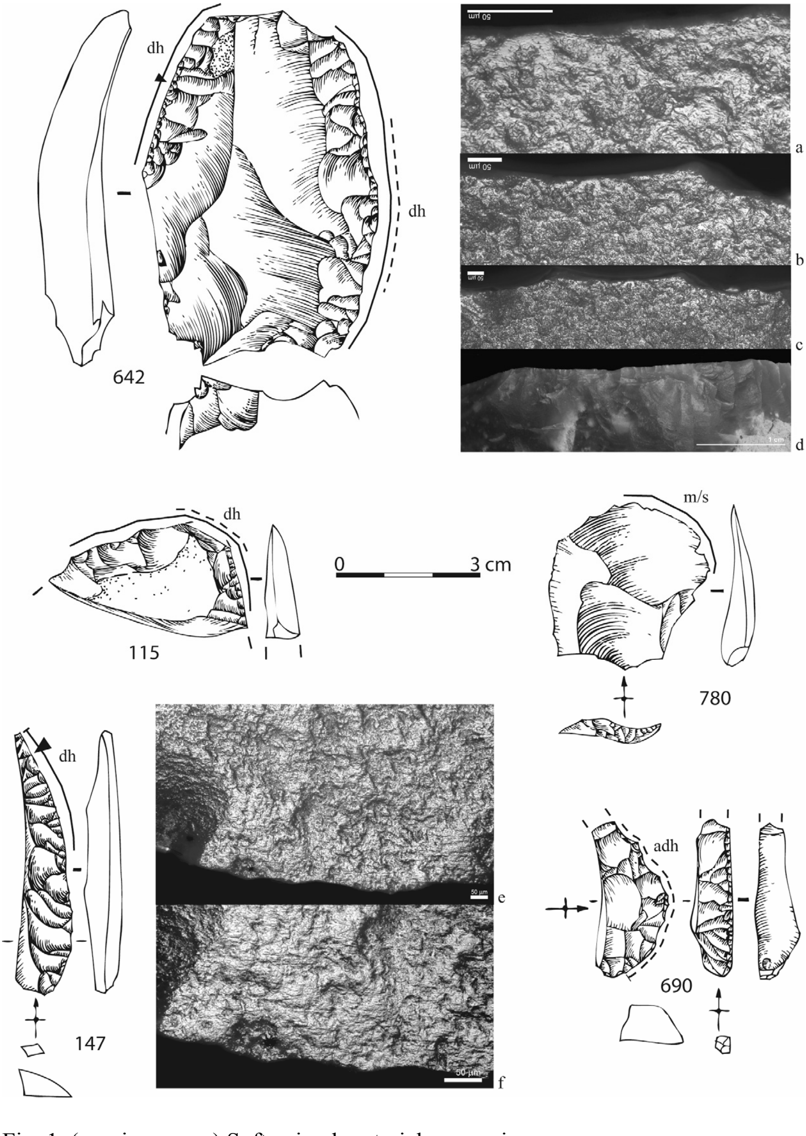

Fig. 1. (previous page) Soft animal material processing.

642: side-scraper; a: objective 50X, b: objective 20X, c: objective 10X, d: objective 1X.
115: bilateral side-scraper (distal fragment).
780: thin flake.
147: burin spall on side-scraper; e: objective 10X, f: objective 20X.
690: transversal burin spall on end-scraper
Longitudinal motion (solid line); Transverse motion (dashed line); Grooving motion (dot-dashed line); Bars at ends indicate abrupt termination to use-wear polishes because of intentional modification or accidental damage to the edge after utilisation. Photo capture localization (black triangle pointed down);
m/s = meat/fresh skin
dh = dry hide
adh = abrasive dry hide
hm = hard material
ahm = abrasive hard material
om = osseous material
sm = soft material

Fig. 2. Osseous material working.
681, 722 : abrupt retouched thick flakes; a: objective 20X, b: objective 50X
836, 790: reffiting between two atypical *raclettes*.
4: fractured atypical *raclette*;
489: side-scraper with abrupt termination (*museau*)

Longitudinal motion (solid line); Transverse motion (dashed line); Grooving motion (dot-dashed line); Bars at ends indicate abrupt termination to use-wear polishes because of intentional modification or accidental damage to the edge after utilisation. Photo capture localization (black triangle pointed down);

m/s = meat/fresh skin
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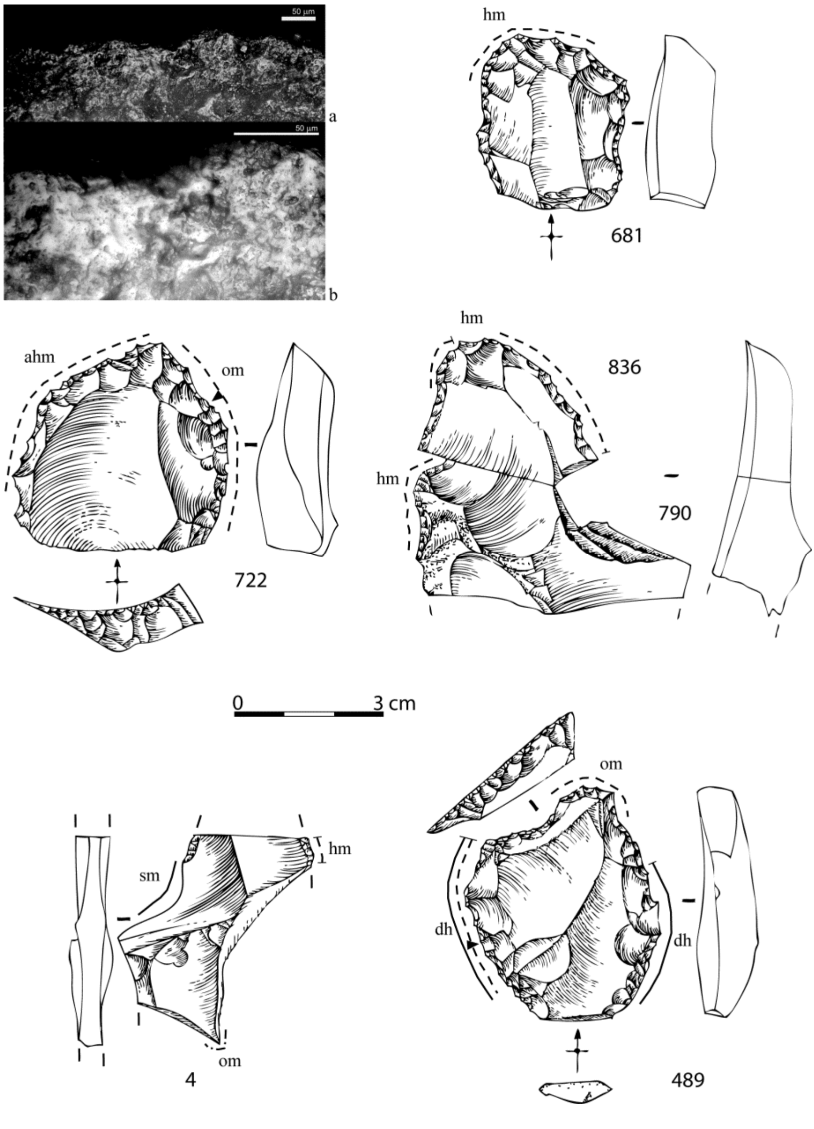
50 µm
a
50 µm
b
hm
681
ahm
om
722
hm
836
hm
790
0
3 cm
om
hm
sm
om
4
dh
dh
489

3. Flint Lithic Industry

Unlike at other Badegoulian settlements where raw material is mainly acquired in the nearby or regional environment (Cretin 2007), at Coimères the local tertiary flint is underrepresented (and not counterbalanced by quartzite). The industry is made up of allochtonous flints (97% of the set) collected over 90 km south of the site, in the Adour Basin. The major and nearest collecting area southwards, corresponds to the maastrichtian outcrops of Chalosse-Audignon (86% of the set), characterized by Lepidorbitoïdes (Séronie-Vivien et al. 2006), showing two features: a translucent microcrystalline one (56%) and an opaque microcrystalline one (30%). The other southern flints quantitatively decrease in proportion to the distance of collection.

Thanks to Le Péhau's originality in flint resources in comparison to the Badegoulian backdrop, an uncommon opportunity arises: we can focus on the settlement of a human group in a new area near the Garonne River, at least 90 km to the north of the Adour's Basin where they came from. We can argue at this point that this human group carried to Coimères a whole flint set, which it did not renew with local materials – at least not in the excavated area of the site.

In this long-distance travelling context, the main aspect of the Badegoulian lithic strategy is the transport of large mobile blanks (mostly flakes) presenting a huge potential for tool resharpening and/or typological modification (Fig. 1: 642; Fig. 2) and thereby a long functional life. The consumption of these high potential blanks is highlighted (1) through the amount of retouched flakes (29% of the total flint assemblage) in contrast to the retouched tools and tool fragments (3.6%), and (2) through the use of systematic breakages as a maintenance strategy to reuse the blanks (Fig. 1: 115; Fig. 2: 4, 836+790; cf. infra).

In situ debitages correspond mainly to the production of small thin flakes (Fig. 1: 780), a small amount of bladelets, and unstandardized blades for opportunistic use.

4. Use-wear analysis results

A total of 184 flints (95 retouched and 89 unretouched) were analysed[1], after a preliminary observation carried out to evaluate the use-

[1] Combining the low power approach and the high power approach (cf. Hayden, 1979; Keeley, 1980; Plisson, 1985; Vaughan 1985a; van Gijn, 1989; González, Ibáñez, 1994 among others) according to Semenov's methodology (Semenov, 1964).

wear potential of the whole lithic assemblage.

The retained sample amounts to 95 specimens which show macro- and microscopic use-wear traces, corresponding to 121 Active Zones of use – AZ.

Most of the retouched tools (75%) show diagnostic marks of use, whereas only 27% of the unretouched blanks, often with regular and thin edges, seem to have been used.

Some lithic surfaces are very well preserved (recognizable micro-polishes and striations), instead others conserve only macro-indicators (microchipping and/or edge rounding).

Two main activities are represented at Le Péhau, in association with animal exploitation: soft animal material treatment, such as hide and meat processing (73 AZ), and hard animal material working, such as osseous raw material (48 AZ). They are clearly integrated among the raw material economy. The microcrystalline flints which provide the sharpest edges, are mostly associated to the soft animal matter/hide working (81% AZ), and the mesocrystalline ones with the hard/osseous matter working (62% AZ), because of their abrasiveness.

The entire hide-working chaîne opératoire is represented on site. The butchering of prey (5 AZ), followed by defleshing and the removal of the skin (4 AZ) essentially involves thin flakes (Fig. 1: 780) and unretouched blades with regular and thin edges and marginal retouched tools.

The next step is dry hide working (20 AZ), occasionally with the addition of an abrasive substance (2 AZ), involving cutting (8 AZ), scraping (4 AZ), piercing (1 AZ) and mixed actions (7 AZ).

The edges used in hide processing show similar technological characters. They are regular and convex, carefully realised by parallel low angle or semi-abrupt retouch (Fig. 1). Side scrapers (19 AZ) and end scrapers (9 AZ) are polyvalent tools presenting a regular edge angle between 40° and 70° for cutting, scraping or mixed actions.

Hide working significantly wears microcrystalline flint edges, explaining the constant resharpening witnessed on Coimères' tools (cf. infra).

The second major task at Le Péhau was hard substances working (48 AZ; Fig 2), mainly on osseous material (11 AZ) identified in some cases as bone (1 AZ) and antler (1 AZ). Some examples of contact with abrasive hard material are documented too (6 AZ). This activity was primarily performed through transverse motions (39 AZ), mostly using mesocrystalline flints.

The tools related with hard material transformation are more strongly characterised by an abrupt retouch than by their typological attributions.

The thickest blanks (mostly flakes, fewer blades) show two generations of scars: a large, scalar, and semi-abrupt to abrupt retouch, which is overlapped by a shorter abrupt and frequently rounded or abraded one. These tools may look like end scrapers or denticulates (Fig. 2: 681, 722), while the second generation of scars observed relates to the classic Badegoulian raclette's retouch. Some other tools present a short abrupt retouch realised on the thinnest or less standardized blanks and are considered as atypical raclettes (Fig 2: 4, 836+790).

Despite the fact that organic matter is not preserved at Coimères, these osseous matter working tools showing technological analogy with raclettes could be related to the intensive scraping process observed on Badegoulian antler points and wedges (Pétillon and Ducasse 2012).

5. Tool maintenance

Both scrapers and abrupt retouched tools were intensively used and frequently reduced and modified, exhibiting a high proportion of used AZ.

Three different edge-removing methods have been detected for tool maintenance:

1 – The burin-blow technique;
2 – The fracturing of the blank;
3 – The retouching of the edge.

1 - The presence of burin spalls removed from retouched and used edges (Fig 1: 147, 690), and the lack of traces on facets and bevels on the burins indicate that burin-blow technique was employed with an "eliminator function" (Vaughan 1985b), in order to remove worn edges.

Whereas technological burins are attested, they do not show use-wear traces related to the burin function.

2 - Many intentional breakages have been recognised. Worn tools on large blanks can be transformed by fracturing before reshaping (Fig. 1: 115, Fig. 2: 836+790). Furthermore fractured tools can be reutilised on their broken edges or tips (Fig 2: 4).

3 - Some specimens bear use-wear traces indicating a transformation of tools by edge retouching. An example (Fig 2: 489) shows a "side scraper" first used on dry hide along both its edges, and then modified on its distal part by retouch. This abrupt retouched nose-like termination (museau) served for scraping osseous material.

6. Comparisons

The use-wear analysis of Cassegros (Vaughan 1985a) is the only comparison which can help us understand the functional aspect of the French Badegoulian. Located about 100 km east of Le Péhau, Cassegros cave (Lot-et-Garonne) yielded an Early Badegoulian assemblage (Magdalenian 0) which presents comparable functional aspects to Coimères. The two sites can be considered as temporary dry hide working settlements, although at Cassegros osseous materials are less frequently treated. Cassegros also shows some examples of wood working which do not take place in Coimères. The main difference however appears in tool selection. While in Cassegros the artefacts utilised are commonly unretouched blanks (39%), in Coimères mainly retouched tools are employed. This techno-functional variability between the two Badegoulian assemblages could be due to differences in raw material collection – from the immediate vicinity at Cassegros and transported over long distances to Le Péhau.

7. Conclusions

This study has highlighted a close association of technological, functional and petrographic characteristics that translate into a distinctive raw material economy to be understood as part of a highly mobile strategy. This highly mobile lifestyle is reflected in a flexible reduction sequence. At Coimères the shaping of the active part of the tool takes priority over the tool's shape, and is mirrored in a whole array of tools which cannot easily be categorised on a typological basis. Le Péhau's flint toolkit shows a high versatility mainly achieved through the circulation of large size flakes with significant modification and reduction potential.

The techno-functional differences noticed with regards to Cassegros, further highlight the importance of new analysis to confirm or reject the generalisation of tool economy found at Le Péhau. It is in any case important to remind ourselves that for the moment Le Péhau represents an exception within the Badegoulian behavioural backdrop due to the utilisation of completely allochtonous raw materials.

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CHAPTER TWENTY NINE

HUMAN OCCUPATION OF THE HIGH-MOUNTAIN ENVIRONMENTS: THE CONTRIBUTION OF MICROWEAR ANALYSIS TO THE STUDY OF THE COVA DEL SARDO SITE (SPANISH PYRENEES)

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Abstract

In this report we assess the results of the microwear study of the Cova del Sardo (Catalan Pyrenees). The site is located at an altitude of 1780 m.a.s.l and presents a sequence of prehistoric occupations with radiocarbon dates from the VI millennium to III millennium cal BC. Our data indicate that lithic resources were used for both subsistence and crafting activities. Pastoralism was not the only economic activity practiced by local populations.

Keywords: Pyrenees; High-altitude environment, Neolithic, Lithic assemblage, Use-wear analysis.

1. Introduction

The Cova del Sardo de Boí (Caldes de Boí, Lleida) is one of the highest archeological sites of the Iberian Peninsula. It is a small rock-shelter located in the Sant Nicolau Valley, in the Aiguestortes i Estany de Sant Maurici National Park, at an altitude of 1790 m.a.s.l. The archeological deposit presents a stratigraphical sequence that covers a chronological span between the Early Neolithic to Modern times. Six different phases of prehistoric occupation have been documented: phase 9 (7500-7300 cal BP); phase 8 (6700-6400 cal BP); phase 7 (6000-5500 cal BP); phase 6 (5500-5000 cal BP) and phase 5 (4800-4400 cal BP). A detailed description of the occupational sequence has already been published (Gassiot et al. 2010; Gassiot et al. 2013) as well as a detailed analysis of the palaeobotanical and palynological records (Gassiot et al. 2012b). Some preliminary analyses of the lithic raw material provenance have also been completed (Gassiot et al. 2012a).

This paper will focus mainly on the functional aspects of the Cova del Sardo lithic assemblage. Despite the scarcity of the lithic materials, we can consider the Cova del Sardo industry extremely interesting for at least two reasons: 1) lithics are the most abundant archeological artefact recovered during the excavation. Ceramics and faunal materials are, in fact, poorly conserved. In this sense, the lithic record could offer a fundamental contribution for the understanding of the economic activities realized at the site; 2) the majority of lithic artefacts were transported at the site over mid and long distances: between 30-40 and 100-120 kilometres. Only non-siliceous rocks are available locally. The understanding of the functional destination of those instruments, transported over such territory, is thus even more compelling.

The main aim of this study is to evaluate the extent to which lithic resources contributed to the economic activities realized at the site. Often, starting from the Neolithic period, high-altitude areas were traditionally considered specialized areas, exclusively associated with pastoral practices. In this sense, microwear analysis could represent an appropriate technique to evaluate whether other subsistence or crafting activities were realized at the site.

2. Materials and methods

The analysed sample is made up of 368 elements in total, from phases 8 to 5. In this study we have considered all the lithic materials retrieved from the cave: blades, flakes and waste products (Table 1).

PHASE		Flake	Blade	Core	Débris	Characteristic waste products	Other	Ind.	Tot
5	N	18	24	-	26	6	1	5	80
	%	*22,5%*	*30,0%*	-	*32,5%*	*7,5%*	*1,3%*	*6,2%*	*100%*
6	N	29	11	1	30	5	1	13	90
	%	*32,2%*	*12,2%*	*1,1%*	*33,3%*	*5,6%*	*1,1%*	*14,4%*	*100%*
7	N	34	27	2	26	4	1	46	140
	%	*24,3%*	*19,3%*	*1,4%*	*18,6%*	*2,9%*	*0,7%*	*32,9%*	*100%*
8	N	23	10	-	7	2	-	16	58
	%	*39,7%*	*17,2%*	-	*12,1%*	*3,4%*	-	*27,6%*	*100%*
Tot	N	104	72	3	89	17	3	80	368
	%	*28,3%*	*19,6%*	*0,8%*	*24,2%*	*4,6%*	*0,8%*	*21,7%*	*100%*

Tab. 1. Technological composition of the Cova del Sardo assemblage. *Ind.* indicates indeterminable elements.

Considering the chronological span covered by the Cova del Sardo stratigraphical sequence–more than 3000 years–the lithic assemblage appears extremely scarce. However, this scarceness of findings is a typical characteristic of the Pyrenean Mountain sites in respect to contexts located at lower altitudes. This is probably due to the seasonal character of those occupations, and, not secondarily, to the distance from the raw material sources.

Microwear analysis has been realized through the combined use of a binocular microscope (Leica MZ16 A) equipped with a camera (Leica IC 3D) and a reflected-light microscope (Leica DM2500 M) equipped with a camera (Leica DFC420 C). The conservation of the materials has already been evaluated in a previous study (Mazzucco et al. 2013); experimental sessions have been also carried out (Mazzucco and Clemente 2013).

In this paper we only present a general overview of the obtained results. Data will not be discussed phase by phase, but only as a whole because of the limited extension of the article.

3. Results

The results of the analysis indicate that the majority of materials have not been used (n=308). Used implements amount to 19.5% of the assemblage (n=60 corresponding to 75 areas of use). Of those 54.8% provided a clear interpretation, while the remaining 45.2% show more doubtful traces because of the presence of post-depositional alteration. Non-utilitarian wears (wears caused by actions linked with the production, management or maintenance of the tool, such as technological and hafting traces) have been identified on 6.3% (n=23) of the industry, although we put a word of caution on their interpretation because of the presence of taphonomic agents. Among non-utilitarian wears, 26.1% (n=6) are probably related to hafting; 69.6% (n=16) are probably produced by transportation practices, while 4.3% (n=1) are associated with the presence of residues.

Among use-wears, traces linked to vegetal substances clearly prevail during all phases (n=38; 50.7%). Among those we recognized a large group of instruments related to herbaceous plant cutting and processing activities (n=29; 38.6%). Woodworking (n=2; 2.7%) and other indeterminable vegetal substances are scarcely represented (n=7; 9.3%). Processing of animal substances amount to 6.7% (n=5) of the sample, while indeterminate materials amount to 26.7% (n=20). Elements used as projectiles amount to 16.0% (n=12). A synthesis of those results is presented in Table 2.

Phase		Vegetal Material			Animal	Indeterminate materials		Impact traces	Tot
		Herbaceous plants	Woody plants	Vegetal ind.	Soft/medium animal sub.	Soft/medium ind.	Hard ind.	Projectile	
5	**N.**	13	-	1	1	5	-	2	22
	%	*59,1%*	-	*4,5%*	*4,5%*	*22,7%*	-	*9,1%*	*100%*
6	**N.**	2	2	-	1	3	-	2	10
	%	*20,0%*	*20,0%*	-	*10,0%*	*30,0%*	-	*20,0%*	*100%*
7	**N.**	11	-	5	2	6	2	6	32
	%	*34,4%*	-	*15,6%*	*6,3%*	*18,7%*	*6,3%*	*18,7%*	*100%*
8	**N.**	3	-	1	1	4	-	2	11
	%	*27,7%*	-	*9,1%*	*9,1%*	*36,4%*	-	*18,2%*	*100%*
Tot	**N.**	29	2	7	5	18	2	12	75
	%	*38,6%*	*2,7%*	*9,3%*	*6,7%*	*24,0%*	*2,7%*	*16,0%*	*100%*

Tab. 2. Use-wear traces identified among the Cova del Sardo lithic assemblage. The total reported in the table indicates the total number of used areas. *Ind.* indicates indeterminable elements.

4. Discussion

Despite the scarceness of findings, the microwear analysis of the Cova del Sardo lithic assemblage offers some interesting results, representing a relevant contribution for the understanding of the site.

The first aspect to highlight is the importance of the activities linked to herbaceous plant processing, especially during phases 7 and 5, as stated above. Within this category fall a wide number of different activities: cereal harvesting (n=4; 14.3%); cutting straws at ground level (n=15; 53.6%); scraping plants (n=2; 7.1%) and cutting wild plants (n=7; 25%).

Cereal harvesting. Four sickle blades with an intensive cereal lustre (Fig. 1, a-d) (Fig. 2, a-b) were found at the Cova del Sardo, respectively from phases 8, 7 and 5. However, considering that some of those blades show signs of being transported and in some cases retooled, it seems plausible that harvesting activities were not undertaken locally. Clear evidence of retooling, for example, comes from phase 5. In fact, during this phase two large sickle blades were transported to the site and extensively resharpened (Fig. 1, a-b). Under a microscopic view, the cereal polishes appear abruptly interrupted by the resharpening scars (see Fig. 2, b). The same edge has been successively used for cutting other plants or straws at ground level. In this case the edge appears dull, rounded and with many striations (Fig. 2, c). The presence of few barley and wheat burned seeds during phases 8 and 6 suggest that along with sickle blade also cereals grains were consumed at the Cova del Sardo. However, the absence of any Cerealia-type grains in the local pollen diagram also suggests that agricultural activities did not take place locally (Gassiot et al. 2012b). Both sickle blades and cereal grains were probably transported to the rock-shelter from sites located at lower altitudes.

Cutting straws at ground level. Most of the blades retrieved at the site show a vegetal polish with an abrasive component (Fig. 1, b, f, i, q) (Fig. 2, c-d) (Clemente and Gibaja 1998). On the basis of experimental works (Fig. 2, e-f) those traces seem to have been produced by cutting plant straws at ground level: abrasive component is thus produced by the soil particles involved in the action. In our opinion those materials could have been employed as constructive materials (e.g. to create domestic soils, as bedding pavements, or a perishable structure such as wooden/vegetal coverage), as combustible fuels, or as animal feed. In support to our hypothesis, litter/fodder bedding layers of herbs/straws have been discovered in many early Neolithic caves associated with herding practices in the Western Mediterranean (Angelucci et al. 2009). However, phytolith and micromorphological analyses are necessary to test our postulations.

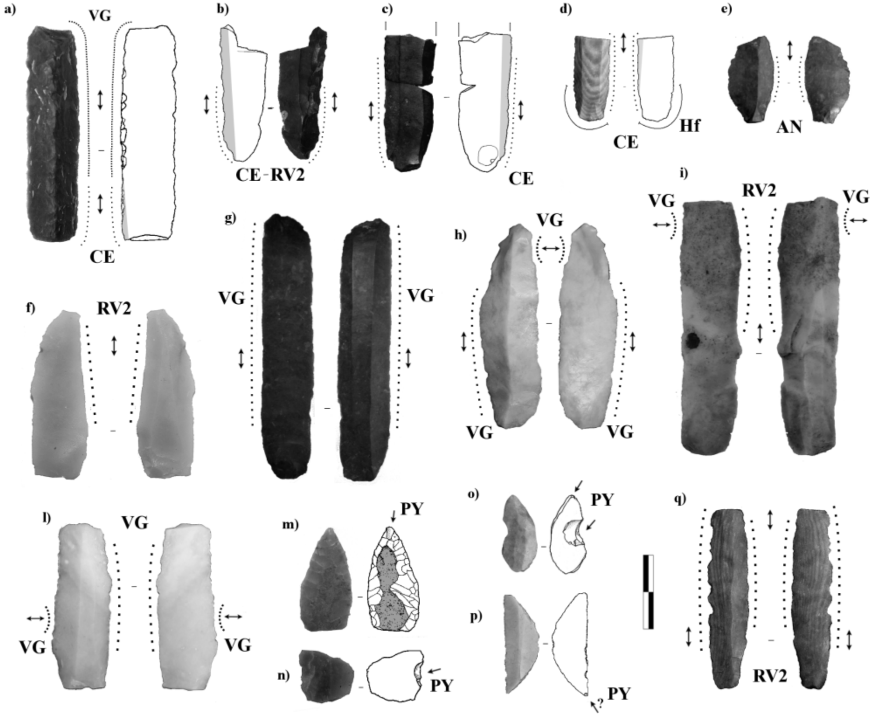

Fig. 1. Selection of the Cova del Sardo assemblage (phases 8, 7, 6, 5). The dots indicate the used areas. The arrows indicate the directionality of the movement. CE – Cereal; VG – Vegetal substance; AN – Soft animal substance; RV2 – vegetal polish with a strong abrasive component; PY – projectile insert; Hf – Hafted part.

Other plant working activities. Vegetal materials were also involved in other types of activities, although with lower percentages. Among those we noticed the scraping of fresh vegetal material (Fig. 1, h, i, l) (Fig. 2, g). This action could correspond to the processing of vegetal fibre in order to produce materials for basketry or rope-making processes. Experimental works seem to confirm our hypothesis (Fig. 2, h). In addition, few lithics seem to have been employed in woodworking activities.

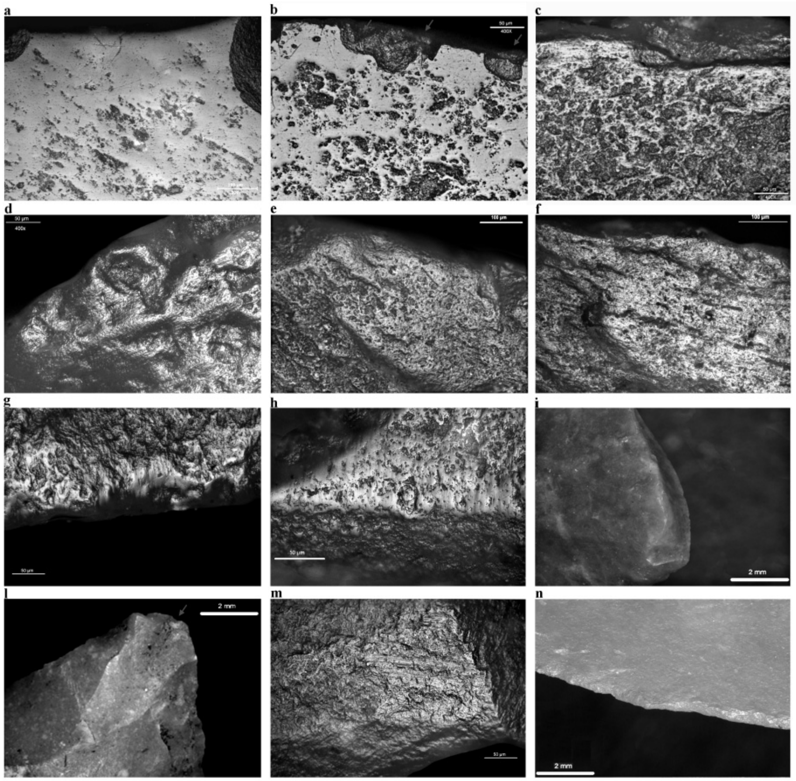

Fig. 2. Selection of use-wear traces from the Cova del Sardo assemblage. a) Extensive cereal polish; b) Cereal polish, ventral face. See how the resharpening scars interrupt the used edge; c) Abrasive plant polish on the same tool of the previous photo, dorsal face; d) Archeological plant polish with a strong abrasive component; e-f) Experimental wear resulting from cutting herbs at ground level, different stages of development; g) Archeological wear from scraping vegetal substance; h) Experimental wear resulting from scraping plant fibers; i) Burin-like fracture on a geometric segment; l) Bending/step fracture on a foliated point; m) MLITs on the same instrument; n) Edge scarring and rounding resulting from working soft animal substances.

The second aspect to remark is the presence of projectile inserts that testify to the practice of hunting activities. Impact traces have been detected mainly on geometric tools (segments and trapezes) (Fig. 1, n-p) except for the presence of a foliated point (Fig. 1, m). Observed use-wears are mainly of three types: extensive burin-like fractures (Fig. 2, i), bifacial bending/step fractures (Fig. 2, l) and MLITs (Fig. 2, m) (Fischer et al. 1994), often in reciprocal association between them. On the basis of the orientation and the position of the impact fractures, most of the instruments seem to have been used as points or transversal arrowheads. However, considering the relatively scarce number of implements, the variability in the raw materials employed for manufacture, and, the variability in the shapes and forms of the microliths, foraging activities seem to respond to an occasional and not to a specialized hunting activity (Bleed 1986). The scarce preservation of faunal materials does not allow a correlation between hunting and the type of game.

Finally, the occasional presence of traces related to the processing of animal substances (butchering, cleaning, dehairing, etc.) (Fig. 1, e) (Fig. 2, n) suggest the realization at the Cova del Sardo of a variety of domestic activities probably associated to food preparation or game processing. It is worth remembering that those kinds of use-wears should be considered underestimated in the analyzed assemblage because of the effects of post-depositional alterations.

5. Conclusion

Starting from the 8th-7th millennium cal BP, the Cova del Sardo went through a long series of short occupations and abandonments; during those periods, human populations introduced domestic livestock in the Sant Nicolau Valley as anthropogenic indicators from pollen diagrams testify (Gassiot et al. 2012b). However, even if pastoral activities probably assumed–since the early Neolithic period–a great relevance in the Eastern Pyrenees, our study demonstrates that local groups also practiced other types of economic activities.

Results indicate that the first groups who settled in the subalpine zones of the Pyrenees were not entirely dependent on pastoral production. Domestic cereals were consumed at the site, even if it is likely that their harvesting was carried out at lower altitudes. In the pre-Pyrenees, the presence of sites, as Cova Colomera (Oms et al. 2008) and Feixa del Moro (Llovera 1986), with evidence of silos and cereal processing, seem to confirm that cultivation was carried out at mid-altitudes (700-1000 m.a.s.l.). The transportation and retooling of sickle blades at the Cova del Sardo should be interpreted within this economic context.

On the other hand, hunting activities were also represented. The integration of hunting in Neolithic agro-pastoral societies has been long discussed and various explications have been given (Orton in press). For highland pasture areas, one of the more reasonable explanations is that hunting was practiced to avoid livestock slaughtering during the summer fattening season; however, more studies are necessary to confirm this hypothesis.

Finally, crafting activities, such as floor preparation, basketry or woodwork, should be considered as occasional practices, related to everyday domestic tasks. Moreover, we have to consider that the number of used implements is greatly reduced, and thus it is difficult to assess the role and the importance of such activities.

In conclusion, this scenario is in accordance with the existence of mobile agro-pastoral groups that seasonally occupied the high mountainous areas, mainly in relation to herding, but not exclusively. The Cova del Sardo was part of a wider subsistence and settlement system.

Acknowledgement

This study is part of the Project: "*Interacción entre clima y ocupación humana en la configuración del paisaje vegetal del Parque Nacional de Aigüestortes i Estany de Sant Maurici a lo largo de los últimos 15.000 años (OCUPA)*" of the Universtat Autónoma of Barcelona, Universitat Rovira i Virgili and Consejo Superior de Investigación Científicas (CEAB-CISC).

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CHAPTER THIRTY

WOOD TECHNOLOGY OF PATAGONIAN HUNTER-GATHERERS: A USE-WEAR ANALYSIS STUDY FROM THE SITE OF CERRO CASA DE PIEDRA 7 (PATAGONIA, ARGENTINA)

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Abstract

In the Patagonian archaeological record, the preservation of wooden artefacts is very restricted. Functional analysis of lithic artefacts is a way to get a better understanding about the use and consumption of vegetative/plant resources. However, although the study of lithic artefacts used during wood processing activities represents a good indication of the use of wood as raw material, such analysis does not give any information about the technological processes applied in wood transformation and manipulation. Therefore, technological and functional analysis is a reliable way to approach the production processes of wooden artefacts.

In this paper we present the results of the analysis of traces preserved on the surface of a wooden artefact retrieved from layer 6 (5.310±110 BP) at the site of Cerro Casa de Piedra 7 (province of Santa Cruz, Patagonia, Argentina). The interpretation of this object is complicated due to the absence of ethnographical references, and the lack of similar archaeological findings from the contexts of Patagonian hunter-gatherers. However, through the observation of the use-wear traces it is possible to reconstruct part of the manufacturing process, as well as some of the employed instruments.

Keywords: Patagonian hunter-gatherers, wood, use-wear analysis

1. Introduction

Wooden objects in the Patagonian archaeological deposits are extremely rare. In fact, most sites do not present the taphonomical conditions necessary for the preservation of organic matter. Only in rare occasions has it been possible to carry out a detailed study of a piece of wood (Capparelli et al. 2009; etc.). Several historical sources (Gallardo 1910; Gusinde 1937; among others) and archaeobotanical studies (Piqué 2006; Fermé Caruso 2008; Fermé Caruso et al. 2011) mention the development of specific technical operations for the manufacture of instruments attributed to groups of Patagonian hunter-gatherers.

Functional analysis of lithic artefacts allows a deeper study of the uses of raw materials of plant origin by prehistoric populations. However, although lithic or bone tools used in wood processing activities are good indicators of wood utilization as raw material, the technological processes carried out on wood are unknown. Therefore, technological and functional analysis is one possible approach for the understanding of production processes involved in the manufacture of wooden instruments.

The study of the technological processes of wooden instruments aims to reconstruct the process of production and the use of these objects. The analysis of growth rings and the observation of the orientation of wood fibres are both elements that make it possible to perform the taxonomic (species and genera) and anatomical recognition (section-branch, complete or segmented trunk, etc.). Moreover, the existence of residual bark and/or traces left by debarking is indicative of the preparation of the support. Vice versa, evidence of combustion or adhesive residues provides information about the hafting process or the assemblage of different parts, among other things (Palomo et al. 2011; Caruso Fermé 2012).

2. The site Cerro Casa de Piedra 7 (CCP7)

The site Cerro Casa de Piedra 7–47°57’S, 72°05’W–is located in the mountains of the Perito Moreno National Park, in the north-west of Santa Cruz Province (Argentina). Cerro Casa de Piedra is a volcanic rhyolitic hill, with several caves and rock-shelters looking northwards. It is located approximately 2 km east-southeast of Burmeister Lake. The latter, together with lakes Belgrano, Azara and Nansen y Mogote forms one of the glacial basins set up in the northwest of Santa Cruz province, Argentine Patagonia (Fig. 1).

Fig. 1. Cerro Casa de Piedra 7 site

The oldest radiocarbon dates come from cave 7. This site was intensively studied, producing evidence of human occupation dated to between ca. 10600 and 3400 14C yr BP. The continuity of occupations is remarkable across the Holocene. Several occupations, dated to ca. 5000 yr BP (Aschero 1996), testify to a variety of evidence which include faunal and lithic assemblages in association with hearths. The cold and dry conditions in the cave favoured the preservation of guanaco (*llama guanicoe*) skin/hide, vegetable fibre, bones, vein thread, as well as artefacts made of wood, bone, and lithic. A model of settlement strategies has been proposed, and a pattern of residential mobility has been modelled. CCP7 probably served as a base camp where multiple subsistence activities took place.

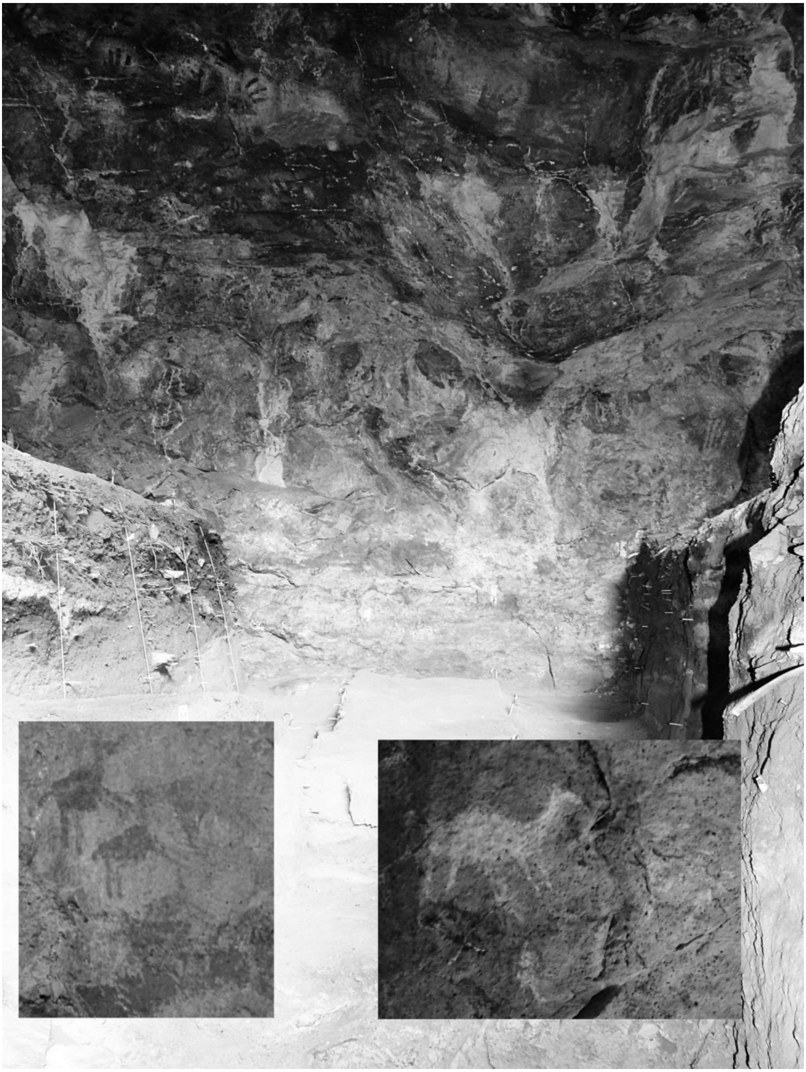

Fig. 2. The production of the rock art

The archaeological information is complemented by the overlapping and extension of a diverse set of paintings on the cave´s walls (Fig. 2). The walls of the site Cerro Casa de Piedra 7 are characterized by representations of hands and guanaco (*Llama guanicoe*). The colours of the images are: black, red, and white. Depending on the colours of each image we observe differences in the orientation of the painted sequences (Aschero 1996). On the basis of the relation between animal representations and the negative handprints it is possible to hypothesize that juvenile, infant, and adult people (possibly women) were co-participating in the observation and/or in the execution of rock art (Aschero 1996).

Geomorphological studies suggest that the cave was abandoned in a period of landslides ca. 3500 AP (Aschero et al. 2005), and later temporarily occupied during times of exploitation of terrestrial resources (Civalero et al. 2006/07).

The exceptional preservation conditions that characterize CCP7 enabled the recovery of two wooden objects. This paper focuses on the taxonomic, morphological, and traceological analyses of the wooden object number 897, recovered in Layer 6 (5.310±110 BP).

The objective of the present study is twofold. First, to reconstruct the manufacturing process of the above mentioned wooden object, and to infer the types of instruments employed. The second objective is to determine if the instruments were used, and, if so, how.

3. Materials and methods

The wooden object (Fig. 3, A) was recovered during the excavation of one of the hearths documented in Layer 6. The study of technological processes is based on the taxonomic, morphological and traceological analyses.

The identification of the species was based on the observation of the anatomical structure of the three natural planes. The thin sheets removed from the piece were examined through a transmitted light microscope (Zeiss Axioskop 40), and compared with reference samples of present day wood. Morphological analysis was based on the registration of the length and width of the central part of the piece, and of both extremities: proximal and distal. Every trace observed on the surface was recorded, including the presence of residual bark, evidence of thermal alteration and other features of the material's surfaces–i.e. polishes or debarking marks. These were studied by the combined use of a binocular microscope (Leica DM 2500M) equipped with a camera (Leica IC 3D), and a stereoscopic microscope (Leica MZ16A) with camera (Leica DFC 420).

4. Results

The taxonomic analysis showed the use of the shrub taxa as raw material: *Maytenus magellanica* (Lam.) Hook. F.–Firing duration (Fermé Caruso 2012).

The total length of the object is 133.89 mm. The proximal end has a diameter of 11.81 x 10.34 mm, the central portion 11.72 x 10.7 mm and the distal end 11.92 x 10.92 mm.

The proximal end displays signs of several incisions of different depth to make the branch thinner and then finally broken by bending it (Fig. 3, B, C). Thin longitudinal marks on the surface suggest that the bark was removed and the branch was probably smoothed using the edge of a lithic implement.

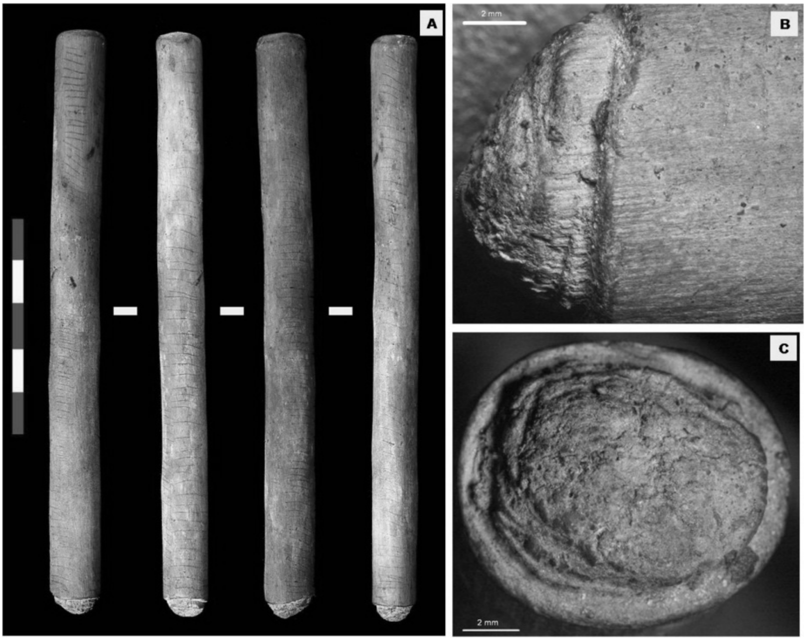

Fig. 3. A) wooden artefact the site Cerro casa de Piedra 7 -Layer 6: 5310 ± 110 BP-, B-C) Proximal extreme

A series of short shallow grooves-striations all around the branch were made after the bark was removed (Fig. 4). These striations present a greater depth in the distal part of the branch, whereas in the medial and proximal part they gradually tend to disappear, becoming more superficial. This is especially so in the proximal end where they look like thin lines painted on the surface. Preliminary experimental works have shown that these types of striations are easily filled by impurities (such as dust, dirt, remains of skin from the hand, etc.) after a short time of use.

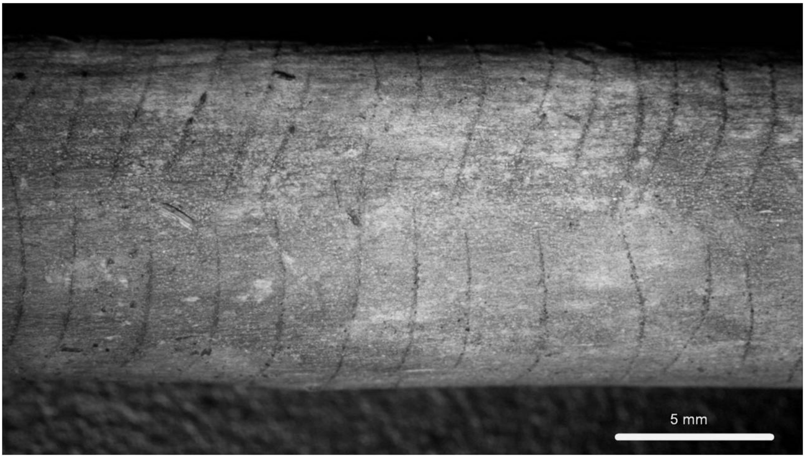

Fig. 4. Series of short all around the branch

Marks attributable to use:

We have identified marks on the surface of the wooden artefact which can be attributed to its use and/or handling. These marks are concentrated mainly at the distal end of the object and consist of:

1) Rounding/abrasion: in the transversal section through the branch. It is more noticeable in the reverse or lower face of the artefact, where the wood fibres have suffered pressure and abrasion along the longitudinal axis (Fig. 5, A).

2) Polishing: glossy and greasy-looking "polishes" have been observed in the same area, the distal portion of the artefact (Fig. 5, B), contrasting with the wood natural surfaces, more rough and opaque.

3) Residues and colouring: Reddish-colouring is seen at the distal end. In the area where this is best preserved, the micro-polish is oriented, glossy, and has a closed mesh which is similar to that of contact with mineral in other raw materials (Fig. 5, C). Remains of a whitish colouring, covering a large part of the surface on the reverse of the artefact, also seem to be mineral when observed under the microscope (Fig. 5, D). Additionally, a black residue has been observed on different parts of the

object, which consists mainly of flat stains or small drops adhered to the surface.

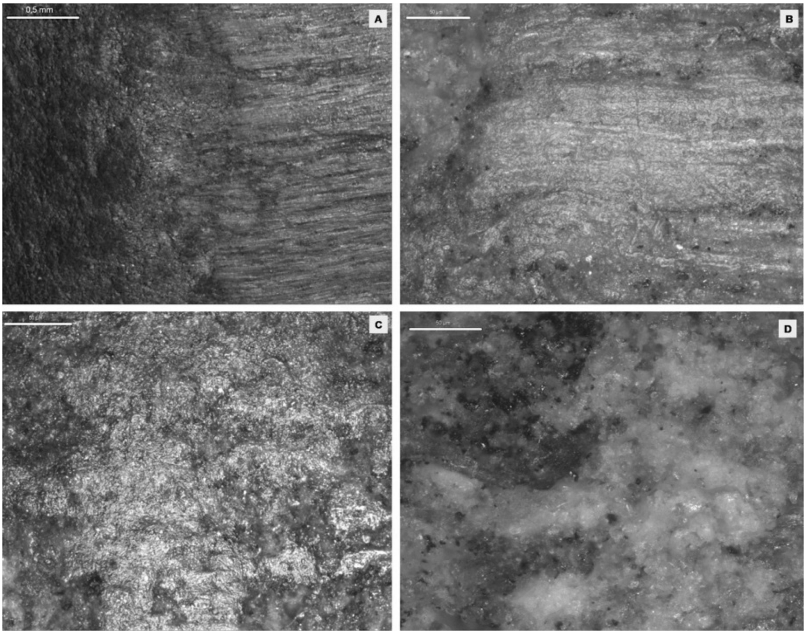

Fig. 5. A) Rounding/abrasion in the transversal section, B) Polishing: Glossy and greasy-looking, C) Reddish-colouring is seen at the distal end, D) Remains of whitish colouring

5. Discussion and conclusion

Firstly, the various analyses employed together with the taxonomic results of the woody material suggest the selection of the raw material for the preparation of this object. This is reinforced by the absence of the employed species (*Maytenus magellanica*) among the dispersed material in the sediment of the excavation, and that recovered from the combustion structure (Caruso Fermé 2012).

Secondly, the analyses revealed that after selecting the wood, various technical operations were carried out, namely, splitting the branch and debarking–as evidenced by delicate longitudinal traces, etc.

These results demonstrate that the wooden object recovered from Layer 6 (5.310±110 BP) at the site of Cerro Casa de Piedra 7, was indeed an artefact on which diverse technological processes were performed.

Future studies will investigate possible relationships between the wooden artefact and the rock-art paintings. Our hypothesis is that, due to the position and distribution of the use-wear marks and to the presence of mineral-organic residues, the wooden artefact could have been implicated in the production processes of the rock art (Fig. 2). Mineralogical and chemical analysis of the residues and further experimentation will be soon carried out in order to confirm this hypothesis. However, in the present phase of the study we are able to point out the existence of a timber technology in these early periods.

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CHAPTER THIRTY ONE

UNMODIFIED QUARTZ FLAKE FRAGMENTS AS COGNITIVE TOOL CATEGORIES: TESTING THE WEAR PRESERVATION, PREVIOUS LOW MAGNIFICATION USE-WEAR RESULTS AND CRITERIA FOR TOOL BLANK SELECTION IN TWO LATE MESOLITHIC QUARTZ ASSEMBLAGES FROM FINLAND

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Abstract

We present the results of the first microwear analysis made on quartz artefacts excavated in Finland. Fifty-nine pieces from two Late Mesolithic sites were analyzed, including both morphological tools and unmodified flakes and flake fragments. Both assemblages have been previously analyzed using a stereomicroscope (Pesonen & Tallavaara 2006, Rankama & Kankaanpää 2011). Our results show that unmodified quartz fragments have been utilized as tools and therefore new tool categories can be found among the material previously treated as production waste. The results also indicate that the reliability of low magnification analysis depends greatly on the level of wear preservation, as well as on tool edge morphology, as obtuse-angled working edges could only be identified as used with high magnifications. Preliminary observations about possible tool blank selection criteria, such as the preference of intact flakes over flake fragments, should be tested with larger and more varied samples.

Keywords: Microwear analysis, vein quartz, Late Mesolithic, Finland

1. Introduction

Due to the idiosyncratic fracturing patterns of vein quartz, the quartz industries of eastern Fennoscandia were long misunderstood (Knutsson 1998; Siiriäinen 1981). While the quartz assemblages are nowadays better comprehended in terms of technology (see Callahan et al. 1992; Driscoll 2011; Tallavaara et al. 2010), formal tools are typically rare in the assemblages (e.g. Manninen & Knutsson 2011), and the use of unmodified flakes and fragments has been demonstrated to be a common trait among quartz-using groups in Sweden. Because of this, microwear analysis is often needed to reconstruct and understand the logic of tool blank production, selection and use (see Knutsson 1988a, 1988b; Knutsson & Knutsson 2009).

In Finland, vein quartz was the most common raw material for tools throughout the Stone Age. Although some recent studies have utilized stereomicroscopy in the analysis of quartz in order to recognize small retouch and possible use-wear (Pesonen & Tallavaara 2006; Rankama 2002; Rankama & Kankaanpää 2011; Tallavaara 2007), high magnifications have not been used in Finland prior to our study. Here, we present the results of the microwear analysis of 38 pieces from Pello Kaaraneskoski and 21 pieces from Lohja Hossanmäki. The sites have been subject to rescue excavations, which covered parts of the settlement areas. At both sites, a number of finds concentrations have been observed and may reflect repeated short-term occupations and/or variability in the activities performed at the sites. The inner chronology of the sites remains somewhat open, but both quartz assemblages have been dated to the Late Mesolithic (Pesonen & Tallavaara 2006; Rankama & Kankaanpää 2011). The purpose of our study was 1) to examine the level of microwear preservation in the two assemblages; 2) to evaluate the relationship between the results of low magnification and high magnification analyses, carried out separately; and 3) to make observations about the possible patterns in tool blank selection at the two sites.

2. Materials and methods

A high power method for the analysis of use-wear on vein quartz artefacts has been developed in Sweden since the 1980s (Knutsson 1988a, 1988b; Knutsson & Knutsson 2009; Knutsson et al. in prep.). Experimental programs devoted to macroscopic wear on quartz tools, on the other hand, have to our knowledge been very rare. A study by Broadbent and Knutsson (1975), focussed on quartz scrapers, has been used as a reference in the stereomicroscope analysis of the Kaaraneskoski material (Rankama & Kankaanpää 2011), whereas the interpretation of the Hossanmäki material (Pesonen & Tallavaara 2006) relies on more general observations made in the context of experiments involving other lithic raw materials. Our interpretations of the wear observed under high (mainly 400×) magnifications are based on the experimental results published by K. Knutsson (1988a) and on the results of a small experimental series produced for the purposes of this study (see Taipale 2012).

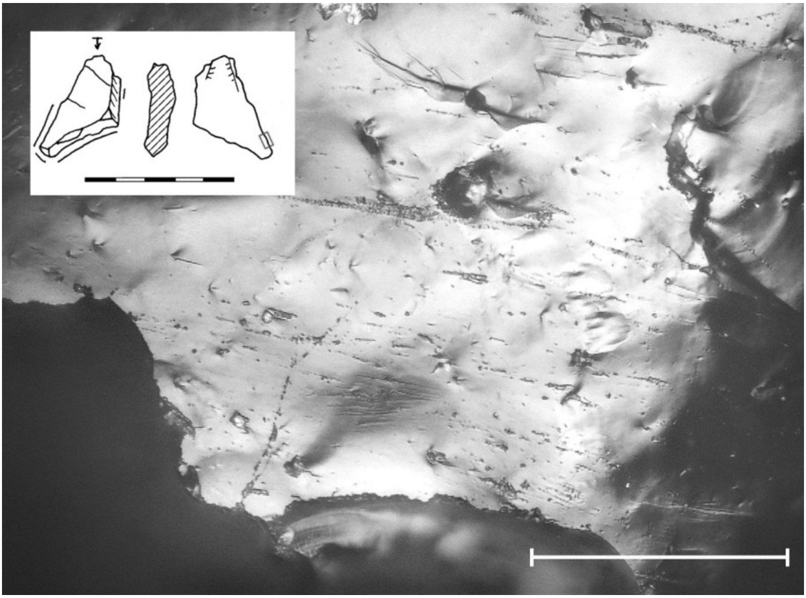

Fig. 1. Wear from sawing on tool NM 31377:642, a flake fragment, from Pello Kaaraneskoski. Discontiuous striations run parallel to the edge line. Magnification 400×, scale bar 100µm.

A clear difference was observed in the level of preservation between the two samples of archaeological tools. This might be partly due to the differences between the soil types at the sites. The silt moraine at Hossanmäki is generally more fine-grained than the sandy soil found at Kaaraneskoski (Pesonen & Tallavaara 2006; Rankama & Kankaanpää 2011), and it is possible that the difference in the grain size of the sediment affects the way the worn surfaces preserve. It seems likely, however, that other factors play a part here as well. Possible differences in the stability of the soil, for instance, cannot be ruled out. Some tool edges in the Kaaraneskoski sample have suffered damage that is visible as rather heavy rounding. Occasionally this rounding appears on edges without linear features that would clearly indicate use, and therefore its connection with prehistoric tool use is ambiguous. Despite these observations, the Kaaraneskoski assemblage also shows evidence of well-preserved microwear (see Figs. 1 and 2). Features like the rounding mentioned above pose challenges for low magnification use-wear analysis.

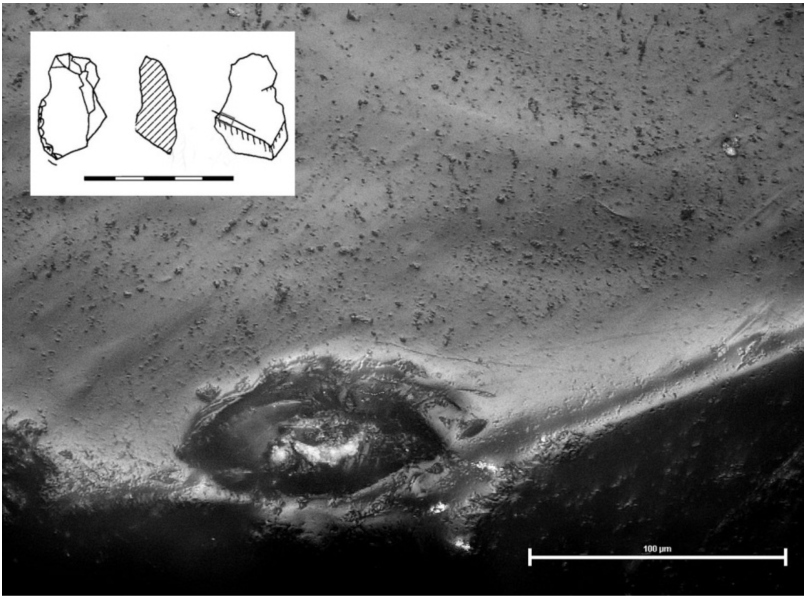

Fig. 2. Wear from planing/scraping on an unmodified, obtuse-angled edge of tool NM 31377:1043 from Kaaraneskoski. The polished surface is covered in numerous impact pits and discontinuous striations, running at slightly varying angles, generally perpendicular to the edge line. Magnification 400×, scale bar 100µm.

3. Results

The Hossanmäki assemblage showed an excellent level of preservation, which probably has an effect on the good agreement between the results of the two analyses in the case of our sample (see Table 2). Tables 1 and 2 show the frequencies of morphological tools and unmodified flakes identified as used during the microwear analysis. Our analysis showed that the correlation between the low magnification and high magnification results depends greatly on the level of postdepositional damage on tool edges. The amount and quality of this damage cannot be evaluated without examining the tools with magnifications of 200-400×. Low magnification analysis, though showing promising results especially in the case of the Hossanmäki sample, is further complicated by the fact that fractures occur frequently on quartz tool edges, and it is not easy to separate those originating from tool use from those caused by retouch or later damage.

PELLO KAARANESKOSKI	Number of used pieces	Number of analysed pieces
Tools with secondary modification	7	20
Tools with edge rounding or crushing	3	4
Flakes and flake fragments	3	14
Total	**13**	**38**

Table 1. The number of pieces with clearly identifiable use-wear observed under magnifications of 200–400×. Groups represent the categories from the earlier analysis (Rankama & Kankaanpää 2011) using magnifications of 24× or less. On several retouched pieces, wear in the form of edge rounding and crushing was registered during the initial stereomicroscope analysis, but it could not always be connected to tool use and is interpreted as being partly caused by postdepositional processes.

LOHJA HOSSANMÄKI	Number of used pieces	Number of analysed pieces
Tools with secondary modification	6	8
Tools with edge rounding or crushing	6	7
Flakes and flake fragments	3	6
Total	**15**	**21**

Table 2. The number of pieces with clearly identifiable use-wear observed under magnifications of 200–400×. Groups represent the categories from the earlier analysis (Pesonen & Tallavaaara 2006) using magnifications of 24× or less. The use-wear was well-preserved on these pieces, which is also reflected in the agreement between the two methods.

Also, a trait common to both samples was the evident utilization of right- or obtuse-angled edges for different tasks such as sawing, planing and scraping (Figs. 2 and 3). Typically, the edges identified as used under a stereomicroscope in the Hossanmäki sample are rather sharp and thin. In both assemblages, the low-power method failed to identify the obtuse-angled tool edges as used, probably due to their resistance to severe rounding and crushing. Therefore, it can be suspected that tools with thin edges are overrepresented in assemblages that have been analyzed with low magnifications, while obtuse-angled edges suitable for planing, scraping or sawing remain undetected. This observation further underlines the potential value of microwear analysis in future studies dedicated to observing cultural and behavioural patterns in the use of quartz in the area of present-day Finland.

When quartz is knapped, flakes fragment more easily than is the case with most lithic raw materials. Because of this, fragments with different shapes and edge qualities are found in assemblages together with intact flakes (Callahan et al. 1992). It has sometimes been suggested that certain fragment types might have been preferred for certain tool types (e.g. Rankama 2002). While no clear connection between fragment types and specific tasks was observed in our study, both the samples show a preference of intact flakes over flake fragments. These pieces often possess a sharp edge suitable for, e.g., cutting or whittling, and at least at Hossanmäki, they have also served as scraper blanks.

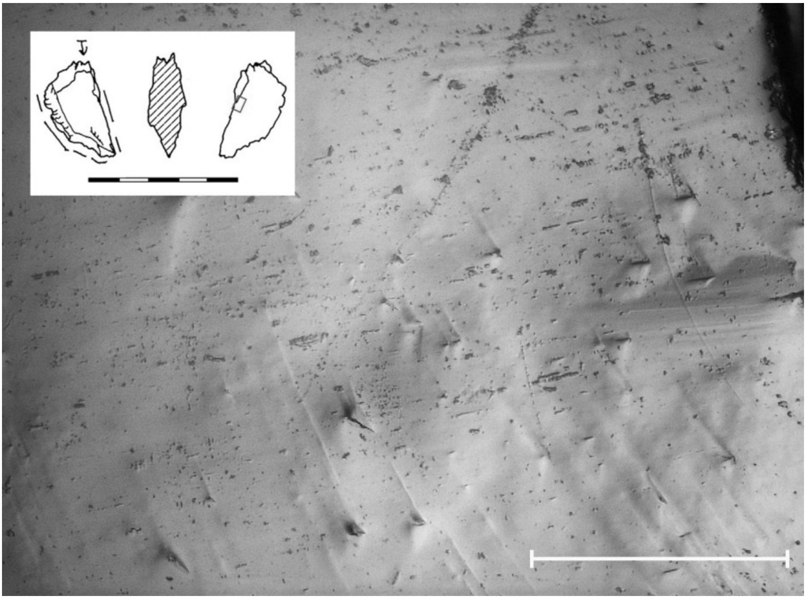

Fig. 3. Wear from sawing on an obtuse-angled edge of tool NM 34856:104, a flake fragment, from Lohja Hossanmäki. Very parallel discontinuous and straight-sided striations cover the surface. The edge rim is located below the picture and runs parallel to the striations. Magnification 400×, scale bar 100μm.

4. Discussion

The samples for this study were chosen primarily on the basis of the earlier macrowear results (Pesonen & Tallavaara 2006; Rankama & Kankaanpää 2011) in order to assess the feasibility of the method in the study of quartz tools. As said, this method may recognize certain tool categories such as sharp cutting edges more readily than others, and our samples do not therefore necessarily reflect the overall variation in tool blank morphology. Therefore, results presented here remain suggestive and should be tested against larger samples picked in a different manner. In the case of the Kaaraneskoski sample, the large portion of secondarily modified tools among the used pieces (five out of 13) further complicates the evaluation of the relationship between the fragment types and use, since retouch prevents the recognition of the types of fragments that have served as blanks for these five tools. When they are excluded, the second largest category (three pieces), are intact flakes. While the dominance of intact flakes seemed clearer among the used pieces from Hossanmäki, it was not found statistically significant in the small sample (see Taipale 2012) and should also be tested further.

Some differences were observed between the groups of used pieces from the two sites. For instance, the use of multiple edges was more common in the Hossanmäki sample than in the Kaaraneskoski sample. Among the Kaaraneskoski tools, the amount of retouch seems to correlate with the amount of wear, whereas no such connection was observed in the Hossanmäki sample. In the case of the latter, unmodified pieces also exhibited strong wear. These observations would be worth investigating further, especially with respect to the spatial distribution of the artefacts, since both the sites can be interpreted as the remains of several occupations that have occurred over a period of time (Pesonen & Tallavaara 2006; Rankama & Kankaanpää 2011).

Despite the observed differences, there are also similarities between the samples. Our study clearly demonstrates that the use of unmodified quartz flakes and fragments has been part of the strategies used by the groups visiting Kaaraneskoski and Hossanmäki. Another trait common to both the samples is the selection of sturdy, straight natural edges with angles close to 90° for different tasks such as sawing or planing. These are exactly the type of edges that commonly appear on quartz flake fragments and are not easily recognized as used in low magnification analysis. Both these observations have implications for future quartz studies in Finland, and underline the importance of integrating microwear analysis with other analytical methods.

Acknowledgements

We would like to thank Gunvor and Josef Anér's foundation and Berit Wallenberg's foundation that partly funded the teaching and supervision involved in the project. We also want to thank Tuija Rankama, Petro Pesonen and Miikka Tallavaara for providing us with the macrowear analysis results, and Miikka Tallavaara for the help with statistical testing.

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CHAPTER THIRTY TWO

A CONSIDERATION OF BURIN-BLOW FUNCTION: USE-WEAR ANALYSIS OF KAMIYAMA-TYPE BURIN FROM THE SUGIKUBO BLADE ASSEMBLAGE IN NORTH-CENTRAL JAPAN

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Abstract

Burin is the lithic tool class defined as having a burin facet edge created by a burin-blow. It has long been considered to be used for engraving bones, antler and ivory. Recent analyses of use-wear indicate that burins were not always used for hard material working and that the burin-blow function was not only used to make the working edges, but also for other purposes.

This study investigates the burin-blow function of Kamiyama-type burin, based on the results of use-wear analysis of Upper Palaeolithic artefacts from the Sugikubo blade assemblages. The Sugikubo assemblage mainly distributed in north-central Japan dates to roughly 23000-22000 cal BP. The assemblage is characterized by a number of burins including the Kamiyama-type burin. The results of use-wear analysis on Kamiyama-type burin indicate that burin bits and burin facet edges show no correlation with hard material working. Rather, use-wear traces formed by

cutting or sawing hide and soft materials are located on burin facet edges and adjacent non-burin-related edges. In addition, angles of burin facet edges are acute and burin-blows usually removed worn lateral edges, suggesting that this type of burination served as a technique for edge modification to create and rejuvenate an acute edge suitable for longitudinal activities.

Keywords: Upper Paleolithic, Japanese Archipelago, Sugikubo blade assemblage, Kamiyama-type burin, burin-blow function.

1. Introduction

Burin is the lithic tool class defined as having a burin facet edge created by burin-blow (Vaughan 1985b; Barton et al. 1996) (Fig. 1). It has long been considered to be used for engraving bones, antler and ivory (Clark and Thompson 1954; Semenov 1964; Stafford 1977). Recent analyses of use-wear, however, indicate that burins were not always used for hard material working and that burin bits and burin facet edges often show no use-wear traces, suggesting that the burin-blow function is not only to make the working edges but also for other purposes (Moss 1983; Vaughan 1985a, 1985b; Symens 1986; Straus et al. 1988; Barton et al. 1996; Tomáŝková 2005; Sano 2011). This study investigates the burin-blow function of Kamiyama-type burin, based on the results of use-wear analysis of Upper Palaeolithic artefacts from five Sugikubo blade assemblages in north-central Japan.

2. Palaeogeography, flora, and fauna during the LGM

During the late Late Pleistocene, four main islands of the Japanese Archipelag, Hokkaido, Honshu, Shikoku and Kyushu, were combined into two land masses; the Palaeo-Sakhalin/Hokkaido/Kurile Peninsula (Palaeo-SHK Peninsula) and the Palaeo-Honshu Island (Ono 1990; Ota and Yonekura 1987) (Fig. 2). Macroscopically, during the Last Glacial Maximum (LGM: 30,000-19,000 cal BP–Yokoyama et al. 2007; Lambeck, et al. 2002) the vegetation in the southern part of the Palaeo-SHK Peninsula was characterized by the patches of open coniferous forest and grassland with cool-temperate coniferous forest (Igarashi 2010; Ono and Igarashi 1993) (Fig. 2). Large mammals adapted to cold environment such as woolly mammoth and steppe bison survived during the LGM in the Palaeo-SHK Peninsula (Takahashi et al. 2006; Iwase et al. 2012). On the other hand, the Palaeo-Honshu Island was characterized by two types of forest vegetation; cool-temperate coniferous forest and temperate Pan-mixed forest (Ono and Igarashi 1993). Large mammals on the Palaeo-Honshu Island, for example Naumann's elephant inhabiting the temperate forest, went extinct roughly coinciding with the onset of the LGM (Takahashi et al. 2006; Iwase et al. 2012).

The above differences between the Palaeo-SHK Peninsula and the Palaeo-Honshu Island imply the possibility that hunter-gatherers developed different technologies to adapt to each environment during the LGM (Iwase 2011, 2012). The present paper illuminates one aspect of technology adapted to cold-temperate forests on the Palaeo-Honshu Island through use-wear analysis.

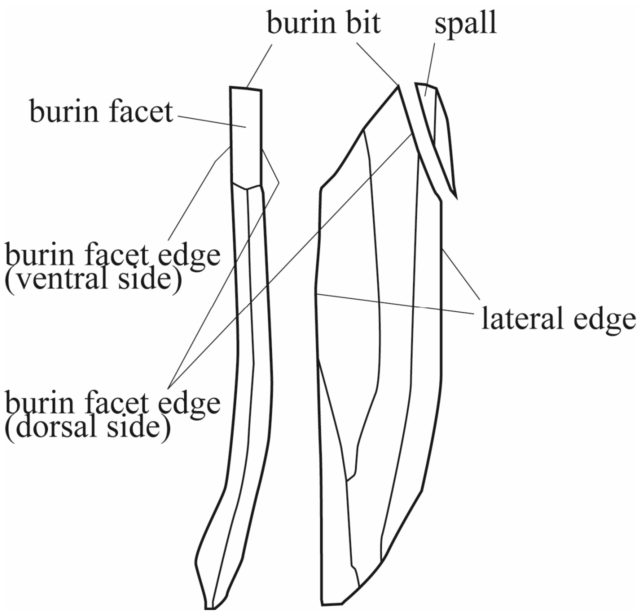

Fig.1 Burin features (modified from Barton et al. (1996: Fig.1))

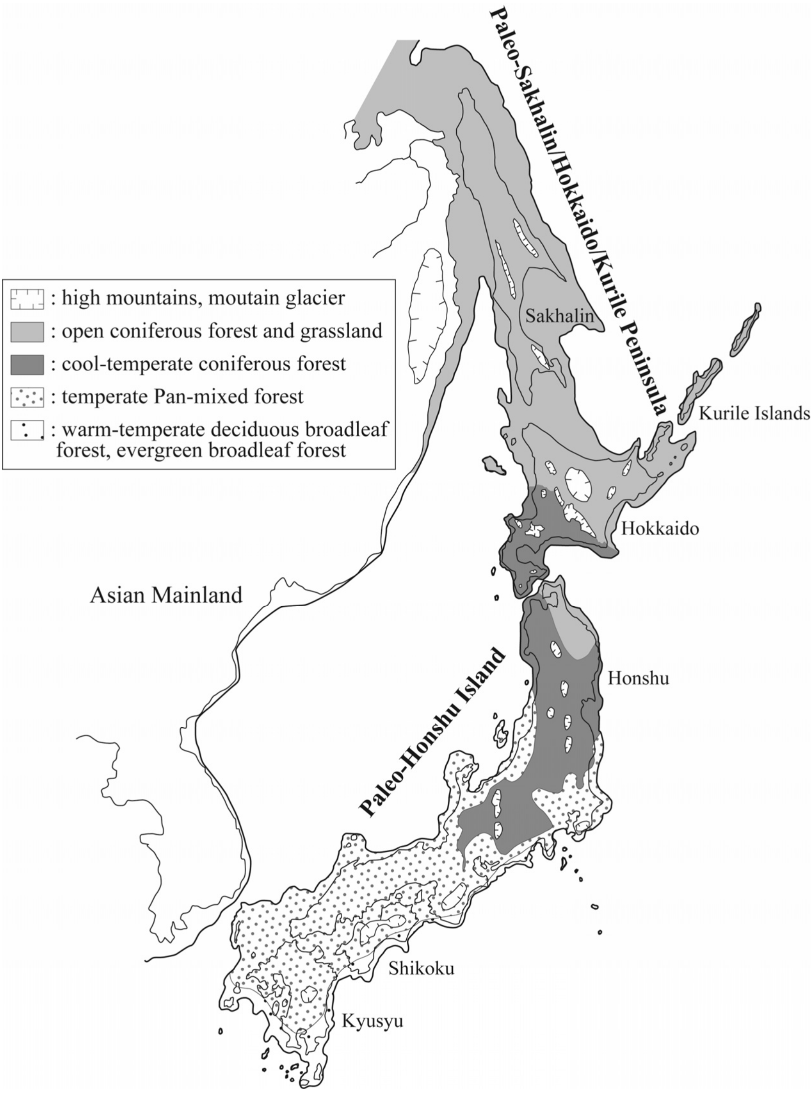

Fig.2 Topography and vegetation zones of the Japanese archipelago during the LGM

3. Materials and Methods

The Sugikubo blade assemblage was mainly present in north-central Japan (Fig. 3) and dates to ca. 230000-22000 cal BP, which corresponds to the late LGM (Iwase 2009, 2010, 2011, 2012). This assemblage characterized by a few formal tool types such as the Sugikubo-type point and the Kamiyama-type burin (Fig. 4) is considered to be one phenotype of a blade industry adapted to cold-temperate forests (Iwase 2011, 2012). The Sugikubo-type point has a tip created by abrupt retouches and a pointed base formed by flat retouches on the ventral face. The Kamiyama-type burin has a retouched platform on the ventral surface of the blank from which burin spalls were detached obliquely. Broken or unusable points were frequently recycled into burins. In this study, Kamiyama-type burins (n=69) and other burins (N=37) from five Subikugo obsidian and hard shale assemblages; Uenohara (2nd and 5th excavation), Mattobara Loc. D, Kannoki Loc. 2, and Nanatsuguri (Tani 2000; Otake 2000; Nakamura et al. 2008; Nakamura and Iwase 2008; Hashizume et al. 2011) (Fig. 3), were chosen for the present analysis.

The methods of use-wear analysis applied here are the high-power (Keeley 1980) and low-power (Tringham et al. 1974; Midoshima 1982) approaches. To observe microscopic traces of utilization on lithic surfaces a digital microscope (KEYENCE VHX) and incident light microscope (Olympus BXFM-S) were used, following Kajiwara and Akoshima (1981) and Midoshima (1986) as the reference of identification of use-wear types on hard shale and obsidian artefacts.

4. Results

As a result of use-wear analysis, 55 independent use zones (IUZ: Vaughan 1985b) on 32 specimens (Kamiyama-type=19, others=13) were identified. Figs. 5 and 6 show some use-wear traces found on analyzed artefacts. Based on the number of IUZ, Tables 1 and 2 summarize inferred used portions, use motions, and worked materials of Kamiyama-type burins and other types, respectively. Figs. 5, 6, and Table 1 s that Kamiyama-type burins were mainly utilized for cutting or sawing activities. Particularly interesting is the fact that no Kamiyama-type burins bear definite signs of having been used for scraping, whittling, or engraving hard materials like bones, antler, and ivory. Rather, the burin facet edges (Fig. 5: 1-4, 7, 10, 11; Table 1) were usually used for cutting or sawing the dry hide, raw hide, and unidentified soft materials.

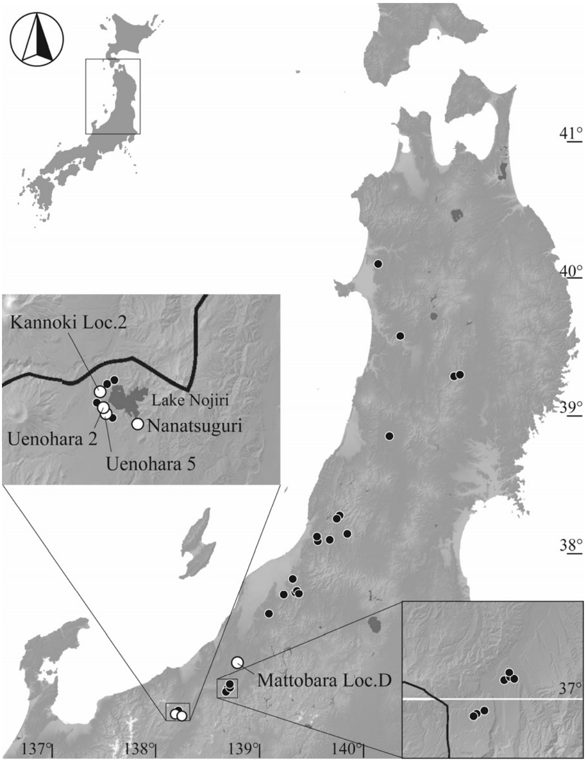

Fig. 3 Distribution map of Sugikubo assemblage

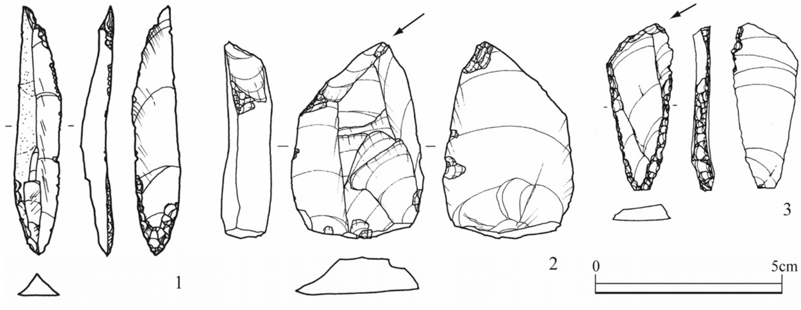

Fig. 4 Sugikubo-type point (1), Kamiyama-type burin (2), and point recycled into burin (3)

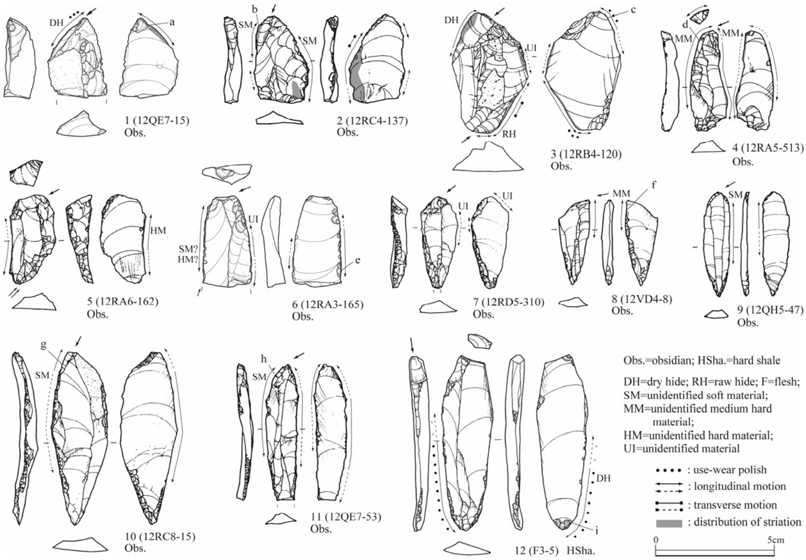

Fig.5 Analyzed Kamiyama-type burins (1-11) and other type burin (12). (1-11 from Uenohara 5th; 12 from Uenohara 2nd)

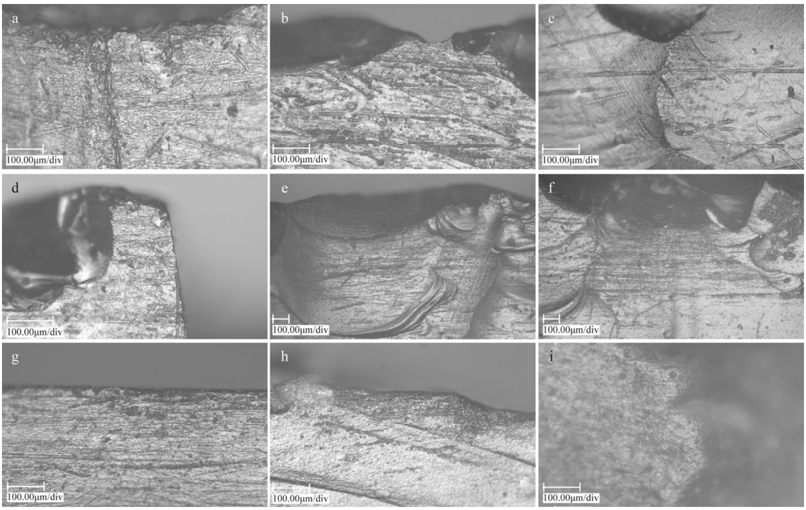

Fig.6 Use-wear traces on analyzed artifacts. (Letters in Fig.5 correspond to these photographs.)

	Cutting or Sawing					Whittling	Scraping or Whittling		Total
	DH, RH, F	SM	MM	HM	UI	MM	SM	UI	
Lateral edge		9	4	3	7	1	1	2	27
Burin facet edge	3	3	1		1			2	10
Total	3	12	5	3	8	1	1	4	37

DH=dry hide; RH=raw hide; F=flesh; SM=unidentified soft material; MM=unidentified medium hard material; HM=unidentified hard material; UI=unidentified material

Tab.1 Used portions, usages, and worked materials inferred from use-wear traces on Kamiyama-type burins based on the number of independent use zone (IUZ)

Furthermore, Fig. 5 and Table 1 indicate that burin facet edges and adjacent lateral edges were used for the same tasks. Although burin-blows usually removed worn lateral edges, some burins (Fig. 5: 2, 4, 10, 11) bear the same type of traces on burin facet edges and on adjacent lateral non-burin-related edges (Table 3). The traces on the facet edges are less developed than those on the adjacent edges, suggesting that the blade or flake edge was used for cutting or sawing tasks, then the edge was removed by a burin-blow, and subsequently the same side was reused again for the same tasks. In addition, the angles of burin facet edges are usually less than 90 degrees (Fig. 7), implying that they are relatively acute and unsuitable for scraping, whittling, and engraving hard materials such as bones, antler and ivory.

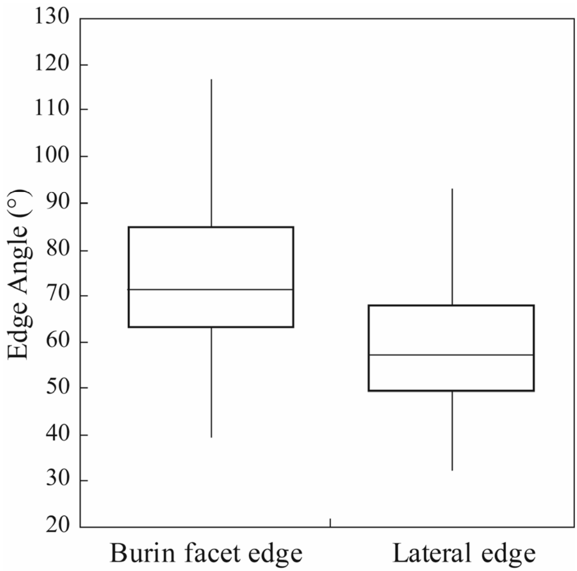

Fig.7 Box-plot chart for burin facet edge and lateral edge angle.

	Cutting or Sawing					**Whittling**	**Scraping or Whittling**		**Total**
	DH, RH, F	**SM**	**MM**	**HM**	**UI**	**MM**	**SM**	**UI**	
Lateral edge	**1**	**2**	**2**	**5**	**4**			**1**	**15**
Burin facet edge		**1**					**1**		**2**
Truncation								**1**	**1**
Total	**1**	**3**	**2**	**5**	**4**		**1**	**2**	**18**

DH=dry hide; RH=raw hide; F=flesh; SM=unidentified soft material; MM=unidentified medium hard material; HM=unidentified hard material; UI=unidentified material

Tab.2 Used portions, usages, and worked materials inferred from use-wear traces on burins excluding the Kamiyama-type based on the number of independent use zone (IUZ)

Burin-blow interrupts traces on used lateral edge.	**11**
Burin facet edge and adjacent lateral edge bear the same type of traces.	**4**

Tab.3 Interruption of burin-blow to use-wear traces on lateral edge of Kamiyama-type burin

5. Discussions

The above results suggest that the Kamiyama-type burin-blow served as a technique for edge modification to create and rejuvenate an edge suitable for longitudinal activities. Since present analysis could not reveal a large number of IUZ on burin-blow-related edges of other type burins (Table 2), their burin-blow functions are still unclear. Nonetheless the results indicate that others were also rarely used for the scraping, whittling, and engraving of hard materials. These results imply that hunter-gatherers adapted to cold-temperate forests in north-central Japan had not fully developed the lithic technologies to shape bone, antler, and ivory tools. Presumably, the paucity of evidence for hard material working reflects one aspect of technology adapted to richer timber resources of cold-temperate forests in the central Honshu (Fig. 2). This technology would have been different from that of the cold and arid environments of higher latitudes in northern Asia including the Palaeo-SHK Peninsula where timber resources were relatively scarce and ground osseous implements were heavily used.

6. Conclusion

The result of the use-wear analysis of Kamiyama-type burins indicates that both burin bits and burin facet edges show no correlation with hard material working. Rather, use-wear traces formed by cutting or sawing hide and soft material are located on burin facet edges and adjacent non-burin-related edges. The angles of burin facet edges are usually acute: less than 90 degrees. Burin-blows usually removed worn lateral edges, suggesting that Kamiyama-type burination served as a technique for edge modification to create and rejuvenate an acute edge which served for longitudinal activities.

Acknowledgements

I thank Yoshikatsu Nakamura for permission to examine lithic assemblages from Uenohara site and to publish the results. I also am thankful to Masami Izuho, Nakazawa Yuichi, Takuya Yamaoka, and Katsuhiro Sano for their helpful suggestions, comments on and discussion of my work. I am grateful to Katsunori Takase and Shoh Yamada for teaching me the basic method of traceological analysis. For all remaining mistakes only I am responsible.

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CHAPTER THIRTY THREE

THE TWO FACES OF RESHARPENING: MANAGEMENT AND USE OF RESHARPENING FLAKES IN THE MIDDLE PALEOLITHIC AT CUEVA MORÍN

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Abstract

This paper presents the results of a techno-functional analysis of series of resharpening flakes from Level 16 at Cueva Morín (Northern Spain). The study takes on the lack of information available for most sites relating to the objective of this technical strategy: the resharpening of the edges of massive side scrapers, the occasional re-use of some of these artefacts, or the systematic production of smaller blanks.

In the case of used artefacts, a further question refers to the type of activities with which they were associated. In Level 16 at Cueva Morín, the resharpening flakes were used as a new generation of tools. They were incorporated into working processes of certain intensity which required the preparation of additional tools. They were not implements specifically designed for particular tasks but were used in processing various worked materials, in both cutting and scraping activities.

Keywords: Middle Paleolithic, resharpening, recycling, use-wear analysis, lithic technology.

1. The site of Cueva Morín

Cueva Morín is located in the eastern-central sector of Northern Spain, on the Atlantic façade of Europe, at 55m altitude above sea level (Fig. 1)

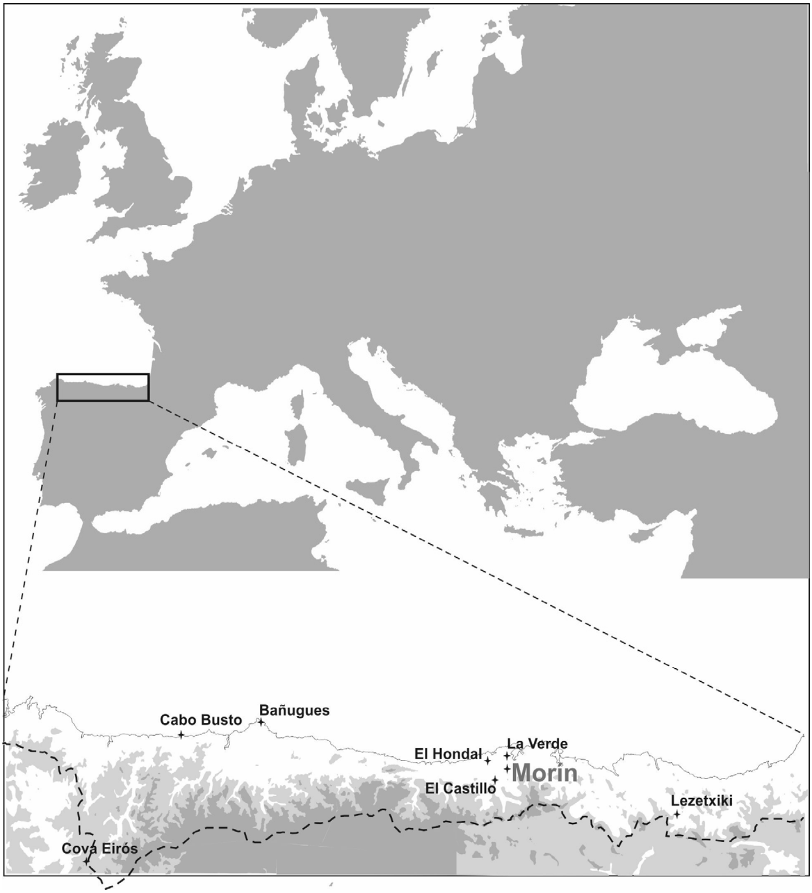

Fig. 1. Map of Europe with Middle Paleolithic sites in coastal northern Spain.

The deposit was discovered by H. Obermaier and P. Wernert in 1901. After that time, the cave was excavated on different occasions, mainly in the 1900s, by J. Carballo and Count Vega del Sella (Vega del Sella 1921; Carballo 1922, 1924) and in the late 1960s, directed by J. González Echegaray and L. G. Freeman (González Echegaray and Freeman 1971, 1973). The basic stratigraphy of the deposit was established in the course of the latter excavations and consists of 22 levels, with occupations from the early Middle Palaeolithic to the Azilian period (Fig. 2). The Middle Palaeolithic sequence (Levels 11 to 17) is dated from OIS 5 to OIS 3.

2. Level 16: general characteristics

The results presented here are based on the study of the assemblage from Morín 16, consisting of 1900 chipped lithic remains. About 60% of these are knapping waste. The most common raw material is flint (61.5%) followed by quartzite (23.7%) and a much smaller percentage of ophite (13.5%). Other raw materials are present in very small proportions of less than 1%. If the knapping waste is excluded from the calculation of these percentages, as its over-representation may obscure the general characteristics of the lithic assemblage, the frequencies of the main raw materials are more balanced: flint 38.6%, quartzite 31.7% and ophite 25%.

Retouched tools amount to nearly 13% of the assemblage (n=243) while cores make up less than 2% (n=32). Side scrapers of different types (lateral, double, transversal, Quina and convergent) are quantitatively the most important among the retouched flakes, as they make up practically half of the retouched tools. One of the characteristics of this level is the considerable number of cleavers made in ophite.

The functional study has shown that in Level 16 at Cueva Morín a variety of activities were performed with stone tools, including butchery tasks and the processing of hides and plant matter. In addition a group of points were used as hunting weapons (Lazuén 2012a), with all the economic and organisational implications this involved. The faunal remains have been the object of several studies (Altuna 1971; Yravedra and Gómez-Castanedo 2011). Taxonomical and taphonomic identifications indicate the presence of large mammals (large bovines, horse and red deer) with evidence of anthropic processing.

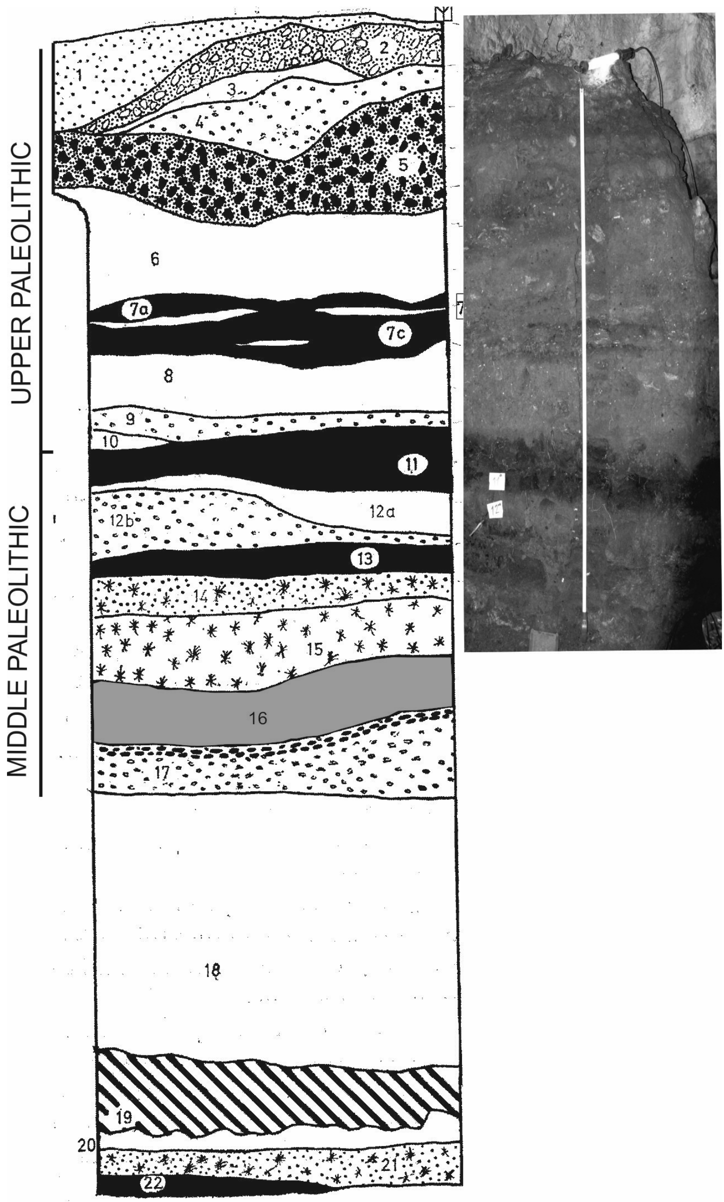

Fig. 2. Stratigraphy of Cueva Morín (adapted from González Echegaray and Freeman, 1973).

3. Production and use of resharpening flakes

The production of small flakes, obtained with different techniques–unipolar, discoid, Levallois or Kombewa–was a strategy that is being increasingly documented in the Middle and early Middle Palaeolithic, from at least OIS 5 onwards (Moncel 2003; González-Urquijo et al. 2005; Dibble and McPherron 2006; Cortés 2008).

The use of the blanks produced by resharpening the edges of some tools is linked with the search for these types of small products. One of the proofs of the use of these flakes as a new generation of tools is that they were shaped by retouch (Meignen 1988; Bourguignon 1997; Jaubert 2001; Soressi 2004; González-Urquijo et al 2005, 2006). However, it is difficult to understand the ultimate objective of this production in the absence of use-wear analysis. The functional study of this type of tool in Level 16 at Cueva Morín sought to determine the purpose of the products and the type of activities they were involved in.

3.1. Production and management

The assemblage contains 29 resharpening flakes; 82.8% of these are flint and 17.2% are quartzite (Fig. 3). They were extracted from the edge of the side scrapers or from the side-lateral resharpening flakes (Bourguignon 1997). The former tended to maintain the working angle and the shape of the edge, while the latter extractions removed much of the original edge, which was probably connected with (1) the general state of exhaustion of the tool–strictly speaking of the edge, but also in terms of more limited resharpening possibilities–and/or (2) the re-use of the tool for a different task.

Resharpening flakes larger than 25mm in one of their two main dimensions (length and width) were selected to be shaped by retouching (Fig. 4). The only resharpening flakes larger than 25mm that were not retouched were some of those extracted from the side of the side scrapers.

The sample selected for the functional study (n=17) includes about 60% of the resharpening flakes in the assemblage: the best conserved specimens at a macroscopic scale. It consists of twelve non-modified resharpening flakes and five retouched resharpening flakes.

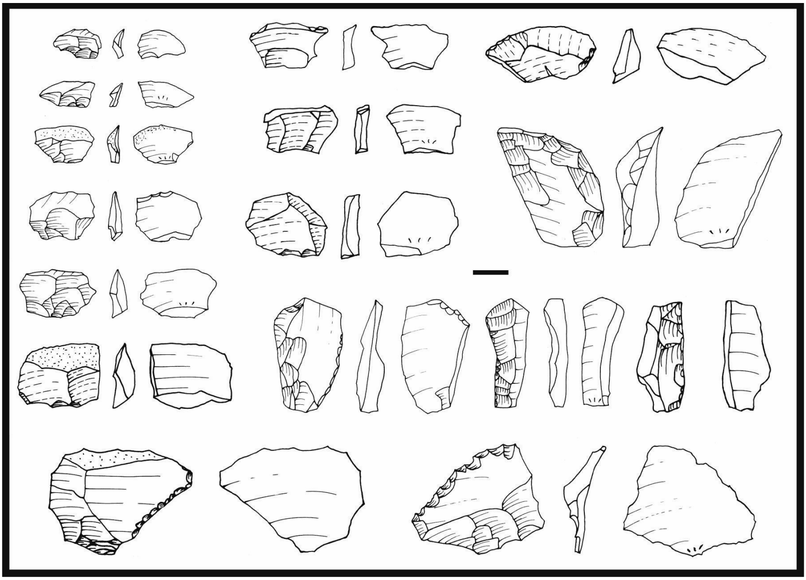

Fig. 3. Resharpening flakes from Cueva Morín level 16.

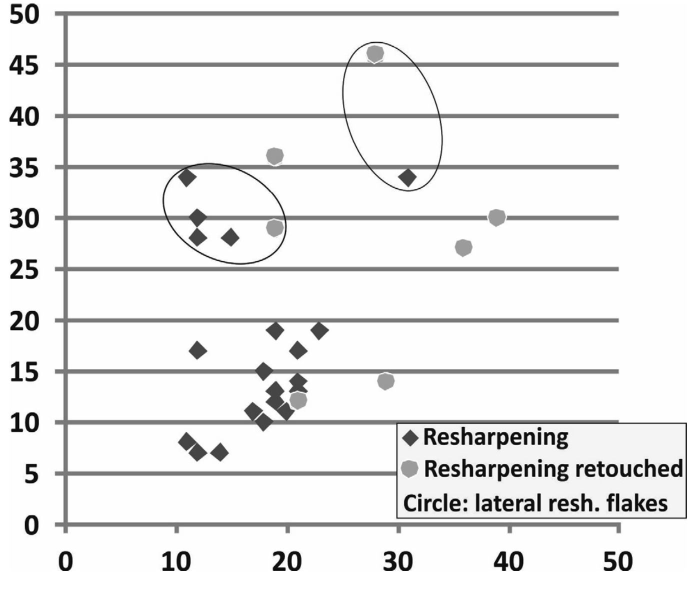

Fig. 4. Length vs. width of non-retouched and retouched resharpening flakes.

3.2. Use

The functional analysis of the resharpening flakes has taken into account: (1) the information they conserve about the function of the tool from which they were extracted, the "fossil edge", and (2) the use given to the resharpening flake itself, its "own edge".

The study of the "own edge" found evidence of use in five cases (Table 1). Scraping (n=4) was the most common task within the range of activities they were associated with. For this work, various blanks and edges were chosen, including flakes of different sizes and both non-retouched and retouched edges. In most cases it was not possible to determine the specific material that was worked, although at least one edge was used with non-woody plant matter or wood. To cut soft matter (n=1) a straight non-retouched edge opposite the "fossil edge" was used.

The functional information as a whole suggests the tools were used little and/or with soft substances, because of both the faintness of the use-wear marks and their absence, even on some of the retouched edges.

The use-wear observations of the "fossil edges" found evidence of use in nine cases (Table 1). The use-wear marks are associated with scraping plant matter or wood (Figs. 5 and 6) and scraping dry hide (Fig. 7). Angles of about 65º were used to scrape hide, while sharper active edges of 55º were used to work with plant matter and wood. The same tasks have been identified on the edges of side scrapers from the same archaeological level.

In a further three cases, it was seen that the "fossil edge" was used for scraping, but it was not possible to determine the worked material (Fig. 8). In the other eight cases, the fossil edges had not been used, or the use-wear marks were very faint or had become altered, hindering precise identification.

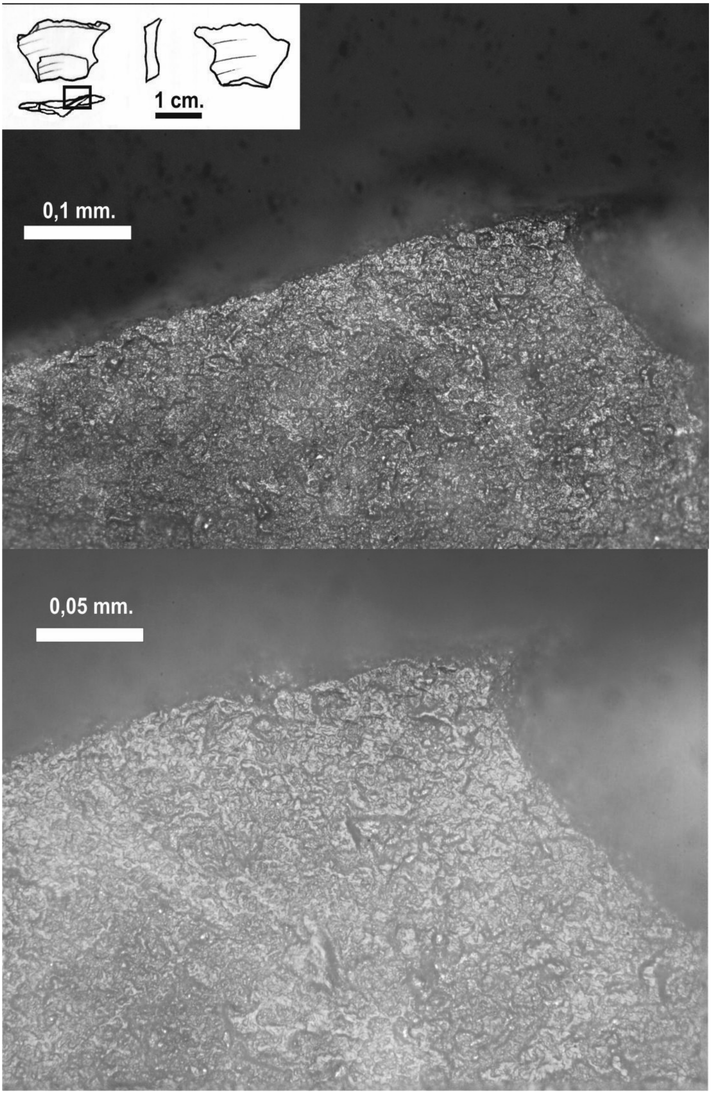

Fig. 5. Use-wear traces from scraping plant matter/wood with a flint flake.

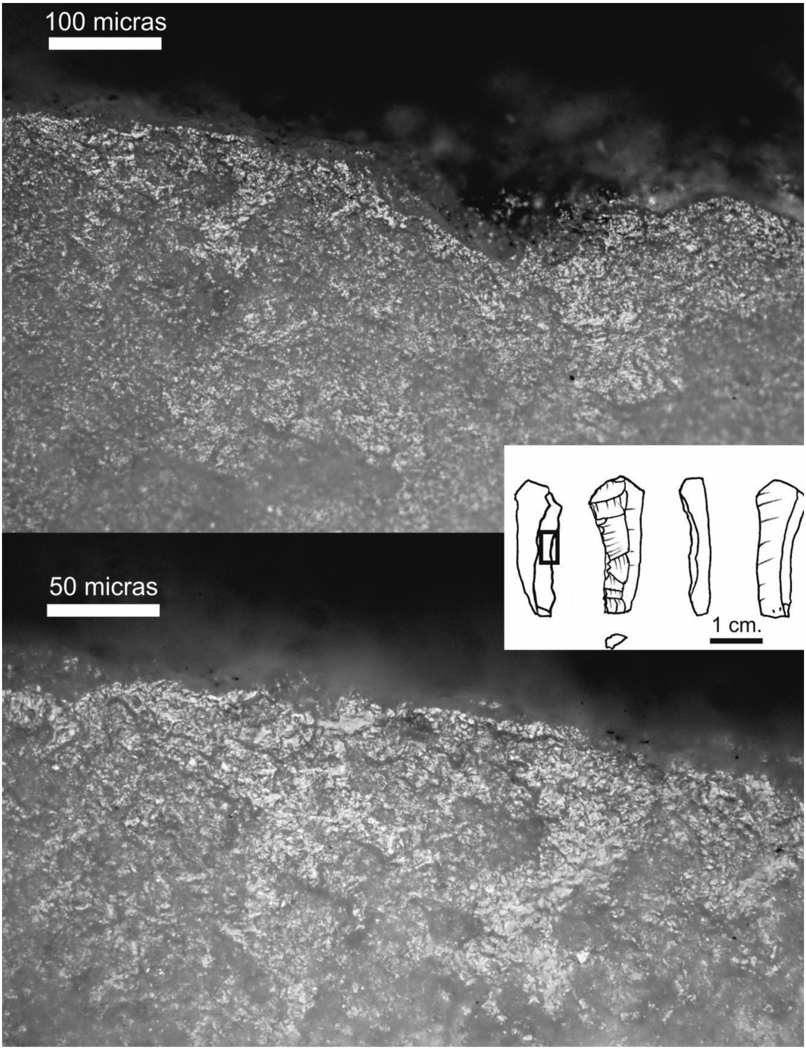

Fig. 6. Use-wear traces from scraping wood with a flint flake.

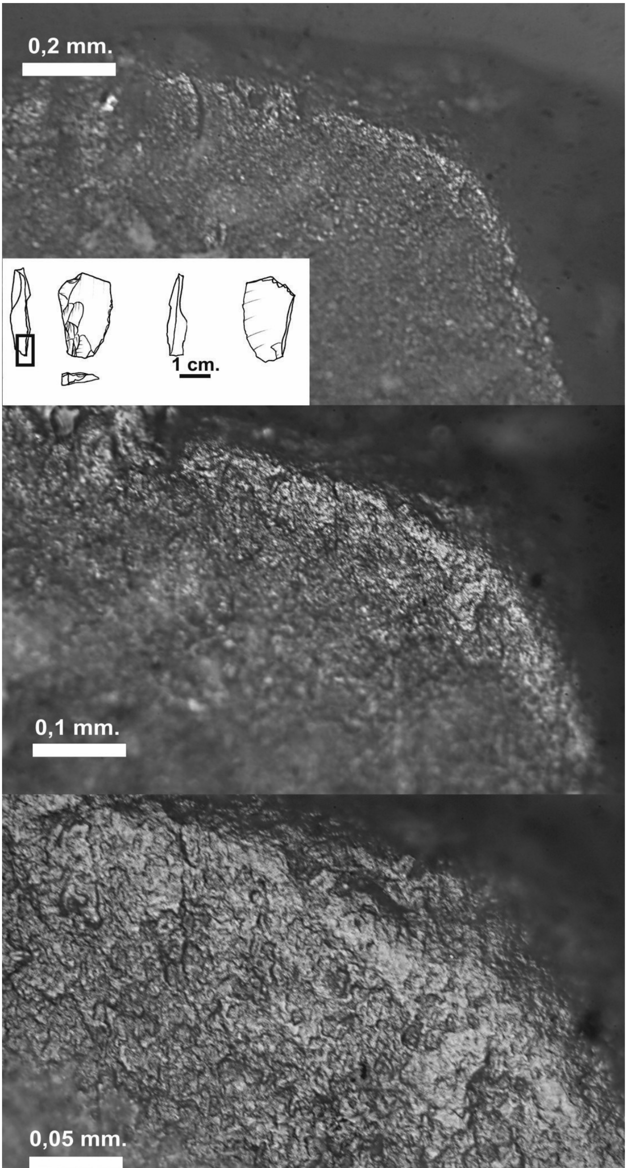

Fig. 7. Use-wear traces from scraping dry hide with a flint flake.

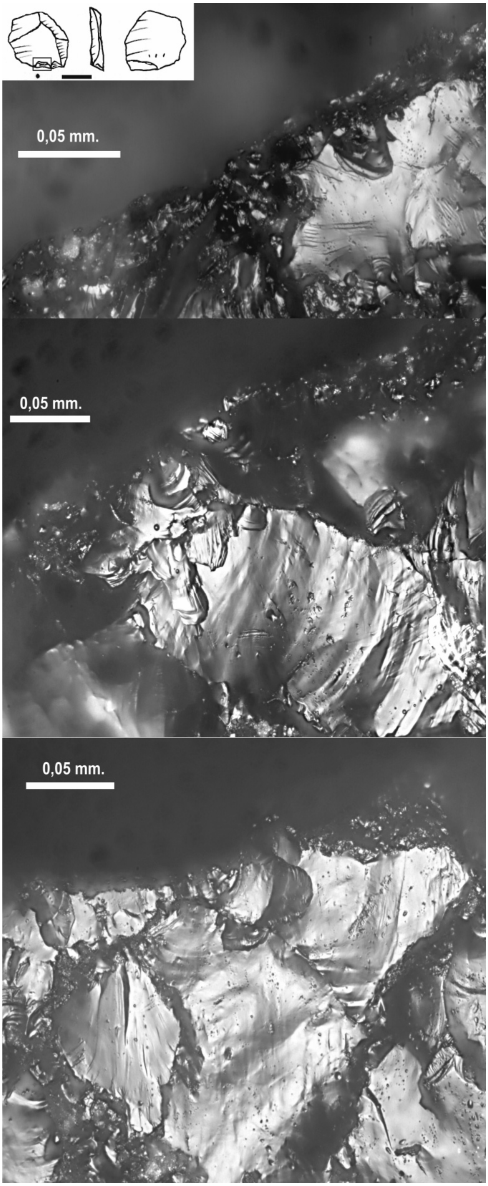

Fig. 8. Use-wear traces from scraping indeterminate medium hardness material with a quartzite flake.

	FLINT		QUARTZITE	
	Fossil edge	Own edge	Fossil edge	Own edge
Scrape dry hide	3			
Scrape plant matter/wood	2	1		
Scrape undetermined	2	3	1	
Cut soft matter		1		
Use undetermined	1			
Altered	3			
Absence of marks	4	10	1	2

Tab. 1 Worked material with resharpening flakes ("fossil edge" / "own edge")

4. Conclusions

The general study of tool function in Level 16 at Cueva Morín (Lazuén 2012b) has shown the importance of complex processing tasks.

This is seen in (1) the importance of working with hide, non-woody plants and wood; (2) the type of implements used for these tasks, which were the largest and best shaped tools; and (3) the intensity with which this work was carried out, involving significant cycles of resharpening and re-use.

This intensity is related to the pattern of the use of the resharpening flakes, which were used above all for scraping, in a similar way to the fossil edges they resharpened (which came from the side scrapers in this level). However, the "fossil edges" do not display evidence of severe blunting or alteration due to their use. This suggests that some of the flakes were extracted for another purpose than that of resharpening the tool they came from.

This suggests that in Level 16 at Cueva Morín, the production of these flakes was in connection with work scraping different kinds of material (above all hide and wood), in the course of which additional tools were needed and created in this way.

In the case of Morín 16, the resharpening flakes were intended to be a new generation of tools, as can be appreciated by technological and functional criteria, that is to say, by the presence of retouching and use-wear marks on their edges. They were not made for any specific tasks, as there is no clear link between these tools and any specific activity. On the contrary, they were used for scraping various kinds of substances and occasionally for cutting. This is the same range of activities observed both on the "fossil edges" and on the side scrapers in general in this level.

In short, the structured study of the production and use of resharpening flakes in Level 16 at Cueva Morín reveals the existence of complex tool management systems. The resharpening and recycling of part of the tool-kit and the production of a new generation of tools was integrated within the same technical gesture.

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CHAPTER THIRTY FOUR

LOOKING FOR THE USE AND FUNCTION OF PRISMATIC TOOLS IN THE MESOLITHIC OF THE PARIS BASIN (FRANCE): FIRST RESULTS AND INTERPRETATIONS

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Abstract

Emblematic of the so-called "montmorencien" sites in the Paris basin, prismatic tools are dated to the first Mesolithic according to the chrono-typological analysis of the associated microlithic tools. Generally made on thick quartzite flakes, these original tools share several technological characteristics. Their flat to slightly convex quadrangular upper faces correspond to the internal side of a flake. Their triangular sections are the results of the shaping by flaking of the sides and of an edge on their back.

Until recently, very little was known about the possible function and use of these tools. The first use-wear analyses indicate that the longitudinal edges of the face and back of the tools were used for the transformation of a hard mineral matter. This contradicts the former functional hypotheses as picks that were relying on the traces observed on some of their extremities.

This paper presents the experimental dataset and discusses the functional interpretations of archaeological tools. In particular, we

examine the hypothetical role of these prismatic tools for the production of arrowheads, by testing the microburin technique for the fracturation of bladelets.

Keywords: Prismatic tools, quartzite, Mesolithic, Paris Basin (France)

1. Archaeological context and aim of the study

Mesolithic prismatic tools are well-represented and centred around the Île-de-France and the Paris Basin. “Montmorencian” “production and/or extraction” sites are found along the sandstone-quartzite outcrops of the Stampian massifs and hills; they are distinguishable by the presence of specialised zones of sandstone-quartzite extraction and exploitation, essentially composed of rough-outs and tool preforms, often broken during manufacture and associated with significant shaping wastes (Tarrête 1977). The choice of quartzite, with properties of hardness and amenity to conchoidal fracture is not so common used in the Mesolithic context, and reinforces the particular character of these tools. Several campsites dated to the first Mesolithic show the presence and use of several of these tools, such as Farman in Paris (Griselin & Hamon 2013), les Closeaux in Rueil-Malmaison (Hauts-de-Seine; Lang et Sicard 2008), Chemin-fin-de-Oise in Neuville-sur-Oise (Val-d'Oise; Souffi et al. 2010) or Haut-de-Vallière in Rosnay (Marne; Souffi et al. 2011) and Le Parc du Chateau in Auneau (Eure-et-Loir; Dubois et al. 1998).

2. Technical characteristics

These tools are generally broken, but can measure up to 10 cm in length when whole (Fig.). They have triangular and/or trapezoidal cross-sections with a characteristic flat un-retouched face. Their shaping of the sides and the dorsal face is relatively simple: it aims at forming the tool's three longitudinal ridges (two on the sides of the tool's flat face and one on its back). The face lateral ridges are shaped by a series of unipolar removals originating from the flat face serving as a striking platform. The dorsal ridge is then retouched, reducing the thickness of the piece by unifacial, and more rarely bifacial, removals. The finishing of the tool consists of a rectification of the edges and a removing of the small prominences to regularise the “line” of the sides by abrupt unipolar and scalariform retouch. Different degrees of repair are observable on the tools, indicating a fairly long period of use. When the ridges become too damaged by repeated rejuvenation, repair consists of a complete modification of the ridges' entire length.

3. First use-wear analysis

Numerous functional hypotheses had been proposed for these prismatic tools such as for wood, bone and skin working, and even as tools for agricultural activities. The first use-wear analysis of such tools was conducted by L. Lang in Les Closeaux at Rueil-Malmaison (Hauts-de-Seine), who demonstrated the presence of longitudinal abrasion traces on the lateral ridges (Lang et al. 1997, 184). A second analysis was carried out by S. Philibert on Les Baraquettes in the Cantal: she suggested use as a pick on hard material with a mineral component, according to abrasion and percussion traces on the extremities of some tools (Surmely et al. 2003, 191-193). Nonetheless, very few experiments have been conducted to confirm these first hypotheses.

To guide our experiments, a first use-wear analysis was carried out on an ensemble of 24 prismatic tools coming from 5 sites of the Paris Basin, among which 16 come from 6 loci of the Paris Farman site (Griselin & Hamon 2013). It demonstrates that the lateral ridges were the main active surfaces (Fig. 1). The smoothing of the longitudinal ridges looks macroscopically as a levelling of the grains with altered faces and, microscopically as a semi-hard, convex and loosely-welded coalescence. Smoothing is therefore accompanied by edge-damage; however it is sometimes difficult to distinguish traces of use from retouch designed to repair the edges since these tools all appear to have been refreshed. This wear could be interpreted in terms of the longitudinal abrasion of a semi-hard matter of a probable mineral component. The extremities were rarely used which, in our opinion, excludes a main functioning as a "pick": only one tool presents bifacial edge damage, while two others bear slight wear on their ends extended from the longitudinal ridges. Finally, the flat face and microreliefs of the sides show secondary traces of use. The topography of the tools' sides and the flat face's asperities carry a second, significantly less pronounced, type of wear. Its arrangement and aspect indicate an unexplained secondary friction whose use-wear signature is however reminiscent of contact with dry hides.

4. Experiments and functional hypotheses

After these observations, two sets of experiments have been conducted considering that the lateral ridges were the main active surfaces (Table 1). A first set of 16 tests was conducted in order to test a plausible functional hypothesis for the fracture of flint bladelets using the microburin technique to create microlithic blanks. Different gestures, orientations of the prismatic tools and types of anvils were tested in order to compare the use-wear traces obtained with different conditions of use of the prismatic tools. A second set of 15 comparative experiments was built using throwing percussion, sawing and scraping on marcasite, bone, antler, skin, wood and bark during approximately one hour.

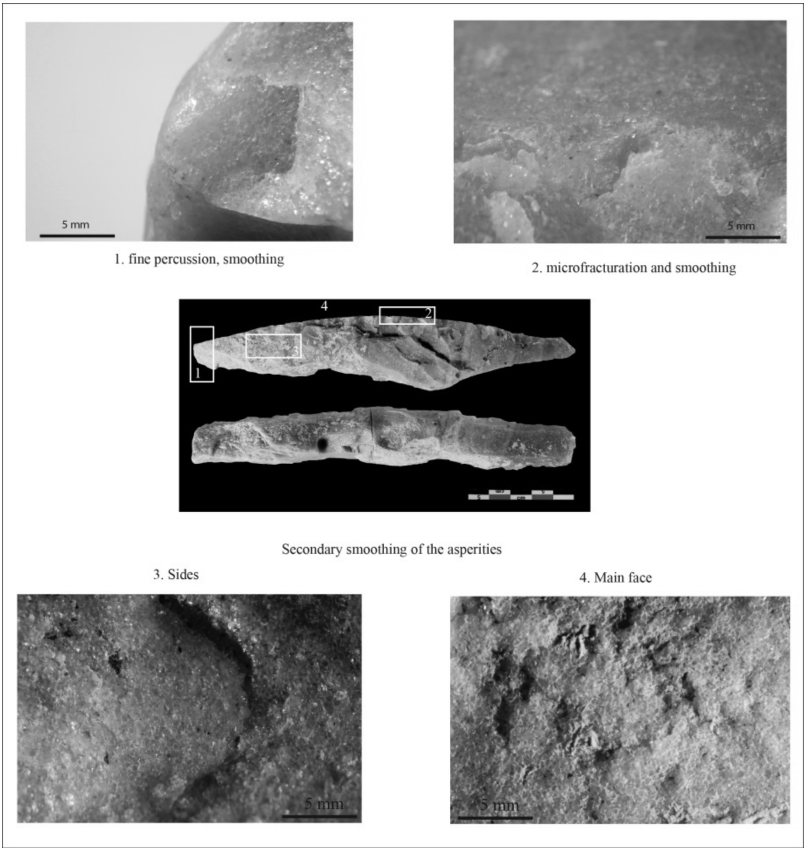

Fig. 1. Localization of the different use-wear traces on archaeological prismatic tools (photos : S. Griselin & C. Hamon)

N° tool	Used zone	activity	transformed matter	gesture	manipulation/handling	duration of use
26	ridge A & end	strike-a-light	marcasite	tangential direct percussion	-	65 min
26	ridge B	bloc opening	marcasite	direct percussion and grooving	-	66 min
2	ridge A	bloc opening	marcasite	tangential direct percussion	-	67 min
2	ridge B	bloc opening	marcasite	longitudinal grooving	-	68 min
2	end	bloc opening	marcasite	longitudinal grooving	-	69 min
5	ridge A	fracturation	dry bone	longitudinal sawing	-	70 min
5	ridge B	fracturation	dry antler	longitudinal sawing	-	63 min
5	ridge C1	fracturation	soaked antler	longitudinal sawing	-	65 min
5	ridge C2	fracturation	soaked antler	oblic direct percussion	-	65 min
17	ridge A & end	defleshing	dear fresh skin + kaolinite	transversal scraping	-	42 min
17	ridge B1	cleaning	dear dry skin + kaolinite	transversal scraping	-	65 min
17	end	cleaning	dear dry skin + kaolinite	transversal scraping	-	37 min
38	ridge A	cutting	half dry wood (hazel tree)	longitudinal sawing	-	65 min
38	ridge B	debarking	hald fresh bark (hazel tree)	transversal scraping	-	65 min
1	ridge A	debitage	flint bladelets	tangential & non-tangentielle direct percussion	stone anvil + skin	57 bladelets
1	ridge B	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	36 bladelets
9	ridge A	debitage	flint bladelets	tangential & non-tangential direct percussion	stone anvil + skin	9 bladelets
9	ridge B	debitage	flint bladelets	tangential & non-tangential direct percussion	stone anvil + skin	22 bladelets

14	ridge A	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	22 bladelets
15	ridge A	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	52 bladelets
15	ridge B	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	65 bladelets
16	ridge A	debitage	flint bladelets	tangential direct percussion	multiple tests	323 bladelets
27	ridge A	debitage	flint bladelets	tangential & non-tangential direct percussion	wood anvil	13 bladelets
29	ridge A	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	32 bladelets
29	ridge B	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	42 bladelets
32	ridge A	debitage	flint bladelets	tangential & non-tangential direct percussion	stone anvil + skin	13 bladelets
32	ridge B	debitage	flint bladelets	tangential & non-tangential direct percussion	wood anvil	4 bladelets
37	ridge A	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	50 bladelets
37	ridge B	debitage	flint bladelets	tangential direct percussion	stone anvil + skin	50 bladelets
674	covering	secondary friction	skin	unidirectional friction		6000 min

Tab. 1. Set of experiments realized with prismatic tools

The processing of organic matter, especially vegetal ones, affects the surfaces too slightly to be interpreted with certainty. The light smoothing of the ridges created by bone and antler sawing does not affect the related face and side contrary to archaeological samples (Fig. 2).

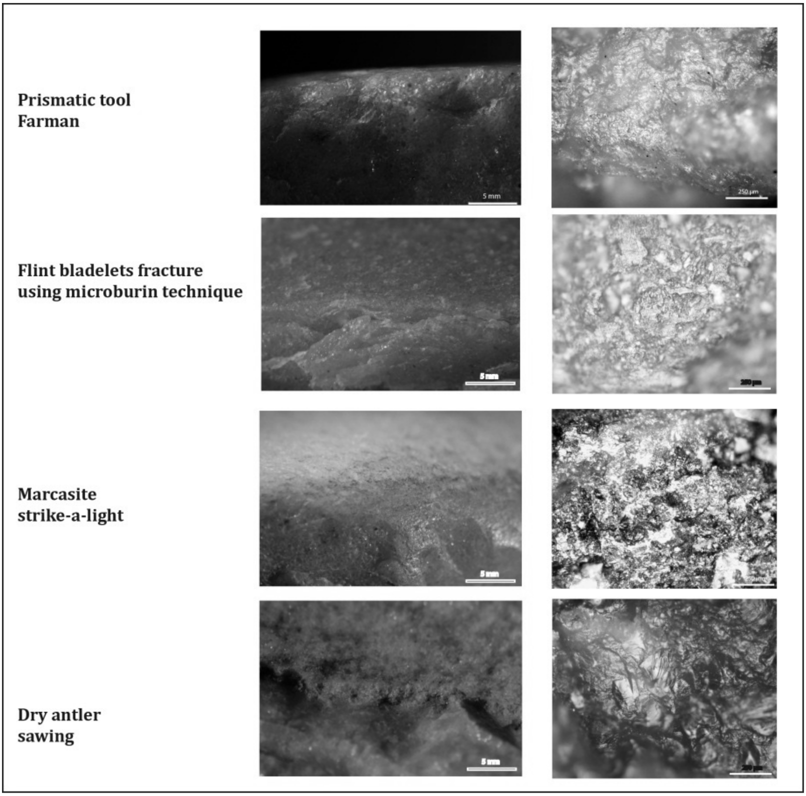

Fig. 2. Comparison of the archaeological and experimental traces (photos: C. Hamon)

The comparison of the archaeological and experimental surfaces excludes a use for marcasite processing. The strong levelling and shine created by the use of marcasite do not fit with the archaeological surfaces.

Finally, the use of prismatic tools for the debitage of bladelets creates the closest traces between experimental and archaeological tools, both on the ridges and on the related faces and sides. The motion and position of the prismatic tool appear of main importance for the formation of the traces: the use of prismatic tools with an “abrading” gesture to fracture bladelets has to be excluded contrary to tangential throwing percussion which seems the most efficient technique to produce microlithic blanks with the closest traces of use.

Nonetheless, several points are still unclear. Although smoothing and microfracturation of the ridges have been reproduced separately by different uses for the debitage of bladelets using the microburin technique, it has not been possible to reproduce their narrow association on the same ridges. This could be explained either by the processing of a different type of hard mineral matter, or by a different motion alternating perpendicular and tangential percussion. Besides, the aspect of the smoothing of the archaeological tools’ faces and sides differs slightly from the ridges: this could imply a specific type of handling or secondary contact which was not reproduced experimentally.

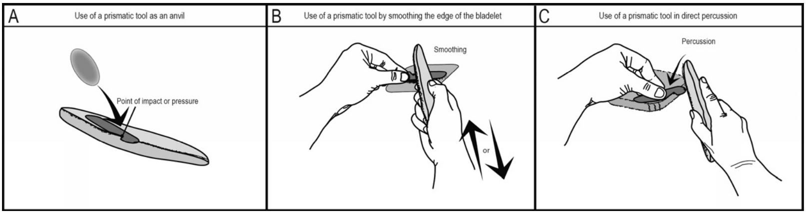

Fig. 3. Different gesture of use of primatic tools for the fracture of bladelets using the microburin technique and use of macrasite as strike-a-light (drawings : S. Griselin)

5. Conclusion

In conclusion, the use-wear analysis of a first series of Mesolithic prismatic tools brings new elements concerning their functioning and possible function. The experiments conducted show that a tangential throwing percussion is involved in the creation of the most significant use-wear traces on the lateral and longitudinal ridges of the tools. They also confirm that a hard mineral matter has been processed through these operations, as first suggested by Lang and Philibert. Further experiments and observations are now necessary to go further into details to understand the exact motion and the combined role of each part of the prismatic tools.

Acknowledgments

We would like to thank Bénédicte Souffi, as well as Jérémie Couderc, Nicolas Samuelian and Joel Confalonieri for their contribution to experimental tests.

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CHAPTER THIRTY FIVE

SEMI-PRODUCT, WASTE, TOOL… ARE WE SURE? FUNCTIONAL ASPECT OF STONE AGE MORPHOLOGICAL FLINT TOOLS

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Abstract

This present study describes, based on use-wear analysis from 31 sites from Central Poland, the characteristics of several exploitation modes of various flint forms (mostly morphological tools). The chronology of the assemblages dates from the Older Dryas to the Atlantic period and includes 3 prehistoric stages: Final Palaeolothic, Mesolithic and Early and Middle Neolithic. Overall analysis was performed on 10199 specimens (all uncovered at the described sites), from which 1755 were functional tools. The study attempts to verify the correctness of the interpretation of the archeological site's function based on use-wear analysis of these selected sources. In addition, the possibility of a morphological-functional typology, i.e. a classification connecting tool form and its function, has been discussed.

Keywords: Flint, morphological tool, use-wear analyze, Poland, Paleolithic, Mesolithic, Neolithic.

1. Introduction

Products made of inorganic materials are one of the main types of sources used to reconstruct the life of prehistoric communities. Among them, flint artefacts are the best-preserved products which have lasted to this day in their primary form. Very early on, flint products were of interest to archeologists and have been the subject of various analyses. Their goal was mainly the reconstruction of producing techniques and generating morphological courses allowing an estimation of the relative chronology of the collections. However, more recently new methods have become available which enable archaeologists to obtain information previously unavailable. Use-wear analysis seems to be very useful regarding possible interpretations of flint tool function based on preserved use traces. This method, which is known from 1964 (English-language edition of S. A. Semanov), is frequently used in Poland (Osipowicz 2010).

In many cases, modern use-wear analysis concerns selected flint products, usually retouched tools. Such an approach results from the fact that it is considered impossible to analyze all of the collected flint material, since it would be very time consuming. This is well illustrated by Annelou van Gijn (1989), the number of pieces which can be examined per day is in the range of 6-10 (unused pieces included; if one has a large biface, one can spend an entire day) (van Gijn 1989). A similar approach can also be found in the Polish literature (Winiarska-Kabacińska 1992; 2002, 2004, 2005, 2007a, 2007b; Cyrek 1996; Pelisiak and Rybicka 2003; Pelisiak A. 2004). In some cases it seems a validation to talk about the functional structure of the entire assemblage on the basis of the analysis of selected tools, suggesting that ignoring other objects has no effect (or little influence) on the reliability of conclusions (Cyrek 1996; Winiarska-Kabacińska 1992, 2002, 2007a). The following study attempts to verify the correctness of this approach based on use-wear analysis of flint material from Poland. Moreover, brief characteristics of the exploitation mode of various morphological forms from analyzed sites have been prepared. Finally, the question of a new morphological-functional typology has been attempted to answer these problems.

2. Archeological sources

In this study, analysis was based on flint material from 31 archeological sites, of which the majority (29) is located in the Chełmińsko-Dobrzyńskie Lake District, in the historical area of Chełmno Land, and 2 on the west side of Vistula, in the area of the Toruńsko-Eberswaldzka Valley and in

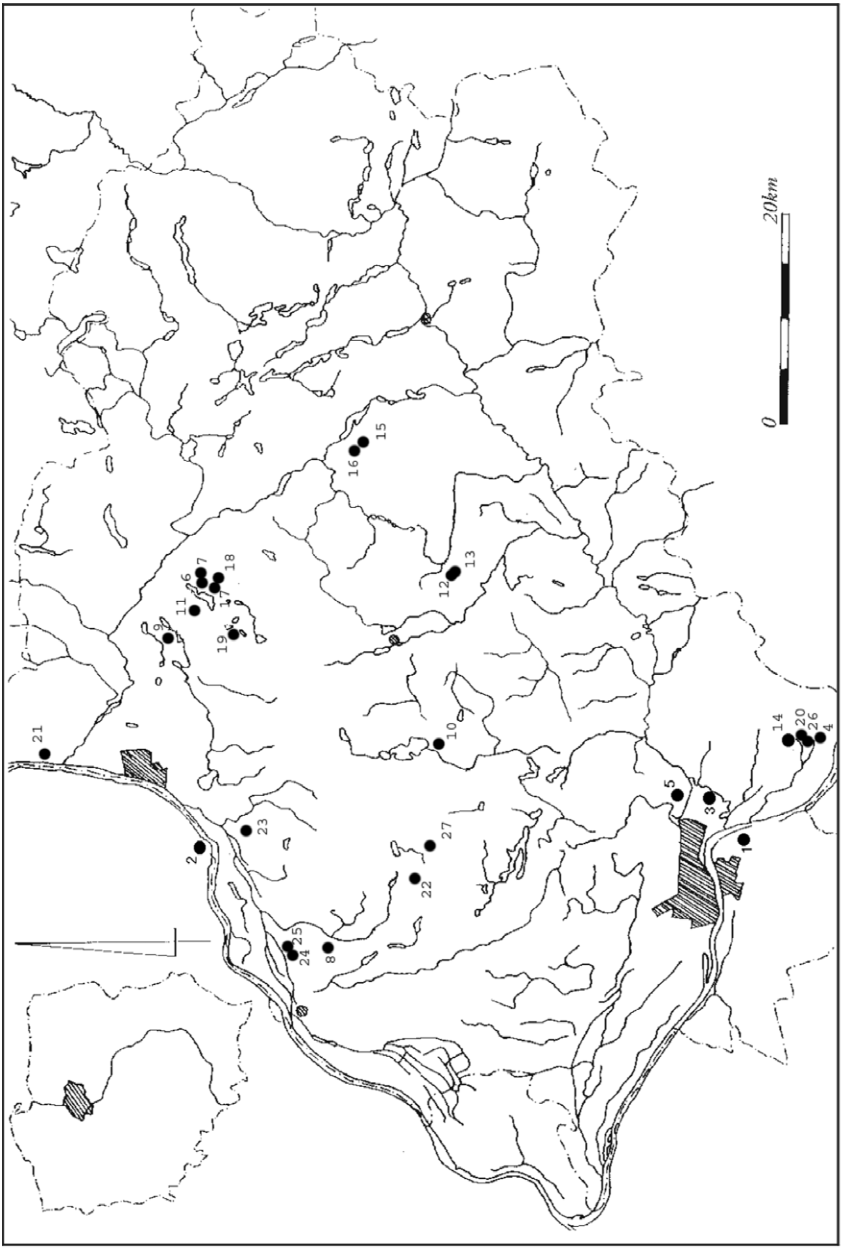
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Fig. 1. (previous page) Archaeological sites location: 1 – Brzoza, gm. Wielka Nieszawa, stan. 15 i 34; 2 – Stare Marzy, gm. Dragacz, stan. 5; 3 – Lubicz, gm. loco, stan. 12,13,18; 4 – Sąsieczno, gm. Obrowo, stan 4; 5 – Toruń, stan. 247 i 249; 6 – Boguszewo, gm. Gruta stan. 41; 7 – Boguszewo, gm. Gruta, stan. 43a; 8 – Stolno, gm. loco, stan. 2; 9 – Annowo, gm. Gruta, stan. 7; 10 – Ryńsk, gm. Wąbrzeźno stan. 42; 11 – Gruta, gm. loco, stan. 52; 12,13 – Wielkie Radowiska, gm. Dębowa Łąka stan. 22 i 24; 14 – Osiek, gm. Obrowo, stan. 9; 15,16 – Lembarg, gm. Jabłonowo Pomorskie, stan. 94, 95 i 96; 17 – Linowo, gm. Świecie n. Osą, stan. 25; 18 – Linowo, gm. Świecie n. Osą stan. 63; 19 – Zakrzewo, gm. Radzyń Chełmiński stan. 6; 20 – Smogorzewiec, gm. Obrowo, stan. 9; 21 - Wełcz Wielki, gm. Grudziądz, stan. 10B; 22 – Niemczyk-Wrocławki, gm. Papowo Biskupie, stan. 1; 23 – Gogolin, gm. Grudziądz, stan. 15; 24,25 – Klamry, gm. Chełmno, stan. 7 i 8; 26 – Sąsieczno, gm. Obrowo, stan. 1; 27 – Dubiello, gm. Papowo Biskupie, stan. 18.

the Lower Vistula Valley (Fig. 1). The chronology of the assemblages embraces the Older Dryas and Atlantic period and includes 3 prehistoric stages: Final Palaeolithic, Mesolithic and Early and Middle Neolithic.

Three sites date back to the period of the Final Palaeolithic: Brzoza, the commune of Wielka Nieszawa, sites 15 and 34 (B15, 34) and site 5 in Stare Marzy, the commune of Dragacz (SM5).

The complex of Final Palaeolithic sites in Brzoza is located in dune fields, in the Lower Vistula Valley. Around 90 spots related to Final Palaeolithic settlement have been identified; mainly of Swiderian culture (Cyrek 2002). 696 wares come from site 15 and their analysis has led to the identification of 62 functional tools. At site 34, 440 wares have been uncovered, of which 57 were functional tools (Osipowicz 2010).

Site 5 in Stare Marzy is located in the south part of the Grudziądz Basin, on the bank of the Vistula river terraces (Fig. 1). Almost all of the products (1418) related to the Final Palaeolithic Swiderian culture were uncovered within 10 flint concentrations of various sizes and shapes. Their microscopic analysis enabled the identification of 322 functional tools (Osipowicz 2010).

Mesolithic materials included in the studies come from 6 archeological sites: Sasieczno 4, the commune of Obrowo (S4), Toruń 247 and 249, the commune of Toruń (T247, 249) and Lubicz 12, 13 and 18, the commune of Lubicz (L12, 13, 18).

Site 4 in Sąsieczno is set within the Toruń Basin, about 5 km from the current Vistula bed (Fig. 1). The majority of uncovered products relate to the Funnel Beaker Culture (TRB). Mesolithic items occurred solely in the northern part, about 20 m from the area of TRB material. Three flint concentrations were found here. 1180 wares come from flint concentration 1, which can be related to the Komornica culture (Duvensee complex).

Charcoal samples were collected from the layer of archeological material for further radiocarbon dating (14C) which indicated 6810±100 BP (Ki–8901). Analogically, the result of 6930 ±140 BP (Ki–11116) from flint concentration 3 has been obtained (materials did not undergo use-wear analysis).

Use-wear analysis of products from flint concentration 1 identified 123 functional tools (Osipowicz 2010). From flint concentration 2 come 2543 flint materials, which profile enables their assignment to the last phase of Komornica culture development, while it was also strongly impacted by Maglemosian culture (Galiński 2002). Use-wear analysis of this collection identified 311 functional tools (Osipowicz 2010).

Sites 247 and 249 in Toruń were discovered in 1989 during fieldwalking surveys made within the program Poland Archeological Photo. Excavations were not performed there. 361 flint wares were uncovered from the surface of site 247, of which 74 have been identified as functional tools (Osipowicz 2010). This material is related to the Komornica culture and dates back to the Boreal period. 21 products were recovered from site 249, from which a microscopic analysis revealed 4 functional tools (Osipowicz 2010). This collection can be linked to complex of Maglemosian cultures.

Sites in Lubicz are situated in the Drwęca Valley in the eastern part of the Toruń Lowland. All of them can be related to the Chojnica group of Chojnica and Pieńki culture and dated back to the Atlantic period. 762 flint wares derive from site 12, which analysis identified 116 functional tools. At site 13 flint products reached the amount of 158, among which 32 products were associated with 36 functions, while in Lubicz 18 the collection was composed of 310 wares, of which 71 bear use traces and form a set of 80 function tools (Osipowicz 2010).

Material from two Neolithic cultures was analyzed: Linear Band Pottery Culture (LBK) and Funnel Beaker Culture. Products of the first culture come from particular sites: Annowo 7, the commune of Gruta (An7), Boguszewo 41 and 43a (Bo41, 43a), commune of Gruta, Stolno 2, commune of Stolno (St2), Ryńsk 42, commune of Wąbrzeźno (Ry42), Gruta 52, the commune of Gruta (Gr52), Wielkie Radowiska 22 and 24, and the commune of Dębowa Łąka (Wr22, 24). TRB material was uncovered from sites: Dubielno 18, the commune of Papowo Biskupie (Du18), Gogolin 15, the commune of Grudziądz (Go15), Klamry 7 and 8, the commune of Chełmno (Kl7, 8), Lembarg 94, 95 and 96, the commune of Jabłonowo Pomorskie (Le94, 95, 96), Linowo 25 and 63, the commune of Świecie by Osa (Li25, 63), Niemczyk-Wrocławki 1, the commune of Papowo Biskupie (NW1), Osiek 9, the commune of Obrowo (Os9), Smogorzewiec 9, the commune of Obrowo (Sm9), Wełcz Wielki 10B, the commune of Grudziądz (WW10B) and Zakrzewo 6, the commune of Radzyń Chełmiński (Za6). Overall use-wear analysis included 1134 products from LBK and 1112 from TRB and revealed 570 functional tools (328 from LBK and 242 from TRB). The full results of this study were presented by Jolanta Małecka-Kukawka (2001).

A complete use-wear analysis was performed on 10199 products (all of the items found at the described sites) and 1755 functional tools were recognized (Osipowicz 2010). Besides the author, use-wear analysis was done in association with Prof. Galina F. Korobkowa (Russian Academy of Sciences, St. Petersburg), Ludmiła Čajkina (Russian Academy of Sciences, St. Petersburg) and Dr. hab. Jolanta Małecka-Kukawka (Nicolaus Copernicus University in Toruń). Initial microscopic analysis was conducted with microscopic-computer kit Nikon SMZ-2T. The described device enables a limiting magnitude up to 12.6x (with real magnitude 120x), computer digitization and the processing of optical images. During further optical analysis, microscopic-copmuter kit Zeiss-Axiotech was used, which enables a limiting magnitude up to 50x (with real magnitude 500x).

3. Microscopic analysis of selected flint sources

Morphological tools are frequently the subjects of the majority of current use-wear analyses, as well as the basis for reasoning about the functional structure of flint collection. The presented results from various sites in Poland indicate that this group cannot be considered representative of whole assemblages due to many obstacles. Primarily, it is a small number of the group which would cast doubt on its representativness. In analysed Palaeolithic and Mesolithic material morphological tools constitute only 1.6-11.4% (in most cases below 7%–Table 1). In Neolithic material they are more numerous and reach 20%. Considering the number of activities that were probably conducted at those sites and the fact that some of them must have been very laborious, it is obvious that this morphologic group is not representative of the total number of functional flint tools utilised within settlements or camps (at least concerning those sites which supposedly functioned for a longer period of time–Knutson 1990). Such an opinion had already been given in the 1980s (Juel Jensen and Petersen 1985). The cognitive value of this type of wares is further diminished by the theory concerning transportation, reparation and alternation (Knutson 1990). This allows suggestions that a part of these tools bear signs of utilization unrelated to the place in which they were

Site/ flint concentration	Share of morphological tools in the assemblage	Ratio of morphological tools' utilization	Share of functional tools in the assemblage	Share of unretouched semi-finished tools among functional tools
		Final paleolithic		
SM5, KI	1,6	100	8,2	80,7
SM5, KII	3,6	75	12,3	77,8
SM5, KIII	9,7	97,1	23,9	60,4
SM5, KVIII	2,7	100	23,6	88,3
SM5, KX	6	92,8	14,5	61,7
		Mesolithic		
S4, K1	3,6	93	9,5	63,4
S4, K2	3,2	80,2	10,7	76,1
L12	7,9	88,3	14,8	53,1
L13	6,3	100	20,2	68,7
L18	10	100	22,9	56,3
T247	11,4	87,8	25,4	48,6
		Neolithic		
Bo 41	14,8	95	37,8	52,9
Bo 43a	17,1	100	44,1	13,7
St 2	7,4	100	16	46,1
An 7	12,2	96,7	35,5	57,8
Ry 42	12,2	91,6	30,6	63,3
Gr 52	12,3	85,7	17,5	40
Wr 22, ob. 2	17	100	37,8	41,9
Wr 24, ob. 1	15,1	80	31,25	60
Wr 24, ob. 2	8,9	94,7	22,4	54,7
Wr 24, ob. 4	11,3	84,2	27	38,2
Os 9	10	89,5	41	73
Du 18	12	28,5	8,6	60
Le 94, 95, 96	7,8	83,3	23,5	66,7
Li 25	8,3	50	10,1	47
Li 63	19,4	14,3	5,5	50
Za 6	17,1	28,3	12,2	60
Sm 9	18,8	68,3	34,2	50
WW 10	17,6	88,9	31,4	50
Nw 1	7,2	83,3	3,6	31,25
Go 15	36	66,6	28	14,3
Kl 7	27,8	90	36,1	23,1
l 8	25,7	83,3	41,4	37,9

Tab. 1. Morphological and functional tools – share of the assemblage and ratio of utilization.

uncovered, decisively diminishing their usefulness from the perspective of the profile of the discussed analysis. The hypothetical nature of such assumptions cannot constitute a reason for the functional analysis of entire collections of flint; however, it is something to think over.

Undoubtedly, treating morphological tools as used wares is advisable. In most of the analyzed collections their index of utilization exceeds 80% (Table 1). Though, it is notable that at some of the TRB sites the amount is below 50%. This is possibly caused by the short time of their utilization, yet other causes are also possible. A similarly low level was registered on Dutch LBK sites in Beek-Molensteeg (van Gijn 1989).

Prepared statements (Table 1) clearly indicate that at least at these investigated sites, morphological tools could not have been the only products used for everyday work. How does the functional structure of studied collections look after performing use-wear analysis on all products? At Palaeolithic and Mesolithic sites functional tools constitute around 8 to 25% of uncovered flint objects (Table 1). It is a significant amount, especially while considering the quantity of splinters and debitage uncovered here (Osipowicz 2010). Comparing to the number of identified morphological tools, the percentage of used products increased from around 6% (Stare Marzy, flint concentration 1; Sąsieczno flint concentration I; Lubicz, site 12) to around 20% (Stare Marzy, flint concentration VIII). This considerable difference explicitly suggests that unretouched semi-finished products were very often utilized as tools. The tendency is even more visible at Neolithic sites, where an increase of around 15-20% is practically a standard (Table 1). Some TRB sites have to be considered here as the number of identified functional tools is smaller than morphological ones: Dubielno (site 18), Linowo (site 63), Zakrzewo (site 6), Sąsieczno (site 1), Niemczyk-Wrocławki (site 1) and Gogolin (site 15). The possible explanation is the specifics of tasks performed at those sites. Mainly completed products were brought to the sites (thus a relatively large amount of morphological tools), which on some occasions were abandoned even before being used.

How does a functional tool group look in specific periods? Over 60% of used wares (in some cases over 80%–Table 1) of all analyzed Final Palaeolithic materials are unretouched objects, which would be left out in the case of use-wear analysis with conducted source selection. In Mesolithic collections tools of this type amount to around 48-76%, and at Neolithic sites around 14 to 73% (over 40% on average). The described trends are easily noted in the situation observed at the late Mesolithic Tågerup site (Kongemose culture). During the analysis of flint material from that site, it was noticed that morphologically identifiable forms are dominated by broken blades. Their large amount was impossible to explain even while considering the fact that they were a basic source material for the production of morphological tools. Among 15 specimens chosen for use-wear analysis, only 4 did not display any traces of usage (Knarrstrom 2001). Around 26000 broken blades were uncovered at the described site. Assuming that the attained proportion is correct (which is of course a considerable simplification), around 20000 of these (76%) would have been used. Considering the proportions noted in the materials of this study (around 20-30%), or those (similar) noted by Helle Juel Jesen and Erik Brinch Petersen in Vaenger Nord (about 23%–1985) we still get between 5200 to 7800 products. Can excluding such number of objects do not impact conclusions concerning site's function?

Even though the problem is usually understated, other scholars who select tools for use-wear analysis have also noticed the importance of unretouched products. Talking about the utilization of analyzed late Mesolithic blade end scrapers' side edges, Helle Juel Jensen declares "(…) it is my hypothesis that blades were primarily produced and used as unretouched tools, and only served secondarily as blanks for the retouched pieces" (Juel Jensen 1982). Only a few years later, the question concerning the use of debitage tool groups becomes one of the main problems discussed by the same author prior to material analysis (Juel Jensen and Petersen 1985).

In light of all the presented arguments, any conclusion based on functional analysis of selected flint forms and concerning all activities performed within a settlement seems to be groundless. In the case of the material examination of this type, it is essential to take into account all products from a site. If it is impossible (for example in the case of a vast number of finds), then "closed" assemblages should be analyzed (originating from isolated cultural features or layers). The necessity of such a proceeding was already noticed in the 1980s by P. C. Vaughan (1985).

4. Form vs. function i.e. exploitation modes of morphological forms

The functional analysis carried out in this study demonstrated significant differentiation in the exploitation modes of particular morphologic types present in the assemblages. A set of regularities has been observed, which confirms the suggestions of several authors about the microscopic analysis of product form, ethnographic analogies or microscopic analysis of other flint materials. However, some discrepancies occurred, which should lead to greater caution in forming hypotheses about the function of flint products without use-wear analysis and concluding further than the analyzed materials. An overview of observation progress is presented below.

4.1. End scrapers

End scrapers are one of the most commonly identified categories of morphological tools at Palaeolithic and Neolithic sites included in this study (Tables 2, 4) while at Mesolithic sites their proportion decreases in favour of side scrapers (Table 3).

In the Final Palaeolithic tools of this type were used primarily for hide processing (Fig. 5a). Traces characteristic for this action were found on 26 out of 32 analyzed specimens (Table 2; Fig. 2: 1, 3). Five other end scrapers were used for the processing of antler/bone (Fig. 2: 2) and one for wood. In the Mesolithic period their function was similar (Table 3). Over half of those with traces of use (16 examples) were employed for hide processing (Fig. 3, 1-4). More often than previously end scrapers were used for other tasks (mainly scraping antler/bone and wood). In the Neolithic period their basic function continued to be the same (Fig. 4: 1-4). Traces of hide processing were found on 70 examples (Table 4). Nevertheless, it is worth mentioning that often they were also used as sickle blades (11 examples, Fig. 4: 3, 4). However, this is usually a secondary function for end scrapers which are primarily used to work with hide (compare Małecka-Kukawka 2001).

The described correlation of form and function is also noticeable at other Polish sites (Winiarska-Kabacińska 1990; 1992; 2002, Table 2; 2005; 2007b), as well as within foreign materials from France (Vaughan 1985, Fig. 4.1–Magdalenian culture), Zealand (Vaenget Nord) and southern Sweden (Juel Jensen and Petersen 1985; Knarrstöm 2001, Fig. 25: 1-3–Kongemose culture), Ringkloser in Denmark (Juel Jensen 1982–Ertebølle culture), Beek-Molensteeg in Holand (van Gijn 1989, Table 22–LBK), Dagstrop in Sweden (Knarrstöm 2001, Fig. 42: 3-4–TRB) and Hekelingen III in Holand (van Gijn 1989, Tables 41, 42–late Neolithic period).

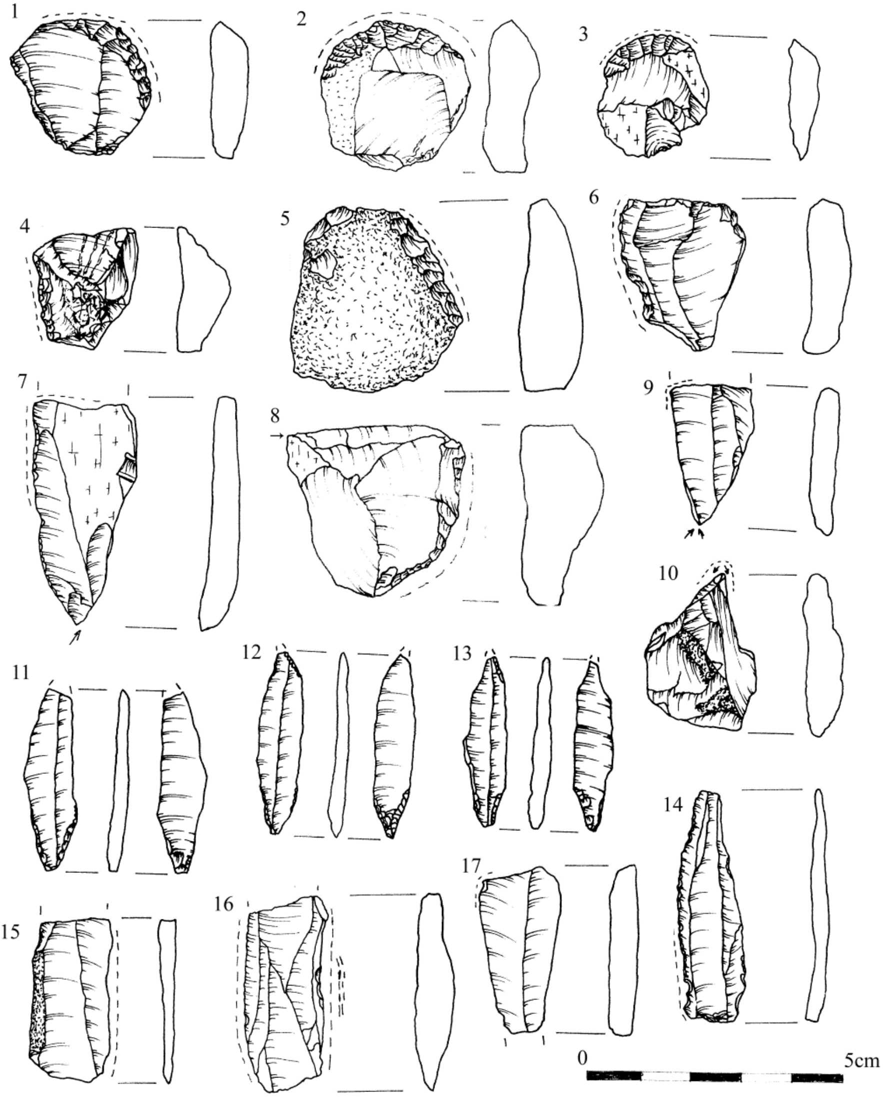

Fig. 2. Final Paleolithic. Example of utilization of different morphological forms: hide scrapers (1, 3, 7, 14, 16), meat knife (15), wood scrapers (4, 5), arrowheads (11-13), bone/antler scraper (2, 6, 8), wood burin (9, 10, 17). Second function of a tool (===): bone/antler whittling tool (16). Draw. D. Nowak

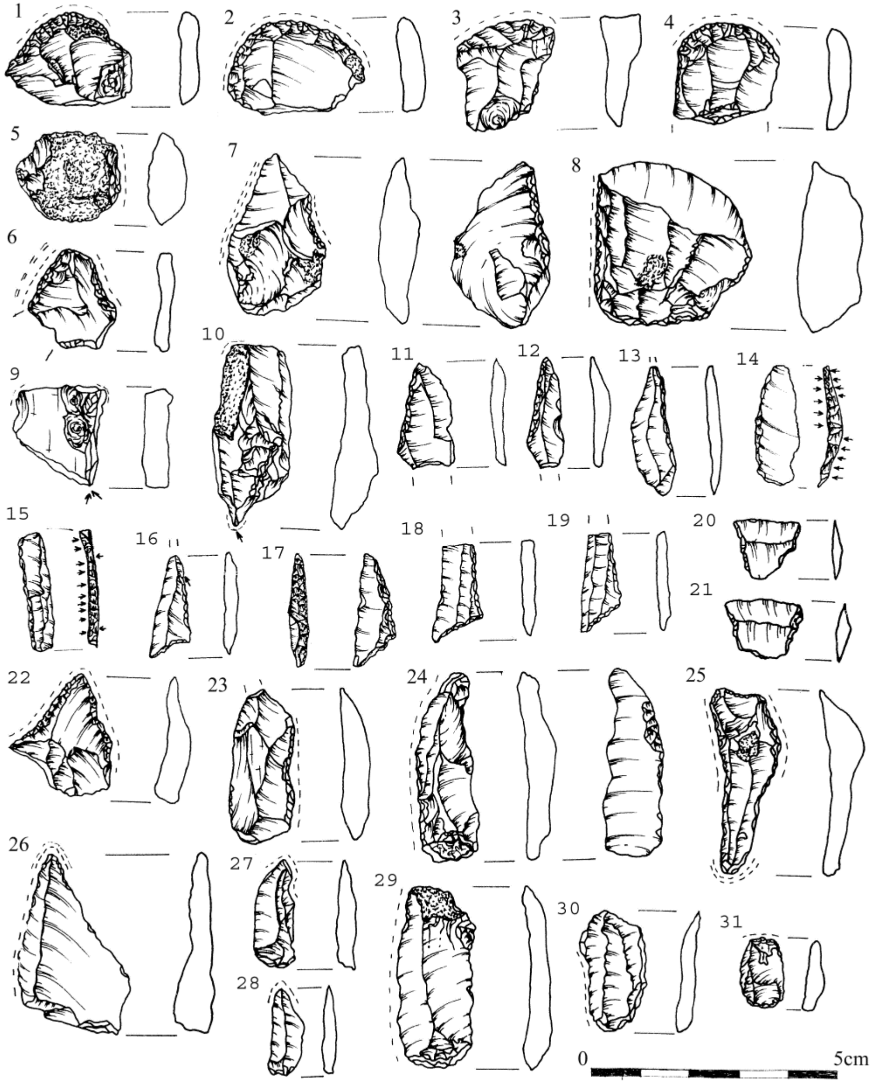

Fig. 3. Mesolithic. Example of utilization of different morphological forms: hide scrapers (1-5, 26), bone/antler whittling tool (6, 7), bone/antler scraper (8, 10, 25), wood burin (9), arrowheads (11, 12, 14, 16, 20-21), side insets of arrow/harpoon (13, 15, 17-19), wood borer (22), wood whittling tool (23), bone/antler saw (25), hide perforator (27, 28), meat knife (29, 30), microscraper (31). Second function of a tool (===): bone/antler scraper (6, 7), bone/antler borer (25), hide perforator (26). Draw. D. Nowak

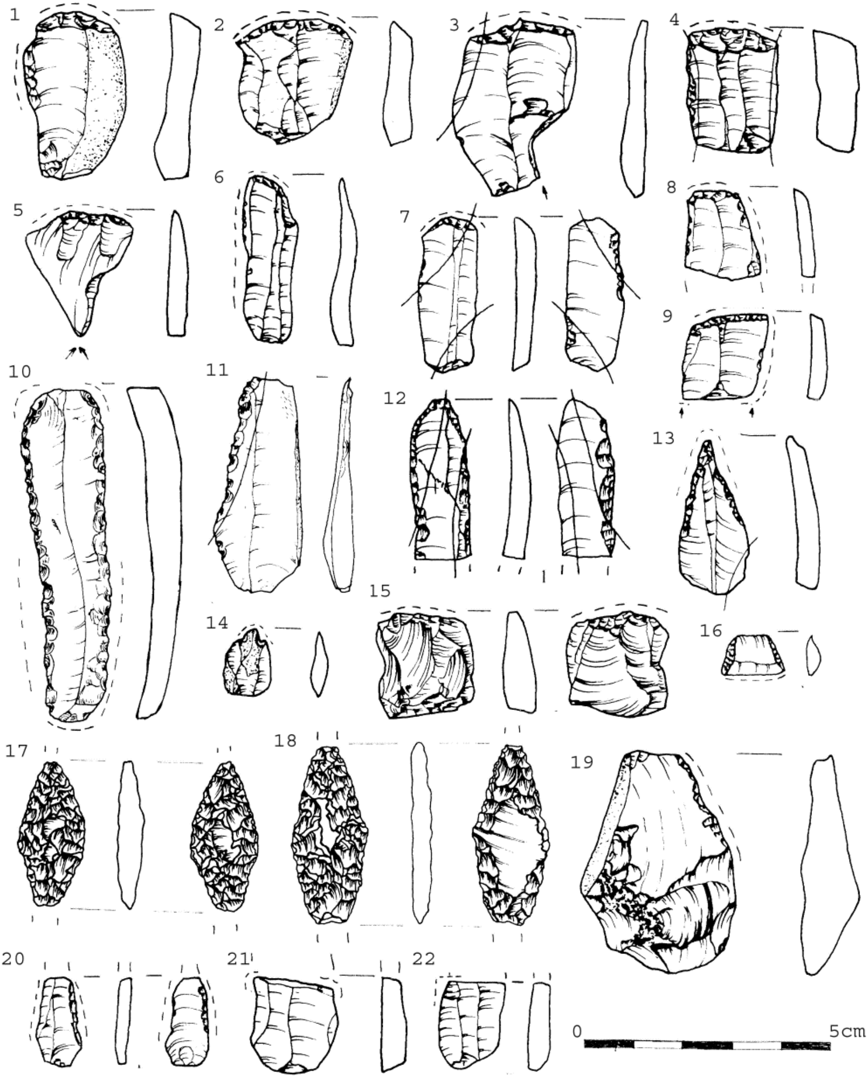

Fig. 4. Neolithic. Example of utilization of different morphological forms: hide scrapers (1-4, 6-10, 19), wood chisel (5, 15), harvesting tool (11-12, 14), hide perforator (14), meat knife (16), arrowhead (17-18), wood burin (21-22), bone/antler scraper (20). Other functions of a tool: harvesting tool (3, 7, 13), cutting grass knife (4), meat knife (6, 8-9), wood burin (9), bone/antler scraper and burin (10), bone/antler borer (13). Draw. J. Małecka-Kukawka, no. 17 and 18 draw. D. Nowak.

Morfological clasifica-tion / Functional clasification	End scrapers	Side scrapers	Burins	Truncated blades	Tanged points	Perforators	Splintered cores	Retouched flakes and blades	Unretouched tools	Total
Hide scraper	**26**	**2**	**3**	-	-	-	-	**2**	**16**	**49**
Hide perforator	-	-	-	-	-	-	-	**2**	**27**	**29**
Meat knife	-	-	-	**1**	-	-	-	**6**	**140**	**147**
Wood scraper	**1**	-	**3**	**1**	-	-	-	**1**	**12**	**18**
Wood saw	-	-	**1**	-	-	-	-		**4**	**5**
Wood whittling tool	-	**3**	**1**	-	-	-	-	**3**	**10**	**17**
Wood chisel	-	-	**1**	-	-	-	**2**		-	**3**
Wood burin	-	**1**	**5**	-	-	-	-		**70**	**76**
Wood borer	-	-	-	-	-	-	-	**1**	-	**1**
Bone/antler scraper	**5**	**7**	**7**	-	-	-	-	**1**	**14**	**34**
Bone/antler saw	-	-	-	-	-	-	-		**1**	**1**
Bone/antler whittling tool	-	-	-	-	-	-	-		**2**	**2**
Bone/antler burin	-	-	**4**	-	-	-	-	**1**	**16**	**21**
Bone/antler borer	-	-	-	-	-	**2**	-	**1**	-	**3**
Cutting grass knife	-	-	-	-	-	-	-	**1**	**2**	**3**
Arrow heads	-	-	-	-	**18**	-	-	**3**	-	**21**
Total	**32**	**13**	**25**	**2**	**18**	**2**	**2**	**22**	**314**	**430**

Tab. 2. Final Paleolithic - morphologic forms and their employment.

Morfological clasifica-tion / Functional clasification	End scrapers	Side scrapers	Burins	Truncated blades	Backed pieces	Perforators	Borers	Geometric microliths	Retouched flakes and blades	Unretouched tools	Total
Hide scraper	**16**	**19**	-	-		**1**	-		**4**	**34**	**74**
Hide perforator	-	-	-	-		-	-	**1**	**1**	**21**	**23**
Hide knife	-	**1**	-	-		-	-		**2**	**11**	**14**
Meat knife	-	-	**1**	-		-	-		**2**	**58**	**61**
Wood scraper	**6**	**17**	**1**	**1**		-	**1**		**11**	**24**	**61**
Microscraper	**1**	-	-	-		-	-		**1**	**99**	**101**
Wood saw	-	**1**	-	-		-	-		-	**7**	**8**
Wood whittling tool	**1**	-	-	-		-	-		**4**	**27**	**32**
Wood chiesel	-	-	-	-		-	-		-	**2**	**2**
Wood burin	**1**	**1**	**3**	-		-	-		-	**60**	**65**
Wood borer	-	**1**	-	-		**1**	-		**2**	**3**	**7**
Bone/antler scraper	**8**	**31**	-	**1**		**1**	-		**8**	**23**	**72**
Bone/antler saw	-	**1**	-	-		-	-		**2**	**5**	**8**
Bone/antler whittling tool	-	**1**	-	-		-	-		**2**	**6**	**9**
Bone/antler burin	-	**2**	**3**	-		**1**	-		**1**	**13**	**20**
Bone/antler borer	-	**1**	-	-		-	**1**		-	**3**	**5**
Cutting grass knife	-	-	-	-		-	-		-	**1**	**1**

Splitting plant fiber tool	**-**	**-**	**-**	**-**		**-**	**-**		**-**	**4**	**4**
Arrowheads and side insets of arrow/harpoon	**-**	**-**	**-**	**5**	**19**	**-**	**-**	**21**	**-**	**4**	**49**
Total	**33**	**76**	**8**	**7**	**19**	**4**	**2**	**22**	**40**	**405**	**616**

Tab. 3. Mesolithic - morphologic forms and their employment.

Thus, it can be stated that hide processing was a basic function of end scrapers in all of the investigated periods. Not so long ago, they were still used in the same way by Inuit and North American Indian societies (Evans 1872; Hayden 1979, Table 1; 1990). Some scholars consider them to be the greatest achievement in the evolution of flint tools for processing animal hides, and their appearance in prehistory may only be characteristic of those cultures where hides were processed in great quantities (Hayden 1990). Sometimes they were also used for other purposes (compare Juel Jensen 1982; Vaughan 1985; Andrewsky 2005). But so far no "other" function has been found to be dominant.

4.2. Side scrapers

Decisive majority of side scrapers analyzed in this study was uncovered at Mesolithic sites. In Final Palaeolithic materials, there were 13 tools of this type (Table 2) and only one in Neolithic (Table 4).

In the Final Palaeolithic period side scrapers were used mainly for processing antler/bone (Fig. 2: 6, 8). Though, considering the small number of tools uncovered, it is uncertain whether a true regularity was observed here. Moreover, 3 of remaining side scrapers were used for planing wood, 2 for scraping hides, and one for boring in the wood (Table 2). Also in Mesolithic period scraping bones/antler was a basic activity performed with side scrapers (Table 3; Fig. 3: 8). Very often they were also used for processing of hides and wood (Fig. 5, c). Sporadically, side scrapers were used for other tasks. The only identified Neolithic scraper was used for hides processing (Table 4).

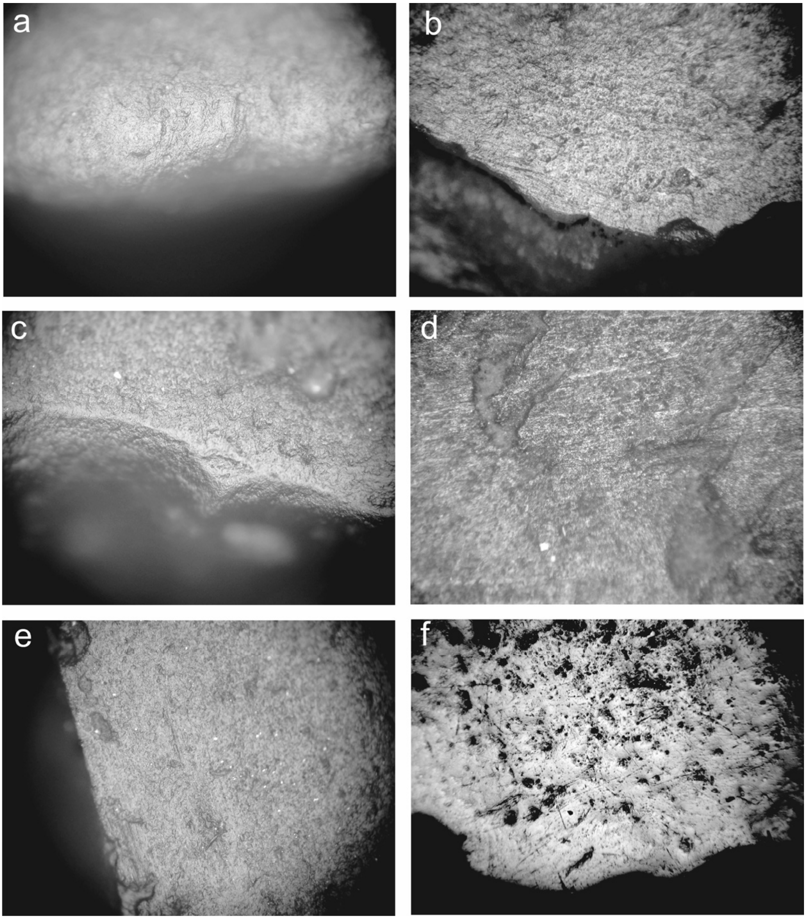

Fig. 5. Use wear traces observed on: a – Final Paleolithic hide scraper (Stare Marzy 5; x 250, ob. x 20), b – Mesolithic hide knife (Lubicz 12; x 250, ob. x 20), c – Mesolithic wood scraper (Lubicz 18; x 250, ob. x 20), d – Final Paleolithic bone/antler saw (Stare Marzy 5; x 250, ob. x 20), e – Mesolithic arrowhead (Lubicz 18; x 250, ob. x 20), f – Neolithic harvesting knife (Wielkie Radowiska 24; x 125, ob. x 10).

Morfological clasifica-tion / Functional clasification	End scrapers	Side scrapers	Burins	Trunca-ted blades	Regular-ly retouch-ed blades	Perfora-tors	Boreres	Splinie-red cores	Bifacial points	Geome-tric micro-liths	Retouch-ed flakes and blades	Unre-touched tools	Total
Hide scraper	**70**	**1**	-	**21**	**2**	-	-	-	-	-	**3**	**9**	**106**
Perforator	-	-	-	**3**	-	-	-	-	-	-	**1**	**16**	**20**
Hide knife	-	-	-	-	-	-	-	-	-	-	-	**1**	**1**
Meat knif	**4**	-	-	**7**	-	-	-	-	-	**2**	**4**	**90**	**107**
Wood scraper	**1**	-	-	-	-	-	-	-	-	-	**4**	**21**	**26**
Wood saw	-	-	-	-	-	-	-	-	-	-	**2**	**4**	**6**
Wood whittling tool	-	-	-	-	-	-	-	-	-	-	**1**	**11**	**12**
Wood chisel	-	-	**1**	-	-	**1**	-	**45**	-	-	**3**	**17**	**67**
Wood burin	-	-	-	**3**	-	-	-	-	-	-	**2**	**87**	**92**
Wood borer	-	-	-	-	-	**2**	**1**	-	-	-	-	-	**3**
Bone/antler scraper	**3**	-	-	-	**1**	-	-	**1**	-	-	**9**	**3**	**17**
Bone/antler saw	-	-	-	-	-	-	-	-	-	-	**1**	**3**	**4**
Bone/antler whittling tool	-	-	-	**1**	-	-	-	-	-	-	-	**2**	**3**
Bone/antler burin	-	-	-	-	**1**	-	-	-	-	-	**5**	**18**	**24**
Bone/antler borer	-	-	-	-	-	**4**	**4**	-	-	-	**1**	**1**	**10**
Cutting grass knife	-	-	-	**1**	-	-	-	-	-	-	**2**	-	**3**
Harvesting tool	**11**	-	-	**15**	**8**	**1**	-	-	-	-	**7**	**15**	**57**

Arrowheads and side insets of arrow/harpoon	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**5**	**3**	**-**	**1**	**10**
Stone saw	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Shell saw	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
Total	**90**	**1**	**1**	**52**	**12**	**8**	**5**	**46**	**5**	**5**	**46**	**299**	**570**

Tab. 4. Neolithic - morphologic forms and their employment.

Analysis of activities performed with the use of the discussed tools indicates that they were utilized for a wide range of tasks. Excluding the material which they were used for, the data shows that such tools were used mainly for actions involving scraping, as was also observed at other archeological sites (compare Vaughan 1985, Fig. 5.5; Andrewsky 2005).

4.3. Burins

Final Palaeolithic morphological burins were used for various activities (Table 2). Among 25 functions, for which the tools were used, traces characteristic for scraping and carving in antler/bone were identified, as well as those that originated from activities associated with wood processing and scraping hides (Table 2; Fig. 2: 7). Similar diversity was observed at the site in Wojnowo (Winiarska-Kabacińska 1992).

Mesolithic burins were used mainly in the same way i.e. for cutting meat, scraping wood and carving in wood and antler/bone (Table 3). The uncovered Neolithic morphological burin is a wood chisel (Table 4). Therefore, the only feature connecting all of the described tools is the burin spall. What was its function? In most cases the microscopic analysis of burins included in this study has shown no traces of utilization of the burin spalls (Korobkowa 1999). It means that usually these tools were not used for any kind of activities and definitely not for carving. Out of 287 identified burins, only 9 had traces of use on the chisel-like edge. Additionally, two of these tools displayed a described feature which could have been formed as a result of exploitation. Moreover, there are no traces of use on burin spalls within tools analyzed by P. C. Vaughan (1985, Fig. 4.2) and M. Winiarska-Kabacińska (2002, Fig. 1:1-3; 2005). What were they used for then? Results of a conducted analysis suggest that making median burins (no matter which type) was intended for an easier setting of the product (it was simpler to wedge a sharp end of a tool in a wooden setting). Striking a flake on the side of a semi-finished product has a similar function. It was probably aimed to create a blunt back surface thus allowing a safe hold of the tool. Such a function of the burin spall seems to be confirmed by its location which is exactly opposite to the true working edge. Thus, the described procedures have a strictly functional character. However, they cannot be linked with the actual function of a tool, as products prepared in this way were applied for various tasks.

A different point of view on burin spall utilization was presented by Zbigniew Pianowski (1977). It would be difficult to polemize with his conclusions. Possibly, he may have misinterpreted scratches caused by the use of a hard stone percussor with the linear traces resulting from edge utilization; nevertheless, the correctness of his assumption cannot be refuted. The employment of burins in accordance with their morphology was also suggested by other authors (Knarrström 2001). An interesting opinion was presented by Danish scholars after an analysis of artefacts from the late Mesolithic site in Vaenget Nord (Juel Jensen and Petersen 1985). Specimens described there were employed for the processing of antler/bone, particularly for scraping and scarving. During the process the side edges of burin spalls were employed (Juel Jensen and Petersen 1985, Fig. 5). A similar situation was observed by P. C. Vaughan on Magdalenian burins, although these were used mainly for scraping hides (Vaughan 1985).

4.4. Truncated bladelets

Most of the analysed truncated bladelets are of Neolithic and (in a much lesser degree) Mesolithic origin. Only two tools of this type were found on Final Palaeolithic sites (Table 2), thus making it impossible to attempt a broader analysis of their use in this period.

Mesolithic truncated bladelets are mainly arrowheads (Table 3; Fig. 3: 11, 12). One for each of the wears show evidences of scraping wood and antler/bone. Neolithic objects of this type fulfilled various functions (Table 4; compare Małecka-Kukawka 2001). Most often they were used for scraping hides (Fig. 4: 6-9; this action was carried out with the retouched part of the product) or harvesting cereal (Fig. 4: 7; unretouched side edge of the item). Additionally, they were used for cutting meat (Fig. 4: 8, 9); occasional use for other activities was also observed. Most of the truncated bladelets from the earlier above-mentioned site in Vaenget Norg in Denmark were employed as knives/side scrapers for hide processing (Juel Jensen and Petersen 1985).

While analyzing methods of usage of the truncated bladelets at various sites included in this study, it has to be noted that their functions differed considerably in Mesolithic and Neolithic periods. Observed differences could be accidental (caused by a small number of Mesolithic products) or the result of the tools' morphology (which seems much more probable). Otherwise, they could also be due to a cultural background, which would make them important for the purpose of studying changes which occurred in the utilization of specific tool types in the Stone Age. This matter requires further study.

4.5. Backed pieces

Backed pieces were only found on Mesolithic sites. All of them were used as arrowheads or the side insets of arrow/harpoon (Fig. 3: 13-15). One of the specimens recently analysed by M. Winiarska-Kabacińska fulfilled a similar function (2007b). The second tool of this type taken into account by that author carried traces of being used as a meat knife (Winiarska-Kabacińska 2007b). Still, it has to be remembered that use-wear traces characteristic for cutting meat very often only subtly differ from use retouch observed on side insets of arrows and harpoons. Both tool types "work" in the same material, in a very similar way. There is a probability that traces formed by a short usage on a knife will be identical to those formed on an extensively used harpoon. The suggested way of employing discussed morphological forms can be confirmed by an analysis of specimens from the Verrebroek site, although those backed pieces were used exclusively as arrowheads (Crombe et al. 2001).

4.6. Perforators and borers

Both these tool types are represented by small groups, thus making it difficult to characterize the way in which they were utilised. Only two perforators were uncovered at Palaeolithic sites. Both were exploited as burins for antler/bone. On wares analysed by M. Winiarska-Kabacińska (2002) from this period, there were traces left by scraping hide and drilling in wood. On Mesolithic perforators analyzed in this study, recorded traces were characteristic of four activities: scraping hide, drilling in wood (Fig. 3: 22), and scraping and boring in antler/bone. Borers of this period were used for scraping wood and drilling in antler/bone (Table 3). Neolithic perforators also fulfilled diverse functions (Table 4). In four cases they were used as borers for antler/bone (Fig. 4: 13), two others were employed for drilling in wood, one was utilized as a chisel and one as a sickle inset. The period's borers were mostly implemented for drilling in antler/bone (4 examples). Furthermore one product was used for boring in wood (Table 4).

In the described tool collection no significant differences in employment of perforators and borers were noticed (compare Andrewsky 2005). Both tool types fulfilled few functions, among which drilling in antler/bone seems to be the fundamental one. Palaeolithic and Neolithic tools were used in a similar way, while only Mesolithic products differ from this pattern. To confirm these conclusions, further miscroscopic analyses of other material are required.

4.7. Tanged points

All of the analyzed tanged points bear traces of being used as arrowheads (Table 2; Fig. 2: 11-13). This thus confirms a common opinion concerning their function. Certainly, they were secondarily used for other activities (Pianowski 1977).

Use-wear analysis of West European tools showed that the majority of them were unused (Fischer et al. 1984, Fischer 1989). This leads to the conclusion that they were produced in number exceeding existing needs (“for storage”–Fischer et al. 1984; Fischer 1989). The results of this analysis did not confirm this hypothesis, as only a few products had no signs of wear. A different situation was observed at the Kraków-Kurdwanowo site (Winiarska-Kabacińska 2002). Only 4 of the 21 analyzed artefacts had traces of use-wear, while 2 were exploited in a different way to the arrowheads. An unambiguous explanation of this matter has thus far been impossible.

4.8. Geometric microliths

Microlithic insets described here are mainly of Mesolithic sites. Few products of this type are also present in LBK material.

In the Mesolithic these tools were used as arrowheads or side insets of arrows and harpoons (Fig. 3: 18-21; 5e). A similar tools’ function was observed in specimens from site 71 in Dąbrowa Biskupia, Kuyavian-Pomeranian Voivodeship (Winiarska-Kabacińska 2007a) and European sites (Juel Jensen and Petersen 1985; Crombe et al. 2001; Odell 2003; Andrewsky 2005) whereas some of them were used solely as side insets and only occasionally as arrowheads (Crombe et al. 2001).

It has to be remembered that traces recorded on part of the specimens do not exclude the possibility that they were used as knives for meat and hides (Winiarska-Kabacińska 2002; 2007b), as well as for other tasks (Andrewsky 2005). One of the analyzed objects was employed as a perforator (Table 3). An inset used in the same way was found at site 71 in Dąbrowa Biskupia (Winiarska-Kabacińska 2007a). Therefore, some functional disparity can be noticed in this morphological group. It is possible that analysis of further materials will allow clarification.

Trapeze insets uncovered on LBK sites were employed in two ways i.e. as a meat knife (Fig. 4: 16) and an arrowhead (Table 4). Extensive analysis is impossible due to the small number of wares.

4.9. Regularly retouched blades

Regularly retouched blades were found only at Neolithic sites. Most of them were used for harvesting cereal (Table 4; Fig. 5b) while in two cases they were employed for scraping hides. This function was fulfilled by a working edge formed on the tip of the blade instead of its side edge. Furthermore, one blade was used for scraping bone/antler (Fig. 4: 10).

4.10. Bifacial points

All of the analyzed "bifaces" that bear marks of use-wear were employed as arrowheads (Fig. 4: 17, 18) as confirmed by analogies from other sites. Yet, it has to be remembered that in some cultures and periods they also fulfilled other functions (Andrewsky 2005). Utilizing bifacial points (heart-shaped) as knives for soft material was mentioned by Barbara Drobniewicz (1979, 91) while the hypotheses' review of bifacial forms' usage was presented by Jerzy Libera (2001, 37-40, 42, 43, 63-75).

4.11. Splintered cores

The majority of splintered cores were found at Neolithic sites (Fig. 4: 5, 15). Only two specimens (used ones) of this type originate from a collection of different chronology (Final Palaeolithic).

Both Palaeolithic examples (Table 2), as well as almost all of the Neolithic ones (Table 4) bear use-wear marks similar to those observed on experimental tools used as wood chisels. Their presence can be interpreted in a few ways. Mainly, these could be the result of the way in which those products were utilized; thus meaning that (at least in material analyzed here) the splinter technique was not a way of splintered flakes' production, but rather a specific method of creating core tools used as chisels for processing wood (or in another way–compare Vaughan 1985). Such an interpretation seems to be confirmed by current analysis. Almost none of the few hundred analyzed splintered flakes had any traces of use-wear, so they cannot be recognized as semi-finished products. Traces of wear registered on splintered cores in most cases are formed by use retouch only. Only a few specimens have traces of glossing and linear marks. However, the lack of such traces can be the result of very invasive crumbling of the working edge, as well as other factors, such as post depositional processes, length of use, or employment of products differing from the suggested one. The problem of the splinter technique has already been mentioned in literature (among others Migal 1987; Małecka-

Kukawka 1992; 2001).

Another conclusion of the presence of these traces results from observations based on archaeological experiments. Considering the way in which experimental chisels for wood are damaged, it is possible that at least some of the prehistoric splintered cores were formed entirely as a result of the usage of raw flakes (for that activity). In this case, they should be treated as waste material i.e. used-up tools abandoned as useless. Certainly, such an origin cannot be referred to all forms of this type.

The third interpretation is the least probable. Supposedly, the referred traces could have been formed as the core was empaled into a wooden base during the processing of splintered flakes. However, the character of traces, as already mentioned, is too invasive and there is not enough material evidence that splintered flakes were used as semi-finished products. However, it should be noted that these conclusions should be uniquely related to analyzed LBK and TRB assemblages. The recent use-wear analysis of splintered cores from the Linear Pottery Culture did not display any presence of use traces while parameters of gained semi-finished product made it tool-useful. Therefore, it seems that this technique could play a dual role within early agricultural societies. On the one hand, it was implemented for the creation of specific core tools. These specimens have determined forms and well-kept proportions (Osipowicz 2010). On the other hand, it was one of the methods for obtaining flint semi-finished products.

4.12. Retouched flakes and blades

Retouched flakes and blades are one of the most largely represented categories of morphological tools in all periods included in this study. Such products were used for all sorts of tasks (Table 2-4; Fig. 2: 14; 3: 23-25; 4: 20), which were also registered at sites abroad (Vaughan 1985, Fig. 4.10-12; van Gijn 1989, Tab. 22, 23; Andrewsky 2005). So far, no regularities have been found in the ways of their employment. Only some similarities have been observed by M. Winiarska-Kabacińska during the analysis of Kraków-Kurdanowo tools. Most of the specimens described by this author bear use-wear traces associated with the processing of hides and meat cutting (Winiarska-Kabacińska 2002).

It is probable that in the majority of cases, these tools were made and used occasionally, for current expediency. It cannot be denied that more precise morphological-functional analyses would allow for the finding of some regularities in their use.

5. Functional tools from unretouched semi-finished product

Unretouched tools are usually the largest group of products with use-wear traces, identified at Final Palaeolithic, Mesolithic and Neolithic sites. Similarly, as with retouched blades and flakes, they were utilized for all kinds of tasks (Table 2-4, Fig. 2: 15-17; 3: 26-31; 4: 21, 22; compare Juel Jensen, Petersen 1985; Vaughan 1985, Fig. 4.10-13; van Gijn 1989, Tab. 22, 23; Andrewsky 2005). Nonetheless, the performed analysis allowed identification of a task, carried out almost exclusively with the use of those products. In all periods unretouched semi-finished products were a basic morphological form used for cutting meat, puncturing hides, boring in wood and (in a lesser degree) in antler/bone. Another function which they probably fulfilled was sawing wood; although a small number of uncovered objects associated with this function make this interpretation uncertain. Mesolithic specimens were mainly implemented for cutting hides (Fig. 5b) and it seems that they were the only tools used for splitting plant fibre (as a curved knife). Neolithic products were the main type of functional "scrapers" for wood, while both in Mesolithic and Neolithic periods they were commonly used for planing wood and sawing antler/bone.

Analysis of a larger amount of material would probably allow the recognition of even more regularities. No matter what the results of future studies, observations presented here show the significant role of this group of objects among analysed collection. Ignoring it in use-wear analysis would cause a considerable error in final observations. The extensive usefulness and differentiation of employment ways of unretouched flakes have already been mentioned in literature in the time when archaeology was at its beginnings (Evans 1872).

6. Morphological-functional typology, is that possible?

The described results of the conducted use-wear analysis are evidence of the skills of Stone Age people for the very effective employment of accessible raw flint material, especially in its preparation to fulfill specific functions. Tools of most types were very well prepared to cope with tasks for which they were created. Prehistoric people made instruments which allowed the quick and unhindered execution of planned errands. A similar approach can also be observed among modern archaic societies (compare Andrewsky 2005). The morphology of tools was associated mainly with functional factors, although some of their types (like arrowheads) were also dependent on cultural traditions.

In the process of tools' production the most important factor was the quality of the working edge, as well as the possibility of the comfortable application of the products, which was ensured by an adequate bulkiness of the used semi-finished product or its setting. In the course of time, ways in which different materials were processed were brought to a level at which techniques and especially tools did not undergo significant modifications, as their form was perfect for effective work. Although the size or type of used semi-finished products still changed, the character of the working edge remained the same. This process resulted in the general unification of some functional tools' forms, which can be observed during use-wear analysis. Individual examples of such tools have many common characteristics, in spite of geographical, cultural and even chronological barriers. Registered similarities raised a question of whether it would be possible to classify those features and to create a kind of morphological-functional typology. Each functional type would have assigned morphological forms, used for this specific activity in all periods of the Stone Age. Conducted analysis suggests it to be possible, although only to limited degree and not at this stage of study.

A morphological-functional typology, perceptible after the analysis of flint products described here, does not fully correspond with the definition of this term (Kaczanowski and Kozłowski 1998). It is impossible to assign a morphological form to every functional tool, or to define its characteristics absent in other tools. It is not solely based on divisions made by researchers, but it is also connected to prehistoric realities i.e. the preferences of tools users and the natural predisposition of certain morphologic form to perform specific tasks. Some of these required employment of similar tools. Consequently, it is possible that a specific morphological form will be characteristic for a couple of different functional tools.

Most tool types have specific characteristics repeatable through all periods. For example, hide side scrapers had convex retouched working edges while antler/bone burins had retouched stings. These characteristics bind mentioned products with specific morphological forms and in many cases allow their relatively easy differentiation from their counterparts used for work with other materials, or from other employed specimens. However, most of the functional tools are unretouched forms and their characteristics can be also found on other wares. An example would be meat knives and wood burins, in both of which the correction of the working edge was applied (breaking a semi-finished product). In the case of knives it was used for straightening the line of the blade or the removal of the most crumbly parts of the material, while burins for wood had their working edge created in this way (Osipowicz 2010). It is impossible to distinguish these tools without the use of a microscope. Some functional types are even similar morphologically, e.g. perforators and borers for wood. In both cases blades were being employed, as well as in both of these products the same natural working edges were used.

In consequence, morphological-functional typology will not allow the identification of a tool's function without use-wear analysis. Nevertheless, sometimes it can be simplified. It could also be useful for determining the age of a single artefact as well as whole flint assemblages. In certain periods some functional tool types have exclusive characteristics not found in specimens from other periods e.g. Mesolithic burins for antler/bone and microscraper, Final Palaeolithic blade side scrapers, or Neolithic chisels for wood.

Perhaps use-wear analysis of other assemblages will demonstrate that current conclusions are characteristic solely for artefacts of the analyzed archeological site. However, due to the size of the tested group, the randomness of selection and chronological differences, the performed analysis can be considered as a relatively reliable test with possible discrepancies resulting from local specialization or minor cultural disparities. The described issue requires a wide range of further use-wear analysis for chronologically and culturally diverse material. Unfortunately not much has changed here since the 1980s, when P. C. Vaughan wrote that we should not draw hard and fast conclusions now concerning the relationship between stone tool typology and utilization, given the present small sample of functionally analyzed stone tools (Vaughan 1985).

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CHAPTER THIRTY SIX

THE HISTORY OF ONE ARROWHEAD FROM A PEAT BOG SITE IN CENTRAL RUSSIA (TECHNOLOGICAL AND USE-WEAR STUDIES)

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Abstract

The modern study of ancient tools includes technical and morphological, experimental-traceological analyses, research of archaeological context and ethnographic observation, as well as the data obtained by means of research by various methods of natural sciences.

Such an approach can be used both for mass materials, and for separate artefacts. The comprehensive study of one bone point from Mesolithic site Ivanovskoye 7 (Central Russia) can serve as an example of such research. Technical, morphological and experimental analyses allowed the reconstruction of the technology of its production, and a traceological study showed how it was used. Thus, the application of the complex method of research of ancient tools allows to gain the maximum information necessary for the interpretation of artefacts and for making reconstructions.

Keywords: The Mesolithic, a bone arrowhead, experimental-traceological analyses, reconstruction.

1. Introduction

Nowadays, interdisciplinary methods are used to obtain the maximum information in the research of ancient artefacts including morphological and technical studies, traceological functional analyses, experiments, archaeological context data, ethnographic records and various data of natural sciences used in archaeology. There is a large number of publications devoted to these problems which makes it impossible to give a full list of them here (Semenov 1964 and others). The proceedings of the international traceological congress which took place in Verona in 2005 demonstrate the modern level of such research (Longo, Skakun 2008). Positive results of the use of these methods were achieved during studies of both mass lithic collections from sites and archaeological cultures and cultural regions (Semenov 1957b), and separate artefacts.

2. Materials and methods

The results of a detailed study of a composite bone arrowhead from the Mesolithic site Ivanovskoye 7 (Fig. 1, 2) can serve as a good example of an analysis of a single artefact. The site is situated in Central Russia (Fig. 1: 1). Excavations by D. A. Krainov and M. G. Zhilin in 1974-1997 investigated three Mesolithic, several Neolithic and later cultural layers, embedded in lake and bog sediments. The lower, early Mesolithic (IV) layer, which produced this arrowhead, is dated by 14-C to 9650-9640 BP uncal. and to the early Preboreal period by pollen. The site was situated at the low promontory of a lake. Pollen data indicate taiga type forest with meadows and swamps on its shores. The bones of various forest mammals, birds and fish indicate that hunting and fishing were the main subsistence strategies of the site occupants. About 300 bone and antler artefacts were found in this layer.

Arrowheads are most numerous among weapons, indicating that bow and arrows were the main hunting weapons (Zhilin 2004). Various types of arrowheads were found in this layer: needle-shaped, similar with a slot for inserts, with thick biconical head, narrow flat with one slot, one-winged with a barb and a slot along the opposite side of the wing, a small barbed one for shooting pike (Zhilin et al. 2002, 131-133).

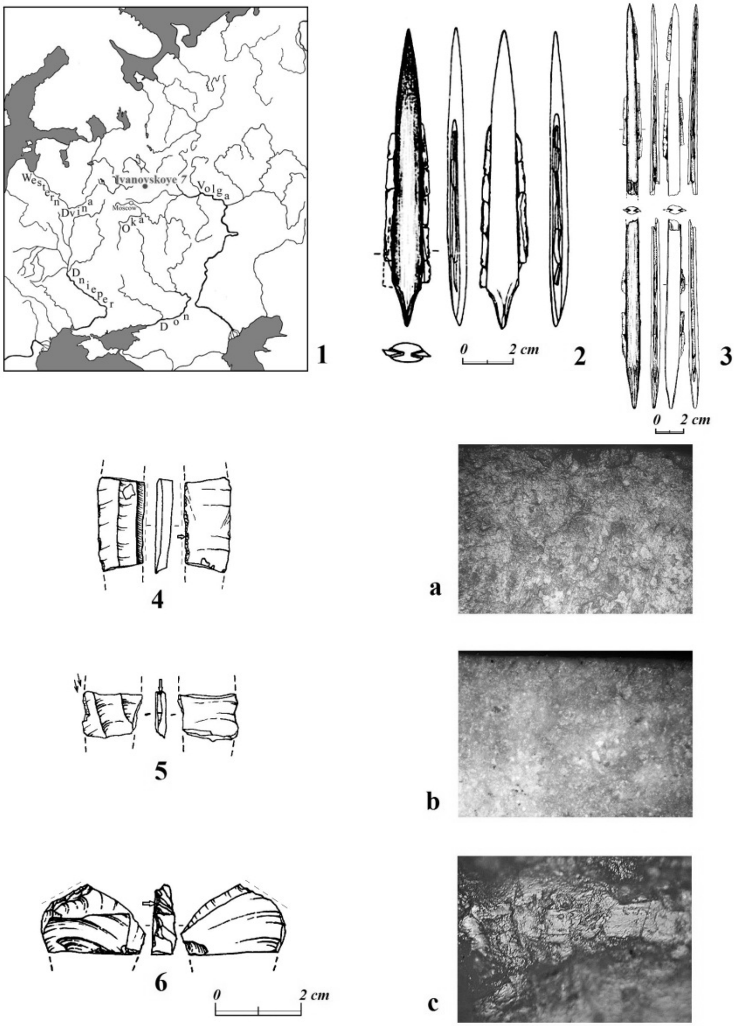

Fig. 1: 1. The map of the site Ivanovskoye 7 location; 2. The composite bone arrowhead from the site Ivanovskoye 7; 3. Fragments of two composite bone arrowheads from the site Stanovoye 4, layer III; 4. The whittling knife for bone and antler from the site Ivanovskoye 7; a – use traces on the whittling knife for bone and antler (a microphoto ×200); 5. The burin for bone and antler from the site Ivanovskoye 7; b – use traces on the burin for bone and antler (a microphoto ×100); 6. The scraper for bone and antler from the site Ivanovskoye 7; c – use traces on the scraper for bone and antler (a microphoto ×200).

An intact composite bone arrowhead with flint inserts is among the most interesting finds from the series. The arrowhead is narrow and flat, originally it was longer. Sides are very gently narrowing to the point. A short tang is defined at the base of the artefact. Long slots with preserved inserts, fixed with glue run across both sides of the arrowhead. The arrowhead is 7 grams in weight, 10 cm long, 1.4 cm wide, the tang is 0.9-0.4 cm wide, and the width of the point in front of the inserts is 0.9 cm.

This arrowhead belongs to the type of narrow flat slotted arrowheads which were widespread during the Mesolithic in Northern and Eastern Europe (Zhilin 2001). The earliest arrowheads with two slots were found in the bottom layer of the Stanovoye 4 site on the Upper Volga, dated to the transition from the Younger Dryas to Preboreal period (Fig. 1: 3) (Zhilin 2006). During the Preboreal and Boreal periods they were widespread in Mesolithic cultures from the Baltic to the areas of the Eastern Urals. In the second half of the Boreal period such arrowheads emerge in Northern Europe, where they were in use during the early Atlantic period, but in Central Russia they disappear at that time.

The careful visual and microscopic study of the surface of this arrowhead has made it possible to reconstruct the technology of its manufacture based on the traces on its surface. It is possible that the artefact was made at the site, because various bone working lithic tools were discovered in its inventory (Skakun et al. 2011). Such tools make up 24% of all tools with use-wear traces.Singled out among them were saws, whittling knives, scrapers, burins and polishing slabs.

Due to the preserved traces of the treatment on the arrowhead and experimental-traceological research of flint tools it was possible to reproduce the process of manufacture of similar arrowheads experimentally (Zhilin 1998; Savchenko 2010).

3. Results

The arrowhead was made from a splinter removed from a long bone of a large mammal, most probably elk. Usually such splinters have one concave and one convex face, according to the cross-section of the bone. Even after careful treatment, indications of such blank are observed in some asymmetry of the profile and the cross-section of our arrowhead (Fig. 2: 1). Before processing mammalian bones were softened in various ways (Semenov 1957a, 192-194; Zhilin 1998; Zhilin 2001). In our case wetting is most probable, as indicated by a cache of three elk metapodia placed in a pit below the ancient water level in the lower Mesolithic layer of Ivanovkoye 7 site (Zhilin et al. 2002), from which comes the studied arrowhead. During our experiments this simplest technology proved rather useful. After removal the splinter was shaped into a preform with the help of longitudinal whittling. The latter produced long flat scars visible on the surface of our arrowhead inflicted by a whittling knife which moved forward at a sharp angle to the worked surface (Fig. 2: 3, A; 4, B). Whittling knives were singled out from fragments of blades and flakes with a suitable sharp edge. Single flat use-wear facets and microwear in the shape of polishing and linear traces, running from the edge perpendicularly or slightly obliquely to it are observed on the working side of such whittling knives (Fig. 1: 4, a). Whittling was used for planing surfaces of preforms, removing waste material and executing details, such as shaping the tang of our arrowhead (Fig. 2: 5). This operation was first described by S. A. Semenov (Semenov 1957a, 192).

Two long slots for inserts run along both sides of our arrowhead (5.5 cm long, 0.3 cm wide, and 0.3 cm deep) (Fig. 2: 1). Traces of grooving with a very sharp burin are observed at the walls of these slots where they are not obscured by inserts. Slots have a trapezoidal cross-section (Fig. 2: 5, C). Our experiments showed that such slots could be made with the angle of a broken blade or flake. S. A. Semenov wrote that the invention of burins in the Upper Palaeolithic had great significance for improving the technology of bone working and compared their role with the role of steel burins in modern industry (Semenov 1957a, 188).

A use-wear characteristic for bone working burins was observed in the inventory of Ivanovskoye 7 both on typologically defined burins and also on fragments of blades and flakes that have a tiny burin scar or just a sharp angle suitable for work. Typical burin use-wear traces include scarce short scratches, running perpendicularly or obliquely to the working edge and partial polishing at areas near the working edge (Fig. 1: 5, b).

After the grooving of slots, the surface of the arrowhead was smoothed by fine whittling and scraping with a very gentle effort. Longitudinal traces left by the edge of a knife or scraper are observed at some areas on both faces of the arrowhead (Fig. 2: 3, A). Their clear appearance is a result of the chipping of the edge of a tool during use. Blades and flakes with massive working edges often with steep multiple facets of abrupt utilization retouch and singled out in the inventory of the Ivanovskye 7, served as scrapers for bone work. It is worth noting that such macrowear is typical for scrapers used for the crude primary scraping of preforms with a large amount of force applied to the tool. The working edges of scrapers that were put vertically to the worked surface display short linear traces running across the working edge and areas of polish near it (Fig. 1: 6, c).

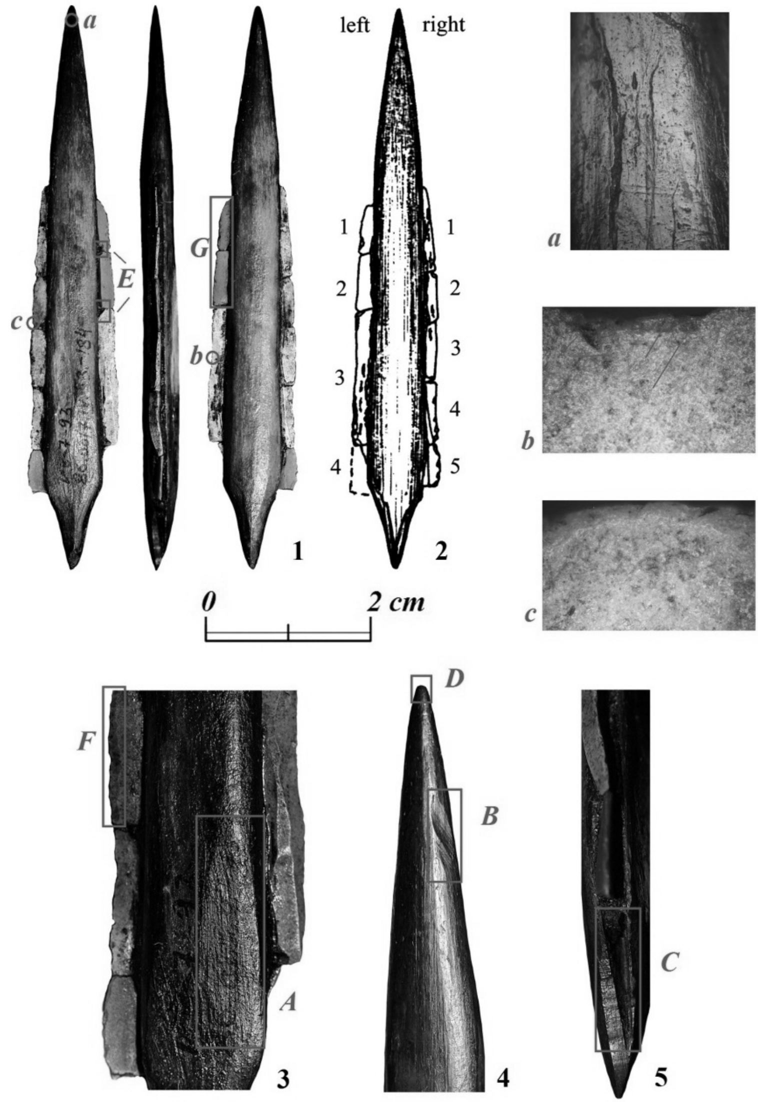

Fig. 2: 1. The composite bone arrowhead from the site Ivanovskoye 7: a - two types of linear traces at the point of the arrowhead (a microphoto ×50); b – linear traces on an insert (a microphoto ×200); c – rounded edge of an insert (a microphoto ×200); E – residues of grayish-brown glue; G – two inserts of the arrowhead from the same microblade; 2. The drawing of the arrowhead with

numbers of inserts; 3. Details of the composite bone arrowhead from the site Ivanovskoye 7: A – facet from treatment by whittling knife and long liner traces from treatment by scraper; F – retouched microblade; 4. Polished part of the composite bone arrowhead from the site Ivanovskoye 7: B – Deep facet from primary treatment by whittling knife; D – signs of deformation of the arrowhead point; 5. The tang of the composite bone arrowhead from the site Ivanovskoye 7: C – traces of treatment by whittling knife and trapezoidal cross section of slot.

Grinding and polishing were the next stage of arrowhead treatment. These destroyed traces of previous operations on some areas of its surface, but on other areas these traces are still visible. A number of coarse and fine-grained abrasive slabs were singled out among lithic artefacts from the Ivanovskoye 7. According to ethnographic data and our experiments fine polishing could be done with the help of lime bark, leather or hide. It is worth noting that the polishing of sides of the arrowhead was removed by the whittling of the tang (Fig. 2: 1). This confirms the reshaping of this arrowhead into a shorter one most probably after breakage. Fragments from two different arrowheads from Stanovoye 4 Mesolithic site show what could have happened when a long flat narrow arrowhead broke in two parts (Fig. 1: 3). The point of our arrowhead remained unmodified which indicates that the upper part of a long broken arrowhead was supplied with a new tang, and a short arrowhead was made from such a fragment. It is worth noting that the remaining inserts were not changed, which is clearly indicated by the position of fragments of a last broken insert in the slot on the left side of the arrowhead near its base (Fig. 2: 1, 2, 3).

Thus the study of the surface of this arrowhead has made it possible to establish the following chain of operations connected with the manufacture of its bone base: obtaining a blank with a help of a “groove and splinter” technique, shaping the preform by whittling, the grooving of slots, the secondary treatment of the artefact by fine whittling and scraping, and the final treatment of its surface by fine grinding and polishing. It was also established that the bevel of this arrowhead was reworked, most probably after breakage.

Inserts made from fragmented microblades are preserved in situ in both slots. They were made of two sorts of local moraine flint–reddish-brown and grey. These microblades have a regular geometric shape, usually a straight profile, and a triangular or trapezoidal cross-section, and even sides. The striking platform is small where preserved. Most inserts are unretouched microblades, but some are trimmed with retouch (Fig. 2: 3, F). The bottom layer of the site produced both microblade cores and waste that indicates the local production of microblades.

In both slots inserts were fixed with grayish-brown glue. Microscopic analysis indicates that most probably the glue is a mixture of coniferous pitch, beeswax and charcoal dust. Our experiments proved that such glue was very good for fixing projectile inserts. Fragments of microblades less than 7 cm wide were arranged in such a way, that on the left side all of them are placed in the slot with their dorsal face up, and on the right side– with their dorsal face down. They are protruding about 3-4 mm from the slot (Fig. 2: 1, 2).

Two upper inserts on the left side of the arrowhead, nearest to its point are parts of the same microblade (Fig. 2: 1, G; 2). The protruding angle of the first is rounded by a very fine steep retouch. A tiny drop of glue, which set and was preserved on one facet of retouch, proved that the trimming of this insert was done before inserts were mounted into the slot (Fig. 2: 1, E).

The second insert lacks a secondary treatment, but flat microchips follow each other like a chain along the whole length of its side. Angles of the third insert are trimmed with slanting ventral retouch, micro chipping is observed at its middle part. The fourth insert is represented by a fragment, which was not removed and changed after the breakage of the arrowhead.

On the right side two first inserts, made from one microblade and the fourth insert are trimmed by a very fine ventral retouch. The angle of the last insert in this row near the tang is trimmed with fine steep retouch. Other inserts are unretouched, but display edge damage in the form of single chips.

The detailed study of the edges of inserts and experimental data indicates that the grooves were first filled with glue then the artefact was heated over hot charcoal or a very small fire until the glue became soft. Then inserts were put into each slot resulting in extra glue pressing from it. The latter covered the sides of the inserts and was removed by longitudinal movement, which produced long striations on the remains of the glue, covering the side surfaces of inserts (Fig. 2: 1). When the glue became hard the arrowhead was ready. Special attention was paid to the firm placement of inserts for obtaining a straight even cutting edge. The row of inserts for each side of an arrowhead was composed in advance. If needed, intact microblades were broken into parts, documented by glue covering the breakage between the fragments of one microblade.

Dull polishing running from the tip and gradually disappearing is observed at the point of the arrowhead. Furthermore inside this polishing two types of linear traces are observed (Fig. 2: 1, a). The first is represented by thin short striations running from the tip in a screw-like pattern at an acute angle to the axis of the artefact. Such traces originate when the arrow is rolling over its axis when hitting the target. Other linear traces–straight thin striations and scarce grooves running from the tip along the axis of the arrowhead emerge when the arrow is not rolling. Our experiments showed that this is controlled by the fletching of the arrow. The coexistence of both types of linear traces most probably indicates the change of fletching and, possibly, the shaft during the use of this arrowhead. Most probably it is connected with its breakage and reshaping of the tang. Traces on the point of the arrowhead indicate multiple penetration into soft medium dirty material and also scarce hits into the ground at a small depth. The latter is indicated by scarce grooves at the tip and nearby and the absence of such grooves at the distance of about 2 cm from the tip and further. Rounding, chipping and small pits are observed at the very tip of the arrowhead point (Fig. 2: 4, D). Besides these, various deformations caused by its long use by natural damage in the cultural layer are observed on its surface.

The microscopic study of inserts shows that their edges are rounded and smoothed and that they bear traces of abrasion (Fig. 2: 1, c). Such features are probably connected with keeping this arrow in the quiver together with other arrows when arrowheads were in contact with each other. Besides this, inserts display utilization chipping on their edges. Stripes of oriented polishing running from the point of the arrowhead at an acute angle to the edge of an insert were observed at some inserts, especially at the second insert from the left and the third insert from the right side. Scarce thin scratches running in the same direction (Fig. 2: 1, b) were also discovered there. Such traces probably emerged from multiple sliding contacts with the bones, sinew, cartilage and dirty skin of animals when the arrowhead hit the target.

Experiments aimed at the research of the process of manufacture of composite slotted arrowheads showed that similar bone arrowheads could be produced by an inexperienced person during one day (Savchenko 2010), while it takes from 4 to 6 hours of work by an experienced person and about 5-10 flint tools were needed including burins, a wedge, scrapers, whittling knife, abrasive slab and organic polishing material.

4. Conclusion

Detailed research of a composite slotted arrowhead from the bottom layer of the site Ivanovskoye 7 made possible a reconstruction of the technology of its manufacture with the help of various tools employed in this process. Experiments showed the high efficiency of such tools and technologies. Use-wear study of the bone point and flint inserts revealed traces of its use, and made it possible to detect the real history of one very important artefact from an early Mesolithic site in Central Russia.

Acknowledgements

The research was supported by the Russian Humanitarian foundation, grant № 14-21-17003a_Fra.

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PART III:

PROJECTILE TECHNOLOGY

CHAPTER THIRTY SEVEN

THE FUNCTIONALITY OF PALMELA POINTS AS THROWING WEAPONS AND PROJECTILES: USE-WEAR MARKS

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Abstract

This paper will give an account of an experimental program involving 33 copper and bronze Palmela points, used as arrow, spear and javelin heads. Experiments were carried out using a dead sheep, and also included distance and ballistic testing. In a large number of cases the marks resulting from the use of Palmela points as throwing weapons (javelin, spears) and projectiles (arrows) can be identified by use-wear analysis. Diagnostic use marks show a wide distribution on the points, being particularly relevant and abundant on the distal apex, which is the main impact zone. The study of such marks, which include a wide range of deformations, not always perceptible to the naked eye, requires the use of a stereomicroscope.

Keywords: Traceology, Archaeometallurgy, Palmela points, Experimental Archaeology, Bell Beakers.

1. Introduction

Palmela points are well-known archaeological artefacts, as Chalcolithic grave goods from the Iberian Peninsula and southern France. Originated during the Bell-Beaker Period, they will stay in use until the Early Bronze Age. Palmela points are especially present in the northern Meseta. Many are found out of context; in archaeological sites they are more commonly found in burial contexts rather than dwelling ones.

Made from copper or arsenical copper, their morphology is easily recognizable. Nonetheless, they feature a formal diversity typified by Delibes in three basic types and 6 different subtypes, several of which may occur in the same site (Delibes 1977, 110-111) (Fig. 1-1).

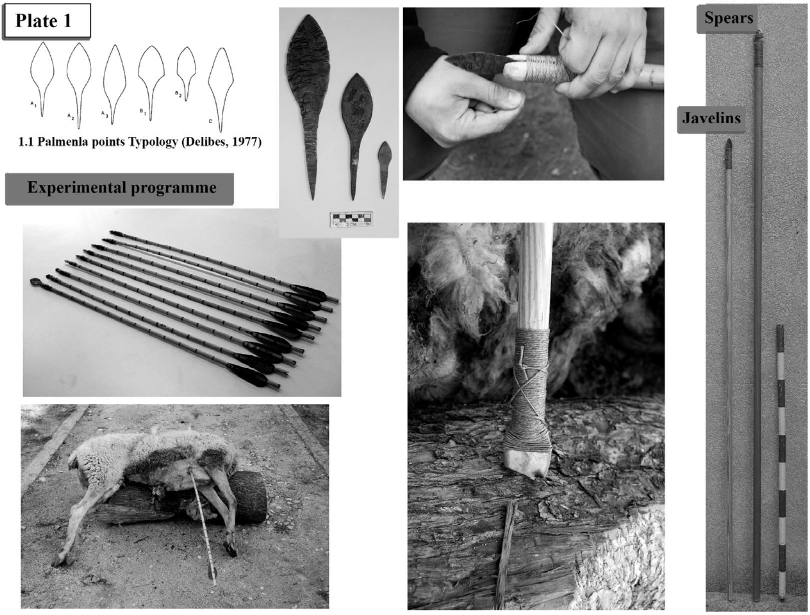

Fig. 1. Experimental programme

Some authors, like Simón, propose an evolution of the Palmela point, from Beaker shapes with a broader, oval-shaped body and a semicircular union to a quadrangular tang to more stylized Early Bronze forms with an oval-shaped union between body and tang (Simón 1998, 265). There are also contemporary specimens featuring a midrib, as an innovation that adds toughness and avoids bending upon impact. This technical feature will be widely applied to different types of metallic points during the Late Bronze Age (Kaiser 2003, 79 & 88).

Furthermore, there is a conspicuous variation in weight and size, already highlighted by Garrido Pena (2000, 174-175) in his study of Palmela points from the Meseta. And even greater differences were found among the points included in the Proyecto de Arqueometalurgia de la Península Ibérica (Rovira et al. 1997), with lengths ranging from 3.8 to 18 cm, widths from 1.1 to 3.7 cm, and weights from 4 to 38 gr.

Such a disparity in point weights and sizes is an added difficulty for the identification of their function. The excessive weight of many specimens led to the identification of these artefacts as spear or javelin points (Briard y Mohen 1983, 117-118; Delibes 1977, 109; Garrido Pena 2000, 211; Kaiser 2003, 79 & 87). Fewer researchers argue in favour of their use as arrowheads (Blas Cortina y Rovira Llorens 2006, 290-292; Gutiérrez Sáez et al. 2010). On other occasions, their actual use as projectile points was questioned due to the poor mechanical properties of copper, assuming therefore a symbolic rather than functional value (Delibes y Santiago 1997, 103, 107; Fernández Manzano y Montero 1997, 111-113).

Our first objective was the evaluation of their suitability as arrows, spears and javelins (Gutiérrez Sáez et al. 2010). In this paper we want to introduce the hypothesis which considers that use can be identified through the analysis of use-wear marks, following a common methodology in traceological studies.

2. The experiments

In order to test the effectiveness of Palmela points as arrow, javelin and spear heads, we carried out an experimental program using a set of points arranged in three size/weight classes: 13 small points, which are 40-50 mm long, 12-15 mm wide and 0.8-1.8 mm thick with weights between 3.5 and 6 gr. 15 mid-sized points, 90-115 mm long, 20-28 mm wide and 1.8-2.8 mm thick with weights between 18 and 22 gr. and 9 large points, 130-150 mm long, 30-40 mm wide and 1.5-2.5 mm thick with weights between 30 and 41 gr. (Figs. 1-2, 3,7)

The copper points were made by cold-hammering, from a sheet of pure copper (28 points). Bronze points were produced in a furnace, using copper casting grain and 2% of tin powder, and a sand mould; points were then worked by cold-hammering and filing (9 points). Tin was used instead of arsenic because the mechanical properties of both are similar in low alloys (Northover 1998). Cold-hammering caused fissures in some specimens; the problem was solved by annealing 8 copper and 1 bronze points at 600ºC for one hour.

The points were fitted into different types of weapons:

Bow and arrows. For experimentation purposes, a D-section bow was made of ash wood (Fraxinus excelsior L), with a length of 178 cm and a braided linen string. With a draw weight of 35 pounds, the bow was slightly less powerful than other prehistoric bows such as those from Meare Heath and Ashcott Heath (Clark 1963). 81.5 cm long and 1 cm thick arrows were used, made from spruce, with goose feather fletching. Points were attached to the shaft's upper end by fitting tangs to a slot and tying them with sheep gut (small points) or linen rope (mid-sized points). Total arrow weight was 56 g for small points and 71 g for mid-sized ones. 11 arrows were used to shoot at a dead animal target–a sheep, 5 in distance tests and 4 in ballistic tests.

Javelin. Pine wood shafts measuring 163 x 2 cm were used, with slots on the upper end to fit the Palmela points, which were then attached with linen rope (Figs. 1-5). The average weight of mid-sized point javelins was 346 g. 7 javelins were thrown at the sheep, 4 other were used in distance tests.

Six pine wood 200 x 2.8 cm spears were also made; points were fitted in the same way as in former weapons. Average weight using a large point was 658 g. All were used against the dead animal.

3. Experiment results

Shooting at a dead animal target. Results from shots/throws with arrow, javelin and spearheads are shown on Table 1.

Shooting at the sheep produced different results, for different reasons. For all three weapon types, cold-hammered Palmela points proved to be much more effective than annealed points. Annealing eliminates tensions and fissures but, on the other hand, softens the metal. Nearly all of the latter were bent after the first or second impact, and were thus useless. Another issue that contributed to bending was the way they were attached to the shaft. The first points used were fitted into the shaft up to the union between body and tang, and they were more likely to bend. Points were then removed from shafts and refitted, only this time sliding the entire lower third of the point into the shaft. Points that were bent or came off the shaft were not reused.

Nº	Raw material	Size/ Weight (gr)	Weapon	Shot results	Total shots
1	Co, CH+R	Small (4)	Arrow	1Stuck (sheep)	1
2	Co, CH+R	Small (4)	Arrow	1 Stuck (sheep), 1 rebound	2
3	Co, CH+R	Small (4)	Arrow	1 Stuck (sheep)	1
4	Co, CH+R	Small (3,8)	Arrow	1 missed	1
5	Co, CH	Small (4)	Arrow	1 missed (**lost**)	1
6	Co, CH	Small (4,2)	Arrow	3 Stuck (sheep) (**lost**)	3
7	Co, CH	Small (4)	Arrow	6 Stuck (sheep), 2 rebounds, 2 missed	10*
8	Co, CH	Small (4,6)	Arrow	3 rebounds	3
9	Co, CH+R	Mid-sized (19)	Arrow	2 missed, 1 rebound	3
10	Co, CH	Mid-sized (20,69)	Arrow	3 Stuck (2 sheep, 1 wood), 1 missed	4*
11	Co, CH	Mid-sized (21,9)	Arrow	5 Stuck (sheep), 12 rebounds, 13 missed	30
12	Co, CH+R	Mid-sized (18,7)	Javelin	2 rebounds, 6 missed	8
13	Co, CH	Mid-sized (18,5)	Javelin	2 Stuck (sheep), 3 rebounds, 1missed	6
14	Co, CH	Mid-sized (20,1)	Javelin	7 rebounds, 3 missed	10
15	Co, CH	Mid-sized (19,6)	Javelin	2 Stuck (sheep), 9 rebounds, 3 missed	14
16	Co, CH	Mid-sized (18,7)	Javelin	1Stuck (sheep and wood), 4 rebounds, 1missed	6
17	Co, CH	Large (35,1)	Javelin	1Stuck (wood), 6 rebounds, 1missed	8
18	B 2%,C+CH	Mid-sized (21,8)	Javelin	2 Stuck (wood), 1 rebound, 3 missed	6
19	Co, CH	Mid-sized (21,7)	Spear	5 Stuck (sheep), 2 rebounds, 3 missed,	10*
20	Co, CH+R	Large (30,5)	Spear	1 Stuck (sheep)	1
21	Co, CH+R	Large (32,7)	Spear	1 Stuck (sheep)	1
22	Co, CH	Large (33,8)	Spear	1 Stuck (sheep), 1 rebound	2
23	Co, CH	Large (32,2)	Spear	1 Stuck (sheep), 1 rebound	2
24	Co, CH	Large (32,5)	Spear	23 Stuck (sheep), 2 rebounds	25*

Tab. 1. (previous page) Experiments on animal target. Co: Copper, B: Bronze, C: Cast, CH: Cold-hammering, R: Reheating. * Leather piece covering the target

For some shots with arrows and spears, the sheep was covered with a piece of 2mm thick leather. Both types of weapon went neatly through the leather on a high number of shots.

The shooting distance ranged from 3 to 5 m for arrows and javelins; point no. 9 was shot at 20 m. A number of shots with both weapons missed the target, particularly javelin shots, due to the participants' lack of experience. Furthermore, 4 javelins and one arrowhead–nos. 10, 17 and 18–got stuck on the wood trunk supporting the sheep, nearly up to the middle of the body (Plate 38-1-6). All of them could be extracted without damage for further use. Many points penetrated the animal's body, up to 8 cm in the case of mid-sized arrowhead no. 11 (Fig. 1-4). The small no. 7 arrowhead neatly penetrated to 25 cm and to 6 cm after going through the leather piece. Two arrowheads stayed inside the sheep, which was buried after the experiment. Points were left inside so that alteration studies can be carried out later on. Thus, they were not included in the use-wear analysis.

Spears were used as thrusting spears. Body penetration caused serious injuries in bones and tissues, particularly on ribs.

In broad terms, Palmela points proved to be effective with all three types of weapon, even if most of them were bent after use. Some, such as nos. 11, 15 and 24, were used several times. We should also bear in mind that the number of impacts was high, as all impacts were included, not only those which were stuck in the animal's body or in the wood, but also those that rebounded on the target or its supporting trunk.

Distance tests (Table 2). Distance results are poor due to a number of reasons. Javelins are difficult to handle effectively without adequate training. Regarding arrows and for the sake of safety, most shots were straight, not parabolic. The first parabolic shot flew over the 125 m of a rugby field and got stuck on the asphalt of an adjacent mound; the point could not be recovered. The second point used in this manner was a large Palmela point that had previously been used on a javelin, and then attached to an arrow and reused. Its weight kept it from crossing the rugby field. Therefore, the distance an arrow can reach could not be verified, as it would require a larger area.

No	Raw material	Size / Weight (gr)	Weapon	Total shots	Average distance
25	Co CH	Small (5,02)	Arrow	1	> 125 m (**lost**)
26	B 2% C+CH	Small (5,43)	Arrow	5	77.02 m
27	Co CH	Mid-sized (21,16)	Arrow	5	48.18
28	B 2% C+CH	Mid-sized (23,42)	Arrow	5	44.5 m
29	B 2% C+CH	Mid-sized (23,91)	Javelin	5	19.17 m
30	Co CH	Large (33,34)	Javelin	5	19.27 m
31	B 2% C+CH	Large (39,49)	Javelin	5	15.5 m
32a	B 2% C+CH	Large (40,26)	Javelin	5	18.5 m
32b	B 2% C+CH	Large (40,26)	Arrow	5	79.59 (reused)

Tab. 2. Distance testing. C: Copper, B: Bronze, C: Cast, CH: Cold-hammering

Ballistic tests. Four arrow heads, 2 large and 2 mid-sized, were tested using a Drello&BAL4042 V-computer velocity measuring system, with two photoelectric cells separated by a distance of 1128mm. Results are expressed in metres per second. We used our ash bow, with the archer standing 3 m away from the first photoelectric cell. Five shots were fired with each point. Results shown in Table 3 are an average of those shots.

Small points reached higher velocities than bigger ones. Amongst the former, the copper point proved to be particularly light, while the bronze one was somewhat heavier. Both results from mid-sized points are very similar, which suggests that velocity depends on the total weight of the arrow, rather than on the weight of the point itself. These data can be compared to data gathered from Egyptian New Kingdom (1550-1070 BC) bow replicas. In this case, large copper points reached 32 m/s using bows more powerful than ours (Quesada Sanz 2008).

No	Raw material	Dimensions (mm)	Weight (gr)	Arrow weight	Result (m/s)
33	Co CH	Small: 45x13x1.2	3.77	46.62	41.20
34	B 2% C+CH	Small: 46x14x2	5.33	58.38	34.52
35	Co CH	Mid-sized: 98x28x2.2	18.94	70.43	28.87
36	B 2% C+CH	Mid-sized: 05x27x2.9	23.41	73.96	28.34

Tab. 3. Ballistic testing. C: Copper, B: Bronze, C: Cast, CH: Cold-hammering

3.1. Use-wear marks

A Leica Wild M3C stereomicroscope with two wide-angle 10x/21B oculars, magnification intervals at 6.4, 10, 16, 25 and 40, and 0.32x, 0.63x and 1.2x objectives was used for use-wear analysis, with a magnification range between 2x and 48x. Marks were photographed with a Canon Powershot S45 digital camera.

3.2. Diagnostic marks

Thirty three out of 36 experimental Palmela points were studied–16 arrow heads, 11 javelin heads and 6 spear heads, as points no. 5, 6 and 25 were lost.

Distal and proximal parts. The use of Palmela points as projectiles and parts of throwing weapons generates a whole range of use marks all over the point, but not with the same frequency. Marks located on the distal apex are particularly interesting, since they provide the most direct evidence of impact on the target or any other material. Similar marks can be found on the proximal apex, which is affected by the shaft’s backslash.

Flattening of the tip. This is the most frequent mark–the pointed apex looks like a flat surface (Fig. 2-8). Flattening can be central or lateral (much like a burin). The metal displaced by the backwards motion is left close to the flattening, either as a ridge (Fig. 2-5, 6), or as a thickening of the distal ends on both sides. Thickening creates a sort of roundish bulge (Fig. 2-7). In some cases, flattening shows a rough surface (Plate 2-9) resulting from the breakage of the metallic surface due to increased acrimony as the metal deforms and overflows. This was observed on 22 distal–66.6%–and 15 proximal–45.4%–apices and it is not uncommon to find a double flattening on the same apex. To a lesser extent, flattering can also be found on the points' lateral edges.

Microfolds. The pointed apex bends over one of the sides and may even stick to it (Plate 38-2-2, 3, 4, Plate 38-3-7). This was observed on 4 distal–12.1%–and 5 proximal–15.1%–apices.

Torsion. The point's distal end may show torsion, as a slight twist of helicoidal tendency (Fig. 2-1). This type of mark can also be found on the tang's lower end. 6 points featured torsion, 3 on the distal–9.1%–and 3 other–9.1%–on the proximal parts.

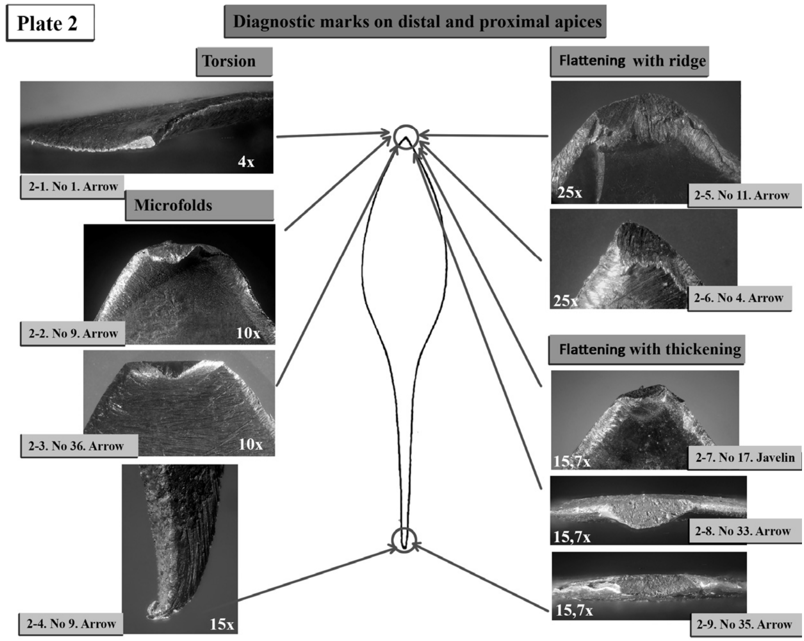

Fig. 2. Diagnostic marks on distal and proximal apices

Occasionally, two of these marks may appear on the same apex, on points that were used several times or on reheated points, which are easier to deform. The variety of marks can be caused by different motives, such as the point's penetration angle or the toughness of the material it hits.

Body and tang. Different marks were observed on these parts.

Folding. The most common mark is folding over one side. Folding is found either on the area where the point is no longer protected by the shaft, on the body-tang union or on the lower third of the body (Fig. 3-6).

Reheated points bent upon the first or second hit, with two exceptions. Points worked only by cold-hammering lasted much longer but mostly ended up bending as well. Folding can show an open (Fig. 3-4) or closed angle (Plate 3-5). From 24 points shot at the dead animal, 19 bent–57.5%, 12 on the body–36.3%, 6 on the body-tang union–18.1%–and 3 on the tang–9.1%. Points used for distance testing were not affected by folding. Amongst those used for ballistic testing only one tang bent.

Band of fissures. A group of parallel fissures form a band. These are very shallow and hard to identify, even under the magnifier (Fig. 3-3). Bands of fissures appeared on the body-tang union of 2 bent points, after they were straightened again. Though not yet well documented, this particular mark can be a very useful sign of reuse on archaeological points.

Lateral folding. This is the bending of the tang over one side of the point (Fig. 3-2) which was observed on 2 arrows and 1 javelin.

S-shaped silhouette. Repeated folding causes an S-shaped silhouette (Fig. 3-1). During our experiments, this mark only appeared on a tang–no. 12–that showed torsion as well. In archaeological assemblages this mark can affect the whole point (Gutiérrez Sáez et al. in preparation).

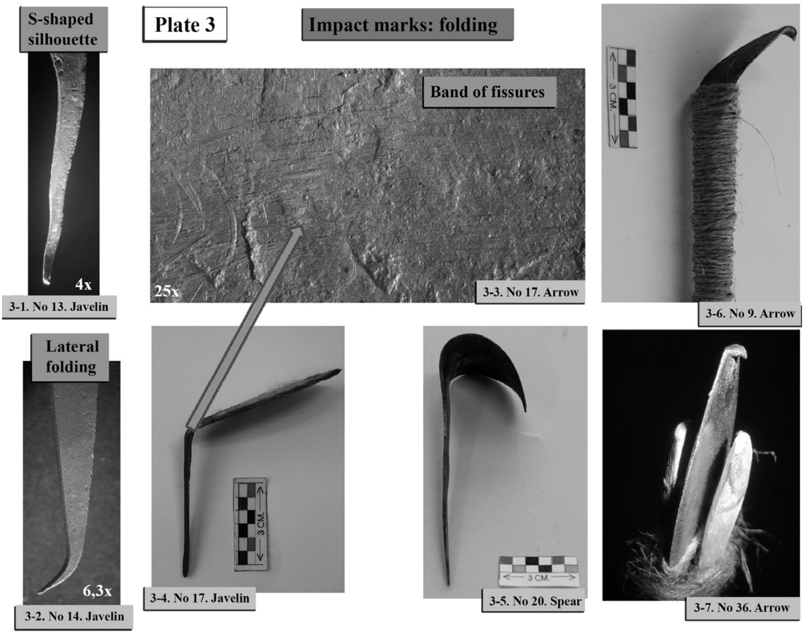

Fig. 3. Impact marks: folding

3.3. Other marks

In addition to what we may consider as diagnostic impact marks, experimental Palmela points show other types of traces resulting from fabrication processes, such as fissures, breakage and anvil or hammer imprints, which we shall not address here. The following marks are use-related:

Ridges and notches. These are the more frequent marks on metallic points. They can be caused by technological processes or–more frequently–by use (Soriano y Gutiérrez 2007). Notches are usually similar in both cases, but ridges are usually different. Ridges formed during hammering and filing are coarse, irregular and raised over the edge (Fig. 4-6), while use-caused ridges are smooth (Fig. 4-7); furthermore, coarse ridges are commonly smoothed after use. Our Palmela points show a high number of ridges–256–and fewer notches–41, all over the point but less frequent on the apical ends–37 and 8, respectively. Both marks and particularly ridges can be more pronounced on the lateral edges, at the point of contact with the handle. Their presence at the same height on both lateral edges is an indication of the hafting's limits. On the experimental Palmela points, only used as projectile parts, their average frequency is 5.8 ridges and 1.06 notches per point.

Striations. These marks are also problematic since they are massively produced during filing. We were able to identify a few examples–on 2 points–caused by impact, thanks to the graphic documentation of finished points before use (Fig. 4-1). Nonetheless, on archaeological specimens it is difficult to find striations that are not caused by restoration processes. This is due to the expansion of tenorite and other corrosion products . The Palmela point illustrated on Plate 38-4-2 shows a coarse concave upper zone that was not reached during filing; the filed metallic surface can be seen in the middle part, showing a golden shine; and the lower part shows how a dark tenorite layer is covering and hiding the striations.

Different patinas. Besides tenorite, common to all points, we have also observed some use-activated corrosion processes. For instance, javelin represented in the Fig. 4-4 penetrated the sheep's digestive system, where acids caused a rapid expansion of chlorides. To a lesser extent, chlorides also appeared in parts where there was contact between the metal and the dry gut used to reinforce the hafting system (Fig. 4-5).

Residues. Three small fragments of wood embedded on the surface of 2 points were also detected. They may be residues from the shaft, since none of these points hit the target's wooden support.

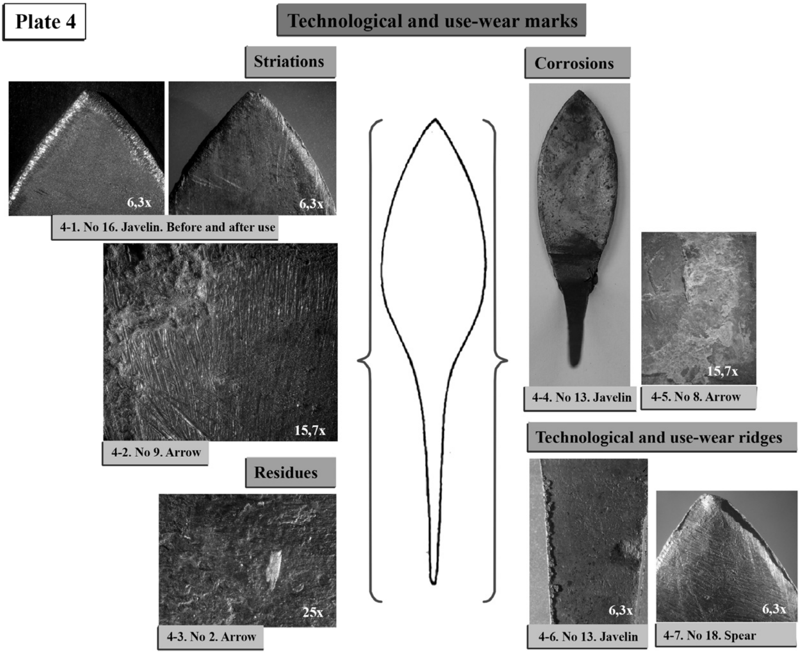

Fig. 4. Technological and use-wear marks

Some marks such as notches and large ridges or folding can be identified by the naked eye but ridged flattering and thickening, microfolds, striations and residues are microscopic, and need to be observed under the stereomicroscope at more than 10 or 15x.

3.4. The distribution of significant marks

As far as the sharp ends are concerned, the diagnostic marks taken into consideration were flattening, microfolding and torsion. The highest number of diagnostic marks was observed on distal apices–28 out of 33 points, 84.5%–since this is the part that penetrates first and deeper into the target material. 4 Palmela points only showed marks in this part. Yet, no such marks were found on points 16, 17 and 22, which hit the sheep and the wood, or on javelins 29 and 32, used for distance testing. The absence of marks on throwing weapons and projectiles does not always mean the absence of impact, a well-known fact about lithic points, and now also for metallic points.

Right after the tip, the distal apex is the other part that shows more abundant marks–23 out of 33, 69.6%. However, this is indirect evidence, resulting from handle backlash. They indicate the strength involved in a use that might be interpreted as the impact of a throwing weapon or projectile, but not exclusively so. Extended experimentation might allow sharper conclusions on this issue.

The body (not considering the apex) shows decisive marks such as folding and torsion in a little more than half of the cases–18 out of 33, 54.5%. Besides, during experimentation marks were more abundant in shots against the animal target; none was observed after ballistic and distance testing.

Concerning the lower half of the Palmela points, marks such as folding, lateral folding and torsion were considered impact-specific marks. Few specimens show these marks on the body-tang union–7 out of 33, 21.2%. All were shot against the animal target. A similar amount–6 out of 33, 18.1%–show the same marks on the tang; 5 were shot against the sheep, 1 was used for ballistic testing.

All specimens used in our experiments showed diagnostic marks of some kind. Points with the lesser amount of marks (6 specimens, 18.1%) feature a single part with significant marks. In 4 of these, marks are located on the distal apex, thus their interpretation poses no problem. On the contrary, the other two – 6.1% –show marks on the proximal apex. This would indicate a strong hit against the handle but, as stated before and lacking further experiments, it might not be exclusively caused by its use as a projectile or throwing weapon.

4. Conclusions

The first conclusion we can draw from this work is that the use of metallic arrow, spear or javelin heads can be identified through the use-wear analysis of a high number of specimens, as long as points remain intact after use and have not been repaired. The clearest evidence for use is located on the points' distal apex. Nevertheless, the whole point shows traces of impact, in varying degrees.

Secondly, the main alterations were caused by impacts that happened during experiments with the animal target, being much scarcer in all other experiments. In distance testing, at least, the point's shock might have caused a weaker impact than a hit against the animal target, which would explain the lesser degree of damage to these specimens.

We have not noted any relevant differences in the use of Palmela points as arrow, spear or javelin heads, apart from a slightly lesser amount of marks on the points' lower half. Identifying the type of weapon used by means of use-wear marks is not yet possible, therefore further experimentation is required.

Acknowledgements

Many people collaborated in this work from the beginning. Álvaro Simón, Pedro Muñoz, Elena Sanz, Olga de Miguel, Sergio Martín, Belén Márquez, Ana Isabel Pardo, Jorge Chamón and Juan A. Marín de Espinosa took part in the experimentation and materials treatment processes. Fernando Quesada advised us on ancient weaponry. Ángel Romo, Miguel Ángel Varona, Daniel Bermejo and José Daniel Gómez, from the *Departamento de Armas de la Dirección General de la Policía del Ministerio de Interior* (Madrid) facilitated ballistic testing. Thank you all so much.

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CHAPTER THIRTY EIGHT

ARROWHEADS WITHOUT TRACES: NOT USED, PERFECT HIT OR EXCESSIVE HAFTING MATERIAL?

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Abstract

Dutch assemblages of Mesolithic arrowheads commonly show relatively few use-wear traces (Peeters et al. 2001; Siebelink et al. in press; Van Gijn et al. 2001 a, b). The reason for this observation has not been clarified so far. Hypotheses focus on differences in hafting and shooting, rather than explaining the absence of traces by a lack of use. In this paper we will demonstrate that, based on experimental results, the differences in wear traces observed in points can be largely attributed to the shape of the points, their edge angles and the presence or absence of retouch. In our opinion, the modest amount of traces is mainly caused by the abundant presence of hafting material–leaving "no room" for traces. However, our experiments have also shown that as is often observed in experimental

implements, not all actions leave traces at all times. It is therefore reasonable to acknowledge that the absence of points with traces is caused by the fact that the points found in the archaeological record could either be fresh and unused or simply be lacking traces.

Keywords: Arrowheads, Neolithic, Mesolithic, hafting, experiments.

1. Introduction

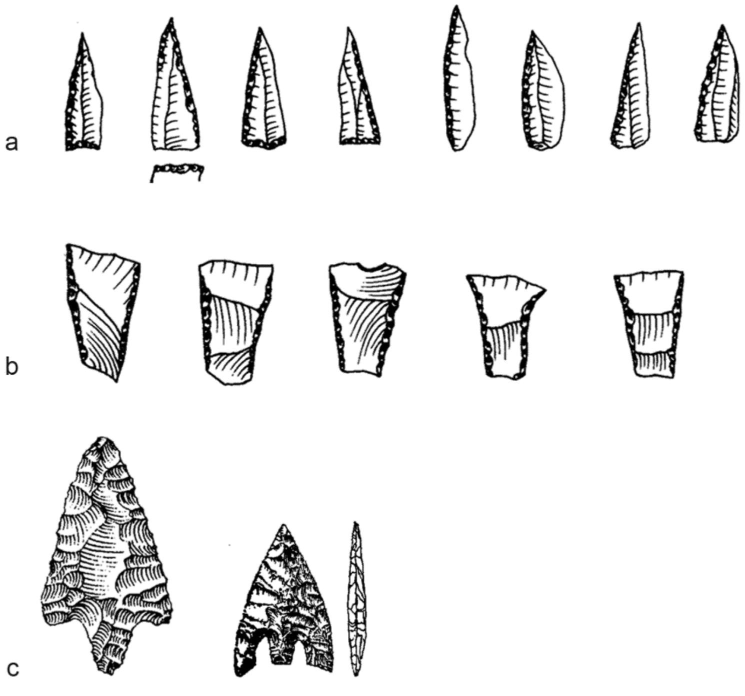

Fig. 1. Types of arrowheads used in the experiments. A: Microliths, B: Transverse points, C: Barbed and triangular shaped points (drawings taken from Beuker 2010).

Projectile points in Dutch Mesolithic assemblages often display a remarkable lack of traces, which has not been explained so far. This paper combines three experimental sessions in which three types of projectile points were used, covering typologies from the Mesolithic to the late Neolithic age (Fig. 1). The experimental points were studied for manufacturing traces and then hafted in arrow shafts, used, photographed and studied again. We studied a total amount of 40 experimental arrows and 2 experimental spears.

Here, we will give an outline of our observations of the traces, and we will demonstrate what, in our opinion, is the most likely cause of the relatively modest appearance of use-wear traces on points.

2. Experiments with projectiles

2.1. Microliths used on a goat

Inspired by Mesolithic assemblages, microliths hafted as points and barbs were used on a goat in 2012. The goat had been slaughtered several hours before the experiment. Five arrows were shot with a long bow, from a distance of 7 metres. In addition two spears were thrown with the use of a spear thrower from the same distance.

Arrows as well as spears were very effective and almost every shot would have been lethal. After the experiment the goat was cut open to be able to register all the layers of skin, fat, meat and bone the projectiles had hit. We were hoping that by doing so we would be able to retrieve all points, even if they had come out of their shafts. Unfortunately, this was not the case and some of the points could not be found again.

2.2. Transverse projectiles used on roe deer

In 1984, 11 arrows with transverse points were fired at a recently killed roe deer, which was put up in an upright position. The arrows were hafted using tar as hafting material. Each arrow was fired only once, 9 were shot into the animal, one went through the animal and hit the soil, one missed and got lost in the soil. The arrows proved to be very effective and all hits would have been lethal.

2.3. Barbed points and triangular shaped points

The third session described here was carried out in 2009, when we were given the opportunity to do experiments on a wild boar. The 24 arrowheads were manufactured by Ton van Grunsven, who used an antler awl to produce the surface retouch. The points were hafted with the aid of tar and were shot 1, 2 or 3 times. Two of them were deliberately shot into a tree (one living, one dead and mouldy) and one arrow was shot 6 times into the forest soil. The arrows were effective and most shots would have been lethal.

a b c

Fig. 2. Experiments on goat, deer and boar, using microliths hafted as points and barbs (A), transverse points (B) and triangular shaped points (C) (all photos Laboratory for Artefact Studies, Leiden University).

3. Observed traces

3.1. Linear streaks of polish and polish with striations (Fig. 3)

Studying the points, we observed the presence of the different types of polish, as described in earlier studies to be apparent on projectiles (e.g. Van Gijn et al. 2001 a, b).

Firstly, we saw linear streaks of polish, the so-called "MLITS", but we noted that there appear to be two different types. One type can be related to shots that missed the animals and landed on the ground (Fig. 3a). The other type seems to be the result of contact with animal material (Fig. 3b). The difference between the two is found in their length: streaks of polish resulting from contact with the ground are generally relatively long and thin. Streaks of polish resulting from contact with animal material are shorter and wider and are sometimes connected with the occurrence of a small spot of polish.

Besides streaks of polish, we observed polish with striations, related to contact with animal material (Fig. 3c). The polish is quite flat compared to polish from contact with animal material resulting from other activities, but it still has the same greasy appearance. The polish in Fig. 3d is the result of contact with a tree. Again the polish is relatively flat in structure but more reflective than the polish resulting from contact with animal material.

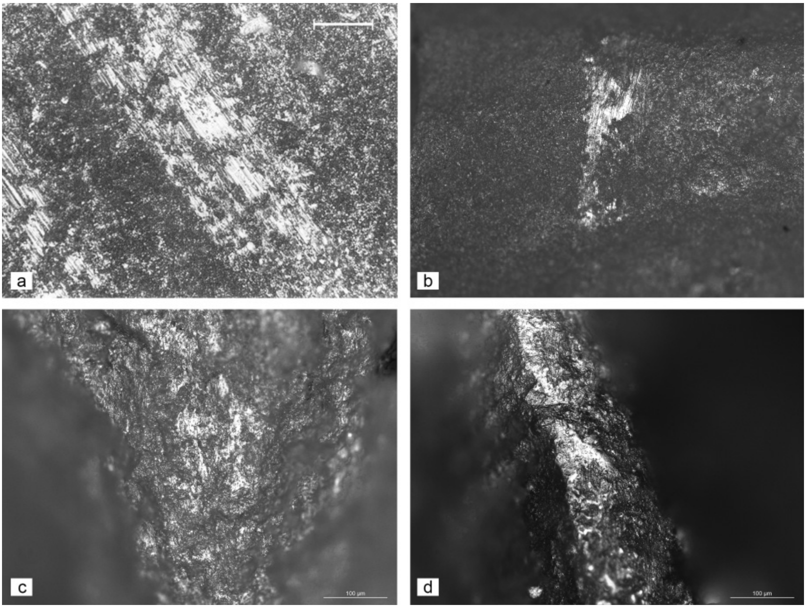

Fig. 3. Linear streaks of polish and polish with striations. A: Streaks of polish on exp. 129, missed shot on ground, B: Streaks of polish on exp. 2134, shot in animal, C: Polish with striations on exp. 1588, shot in animal, D: Polish with striations on exp. 1634, shot in tree (all photos Laboratory for Artefact Studies, Leiden University).

3.2. Impact fractures, use retouch and micro retouch (Fig. 4)

In addition to polish, several arrowheads display edge removals and impact fractures. For this study we classified every crescent-shaped fracture as an impact fracture, regardless of its size. Edge removals are either spread along the edge or occurring as micro retouch in connection with diagonal streaks of polish that slightly resemble the ones that are found on the surface of the arrowheads. This type of retouch was seen spread over a large part or the entire edge. Arrowheads with protruding edges often display single micro retouches.

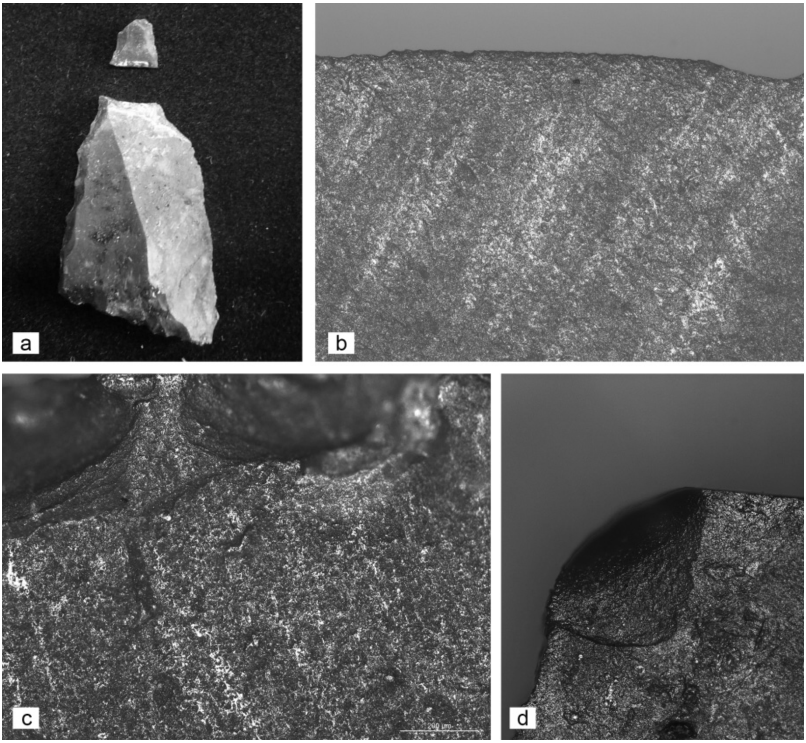

Fig. 4. Impact fractures, use retouch and micro retouch. A: Impact fracture, B: Micro retouch and diagonal streaks of polish on exp. 135, C: Retouch and streaks of polish on exp. 128, D: Micro retouch on protruding edge of exp. 2135 (all photos Laboratory for Artefact Studies, Leiden University).

3.3. Different traces per type of point

To conclude it can be stated that the types of points and the specific traces are related.

The transverse points show a lot of streaks of polish, but in all cases, except for one, this presence is related to contact with soil. These points also display a lot of micro retouch and retouch, sometimes in combination with diagonal streaks of polish.

The barbed and triangular points often display impact fractures, as you can see in these pictures. In this type of arrowhead we did not observe streaks of polish, but we did register another type of flat animal-like polish occurring in streaks. The fact that these points were made with the aid of an antler awl to produce the surface retouch might have influenced our observations.

For the microliths there is a difference between the ones used as tips and the ones used as barbs. The ones used as tips always have an impact fracture and display streaks of polish only in one case. Some of the points scattered after impact and some of them could not be retrieved, probably indicating that they scattered as well.

In contrast, the microliths that were hafted as barbs generally lack abundant wear traces. The edge removals they display are exceptionally small, and are classified as micro retouch. This retouch was mostly observed on the protruding edge corners and, in some cases, along the edge.

4. Conclusions

The differences in wear traces observed in the points can be largely attributed to the shape of the points, their edge angles and the presence or absence of retouch.

The skin is the hardest part of the animal to penetrate. The tip of an arrow therefore takes most of the force of the shot, which is specifically reflected in the amount of impact scars and edge removals on the transverse points and triangular points. It was also demonstrated in a microlithic tip that was found in the trajectory of the arrow, just behind the skin, while the shaft went all the way to the bone.

After the penetration of the skin the contact between the flint implement and the animal seems to be minimal. MLITS on the surface do seldom occur as a result of contact with animal material, although the triangular points do display streaks of polish that we interpreted as the result of contact with bone.

The barbs also seem to have minimal contact with the animal when shot. Only the protruding edge corners of microliths used as barbs, and the protruding parts of the barbed points show small edge removals and sometimes micro retouch along the edge. Polish or linear streaks of polish were not present however.

In our opinion, the modest amount of traces is mainly caused by the abundant presence of hafting material–leaving “no room” for traces. Microliths as well as triangular shaped points were hafted in such a way that the majority of the surface was covered in birch tar. Only a limited amount of surface could have been in contact with either skin, meat or bone material. For the transverse points this is much less the case, explaining why the transverse points display the most traces. Traces of hafting were limited to some minor abrasion on the ribs–which in some cases might easily be mistaken for manufacturing traces and the result of an abundant presence of birch tar residue. In none of our arrows was there any direct contact between flint and shaft.

As often occurs in functional analysis, we also have to conclude that, even regardless of the restriction because of the excessive hafting material, not all actions leave traces. Some arrows were used several times, and still did not show any damage, in either the form of impact scars, micro retouch or MLITS. In addition, especially the microliths hafted as tips tended to get lost or scattered during the experiments, which would take them out of the archaeological record. It is therefore reasonable to acknowledge that the absence of points with traces is caused by the fact that the points found in the archaeological record could either be fresh and unused or simply be lacking traces.

5. Suggestions for further research

During our experiments and analysis we were very careful not to harm the implements. However, this carefulness probably does not reflect past reality. The edges of all types of points are relatively fragile and can easily be damaged by post depositional processes, excavation methods or storage. We therefore wonder whether the micro retouch that we observed on protruding edges would be visible or recognized in the archaeological record. If we conclude that this is not the case, shooting traces would be limited to clear impact fractures, MLITS and streaks of polish with a clear directionality. It would be interesting to expand this research to experiments on post depositional influences.

A second suggestion for further research is based on the observation of our archer, who noticed that shooting the goat took much more force than shooting the wild boar. Having the experience of working with both goat- and boar skin we had expected that there would be a difference and that the goat would be easier to shoot. The goat however was in a state of "rigor mortis", while the boar was not.

Further research should in our opinion involve the question of to what extent the state of the animal is influencing our use-wear traces. A running animal with tensed muscles might lead to altogether different traces than a dead animal which is completely limp or still in rigor mortis (which occurs between several hours after death and lasts up till three days). Even the difference between an animal lying on the ground and an animal hanging in an upright position might influence our results. We hope to expand our experiments and research to get answers to these questions in the future.

Acknowledgements

We would like to thank Natuurmonumenten and Staatsbosbeheer for financial support. For all their help we would like to thank: Ton van Grunsven, Jaap Beuker, Eric Mulder, Sara Graziano, VirginiaGarcia-Diaz, Jordi Aal and Leendert Louwe Kooijmans.

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CHAPTER THIRTY NINE

PROJECTILE EXPERIMENTATION FOR IDENTIFYING HUNTING METHODS WITH REPLICAS OF UPPER PALAEOLITHIC WEAPONRY FROM JAPAN

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Abstract

The relationship between human evolution and advances in hunting evolution is one of the frequently debated issues of Palaeolithic studies in the last decade. Recent studies suggest that long-range projectile hunting was innovated by modern humans, but not practiced by previous humans, and the complex projectile technology using spearthrower or bow indicates the high cognitive ability of modern humans. If this hypothesis is true, evidence for long-range projectile hunting must be found at the early Upper Palaeolithic sites in East Asia as well. In order to better understand hunting evolution in East Asia, we started a projectile experiment project which allows us to reconstruct hunting methods, such as the use of thrusting lances, hand-casting javelins, spearthrower darts, and bow and arrow, on the basis of the traces on lithic artefacts.

Macroscopic analysis of the experimental specimens shows that there is a correlation between the formation patterns of impact fractures and the impact velocities. Especially, the frequency and dimension of impact

fractures and the volume reduction rate would be useful indicators for detecting the use of spearthrower and bow in archaeological assemblages.

Keywords: Hunting evolution, long-range projectiles, projectile experiments, impact fractures, Japanese Palaeolithic

1. Introduction

The study of hunting evolution provides important insights into the change of human subsistence strategies throughout time. Recent morphometric analyses of stone tips by measuring tip cross-sectional area (TCSA) and tip cross-sectional perimeter (TCSP) suggest that long-range projectile technology emerged in Europe and the Levant after 50-40 ka which coincides with the dispersal of *Homo sapiens* into western Eurasia (Shea 2006; Shea and Sisk 2010). Shea and Sisk (2010) claim that complex projectile technology by using spearthrower darts and bow and arrow offers a significant ecological advantage, since spearthrower and bow enable humans to “exploit a far greater range of potential animal prey” (op. cit., 101), and to “inflict a lethal puncture wound on a target from a safe distance” (op. cit., 102).

Yet, it should be disputed whether or not the complex projectile technology was an exclusive unique ability for modern humans, since Shea himself suggested that Chatelperronian points functioned as spearthrower darts (Shea 2006), meaning that some groups of Neanderthals exploited long-range hunting if the associations of Chatelperronian assemblages with Neanderthal fossils at Grotte du Renne (Hublin 1996) and St.-Césaire (Lévêque and Vandermeersch 1980) are reliable. Nonetheless, it is undoubtedly important to examine the possibility that *Homo sapiens’* groups expanded out-of Africa into Eastern Eurasia also equipped themselves with the long-range projectile technology, as this implies that the modern humans would have obtained a significant advantage over previous hominids in subsistence strategy when they colonized into new territories.

Two dispersal routes into East Asia were supposed: one is a northern route through the Altai and another is a southern route along the coastlines (Mellars 2006; Goebel 2007). Although genetic studies suggest southern coastal migration into East Asia during OIS 4 (e.g. Oppenheimer 2009), there is little anthropological and archaeological evidence for supporting the southern route. On the other hand, considerable numbers of archaeological records indicate that Upper Palaeolithic human occupations emerged in Central Asia between 45-38 ka (Derevianko 2010).

Furthermore, a great amount of excavations in the Korean Peninsula and in the Japanese islands provided evidence for showing that modern humans migrated in the Korean Peninsula around 40 ka (Lee 2012) and in the Japanese islands around 38 ka (Kudo and Kumon 2012).

This research project attempts to investigate whether the first modern humans in East Asia used the complex projectile technology and had a significant ecological advantage over previous humans in this region (Sano et al. in press). Achieving this purpose, we started projectile experiments in order to reconstruct prehistoric hunting methods based on patterns of impact scars observed on experimental specimens. First, we have conducted projectile experiments with representative hunting armatures from Japan, including trapezoids, backed points, bifacial leaf-shaped points, and antler points in which microblades inserted.

The TCSA and TCSP values offer indices for estimating the projectile potentials of stone tips; however, this does not necessarily coincide with the real function of the stone tips. On the other hand, macroscopic and microscopic analyses of hunting scars, as impact fractures and microscopic linear impact traces (MLITs), provide us with clues for reconstructing how prehistoric stone tips were actually used. This paper presents the preliminary results of projectile experiments with replicas of trapezoids and backed points which would offer further indicators for evaluating their delivery methods, as thrusting, throwing, shooting by spearthrower, or firing by bow.

2. Projectile experiments

2.1. Method

It has long been confirmed that particular types of fractures on lithic artefacts enable us to identify prehistoric hunting weaponry (Barton and Bergman 1982; Moss and Newcomer 1982; Huckell 1982; Bergman and Newcomer 1983; Fischer et al. 1984; Odell and Cowan 1986; Shea 1988; Midoshima 1991, 1996; Geneste and Plisson 1993; Caspar and De Bie 1996; Kelterborn 2000; Crombé et al. 2001; Lombard et al. 2004; Lombard and Pargeter 2008; Sisk and Shea 2009; Yaroshevich et al. 2010). The fracture types frequently occurring due to impact are often used as “diagnostic impact fractures” (DIFs), though the DIFs should be used with some caution (Sano 2009; Pargeter 2011; Pargeter and Brandfield 2012).

Since one of the important factors determining fracture formation patterns is kinetic energy, there would be a correlation between the velocity of projectiles and the patterns of impact fractures. Therefore, we conducted projectile experiments controlling loading conditions according to the estimated impact velocities of throwing, spearthrower, and bow respectively by using a calibrated crossbow (Sano et al. in press). For thrusting, a realistic experiment was conducted, as the kinematic mechanics of thrusting is difficult to reconstruct using the crossbow.

Ethnographic and experimental studies indicate that the most effective and average range for spearthrower and bow hunting is around 20 m (Churchill 1993; Stodiek 1993; Cattelain 1997). The velocities of shooting replicated spears by the calibrated crossbow for each delivery method are based on Stodiek's experiments which reported the velocities of spearthrower darts and bow and arrow at a distance of 20 m (Stodiek 1993). Regarding the throwing hunting, as there was no available data on the decline rate of the velocity according to the distances; we employed the average velocity of 17.8 m/s presented by Hughes (1998). Thus, we calibrated the crossbow to shoot spears at impact velocities of 31.4 m/s for bow, 21.7 m/s for spearthrower, and 17.8 m/s for throwing with ± 1.0 m/s in deviation.

The stone tips were hafted to wooden foreshafts using glue before being fasted to the mains shafts. A skilful knapper manufactured lithic replicas of trapezoids and backed points made on siliceous hard shale from the northwestern Honshu island of Japan. Forty replicas were prepared for the experiments of trapezoids and backed points respectively, 10 of which were used for the experiments of thrusting, throwing, spearthrower, and bow. Each specimen was shot only once at an undamaged target assembled from deer hide, ballistic gelatine, and cattle scapulae. The crossbow was set at a distance of 1.5 m from the target to ensure that the impact and initial velocities were almost identical.

The specimens were first macroscopically observed by the naked eye and loupe, and impact fractures were photographed by using a digital single-lens reflex camera Canon EOS 7D with Canon EF 100mm f/2.8L IS USM Macro. Then, a microscopic analysis was undertaken by using a digital microscope KYENCE VXH-1000 and a metallographic microscope Olympus BXFM-S.

2.2. Results

The formation patterns of MLITs and impact fractures of trapezoid replicas have already been described elsewhere (Sano et al. in press). Here we present new results of a macroscopic analysis of backed points and compare them with the results of trapezoids.

	N of specimens	N of specimens with IF	Types of IF										
			Cr	A	B	C1	C2	C3	C4	D1	D2	D3	Total
Trapezoids													
Thrusting	10	2	1	1	0	0	0	0	0	0	0	0	2
Throwing	10	6	6	14	2	0	0	0	0	0	0	0	22
Spearthrower	10	10	12	20	7	0	0	0	0	0	0	0	39
Bow	10	10	12	29	6	1	0	0	4	0	3	8	63
Backed points													
Thrusting	10	7	2	4	0	0	0	0	3	4	0	0	13
Throwing	10	10	3	1	7	1	5	0	3	11	0	6	37
Spearthrower	10	10	4	8	3	4	1	5	5	31	3	10	74
Bow	10	10	3	10	6	1	0	5	3	57	3	9	97

Table 1. Frequencies of the impact fractures on trapezoids and backed points by thrusting, throwing, spearthrower, and bow. IF: impact fractures, Cr: crushing, A: flute-like fractures, B: burin-like fractures, C: transverse fractures with feather (C1), hinge (C2), step (C3), and snap (C4) terminations, D1: bifacial spin-off fractures, D2: unifacial spin-off fractures > 6mm, D3: unifacial spin-off fractures < 6mm.

All of the impact fractures collected are summarized in Table 1 according to the patterns of impact fractures proposed by Sano (2009). The projectile experiments show a good correlation between the frequency of the total numbers of the impact fractures and the delivery methods. The specimens of backed points bear impact fractures more frequently than those of trapezoids, as backed points are overall elongated and thinner than trapezoids.

The most frequent primary fracture types are flute-like fractures in both the backed point and trapezoid experiments (Fig. 1: 1, 3), and then burin-like fractures in backed points (Fig. 1: 2), but crushing in trapezoids. While the transverse fractures were generally rare in trapezoids, as they were hardly broken transversely because of their stocky morphology, backed points bear considerable numbers of transverse fractures with feather, hinge, step, and snap terminations (Fig. 1: 4) (Ho Ho Classification and Nomenclature Committee 1979). Consequently, spin-off fractures which secondarily occur due to continued force from the broken surfaces against each other are observed on numerous backed points, but on few trapezoids. Especially, the experiments of the backed points by the velocities of spearthrower and bow induce amounts of bifacial spin-off fractures that are almost exclusively relating to impact (Fischer et al. 1984; Sano 2009; Pargeter 2011; Pargeter and Bradfield 2012).

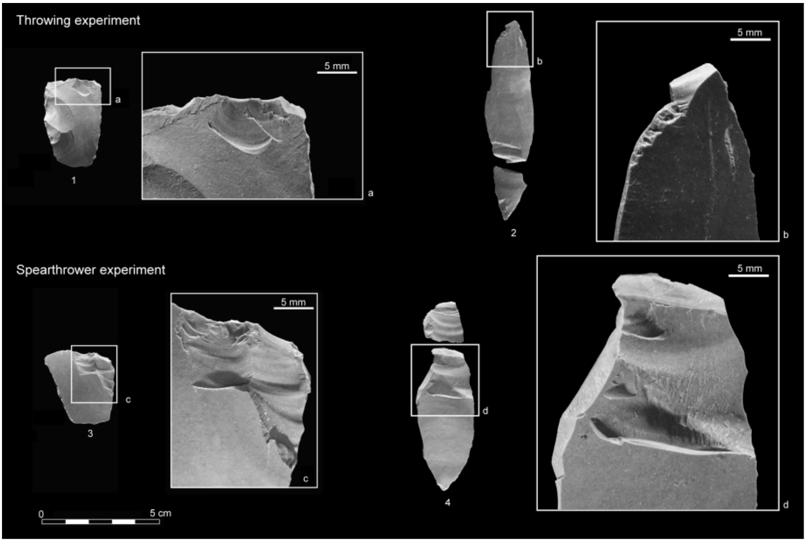


Fig. 1. Replicas of trapezoids and backed points after throwing and spearthrower experiments. Photos a, c: flute-like fractures, Photo b: burin-like fracture, Photo c: transverse fracture with step termination.

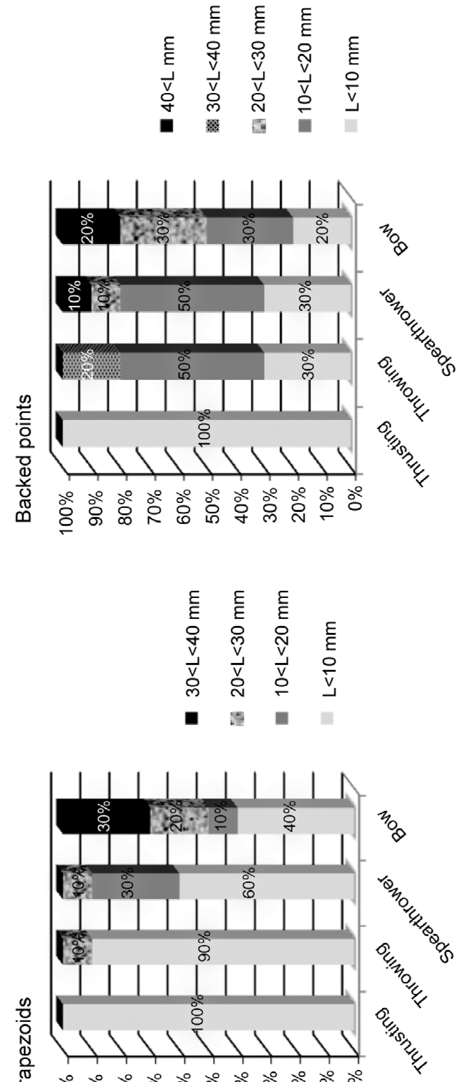


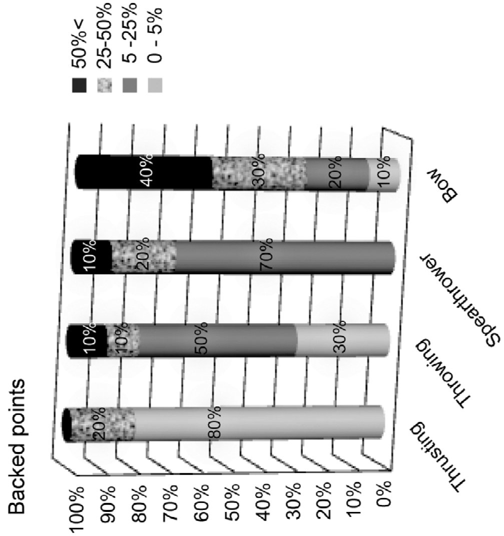
Fig. 2. Length of impact fractures of trapezoids and backed points by thrusting, throwing, spearthrower, and bow.

The dimension of impact fractures seems to also be related to the impact velocities (Fig. 2). None of the impact fractures which occurred in thrusting spear experiments exceed 10 mm in length. On the other hand, the velocity of the bow produced distinctively longer impact fractures than those of the other delivery methods; 50% of the impact fractures on the backed points and trapezoids exceed 20 mm in length. Whilst the differences in the lengths of impact fractures on trapezoid replicas between throwing and spearthrower would make it possible to distinguish spearthrower darts from hand-casting spear points in archaeological assemblages, the differences on the backed point replicas are not significantly distinctive. Therefore, recognising the use of spearthrower darts for backed points in archaeological assemblages requires further indices.

The most obvious pattern appearing during experiments was visible in the reduction rate of the volume of the replicas. Both the replicas of the backed points and trapezoids illustrate strong correlations between the volume reduction ratios and the delivery methods (Figs. 1, 3). Higher impact velocities, as for spearthrower and bow, lead to the loss of a larger volume of the specimens. Out of the 10 trapezoid replicas delivered by the velocity of bow, six specimens reduced their volume over 25% and two of them lost more than half of their volume. Concerning the backed points, three specimens delivered by the velocity of spearthrower reduced their volume over 25%. Seven specimens shot by the velocity of bow showed over 25% reduction of the volume and four replicas sustained their volume less than 50%. Thus, the volume reduction ratio can be used as a useful clue for distinguishing darts and arrowheads from thrusting lance tips and throwing javelin points.

3. Discussion and conclusions

The preliminary results of the projectile experiments suggest that the frequency and length of impact fractures and volume reduction rate would offer indices for identifying delivery methods of prehistoric hunting weaponry. It should be kept in mind, however, that archaeological stone tips include not only hunting weaponry, but also a variety of tools for processing hide, antler, bone, etc. Hence, microscopic use-wear analysis is required for confirming the functions of specimens. In addition, although the overall tendency in fracture patterns relating to the delivery methods was identical between trapezoids and backed points, they quantitatively show differences to one another. Therefore, it is certainly worth noting that a comparative analysis between archaeological and experimental data should be conducted within the same type of stone tips.



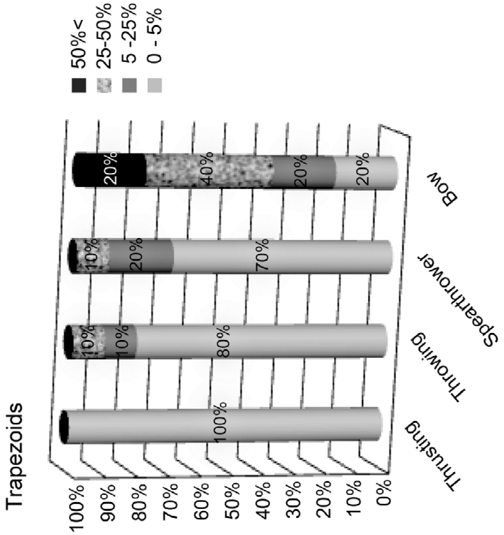


Fig. 3. Volume reduction rate of trapezoids and backed points by thrusting, throwing, spearthrower, and bow.

It is important to multiply analyze the frequency and dimension of impact fractures as well as the volume reduction rate when investigating archaeological stone tips, since it is difficult to precisely reconstruct the percentage of analyzed stone tips from an archaeological site that has actually been used as hunting weaponry, as a few replicas indicate distinctive impact scars in thrusting experiments. Integrating the analysis of TCSA and TCSP values would be, therefore, beneficial to evaluate the projectile potentials of the analysed stone tips. This paper is intended not to provide the only conclusive method for detecting prehistoric delivery methods, but rather to offer further indicators to approach an understanding of the relationship between human evolution and advances in hunting evolution.

Acknowledgement

We are grateful to João Marreiros, Nuno Bicho, and Juan Gibaja Bao for organizing the International Conference on Use-Wear Analysis held at University of Algarve in Faro, Portugal. We thank Walter Mehlem for making the calibrated crossbow. We wish to our gratitude to Kaoru Akoshima and Yoshitaka Kanomata who gave constant support and advice. Thanks are due to Yoshitaka Denda, Hyewon Hong, Siyi Zhang, and students at Tohoku University for helping the experiments. The project is supported by a grant from the Japan Society for the Promotion of Science.

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CHAPTER FORTY

POSSIBILITIES OF IDENTIFYING TRANSPORTATION AND USE-WEAR TRACES OF MESOLITHIC MICROLITHS FROM THE POLISH PLAIN

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Abstract

The subject of our study was the identification of micro traces observed on the Mesolithic projectiles from the Polish Plain. We mainly focus on the origin of one group of traces. We test the plausibility of several explanations for the use-wear traces created through friction with soft organic tissue, such as rawhide. Comparison of experimental results with the Mesolithic microliths from the Polish Plain favours the explanation that these traces are the result of the storage and transportation of microlithic projectiles during hunting.

Keywords: Mesolithic, microliths, projectiles, transportation

1. Introduction

In this paper we focus on the origin of wear traces found on the Mesolithic projectiles from the Polish Plain (Kozłowski 2009). What is peculiar about some of these traces is that they resulted from contact with animal tissues, mainly skin. In this article we present different explanations of these traces that we examined during our experimental tests.

We consider that such wear traces may have been simply created while using the microliths as projectiles. According to this, the wear traces are merely the result of contact with skin, meat and bones during arrow penetration.

On the other hand, we speculate that microliths may have been used to cut animal soft tissue. We consider the possibility of dual function, i.e. as both projectiles and tools used to cut animal carcasses.

We also raise the idea that such wear traces were created during transportation. These studies argue that some hide marks and other organic polishes that are visible on various artefacts most probably resulted from a more permanent contact with containers used to carry weapons during hunting (Mazzucco and Clemente 2013; Pyżewicz 2013).

To test the plausibility of these theories, we combined microscopic analysis with experimental data.

2. Artefacts

The research focused on the results of the use-wear analysis of 371 flint microliths (Table 1) originating from 4 archaeological sites: Wojnowo 3, Kargowa county (Early Mesolithic site), Jastrzębia Góra 4, Władysławowo county (Late Mesolithic site), Turowiec 3, Brusy county and Żuławka 13, Wyrzysk county (both multicultural sites containing the remains of a Mesolithic settlement) (Pyżewicz 2013).

The initial examination verified that the selected artefacts–truncated and backed bladelets, triangles and trapezes–were indeed used as projectiles (Fig. 1, 2: 5-6) (cf. Barton and Bergman 1982; Chesnaux 2008; Crombe et al. 2001; Fischer et al. 1984; Grimaldi 2008a, 2008b; Grøn, 1992; Willis 1992). Distinctive fractures (Fig. 1: A) and linear traces characteristic of projectiles (Fig. 1: D) were detected on their surfaces. The direction of linear striations and polishes, as well as hafting traces (the correspondence of the shaft's and microlith's axes of symmetry) further testified to their use as projectiles.

Type of use-wear traces	Wojnowo 3, Kargowa county	Jastrzębia Góra 4, Władysławowo county	Turowiec 3, Brusy county	Żuławka 13, Wyrzysk county	Total
Macro-and micro deformation associated with the use microliths as projectile points	10	19	40	106	175
Macro-and micro deformation associated with the use microliths as projectile points + traces formed as a result of contact with the hide	-	7	-	10	17
Macro-and micro deformation associated with the use microliths as projectile points + traces formed as a result of contact with the soft tissue and / or bone material	-	-	2	1	3
Macro-and micro deformation associated with the use microliths as projectile points + undefined traces	-	-	-	6	6
Traces formed as a result of contact with the hide	-	4	-	6	10
Traces formed as a result of contact with the soft tissue and / or bone material	1	-	-	-	1
Undefined traces	-	2	-	-	2

Table 1. Types of use-wear traces observed on the Mesolithic microliths from Polish Lowland (Pyżewicz, 2013).

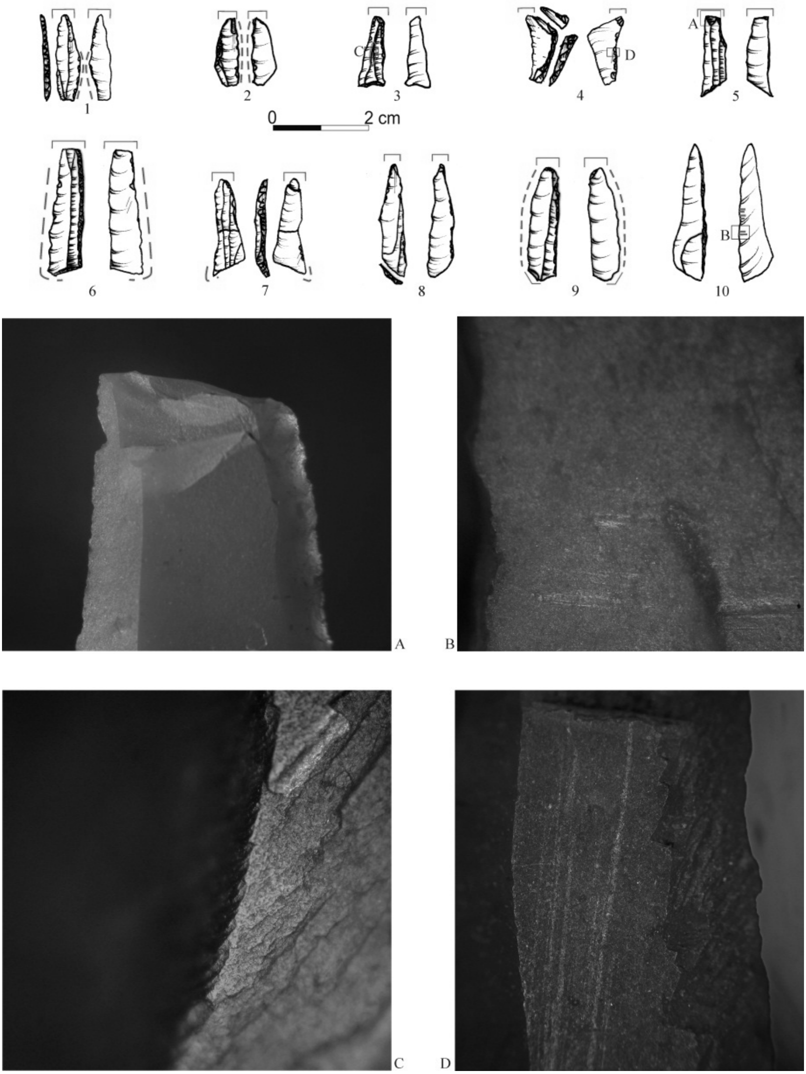

Fig.1. The Mesolithic microliths (Żuławka, Site 13 - 11-2, 4, 7-9; Turowiec, Site 3 - 3; Jastrzębia Góra, Site 4 - 5-6; Wojnowo, Site 3 - 10). A - step terminating bending fracture 21×; B - technological linear traces 50×; C - hafting traces 200×; D - linear impact traces 50× (Pyżewicz, 2013).

Slight differences in the hafting methods were observed. The artefacts were mounted either individually, or in groups, either on one, or on both sides of the haft. Backed bladelets and trapezes were mounted only on the haft tips. The triangles, truncated bladelets and other microliths with retouched bases were also mounted in the same places, but side inserts were made with triangles and truncated bladelets.

Some observed traces were clearly made during the production of the microblades from which the microliths were formed. Some others were the result of the final retouch (Fig. 1: B). Identification of the retouching techniques was greatly complicated by the numerous hafting and postdepositional traces covering the surface of the artefacts.

3. Soft Use-wear Traces

However, our attention focused on the traces resulting from the contact with animal tissues (Fig. 1-2: B). These traces are found on working edges, and are usually accompanied by the rounding of protruding parts. They are sometimes obscured by the postdepositional traces (mainly mechanical weathering and "post-excavation" traces, which, in some cases, may look similar to using and hafting traces). These types of traces typically co-occur with the signs of using microliths as projectiles.

We carried out a detailed microscopic analysis and compared the original artefacts to the objects produced in experimental studies. In the experiments we evaluated several dozens lithic microliths which were used as elements of arrows (Dmochowski and Pyżewicz 2012) or transported in pouches and containers made from leather and bone (lithic copies were stored together for one month and loosely carried in both types of containers which resulted in them moving around and touching skin and bone) (Pyżewicz 2012).

The experiments could not recreate similar traces by mere penetration. The traces of interest must have been created through an intense and prolonged friction (such as rubbing against soft tissue), rather than by an instantaneous contact with skin, meat and bones that would occur during penetration. The experimental data thus clearly point out that most of these wear traces could not have resulted as an accidental by-product of penetration (only in individual cases, we can conclude that the traces observed on the Mesolithic microliths could be formed during the penetration of animal carcasses by the arrow).

We considered that these traces could have been created while using the microliths for cutting soft tissues after the animal was killed (cf. Winiarska-Kabacińska 2007). Such prolonged use would provide the polishing action and the abrasive friction required for edge rounding. However, this theory is inconsistent with the signs of using the microliths as projectiles in hunting. Dual use theory could reconcile these contradicting findings, but it is nonetheless not very convincing. It is difficult to explain why a Mesolithic hunter would first fit a microlith to an arrow haft, and then use it for cutting flesh and scraping bones.

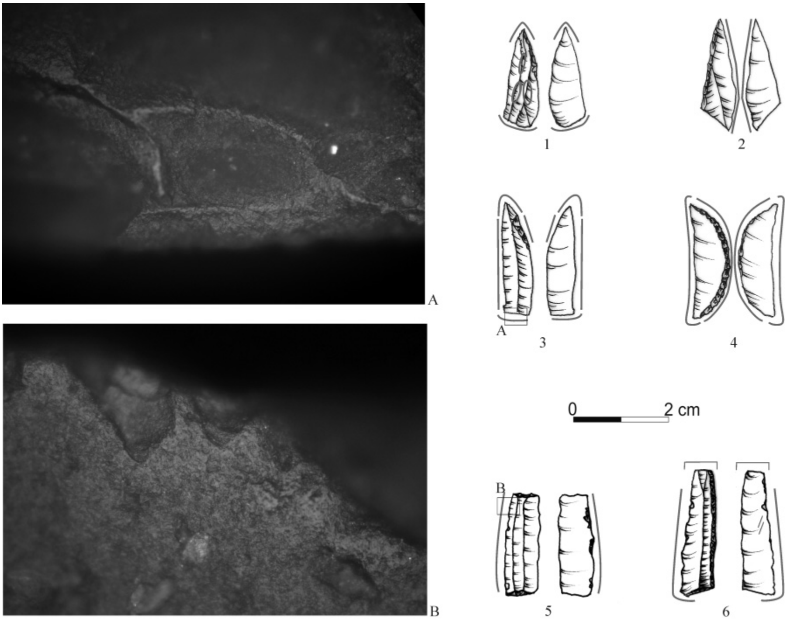

Fig. 2. The experimental microliths (1-4) and the Mesolithic microliths (5-6). A- microscopic traces of the storage and transportation of microliths in the skin pouch 200×; B - hide polishes (traces of the storage and transportation?) 200× (Pyżewicz 2012, 2013).

A more plausible explanation is that the organic polishes resulted in a permanent contact with containers (cf. Marquez et al. 2008; Pyżewicz 2012; Rots 2010; Van Gijn 2010) used to carry weapons during hunting. This would explain the co-occurrence of the traces characteristic of projectiles and those resulting from a prolonged contact with organic materials. Indeed, the experimental results support this explanation, since similar traces were successfully reproduced through the storage and transportation of copies of Mesolithic tools in various types of containers made from leather and bone (Fig. 2:1-4, A). On the surfaces of the experimental microliths we noticed a number of polishes, which had structures (depending on a material from which a container was made) similar to the traces formed as a result of contact with soft tissue–mainly leather, bone, or due to weak development with unspecified organic material. Furthermore, polishes are usually accompanied by the rounding of protruding parts. Presented traces are located along the whole side or just in certain parts of the lateral edges. Usually, the most intense polishes and rounding occur in the tips of the microliths, rarely on the ridges. In our opinion, this set of characteristics (the morphology and location of traces) allows us to identify the modifications which resulted from storage and transportation from others like using, hafting and postdepositional microscopic traces.

4. Conclusions

Comparison of the experimental data with the original Mesolithic artefacts favours the explanation of the soft tissue traces as resulting from storage and transportation. The prolonged friction with leather and bone containers in which microlithic projectiles were carried during hunting is most probably responsible for the use-wear traces of interest. Other explanations were either discarded by the experiments as irreproducible, or deemed unlikely by firmly establishing that these microliths were primarily used as projectiles.

The combination of use-wear analysis and experimentation provides data for further discussions on the limitations of readability of particular types of traces. It has been shown that the identification of processes that cause microscopic changes formed on artefacts requires the utmost cautiousness and meticulousness.

Similarly, when performing use-wear studies great attention should be paid to the number of factors influencing the formation of the final image of microscopic traces. These factors come from a broad range of social activities, in which lithic microliths played a role. The biography of particular artefacts includes overlapping traces of usage, hafting or deposition, removing and inserting in to various types of containers. The read ability of these signs depends on postdepositional factors, which make it difficult to determine whether the identified traces were created during usage or as a result of another type of treatment. Therefore, when analyzing the origins of different types of traces, it is necessary to take into account the whole set of observed changes, both those resulted from human activities and natural factors.

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CHAPTER FORTY ONE

USE AND MAINTENANCE OF LEAF-SHAPED POINTS IN THE LATE UPPER PALAEOLITHIC IN THE JAPANESE ISLANDS

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Abstract

This paper presents a case study about leaf-shaped points from the Late Upper Palaeolithic in the Japanese Islands. Based on an examination of the leaf-shaped points from the Mattobara site in Nigata Prefecture, I will discuss formation factors associated with the breakage patterns of leaf-shaped points, as well as their use and maintenance. Results indicate that leaf-shaped points were designed to be basally hafted and used as hunting weapons. They also indicate that broken leaf-shaped points were formed in two behavioural contexts. Some were broken during manufacture at the site, while others were broken during hunting activities. Broken leaf-shaped points during hunting activities were brought back to the site and replaced and discarded at the site while retooling hunting weapons, suggesting the reoccupation of the site during planned hunting activities. A refitting group including a leaf-shaped point with impact fractures shows that it was manufactured, used and discarded in a very short episode. These results provide clear evidence of the logistical mobility of hunter-gatherers during the Upper Palaeolithic. My recent experimental studies about manufacturing, shooting and stabbing supported these results as well as showed some implications of the use of leaf-shaped points in hunting activities.

Keywords: Leaf-shaped point, Late Upper Paleolithic, Logistical mobility, Japan

1. General background of a studied site

The Mattobara site (37°13′42″N, 138°46′22″E) is a late Upper Palaeolithic campsite located in Ojiya-City, Nigata Prefecture. The site is composed of four localities (A, B, C and D). Lithic assemblages from localities A, B and C are very similar to each other in both technology and tool types. Both blade technology and bifacial technology are confirmed in these assemblages. Tool types in each assemblage are composed of leaf-shaped points, scrapers, gravers and so on. Leaf-shaped points are especially abundant in each locality. No single microblade and microblade core were found as well as the typical backed blade in these localities. So, the technological and morph-technological position of these assemblages belongs to the time range between the end of the backed blade phase and the beginning of the microblade phase. The most stable horizon of the lithic scatters of these assemblages lies between the AT marker-tephra (ca. 25000-26000 years BP) and AS-YPk tephra (ca. 14000-13000 years BP). The dates of these assemblages have been estimated at ca. 15000-14000 years BP from the chronology of lithic assemblages in neighbouring regions and tephrochronology. There are refitted flakes between localities A and C. It indicates that lithic assemblages from both localities were left during a very adjacent time range (Ono 1997; Ono 2002). Details about use and maintenance of leaf-shaped points from localities A and C in the Mattobara site are presented here.

2. Analyses of leaf-shaped points from localities A and C in the Mattobara site

The locality A lithic assemblage (n=3568) includes 82 leaf-shaped points (Ono 2002), while the locality C assemblage (n=4446) includes 94 leaf-shaped points (Ono 1997). They were made on various blanks such as blades, elongated flakes and other flakes. These points were also made by various combinations of invasive and marginal retouches to adjust various blank forms. They include completely unifacial points with marginal inverse retouch, only marginal retouched points, partly bifacial points and so on as well as completely bifacial points. Their shapes are symmetric (Fig. 2). They were mainly made of shale. And a lot of broken pieces are included in them. Morphological comparison and macro-fracture analysis of leaf-shaped points from the Mattobara site localities A and C as well as experimental studies were conducted to clarify formation factors of these broken leaf-shaped points. For the morphological comparison, leaf-shaped points were classified into two categories: complete (expediently called "unbroken") and incomplete (expediently called "broken"). Unbroken leaf-shaped points include several refitted specimens.

Fig. 1 shows length-to-width distributions of unbroken leaf-shaped points and the base (or the tip) of broken points. They show that most of the widths of the unbroken leaf-shaped points are about 2 cm or less, suggesting that widths may have been intentionally adjusted to fit shafts. Fig. 1 also shows a concentrated distribution of broken point size less than 3 cm long and 2 cm wide. Many of the fragmented point bases (Fig. 3) fit within this size distribution, further suggesting their replacement at the site. Interestingly, some of the broken points are wider (more than 2 cm) and their shapes are unsymmetrical. On these points secondary retouch is not so intensive (Fig. 4). These latter point fragments may have been broken during manufacture. Fig. 5 shows leaf-shaped points with clear impact fractures (Barton and Bergman 1982; Sano 2009), indicating that leaf-shaped points from the site were used as tips of hunting weapons in other places, transported to the Mattobara site, removed from hafts, and abandoned at the site where hunting weapons were repaired. Thus, at the Mattobara site, broken points were formed in two behavioural contexts. Some were broken during manufacture at the site, while others were broken during hunting activities. Broken leaf-shaped points during hunting activities were brought back to the site and replaced and discarded at the site while retooling hunting weapons. These findings are supported by the refitting analysis (Ono 1997). Refitted specimens from locality C (Fig. 6) representing a bifacial reduction sequence consists of 82 flakes, 2 points and 1 bifacial core, all restored into a single nodule of a flat pebble (Naganuma 2006). This nodule appears to have been reduced in a relatively short period of time at a single location. A broken point with impact fractures (Fig. 5: 5) is included in the refitted specimens, indicating that the broken point was manufactured in locality C, used as a tip of a hunting weapon in another place, brought back to locality C after being broken, and, finally, removed from the haft and abandoned. These data provide clear evidence of logistical mobility (Binford 1980; Habu 1994) of hunter-gatherers during the Upper Palaeolithic.

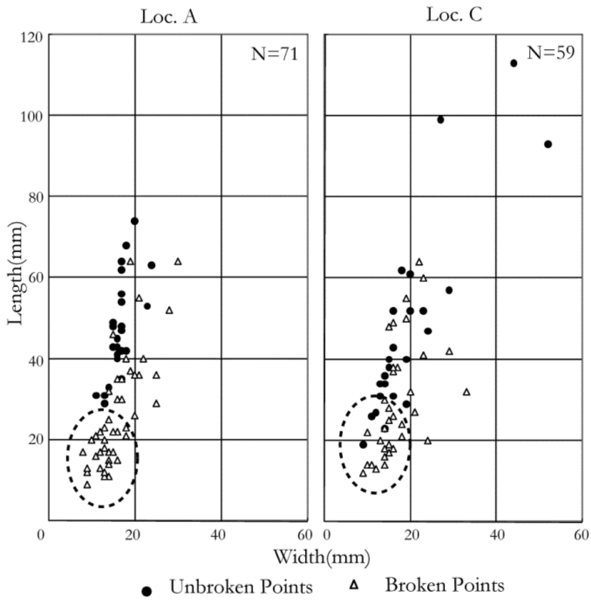

Fig.1 Length-Width distributions of points from the Mattobara Site

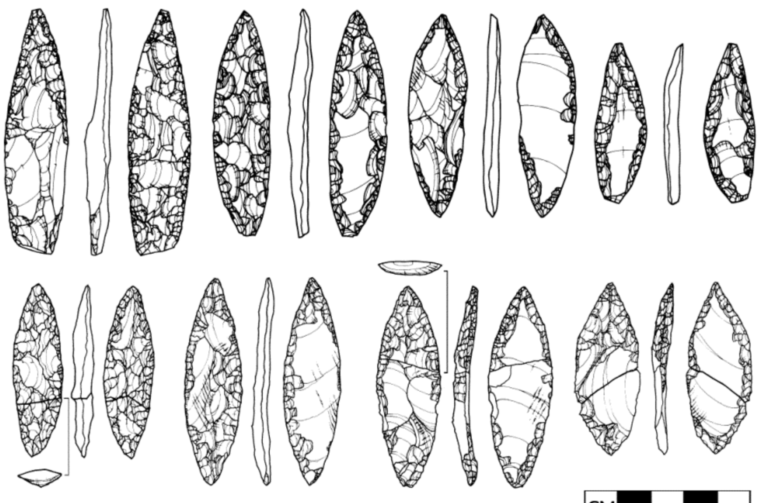

Fig.2 Unbroken points from the Mattobara site [upper from Loc.A (Ono 2002), lower from Loc.C (Ono 1997)]

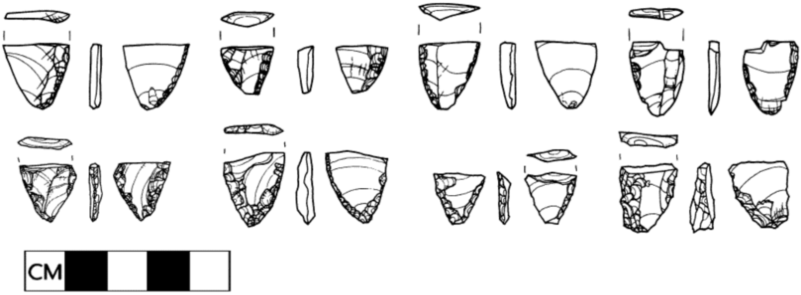

Fig.3 Broken points from the Mattobara site (1) [upper from Loc. A (Ono 2002), lower from Loc. C (Ono 1997)]

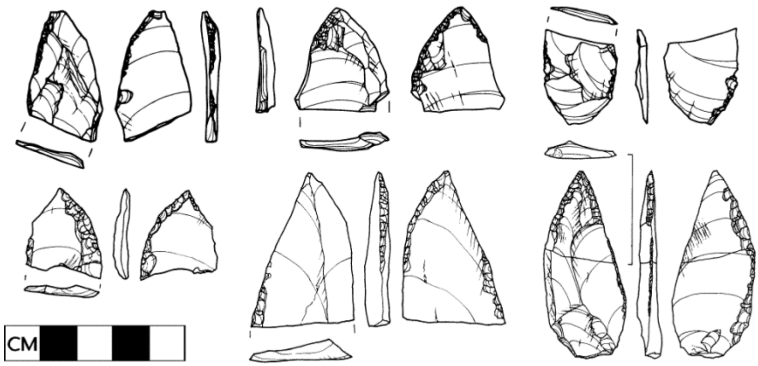

Fig.4 Broken points from the Mattobara site (2) [upper from Loc. A (Ono 2002), lower from Loc. C (Ono 1997)]

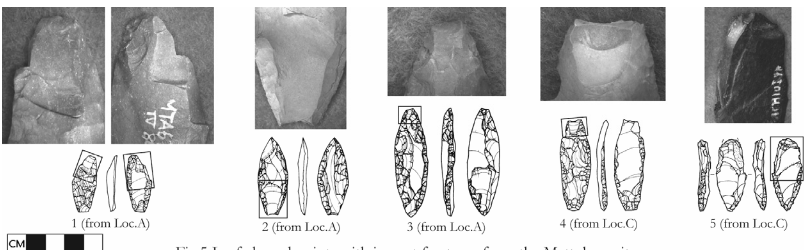

Fig.5 Leaf-shaped points with impact fractures from the Mattobara site

Fig.5 Leaf-shaped points with impact fractures from the Mattobara site (the drawings from Ono 1997 and Ono 2002)

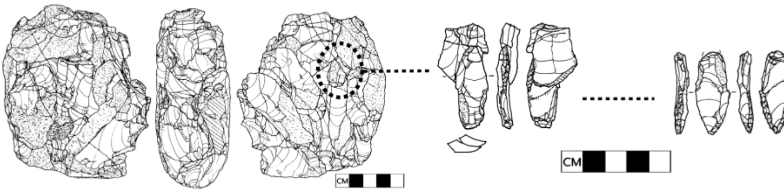

Fig.6 Refitted specimens including a broken point with impact fractures from the Mattobara site Loc. C (Ono 1997)

3. Experimental studies

Results of experimental studies basically support the results of analyses of leaf-shaped points from the Mattobara site. They consist of both manufacturing experiments and shooting and stabbing experiments. The results of shooting and stabbing experiments also indicate further implications of their use in hunting activities.

A manufacturing experiment was conducted to clarify features of broken specimens during manufacturing and to obtain replicated leaf-shaped points for shooting and stabbing experiments. Three knappers manufactured leaf-shaped points from 83 shale flake blanks. They were required to manufacture symmetrical leaf-shaped points that are longer than 3cm in length, narrower than 2.5cm in width, and thinner than 9mm in thickness, based on the data from the Mattobara specimens. From this manufacturing experiment, three kinds of specimens were obtained. The first were complete leaf-shaped points meeting requirements (50 specimens). The second were incomplete points not meeting requirements (16 specimens), most of them are thicker than 9mm. The third were specimens broken during manufacturing (26 specimens). These, the third, were the specimens which knappers gave up manufacturing to the required shape. Broken specimens during manufacturing are wider than specimens belonging to the other two categories (Fig. 7). In most of the broken specimens, secondary retouches are partial. Their shapes are unsymmetrical. These features are similar to the features of broken points from the Mattobara site (Fig. 4).

Shooting and stabbing experiments were conducted to clarify relations between fracture patterns and methods of use and other factors. In total, 50 replicated leaf-shaped points were used for these experiments (Fig. 8). In these experiments, the mode of action, impact velocity and weight of shafts were controlled. A leaf-shaped point and a wooden short shaft were bound with hemp yarn and inserted into a bamboo long shaft. In shooting experiments, both a heavier shaft (200g) and a lighter shaft (100g) were used. An atlatl was used in the experiments. A target, some chicken wrapped around two shoulder blades of a cow, bound with string, and covered with deer's fur, was constructed. People threw the shafts from a position 4m away from the target. And the hit object (the target, a wooden board, concrete blocks) was recorded in each shooting.

Results of shooting and stabbing experiments indicate that there are several factors that affect fracture patterns of leaf-shaped points. There are at least the following 4 factors: the form of the leaf-shaped point (especially thickness), impact velocity (stabbing/throwing by the hand/throwing by the atlatl), and the characteristic of the hit object (especially hardness) and the mode of action (stabbing/throwing). There are distinctive fractures in different impact velocities, different hit objects and different modes of action.

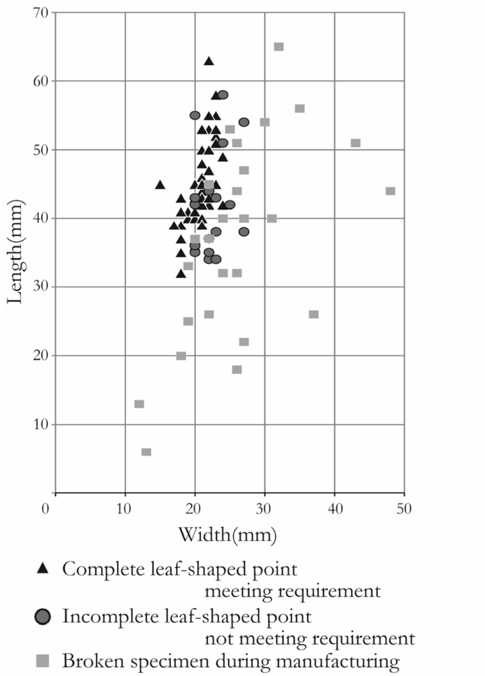

Fig.7 Length-Width distributions of specimens from manufacturing experiment

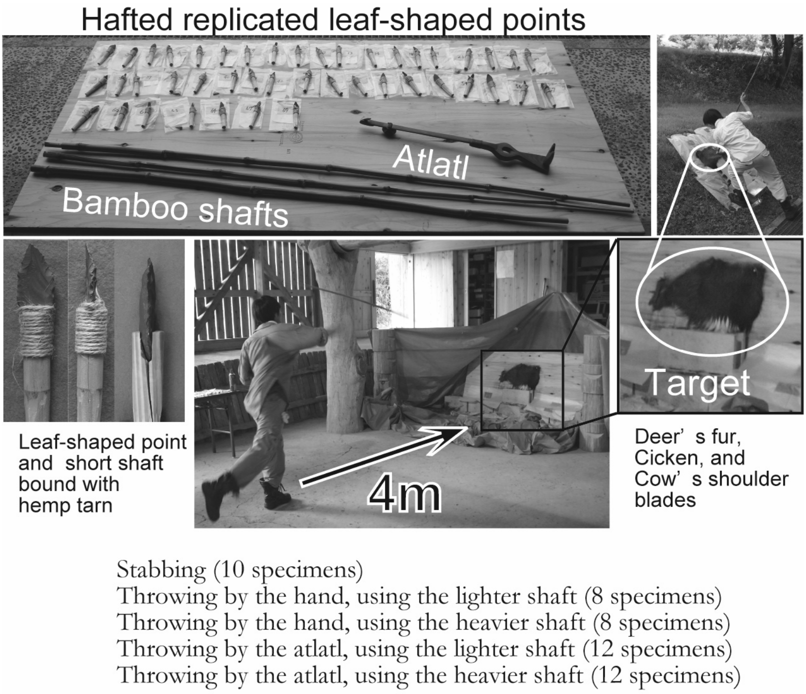

Fig.8 Conditions and contents of shooting and stabbing experiments

Fig. 9 shows specimens that were thrown and hit the wooden board. A transverse fracture at the middle or base adjacent to the limit of the shaft is frequently found on these specimens (1-6). Transverse fractures on both distal portions are frequently found on these specimens (1-3). A transverse fracture with burin-like fractures is found on 5. A burin-like fracture and other fractures are found on 6. They also look like vending fractures. They are overlapping on the tip. These two kinds of fracture patterns are found only on specimens that were thrown by the atlatl using the heavier shaft.

Fig. 10 shows specimens that were thrown and hit the concrete block. A transverse fracture with crushing is frequently found on these specimens (2, 3 and 5). They cannot be refitted because of losing medial parts due to crushing. A single large spin-off fracture is found on 2. And relatively large burin-like and flute-like fractures are found on 1 and 4. The flute-like fracture on 4 is the largest one in all of the fractures found on all specimens. These kinds of fractures are frequently found on specimens that hit the concrete block. They were rarely found on leaf-shaped points from the Mattobara site.

Fig. 11 shows specimens that were thrown and hit the target. There is no or very little damage on half of the specimens. It seems to be because the fur and meat acted as cushions. A small flute-like fracture is found on 1. And transverse fractures are found on 2 and 4.

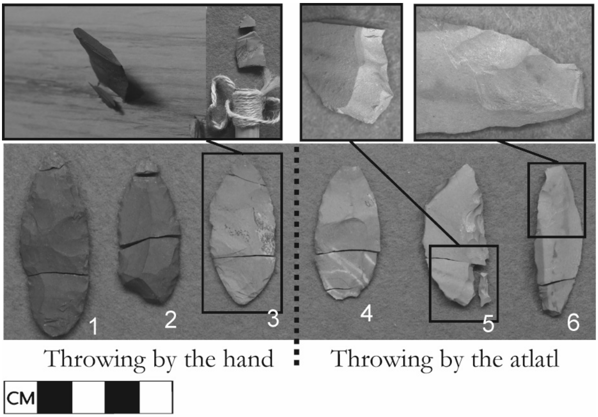

Fig.9 Specimens which hit the wooden board (N=22)

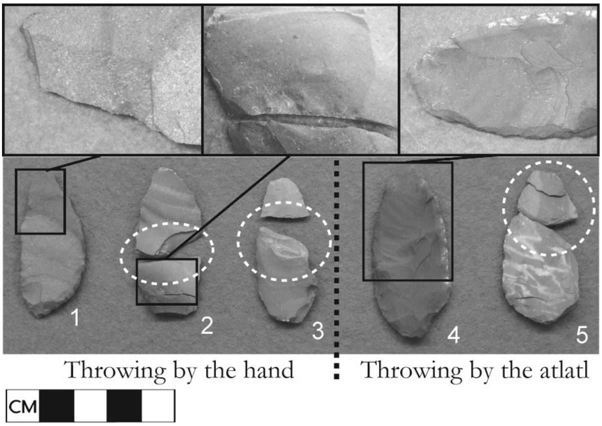

Fig.10 Specimens which hit the concrete blocks (N=7)

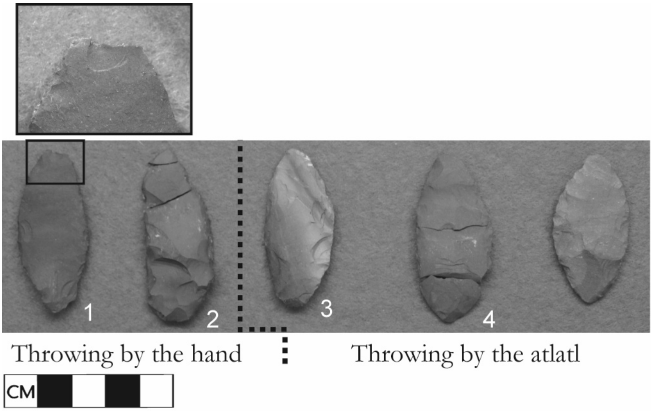

Fig.11 Specimens which hit the target by throwing (N=8)

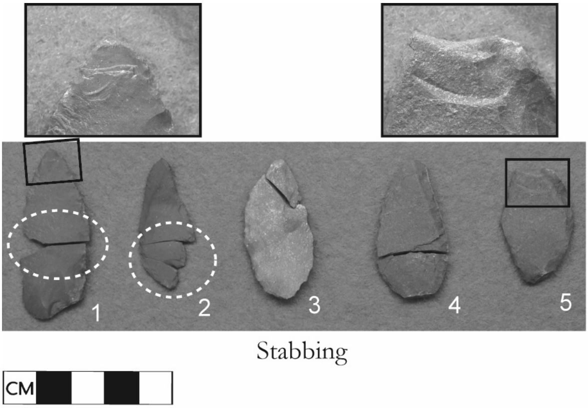

Fig.12 Specimens which hit the target by stabbing (N=8)

On the other hand, specimens, which were stabbed and hit the target, have very different fractures (Fig. 42-12). Various kinds of fractures are found on these specimens (a relatively large flute-like fracture: 5, a relatively large burin-like fracture: 3, a transverse fracture at the base adjacent to the limit of the shaft: 4, a transverse fracture with crushing: 1 and 2). It is because impact power was maintained by the strength and weight of people and then the fur and meat did not act as a good enough cushion. But transverse fractures on both distal portions, a transverse fracture with burin-like fractures and overlapping burin-like fractures on the tip are not found in these specimens at all. It indicates that mode of action and impact velocity are both important factors of the breakage patterns of leaf-shaped points.

4. Discussion

Based on both results from analyses of the Mattobara specimens and the shooting and stabbing experiment, I will discuss further implications of the use of leaf-shaped points in hunting activities. From the Mattobara site, many leaf-shaped points were found with a transverse fracture at the base (Fig. 1 and Fig. 3). Several leaf-shaped points with transverse fractures on both distal portions are also included in them. It seems to indicate that a lot of broken points were broken by hitting objects with the exclusion of hunting games. It may possibly have been trees. Besides this, a transverse fracture with burin-like fractures and overlapping burin-like fractures on the tip were also found in the Mattobara specimens (Fig. 5: 1 and 5). This indicates that these leaf-shaped points at least were shot by a tool such as the atlatl. Based on these, the breakage patterns observed on leaf-shaped points from the Mattobara site seem to reflect the manufacture and maintenance of hunting weapons accompanied by technologically-assisted hunting in a forest environment.

Acknowledgements

I thank Prof. Masahisa Yamada, Prof. Masami Izuho, Tomoyo Kuribayashi, Kyosuke Hori, Taichi Kuronuma and Takahiko Yukawa (Tokyo Metropolitan University), Jun Hashizume (Meiji University), Akira Iwase (Tokyo Metropolitan University),, Keisuke Arata (National Research Institute for Cultural Properties, Nara, Japan), Dr. Shoh Yamada (Institute of Accelerator Analysis Ltd.) and Todd Thomas for their help on this study. This work was supported by JSPS KAKEN Grant Number 21320146.

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Chapter Forty Two

Projectiles from the Last Paleolithic Hunter-Gatherers in the Eastern Cantabrian Region: Azilian Backed Points at the Site of Santa Catalina

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Abstract

The site of Santa Catalina contains a succession of occupations dated approximately between 12650 and 10250 cal BP. The inhabitants exploited a wide range of marine and terrestrial animal resources. The lithic tool production was oriented especially towards obtaining bladelets, which were turned into several types of backed tools. The study of these backed elements has succeeded in determining that these were generally used as projectile elements. The projectile types are quite homogeneous in their morphology but vary considerably in their size. The points were placed in an axial position at the tip of the shafts and were probably accompanied by lateral barbs made from small backed bladelets. The projectiles were managed very strictly as these lithic elements were not used for any other tasks. This management clearly contrasts with the situation in the

Magdalenian levels at the same site but is similar to the pattern observed at other Azilian occupations in Europe.

Keywords: Projectiles, Azilian, lithic technology, use-wear analysis, Iberian Peninsula

1. Introduction: the Azilian in eastern Cantabrian Spain

In the north of the Iberian Peninsula, the Azilian period lasted from 11800/11600 BP to about 9000 BP (approximately 13770 to 10200 cal BP). The environmental conditions were very unstable, due to the succession of the Allerod, Younger Dryas and recent Holocene, despite which cultural behaviour appears to have been quite homogeneous throughout the period. The Azilian is characterized by a certain continuity from the late Magdalenian, as most of the changes began to take place after about 12500 BP or 14500/15000 cal BP (Fernández-Tresguerres 2006; González Sainz and González Urquijo 2007). From this time on, a gradual change is seen in the exploitation of animal resources, involving diversification in hunting large mammals, an intensification in the use of marine resources (fish and molluscs), and fowling. Another important trait is the restriction in mobility systems, which is paradoxically coupled with territorial diversification, with contemporary strictly coastal sites and other occupations at locally high altitudes, above 1000 metres. This pattern differs sharply from the Magdalenian territory use pattern.

The overall simplification of technical systems is noteworthy. The lithic industry exploited local raw materials–flint of poorer quality or quartzite depending on local availability. Lithic production is blade oriented, mainly for bladelets, with less technical investment. Lithic tool types are dominated by backed bladelets and backed micropoints, small end scrapers and few burins. The bone industry is simpler than before and undecorated; osseous points such as Azilian harpoons are made in bone, not in antler as in Magdalenian times. In another sense, artistic expression is rare and figurative representations disappear (Berganza 2005).

2. Azilian in Santa Catalina Cave

Santa Catalina is a coastal site, with a northeast facing entrance, located on the eastern side of the northern Atlantic Iberian coast. The entrance is in limestone cliffs thirty-five metres above the modern sea level but in Azilian times the shoreline was not more than two or three kilometres away from the cave. The excavations carried out in the cave mouth from 1982 to 2000 revealed a deposit with three archaeological layers attributed to the Azilian, Final Magdalenian and Late Magdalenian (Berganza et al. 2012). A surface area of nine square metres with an average thickness of 30 centimetres was excavated in the Azilian level. Radiocarbon dates from this level range from 10530 ± 110 BP (12426 ± 209 cal BP) to 9180 ± 110 BP (10385 ± 119 cal BP).

The large faunal assemblage is varied in the types of mammal and bird species it comprises. The most numerous mammal remains are of red deer and roe deer, and it is worth noting the presence of reindeer, normally absent even in cold Pleistocene times. The most frequently consumed fowl were geese and ducks, which were probably hunted in marshes near the site.

The occupants at Santa Catalina exploited the coastal environment systematically, as mollusc shells are extremely abundant. The accumulation of limpet and periwinkle shells, together with remains of sea urchins and goose-neck barnacles etc., forms a veritable shellmidden. In addition, ichthyofaunal remains suggest that the occupants of the cave were also fishermen.

The lithic and bone industries are typically Azilian. The osseous industry consists of flat Azilian harpoons, antler points and abundant manufacturing waste.

3. Lithic tools in the Azilian level

The level has yielded over 13000 lithic remains (Table 1), nearly all in flint; among these more than 1200 are blade blanks and 260 are retouched tools. Retouched tools are made mainly from blade blanks (85%); in fact the majority are bladelets (backed bladelets and backed micropoints). The backed points include both straight and curved backs. As usual, end scrapers are more abundant than burins.

Lithic remains	**13219**
Blade (complete+ fragments)	**1226**
Retouched tools	**261**
Backed bladelets and points	*152*
Enscrapers	*28*

Tab. 1. Lithic counts in Santa Catalina azilian level

Lithic production was focused on obtaining blades, above all bladelets, which make up 75% of the blade type products. Nearly all the cores and rejuvenation flakes and tablets are related to bladelet production. Larger blades, unretouched or as finished tools, were imported. Additionally, some points and bladelets in exotic flint types, not knapped at the site, were probably imported as finished tools.

4. Projectile use

4.1. Experimental program

To evaluate the use of backed tools as projectiles, an experimental reference collection was produced by a program of projectile use replication. 52 experimental weapons were used, 39 of them armed with backed bladelets and points, nearly all of them in the same flint (Upper Cretaceous flysch flint) used in the Azilian level at Santa Catalina. The weapons were used as arrows, javelins and pikes. Arrows were shot between one and three times; javelins and pikes were each used between two and nine times (González-Urquijo, Ibáñez 1994).

The typical catalogue of diagnostic impact features developed: crushing damage; burin-like lateral impact scars or hinged scars towards the dorsal or ventral face; distal fractures removing the tip; proximal flaking or medial fractures (see Arrighi et al. 2008 for a comprehensive illustration). At a microscopic level (i.e. observed under an incident light microscope), these fractures may be accompanied by dark bottom striations and linear polishing.

We observed some variability in the traces, as has been also stressed in other analyses. This was due to several factors: weight and morphology of the point, the target, and propulsion modality, although the latter variable may be less important. In contrast, hafting composition is a particularly important factor. We found that deeply inserted points had significantly fewer impact marks, whereas more prominent ones suffered more frequent but undiagnostic mesial fractures. Another important factor is the degree of projectile reuse, which is well known behaviour amongst recent hunter-gatherers (Lee 1979). Other scholars have stressed the fact that not all the used projectiles bear impact fractures, given the random nature of the specific material impacted in each episode of use. Figures between 30 and 60 percent have been proposed for different light projectiles (Moss 1983; Fischer et al. 1984). In our set, percentages of points with diagnostic fractures increased from 27 to 68 percent from the first to the third utilization in the arrow sample. At this stage, most of the points were useless because of the damage. We observed very few diagnostic traces in the backed bladelets located as barbs in the shafts of arrows and darts.

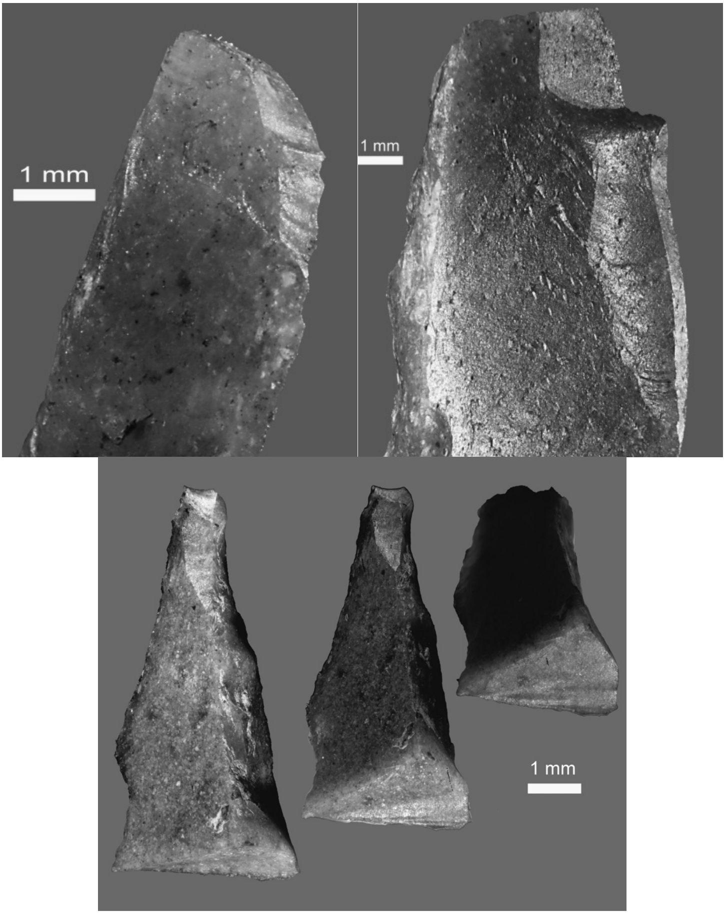
4.2. Points and bladelet tools use

All the backed tools in the archaeological collection were studied macroscopically at between 5 and 50 magnifications. A sample of 48 (38 backed bladelets and 10 backed points–Microgravette and Azilian type points) were also examined at a microscopic scale with an incident light microscope, normally at 100 and 200 magnifications.

Twenty six bear diagnostic traces of impact, compatible with a use as a point, but only 2 are morphologically backed points. Clearly, most of them were originally backed points, now deformed by impact. In contrast, 8 backed points lack diagnostic traces of impact, although some of them are fractured. Hafting must have been axial as nearly all traces of impact are parallel to the long axis of the point (Figs. 1, 2, 3).

The pieces used as projectiles vary greatly in size. The smallest are about 2mm wide (about 1 square mm in cross-section) whereas the largest are over 10mm wide, over 25 square mm in cross-section (Fig. 4). As ethnographic literature has shown, point size may be related to the form of propulsion, the type of haft, or the shape of the dart; and also with the size of the prey the projectile is fired at. The wide range of animal resources hunted at Santa Catalina (mammals, birds, and fish) probably explains a part of the variety in the hunting techniques and weapons.

The points in this Azilian level were used only as projectiles. The fourteen tools in this group studied under the microscope revealed no traces of any another kind of utilization, either before or after use as a projectile. However, at least three of the points fractured during use were repaired, redressing the backed side in order to be used again as a projectile (Fig. 5). A further eight morphologically pointed backed bladelets without traces of impact exhibit no other types of use. This result is in sharp contrast with the observations in the final Magdalenian level at this same site or at others (as Andernach), where eight out of twenty-nine used projectiles had been employed in other tasks, mainly butchery. Points from Azilian type levels always reveal a discrete number of uses as knives, as seen at Pont d'Ambon (Moss 1983), Rekem (Caspar and De Bie 1996), Bois-Ragot (Plisson 2005), Val Lastari (Ziggiotti 2008) and Temnata (Gurova y Schelinski).



Figs. 1, 2, 3. Santa Catalina azilian projectile points. Impacts parallel to the long axis of the point.

Out of the sample of thirty-four backed bladelets with no visible traces of impact, eighteen were used mainly in butchery tasks and marginally in cutting/scraping hide. The whole set of backed bladelets from the Azilian level form at least two different populations depending on their size: one around 7 millimetres wide, and another of less than 4 millimetres width (Fig. 6). The butchery knives mainly belonged in the larger group (mean 21 x 7.6 mm). The absence of traces in the set of smaller backed bladelets (mean 14.8 x 5.1 mm) suggests a use as a lateral barb in the projectile shaft, as noted by Donahue (1988) at Paglicci.

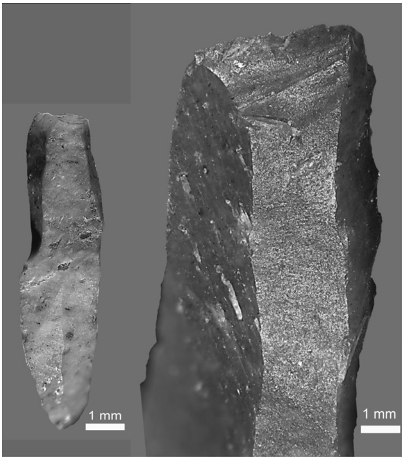


Fig. 4. Santa Catalina azilian projectile points. Variation in size.

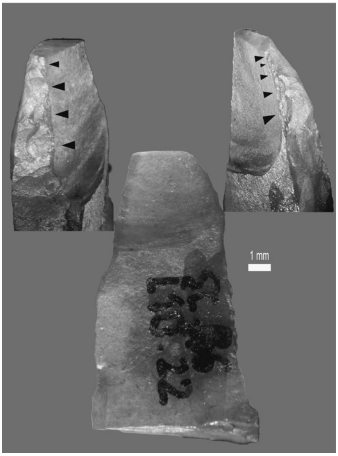


Fig. 5. Santa Catalina azilian projectile points. Apex repaired after impact fracture by double backed retouch.

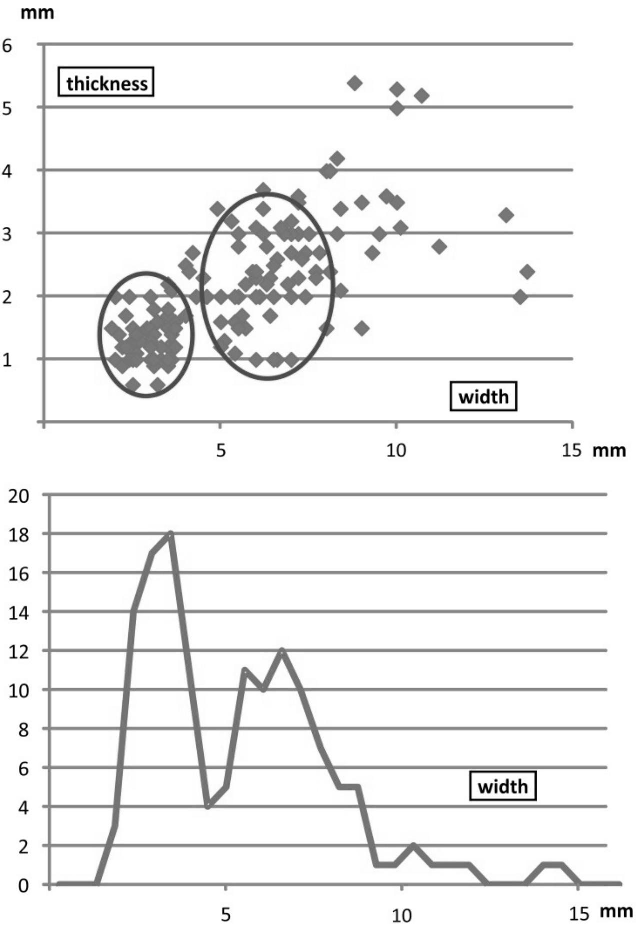


Fig. 6. Backed bladelet size. Up, width vs thickness population. Down, bimodal distribution in thickness.

The analysis of the sample of unretouched bladelets from this Azilian layer (Ibáñez, González Urquijo 1996) showed that bladelets were not used unretouched; only the larger ones, over 10 mm wide, were used for butchery, as unretouched blade blanks. In addition to these tasks of hunting and butchering, another important task at the site was working with fresh hide. This work was carried out mainly with end scrapers made on imported blades.

This set of work reveals a focus on the capture and primary transformation of hunting resources. The transformation of other materials is minimal and restricted to the immediate repair or resharpening of tools made from bony materials.

This spectrum is in sharp contrast with the repertoire seen in the final Magdalenian level at Santa Catalina, where capture and primary transformation of animals was less important, and tasks focused on the production of a vast and complex array of final products in lithics, bone/antler and hide.

5. Conclusion

The Azilian level appears to represent a rather specialized site: lithic production was aimed at obtaining bladelets that were made into a large number of projectile implements, while other types of lithic, antler and osseous implements were brought to the site already manufactured and ready to be used. Most of the lithic implements were used to catch and process animals, while tasks involving other materials or for other purposes were performed only marginally.

The number of projectiles used and abandoned at the site is quite low. As has long been noted, beginning with L. H. Keeley's research and ethnographic observations, the management of hunting implements is quite complex. The places where the implements are made, repaired or replaced, used and abandoned are often different and distant from one another, depending on the general strategies of mobility and work organization. Thus, abandoned points might be found in the places used for the general preparation and replacement of implements or in areas related spatially or functionally to their use, in hunting stations.

The management of Azilian projectiles was clearly specialized. They were only used for hunting and not for the subsequent butchery tasks. This seems to have been the normal behaviour in the late stages of the Pleistocene, while it differs from Magdalenian tool management, where points were often used for butchery. The significant differences must be explained by a change in economic strategies and mobility from Magdalenian to Azilian times.

Acknowledgements

We are grateful to Peter Smith for the English translation of this text.

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PART IV:

BONE TECHNOLOGY

CHAPTER FORTY THREE

TWO EXPERIMENTAL PROGRAMS TO STUDY THE BONE TOOLS FROM THE MIDDLE PALEOLITHIC HUNTER-GATHERERS

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Abstract

Here I present two experimental programs, which are in different stages of development. The first item is an already finished experimental program about the collection and use of retouching tools made on macro mammal diaphyseal fragments. The second is an ongoing program on the use of unmodified bone diaphyseal fragments to work hide and wood. Both programs are directly related to the archaeological evidence found in a series of Middle Palaeolithic sites in the North of the Iberian Peninsula.

Keywords: Middle Paleolithic, Mousterian, Bone tools.

1. Introduction

Middle Palaeolithic hunter-gatherers (which are broadly identified with Mousterian evidence in the Iberian Peninsula) are typically characterized as groups that did not use bone as raw material for tools. In my research of a series of excavated archaeological sites, I found small samples of faunal remains showing marks, stigmas and erosions that could not be easily related to butchery or consumption practices by humans. A more detailed examination showed that those traces were also not related with other taphonomical agents. Some bone remains showed typical features of an already well-known tool type: the retouching tool on macro mammal diaphyseal fragments (Henri-Martin 1910). Other fragments showed less typical or recognizable features, but their marks and modifications suggested that they were also used as tools. The specific sites with both kinds of artefacts are Axlor (González-Urquijo et al. 2005), Covalejos (Sanguino and Montes-Barquín 2005), Cueva Morín (González-Echegaray and Freeman 1978), Peña Miel (Utrilla et al. 1987) and Prado Vargas (Navazo et al. 2005).

2. Collection and use of retouching tools

The first experimental program was designed to analyze and understand the collection and use of retouching tools. Complementary objectives were: (1) to find patterns (on fracturing and use marks and wear) which would be specific to particular strategies and technical solutions, and (2) to generate a robust experimental corpus to compare, on a dynamic and dialectic way, with the archaeological material and data.

The first part of this experimental program was the blank collecting phase, which comprised 38 experiments of massive percussion and breakage of Cervus elaphus and Bos taurus long bones and metapodials, using lithic macro-tools (Fig. 1). A series of quantitative, statistical variables was defined and recorded. Independent variables were: the species and anatomical element, bone freshness and fracturing strategies. Dependent variables were initial fracture delineation, descriptive features of the fractures, the usable vs. non-usable number of blanks, and morphology/morphometry of blanks (length, width, thickness, curvature, etc.).

The results on the bone freshness variable are coherent with existing research in this matter (Pickering and Egeland 2006) and indicate that fresh bone produces a higher number of oblique initial fractures (58%), a scarcity of very small splinters, and slightly smaller usable blanks (length $\bar{x}$=88 mm–Bos Taurus sample only). In contrast, dry bone produces transversal initial fractures (83%), an abundance of very small splinters or fragments, and bigger usable blanks (length $\bar{x}$=107 mm–Bos Taurus sample only). From a qualitative point of view, dry bone typical fractures are straight or stepped, with irregular edges, while those of fresh bone are straight or helical, with smooth edges.

Some interesting observations were found from an anatomical and taxonomical perspective: within the deer bone sample, long bones showed a relative abundance of transverse fractures (75%) that resulted in a high percentage of tubular blanks. In contrast, deer metapodials showed an abundance of oblique (70%) fractures, followed by longitudinal ones (20%), which resulted in a higher number of straight and non-tubular blanks. The Bos taurus sample showed an abundance of oblique fractures (61%), followed by transversal ones (23%), which translated into a higher variability of blanks. Yet, within this variability, a typical shape dominates: elongated, rectangular and plane-convex blanks.

Fig. 1. Aspects of bone fracture for blank collecting. A: Dry *Bos taurus* long bone with transverse (and irregular) initial fracture delineation. B: *Cervus elaphus* metapodial with longitudinal (and smooth-edged) initial fracture delineation; a parasite flake is still attached to fragment. C: Percussion impact during the fracture tasks (corresponding to the fat extraction strategy). D: Fresh *Bos taurus* long bone with transverse (and helical) initial fracture delineation. E: *Cervus elaphus* metapodial showing fracturing impacts near the epiphysis and longitudinal initial fracture delineation. F: *Cervus elaphus* metapodial usable blanks, from the blank producing strategy.

A series of different fracture strategies were implemented in the experimental program. The main two had opposed technical objectives: fat extraction versus blank collection. The main difference between both strategies is the control of percussion: in the blank collection strategy it was deemed necessary to keep a thigh control of percussion movements and to carefully choose the impact point of each strike. The results indicate that, when the objective was bone fat extraction, the percussion produced a higher number of non-usable splinters (76% of fragments), and a more heterogeneous morphology of blanks (length σ=0.25–deer metapodial sample only). At the same time, in the blank collection strategy, the percussion produced a relatively lower number of non-usable splinters (65% of fragments), and a less heterogeneous morphology of blanks (length σ=0.15–deer metapodial sample only).

The second phase of this experimental program addressed the use of blanks in different retouching tasks. 177 experiments were carried out, doing both pressure and percussion (Quina, simple) retouch on flint and quartzite tools. In this case, independent variables were bone freshness, specific retouching task, lithic raw material, and intensity of use (measured both in working time and number of impacts). On the other hand, dependent variables were discriminated into two groups. The first was related to the whole of the use area (morphometry, position and description), and the second group was related to the traces of use, specifically its size (length) and number. The studied traces of use were the linear impressions, trihedral impressions, striations, and massive chipping.

For the used areas, the most interesting result was the realization that a clear pattern of lateralization, directly associated with the fact that the experimenter was right-handed, made itself evident when considering the position of such use areas on the blanks: 53% of the use areas were lateralized to the right side of the blank, in contrast with the 32% that showed left-side lateralization. In the remaining 15% of blanks, use area reached both sides of its width, so no lateralization could be measured in them.

The study of the traces of use allows other conclusions, which relate to bone freshness, retouching task, lithic raw material and intensity of use. In the bone freshness variable (Fig. 2: A, B), dry bone shows a smaller number of linear impressions while, at the same levels of intensity of use, fresh bone shows a higher number of those traces. At medium intensity of use, there are 35 linear impressions per use area on dry blanks, while the same mean is of 49 impressions on fresh blanks. Also, the qualitative appearance of linear impressions on dry bone is different from the ones made on fresh bone. On the other hand, when considering the remaining types of traces (trihedral impressions, striations and massive chipping), only small and relative differences were documented in dry vs. fresh bone comparison.

When considering the features of stigmas in relation to the different tasks, first and foremost a difference arises between pressure and percussion (including both Quina and simple types) retouch (Fig. 2: C, D). In this pairing of tasks, percussion is characterized by longer linear impressions (length σ=1.8 mm), a low presence of massive chipping on use areas

(31%), and a relatively high presence of trihedral impressions (46%). Therefore, pressure is characterized by shorter linear impressions (length σ=1.1 mm), a higher presence of massive chipping (50%) and a lower presence of trihedral impressions (21%). Within the percussion tasks, Quina and simple retouching tasks (Fig. 3: A, B) were compared (subsample of flint retouch with medium intensity). Quina is characterized by longer and more abundant linear impressions (length σ=2.9 mm; number of impressions per use area σ=46), a scarcity of striations (σ=6 per use area) and a high incidence of trihedral impressions (60%) and massive chipping (60%). The same data for simple retouch are as follows: linear impression length σ=1.7 mm; number of impressions per use area σ=41, striation number per use area σ=11; and a low incidence of trihedral impressions (17%) and the massive chipping (9%).

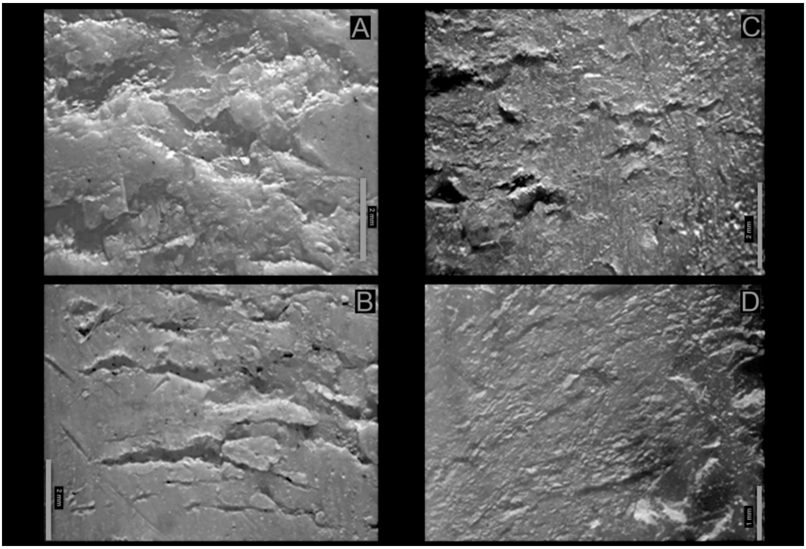

Fig. 2. Different aspects of use traces on retouching tools (related to bone freshness and percussion versus pressure tasks) as observed at low augmentation (x15-x30). A: Use area and traces from retouching tasks made with dry bone. B: Use area and traces from retouching tasks made with fresh bone. C: Use area and traces from percussion retouching tasks. D: Use area and traces from pressure retouching tasks.

Plotting both simple and Quina retouch on flint and comparing with the same tasks on quartzite (Fig. 3: C, D) produces a slightly less specific pattern, but two differences can be pointed out: retouch on flint always produces longer linear impressions, and fewer striations per use area, e.g. within the Quina retouch, tasks on flint have linear impressions with a length of $\bar{x}$=3 mm, and a mean of striations per use of 10; compared to that, tasks on quartzite show linear impressions with a length of σ=1.6, and a mean of striations per use area of 20).

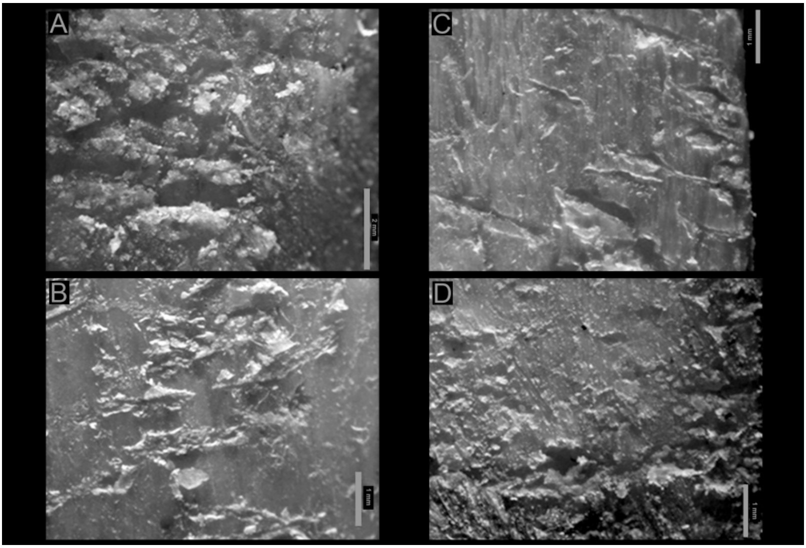

Fig. 3. Different aspects of use traces on retouching tools (related to Quina versus simple tasks and lithic raw material) as observed at low augmentation (x15-x30). A: Use area and traces from Quina retouching tasks. B: Use area and traces from simple retouching tasks. C: Use area and traces from retouching tasks made while retouching flint. D: Use area and traces from retouching tasks made while retouching quartzite.

3. Bone fragments to work hide and wood

The second item presented here is an experimental program about the use of unmodified bone diaphyseal fragments to work hide and wood. The starting point is a small but significant sample of bone tools found in the Mousterian sites from Iberia mentioned at the beginning of this paper. Those implements are retouched and unretouched bone fragments, with probable traces of use. Traces show similarities with wood and skin traces seen on other bone tools from different chronologies and regions. Those types of tools are relatively well-known and studied, but the research effort is biased towards recent prehistoric times, and has been very limited for the older stages of European Palaeolithic. Specifically, there is a scarcity of technological and use-wear studies (with notable exceptions such as Burke and d'Errico 2008, or Vincent 1988).

For this experimental program I preferred a classical and traceological high augmentation use-wear analysis (Semenov 1964). The main goal of this second program is to describe and quantify the use-wear on each stage of work, in order to understand its development process, with the aforementioned constraints (time, working material, worked material and the shape of active parts of the tools).

Thus, a series of experiments have been designed, using fresh and dry bone splinters to work hide and wood. The program is at its beginning and only two sets of experiments (Fig. 4) have been carried out: fresh hide working with unmodified fresh bone splinters (including three different rows of working times of 5, 10 and 20 minutes), and the same kind of set, but for dry hide working.

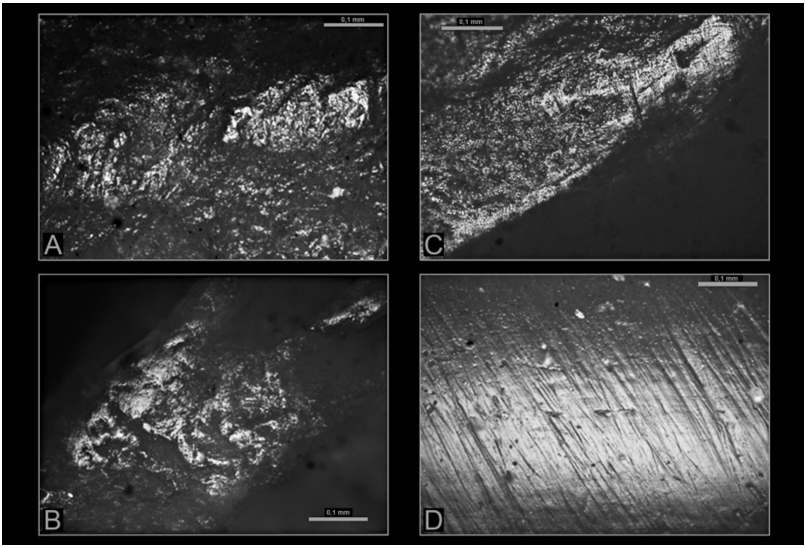

Fig. 4. Hide working traces at high augmentation (x200). A: 5 minutes fresh hide working with unmodified fresh bone. B: 20 minutes fresh hide working with unmodified fresh bone. C: 5 minutes dry hide working with unmodified fresh bone. D: 20 minutes dry hide working with unmodified fresh bone.

Acknowledgements

I want to thank Xavier Terradas Batlle (IMF-CSIC) and Jesus E. González-Urquijo (UC) for their supervision during experimental programs, and the participation of the students and colleagues from UC, UPV, UAB and IMF-CSIC on experiments.

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CHAPTER FORTY FOUR

ALL THE SAME, ALL DIFFERENT! MESOLITHIC AND NEOLITHIC "45° BEVELLED BONE TOOLS" FROM ZAMOSTJE 2 (MOSCOW, RUSSIA)

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Abstract

Zamostje 2 is a river bank site located in the region of Serguei Possad (Russia). The Zamostje 2 settlement has been excavated by Vladimir

Lozovski and Olga Lozovskaya since 1989. This site is composed of occupations from the late Mesolithic to the middle Neolithic. Although no habitat structures were discovered, structures and many artefacts dealing with fishing practices have been found there. Our attention was drawn to a particular typological set of bone artefacts from Zamostje: narrow transverse-lateral bevel ended tools with sides invariably composing an angle of 45°. The functional study of around forty pieces had allowed a match with wood working (Лозовская 1997). However, the variability in the breaks and the distribution of use-wear patterns means that kinematics could not be apparently cleared. From these first results and with the help of target experiments, we carried out the use-wear analysis of all the collection that numbers more than one hundred "45° bevelled bone tools". We expected to specify their function and their connections with structures dealing with fishing at Zamostje.

Keywords: Bone tools, woodworking, use-wear analysis, experimentation, Mesolithic and Neolithic of the Russian plain.

1. Introduction

The site of Zamostje 2 is located in the Dubna valley, around 110 km to the northeast of Moscow (Fig. 1). This riverbank site was excavated under the direction of V. Lozovski during the 1990s and then by O. V. Lozovskaya for the last two years, 2010-2011. Its chronological sequence extends from the 6th to the 5th millennia BC, from the late Mesolithic to the middle Neolithic (Лозовский 2003). While no habitat structures were found, structures and artefacts dealing with fishing practices were discovered, including fish-traps made from long and thin wooden rods (made from pine). A large quantity of fish remains was recovered in the occupation levels. According to some estimations, the ichthyological remains represent 64% of all the fauna consumed (Chaix 2003). Tools associated with halieutic activities are also numerous: harpoons, fish hooks (Maigrot et al. 2014), bone knives used for scaling fishes (Clemente et al. 2002; Клемеите and Гиря 2003), pine bark floats, etc. Among the thousands of bone tools from Zamostje 2, there is a specific typological group called "45° bevelled tools". In 1997, Olga Lozovskaya published a traceological study of around forty of them (Лозовская 1997). She proposed to associate their use to wood working without understanding their kinematics or their real technical function. Indeed, morphology of those tools constitutes a well-defined typological group. At the same time, the variability of their use-wear patterns is very impressive. In order to understand their use, we carried out experiments that are focused on wood working, and to analyze, from the traceological point of view, all the collection.

Fig. 1: Location of the site of Zamostje 2.

2. Presentation of the corpus

At Zamostje, the bone assemblage includes one hundred and thirty-six 45° bevelled tools. This name was chosen because the angle formed by the lateral bevel is always nearly 45° (Fig. 2). We observed grooving marks bordering the shaping of the desired angle in one case (Fig. 3: 1). The lower side, called “plateforme”, is flat shaped by scraping (Fig. 3: 3). The upper side, called “contre-plateforme”, is rounded by scraping (Fig. 3: 2). The “contre-plateforme” (average length 32 mm) is always longer than the “plateforme” (average length 26 mm). The convex edge is very thin, between 5 and 7 mm. 45° bevelled tools are mostly made from elk bone (a metapodial split in half or a whole ulna), only two specimens have been produced from elk antler. Those implements, which are characterized by specific morphology and standardized shaping processes, are common to Mesolithic and Neolithic levels.

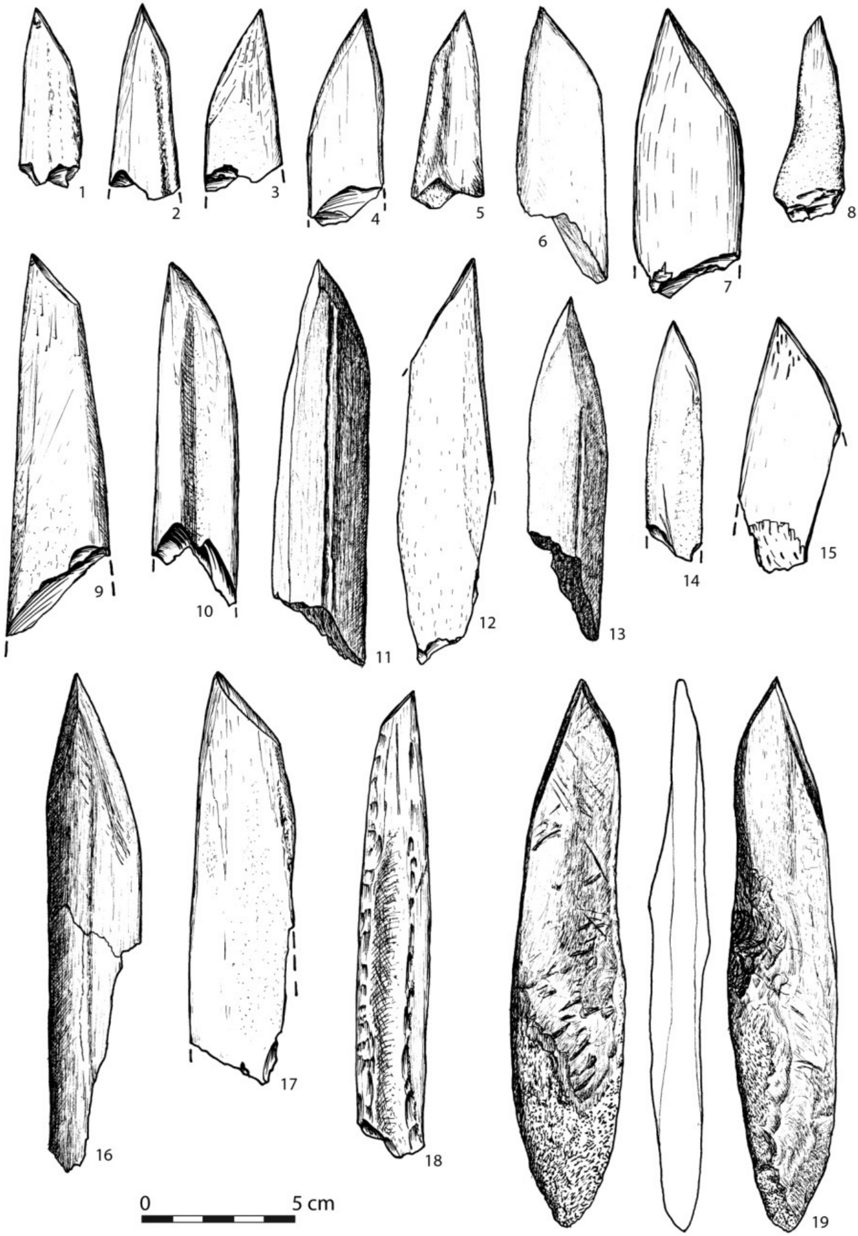

Fig. 2: 45° beveled bone tools from Zamostje 2. Drawings: O. Lozovskaya.

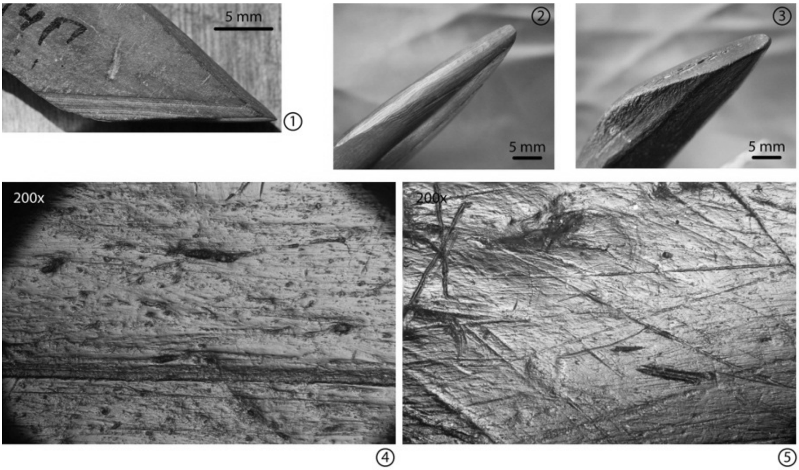

Fig. 3: Close up of 45° beveled bone tools from Zamostje 2. 1-3: technical traces; 4-5: use-wear traces. Photographs 1, 4 & 5: Y. Maigrot, 2 & 3: O. Lozovskaya

Around 90% of the 45° bone tools are broken. Transversal fractures are the more numerous. We have recorded 50 tools with this damage, which could affect distal or mesial parts (Fig. 2: 1 to 5). Forty-one tools show oblique fractures (Fig. 2: 6, 9, 13), and sixteen present longitudinal fractures (Fig. 2: 12). And well, a few of them are characterized by a combination of breaks: longitudinal and oblique fractures or transverse and oblique fractures (Fig. 2: 15, 17). Most of them present a more or less developed rounding of the active part. Usually, the tip of the edge shows little flakes located on the “contre-plateforme” side.

Complete tools are scarce (n=14; Fig. 2: 18 and 19). They are quite long for bone implements: their average length is more than 122 mm. Some of them show a proximal part with compacted bone and flakes, which indicates that they have been probably used by indirect percussion. Others show a shaping by retouch of their proximal part, which suggests that they could have been hafted.

From the micro-wear point of view, archaeological traces are always very close to experimental wear observed on bone tools used for working wood (Maigrot 2003; Van Gijn 2005). However, we have noticed variability in the distribution more and less invasive of the traces, but also in some use-wear patterns. Under the metallographic microscope, we can generally observe a smoothed and quite flat topography, a shining surface with intrusive micro-polish, and numerous pits and cracks. This surface could be affected by thin, long and continuous striations, parallel between

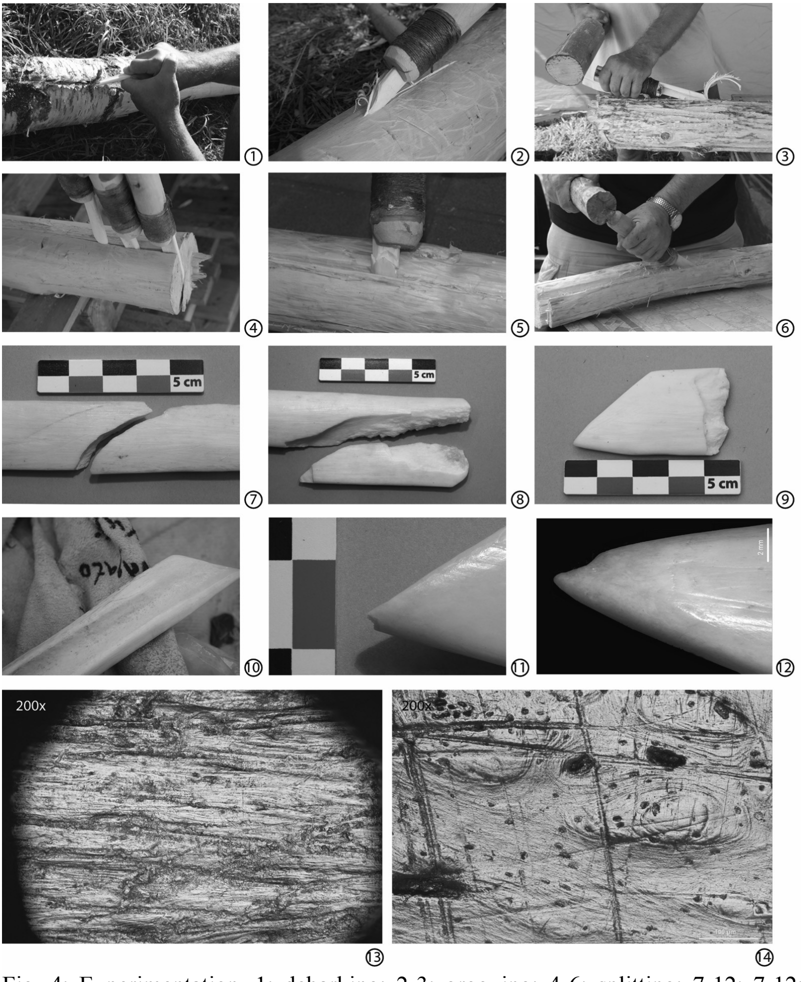

Fig. 4: Experimentation. 1: debarking; 2-3: grooving; 4-6: splitting; 7-12: 7-12: breaks and rounding; 13-14: micro-wear traces. Photographs 1, 3, 7-11, 13 & 14: Y. Maigrot, 2: E. Gyria, 4-6 & 12: I. Clemente.

them and perpendicular to the edge (Fig. 3: 4). They indicate a transverse movement, but mainly, striations are very wide and crossed suggesting a multidirectional gesture (Fig. 3: 5). 45° bone tools have been used on wood, but the question is: what for?

3. Experimentation and use-wear analysis

To try to answer this question and to understand the technical function of those tools, we decided to carry out experiments. We prepared several 45° bone tools, hafted or not. Regarding their specific morphology and the previous traceological results, we have focused our experimentation on removing bark, grooving and splitting wood.

Experimental 45° tools were used to remove bark from fresh birch and pine for one to two hours (Fig. 4: 1). After their use, edges show a characteristic indented macroscopic rounding (Fig. 4: 12). We have never observed this kind of modification on the active part of Mesolithic and Neolithic tools. At high magnification, the surface of experimental tools appears striated, bright and above all rounded. Traces resulting in debarking wood do not fit with archaeological use-wears.

Concerning to wood grooving (Fig. 4: 2 and 3), we used hafted and un-hafted experimental bone tools to work, in indirect percussion, birch (fresh) and pine (fresh and dry). We employed different hammers: from wood, antler and stone. The proximal basis of un-hafted tools appears crushed and flaked, attesting to the use of an experimental soft hammer, from wood or antler. These stigmas have been recorded on all complete tools from Zamostje. On the other hand, in the archaeological sample, we have never observed the huge damage resulting from the experimental use of a stone hammer (Fig. 4: 8). During our experiments and with deep grooving, the active part of some tools has been accidentally broken transversally. Such breaks have been observed in 45° bevelled bone from Zamostje. After use, all experimental edges show micro-flakes on the “contre-plateforme” side, as the archaeological cases. Under the metallographic microscope, experimental used surfaces appear quite flat with a bright polish and parallel striations (Fig. 4: 13). Similar traces have been also observed on a few Mesolithic and Neolithic tools, which have been probably used to groove wood.

Lastly, we have used experimental 45° bevelled bones to split pine and birch, in order to extract wood blanks and long rods (Fig. 4: 4 to 6). Experimental implements have been used until breakage and, if not, for 3 hours. All the tools were hafted and employed by indirect percussion with a soft hammer. Breaks mainly appeared during splitting wood. Transverse breaks resulting from fracture by flexion were the more numerous (Fig. 4: 5 and 9). Like archaeological samples, they have affected the distal and mesial part just at the limit of the haft. The second kind of fracture obtained is oblique (Fig. 4: 7). This damage resulting from lateral percussion applied to unblock bone tools deeply wedged in the wood. No longitudinal breaks, as we have observed on some archaeological pieces, have been obtained during our experiments. But one experimental tool shows a longitudinal hairline fracture in its lower side (Fig. 4: 10). All the edges are rounded and present micro-flakes, in particular on the "contre-plateforme" side (Fig. 4: 11). Splitting wood produces the more invasive use-wear. Traces could be observed on the "plateforme" and the "contre-plateforme", but also on the upper and lower side of the active part. Experimental use-wear patterns show some differences between pine and birch. In the case of birch, the surface is flatter than for pine, and the striations are thinner and less deep. Archaeological use-wear traces seem closer to pine working than birch working (Fig. 4: 14). Use-wear resulting from splitting pine affected most of the 45° bevelled bone tools from Zamostje.

4. Discussion

45° bevelled bone tools have a specific morphology. Due to their formal standardization, they constitute a strong typological category which is easy to recognize. From the technological point of view, we can also note a strong standardization and, specially, in the shaping processes of the active part. This standardization contrasts with use-wear patterns. Use-wear analysis shows that tools have probably been used for working wood and mostly by indirect percussion, with a soft hammer. Distribution and characteristics of traces suggest different kinematics and so different functioning: grooving and splitting wood. The design of 45° bevelled bone tools, which are long and thin, perfectly fits within both purposes. And further, cases of traceological overlap exist but are not so frequent.

In our opinion, 45° bevelled tools were employed at different steps of the "chaîne opératoire" dealing with wood production. Considering the archaeological context, their use could be linked to fish trap manufacture involving long pine rods. They could have been used to extract long wooden rods by grooving then splitting, and were broken at different steps. This proposition could explain the variability in the use-wear patterns: fractures, distribution of the traces and organization of the striations.

Acknowledgements

This study was carried out as part of a research project entitled "*Recursos olvidados en el estudio de grupos prehistóricos : el caso de la pesca en sociedades meso-neoliticas de la llanura rusa*" (HAR2008-04461/HIST), supported by the Spanish Ministry of Science and Innovation and directed by I. Clemente Conte.

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CHAPTER FORTY FIVE

RECOVERING THE OLDEST BONE TOOL ASSEMBLAGE FROM LOW PARANÁ WETLAND

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Abstract

This work presents the bone-tool assemblage from the oldest site with bone technology known in the area of Low Paraná wetland: Isla Lechiguanas 1; dated to ca. 2200 years BP.

Until now, information of the area came from sites dated to approximately 1000 years BP. In those cases, morphological and functional standardization was interpreted as a moment of a well-defined techno-complex. According to a previous model of bone raw material exploitation, higher variability is expected for the Isla Lechiguanas 1 sample as the result of an early stage of experimentation.

However, our results show that standardization was already established at 2200 years BP, showing a high correlation between form, function and bone used as raw material.

Keywords: Bone tools, use-wear, function, bone raw material.

1. Introduction

The archaeology of low Paraná wetland (LPW; South America, Argentina) is well-known because of its complex bone technology. Literature on this topic has notably increased in the last ten years particularly on one sector: the River Lowlands (RL; Fig. 1). Sites, dated to 1000-700 C14 years BP, include a varied assemblage of bone tools: harpoons, awls, drilled points, stemmed points, flat points, bipoints, smoothers and hooks from spearthrowers. Morpho-functional groups (MFG) are distributed homogenously among sites. Moreover, each MFG shows inter-site standardization in morphology and taxonomical/anatomical element used as raw material. According to use-wear analysis, most of them also share microscopic patterns, suggesting they were used on the same activities and materials. In other work I proposed that this situation represents a well-established moment of bone material exploitation (Buc 2010). Early stages, implying experimentation with bone as raw material, should have occurred to the north in the Paraná basin.

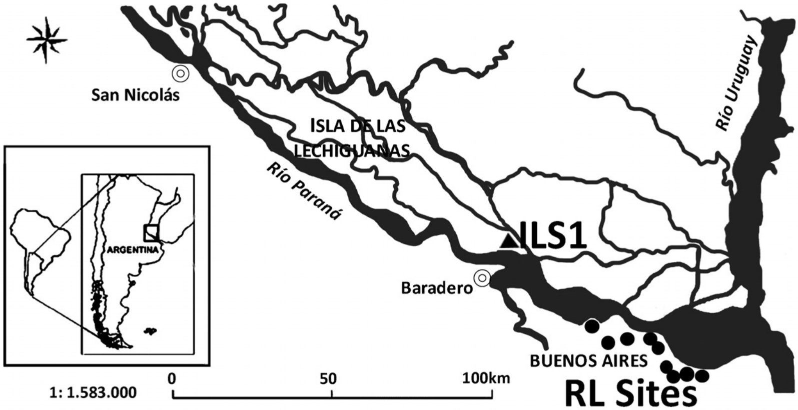

Fig. 1 Area of study: South America, Argentina: Later sites from River Lowlands (RL); Isla Lechiguanas sitio 1 (ILS1).

The current paper brings new and critical evidence for this discussion since it analyzes the earliest site in the LPW with bone technology: Isla Lechiguanas 1 (ILS1). It is located in the Homonym Island; further north than the later RL (Fig. 1). The excavation was directed by Loponte and Acosta in 2011, but Caggiano (1984) worked at this site 30 years earlier. The stratigraphic sequence includes: 1) a ceramic layer, dated to 408 ± 30 years C14 BP (AA97462 1451-1626 cal years AD; Loponte et al. 2012), 2) a malacological deposit, dated to 2740 ± 80 C14 years BP (AC0122 1052-552 cal years BC) and 2550 ± 90 years C14 (AC0124 800-405 cal years BC; Caggiano 1984), 3) a non-ceramic moment, dated to 2296 ± 34 years C14 BP (AA97467 392-206 cal years BC) and 2267 ± 34 years C14 BP (AA97461 386-185 cal years BC ; Loponte et al. 2012). For the aim of this paper, we will focus on the earlier components. In general terms, they it maintains the properties of RL hunter-gatherer sites: high quantities of bone (mainly fishes, marsh deer–Blastocerus dichotomus–and coypus–M. coypus–), scant lithic artefacts, and numerous bone tools. The most significant difference in faunal representation is the absence of pampas deer–Ozotoceros bezoarticus–that is not available in the island. However, the remarkable aspect is that this context is only one in the LPW without pottery remains (Loponte et al. 2012).

Considering the aforementioned model, it could be suggested that bone raw material selection and use-wear will show more variability in ILS1 assemblage than in later RL sites. Artefactual forms would have not accomplished defined functions in the experimentation stage as they did in the exploitation phase. Particularly, in ILS1 is expected:

High MFG variability;
Low standardization in MFG bone raw material;
Low standardization in MFG use-wear.

2. Methodology

Firstly, the sample was classified into MFG according to local types. Then, morphologic, physic and microscopic structures were analyzed. Data published in Buc (2010) from RL were used to compare these results. For microscopic analysis binocular and incidental microscopes were used, between 10X and 200X. Archaeological patterns were compared with experimental ones, taken from our own work (Buc 2011) but also from other colleagues' work (e.g. D'Errico 1993; Griffitts, 2006; Legrand 2007; Maigrot 2003).

3. Results

The analyzed sample comes from 2011 fieldwork, and is composed of 25 items. As the focus of this paper is MFG variability, only groups with two or more items are considered.

3.1. Harpoons

Three harpoon heads were found, which are morphologically different from those of RL: ILS1 harpoons have a circular perforation and acute hook, while RL items have a rectangular perforation and less acute hook (Buc 2010; Fig. 2). Despite this, in both samples antler is always selected as the raw material.

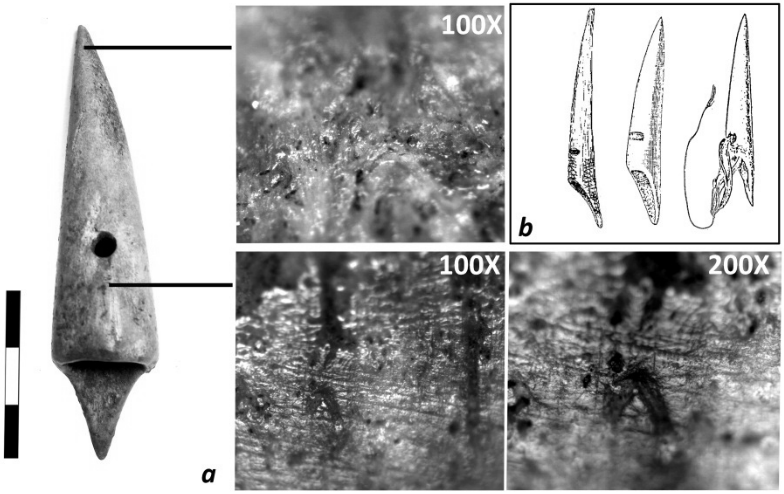

Fig. 2 Harpoon head. a) Microscopic rounded in the apical end, transverse, parallel and fine striations under the external perforation; b) Harpoon heads from later sites of River Lowlands.

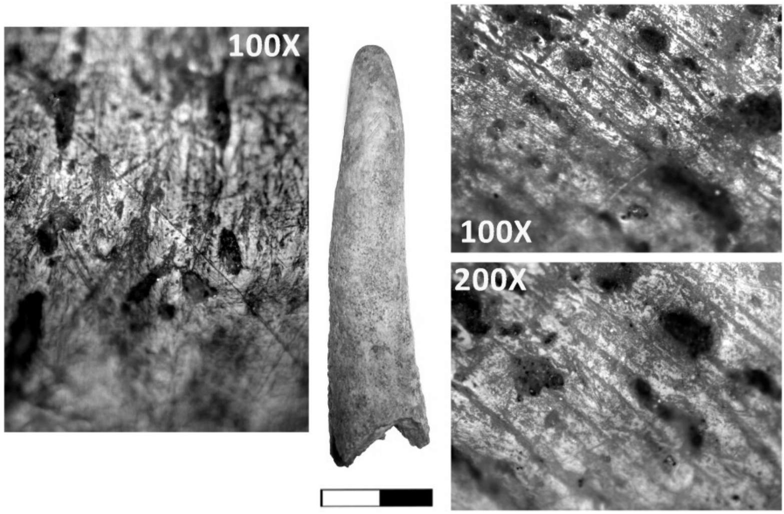

Fig. 3 a) Drilled point: microscopic rounded on the apical end, manufacture traces on the medial sector. b) Wedges: microscopic long, shallow and deep striations; plat micro-relief with smooth high points.

Both assemblages also share microscopic structures: no use-wear in the apical sector, but transverse and parallel shallow striations below the external perforation. This pattern was not replicated in experimental series with harpoons, but is similar to that obtained by scraping silica-rich plants (Buc 2011). Therefore, it could be suggested that the archaeological pattern was made by the rope used to tighten the point to the fisherman (Fig. 2).

3.2. Drilled Points

Three drilled points were found; all made on guanaco (Lama guanicoe) metapodials. Although this bone is used in RL, it is represented in low proportions, highly surpassed by pampas deer metapodials and antlers (Buc 2010).

In the microscopic structure, no striations were recorded. In RL samples, two microscopic patterns were found: one interpreted as a "perforation" pattern, and another similar to this one, which could be linked to projectile points (as it is similar to harpoons' apical end pattern; see the discussion in Buc 2010).

3.3. Flat Points

Four flat points were made on marsh deer ulna. One of them preserves the epiphysis, which has a microscopic pattern of multidirectional striations, interpreted as the result of manipulation. Despite this, flat points show no use-wear in the apical sector, only manufacture traces without modification. Since use-wear is developed in a relatively short time in bones (cf. Buc 2011; Griffitts 2006; Legrand 2007; Maigrot 2003), these points could be considered as expediency tools. Indeed, little time is invested in their manufacture, as deer ulna was selected taking advantage of its natural shape (Fig. 4).

In RL this MFG is rarely present and in low numbers also made from marsh deer ulnas. However, no micro-wear was recorded (Buc 2010).

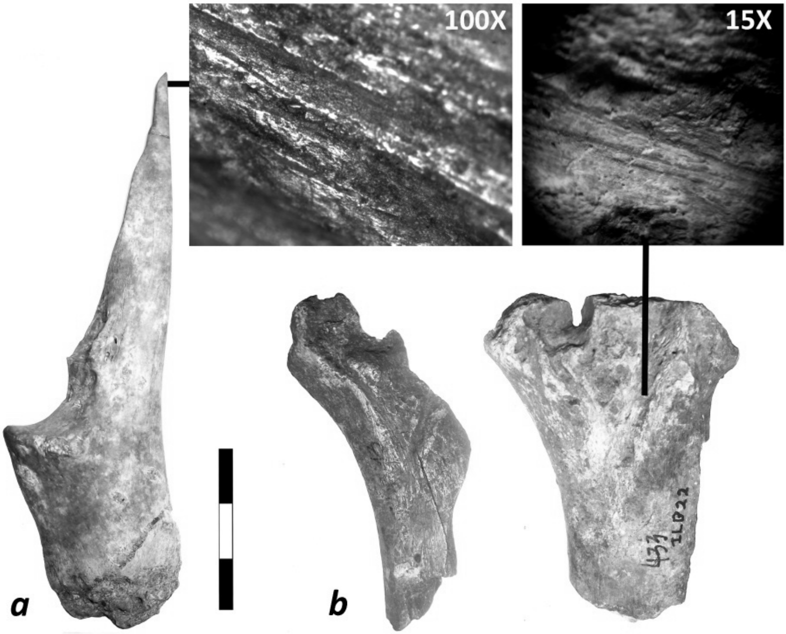

Fig. 4 a) Flat point and microscopic manufacture traces on the apical end. b) Radius with V cut-marks: microscopic coarse and V-shaped striations.

3.4. Wedges

Two wedges were made on antler. It is a novel group, not recorded in RL.

Apical ends are very bright to the naked eye. Under the microscope, longitudinal striations are recorded mostly in the internal face; they are long, shallow and deep. Micro-relief is flat with smooth high points. This pattern is similar to that obtained by wood (cf. Griffitts 2006; Legrand 2007; Maigrot 2003). A rubbing activity could be proposed, though specific experimentation is necessary.

3.5. Manufacture by-products

This group includes seven items: they are four antlers and three marsh deer radius with V cut-marks.

Under the microscope, V cut-marks are seen as wide coarse striations, made by a sharp cutting edge (Buc 2010). Following Clark & Thompson (1953) they can be interpreted as remnants of the grooving technique. It has not been reported in RL sites, although items were recorded to the north, in Middle Paraná (Buc & Pérez Jimeno 2010). In antlers, V cut-marks can be linked to the manufacture of harpoons, as they seem to be negatives of harpoons' acute hooks (the same is suggested for Middle Paraná sites; Buc & Pérez Jimeno 2010). Radius grooving, on the other hand, can be related to flat points made on ulnas. We presume that grooving on the radius was intended to separate bones carefully.

4. Discussion

ILS1bone-tool assemblage shows differences but also continuities with later RL sites. Among the differences: ILS1 tool variability is lower, but shows a morphological variant not previously recorded (wedges) and a morphological option of harpoons (similar to assemblages located north of the Paraná Guazú River; see Buc 2010 for a discussion). Alternative manufacture techniques are also seen after ILS1 manufacture by-products.

On the similarities, MFG represented in ILS1and RL show the same taxonomical and anatomical selection of bones as raw material. Antler is always used in harpoons, and marsh deer ulnas are chosen to make flat points. Metapodials are also preferred to drilled points, though in ILS1 guanaco is used instead of pampas deer, more frequently in RL. This difference, nonetheless, cannot be read as a technological choice, as it is the result of the ecological limitation mentioned above (Loponte et al. 2012). In the continuities, also remarkable is the existence of similar micro-wear patterns in harpoons and drilled points.

In reference to our initial model, results do not support our expectations. Although the ILS1 assemblage is less varied than later sites, this can be due to sampling bias. Both assemblages also share continuities: in ILS1 high standardization is seen in bones used as raw material and use-wear of each MFG, in coincidence with RL samples. As far as sampling, Caggiano (1984) published awls and drilled antlers, which are widely known in later sites (Buc 2010).

5. Conclusion

Conversely to our initial expectations, this sample does not represent an early stage of experimentation with bone raw material. Instead, by 2200 years BP, the LPW has already a well-established bone technology with strategies and material options that will persist for more than 1000 years. Experimentation should have occurred; therefore, in northern portions of the Paraná Basin, following either the Paraná or Uruguay rivers, considering that bone tools presented here are linked to a fishing economy.

Acknowledgements

This research was done in the frame of the project Tecnología ósea en la cuenca del Paraná. Avances desde el Humedal del Paraná Inferior-CONICET-INAPL. Microscopic analysis was made in IMICIHU-CONICET, thanks to the support of Dr. Nora Franco. Leonardo Mucciolo helped with the faunal determination. I also thank Alejandro Acosta and Daniel Loponte for their comments. The revision refined the manuscript with constructive comments.

Chapter Forty Six

Traces on Mesolithic Bone Spatulas: Signs of a Hidden Craft or Post-Excavation Damage?

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Abstract

Use-wear analysis of bone spatulas from the late Mesolithic sites of Hardinxveld-Giessendam Polderweg and De Bruin (Netherlands) revealed traces that resemble experimental wear from working plants. It concerns polish with a distinctive transverse directionality that was initially interpreted as coming from contact with plants. Comparison with the previous bone implements from the same sites, cast doubt on this explanation as these objects displayed traces not previously present. The hypothesis was that some of these traces could be due to handling and post-excavation treatment. In order to check this hypothesis experiments were carried out with working plant materials, notably nettle, and with various post excavation treatments like storage in paper and plastic and cleaning with acetone.

Keywords: Mesolithic, spatulas, post-excavation, experimental archaeology, hidden crafts

1. Introduction: the archaeological context, sample and methodology

At Hardinxveld-Giessendam, two locations, Polderweg and De Bruin, have been excavated under the direction of Louwe Kooijmans in 1997/98. Both locations have three occupation phases, but the largest assemblages come from phase 1 of Polderweg (5400-5100 cal BC) and Phase 2 of De Bruin (5100-4800 cal BC). They have both been interpreted as a winter base camp of hunter-gatherers. The worked hard animal assemblage consists of 597 bone and antler objects. The sample presented here includes c. 10% of the total. The tool types include spatulas, awls, re-used projectiles points, sticks and bird bones. This paper presents part of the functional analyses of a group of spatulas that display transversely oriented use-wear. The morphology of spatulas is quite characteristic: they are flat and slender items of 8/10 cm length, c. half a cm thick, with an oval diameter, with one or two tips, rounded or pointed. Most of the artefacts are covered with Paraloid B72 that makes the surface glossy and obscures traces of use and production. Not all the objects are in a good state of preservation; some of them present a severely degraded bone structure and widespread post-depositional modifications. The specimens were observed with a combination of a low power/stereo microscope, with magnifications between 10-160x, and a high power/metallographic microscope with magnifications between 50x up to 200x.

2. The functional evidence: distribution and directionality of the wear

After a first analysis with the metallographic microscope, it became clear that a substantial number of spatulas displayed a similar distribution and directionality of wear. Therefore, this evidence became the starting point of the analysis. The tips of all spatulas display traces of production developed by shaping the bone with a grinding stone and sand (Graziano, personal experiment), polish that resembles those of experimental plant working and scratches indicating a rotating motion (Louwe Kooijmans L. P. et al. 2001; van Gijn 2007). However, the main question regarding these tools arose from the distribution and directionality of the wear all along the central body. The central section of these implements is covered by striations oriented in a transverse direction to the length of the body and situated strictly parallel to each other, with a very coherent distribution on several different specimens. Moreover, these transverse wears are situated on the top of a very smooth and brilliant polish attributed to contact with plant material. In the very beginning of the research the possibility of a general taphonomic modification had been taken in account, but it was discarded because the distribution of the striations and gloss is limited to the central body of the spatulas and this pattern is visible on almost all the tools: these conditions cannot be fortuitous, they are more likely caused by a specific event.

3. Description: sub-types of transversal wear

In all cases it concerns groups of striations, visible within a zone with polish. After a careful observation of this transversal pattern, it has been possible to recognize different sub-types of striated zones and a different association with other features:

* Type 1 (illustration 1): this kind of striation is short in length, with a very distinct and consistent directionality. It appears on the most prominent surface of the bone. It looks like contact with an abrasive material.

* Type 2 (illustration 2): these kinds of striations are longer than type 1, and they follow the surface of the bone. The scratches are fine and grouped in clusters. They also lie on the top of a very smooth and reflective polish, interpreted as plant polish (van Gijn 2007).

* Type 3a (illustration 3): this kind of surface is an association of different elements. One is the presence of long and fine scratches, with clear directionality, but the distance between the wear and their length is variable. This surface develops all around the tool, and it is associated with rounded depressions, usually interpreted as handling traces (van Gijn 2007). The second element concerns long and fine longitudinal scratches all along the length of the tool (illustration 4).

* Type 3b (illustration 5) : another type concerns short and fine striations that bear a close resemblance to those of type 3a, but the striations are shorter and situated closer to each other. Usually this type of striations occurs in association with type 3a, but occasionally they can be found in isolation.

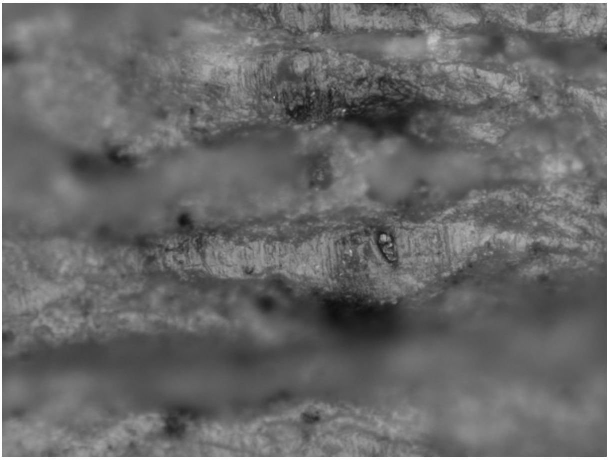

Fig. 1 type1

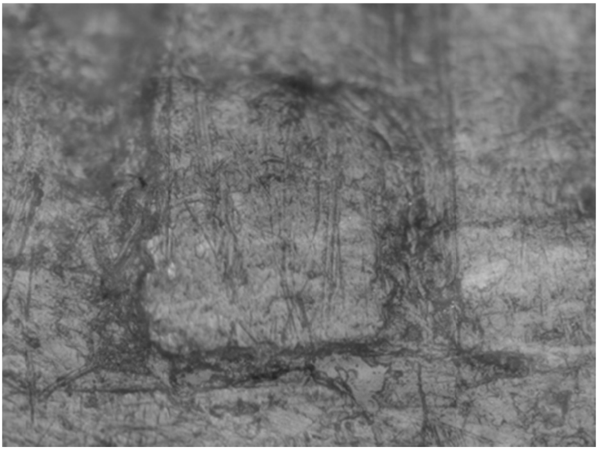

Fig. 2 type 2

Fig. 3 type 3a

Fig. 4 type 3a

Fig. 5 type 3b

At first type 1 to type 3b were all interpreted as evidence for plant craft activities such as net making, basketry and the production of fabrics. A first explorative experiment was therefore done mechanically moving a bone surface along a bunch of nettle fibres (illustration 6), to obtain transverse wear traces on a spatula. The experiment has been realized with a drilling machine. The surface on which it has been realized is not the original bone surface but a spatula experimentally re-sharpened with shark skin. This grinding procedure leaves a surface that is very rough with extremely strong directionality of the striations (illustration 7). The wear traces did not match those on the archaeological spatulas so clearly, it was essential to further study the life-history of these implements and look into post-excavation treatments.

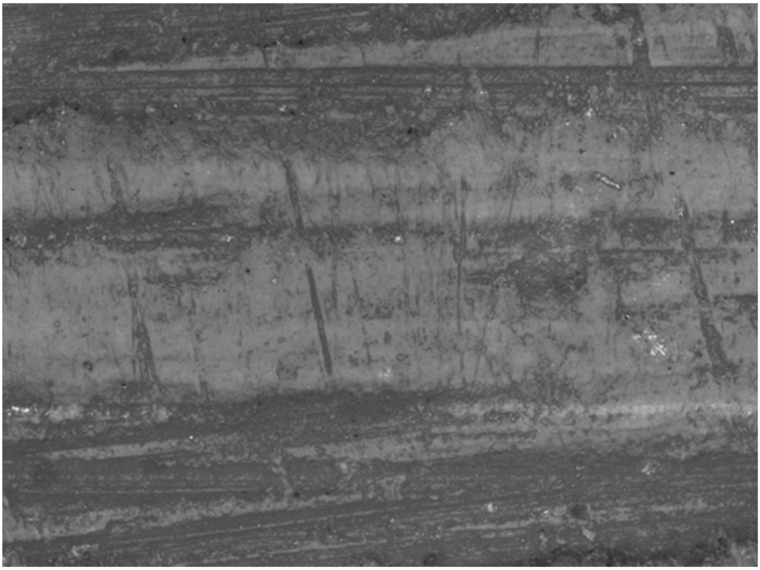

Fig. 6 experiment nettle fibers

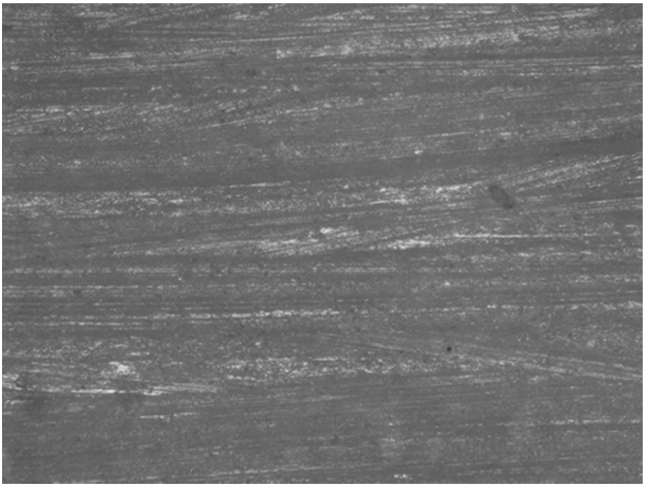

Fig. 7 re-sharpening with shark skin

4. Post-excavation modifications

While interpreting the life-history of artefacts from a biographical point of view (van Gijn 2010, 11), it became clear that we had to investigate the wear patterns caused by post-excavation treatments of the Hardinxveld-Giessendam bone collection. The modifications caused by post-excavation processes could theoretically be due to various phases of the post-excavation trajectory: the extraction methods from the archaeological context, the preservation, the restoration, and the study and drawing of the material. The experimental testing of post-excavation modifications could contribute towards a better understanding of the life-history of these tools. The experiments presented in this paper are not exhaustive, but they are just a preliminary investigation that aims to stimulate bone analysts: since the traces of wear develop on bone really quickly, are the analysts observing hidden crafts or post-excavation modifications?

This research can be seen as a first step in that direction, each experiment presented here being a departure point for more detailed and controlled experimentation. The experiments concern simulations of excavation conditions and manners of preservation and restoration of artefacts, involving paper towels, plastic sieves and cleaning solvents. They were recorded at four time intervals: after 30, 60, 120 and 240 minutes.

5. The Experiments

5.1. Experiment 1: extraction of the bones from the excavation context

The bones were recovered from a peat layer through manual excavations (Louwe Kooijmans L. P. et al. 2001a and b) and cleaned with cold water. The cleaning was done inside a machine that sprays water gently on boxes containing the remains. These boxes were lined with a plastic net. After the wet cleaning, the bones were drained on trays lined with plastic mosquito net (Tom Hamburg, personal observations).

To understand if these operations left wear traces, one awl and one spatula were subjected to mechanical movement inside a machine simulator (illustration 8). The surface of the experimental specimens shows that both with the cleaning sieve and the drying sieve there is development of transverse wear. The wear from contact with the cleaning sieve wear traces, which involved a lot of water, is more detrimental on the total surface of the tool than wear induced by the drying sieve.

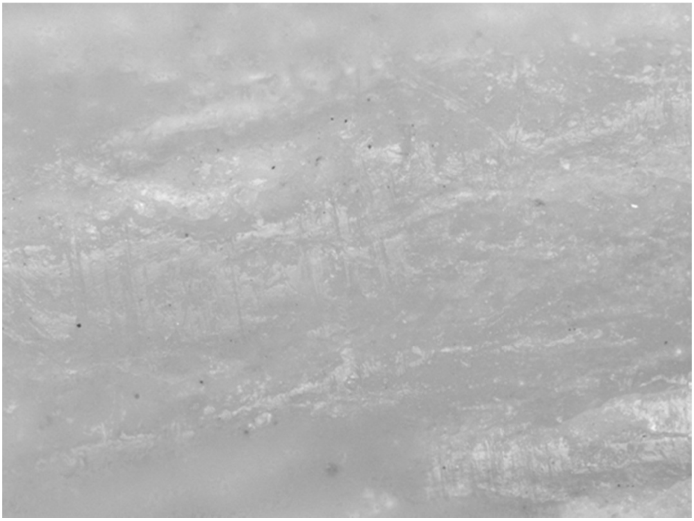

Fig. 8 cleaning sieve

5.2. Experiment 2: storage of the bone tools

The bone tools were stored in drawers lined with paper towels on the bottom. The same paper was occasionally used to clean off some sediment. To understand if the contact with this paper could leave wear traces, two experiments were performed. The first one consisted of rubbing the bone with the paper by hand for one minute (illustration 9). The second consisted of subjecting the bone to mechanical movement inside a machine for half an hour (illustrations 10 and 11). Both of the experiments show quite extensive wear.

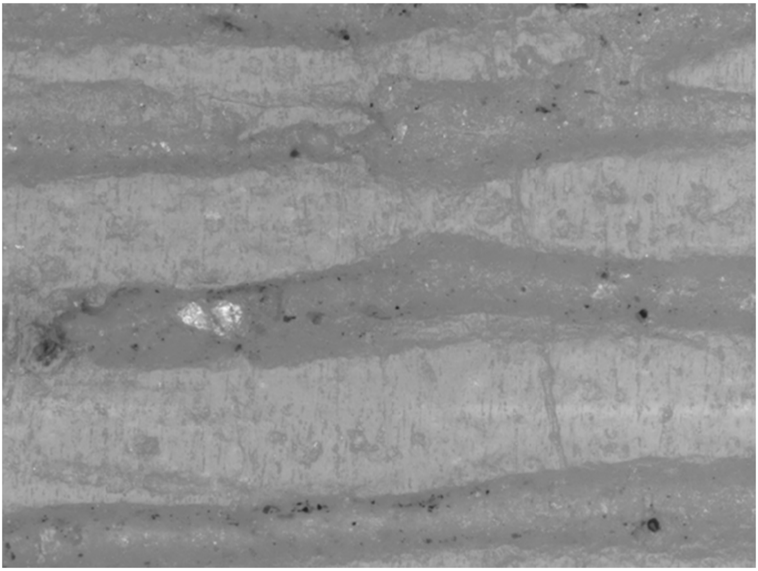

Fig. 9 paper: rubbing by hand

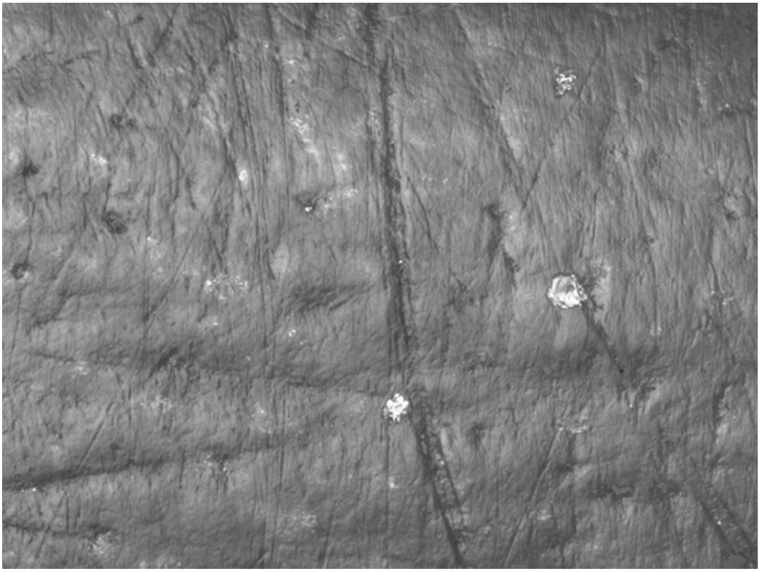

Fig. 10 paper: mechanical simulation

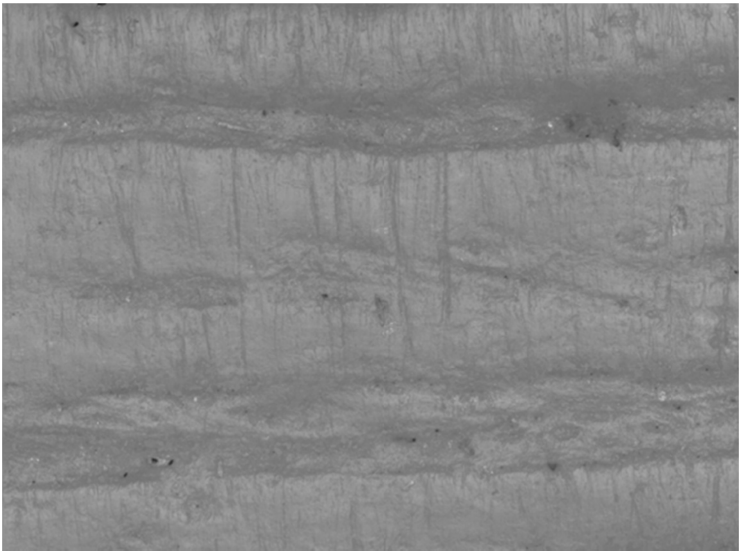

Fig. 11 experimental nettle wear before acetone

5.3. Experiment 3: influences of acetone on plant wear

After the excavations, some tools were preserved with Paraloid B72. The consolidant leaves a film on the bone surface that obscures the use-wear traces underneath it. Thus, some experiments were performed to understand if it is possible to remove the consolidator without removing the wear. The first step is to check the effect of acetone on the wear traces. For this experiment a bone surface with use-wear from contact with nettles (used for 3 minutes) was chosen (illustration 12). This bone was immersed in acetone for 1 minute, after which the acetone was neutralized by immersion in alcohol. This preliminary experiment only demonstrated that wear traces are still visible on the bone surface after limited immersion in acetone (illustration 13) (thesis Lallemand). one experiment removing PB72 from a tool showing pp had already been done by HL?? plant polish has ben done by Hélène Lallemand. It demonstrates that the removal of Paraloid B72 per 3 minute immersion in acetone does not modify the polish but there are no indications concerning striations (Lallemand 2008, 56-64). Moreover, the solvent was cleaned with paper (Lallemand 2008, 56), which we know leaves wear traces type 1. We still need to demonstrate that it is possible to dissolve the consolidant without leaving new wear traces and without modifying the striations.

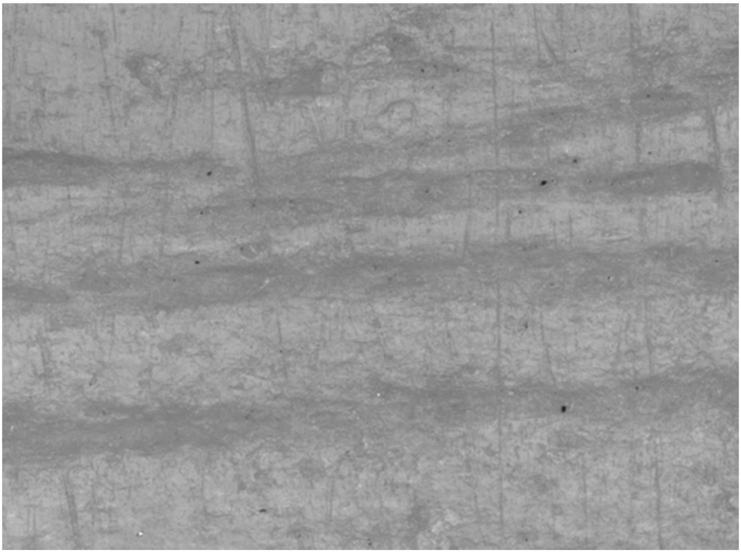

Fig. 12 experimental nettle wear after acetone

6. Conclusions

After these preliminary experiments, it is possible to draw some conclusions concerning the Dutch bone collection and the impact of post-excavation treatment on bone tools. Unfortunately, only one experiment has been performed so far concerning the impact of plastic sieves, which present only transverse wear because the experimental machine just does a back and forth movement. In reality this movement is probably not so regular, in fact on the archaeological finds we observe a consistent multi-directionality.

Contact with paper can influence the surface of the bone, creating modifications. These modifications are similar to plant polish and nettle wear. This is not so strange, because the paper is also made of plant material. Hand rubbing with paper is very damaging, and is visible on a substantial number of artefacts. In fact, in the long period between the first use-wear analysis of the bone and antler tools in the late 1990s and the present one, during which period the material was frequently handled by students, the objects have deteriorated enormously.

Nevertheless, because these post-excavation modifications can be easily distinguished, it is still possible to discern tools that were involved in plant-based crafts. It is however, not clear whether this concerns weaving, net making or yet another activity involving nettles or other siliceous plant materials. An important conclusion is that even moderate handling of bone artefacts can inflict substantial damage. It is therefore very important to stress the relevance of doing micro-wear research of these vulnerable objects directly after excavation. Bone surfaces are much softer than stone and not only do wear traces develop much faster, so do post depositional surface modifications and damage due to excavation procedures and post-excavation treatment.

Acknowledgments

A special thanks to: Annelou van Gijn, Annemieke Verbaas, Eric Mulder and Tom Hamburg, Leiden
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CHAPTER FORTY SEVEN

BONE TOOLS USE-WEAR IN AN EARLY FORMATIVE PASTORALIST SITE OF NORTHERN CHILE: WEAVING AND PIERCING AT THE DAWN OF HERDS

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Abstract

This paper presents the results of use-wear analyses on bone artefacts recovered from an Early Formative site from northern Chile (Tulan 54, ca. 3100-2400 BP). This site presents unquestionable ceremonial and ritual characteristics, associated with domestic activities. Through the implementation of an experimental program for the manufacturing and use of bone artefacts in piercing, skinning, loom-weave and sewing activities, performed over skin, leather and South American camelid wool; different kinds of use-wear patterns were obtained and analyzed at medium and high magnifications in binocular and SEM microscopes.

The images obtained, allow us to evaluate the hypothesis related to the use of these bone tools on the site, revealing manufacturing activities until now underestimated for the site and area, during a period characterized by the presence of fully domesticated camelids, interchanges of goods at

small, medium and long distances, and the appearance of complex ritual architecture.

Keywords: Bone tools, Use-Wear Analysis, Early Formative, Northern Chile, Zooarchaeology

1. The Archaeological Site, Tulan-54

The site is located at 2.950 m m.b.s.l. on the southern sector of the Tulan creek, in the southeastern corner of the Atacama's Salt Lake, Northern Chile (Fig. 1). The site corresponds to an Early Formative occupation dated through C14 to between 3080±70 BP (OXA-1840) and 2380±70 BP (Beta-1988843) (Núñez et al. 2006). The architecture is characterized by different sectors that demonstrate a complex spatial arrangement with a central temple composed of several sub-circular structures surrounded by a perimeter wall, presenting 24 newborn human inhumations, buried with offerings at the base of the occupation. Tulan-54 constitutes a milestone in the research of the process of social complexification in this area of the Andean region, characterized by the intensification and consolidation of productive practices, mainly related with the management of camelid herds (*Lama glama*) and the surplus production of beads, the emphasis in certain ritual expressions, and the use of ceramics (Núñez et al. 2009; Núñez & Santoro 2011). Considering the abundant presence of camelid wool fibres and loop fabrics in Tu-54, as the evidence of skin and leather artefacts in other contemporary sites of the Tulan creek (Tu-55) (Núñez et al. 2006), a hypothesis related to the processing of these materials was formulated.

2. Bone Technology in Tulan-54

During successive fieldwork seasons, 97 archaeological bone tools were recovered from Tulan-54. These artefacts were cleaned and analyzed under strictly morphological criteria, based on the active portion and the cross-section morphology. Once anatomic and taxonomical analyses were performed, the artefacts were separated, measured, weighed and registered in an ad-hoc database. According to Scheinsohn (1997), the tools were classified under three main categories (with the exception of one single bevelled artefact): A) Pointed, with "the convergence of the borders of the tool at one end, configurating an active tip", B) Dull Pointed, where the tip has been blunted, reducing its potentiality as awl or drill; and C) Rounded, tools with an extremity completely blunted, with a curvature close to the circumference. As the major part of round-ending artefacts presents evidence of being used as lithic compressors, this morphology was excluded, resulting in a sample of 41 artefacts analyzed in this work. The artefacts were observed at different magnifications, between 10 and 500 magnifications (preferably between 40X and 150X), using an Olympus® stereomicroscope at 60X; subsequently were analyzed in an Olympus® metallographic microscope.

Figure 1. Site location. (Modified from Cartajena 2011:271)

Tool	Active portion	Cross Section	Category	Angle	Action	Time	Strokes	Material
1	Pointed	Rectangular	Awl	45°	Pierce	10'15"	150	Skin
2	Pointed	Rectangular	Needle	90°	Sew previous perforations	12'	400	Skin
3	Pointed	Semicircular	Awl	45°	Pierce	14'40"	60	Skin
4	Pointed	Triangular	Awl	45°	Pierce	11'20"	100	Skin
5	Pointed	Triangular	Drill	45°	Bi-direccional drilling	10'12"	100	Wet Skin
6	Dull Pointed	Oval	Batten	45°	Sliding pressure	30'	2000	Wool
7	Pointed	Triangular	Drill	45°	Bi-direccional drilling	10'20"	60	Skin
8	Pointed	Circular	Needle	45°	Embroder	12'15"	360	Wool
9	Dull Pointed	Semicircular	Batten	45°	Sliding pressure	25'	1000	Wool
10	Dull Pointed	Triangular	Batten	45°	Sliding pressure	11'20"	1000	Wool
11	Straight border	Rectangular	Batten	45°	Sliding pressure	12'10"	1000	Wool
12	Pointed	Circular	Awl	45°	Pierce	23'50"	1000	Skin
13	Dull Pointed	Oval	Shuttle	<35°	Loom Weaving	+ 48 h	2000	Wool
14	Dull Pointed	Oval	Batten	90°	Sliding pressure	+24 h	1000	Wool
15	Pointed	Triangular	Awl	45°	Pierce	11'20"	700	Skin
16	Pointed	Triangular	Drill	90°	Bi-direccional drilling	16'15"	200	Skin
17	Pointed	Triangular	Drill	90°	Bi-direccional drilling	4'15"	60	Skin

18	Pointed	Triangular	Awl	90°	Pierce	8'	400	Skin
19	Dull Pointed	Rectangular	Batten	90°	Sliding pressure	+24 h	1000	Wool
20	Convexe border	Rectangular	Scrapper	35°-45°	Skin cleaning	30'	400	Wet Skin

Tab. 1. The table shows a synthesis of the experimental bone tools and activities performed.

The collected data includes information concerning the length, depth and width of the striations and polish of the surface, based on the criteria defined by Buc (2011) and LeMoine (1994). The location of these indicators, as well as their intrinsic/extrinsic disposition relative to the axis of the tool, was also detailed.

3. The Experimental Design

The bones were taken from three different animals: Sheep (*Ovis aries*, LINNAEUS 1758), Goat (*Capra hircus* LINNAEUS 1758) and Red Deer (*Cervus elaphus*, (LINNAEUS 1758).

In total, 20 artefacts were elaborated, of which 10 were prepared with pointed morphologies and 8 with blunt tapered morphologies. The artefacts were described in metric terms and photographed. The characteristics of the artefacts included in the present paper, and also the tasks performed and motion are described in Table 1. Even when the analysis was mainly based on the number of strokes (according to the nature of the experiment), the time of work was also considered in order to keep information for possible further studies.

The analysis of experimental bone tools was developed mainly with a stereomicroscope in a range of magnifications between 18X to 110X, and registered with a dedicated Deltapix® model "InfinityX" camera connected to a computer with an image processing software. As external illumination equipment an optic fibre lamp Olympus® was used. These observations were supported by an Olympus® metallographic microscope up to 500X, and some of the artefacts were also observed in an Electronic Scanning Microscope JEOL®, model JSM-6400.

4. Results obtained on experimental materials

At a microscopic level, the experimental artefacts used for textile work reveal the low invasiveness of wool working. Of the eight tools made and used on wool, obvious signs of striations were indistinguishable in three of them, even under an electron microscope. The low visibility of the striations undoubtedly lies on the low abrasiveness of wool, since in different actions, and different numbers of strokes, it was impossible to develop more than very fine striations, usually isolated, but oriented consistently with the respective working direction. One of the pieces, however, exhibits traces oriented transverse to the axis of the work piece, even when the direction of the motion was clearly longitudinal. It seems fairly clear that the most useful criterion for distinguishing bone artefacts involved in wool related work, is a smooth polish, extended and which tends to obliterate the traces of manufacture attacking both the bone surface as the bottom, edges and cusps of the manufacture micro-wear (Fig. 2).

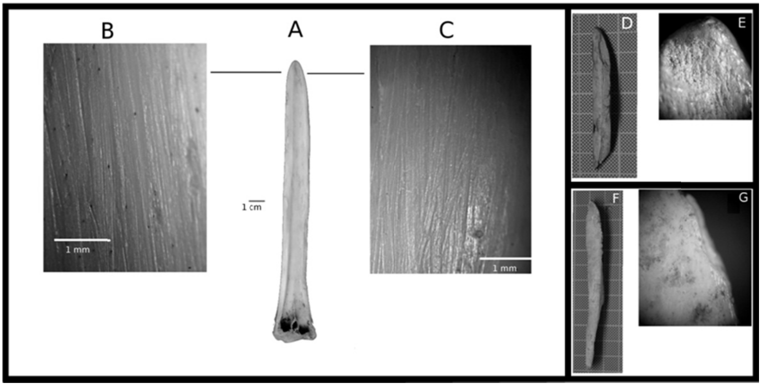

Figure 2. A) Experimental artifact N° 13, Used as Shuttle; B) surface before use, 110X; C) Surface After use (+1000 strokes), 110X. Note the intensive polish; D) 2W-E3 archaeological tool, E) 40x Metallographic image or distal portion; F) H2-40-50 archeological Tool. G) 40x metallographic image at distal border.

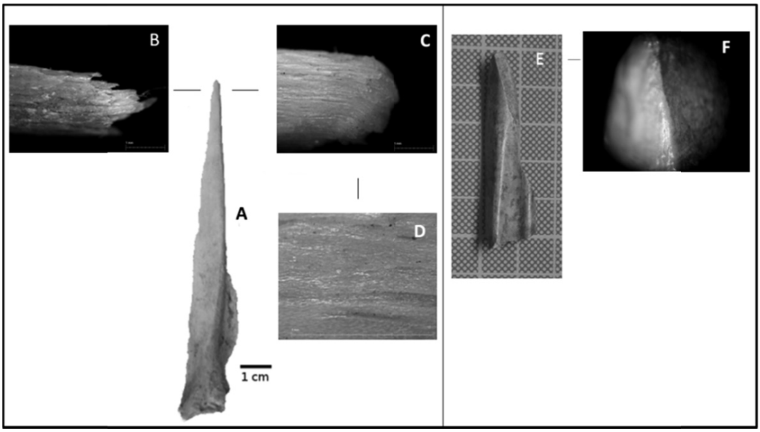

Figure 3. A) Experimental artifact N° 3, Used as awl to pierce dry leather; B) Distal extreme before use, 40X; C) Distal extreme After use (60 strokes), 40X. Note the intensive rounding; D) detail of distal extreme ater use (60 strokes), 110X. E) Archaeological tool (D7-140-145) at 40x; Metallographic image of distal extreme; F) Distal extreme of Archaeological tool (D7-140-145) at 40x; Metallographic image.

The work on skin generates thin striations, with smooth and polished borders. The pointed artefacts used as awls, with unidirectional penetrating movements at different angles over the skin, present longitudinal striations, always with low intersections and slight variations in the intensity of the polish, which tend to be intense.

In the case of the artefacts used in the form of drills, with rotated movements over the axis of the instrument, the characteristics of the grooves tended to vary, not only in terms of location and internal organization of the tracks, but also in relation to their metric characteristics. Striations, in this case, are slightly wider, with a weaker polish at the striation border (Fig. 3).

5. Results obtained on Archaeological remains

A total number of eight archaeological artefacts present use-wear related with activities on wool. Of these, five are attributable to the technological category of "batten", known within the Andean region weavers as “Wichuña” (artefact used to tighten the fibres in the loom to get a most resistant and compact weave); and another two as "shuttles", used to transport the warp in the loom. Five of them had very similar use-wear patterns: thin striations, transversely oriented to the axis of the work piece, slightly invasive with polished cusps, cross-linked and ungrouped, covering portions of the distal and medial portions of the tool, without rounding and with scattered polishes. However, two other exhibit traces revealing fine and non-invasive use-wear, are arranged longitudinally to the axis of the artefacts and parallel to each other, not grouped into specific points on the bone micro-topography but rather scattered in the distal portion. The same happens to the polish that, similarly to the traces observed in the experimental artefact number 13 used as a shuttle for weaving in loom, shows no rounding wear (Fig. 2).

Eleven artefacts exhibit characteristics related with skin processing. Three of them were clearly used as awls and eight as drills. This preference for a drilling motion could be explained by the major effectiveness of this kind of movement to achieve control in the shape of holes in the skin. Some of the artefacts, performed in diaphyseal fragments, exhibit a very low anthropic shaping in the middle and proximal portions, but a very developed active extremity on the distal portion. These artefacts exhibit use-wear and bone deformation similar to the observed in experimental tools used to pierce dry skin (Fig. 3).

6. Discussion and Conclusions

The work over animal soft materials seems to have had a discrete development in Tulan-54 site. Nonetheless, evidence of working in wool and skin are clear, and could be very well understood within a social system oriented to the maintenance of herds of llamas (*Lama glama*, Linnaeus 1758) as a draught animal, in conjunction with the hunting of wild camelids as Guanaco (*Lama guanicoe*, Müller 1776) and Vicuña (*Vicugna vicugna*, Molina 1782) for meat (Cartajena et al. 2007; Núñez et al. 2006). In both of these animals, the human groups could also obtain raw materials like skin, fur and fibres.

Moreover, expedite bone tools analyzed in concordance to experimental approaches and use-wear analysis, present a new outlook for a particular group of artefacts whose morphology appears to have been generated by use, and not by further manufacturing processes. These observations confirm interpretations that were made in the context of a previous work (Santander 2009), referring to the use of long shaft fragments obtained from the fracture of long bones for marrow extraction as tools. As metapodials and phalanges concentrate a high proportion of oleic acid, which gives the marrow fat certain properties, such as rapid melting and a good aptitude for storage (Munro & Bar-Oz 2005), the fracture of these bones could allow the acquisition of rich nutrients and expedite, but effective, raw materials.

Acknowledgements

This paper is result of a Master thesis developed under the funding of the Erasmus Mundus Master in Quaternary and Prehistory at IPT/UTAD, Portugal. Experimental activities were developed in the Instituto Terra e Memoria of Mação, Portugal and several analyses were performed at IPHES in Tarragona, Spain. The archaeological artefacts were recovered in excavations funded by the Chilean National Scientific Research Funding (FONDECYT projects 1020316 and 1070040), leaded by Lautaro Núñez and Isabel Cartajena. My acknowledgments also to Sara and Pedro Cura, Jedson Cerezer and Nelson Almeida from ITM, Mação; and to my M.Sc. advisor, Stefano Grimaldi.

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CHAPTER FORTY EIGHT

ATYPICAL USE OF BONE OBJECTS OF KNOWN FORMS FROM SOME EAST EUROPEAN UPPER PALEOLITHIC SITES

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Abstract

This paper represents an analysis of some atypical use-wear traces on bone objects from the following East European Upper Palaeolithic sites– Zaraysk, Gonzy, Anetovka-2, Byki-1, Byki-7 (layer I), Byki 7 (layer Ia). Particularly, the analyzed bone objects do represent specific cases when the shape of an object does not give us a clue about its use or function. Indeed, some morphologically similar objects could have different functions. That is why it is important to realize that nowadays we, the 21st century people, are not always able to imagine a real use variability of many Palaeolithic worked bone pieces.

Keywords: East European Upper Paleolithic, worked bone objects, use-wear analysis

1. Introduction: Atypical use of bone objects of known forms from some East European Upper Palaeolithic sites

This paper represents an analysis of some atypical use-wear traces on bone objects from some East European Upper Palaeolithic sites–Zaraysk, Gonzy, Anetovka 2, Byki-1, Byki-7 (layer I), Byki 7 (layer Ia). As it is known, the kinematics of many utilitarian worked bone objects is often predetermined by their shapes. Therefore, based on shape characteristics, many bone objects are functionally interpreted without the use of use-wear analysis. In many cases, such an approach is correct. At the same time, only a real use-wear analysis allows us to identify the correct contact material, as even with similar kinematics, the objects could be used in several different ways. In this paper, the author discusses only the most interesting examples after studying collections where the shape of an object cannot give us a clue about its use or function. The presence of such artefacts forces us to be more careful and precise in the identification of use-wear traces for bone objects coming from both new and old excavations, although even a thorough use-wear analysis does not always bring us to an unequivocal interpretation on the functional use of an object. Nevertheless, it is still possible to recognize some possible use, and definitely exclude certain activities for a tool.

2. Study methods

The used methods for micro- and macro analysis studies of worked bone objects are based on methodology developed by the Saint-Petersburg Use-Wear Lab (Institute of History of Material Culture, Russian Academy of Sciences) (Semenov 1952, 1957; Semenov & Korobkova 1983; Filippov 1977, 1983; Schelinsky 1983; Korobkova & Schelinsky 1996 et al.). All bone artefacts have been studied with magnification to 60x using a MBS-10 binocular microscope. Then, most pieces were also analyzed using a metallographic microscope “Polam” (magnification to 200x). A magnification from 10x to 50x is considered to be an optimal one as larger magnification leads to a loss of colour, fatness and density of polished areas that are so necessary for the recognition of a contact material. The study of wear area location, and its characteristics and macro-traces are also significant. A larger magnification for bone object analysis was usually used for the most precise kinematics refinement. The realized analysis was also based on both samples of the author’s own experiments and the experimental samples of the Saint-Petersburg Use-Wear Lab.

Non-utilitarian artefacts are the most difficult for a use interpretation. Archeologists usually do pay more attention to the morphology of pieces, the technology of their production and the context of their discovery. But the use-wear study, in combination with some other data, allows us to get closer to a real understanding of object meaning (Akhmetgaleeva 2010).

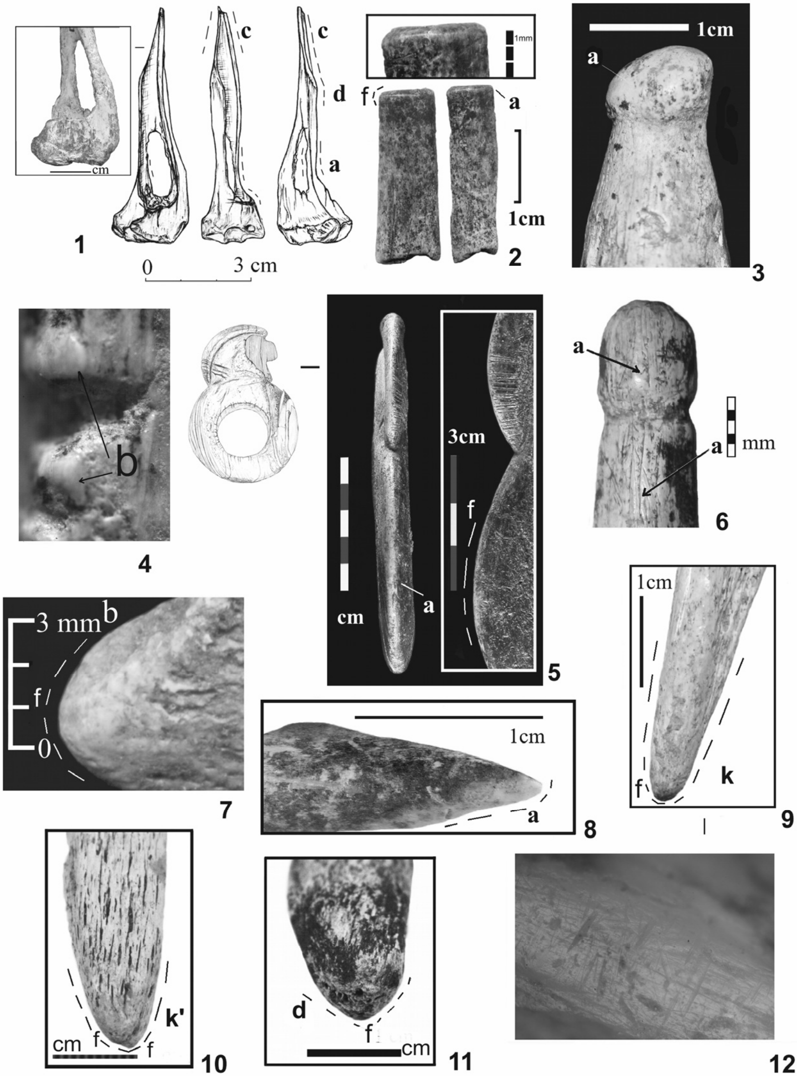

Fig. 1. Worked bones with use-wear traces: 1 – awl with a hole on rabbit tibia bones, Gonzy site; 2 – bead from a small-sized animal's bone tube, Byki-7 site (layer I); 3 – use-traces on feet of an anthropomorphic ivory figurine, Zaraysk A site; 4 – use-traces on an ornamented fragment of a horse's rib, Byki-7 site (layer Ia); 5 - use-traces on a zoomorphic ivory figurine, Byki-7 site (layer I); 6 - use-

traces on a rod-ornamented ivory piece, Zaraysk A site; 7 - use-trace on a pointed flake of a flat large mammal (mammoth?) bone (a tool for some no through-holes' elaboration), Zaraysk A site; 8 - use-traces on a cutting tool produced from a reindeer's tibia bone flake, Byki-7 site (layer Ia); 9 - tip wedge on a long bone of a large-sized ungulate, Anetovka 2; 10 – tip wedge on a mammoth rib, Gonzy; 11 - tip wedge on a mammoth rib, Gonzy; 12 - use-traces on the wedge of №9, macro x 200.

3. The East European Upper Palaeolithic bone objects: the studied examples

3.1. Beads from Byki-7 site (layer I) (ca. 17000 BP uncalibrated, excavated by N. B. Akhmetgaleeva; Akhmetgaleeva 2004)

15 pipe-shaped beads made on the long bones of small animals (bird, hare, and arctic fox) have been found at the site's layer I. The lengths of the beads vary from 1.8 to 2.4 cm (Fig. 1: 2). Only narrow stripes on the beads' edges are polished. These use-traces are clearly fatty indicating the beads' contact with a hide. The polish covers the beads' edges and extends out to their external sides. The internal surface of the holes is not polished. The observed use-traces cannot definitely tell us a function of these pieces, but it could well be that strips of hide were used for connecting the beads (Akhmetgaleeva 2010, 212-213).

3.2. Ornamented fragment of a horse's rib from Byki-7 site (layer Ia) (ca. 16000 BP uncalibrated, excavated by N. B. Akhmetgaleeva; Akhmetgaleeva & Burova 2008)

One edge of a horse's rib fragment is covered by a series of short perpendicular lines after a sawing process. No less than 60 such lines are present there. The surfaces of the barbs are with an easy polish. The polishing is matte and superficial (Fig. 1: 4). It is possible that the barbs did have contact with clay. It is highly likely that the incisions on the artefact were of a utilitarian function.

3.3. An anthropomorphic ivory figurine from the Zaraysk site (ca. 22000 BP, excavated by H. A. Amirkhanov; Amirkhanov et al. 2009)

Some use-wear marks have been recognized on one of the site's Venuses–the largest ivory figurine found there (Amirkhanov et al. 2009, 218, 282). Its height is 16.6 cm. The head and legs are much more carefully crafted and smoothed than the rest of the body. The feet, as the head, are well handled by a mild abrasive (Fig. 1: 3). They have spots of a hide polish. It is not, however, clear–is it the only Venus figurine with such features or could similar traces be found on other female figurines coming from some other Eastern Gravettian sites? It is also of interest to note that the surface of one of the Zaraysk site's "head" rod-ornamented ivory pieces (4.4 cm long) also demonstrates an intensive oily hide polish on its "head" (Fig. 1: 6) that certainly smoothed out the micro-relief there (Amirkhanov et al. 2009, 264).

3.4. A zoomorphic ivory figurine from Byki-7 site (layer I) (ca. 17000 BP uncalibrated, excavated by N. B. Akhmetgaleeva)

A large-sized ivory ring from the site with a top shaped like a horse's head is unique for European Upper Palaeolithic (Akhmetgaleeva 2005, 2009). The edge of the artefact in its «mane» and the adjacent lower area of the ring reveal a clearly polished strip (Fig. 1: 5). Polishing even goes beneath the most superficial surface of the artefact. It is fatty and more yellow in colour than the piece's other areas. It is possible to say that this part of the artefact with the polished strip had contact with a skin or hide. On the other hand, it does not allow us to make a clear-cut suggestion on its function. We might only suggest that it was used for some ritual purposes, because the location of the contact area is hardly compatible with a utilitarian function.

3.5. Various bone tools from several different sites

A special variety of functions have been observed for some tools made on bone, ivory, reindeer antler, random fragments and flakes. They served as piercing tools, cutters, wedges, shovels, retouchers, etc. (Akhmetgaleeva 2006, 2012; Amirkhanov et al. 2009; Sergin & Akhmetgaleeva 2008).

It is also worth noting that bone tools used for similar contact materials do vary by kinematics (Fig. 2: 6, 12). At the same time, tools with similar kinematics have use-wear traces after some work with different materials having variable characteristics (being wet, cold or dry). For example, traces of a contact with sand are different from the traces of snow, frozen or wet sand and silty sediment (Fig. 1: 9-12).

Some important results come after analyses of objects whose function seems to be clear because of their specific morphology (Akhmetgaleeva 2006). For instance, there is an interesting variation of traces for pieces used for digging (Fig. 2: 10-11). In analyzing bone points, it was well established that their function could actually be very different (Fig. 1: 1, 7-12; Fig. 2: 1-6, 8-9). Changes in manufacturing technology and morphology also usually mean modified kinematics and/or contact materials. The most indicative examples of such cases are given below.

3.6. Flat elongated shouldered borers from Byki-1 site (ca. 18000 BP uncalibrated, excavated by A. A. Chubur; Chubur 2001).

The borers have been manufactured on ribs (13 examples) and long bones (2 specimens) of reindeer and horse (Akhmetgaleeva 2006, 196, 200). Their length varies from 3.5 to 9 cm (Fig. 2: 1-5, 8-9). The short tip on some of the tools is a result of their breakage or rejuvenation. Use-wear traces are either absent or weakly present on the borers. The study of complete pieces has shown that apart from just one large-sized object (Fig. 2: 5), none of them were piercing tools, awls, pins, etc. Their precise function remains unknown. According to the present author's special experiments, it could be that they were inserted into already made holes. That is why it is possible that they were used as a component of some complex yet unknown objects. Borer tips have only contacted with a rather soft material (Fig. 2: 1-4, 8-9) that is different from a hide. The closest wear marks correspond to a short-term contact with clay. The side parts of the borers have spots of a skin polish (from a user's hand?). Also, there are some other use-wear traces on the borers. Particularly, there were recognized some rubbing traces after sandy material on the rounded base of one borer (Fig. 2: 4). As a result, some borers did probably serve as combined tools. Finally, it is also important to underline that all borers have been produced in a single technological way.

3.7. Awls with holes from Gonzy site (ca. 14500 BP uncalibrated, excavated by V. Ya. Sergin)

Two awls with minor fragmentation have been produced on rabbit tibia bones (Sergin & Akhmetgaleeva 2008). Awl tips were formed by double grooves, obliquely going on the bone axis. The basic feature of the awls is a deliberately punched oval hole of the size 1.8 x 0.6 cm (Fig. 1: 1). The holes' edge breaks are uneven with some transversal cracks. The holes' breakage features point out a possibility that they were also additionally damaged during the use of the artefacts. The break wedges are slightly worn out after contact with a solid material. The areas adjacent to

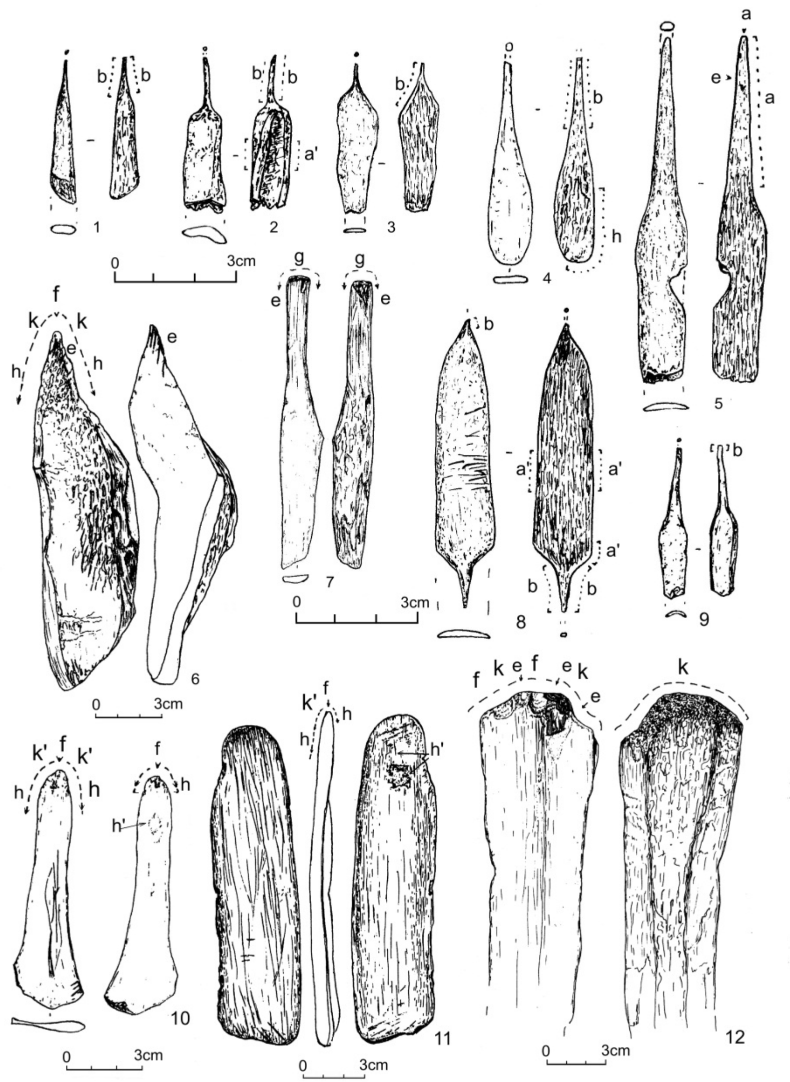

Fig. 2. Worked bones with use-wear traces: 1, 3-5 – flat elongated shouldered borers on rib parts of reindeer and horse, Byki-1 site; 2, 9 - flat elongated shouldered borers on tibia bones of horse and reindeer, Byki-1 site; 6 – pick on a tibia bone of horse, Byki-7 site (layer I); 7 – bevelled tool on a rib of horse, Byki-1 site; 8 – double flat elongated shouldered borer of an ungulate bone, Byki-1 site;

10 – spatulate on a mammoth hyoid bone for digging, Byki-7 site (layer I); 11 – an ivory shovel for digging, Byki-7 site (layer I); 12 – hoe from a mammoth tibia bone, Byki-1 site. Key: a – hide polish, a′ - polish, б – polish of indefinable soft, abrasive material (silty sediment polish?), c – plant polish, d – mixed polish, e – perpendicular line trace, k – loam polish, k′ - ice-soil polish (sand with snow), f – the maximal polish, h – abrasion, h′ – erosion of liquid materials, g –scarred thin edge

thin partitions of the holes are covered by fatty skin polish spots. Also, spots of plant and some mixed polish traces are present in the middle parts of the awls. It seems that the morphologically looking awls were actually used as parts of some binding systems: for example, this could be an intermediate tool for material stretching.

4. Conclusions

Functional analysis results are not always predicted at all. Indeed, they make us cautious on the use and function of many known bone artefacts. Also, it should be remembered that morphologically similar objects might have different functions. It is truly believed by the present author that this fact is no longer a doubt. Additionally, it is also of great significance to realize that we, the 21th century people are not always able to imagine a real use variability of many Palaeolithic worked bone pieces.

Acknowledgements

Russian Foundation has financially supported this work for Humanities, project 11-21-17003a/Fra. I thank my colleague dr. Yuri.E. Demidenko (Ukraine) for help in translating this article into English

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PART V:

FROM THE NEOLITHIC TO THE IRON AGE

CHAPTER FORTY NINE

INVESTIGATING NEOLITHIC ACTIVITIES: THE CONTRIBUTION OF FUNCTIONAL ANALYSIS TO THE RECONSTRUCTION OF SETTLEMENTS' ECONOMY IN CENTRAL-SOUTHERN ITALY

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Abstract

Between the late 7th and early 6th millennium BC, the Neolithic era arrives in Southern Italy by sea with Eastern Mediterranean people. The external origin of the Neolithic seems to be supported by the presence of well-organized villages with an already fully productive economy and ceramic production since their first occupation.

Being part of a wider project on the Neolithization of Italy, this work presents the results obtained from the study of lithic assemblages from a selected number of Neolithic sites: Ripa Tetta (Puglia), Maddalena di Muccia (Marche), S. Stefano (Abruzzo).

Our analyses show how the techno-functional approach to lithic tools can play a significant role in the understanding of the economic and/or cultural choices made by Neolithic groups.

Keywords: Neolithic, Italy, use wear analysis, lithic tools

1. Introduction

This work is part of a larger project that includes the study of materials found at several Neolithic sites of Central-Southern Italy. The purpose of this on-going project is to integrate the traditional studies of lithic tools with use-wear analysis, in order to obtain an exhaustive picture of the first Neolithic communities.

Between the late 7th and early 6th millennium BC, the Neolithic starts in Southern Italy when Eastern Mediterranean people arrive by sea and initially settle down along the coasts of Apulia. The external origin of the Neolithic is attested by the presence of well-organized villages with an already fully productive economy and ceramic production (impressed pottery of archaic type) starting from the oldest occupation levels (Torre Sabea, Trasano ecc…). As demonstrated by several studies, later on the Neolithic spreads inland and up to central Italy along two different paths separated by the Apennines.

The available data concerning the stone industries of those first phases enabled the scholars (Radi and Ronchitelli 2002) to outline a quite detailed picture of their characteristics. Some technological differences have been highlighted, such as the use of special production techniques and the resulting diffusion of different supports inside the complexes. Furthermore there are typological differences due to the quantitative variation of some groups of retouched manufactures.

A functional analysis of the materials has been undertaken in order to outline a general sketch of the activities carried out on the site and their impact on its economy. It was interesting to verify whether there was a change in use of the different typologies of instruments over time.

The analysis was carried out on samples of artefacts from a few sites, analyzed with both low- and high- approaches (Tringham et al. 1974, Keely 1980). This methodology permitted us to identify different use-wear patterns related to the various activities conducted on the sites.

Now we will deal with some of the most interesting results as yet obtained with the help of some relevant case studies (Fig. 1).

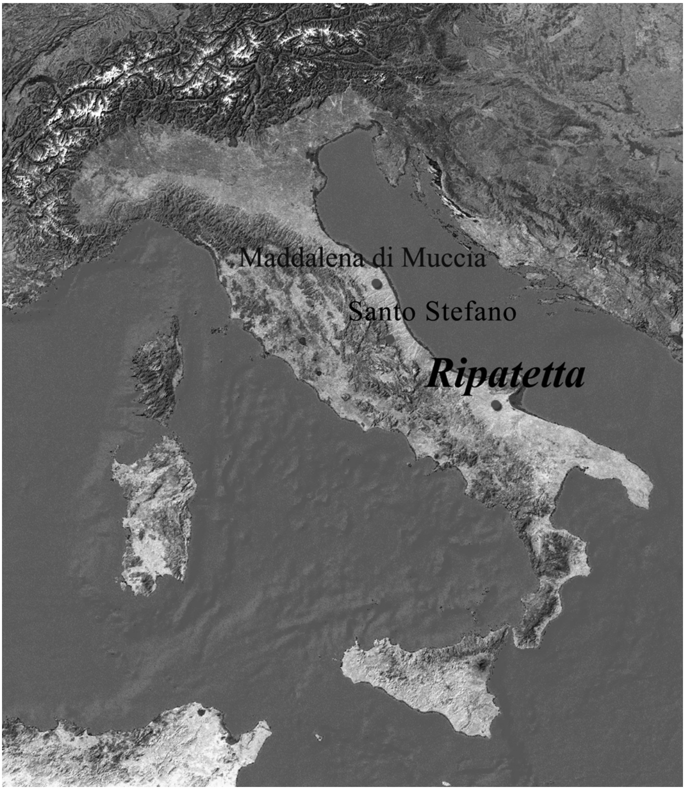


Fig. 1. Site distribution map.

2. Case 1. Ripatetta (FG, Puglia)

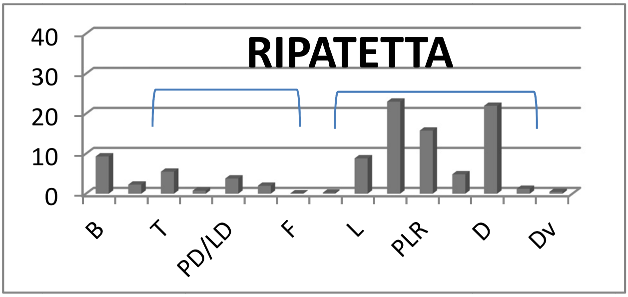
Ripatetta is among the oldest (6890+-60 BP, Beta-47808) and most important settlements in southern Italy (Tozzi and Tasca 1989). This site was investigated from 1982 up to 1992 by the University of Pisa in collaboration with the Ithaca College of New York. A sequence of surveys has shed light on entrenched settlements almost 90 mt in diameter.

On the lowest level, the archeological remnants can be assigned to the type Guadone of the impressed wear. From this to the upper level we can observe the gradual stylistic evolution into the Lagnano da Piede type.

The most used raw material is flint, both local and coming from surrounding areas, such as Gargano, while the diffusion of obsidian is really scanty (0.2%).

Technologically the management of raw materials should have been very complex (Collina 2009). As a matter of fact the local flint appears to be used in order to obtain both flakes and blades through the direct-percussion technique, with both soft and hard hammer.

Flint coming from external sources, on the contrary, is almost exclusively treated for preparing blades and bladelets by a number of different techniques: direct percussion, indirect percussion and pressure (Graph 50-1).



Graph 1. "Struttura elementare" (Laplace 1968) of lithic assemblages.

A functional analysis carried out on two samples of materials coming from two different areas A and B (100 elements from each areas), identifies some interesting aspects of the economy of the site and provides relevant information on the spatial organization of the settlement.

The analysis highlighted some internal peculiarities of every area (Table 1):

Inside A, beyond structures with various morphologies, the remnants of a hut have been found, consisting of a plaster floor surrounded by a series of holes. In this area there must have been major activity differentiation, as indicated by the diffusion of semi-soft materials, such as sickles for vegetable stuffs, whose presence is probably due to the nearness of this area to the cultivated fields.

Inside B, a cobbled pavement of around 70-80 sq.m in size was found, unfortunately partly damaged by modern ploughing activities.

	Ripatetta A	Ripatetta B
Total artefacts	2792	768
Artefacts analysed	100	100
Artefacts with traces	67	66
Meat	3,1 %	4,5 %
Hide	9,5 %	16,6 %
Butchering	0 %	4,5 %
Cereals	7,9 %	1,5 %
Plant/ Wood	12,7 %	12,1 %
Bone	3,1 %	3 %
Antler	0 %	0 %
Mat. Soft.	3,1 %	1,5 %
Mat. Semi-hard	23,8 %	24,1 %
Mat. Hard	1,5 %	10,6 %
Unknown	34,8%	21,2%

Maddalena di Muccia	
Total artefacts (sect. XII-XIII)	1218
Artefacts analysed	100
Artefacts with traces	71
Meat	2,8 %
Hide	13,8 %
Butchering	2,7 %
Cereal	4,2 %
Plant/ Wood	7,04 %
Bone	5,6 %
Antler	5,6 %
Mat. Soft.	4,2 %
Mat. Semi-hard	32,3 %
Mat. Hard	7,4 %
Unknown	18,3 %

Tab. 1. Ripatetta. Use wear by classes.

Data show the prominent presence of edges with traces due to hide/meat-processing, or processes related to butchering activity. Furthermore some elements, in a greater amount here than in A, show very damaged edges, hence they could be associated with hard material processing. For the latter it is often impossible to distinguish the polish and the damage of active edges depending on contact with bone or antler.

Thus we may hypothesize that area B could have been used for treating animal substances in every phase of their processing (Fig. 2).

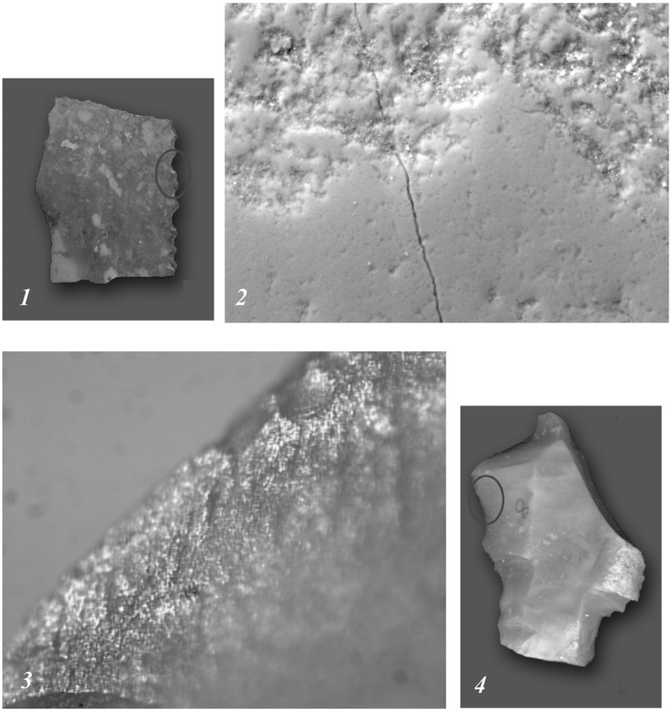


Fig. 2. Ripatetta. 2.1 and 2.2 fragment of sickle blade used to cereal harvesting (1200x With SEM); 2.3 and 2.4 Burin utilised for butchering activity (100x).

3. Case 2. Santo Stefano (AQ, Abruzzo)

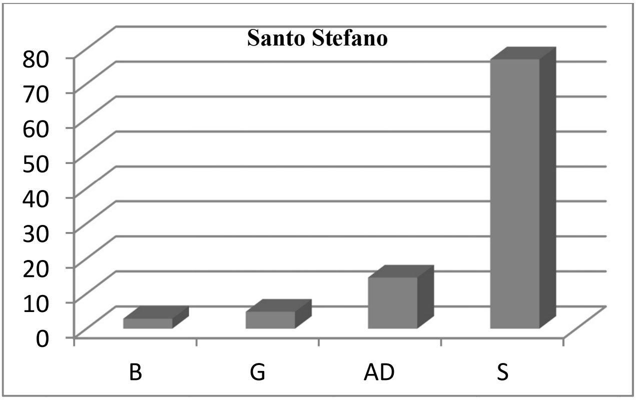
Towards the North lies the site of S. Stefano. The excavations were carried out by the University of Pisa between 1988 and 2002 on a surface of about 230 sq.m. On the basis of the archaeological deposit is revealed a cobbled paving discovered to be over 85 sq. m, cut in a later phase by a duct.

The pottery found inside the deposit belongs to the facies of Middle-Adriatic Impressed Pottery with some southern influences, mostly referable to Guadone's facies (Fabbri 2006).

The lower strata of the excavation could be dated between 6843±40 BP (LTL60A) and 6823±55 BP (LTL526A), while the most recent term is provided by the dating of section 3 to 6579±60 BP (LTL57A).

The mostly used raw material in the stone industry is the flint coming from the neighbouring area, whose suspected origin has been identified by macro and microscopic analysis in the Genzana Mount (Radi and Danese 2003). With respect to other contemporary sites, S. Stefano shows a high diffusion of obsidian, gradually increasing from lower to upper levels, up to 10% of the total.

As has been highlighted in other sites, the direct percussion technique has been used to obtain flakes, while several techniques have been used, since the oldest phases, to produce blades. The tendency to use a pressure technique increases over time (Fabbri et al. 2009) (Graph 2).



Graph. 2. S. Stefano. Main tool type classes (Laplace, 1968) of lithic assemblage.

A still ongoing functional analysis of the materials has been undertaken. Only a very limited sample of manufacturers, such as End Scrapers, Geometrics, Becs, Becked Point and Sickles, has been analyzed until now (60 elements).

Borers and Becked Points are mostly used for piercing. Only in one case did a point reveal itself to being possibly used as a projectile. The use of End Scrapers is heterogeneous. In most cases they show undifferentiated polishing and scarce damage of the active edges that do not correspond exclusively to the retouched edge.

On the other hand, analysis of the class of Geometric objects has been difficult. No element has remnants of polish. Some objects show half-moon microscars along the margin of the main basis, often broken at one or both ends. Their scanty traces and the bibliographic information suggest, in some cases, their use as barbs on projectile weapons.

A careful analysis is also currently taking place on the elements bearing gloss traces.

The most frequent type of trace seems to be a smooth polish due to cereal harvesting. In these cases, the gloss could show oblique or, more rarely, parallel dispersion, revealing probably different hafting typologies or use. Furthermore, a set of elements with denticulate lateral edges shows the dispersion of the polish along a narrow strip parallel to the margin above which there are deep striations. Such artefacts could have been used for cutting hard siliceous plants as reeds.

The vertical distribution of the sickles inside the deposit reveals variations in their presence and morphology. An increase of these elements could be observed over time. The same progression could also be seen in the usage of modified artefacts with abrupt-retouch, lateral or just on one of the edges. The elements with parallel distribution of the gloss show an opposite tendency, tending to decrease in time (Fig. 3).

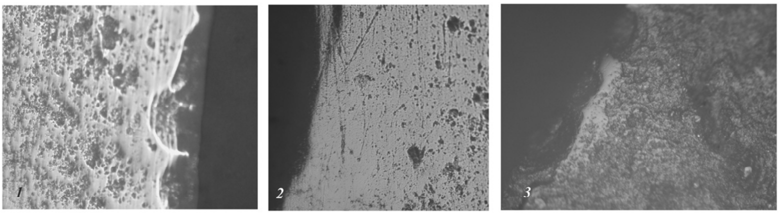


Fig 3. Santo Stefano. 6.1 trace possibly originated by reed cutting (100x); 6.2 polish related to cereals harvesting (100x); 6.3 polish due to contact with bone.

4. Case 3. Maddalena di Muccia (MC, Marche)

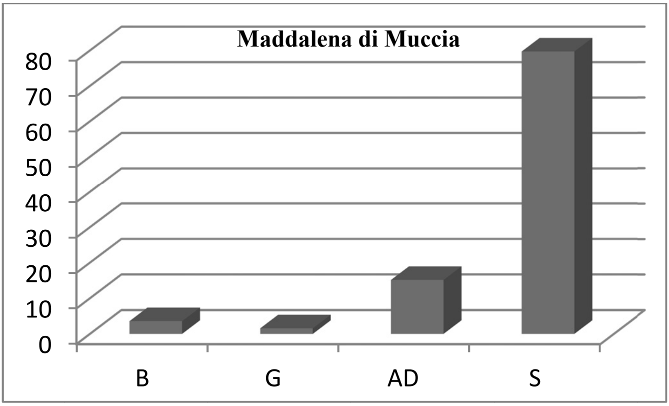
Going northward, following the Adriatic coast lies the site of Maddalena di Muccia.

The investigation of the site was divided into two phases. In 1962 Lollini (Lollini 1965) started the excavations, investigating a c. 60 sq.m extended area, where several embedded structures were discovered. After about 40 years, the Universities of Pisa and Rome with the collaboration of the Soprintendenza delle Marche, restarted the exploration of the site over a 450 sq.m extended area, bringing to the surface a new part of the settlement.

The analysis of the materials puts the site inside the impressed pottery culture of Abruzzo and Marche. The dating traces the duration of the site between 6638±59 BP and 5375±60 BP.

On this site a complete techno-typological analysis of lithic assemblage was conducted on two (XII and XIII) of the sectors in which the site was divided during the excavation.

The raw material mostly used is flint; often the "scaglia rossa" type, probably coming from the neighbouring areas. From a technological point of view, this site uses two different operational chains. The production of blades and bladelets was made by pressure-flaking on carefully prepared cores. Instead direct percussion was used in order to obtain flakes and laminar flakes (Radi et al. 2003) (Graph 50-3).



Graph 3. Maddalena di Muccia. Main tool type classes (Laplace, 1968) of lithic assemblage.

Functional analysis (Table 1) evidenced a general sketch of the activities carried out on the site and their impact on its economy.

In the sample from Muccia, those artefacts having had contact with hard animal substances such as bone and antler happen to be in the majority. The edges used for hide treatment appear in a lesser quantity, mostly for the treatment of fresh hide. In fact there is no trace of edges with strong rounding and a developed polish. Even though in a lesser quantity, there are instruments related to butchering activities (2.8%) or used as projectile points (1.4%).

In Muccia it was possible to identify a typological group which specialized in a particular type of processing: burins, showing a transversal detachment (burin spall) on the distal edge. The manufactures present a strong damage on the ventral portion of the margin close to the biseau, which in most cases has been detached. The presence of deep scars and the lack of polish suggest their use in processing hard substances. In particular, the irregular course of the macro-flake scars could have been caused by the pressure of the object against the roughness, characterizing the antler of the cervid. The form of the supports suggests a manual prehension of the object, with the burin facet exploited as grasp help (Fig. 4).

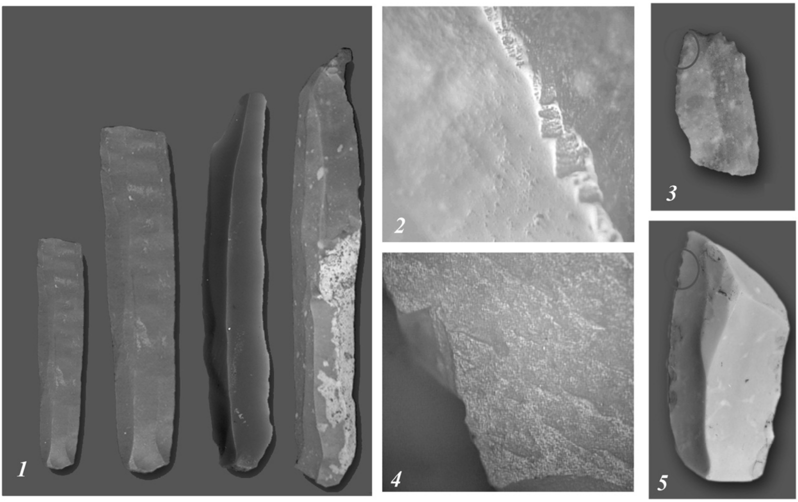


Fig. 4. Maddalena di Muccia. 7.1 pressure production in "Scaglia Rossa"; 7.2 and 7.3 Sickle and polish related to cereals harvesting (100x); 7.4 and 7.5 Burin and trace originated by working hard substances.

5. Conclusions

In conclusion, the data available enabled us to make some considerations. In general data show a tendency to scarce exploitation of manufacturers, highlighted by the frequent presence of undifferentiated polishing, suggesting the use of the active margins for quite short periods. This aspect could be due to the abundance of raw material all over the area. Traces of hafting are rare. Few elements preserve residues of mastic used for pasting a piece into the haft. There is a higher concurrence between typology and function among some groups of material like Burins, Borers and End Scrapers, due to clear morphologic motivations. On every site we can observe the tendency to create standardized groups under the aspect of form and dimension specialized in some activities. Transversal Burins from Maddalena di Muccia and microlithic trapezes from S. Stefano seem to belong to this typology of standardized productions. Between the later a set of larger and flat backed knives morphologically inscribed in the "half-moon" type, whose active margin is the unretouched side, was found in Ripatetta.

Results from the functional analysis on the described stone complex enabled us to integrate our notions on the Italian Neolithic sites and highlighted their economic strategies.

The Neolithic sites have appeared as complex entities since the older phases. Inside many activities were carried out, with a precise internal distribution, as is evident in Ripatetta. Some of these activities have been revealed exclusively by traces of use, as in the case of the burins from Maddalena di Muccia that reveal the presence of antler processing.

Inside the stone complex, one can observe the production of groups of instruments that are morphologically standardized and specialized to some specific activities. The meaning to be attributed to these productions in the old Neolithic as well as in later periods is still to be clarified. In some cases, these instruments seem to suggest the presence inside the villages of people qualified to carry out particular activities while continuing to use the same instruments. It is not yet possible to exclude that in some cases the presence of those instruments is simply related to a form of cultural tradition or a "habit" of every site for using a given morphology for specific kinds of work.

Acknowledgements

I would like to ***thank*** the Institute of Soprintendenza Archeologica delle Marche, especially Dott. Mara Silvestrini for the interesting materials from Maddalena di Muccia. My deepest ***thanks to Professor Carlo*** Tozzi and Professor Giovanna Radi of Pisa University for allowing me to study the lithic industries from Ripatetta and S.Stefano.

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CHAPTER FIFTY

THE USE OF FLINT ARTIFACTS FROM EARLY NEOLITHIC LEVELS AT ATXOSTE (BASQUE COUNTRY): AN INTERPRETATION OF SITE FUNCTION THROUGH USE-WEAR ANALYSES

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Abstract

This paper presents the results of the use-wear analyses on the Early Neolithic flint stone tools from Atxoste (Vírgala Mayor, Álava, Basque Country). With traceology, it was possible to recognize which kinds of tools were used and which activities were performed with them. According to the results, Atxoste can be interpreted as a logistical settlement (hunting-camp), specialized in the acquisition of (wild) animal resources and fully inserted in a complex strategy of exploitation of the territory based on a dense network of different settlements. Other activities related to long-term occupations have also been recognized, including the presence of some evidence of domestication. To sum up, several points essential for the understanding of the transition to the Neolithic in this region are discussed, inserting this settlement within this complex process.

Keywords: Use-wear, Neolithic, lithic tools, rock-shelter, hunting-camp

1. Introduction

Intensification in archaeological research in recent decades has provided a comprehensive documentary body, supported by a large number of settlements along the Ebro Basin (basically rock-shelters) with proper stratigraphic and chronological contextualization (Montes and Alday 2012). We, therefore, need to understand the functionality of these specific sites in order to comprehend why human groups chose them and what role they could have played within their economic systems.

In order to answer these questions, we have carried out use-wear analysis on materials from the Early Neolithic levels at Atxoste (Layers III and IIIb1), which have been dated to 6220±50 BP (GrN-9789) 7043-7218 cal BP (Alday 2009). By studying the manufacture and use of stone tools, we aim to analyze the relationship between tool design, motion and material worked. Furthermore, studying these tools will permit us to comprehend how work was organized in this settlement, and also how economic and social changes took place in this period. We first describe the underlying Neolithization setting and afterwards evaluate the results of the traceological analysis.

2. Atxoste in the regional neolithization context

Atxoste is a rock-shelter located at 740 m.a.s.l. (Alday 1996), at the confluence of complementary ecological areas (the inland zone of the valley and mountain areas). The site is part of a dense network together with other neighbouing rock-shelters that are thought to have acted as logistical sites that were occasionally visited, forming a complex strategy of land occupation in the Upper Ebro valley. The occupations were intense throughout the Mesolithic (Barandiarán et al. 2006; Alday 2005a), and some of them remained even when the Neolithic arrived in the region (Alday 2005b).

According to the radiochronology (Fig. 2), the Neolithic layers of Atxoste were formed around 5360-5000 cal BC. In this period, the expansion of the Neolithic way of life underwent acceleration, and was definitively established in the area (Alday 2009).

Around the last third of the sixth millennium, we find a confusing picture (Fig. 1) in which the use of most rock-shelters and caves shows a decline, coinciding with the growth of new settlements associated with domestication: open air villages with dwellings and burial contexts–such as Los Cascajos (García Gazólaz and Sesma 2001) and Paternanbidea (García Gazólaz 2007)–and specialized sites (caves used as livestock sites) like Los Husos II (Fernández Eraso 2010). Ceramic types (cardial and boquique) also became fully consolidated in this stage in the Iberian Peninsula (although they first appear a bit earlier), and they are both present in the Ebro Basin (Alday and Moral 2011). In the Atlantic watershed, data–normally coming from caves–reveal an exploitation of both coastal and inland resources. Although the C14 dates are subsequent to those from the Upper Ebro Valley (Arias 2007), the connection between both areas has been demonstrated through certain parallels in the pottery, lithic industry, and the exploitation of the same types of flint.

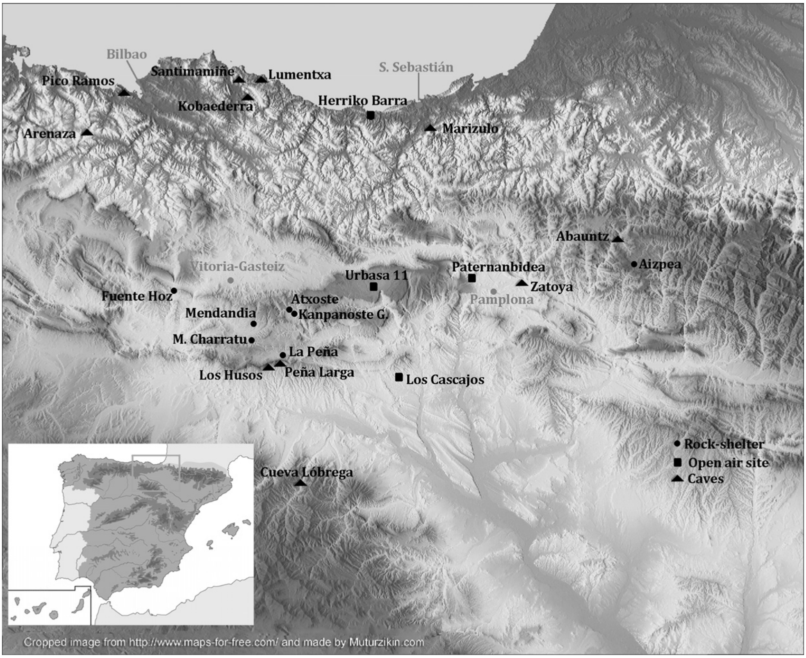
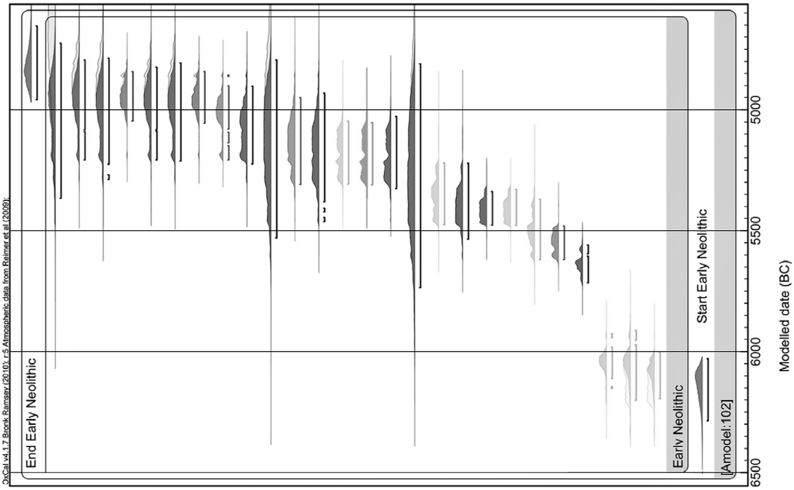


Fig.1. Map of cited sites: Atxoste and its neighbouring settlements



SITE	CONTEXT	LAB.	DATES BP	DATES cal BC
Kobaederra*	III	UBAR-471	5820±240	5310-4230
Herriko Barra	D	Ua-4820	6010±90	5160-4680
Marizulo	II	Ua-4919	6035±110	5270-4670
Los Husos II	IX	Beta-221642	6040±40	5060-4830
Arenaza	IC2	OxA-7157	6040±75	5150-4750
Pico Ramos *	4	Beta-193569	6040±90	5211-4766
Los Husos II	VII	Beta-221640	6050±40	5070-4830
Paternanbidea	Fosa 1	GrA-13673	6090±40	5140-4900
Los Husos I	XV	Beta-161180	6130±60	5270-4910
Peña Larga	IV	I-15150	6150±230	5580-4540
Los Cascajos	Estr. 183	Ua-16024	6185±75	5340-4940
Cueva Lóbrega	III	GrN-16110	6220±100	5410-4930
Atxoste	IIIb1	GrA-9789	6220±50	5360-5000
Los Cascajos*	Inhumac. 497	Ua-24426	6230±50	5370-5010
Los Husos I	XVI	Beta-161182	6240±60	5370-5010
Zatoya	I	Ly-1397	6320±280	5790-4630
Aizpea	III	BrN-18421	6370±70	5520-5200
Marizulo	I	Ua-10272	6425±85	5540-5260
Los Cascajos*	Estr. 551	Ua-24428	6435±35	5500-5340
Mendandia	I	GrN-22740	6440±40	5500-5340
Mendandia	II	GrN-22741	6540±70	5640-5360
Aizpea	II	GrA-779	6600±50	5650-5450
Peña Larga *	IV	Beta-242783	6720±40	5720-5560
Mendandia	IIIsup	GrN-22742	7180±45	6260-5940
Mendandia	IIIsup	GrN-19658	7210±80	6130-5970
Mendandia**	IIIsup	Ua-34366	7265±60	6235-6018

Types of settlements disntinguished by colours
Open air site
Enclosure level
Hunting-stand
Burial

Fig.2. Radiochronology of Early Neolithic in the Upper Ebro Valley and the Atlantic watershed carried out with Oxcal 4.1 (Bronk Ramsey 2009): Some settlements are distinguished by colours attending to their main (but not exclusive) function. Settlements in white have not specific function.

Therefore, taking into account that this region was densely populated during the Mesolithic, when the transition to the Neolithic took place, the population involved in this process had to face diverse situations. Thus, identifying the functionality of such sites as Atxoste will help us to explain why this type of settlement was still occupied when the Neolithic was consolidating in the region. This will allow us to reach a more accurate picture of this process.

3. Lithic tools and their uses

Functional analysis using a stereomicroscope (Nikon SMZ 800) and a metallographic microscope (Olympus BX50) has allowed us to identify a total of 311 stone artefacts within a collection of 5415 flint elements. In consonance with other assemblages in the Ebro Basin, the laminar technology exploited different types of local flint. Some 50% of used tools are blades or bladelets (with or without retouch) used to carry out a wide variety of activities on different materials.

The function of different typological groups:

As can be observed (Fig. 3), the lithic tool-kit is based on two kinds of stone artefacts: large blades used without retouch and geometrics (principally segments with Helwan retouch). The first group represents 40% of the total number of tools and analysis shows that they worked on a large variety of materials–with the special importance of butchering tasks, but also of (dry) hide working, and tasks related to bone/antler, woody materials and even cereals. Geometrics represent 25% of the assemblage, and they were exclusively used for hunting activities (inserted as projectile points or barbs); as has been proposed for other similar assemblages from the Ebro Basin (Domingo 2005), the Cantabrian coastal area (Ibáñez 2001) and the NW of the Iberian Peninsula (Fernández López de Pablo et al. 2008). It is likely that the backed points were also used following the same patterns.

Together with these main tools, a low percentage of other typological groups can be recognized. Among them, other uses can be distinguished: the end scrapers were basically used for processing dry hide and osseous materials; the side scrapers show similar percentages of working with dry hides, wood and osseous materials; notches normally performed work on bone/antler; the scarce number of drills exhibit marks of wood and dry hide working; a backed blade was used for processing hide, a denticulate shows traces related to bone working, and, finally, some non-retouched flakes were used for processing woody materials.

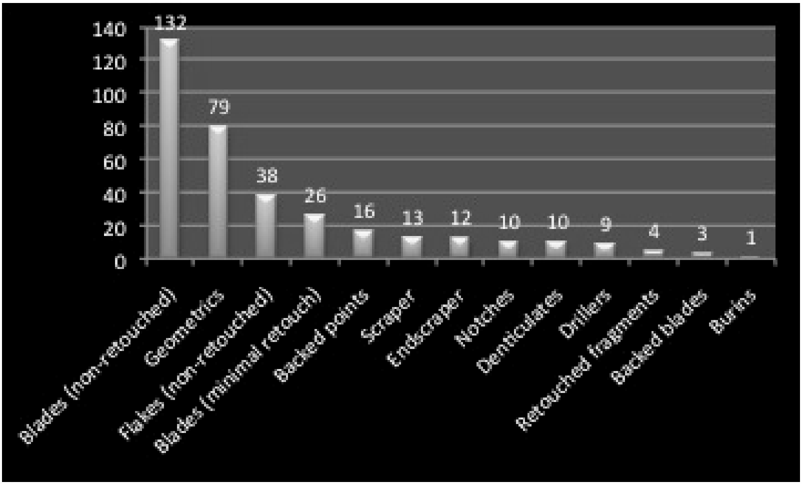


Fig.3. Lithic tools used in the Early Neolithic levels of Atxoste

We have to emphasize that many tools were used without retouching, (especially blades, flakes and some scrapers and laminar notches); so, the retouch can be interpreted in terms of recycling or preparing the active zones, as has been documented in other Early Neolithic contexts (Gassin 1999). Therefore, most cutting edges were preferentially used for longitudinal actions on medium-soft materials, whereas retouched zones worked with transversal movements on harder materials; as can be observed in other contemporary assemblages (Gibaja et al. 2010).

4. Worked materials

Use-wear analysis has recognized different activities performed at the settlement, which permits us to cast some light on the functionality of this kind of rock-shelter (Fig. 4).

Hunting activities play a key role, as can be deduced from the high percentage of geometric projectiles and the impact traces on them (Fig. 5), around 20%, and also from palaeontological data that indicate a large number of wild species and a scarce presence of domestic fauna (Alday et al. 2012b).

The processing of animal materials involved three possible tasks: a) those related to processing and consuming hunted animals, identified thanks to traces of butchering and fresh hide working observed on blades; b) those linked to dry hide management (which could be associated with skin softening; either for storing, or for manufacturing different objects), carried out with blades (Fig. 5), end scrapers, and side scrapers; and c) tasks for repairing or finishing both bone/antler tools and skin elements, carried out with the short (and normally retouched) active zones of blades, notches, denticulates, etc., which leave few use-wear traces.

The processing of plants: this must be associated, on the one hand, with the management of woody materials–probably linked to the last steps of the technical processes of the elaboration of wooden objects–carried out with flakes and blades without retouch, drills with wood-boring traces and some scrapers; as have been documented in other studies (Ibáñez et al. 2007; Gibaja et al. 2010). However, in contrast to Mendandia (Alday et al. 2012b), we have no information about plant fibre scraping tools (probably for basketry). On the other hand, harvesting tasks (most probably of domestic cereals) have been identified through three sickle blade fragments. One of them presents the usual harvesting polish, whereas the

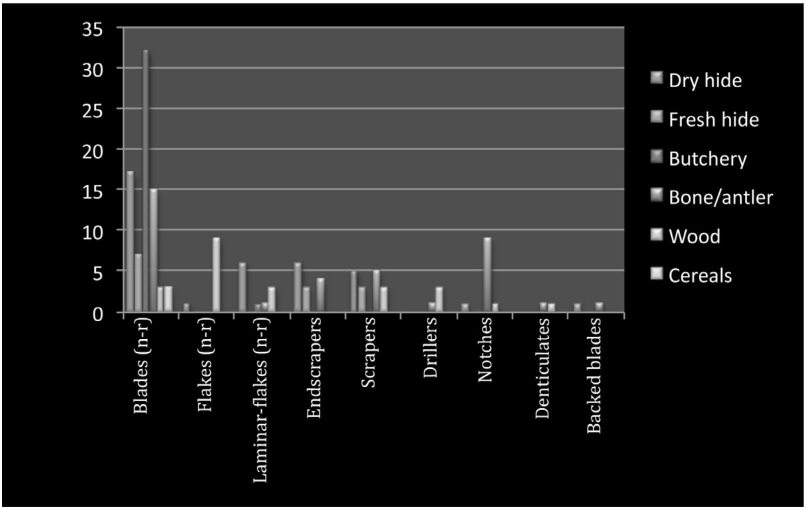


Fig.4. Materials worked by the different stone tools

other two show microwear with an abrasive component that can be produced by carrying out different tasks (all of them related to the use of straw for a wide range of activities): cutting cereals near the ground; cutting the straw on the ground after the harvest (maybe for storing ears); and also separating the roots from the rest of the stem before threshing (Clemente & Gibaja 1998; González et al. 2000; Gibaja 2002). The traces, which display a longitudinal distribution, connect these sickles with cereal harvesting and processing techniques which have been documented in the NE of the Iberian Peninsula, SW France (Ibáñez et al. 2008), the Ebro Basin (Alday et al. 2012b)–and some points of the Duero Basin (Gibaja et al. 2012). The presence of these elements should be interpreted as an indicator of the existence of farming activities and can also be associated with the presence of a quern-stone with plant processing traces (Alday et al. 2014) and the scarce presence of domestic fauna (Alday et al. 2012).

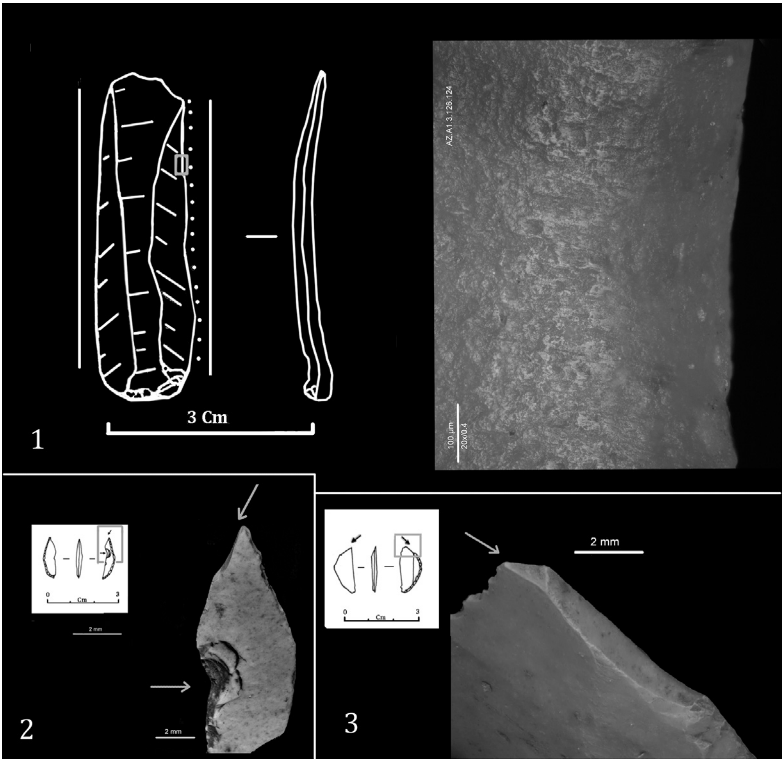


Fig. 5.1. Use-wear traces for working dry hide with a non-retouched blade (200X). 2) Impact traces in segment with transversal insertion. 3) Impact traces in a segment with oblique insertion.

Finally, knapping tasks (most of them with local flints) are abundant in the settlement, and there are also some imported blades–made in coastal flint–which show similar uses to the other tools. Therefore, the data allow us to think that flint tools were manufactured and used within the rockshelter. It can, thus, be assumed that the use-wear traces observed on their surfaces would represent the different tasks developed inside Atxoste.

5. Conclusions

This paper has presented a number of results that can cast light on the functional behaviour of rock-shelters like Atxoste. To be precise, the use-wear analyses of stone tools from the Early Neolithic levels suggest a major role for hunting activities and the processing of animal carcasses. The settlement shares some characteristics with other hunting-camps–such as the large percentages of geometrics and blades with butchering traces–(Philibert 1999), which allow us to confirm the initial hypothesis that proposes an occupation (possibly seasonal but not short) of this rock-shelter by a small group mainly for acquiring animal resources. However, a variety of complementary tasks–such as dry hide processing, flint knapping–and the presence of elements like a quern and the abundant pottery, could be associated with longer stays. Furthermore, the presence of sickle blades indirectly demonstrates the existence of new domestic items, which are missing in earlier stages.

Nevertheless, it is necessary to reflect on the role that these settlements (especially Atxoste) could play during the neolithization process in the region; taking into account that the information supplied by these sites is partial and imbalanced. As can be seen, a significant renovation in the lithic assemblages (like new forms of geometrics based on segments with helwan retouch, larger blades, changes in the percentages of lithic raw materials...) and the appearance of new elements (pottery, sickle blades, domestic fauna, grinding stones, etc.) are clearly detected within the archaeological record in the transition towards the Neolithic; but, in contrast, some patterns of continuity (such as the occupation of the same rock-shelters with similar functionality as in the previous stages and the exploitation of the same variety of lithic raw materials) are also identified.

However, many of the tasks developed in Atxoste (flint knapping and storage, hide processing, tool-making and maintenance, grinding activities…) are linked with relatively long-term occupations. All these data allows us to assume that this rock-shelter was not only a hunting-stand, so it may had been acting as semi-stable settlement, probably occupied in an specific period during the annual cycle. Anyway, an exclusive shelter network is thus hardly feasible to ensure the survival of the population, so these kind of sites may be connected with other habitats, following the subsistence strategies pursued by communities with a certain degree of economic and social complexity.

All in all, we think that it was around the last third of the sixth millennium cal BC when the neolithization process in this area, which had started a few centuries before, became irreversible (Alday 2012). Therefore, although it is likely that the Pre-Neolithic habitat system was now involved in a process of change, the results obtained show that Atxoste was intensely occupied by human groups during the Early Neolithic, as part of a complex strategy of land exploitation that intensifies and adjusts to new times. The specific functionality (linked to the strategic location and good conditions of the settlement) and the abundant procurement of animal resources could explain why visiting this site was worthwhile, even when the Neolithic way of life was being installed throughout the region. Finally, by the end of the sixth millennium, the settlement was abandoned and occasionally visited either to hunt or to carry out a burial in the Chalcolithic period.

Acknowledgements

This research is integrated in a project that involves a full study of the settlement and, particularly, within the project *HAR2011-26364 "Las comunidades humanas de la Alta Cuenca del Ebro en la transición Pleistoceno – Holoceno"*, funded by the Ministry of Science and Innovation of the Spanish government. We also have to thank the Laboratory of Anthropology and Archaeology at IMF – CSIC (Barcelona) and the Laboratory of Prehistory 1.18A at the University of the Basque Country (UPV-EHU) for allowing us to using their installations to carry out our analysis.

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CHAPTER FIFTY ONE

USE-WEAR ANALYSIS OF CHIPPED STONE ASSEMBLAGES FROM NEOLITHIC BURIAL CAVES IN PORTUGUESE ESTREMADURA: THE CASE OF BOM SANTO (LISBON)

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Abstract

Modern lithic studies are a very recent acquisition among Portuguese prehistorians working on the earliest farming societies in the country. This is why use-wear analysis is not a systematic procedure nor was it applied in the analysis of funerary offerings. Bom Santo Cave is a Middle Neolithic burial site undergoing an interdisciplinary research project including use-wear analysis of its lithic components (flint blades and geometrics). In spite of quite severe alterations observed on the flint tools, the outcome of this analysis points to a clear ritual/cultural option of selecting unused or still intact artefacts as offerings. The few tools with wear marks were used as projectile points (in the case of geometrics) or for cutting non-ligneous plants (in the case of blades), among which there are a couple of sickle implements.

Keywords: Neolithic, burial caves, Portugal.

1. Introduction

In the last few years we have witnessed in the Iberian Peninsula a renewed interest in flint tools, focusing both on the knapping techniques involved in their production and on their raw materials. The best examples of this recent trend are flint blades and some formal tools such as arrow heads and geometrics recovered in funerary sites dated to the Late Neolithic and Chalcolithic. These tools had always been mentioned by the archaeologists that excavated the sites but the published information was usually restricted to a brief description of their morphology and retouch type.

With the explicit aim of overcoming this shortage of information, a monothematic workshop took place in Barcelona in 2009 dedicated to the study of blade production systems from the Late Neolithic to the Bronze Age (Gibaja et al., 2010). Regarding research in the Iberian Peninsula, a commonly acknowledged deficiency was the generalized lack of use-wear analyses in the study of these productions.

Clearly, this is the case of the numerous burial caves and megalithic tombs in Portugal. This was the reason why a specific use-wear project was carried out on the chipped assemblage from Bom Santo Cave, the first of this kind to take place in Portugal. In this case, however, as will be shown below, the assemblage is limited by the small number of pieces and their poor state of preservation, a fact that prevented us assessing precisely the activities in which lithic tools were used. Notwithstanding, the obtained results allowed us to infer these communities' behaviour as regards the offering of funerary items with a high functional, symbolic and social meaning, such as flint blades and arrow heads.

2. Bom Santo Cave

Bom Santo is a cave site located in the eastern slope of the Montejunto Mountain, facing the Tagus palaeoestuary, *c.* 50 km north of Lisbon (Fig. 1). Discovered intact in 1993 by a team of speleologists, this is a karst cave system with several galleries and rooms connected by irregular corridors. Systematic survey and excavations took place during the 1990's, in so-called rooms A and B (for a synthesis, see Duarte and Arnaud, 1996). A provisional minimum number of 121 individuals were estimated to be lying on the surface. More or less complete skeletons were found throughout the cave — as well as numerous secondary depositions —

allowing the reconstruction of funerary practices. Its use as a funerary site must have been comprised within a relatively short period of time, estimated at approximately 400 years (*c.* 5800–5400 cal BP). Given the cave's scientific potential, a research project is presently being undertaken focusing mainly on the abundant human remains exhumed (ranging from bioanthropology and archaeology, to chemistry and genetics), of which a preliminary report was recently published (Carvalho et al., 2012).

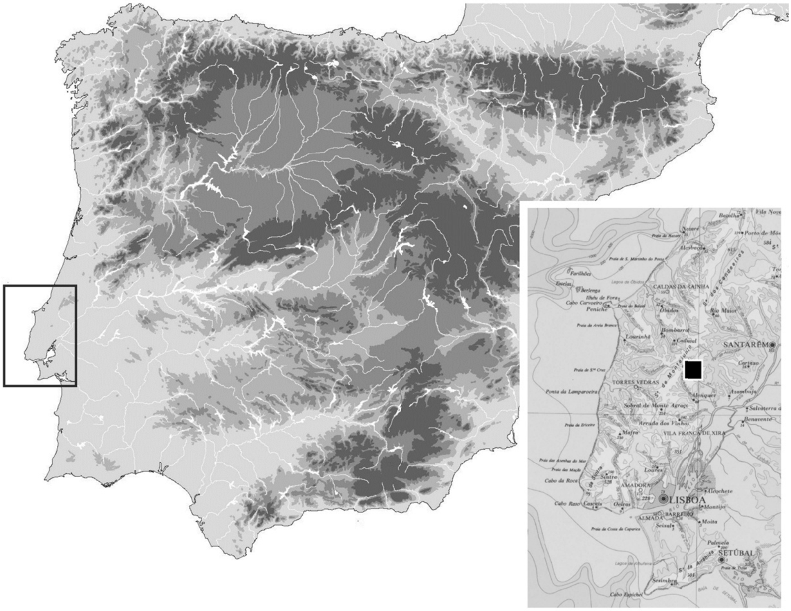

Figure 1. Location of Bom Santo Cave in the Estremadura region of central Portugal (inset lower right) and in the Iberian Peninsula.

Carvalho (2009) carried out a technological and typological analysis of flint blades in the chipped stone assemblage. The geometrics have not been analyzed yet. According to the mentioned study, the blade assemblage consists of 32 flint pieces (not including two refitting crests), most of them intact (n=18; 56%). Plotting of widths and lengths of intact pieces revealed a homogeneous assemblage which can be considered as formed by small blades (widths around 9-18 mm and lengths around 30-90 mm) alongside a single, more robust piece (see Carvalho, 2009: fig. 4). These are pieces with trapezoidal transversal cross-sections (73%), parallel edges (79%) and regular axis (69%) and straight (53%) or plunged (27%) longitudinal cross-sections. Blade butts are usually narrower than their average width, with facetted butts (73%) and prominent bulbs (65%) predominating. Ripples are often identifiable with the naked eye (55%). Taken together, these attributes point to the presence of indirect percussion flaking techniques associated with high percentages of heat treatment (63%).

3. Use-wear analysis: material and methods

Usually, traceologists select a sample of artefacts based on the total number of pieces, state of preservation, presence/absence of specific morphotypes, etc. In this case, given the small number of artefacts (see below), we analyzed almost the whole assemblage[1].

A first step in use-wear analysis is the detection of possible organic and non-organic residues adhering to the surface of the artefacts. In the Bom Santo case, the assemblage had been previously cleaned of sediment or calcareous concretions probably using toothbrushes, therefore making the recognition of those residues impossible. The only exceptions were five pieces (three blades and two geometrics) that were packed with human remains and sediment, with no signs of having been cleaned. Therefore, the artefacts under analysis were only washed with soap and water to remove any remaining vestige of sediment and powder.

A binocular Leica lens (10 to 90 magnifications) and an Olympus BH2 metallographic microscope (50 to 400 magnifications) were used in conjunction. A first conclusion was that some pieces showed alterations restricted to small areas while most were altered over large areas, preventing their functional diagnosis. To the induced alterations mentioned above we must add other, both natural (post-depositional) and artificial (post-excavation) surface alterations. In particular, two types of alterations produced serious problems for use-wear analysis: "soil polishing" and mechanical abrasive effects.

"Soil polishing" is present in most of the pieces, with a high degree of intensity, covering both the higher and lower parts of the pieces' micro-topography (Fig. 2: 1). This hinders the observation of micro-polishing generated by softer materials such as meat, fresh leather or fish. Functional interpretation only becomes possible in cases of well-developed wear

[1] Four blades and three geometrics (one of which is only represented by a small fragment) were not analysed because these were found packed with human remains after the use-wear analysis of the assemblage had been made.

marks, such as in the case of some blades used in cereal harvesting.

Striations and compacted lusters are present on a large number of pieces (Fig. 2: 2). In our opinion, these striations and compact lusters are not evidence for tool use but rather for some type of post-excavation mechanical alterations. These pieces may have been cleaned with toothbrushes with hard bristles. As a result of this option, small polished dots, slight rounded or marked edges could not be used as sufficient diagnostic criteria to determine if these pieces were used or not. Other post-excavation alterations caused less important alterations. This is the case of graphite residues on the tools' nervures due to drawing procedures or polishing due to contact or impact with other flint artefacts (Fig. 2: 3-4) when stored together in the same plastic bags.

Taken as whole, the state of preservation of the Bom Santo material is very deficient. However, we were able to produce some relevant inferences based of their use-wear analysis.

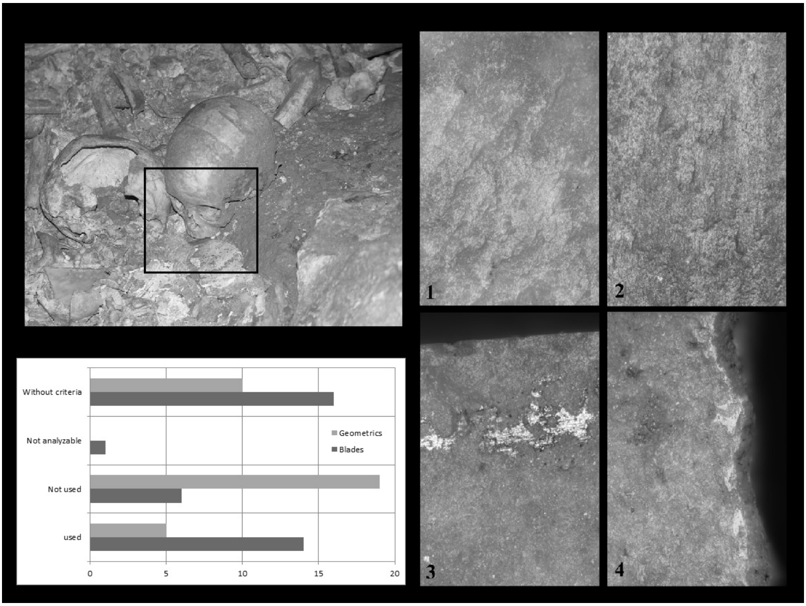

Figure 2. On top left: the lack of direct associations between individuals and artefacts illustrated through a flint blade among human remains; on bottom left: plotting of results of use-wear analysis in flint blades and geometrics; on the right column: observed alterations on the flint tools (all at 100×): 1 - "soil polishing"; 2 - striations; 3 - graphite; 4 - "G" type dots of compacted polishing.

4. Results

A total number of 37 blades/bladelets and 34 geometrics were analyzed. A synthesis of the obtained results is presented in the graph of Figure 2.

A large number of blades/bladelets (n=16) could not be interpreted because we do not have sufficient criteria to define if these were used or not. These seem to be unused blanks, but their edges present a series of small sized marks unevenly distributed in both surfaces that could be the result of cutting some soft animal material. It must be borne in mind however that the offering of unused flint blades is well attested in other similar contexts, such as Pastora Cave, in the Spanish region of Valencia (García et al., 2012); moreover, this possibility at Bom Santo would be in good accord with the lack of use-wear observable among the geometrics (see below).

Used blades/bladelets show the following pattern: two of them exhibit slight modifications generated by contact with an indeterminate soft material; three display undeveloped wear marks related to the cutting of an abrasive soft material; the other nine pieces show marks derived from the cutting of non-ligneous plants, namely cereals.

The two blades with abrasive marks are among those packed in sediment with human remains, which were not washed nor brushed after the excavation. This fact allowed us to observe slight modifications attesting their use; we could not however specify the nature of the worked material. It is possible these could have been used to cut dry hide or to cut stalks of some non-ligneous plants lying on the soil. In any case, it is evident these pieces were selected for burial offering because of their considerable sizes, with only minor fractures and very sharp edges.

Five of the blades used to cut non-ligneous plants display very undeveloped use-wear associated with intense alterations. This prevented us to conclude that if these were used in the harvesting of cereals or wild plants. What is clear is that they were used for only a very short period of time; otherwise their micro-polish would be more developed and visible. With the exception of one piece represented only by its proximal section, these are intact (or almost intact) blades with unretouched edges. Two of them show abrupt retouch on the distal section (truncations) in order to eliminate its curvature; this a commonly attested technique to obtain straight edges to facilitate the hafting of the flint implement.

Three blades also show plant polishing. These are little developed and associated with rounded edges and longitudinal abrasions. This association must be related to tools used for cutting plant stalks near or on top of the soil. However, the observed wear marks may also be a consequence of the use of a toothbrush to clean the artefacts. Once again, these are intact blades with unretouched edges (with one single exception: a blade with abrupt, marginal retouch on the mesial/distal section of its left edge).

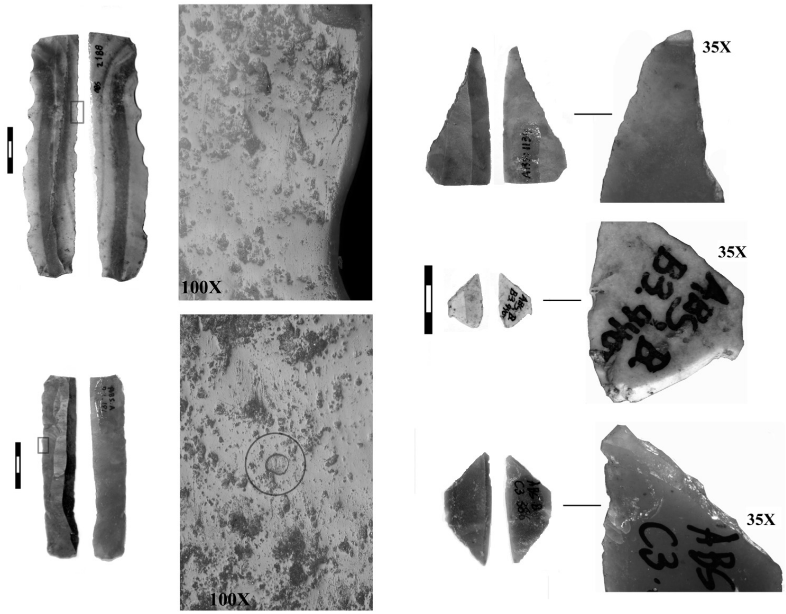

Figure 3. On the right: flint blades used on the harvesting of cereals; on the left: geometrics with impact fractures probably generated by their use as arrow points.

The two blades that were intensively used in the harvesting of cereals exhibit very characteristic micro-polishing. Both present fractured distal ends probably intentionally broken to obtain a straight, regular edge in order to permit their correct hafting (Fig. 3). The distribution of micro-polishing shows us these blades were inserted diagonally, like those recorded in the evolved Early Neolithic site of Cortiçóis (c. 6500 cal BP), also located in the Estremadura region (Carvalho et al., in press), a fact that seems to point to the same technological tradition. While one exhibits only striated micro-polishing, indicating its use in cutting stalks in their middle or upper sections, the other shows a larger number of striations, especially at the proximal end, as a result of a harvesting process focusing the lower part of stalks, near or in contact with the soil. Both are unretouched, with long and very sharp (20º) edges.

Finally, six blades do not show any use-wear. Two of them refit together, a fact that allows us to suppose that in some instances blades were knapped *ex profeso* for burial purposes only. This behavior is documented in other Neolithic funerary contexts in Northeast Iberia (Gibaja, 2003; Gibaja and Terradas, 2012). Moreover, as mentioned above, the possibility that the blades we classified as "without criteria" for use-wear analysis (Fig. 2) were in reality unused tools cannot be ruled out.

Following the same general patterns, most of the geometrics were not subjected to use (Fig. 2). This is true in all recorded sizes and morphologies. Impact fractures and wear marks are absent. Only five geometrics seem to have been used as projectile points if their fractures are considered: four show negatives of burin-like spalls and one shows wear and plunging at one of the ends (Fig. 3).

5. Conclusions

Use-wear analysis of the Bom Santo Cave chipped stone assemblage permit us to draw two main conclusions.

Firstly, the data from Bom Santo coincides in many aspects with results obtained in other Middle/Late Neolithic and Chalcolithic funerary contexts located elsewhere, namely in Northeast Iberia where research is more advanced (Gibaja et al., 2004, 2005). Parallels are not available at Portuguese burial sites dated to the same chronologies, a limitation that prevents the reconstitution of this specific funerary behavior - the making and use of chipped stone tools as grave goods - in the numerous burial caves and megalithic tombs that characterize the later stages of the Neolithic and the Chalcolithic in Portugal (for an overview, see Cardoso, 2007). Bom Santo Cave provides, therefore, a first glimpse of the question for Portuguese contexts.

Secondly, a few blades show some kind of use-wear but most of the assemblage is composed of pieces that are intact, unretouched and unused, or only used for very short periods of time. The only blades that show an intense use-wear are those used as sickle implements. Similarly, these are also in a very good state of preservation. The same pattern is also observed in the geometric assemblage: mostly were not subjected to use; only five pieces show fractures related to their use as arrow points. It is clear therefore that geometrics had been specifically knapped for funerary purposes or were selected among those still available for further use.

In sum, the human group that buried their dead in Bom Santo Cave followed careful criteria, likely according to cultural and ritual prerequisites, in the selection of chipped stone tools as grave goods. Those criteria were based on the type of flint, the regular morphology and relatively standardized size of blades and geometrics, their good state of preservation and functional effectiveness. Systematic analysis of other burial sites dated to the same chronology in the region will be crucial to fully understand these first results and verify if we are dealing with a singular site or if it represents widespread funerary behavior.

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CHAPTER FIFTY TWO

COMPARATIVE ANALYSIS OF SHELL TOOLS FROM TWO NEOLITHIC SITES IN NE IBERIA: LA DRAGA AND SERRA DEL MAS BONET (GIRONA)

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Abstract

In this paper we present the results of the functional analysis of implements made on *Mytilus galloprovincialis* shells found at two sites in the Province of Girona in NE Iberia: La Draga and Serra del Mas Bonet. They are both Neolithic sites and located some 20 or 40 km from the Mediterranean Sea. Unlike other malacological species, the mussels were acquired fresh and could have been eaten before being used as implements. However, the function of these tools was different at each site. At the lakeside site of La Draga (Banyoles, Pla de Estany, Girona) all the *Mytilus* shells were used in the same production process, which involved working with non-woody plants, probably to obtain vegetable fibres. In contrast, at Serra del Mas Bonet (Vilafant, Alt Empordà, Girona), the functional range is much wider as implements made from valves were used in the same way as at La Draga, but also in other activities connected with animal butchery, working hides, and ceramics.

Keywords: Functional analysis, shell tools, *Mytilus galloprovincialis*, Neolithic

1. Introduction

The use of shells as a raw material to make tools has been widely documented in both archaeological and ethnographic studies (Cuenca et al. 2011). However the methodology of functional analysis (Semenov 1964) has rarely been applied to the study of the use of shell tools at Neolithic sites. To date, in Europe it has only been possible to identify this type of use at sites on the Atlantic coast, such as Santimamiñe (North Spain) (Cuenca et al. 2010) and on the Mediterranean shores of France (Vigie and Courtin 1986) and Iberian Peninsula (Cuenca 2013; Maicas 2008; Pascual 2008).

Malacofauna from two Neolithic sites located on the Mediterranean coast of the Iberian Peninsula are studied here: Serra del Mas Bonet and La Draga (Fig. 1). The former is in the municipality of Vilafant (Girona, Catalonia) 20 km from the current coastline. During the archaeological excavation 112 prehistoric negative structures were documented covering a wide time-range from the early fifth millennium to the mid-second millennium cal BC (6940 to 6740/3480 to 3360 2sigma cal BP) (Rosillo et al. 2009, 2012). La Draga is also located in the Province of Girona, by a lake in the municipality of Banyoles, 35km in a straight line from the modern coastline. Radiocarbon determinations place this settlement in the sixth and fifth millennia cal BC (7265 to 6670 2sigma cal BP) (Bogdanovic et al. in press). All dates were calibrated using CALIB Rev 6.0.1 and the curve Intcal09 (Reimer et al. 2009).

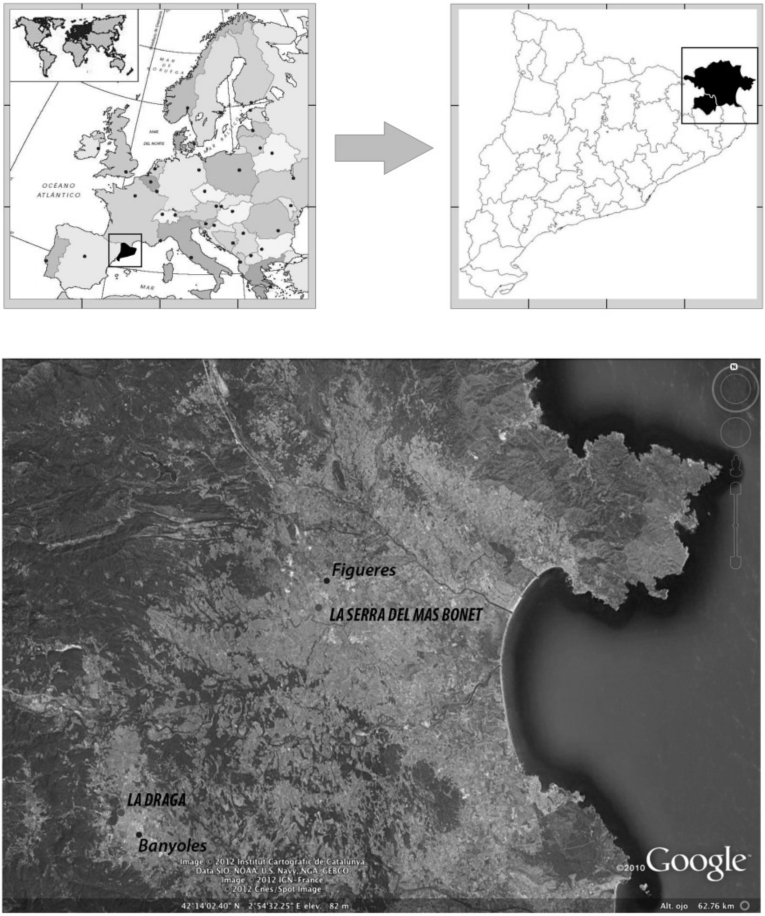

Fig. 1. Location of the Neolithic sites of La Draga and Serra del Mas Bonet

2. Materials and methods

Some 58 remains of malacofauna found at La Draga have been analyzed: 48 *Mytilus galloprovincialis* fragments, 2 *Callista chione* shells, 6 *Margaritifera sp.* shells, and two edge fragments of Donax sp. A total of 375 *Mytilus galloprovincialis* remains from Serra del Mas Bonet have also been studied. These remains were observed and documented photographically with a Leica A16 stereoscopic microscope. Later, a Leica DM2500 metallographic microscope was used to identify the microwear marks and determine how these implements were used (the movements and/or actions performed) and the raw materials they were used with. The archaeological materials were compared with the experimental collections that have been formed in recent years. This experimental program is based on the use of different shells (*Mytilus galloprovincialis, Callista chione, Margaritifera sp.* and *Donax sp.*) to process materials such as wood, hide, pottery, meat, fish, ochre, non-woody plants and others (Clemente 1997; Mansur and Clemente 2009; Cuenca 2010, 2013; Cuenca et al. 2010).

3. Results

All the *Mytilus galloprovincialis* remains from La Draga exhibit very similar use-wear marks that can be associated with working non-woody plant material (Clemente and Cuenca 2011). Certain variability can be seen in the actions, movements and working angles, evidencing both longitudinal cutting action and transversal scraping. On occasions both actions have been identified together. Additionally, both unidirectional and bidirectional movements have been recognized (Fig. 2). This variability of movements, actions and/or angles is probably a consequence of different activities within the same production process. It is therefore likely that first the plants were cut and scraped to obtain fibres with alternate longitudinal and transversal actions using the edges of the shells. Later the fibres were held together and softened by scraping them bidirectionally on a rock or other kind of rigid and/or abrasive surface.

The two *Callista chione* shells exhibit use-wear marks indicating they were used in tasks connected with hide-working. According to the direction of the polish and its linear formation, a scraping action was performed with a transversal and bidirectional movement. One of these fragments displays the same kind of marks but they are less well-developed. However, this piece is exceptional in that the two lateral fractures formed by the breakage of the implement also display use-wear marks. One of the fractures has marks associated with a longitudinal movement performed while working with a soft animal substance. It is likely that these active zones were used in the same production process involving working with animal skins, in which the edge was used to cut the skins and/or to separate areas of flesh or fibres. Use-wear marks associated with a longitudinal movement processing a non-woody plant resource have been identified on the other fracture created by the breakage of the shell (Fig. 3). This piece was therefore used for working with two different kinds of raw materials (skins and non-woody plants) in two productive activities.

Finally, a *Donax* sp. fragment exhibits marks on its edge that may have been formed by working with a non-woody plant resource. Equally, the opposite longitudinal fracture displays marks that could be attributed to contact with a harder plant substance, such as soft and/or fresh wood. A longitudinal action was performed with this edge, perhaps to make incisions in the substance.

At Serra del Mas Bonet, use-wear marks have been identified on 16 *Mytilus galloprovincialis* fragments belonging to 12 different valves. Eight of the fragments are attributed to the Middle Neolithic and the other eight to the Late Neolithic.

Two fragments recovered from the older structures were used to process a non-woody plant resource combining longitudinal and transversal actions, whereas another three fragments were used with transversal actions.

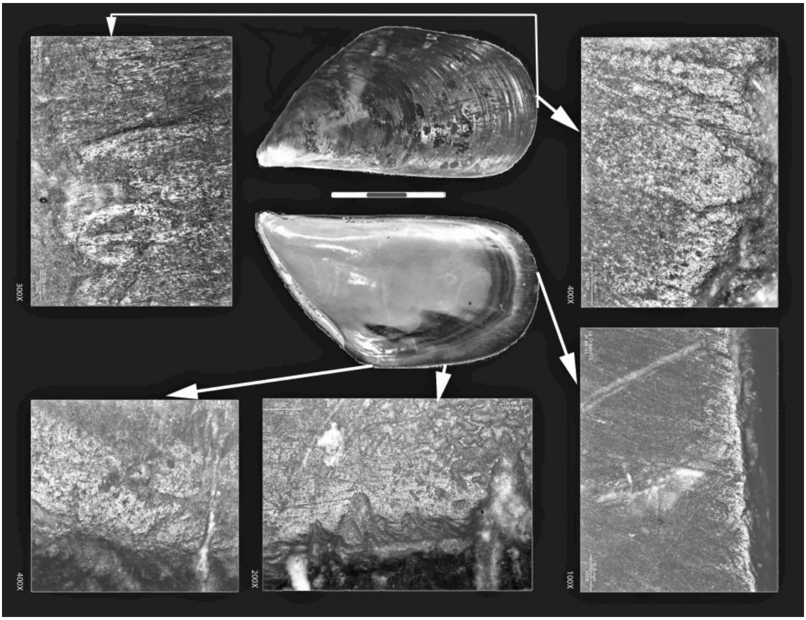

Fig. 2. Archaeological *Mytilus galloprovincialis* valve from the Neolithic site of La Draga with use-wear marks formed by processing plant fibres.

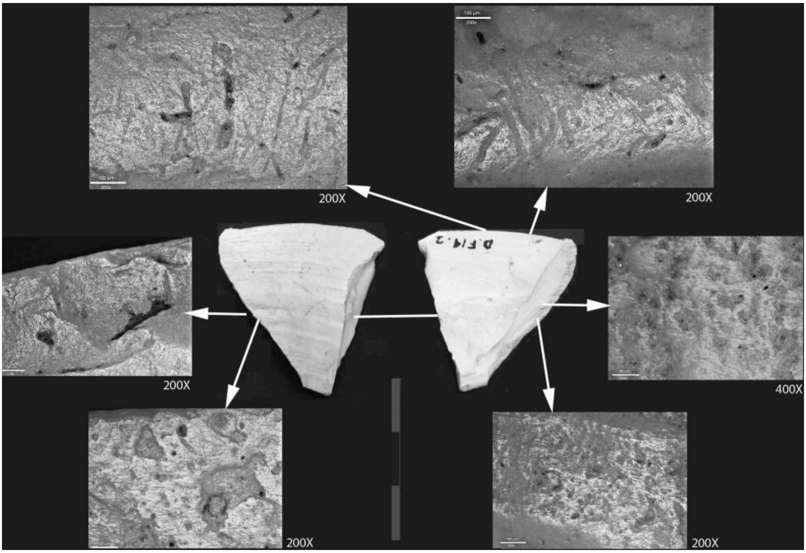

Fig. 3. *Callista chione* fragment from La Draga used to process animal skin with a transversal action using the edge of the shell and later the fractured sides in longitudinal cutting actions to process soft animal matter (left) and plant matter (right).

Three fragments of a single valve were used in a longitudinal action on a soft but abrasive substance that has rounded them considerably. The characteristics of this wear are similar to that produced on experimental pieces used to make incisions in clay. Eight *Mytilus galloprovincialis* fragments from the structures attributed to the Late Neolithic exhibit use-wear marks. One fragment from Structure 1 was used to work with a soft (non-woody) plant resource, alternating transversal and longitudinal actions (Figure 4: 3).

The other seven Late Neolithic fragments come from Structure 17. Two of them were used to work with soft animal matter (Figure 4: 1). One of these was used with a longitudinal cutting action but came into contact with hard bone matter (Figure 4: 2). It was therefore probably used to deflesh or remove matter adhered to a bone.

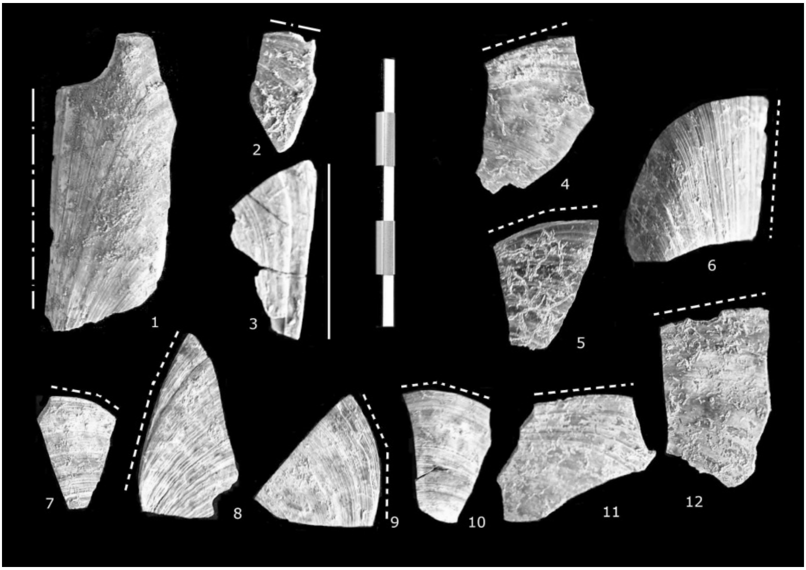

Fig. 4. *Mytilus* fragments with use-wear marks found at Serra del Mas Bonet. 1-6: Found in structures attributed to the Middle Neolithic. 7-12: From structures attributed to the Late Neolithic.

\- - - - - - - - Transversal action
_________ Longitudinal action
__ . __ . __ Longitudinal and transversal action

A further three fragments were used in a transversal scraping action with an abrasive substance of soft/medium hardness (Figure 4: 5). The marks are similar to those obtained experimentally by scraping dry hide (Cuenca et al. 2010). Finally, two *Mytilus* fragments display marks produced by a transversal action while scraping plant matter. In this case, one of the fragments exhibits more compact and glossy micro-polish and it may therefore have been used to plane soft wood (Figure 4: 6).

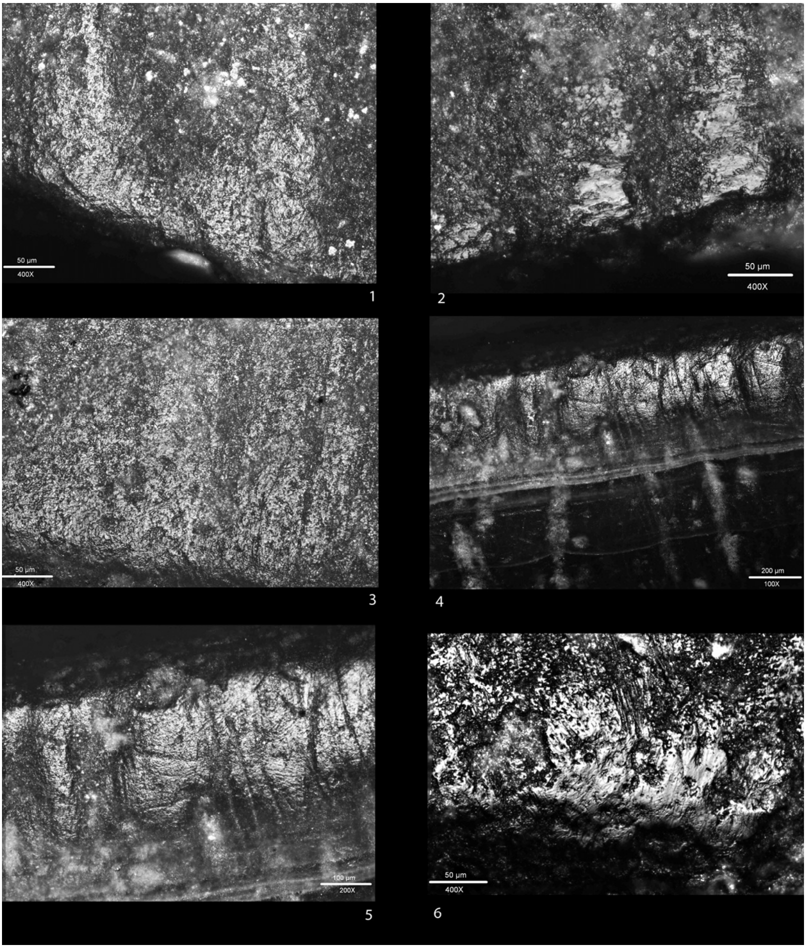

Figure 5. Micro-wear on *Mytilus* fragments dated in the Late Neolithic. 1) Use-wear marks interpreted as the result of working with soft animal matter, at 400X. 2) Use-wear marks interpreted as the result of working with soft animal matter and contact with bone, at 400X. 3) Used with soft animal matter, at 400X. 4) Used with dry hide, at 100X. 5) Used with dry hide, at 200X. 6) Used with soft wood, at 400X.

4. Discussion and conclusion

The results obtained confirm the effectiveness of this type of implement in working with different kinds of raw materials. Whereas the *Mytilus galloprovincialis* shells at La Draga were used exclusively to process plant fibres (Clemente and Cuenca 2011), at Serra del Mas Bonet their use was more varied and associated with resources of animal, plant and mineral origin. The other species documented more rarely (*Callista chione* and *Donax* sp.), which are tougher and more resistant to fracturing, appear to have been used to scrape harder and more abrasive substances like hide and wood (Table 53-1).

SITE	SHELLS ANALIZED	USE	POSSIBLE USE	SPECIES	MATTERS
-La Draga	58	19	10	-*Mytilus galloprovincialis* -*Callista chione* -*Donax* sp.	- Plant non wood -Hide - Soft wood
-Serra del Mas Bonet	375	16	-	-*Mytilus galloprovincialis*	-Plant non wood -Soft Wood -Soft material -Pottery -Hide -Meat and bone

Tab. 1. Shell tools documented at the two sites being studied.

The documentation of this kind of evidence, through the combination of macroscopic and microscopic observation and analytical experimentation, is able to widen our knowledge about the technological range used in these socio-economic formations. At the same time, it contributes towards a modification of the traditional interpretation of malacological resources exclusively as objects of adornment or food waste (Cuenca et al. 2010; Cuenca 2013).

Acknowledgements

DCS was funded by the University of Cantabria through a pre-doctoral contract and Fondation Fyssen with a post-doc fellowship. Parts of the analyses that support this research have been carried out as part of the project: Organización social de las primeras comunidades agrícola-ganaderas a partir del espacio doméstico: Elementos estructurales y áreas de producción y consumo de bienes (HAR2012-38838-C02-01), IP: Xavier Terradas – CSIC. Arquitectura en madera y áreas de procesado y consumo de alimentos (HAR2012-38838-C02-02), IP: Raquel Piqué – UAB. Ministerio de Economía y Competitividad - Subdirección General de Proyectos de Investigación

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Chapter Fifty Three

Investigating Pottery Technological Patterns through Macrowear Analysis: The Chalcolithic Village of Maccarese-Fiumicino (Italy)

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Abstract

The most interesting feature of the Chalcolithic village of Maccarese (Fiumicino, Italy) is the high quantity of pottery unearthed from the living floor. Through archaeometric analyses it has been possible to define the chemical and physical features of the pottery, determining the raw material provenance (Manfredini 2002). In this work, an experimental approach has been integrated with macrowear analysis to define vessel production techniques in more detail. This kind of approach, combining the experimental production of vessels with a macroscopic analysis of the technological traces, is yet not so widespread in the investigation of pottery technology, which is generally studied through ethnographic parallels. The aims of this research are multiple: a definition of the technological characters of the local clay, reconstruction of the modelling techniques and the tools used in pottery manufacturing processes, and definition of techniques and tools exploited for the treatment of the vessels' surfaces. The analysis of the technological macrotraces visible on the surfaces was recorded through the use of an appropriate database, which has permitted the comparison between the traces present on the experimental objects and the one observed on the archaeological materials.

Keywords: Pottery technology, Macrowear analysis, Technical traces, Technological traces, Experimental archaeology

1. Introduction

The main aim of this research is to reconstruct the choices, related to the production of pottery vessels, carried out by the human communities associated with the Copper age village of Maccarese–Le Cerquete Fianello (Fiumicino) (3370-2920 BC).

The technological features along with the shaping and surface treatment techniques and the tools associated to these latter have been investigated. The data obtained through this analysis can help in the definition of the role played by the pottery production within the settlement's community and the way in which it may have influenced the exploitation of the resources offered by the surrounding environment.

One of the main features of the site of Maccarese is the high density of pottery implements from the living floor. In opposition to this large sample is the high fragmentation of this later, along with some damage caused by post-depositional agents. If, on the one hand, these latter aspects can represent a limit to the traditional approach, they could have also stimulated the design and adoption of a specific approach, which focused on the traces present on the vessels' surfaces.

2. Methods

The methodological framework adopted in this research consists of an integrated approach; including both the analysis of technological macro-traces and experimental activities (Fig. 3, 4, 5, 6). This approach is based on a preliminary knowledge of the quantitative, qualitative and compositional features of pottery production.

3. Wear analysis and experimental activity

All the operational phases, related to the production of pottery implements, have been analyzed in this research. These phases included the raw material sourcing, the preparation of the clay paste, the modelling and treatment of the surfaces. These steps have been replicated through experimental activity, that, as suggested by the compositional analyses (Muntoni, Pallecchi 1998), have been carried out by exploiting the raw materials coming from an identified clay outcrop near the village of Maccarese (Fig. 1). In this way it was possible to create an appropriate comparative collection, which is indispensable to interpret the data related to the archaeological sample (Fig. 2).

To understand the "life" of a vessel, it is desirable to adopt a stratigraphic approach (Vidale 1990), which can be defined as the result of a series of activities to which it has been subjected, starting from its building, then with its use (Rice 1987; Skibo 1992) and finally to its abandonment. For this reason, a wear analysis has been carried out over the principal compositional parts (the bottom, wall and rim) of both the archeological implements from Maccarese and the experimental vessels.

Fig. 1 Actual landscape of the Maccarese plain.

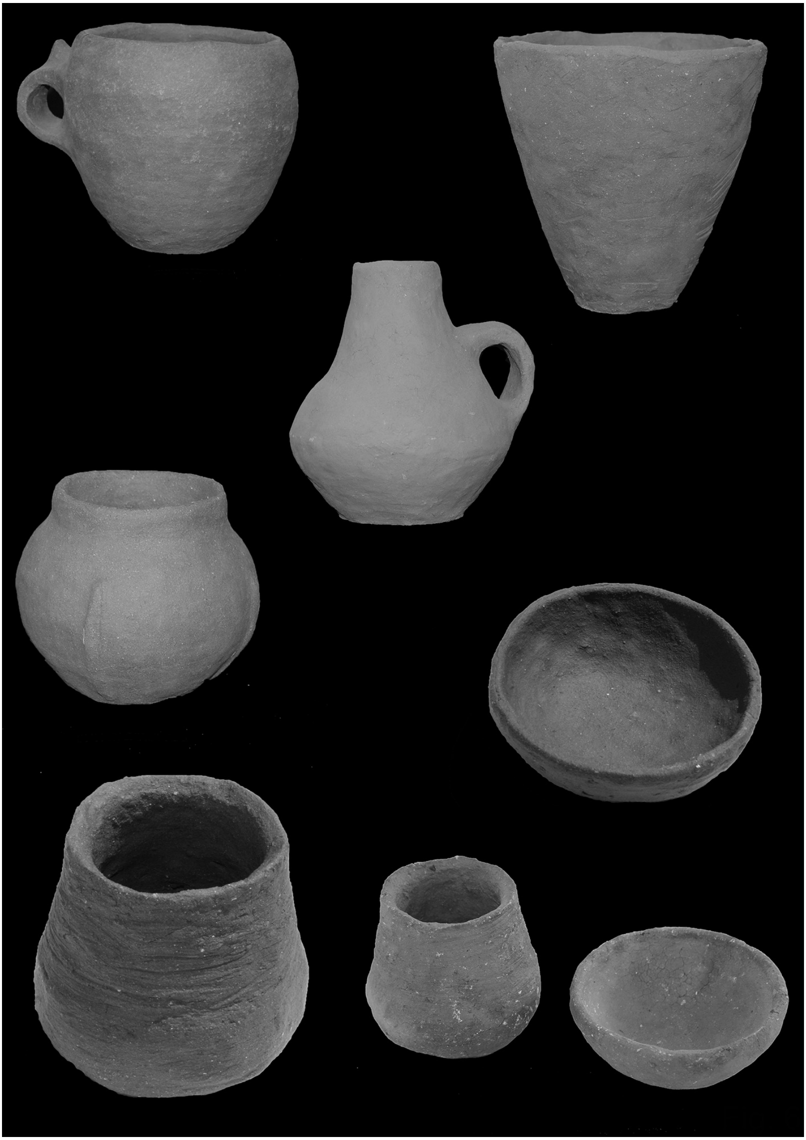

Fig.2 Experimental replicas of the Maccarese pottery production.

Fig.3 Preparation of the clay paste.

Fig.4 Experimental application of the coiling technique.

Fig.5 Experimental surface treatment.

Fig.6 Experimental firing of the vessels.

The macroscopic traces have been analyzed in detail with the aid of a Nikon SMZ-U stereomicroscope, capable of 75X magnification, and then described and recorded into a database according to objective parameters specifically elaborated, as:

1. Surface, to indicate the side of the vessel or potsherd analyzed (internal and external surface);
2. Topography, to define the morphology of the surface (regular and irregular).
3. Typology, to define the type of wear that is being analyzed:
   a. Large and longitudinally developed ridges;
   b. Parallel longitudinally developed striation batches;
   c. Narrow longitudinally developed striation;
   d. Irregular and randomly developed depressions.
4. Frequency, to define the repetitiveness of a type of trace on the surface (isolated or multiple);
5. Orientation, to indicate the direction of a trace (horizontal, vertical, oblique, chaotic and concentric);
6. Position, to define the position of the trace on the vessel;
7. Depth, (shallow and deep);
8. Texture, to indicate the topography of the inner portion of the trace (striped, smooth and rough);
9. Section, to indicate the transversal section of a trace (V and U shaped);
10. Effect, to indicate the degree of brightness or opacity perceivable with the naked eye (shiny and opaque);
11. Fractures, to indicate the fractures that compromise the integrity of the implement (horizontal and vertical);
12. Rifts, to indicate the irregularities that do not compromise the integrity of the object.

By analysing the morphology, the recurrence, the intentionality and other features exhibited by the wear present on pottery surfaces, it seems possible to trace the techniques, the treatments and the choices related to a specific production and technological level.

4. Preliminary results and observations

Nearly 90% of the pots produced at Maccarese are made of local clay, the source of which is located very close to the site (Muntoni, Pallecchi 1998; Manfredini 2002). This is suitable for a domestic type of production that would have been constantly exposed to thermal shocks (e.g. food preparation) (Manfredini 2002).

The objects were modelled by using the coiling technique, as suggested by the fractures' morphology and the numerous fragments, which exhibit a break on the joint points.

The surfaces of the vessels in some cases were subject to a smoothing treatment (Fig. 8 a-b), obtained by passing damped fingers on the surface. Alternatively, the smoothing of the surfaces could have been obtained through the use of pebbles and polished bone or wood tools. The use of these objects is indicated by horizontal, parallel ridges that are seen covering the entire surface (Fig. 7 a-b).

In several cases, on well preserved pottery surfaces the absence of discernible treatments has been detected. This is characterized by surfaces of an irregular morphology that exhibit depressions of different depths and shapes (Fig. 7 c-d), which alternate with more regular areas and finger smoothed areas.

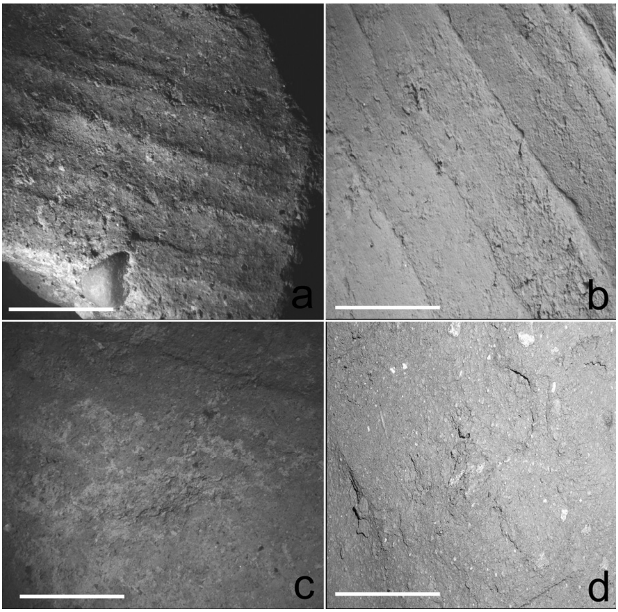

Fig.7 Experimental and archaeological wear comparison. *a*:archaeological parallel ridges; *b* experimental parallel ridges; *c*: archaeological depressions; *d* experimental depressions (White bar is 0,5cm at 0,75X).

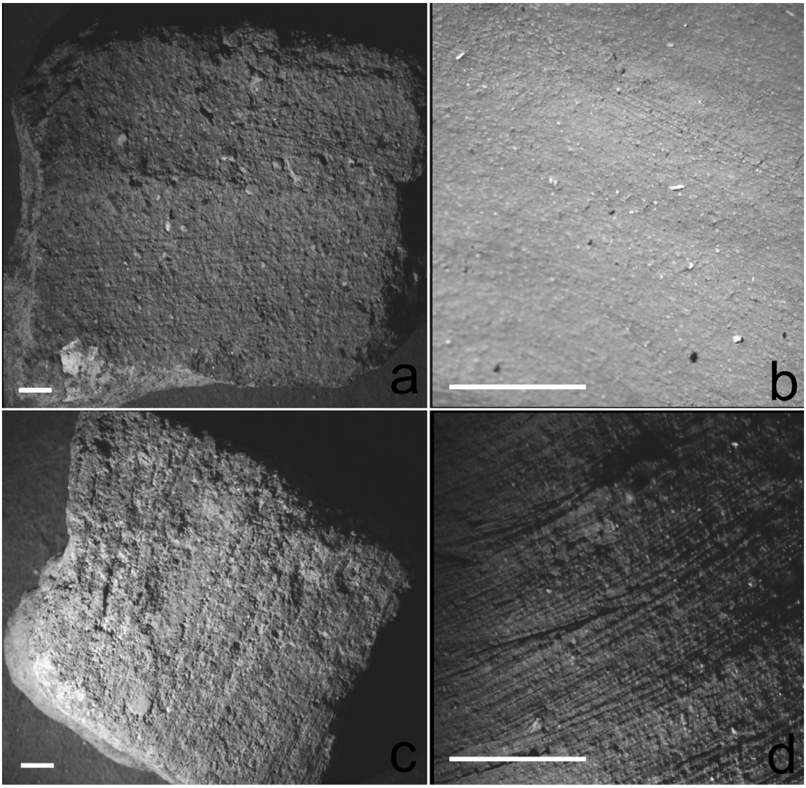

Fig.8 Experimental and archaeological wear comparison. *a*:archaeological finger smoothing traces; *b*:experimental finger smoothing traces; *c*:archaeological multiple striations; *d*: experimental multiple striations (White bar is 0,5cm at 0,75X).

Less common seem to be the use of tools made of plants (Fig. 8, c): the experimental replicas suggest a similarity with the ones observed on several archaeological samples, between the multiple striations that exhibit an horizontal orientation and a variable depth, produced by rubbing the pot's surface with grass (Lolium perenne) (Fig. 8, d) or marsh reeds (Phragmites australis) (Fig. 9, c-d), highly present in or near lake environments, such as the one where Maccarese is located.

Rare cases of shiny surfaces have been recorded in the pottery assemblage of Maccarese, even if this latter surface treatment technique seems to be highly frequent in Italian Copper Age pottery production. This technique, called polishing, is usually associated with fine grained clay (Fig. 9, a), which was rarely exploited at Maccarese, where there is a clear preference for gritty surface treatments.

Through the experiments conducted, it was possible to replicate this surface treatment technique by rubbing a tool (pebble or bone) with a polished hard edge on the surface of a vessel at an initial drying stage (Fig. 9, b).

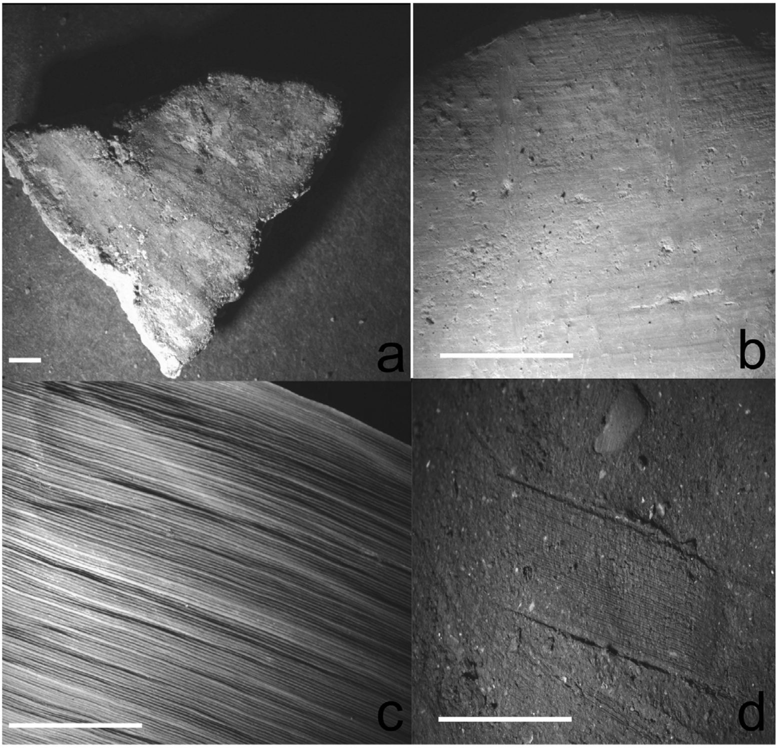

Fig.9 Experimental and archaeological wear comparison. *a*:archaelogical polished surface; *b*: experimetal polished surface; *c*: *Phragmites australis*; *d*:traces left by *Phragmites australis* (White bar is 0,5cm at 0,75X).

At first glance, the surface may appear regular, but through more detailed microscopic observation small parallel, sometimes superimposed, ridges with a regular bottom are visible. It cannot be excluded that this technological choice could be related to an intentional compaction of the walls, associated to closed shaped vessels used to contain liquids: this treatment decreases the porosity, thus improving the ability to contain liquids.

5. Final remarks

The analysis of the orientation patterns of traces indicates that the smoothing and polishing of the surfaces was carried out through horizontal motions. Pottery production, such as the one presented above, characterized by a few open or closed shapes (Manfredini 2002) built through re-constructible techniques, can be described as a domestic type of production. According to Peacock's (Peacock 1981) parameters, it can be described as a household production, manufactured to satisfy the primary needs of the Macarese community. This definition, achieved through the study of the pottery assemblage, fits very well with a context like Maccarese, where the exploited raw material was nearly exclusively local with a high degree of morphological and dimensional variability of the vessels due to handmade techniques, such as coiling that reflected the ultimate purpose for which the pottery vessels were meant.

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CHAPTER FIFTY FOUR

EXPERIMENTAL APPROACH TO USE-WEAR DAMAGE ON LIMESTONE TOOLS COMPARING WITH FLINT TOOLS

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Abstract

In the Eastern Coast of the Peninsula Iberia settlements, limestone is usually used as raw material in prehistoric lithic industries, especially in earlier chronologies. Several specific experiences carried out by some traceologists point to different use-wear patterns between flint/chert tools and limestone tools. However, there are no systematical researches, nor a complete analysis about how different actions damage limestone edges.

Methodology and results from two experimental series about this subject will be presented here. The first series shows and compares use-wear traces from controlled experiences with similar flint and limestone tools, used in the same way on the same worked material at the same time, to observe the difference in the resulting edge damage. On the second experimental series, several actions were developed with similar tools on flint and limestone, and edges were observed at different intervals of time to analyze edge damage evolution.

Keyword: Experiments, methodology, use-wear traces, comparison, limestone.

1. Introduction

In the Eastern Coast of the Iberian Peninsula limestone is usually used as raw material in prehistoric lithic industries, especially in early settlements. The morphology and lithological composition of limestone is quite different from flint and quartzite, and it has no presence in use-wear studies. Some authors had demonstrated that limestone is quite different from flint, but there is no systematic research, or a complete analysis about how different actions damage limestone edges.

We think that use-wear aspects are clearly determined by limestone lithological particularities, and they cannot be analyzed by drawing analogies from flint use-wear damages.

Correlations between flint and limestone edge damage is used here to make several conclusions about how limestone works in different tasks. We present the basis for a great experimental program especially focused on this raw material.

1.1. Objectives

1. To understand the mechanisms that involve the formation of use-wear traces in limestone working edges;
2. To recognize which use-wear traces are characteristic traits of this kind of rocks;
3. To prepare the basis of systematic research about use-wear damage in limestone tools that involves several variables and results in determining the traces that could become diagnostics of actions and materials worked with this kind of rocks.

1.2. Raw materials

Micritical (fine grain) limestone tools and flint tools have been used in these experiments. They come from the area of the Cova del Bolomor settlement (Tabernes de la Valldigna, Valencia, Spain). Lithic industries from this archaeological site have a great number of limestone tools, made of raw material found near the cave (Serra de les Agulles, La Safor). Usually these are green and blue micritic limestones, which are quite homogeneous and easy to knap. We have also found clear flint from the Serpis Valley and grey flint from a marine nucleus.

Differences between both raw materials can be observed at their surfaces. Limestone edges and surfaces have a lot of little flakes, corresponding to partial removals of surface particles. This is the reason why limestone tools have irregular surfaces. These differences are very important to the formation of use-wear traces (Fig. 1 and 2).

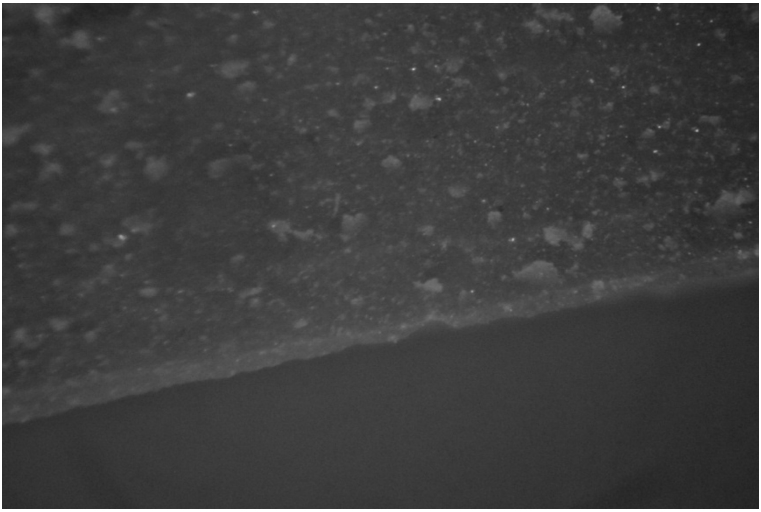

Fig. 1: Flint surface 40x.

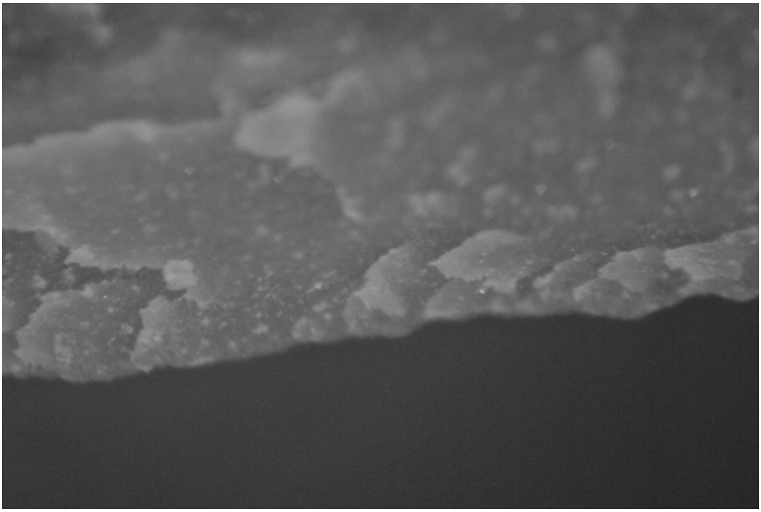

Fig .2: Limestone surface 40x.

2. Experimental protocol

Methodology and results from two experimental series on this topic will be presented here. The first series of controlled experiences with similar flint and limestone tools, used in the same way on the same worked material at the same time, shows how different is the resulting edge damage. On the second experimental series, several actions were carried out with tools on limestone and edges were observed at different intervals of time to analyze edge damage evolution. Other variables have been controlled, such as working angle, edge angle, edge shape…

It is only an approach to the way that limestone works in several actions and with different materials, to visualize the most relevant use-wear traces in this kind of rock.

We chose a little area of the edge, well documented before and after use.

We worked with several animal materials (in butchering tasks), wood and vegetables. Experiences with wooden materials were preferable to other materials because variables taking part in the action were well controlled.

3. Results

3.1. Animal working

There were two different activities in the animal series: the butchering of rabbit, and the butchering and meat-cutting of different cooked animals (duck, goat and rabbit). All actions were longitudinal.

The edge occasionally contacted with tendons, cartilage and bones, which produced small half moon breakages, that increased the irregularity of the edge shape. Flint tools show triangular and trapezoidal micro scars. We also observed soft initial polishes only at the high portions of the microtopography. On limestone tools scars are bigger than on flint edges, making the edge jagged. Scar shape is usually irregular, and has different sizes. Butchering tasks also produced light rounding of the edge, showing a soft and smooth aspect (Fig. 3 and 4).

On flint tools, butchering and cooked meat-cutting produces several half-moon breakages or trapezoidal scars, and soft initial polishes. On limestone surfaces we can observe several small scars, which are triangular and trapezoidal shaped. The edge is well conserved, showing a smooth aspect.

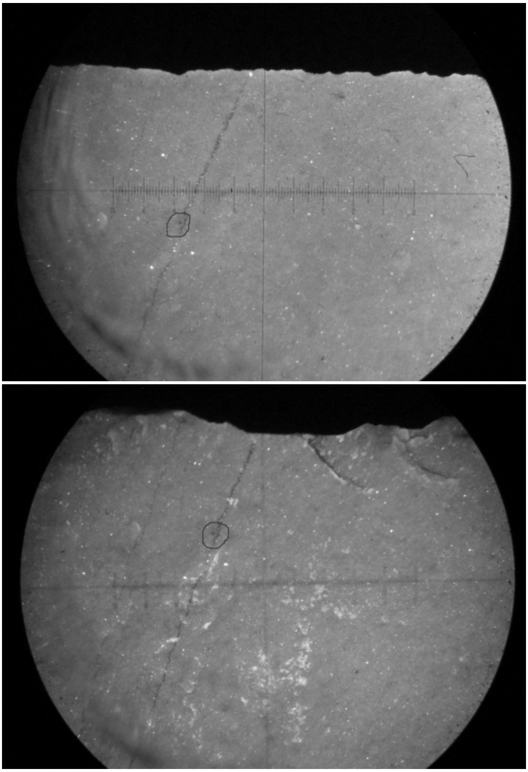

Fig. 3 and 4: Limestone tool before and after butchering rabbit. We can observe the removing of material from the edge by the point of reference (in red). Scales show the direction of the movement (30x).

In butchery tasks, limestone tools usually present a cutting edge much more damaged than flint. Scars tend to be grouped on specific points of the edge. Limestone tools are very effective. The strength that is needed for the work allows you to control the accuracy of cuts.

3.2. Plants and wood working

Limestone tool edges get damaged and dull faster than flint edges for all kind of works and materials. The efficacy of limestone tools does not usually run more than 15 minutes after working wooden materials.

After 2 minutes of use, limestone edges starts to scar, but this fact increases efficacy.

After 5 minutes, scars become larger, there is a loss of edge particles, and damage is obvious, at the thick areas of the edge.

The rounding of the edge, after 8 or 9 minutes of use, produces a loss of effectiveness that quickly increased.

After 10 minutes of use, edges usually get dull.

This process is well documented in cross cutting actions on wood, but also in longitudinal tasks on non-wooden plants.

Cutting non-wooden plants produces less edge loss and rounding on limestone tools. However there are more scars, smaller than in woodworking. No polishes were documented, with results identical to flint tools (Figs. 5 to 7).

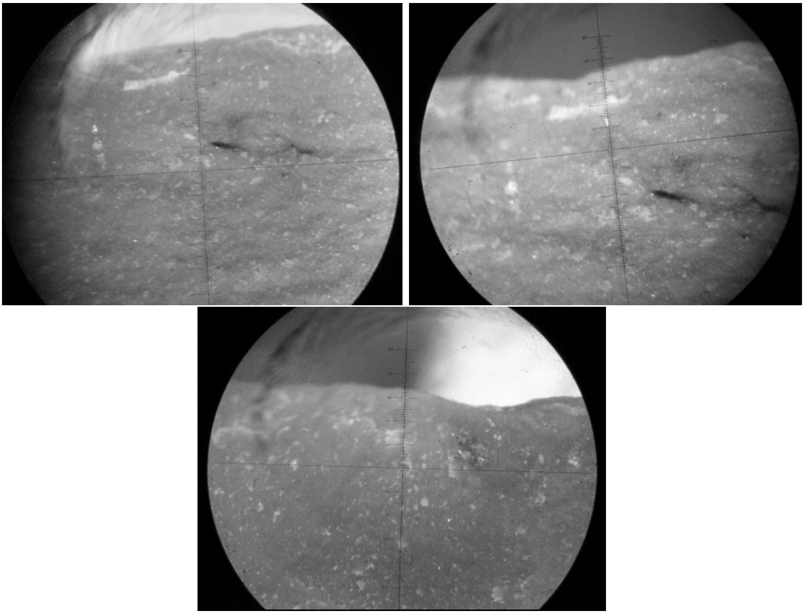

Fig.5 to 7: Limestone edge used to cutting grass after 5, 10 and 20 minutes of use. We can observe the removing of material from the edge by the point of reference (intrusion in orange) 20x.

Longitudinal actions on wood (saw) cause deep damage on limestone tools' edges. The loss of particles from the surface runs higher and faster than on flint tools. The edges show a jagged appearance and suffer heavy retouch from both sides, thus giving the edge a wiggly appearance. The scars look rounded and softened.

Occasionally there are some linear traces produced by the partial detachment of grains from the surface of the work piece. These traces usually run on an oblique path from the edge, and they are moderately long.

No polishes were documented, as those which appear in flint, in the high areas of the microtopography. Several half-moon breakages are documented on flint edges, seen also in limestone, as already mentioned. These breakages are aligned and give the edge an irregular appearance (Figs. 8 and 9).

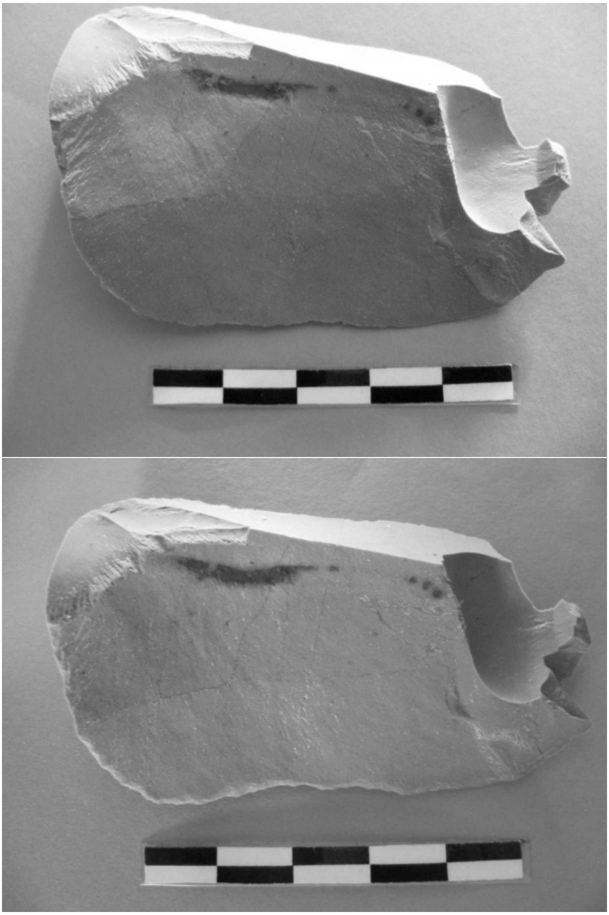

Fig.8 and 9: Limestone tool used on sawing wood, before and after use. It presents hard edge damage.

Scraping wood at right angles, in two directions, leaves very similar scars in limestone tools than those seen in sawing. We could find differences between one and another action, to be confirmed in subsequent experiments, in the presence of linear tracks, the ending of scars, the type of rounding of the edge and the presence and/or disposal of scars along the edge.

Whittling soft seasoned woods and plants (cross-cutting action, one-way, low angle) produces a greater presence of scars on limestone tools than on flint. Shape and size are also different in both raw materials, although they are not usually as large as in other actions. Scars on the flint edge are often on the opposite face to the contact. This face on limestone tools is deeply damaged by breakages and scars. Linear features running perpendicular from the edge may appear, but not polishes or striations.

In this kind of action, if the edge is thick, it suffers great rounding and fewer scars than tools with sharper edges (Figs. 10 and 11).

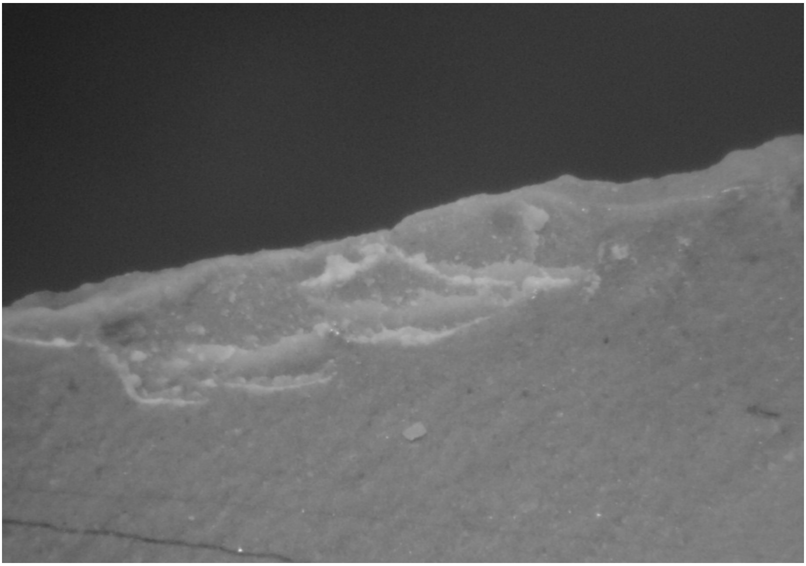

Fig. 10: Limestone sharpe edge after whittling wood. Overleaped scars (20x).

The working of hard or dry woods produces scars and breakages so powerful and steady that no rounding of the edge can be observed on limestone tools. Surface detachments, usually very glued to the edge, are produced on both sides if the edge of the work piece is sharp. Scars on thick edge pieces, as happens with flint, are mainly produced on the opposite side to those of contact, but show a very different aspect, while in flint there are more rounded contours than in limestone.

The ends of these scars often have many micro-scales not completely detached from the surface. Usually, linear features of the partial loosening of surface material, can be observed running perpendicular from the edge (Fig. 12).

Cross-cutting actions, right working angle, and one direction, hardly damage the opposite side to the driving face. Deep scars and micro-breakages along the entire edge, and overlapping in layers, cause the rounding and dulling of the edge in a few minutes. On the supply side, there are some small shallow scars. The border of the edge shows a very smooth appearance. Usually we can observe short, deep striations on this border running perpendicular to the axis of the edge (Figs. 13 and 14).

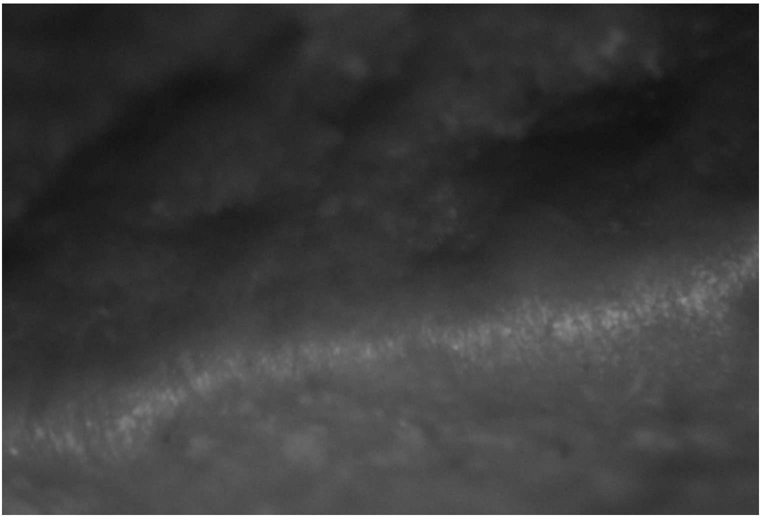

Fig. 11: Limestone thick edge after whittling wood. Striations and rounded edge (50x).

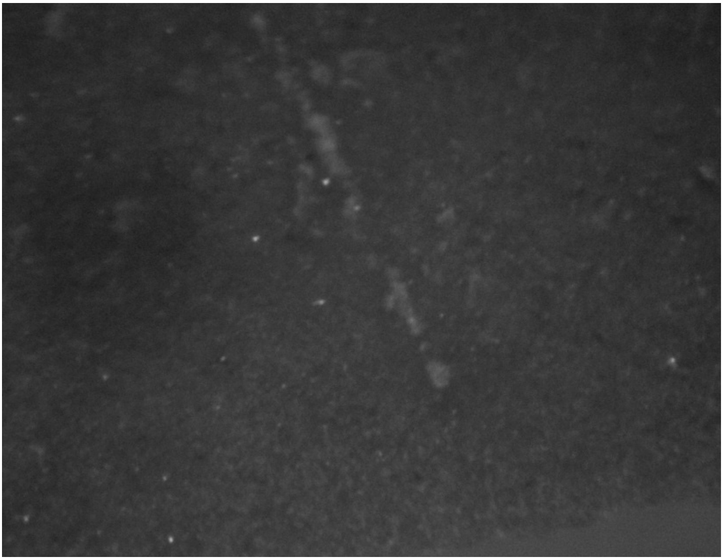

Fig. 12. Linear features on limestone surfaces after working wood. 50x.

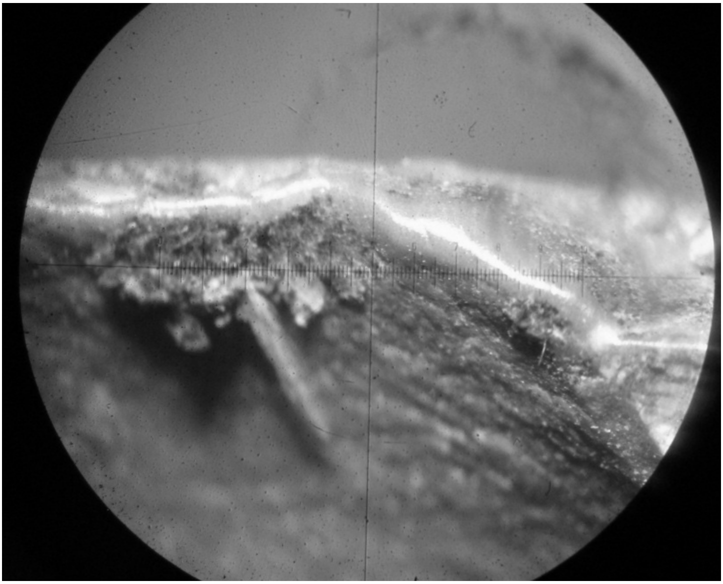

Fig. 13: Wastes and resin after use on seasoned wood. 30x.

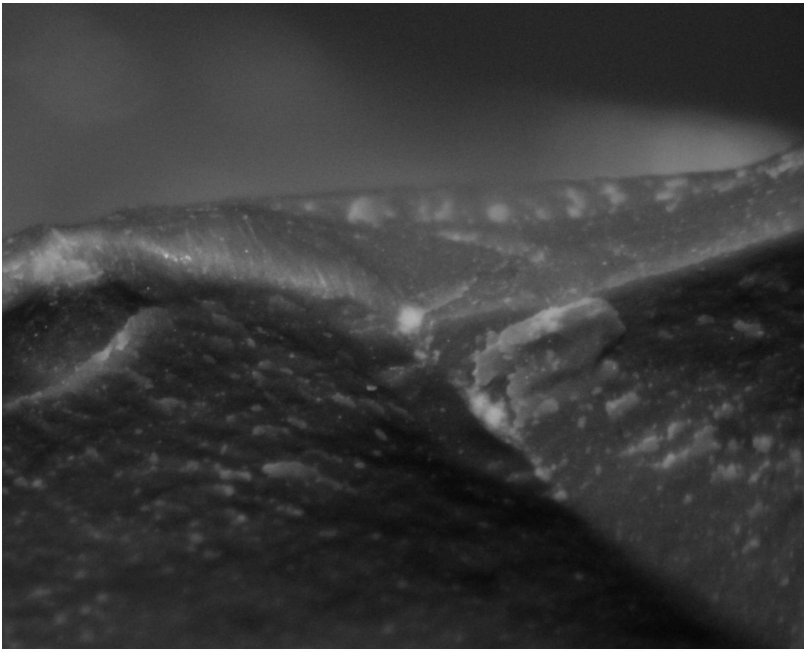

Fig. 14: Striations on limestone edge after cleaning with H2O2. 40x.

We made some experiences with retouched cutting edges for the last action (cross-cutting, right angle, one direction). Retouch increases the effectiveness of the tool. But the scars and the rounding of the edge appear after 5 minutes of use. Use-wear scars often overlap to the intentional retouching, making it difficult to distinguish them from each other after use.

4. Conclusions

Use-wear traces on limestone can be analyzed with low magnification, but striations and other features must be seen under a microscope.

Distinctive elements of use in limestone tools are basically the rounding of the edge and the distribution, form and ending of the scars.

Edge rounding looks very smooth and it could be a diagnostic feature for many actions developed with limestone. It is unlikely to be produced by non-use phenomena. This is a point to be evaluated in future experiments.

Sometimes, striations can be observed on the edge, often linked more to cross-cutting actions on wooden material. These stretch marks appear by removing the waste and resin that protects this trace. Working on dry wood, with no resin, damage edge and do not produce this kind of traces. Therefore resin becomes an important element in the formation of the traces of use in limestone that has worked wood.

In longitudinal actions scars tend to be distributed in some different areas of the ridgeline, which is very upset and shows an irregular appearance. On cross-cutting actions, even if these are two-way, scars tend to concentrate in specific edge points, where the impacts are reiterated and produce deep overlapping.

The end of scars on limestone edges usually looks scalar, because of particles not completely detached from the surface. That helps us to observe the direction of the action.

And regarding the efficacy of the raw material, limestone has been demonstrated to be effective for a short period of time, so it is used for immediate and specific tasks. These conclusions will also determine the selection of actions that could be made with this raw material for a broad future experimental approach.

CHAPTER FIFTY FIVE

USE-WEAR ANALYSIS OF EARLY NEOLITHIC LITHIC INDUSTRY OF PEIRO SIGNADO: A PIONEER IMPLANTATION IN SOUTH OF FRANCE

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Abstract

Contemporary with the beginning of the western Mediterranean Neolithization, Peiro Signado is one of the oldest Neolithic settlements in the south of France. The site shows the installation, on the coast of Languedoc, of small pioneer groups with clearly Italian origins. The lithic industry is characterized by a bladelet production. Use-wear analysis brings to light the diversified forms of Neolithic economy corresponding to a technical system transported by the first settlers. This paper presents the first results of use-wear analysis that will be entirely published in the monograph of the site.

Keywords: Process of neolithization, Impressed ware, lithic industry, blades, sickles, trapezes.

1. Introduction

The Neolithization of the Mediterranean Basin involves complex processes and varied modalities in time and space (Guilaine 2001). In the western Mediterranean, Neolithization begins at 6000 cal BC in southern Italy and Sicily with the emergence of the Impressed Ware culture (Fig. 1). During the same chronological period along the coastlines of Liguria, Provence and Languedoc, appear small pioneer groups with a Neolithic economy and clear Italian origin (Manen 2000, 2002). This sporadic and very fast "colonization" preceded the development of the Cardial. Peiro Signado is an emblematic site of this early colonization phase.

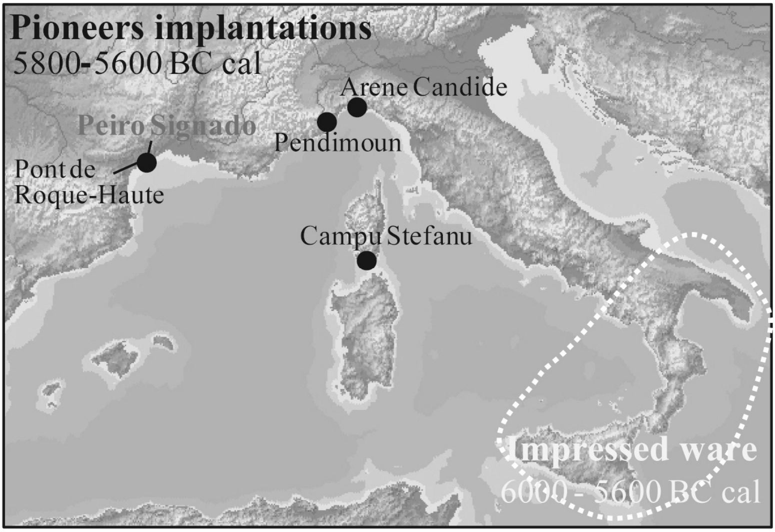

Fig. 1. Peiro Signado and the neolitizathion of Western Mediterranen (from Marchand and Manen, 2010).

2. Peiro Signado (Portiragnes, Hérault)

This open-air site is one of the oldest Neolithic settlements in the south of France, at the beginning of 6th millennium Before Christ (5700-5600 cal BC) and delivered one of the rare dwelling structures (Briois and Manen 2009). The documentation is very rich and reveals a totally established agro-pastoral economy. The lithic industry is mainly produced at the expense of small pebbles of brown or blond flint, probably stemming from littoral deposits or fluvial formations derived from the Bas-Rhône. The obsidian, from the Tyrrhenian area, is also exploited on the site in small quantities (Briois and al. 2009). Knapping activities are oriented towards bladelet production (85%) produced by pressure technique. The retouched tools, which represent 22% of the lithic industry, are mainly made on bladelets (87%) (Briois 2000, 2005).

3. First functional data

The preliminary use-wear analysis concerns a sample of 73 tools stemming essentially from an archaeological deposit connected to the rest of the built in perishable materials (on a total of 191). The study focused on some emblematic tools:

3.1. Retouched or notched bladelets and scraping (planing) activities

The nine analyzed bladelets present partial, irregular or notched retouch, of more or less depth. These bending fracture removals are always on the dorsal face. Eight working edges were observed on four artefacts (one retouched bladelet and three notched bladelets among which one was recycled as a borer). The used zones are the concave part of the notches (5), the retouch zones with slightly concave delineation (2) and unretouched edge (1) (Fig. 2). The asymmetric polish is little developed on the dorsal face, with a low degree of linkage of polished surfaces. On the ventral face, it is a shining marginal polish, forming a convex fluted bevel and few striations. This pattern corresponds to a transversal motion, the retouched dorsal face being the rake face and the rake angle is rather high, for the light scraping of rigid plant or soft wood.

These results suggest a techno-functional convergence with Late Mesolithic notched blades (Gassin and al. this volume). If this is confirmed by the complementary analysis, this convergence would support the perceptible affinities in the lithic sub-system of Castelnovian and Impressed Ware (Martini 2002)

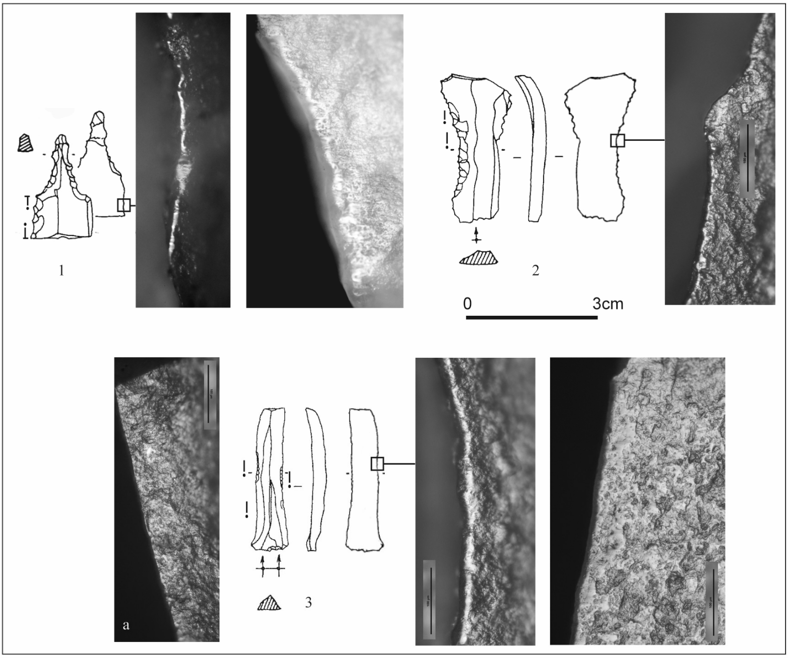

Fig. 2. Retouched or notched bladelets used to scrape vegetal materials. 1: Notched bladelet recycled in bored. 2: Notched bladelet. 3: Retouched bladelet. Asymmetric polish, tiny on the dorsal face (3a), shining fluted domed bevel on the ventral face, marginal to moderate invasiveness (end flank). All photographs taken at 200x.

3.2. The harvest implements: composite sickles with obliquely inserted elements

Peiro Signado delivered a total of 34 glossy blades[1], from the dwelling area, pit n°7 and out-off stratigraphy. These sickle elements are short, generally between 2.5 and 3.5 cm except in some ambiguous cases (too fragmentary blank), the traces develop in diagonal and result from an oblique insertion (Fig. 56-3). Blades are used on a single edge which is, most of the time, unretouched (12) but can be modified by regular semi-abrupt (1) or microdenticulate (8) retouch. The chronology of traces seems

[1] All the glossy blades were studied in association with Bernard Gassin and Juan Francisco Gibaja Bao within the framework of a European collective program on the first cereal harvesting methods in western Mediterranean (Ibánez et al., 2008).

to indicate that these edge modifications can correspond to sharpening in the course of work or blank rectification.

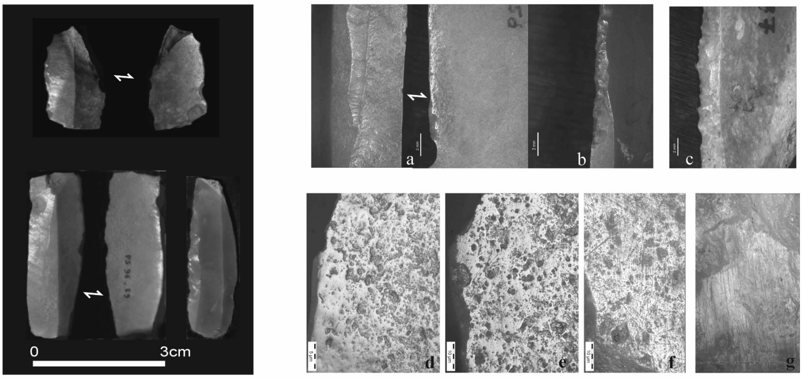

Fig. 3. Sickle blades with oblique gloss, working edges diversity (unretouched edges (a), regular semi-abrupt retouch (b), microdenticulate retouch (c)) and micropolish diversity (smooth coalescence (d), smooth to moderate striation (e, f), very strong striation (g)). All microscope photographs taken at 200x.

Polishes also offer a diversity inferred by the striation level. They raise a smooth coalescence in the majority of the cases (18), smooth to moderate striation (8) or very strong striation (4). These striation levels are not correlated with the edge modifications. The abrasion of some sickle blades could result from a low cutting of stem cereals allowing the recovery of thatches (for the cattle and/or for mud-box house); either of their uses to cut the stems on the ground (Clemente and Gibaja 1998), but we cannot exclude re-uses. The crossing of functional data and the results of archaeobotanical analysis (Marinval, work in progress) will allow the specifying of these hypotheses.

3.3. The symmetrical trapezes: transverse arrowheads

The geometric microliths are represented by a rather important number of trapezes (n=39 found during excavations in 1996-1997). Obtained by bending the breakage of bladelets, microliths are exclusively symmetric bitruncations. The truncations are always direct and rectilinear or slightly concave. The morphometric homogeneity of the trapezes is also characterized by a standardization of the widths (10 ± 2mm), like all the bladelets of the assemblage.

Diagnostic impact traces are observed on 11 microliths out of a total of 30 analyzed. Macro-fractures, burin-spall and spin off, are located on the points formed by truncation and the long base, oriented perpendicularly to the long base (9 cases) (Fig. 4, 1). On the long base, damage impacts are flake scars, often continuous, bifacial, with trapezoidal morphology and step termination (6 cases out of 11) (Fig. 4, 2). On the short base, we observe micro-scars or transversal bending fractures (5 cases) (Fig. 4, 3). Linear micro-traces are identified on two trapezes (Fig. 4, 4), combining linear plastic alterations of the flint surface, abrasion of the microtopography and striations. They arise from microfracturing and crushing. The orientation of linear traces is also largely perpendicular to the long base. The recurring orientation of impact traces, as well as their distribution and combination, confirm the use of the trapezes as projectile points, and more precisely as transverse arrowheads.

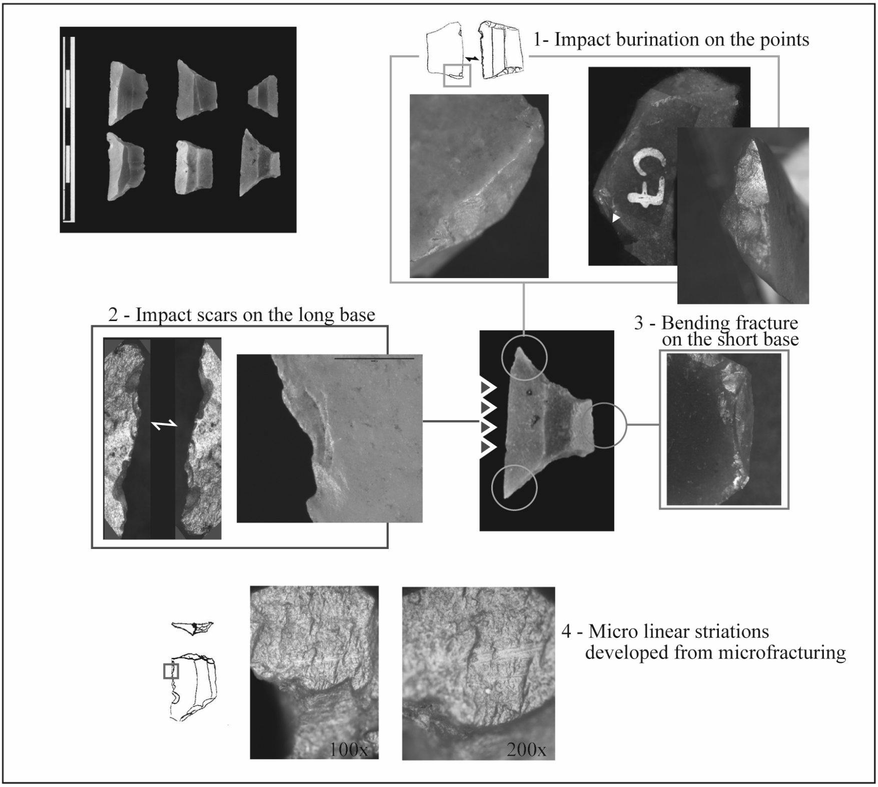

Fig. 4. Diagnostic impact traces on symmetrical trapezes used as transverse arrowheads.

Without underestimating their symbolic or social functions, these arrowheads and the arrows which they armed, probably served for hunting. To consider the part of hunting activities in the Peiro Signado economy is difficult from the only inserts and in the absence of the faunal remains which are very badly preserved on the site. However, the impact rate (37 %) and the important part of the trapezes in the industry spectrum (20% of the retouched tools) allow us to suppose that the hunting contribution was not insignificant, in particular in the raw material supply system (pelt, hide, bones, antler, tendons…).

4. Discussion

At this stage of the study, we have a very partial vision of the technical processes operated by these pioneer groups. The exhaustive analysis of the Peiro Signado industries will allow a more ample questioning of the colonization paradigm.

The strategies of tool kit management appear to contrast with the investment in raw material acquisition. Peiro Signado leptolithic flint tools, little transformed, seem moderately exploited (few recycled, few multiple use). This report may be connected with the very productive character of pressure knapping but also with the lightness of bladelets extracted on the consumption site. We shall underline however the absence of quite close raw materials sources. We can then suppose that the access to the relatively distant zones of supply of flint pebbles in Bas-Languedoc, would have been favoured by the traditions of maritime mobility. In this context, the contacts with the Mesolithic populations remain hypothetical. Through the technical processes, to perceive (or not) the possible techno-functional links, such as they could be envisaged for notched bladelets, could contribute to the debate on the Castelnovian heritage in Impressed Ware and on the interactions between both cultural complexes (Dini and al. 2008; Perrin 2009; Radi and Ronchitelli 2002).

As a supplement of the agro-pastoral economy, these first farmers maintained predation activities, in particular hunting, in open air sites such as Peiro Signado and Pont de Roque-Haute or more intensively in caves and rockshelters such as Pendimoun, Arene Candide, Latronico and l'Uzzo (Vigne, Carrère, in Guilaine et al. 2007). Adaptation to local resources or cultural traditions transposed from the origin area?

Peiro Signado is affiliated to Ligurian Impressed Ware. Indeed, it presents very strong ceramic affinities with the early Neolithic of Arene Candide (Manen 2002; Guilaine and al. 2007). The comparison of lithic industries is supplied with less convincing elements, in particular for 3 sickle blades, which according to B. Voytek, were inserted in parallel (Starnini, Voytek 1997). In South Italy, a new analysis of Torre Sabea glossy blades allowed the characterization, as at Peiro Signado, of an oblique insertion (Gibaja, Mazzucco, personal communication) but in other sites, as Favella (Fuolega; Voytek, in Tiné, 2009) or Ripa Tetta (Petrinelli Pannocchia 2007, 142; 2008), the parallel inserts seem the majority. Although more recent, the Adriatic Impressed Ware sites could offer convergent data, in particular Maddalena di Muccia (Petrinelli Pannocchia 2007, 143) where is attested oblique gloss on short blades, the component of sickles with dented edges. Here still, other elements of the lithic industry, such as geometric microliths, diverge from the Peiro Signado model. The re-examination of tools, the current analysis will bring precision on the sickles morphology, as that of Santo Stefano revealing probably the coexistence of various insertion types unless it is a chronological evolution (Petrinelli Pannocchia, this volume). But sickles being only one of the components to be considered, convergent or clashing components (sickle/arrowhead–lithic/ceramic), in the search for the complex processes which led these sailors-farmers on languedocian shores.

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CHAPTER FIFTY SIX

A NEOLITHIC SICKLE HAFT FROM COSTAMAR (CASTELLÓN, SPAIN)

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Abstract

A possible sickle haft made from a deer antler was found at a major Neolithic site recently excavated in the Iberian Peninsula: Costamar (Castellón, Spain) (Fig. 1: 1). Here, an overview of the site is followed by a morphological and technological characterisation of the lithic tools found in the early Neolithic levels and structures, concluding with a description of the antler haft and its parallels with other hafts and sickle types found at sites in Iberia

Keywords: Iberian Peninsula, Neolithic, sickles, lithic tools.

1. The site of Costamar

Archaeological excavations by the Fundació Marina d'Or at the settlement of Costamar, between 2006 and 2008, uncovered an area of

57,905m² containing 678 archaeological features belonging to Neolithic, Bronze Age, Iberian, Roman, Islamic, late medieval, modern and contemporary times (Fig. 1: 2-3) (Flors, 2010; Flors et al., 2012). The Neolithic features belong to two phases. The first, with 204 storage pits, is characterized by the presence of pottery with incised-impressed decoration combined with plastic decoration and red ochre pigmentation. One outstanding nearly complete vessel is decorated with an anthropomorphic motif (Fig. 1: 4).

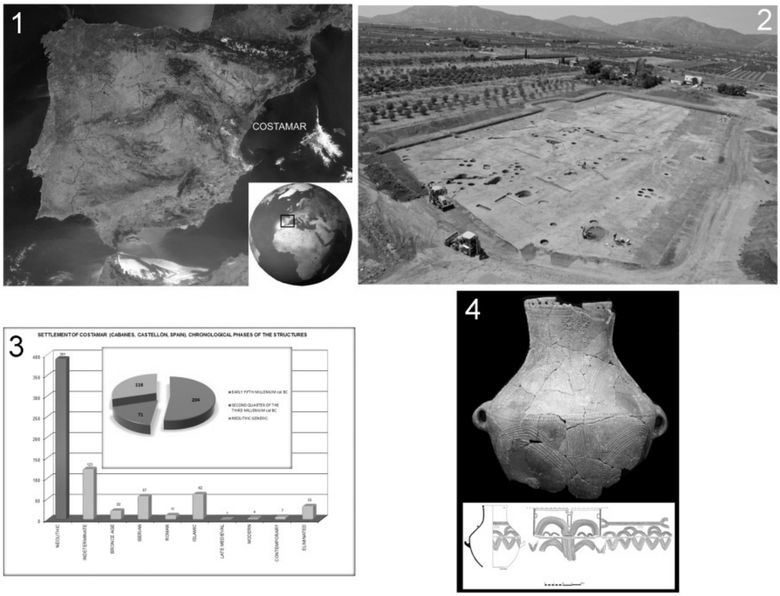

Fig. 1. (1) Location of the settlement of Costamar; (2) Photograph of the area with Neolithic structures; (3) Graph relating the number of structures and their chronology; (4) Neolithic pottery decorated with an anthropomorphic motif

This first phase has been dated by a cattle bone (*Bos taurus*) to 5996±38 (4990–4790 cal BC at 2σ) and by a barley grain (*Hordeum* sp.) to 5965±25 BP (4933–4786 cal BC at 2σ) (Flors, 2010).

The second phase is represented by two pits and 71 other negative features, with a radiocarbon determination for a secondary burial in Structure GE 90 of 4095±28 (2860–2500 cal BC at 2σ). A further 116 features with sparse finds have been attributed to the Neolithic, although it was not possible to assign them to either of the two phases, while another

123 features yielded no finds and have been classified as indeterminate.

The results of the diachronic analysis of the negative structures at Costamar and their fill have identified typological and spatial differences between the two occupation phases. In the early fifth millennium, circular structures predominate, and open and truncated conical shapes are the most common. Several closed, bell-shaped cross-sections have also been documented, while these are unknown in the second phase. Indeed, in the first half of the third millennium, the number of structures decreases, and they become smaller.

The correlation analysis of the two phases, assessing the frequencies of materials, reveals that the greatest variability is concentrated in the first structures. When the absolute values of pot sherds are analysed, they are seen to be scarce in the third millennium structures. Differences are equally seen in the way the human remains were deposited: in the incised-impressed phase at Costamar, four burials were found in a primary position, whereas in the second phase of the occupation the two burials that have been documented contain the remains of three individuals in a secondary position.

It can also be seen that the structures belonging to the second phase are associated with two moats on a west-east line. In contrast, in the incised-impressed phase the structures are grouped above all on the east side, where the burials were located. All this suggests that at the settlement of Costamar, the area was occupied in different ways in each period, in accordance with cultural models and waste management.

2. The lithic tools

Lithic tools from the incised-impressed Neolithic phase show similar characteristics to those appearing at other coetaneous sites in Spain, such as Guixeres de Vilobí (Barcelona), Alonso Norte (Teruel), la Timba dels Barenys (Tarragona), and La Lámpara and La Revilla (Soria).

The number of lithic remains reaches 5154 objects (814 are retouched tools) (García, 2010). They appeared in the fill of a large number of pits (nearly 300) with a final use as a waste midden. Five pits had a funerary use but the lithics recovered do not seem to have any special characteristics as offerings. Stratigraphic data suggest that their presence is linked with infilling the pit.

The raw material corresponds to different varieties of flint, mostly two fine-grained classes of black and white flint (characteristic regional sources). Lithic knapping was mainly aimed at obtaining blade and bladelet blanks. The general absence of core preparation flakes suggests that the roughing out took place at the raw material sources. The first phases of the reduction process were most probably carried out near the outcrops, while the blade/bladelet knapping took place at the site. Blade cores show a characteristic pyramidal or cylindrical shape, allowing a regular and standardized production. Although the first diagnostic conclusion from the preliminary study confirms the use of indirect percussion, we cannot discard the probable use of pressure flaking. The identification of shiny and matt surfaces is linked with heat-treatment.

Among the retouched tools, blades with continuous lateral retouch, drills and lunates predominate. Lunates with bifacial retouch are abundant at other Early Neolithic sites, like Chaves (Huesca), La Draga (Girona), and Can Ballester, Mas Nou and Cova Fosca (all in Castellon).

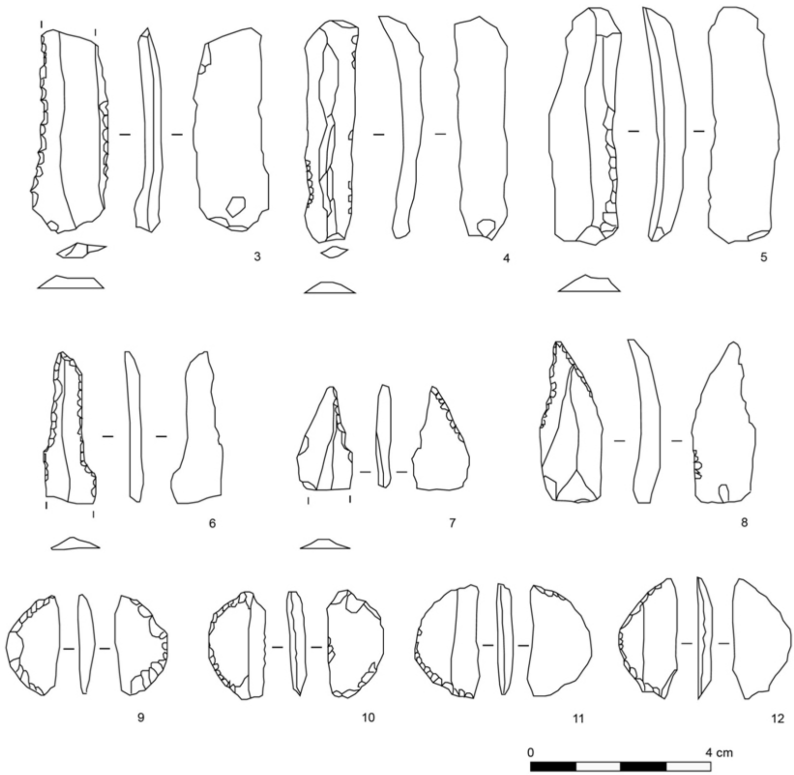

Fig. 2. Lithic tools from the structure GE188 (UE 18802)

3. The antler sickle

An antler sickle recovered in a pit belonging to the first Neolithic phase is an exceptional find as few examples are known from Europe (Flors, 2010: 107-173). The red deer antler sickle was found inside Structure GE 398-651. This structure is a circular pit, with diameters of 108cm and 79cm in its opening and base respectively, and a depth of 31cm. The sickle was found on the base, together with five undecorated sherds belonging to the base of a recipient conserving red ochre remains on their outer surface.

The sickle is a compound tool with a total length of 37cm. The antler was cut off at the handle part, or proximal part, of the implement. The distal end conserved one of the antler points, which would have been used to gather up the stalks. The most interesting feature of the tool is in the centre of the lateral face where there is a groove 2.5cm long and 0.8cm wide at its distal end, narrowing to 0.4cm. This groove was possibly formed by abrasion and on its left-hand side several incisions were caused by the manufacturing process. This groove must have been made to hold a single flint blade inserted diagonally.

The sickle would have been used by holding it at the proximal end, gathering up the stalks with the transversal appendix and holding them in the other hand. At this point, the sickle would have been turned 90º, so that the stalks could be cut with the blade that must have been hafted in the sickle. The analysis of use-wear marks on this sickle from Costamar has revealed that the internal face of the distal appendix is intensely polished due to the friction with the stalks when they were gathered up.

Nine sickles with the same form, but made in wood, have been recovered at the lake-side site of La Draga (Banyoles, Girona, Spain). These sickles consist of a main shaft with a hole in the center and a transversal branch at 90º to the hole, like the specimen from Costamar. One of the sickles from La Draga still conserves a flint blade fragment inserted diagonally (Palomo et al., 2010).

This type of sickle, with a single blade hafted diagonally, has also been documented at other Neolithic sites in the Iberian Peninsula by means of use-wear analysis: at the mining structures at Casa Montero (Madrid), in Cueva de la Vaquera (Segovia), and at the open-air settlements of La Draga (Girona), La Lámpara and La Revilla del Campo (both in Soria) (Gibaja, 2008; Terradas et al., 2010; Palomo et al., 2011; Gibaja et al. 2012).

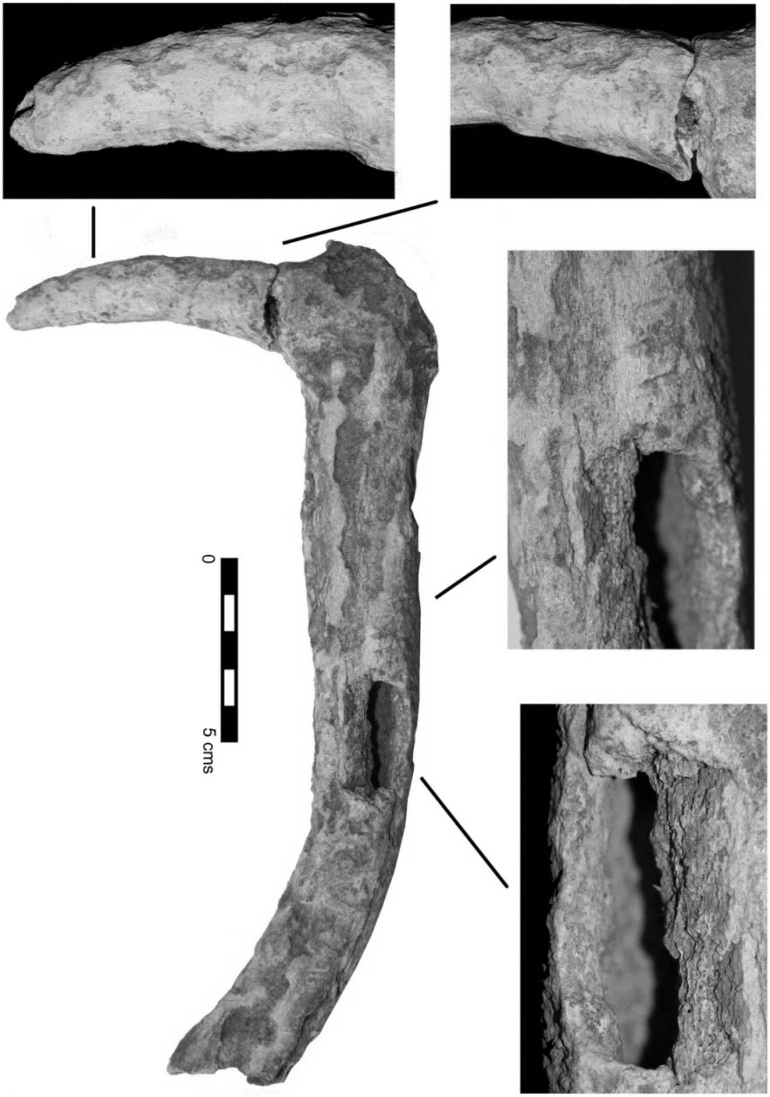

Fig. 3. Red deer antler haft found at Costamar. Several modifications can be seen: the central groove and polishing/abrasion in certain parts, such as the upper appendix of the haft.

This type of sickle was used in conjunction with others with different morphology. These are sickles with flint flakes or blades fitted parallel to the haft. The number of flint pieces used depended on their length. It is likely that sometimes a single long blade was fitted, and on other occasions several fragments were hafted in line. In fact, both sickle types were common in northern Iberia and the south-east of France (Ibáñez et al., 2008).

The Costamar sickle is a significant find in the context of harvesting technology in the Neolithic. The parallels at the site of La Draga and the documentation of flint blades used as oblique insertions in south-east France and the center-northeast of the Iberian Peninsula suggest that this model of sickle was used over a wide area of the western Mediterranean basin in the early Neolithic (Ibáñez et al., 2008).

Acknowledgements

This research was undertaken within the framework of the projects: "Origins and spread of agriculture in the south-western Mediterranean region" of the European Research Council (ERC-AdG 230561.); and "Aproximación a las primeras comunidades neolíticas del NE peninsular a través de sus prácticas funerarias" of the Spanish Ministerio de Ciencia e Innovación (HAR2011-23149).

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CHAPTER FIFTY SEVEN

THE PERFORATION OF POTTERY USING SEASHELLS: AN EXPERIMENTAL APPROACH

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Abstract

Ethnographic and archaeological research has demonstrated that the exoskeletons of certain molluscs could have been used as tools. On the pre-Islamic site of Ed-Dur (Umm al-Qawain, UAE), where many shells of Terebralia Palustris were found in association with pottery dating from the Iron Age, the hypothesis of such a use has been tested. Indeed, among the potsherds unearthed, some show biconical perforations indicating the repair of vessels probably on the site itself. As materials such as metal or flint, which could have been used to make these perforations are completely absent from the site, the specific form of Terebralia Palustris seemed appropriate to be used as a natural drill. In an attempt to prove its use, an experiment was conducted to try to perforate a pottery vessel using this shell.

Keywords: Drill, seashell, ceramic, Pre-Islamic, ed-Dur, experimentation

1. Introduction

Shells are regularly studied as adornments, chronological markers or– in the field of traceology–as a material worked by flint tools. However, the use of shells (seashells in particular) as tools is well documented in archaeological literature and ethnographic research (Flamand 1902). The prehistoric site of Kimanis (Sulawesi Island, Indonesia) constitutes a first example, where seashell scrapers dating to the 9th millennium BP were discovered (Bulbeck 2008). Another example is provided by the research of J. Polet, who has studied bivalves that were used as scraping tools two thousand years before our era on the island of Nyamwan (Ivory Coast) (Polet 1995). The final example comes from the Arabian Peninsula; a very similar context to the one discussed here, where researchers have raised the question of the use of Veneridae (another bivalve mollusc) as scrapers from the Neolithic period to the Iron Age (Charpentier et al. 2004). Most of these studies focus on scraping tools made from bivalve molluscs, however the observation of contemporary practices (conch used as musical instruments, for example) or the name given to seashells by certain populations of New-Caledonia (Rivierre 1973) show the multitude of possible uses for these shells.

An experiment conducted with shells found on an archaeological site of the Arabian Peninsula gives us an insight into one of these potential uses.

2. An Iron Age…without iron

The coastal settlement of Ed-Dur is located in the Emirate of Umm al Qaiwain (United Arab Emirates, Fig. 1) about 150 km to the south-west of the Straits of Hormuz. Considered as one of the largest archaeological sites of this region it was excavated by an international team from 1987 to 1996 (Boucharlat et al. 1989).

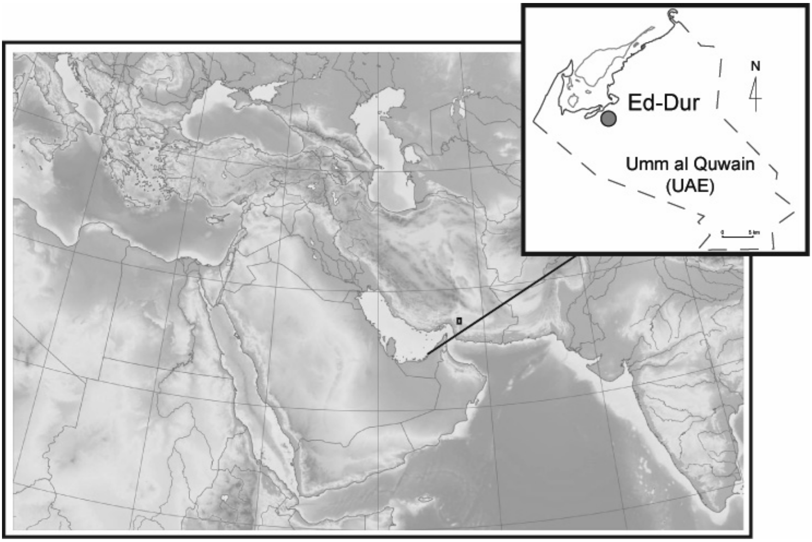


Fig. 1: Site location

If the first evidence of the site's occupation dates back to the 5th millennium BC (Desse et al. 2002), its apogee dates from a period between 100 BC and 250 AD. The archaeological area concerned by this study is located at the edge of the Umm al Qaiwain's lagoon and was inhabited during the Iron Age. It was excavated by a French team under the direction of Olivier Lecomte (CNRS. Lecomte et al. 1989).

Terracotta objects are the main type of archaeological artefact found on the site (Fig. 2). The pottery study reveals that several of these objects were perforated either to be used as fishing net weights, or in order to repair broken vessels. The site of Ed-Dur has also provided an abundance of shells of the Terebralia palustris (Linnaeus, 1767) type. This seashell (Fig. 3) is a gastropod of the Potamididae family, whose preferred habitat is the mangrove (Salles 1984), and many shell middens essentially composed of this type of mollusc have been discovered on the coast of the Arabian Peninsula (Hellyer et al. 2006).

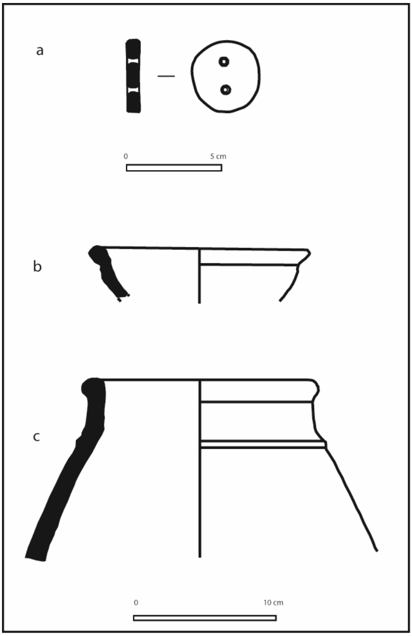


Fig. 2: Iron Age pottery discovered on the archaeological site of Ed-Dur. (a) Terracota fishing net weights. Note the biconic perforations. (b) The «Thick black» ware. (c) The «Thick buff» pottery.

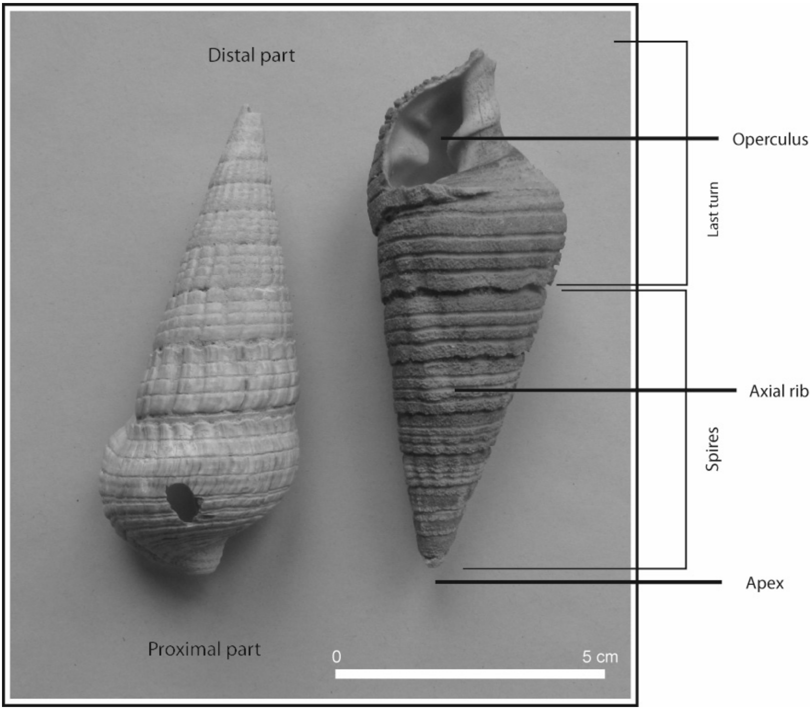


Fig. 3: Terebralia Palustris, description of the seashell.

The presence of numerous perforated ceramics and the absence of tools identified as drills have together been considered as an anomaly and have attracted the attention of the archaeologists. An experiment was therefore conducted to test the hypothesis that the particular morphology of T. palustris could have been useful to perforate objects.

3. Experimental protocols

The initial experiment was carried out on the site of Ed-Dur in 1993, using a simple experimental protocol, the objective being to ensure the feasibility of using a gastropod shell as a tool to drill a perforation in pottery.

A ceramic sherd was held horizontally in the left hand, and the shell of T. palustris was held in the right hand. At first, a cupule was made on the surface of the sherd with a small Terebralia to avoid the slipping of the apex of the larger seashell (Fig. 4) during the perforation process. Then, the ceramic was drilled by applying a semi-rotary movement to the improvised tool. During the procedure, the proximal part (aperture) of the shell was firmly held by the thumb, the index, and the middle fingers while the palm of the hand pushed the distal part of the shell to the ceramic. We added sand to the cavity every few minutes to accelerate the perforation process. The exoskeleton of shell is composed of calcium carbonate ($CaCO_3$) and seems very fragile while the ceramic appears to be particularly strong. However, the time required to perforate the ceramic chosen for the first experiment ("thick black" ware, Fig. 4) was only about ten minutes. As soon as the tip of the shell had totally perforated the sherd, it was turned over and the process was repeated from the other side to widen the perforation. The profile of the finished perforation was therefore biconical, identical to the observed ceramic perforations from the archaeological contexts of Ed-Dur (Fig. 2, a).

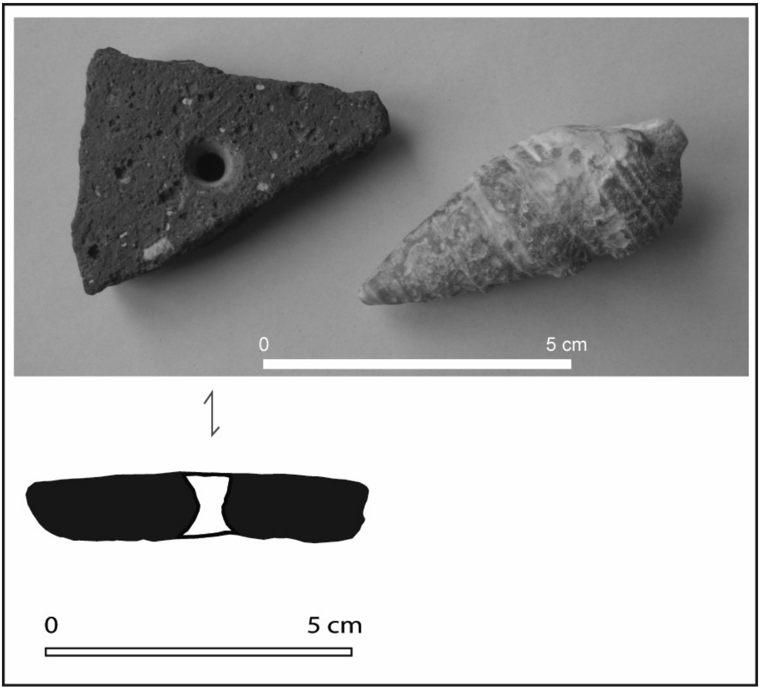


Fig. 4: Shell and ceramic sherd used in the first experiment. Note the biconic perforation on the sherd

The second experiment was conducted in 2012 at the archaeological research centre of Pantin (France), using a more traceological approach. The materials used had been collected from Ed-Dur in 1993. The pottery selected for this second experiment was deliberately chosen as being the densest and the thickest found on the site ("thick buff" pottery, Fig.5, a). The sherd already had two archaeological perforations that could be compared with the experimental one.

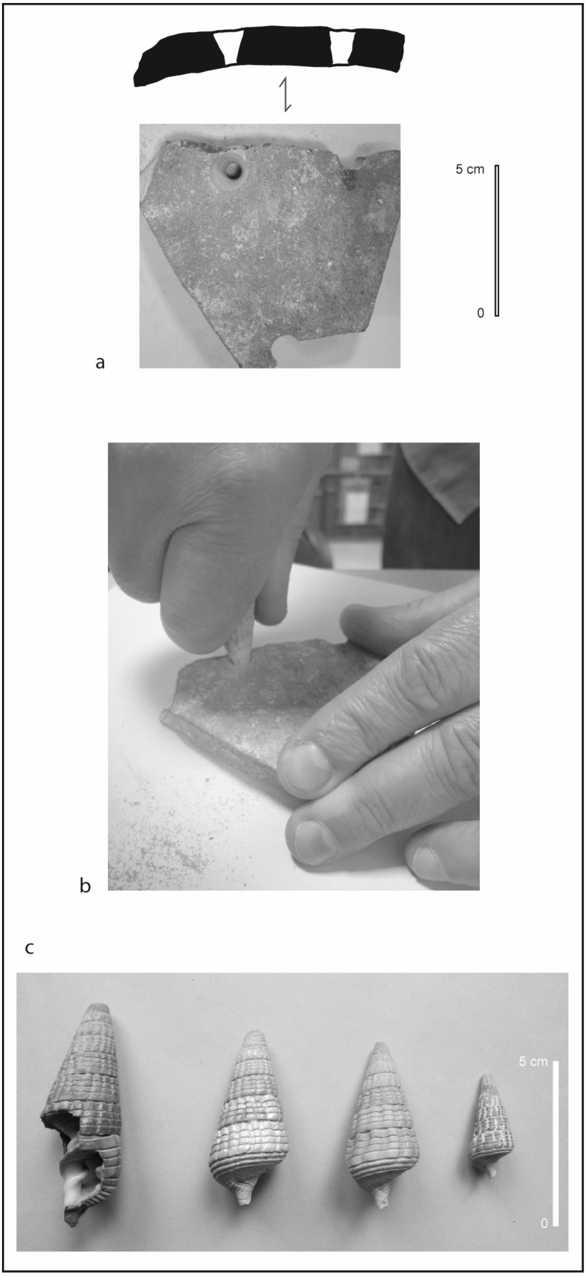
The protocol used in this second experiment was very similar to the one used in 1993, except that the perforation was begun directly with the experimental piece n° 2, and also because the sherd was placed on a table (Fig. 5, b).

It was also decided to perforate the pottery from a single side only. Indeed, the «V» profile of the perforation obtained this way appeared more in compliance with the archaeological perforations observed on the sherd.

One hour of work and four T. palustris (Fig. 5, c) were necessary to reach our objective.

In conclusion, both experiments were successful as the shells were very efficient in drilling ceramics and we can assume that, by using a device such as a "pump drill", the time required to perforate would be greatly shortened.

Fig. 5: (next page) Second experiment. (a) «Thick buff pottery». We can see two archaeological perforations (bottom and top right of the sherd) and the experimental perforation top left. Note the «V» profile of both the archaeological and experimental perforations. (b) Drilling of the ceramic by a rotating movement. (c) The seashells after the experiment. We note the almost complete disappearance of the apex and the flattened tip of the largest Terebraliae.


5 cm
0
a
b
c
5 cm
0

4. Observations and interpretations

All the experimental shells were cleaned with 90% alcohol and studied using a metallurgical microscope (Nikon Optiphot) with magnifications from 50x to 1000x. Observations of the surface of the T. palustris were made and revealed different traces of use depending on which part of the shell was observed. Indeed, the proximal part ("last turn") was seen to be smoother and more regular. It had a very bright soil polish, with numerous striations of different lengths without uniform direction (Fig. 6). The surface of the distal part ("spires") was seen to be rougher and covered with a thin veil of concretions, probably calcareous (Fig. 7).

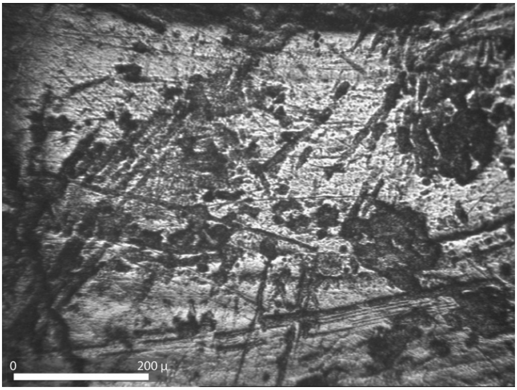


Figure 6: Soil polish on proximal part of experimental tool n°2. x100.

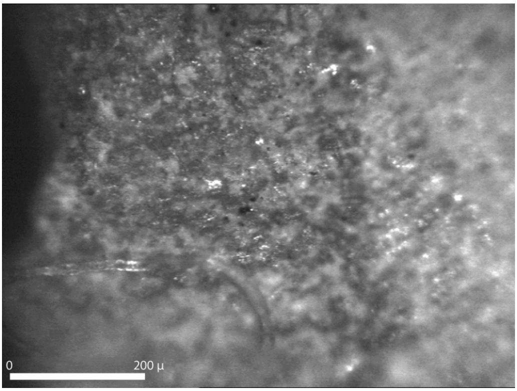


Figure 7: Surface appearance of shell n° 2, before use. Apex area. x100.

By examining the five pieces used in the experiments, it was possible to identify the use-wear on the tools. The first stigma is macroscopic, and concerns the loss of material suffered by the shells at their tip (at least for the largest), as the distal parts of experimental tools n° 2 and 3 decreased to approximately 6 mm. The apex had disappeared by friction with the sand and pottery, and the abrasion flattened the profile of the tip of the shell (Fig. 5, c).

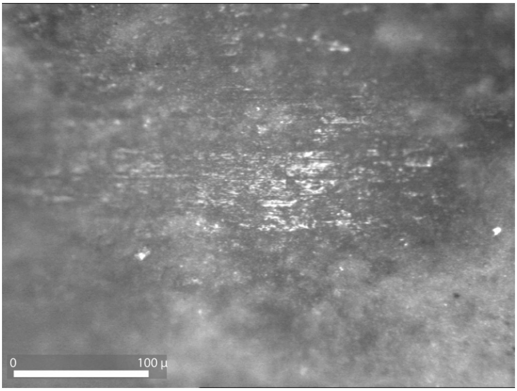


Figure 8: Striations on distal part of experimental tool n° 2. x200.

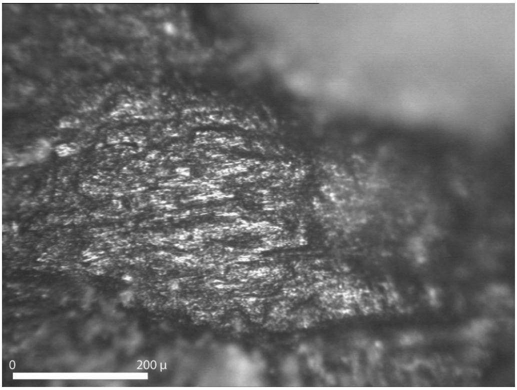


Figure 9: Striations on distal part of experimental tool n° 1. x100.

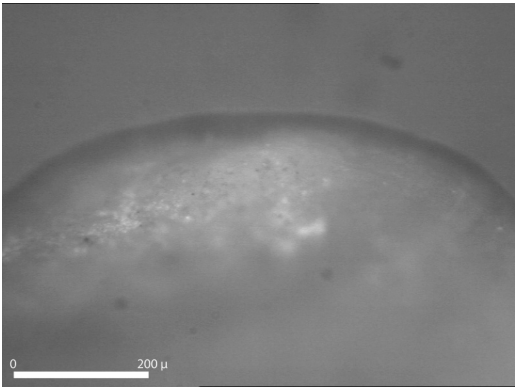


Figure 10: Rounding on distal part of experimental tool n° 1. Apex area. x100.

In this context, most of the microscopic traces disappeared during the use of the tool. However, use-wears were observed. These mainly consisted of very bright striations parallel to the rotation axis of the shell during the use of the tool. These striations affected the upper parts of the surface of the shell, especially when the calcareous concretions had been removed (probably during the perforation). These traces were observed on experimental pieces n° 2 (Fig. 8) and 3, and were very visible on experimental piece n° 1 (Fig. 9). On this last one, we also noted the presence of a strong rounding that affected part of the tip of the shell (Fig. 58-10).

5. Conclusions

This experiment does not intend to impose the idea that all perforations observed on ceramics from Ed-Dur's archaeological site were made using a Terebralia palustris. It was primarily intended to demonstrate that even very dense ceramics could be perforated using one or several shells and to show that this activity creates characteristic use-wears on the surface of the shells that were used as drilling tools.

Beyond the specific context of this experience, we can assume that if the external skeleton of a shell such as T. Palustris is able to drill a thick dense ceramic it can probably be used to perforate many other materials. It will be interesting in the future to test this hypothesis. It will also be interesting to establish a link between the presence of gastropods shells and perforated objects within the same archaeological context.

The recent study of shells has not only focused on their decorative or nutritional aspects, but also on their functional aspects and this field of study has significantly grown in importance in the last few years with the emergence of a new discipline called archaeomalacology (Dupont et al. 2008). Even if, for now, this discipline focuses on bivalve molluscs, we hope that it will quickly expand its field of investigation to other shell species. In light of the results of our experiments on the terebraliae of the pre-Islamic site of Ed-Dur, traceology should be associated with this new approach as a way of taking this research much further.

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CHAPTER FIFTY EIGHT

BEYOND CHAVES: FUNCTIONAL ANALYSIS OF NEOLITHIC BLADES FROM THE EBRO VALLEY

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Abstract

We present the results of a functional analysis applied on several dozens of Neolithic blades from sites located in the Ebro Basin, especially the cave of Chaves (38 pieces). Their main use was that of sickle elements, mowing domestic cereals (identified in the pollen analysis).

Keywords: Neolithic, NE Spain, Ebro Basin, Functional Analysis, Cereal Harvesting.

1. Introduction

The cave of Chaves is one of the most important Neolithic sites in the Iberian Peninsula (Figure 1). The cave's mouth hangs over a small tributary of the Alcanadre River, which in turn flows into the Cinca River, one of the two rivers, along with the Segre, forming the main drainage basin inside the larger Ebro Basin. A combination of excellent dwelling conditions and geographical location, at the foot of the Guara Mountains (Figure 2), converted this place into a preferential site throughout Prehistory, with evidence belonging to the Solutrean industry (scarce), the

Fig. 1: Main Neolithic sites along the Ebro Valley. Those studied in this paper are highlighted in bold letters.

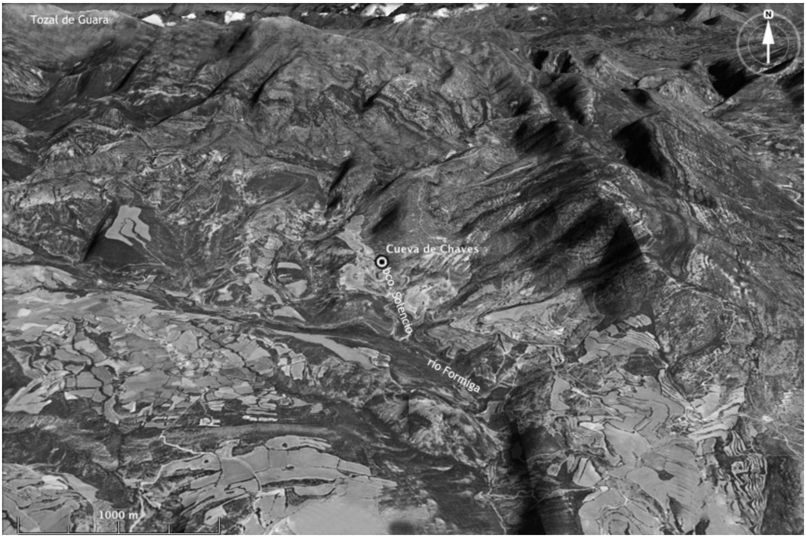


Fig. 2: Cueva de Chaves environs, oblique aerial photograph.

Magdalenian culture (a camp site with abundant animal remains, lithics and bone work), and the Neolithic period, for which the site is now well-known. With only 10% of the surface excavated, 70000 artefacts were recovered (pottery, lithics, animal remains, bone work, and portable art). Unfortunately, the remainder of the site was destroyed, a matter that is currently being dealt with in court.

The site features exceptional characteristics. The cave's large mouth, facing east, measures approximately 60 m wide and 30 m high, giving entry to a floor space of 3000 m^2. A true Neolithic village emerged under the protection of the rocks, rather than in the open. Excavations were directed by Vicente Baldellou and Pilar Utrilla, while A. Cava (2000) undertook the main study of lithic remains.

Chaves is one of the key sites for understanding the introduction of Neolithic ways of life in north-eastern Iberia. Early chronologies coincide with classic sites of the Spanish Levant. For the case of Chaves, we think that cultural influences penetrated inland through the Têt River in southeastern France and the Segre-Cinca Rivers in the Iberian Peninsula, rather than through the coastal plain. Domestic animal remains predominate in level Ib at Chaves, dated to the first half of the 7th millennium BP (with eight samples ranging between 6770 BP and 6330 BP.). Besides, great quantities of seeds were found (acorns), in a material context with striking examples of cardial ware. Similar finds belong to level Ia, which appears slightly later in time (with various dating samples ranging from 6230 BP, a human skeleton -5180±100 cal BC-; GrA-26912, and 6380 BP-5380±60 cal BC-; GrA-28341), although occupation seems to have been less intense. The absence of human activity in the immediately preceding levels indicates that the arrival of the Neolithic to the site was ex novo. An early penetration of the Neolithic in the area is reinforced by evidence from Forcas II, a site located by the Ésera River, which also flows into the Cinca. This site offers very early dates, although for short occupations. Nevertheless, in this case, there is evidence for the continuity of previous hunter-gatherer populations. The consumption of wild animals is found in Forcas II alongside the first examples of pottery and geometric double bevel artefacts (levels V and VI).

2. Neolithic blades from Chaves

Numerous retouched and non-retouched Neolithic blades were recovered from Chaves. Nevertheless, our intention was never to be exhaustive, so 38 pieces were randomly selected (Table 1 and Fig. 3) out of around 450 kept at the Museum of Huesca. The preservation conditions were optimal, as each artefact had been bagged individually to minimize the risk of scratching by contact.

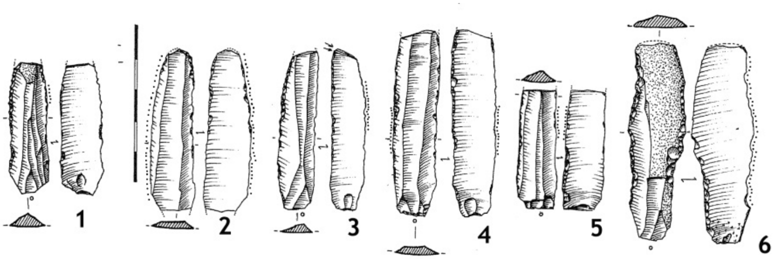


Fig. 3: Cueva de Chaves Neolithic blades (after Cava, 2000). The following uses were identified: 1, hide – questionable; 2, green vegetables; 3, meat – questionable; 4, undetermined use; 5 and 6, dry cereals. The dots signal the edge areas that show microscopic use-wear.

Total no. pieces	Average length / dev. (mm)		Average width / dev. (mm)		Average thickness / dev. (mm)	
38	46	10,5	13	2,8	4	0,8

Table 1: Morphometric data for the sample of Chaves blades.

In general, the pieces lacked integrity; many of them were broken at the distal end, which was weaker in structure and subject to greater wear or postdepositional damage. The technology applied was standard, with subtrapezoidal sections, and the blades seem to have mostly been obtained by soft percussion, although occasional bulbs suggest the use of hard percussion. Lastly, some tools showed prepared butts, although this was not a systematic practice.

Under the microscope, blade surfaces were examined with great ease. Some were covered with marks caused by brushing against the floor or humidity, although this was not usual. Colouring did not affect microscopic observation and generally ranged between a dark brown, almost black, and a honey colour.

Of the 38 blades, 25 belonged to level Ib, 7 to Ia and 6 came from previous excavations with no assigned level. They were studied as a single group due to their material and chronological similarity (Table 59-2). In terms of functionality, microscopic traces indicating use were found on 25 out of the total 38 (almost 66%), which is an elevated number. Among these, four artefacts had unidentifiable marks, either because of poor preservation or because microwear was not well enough developed. The marks identified by the microscope in the remaining 21 tools were sufficiently characteristic so as to assign them a specific use (55% of the total assemblage).

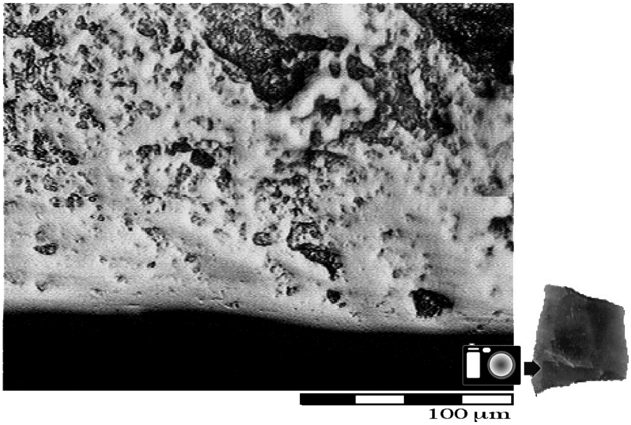
Total	No marks	Used	Clear mowing	Degree of humidity identified	Green plants		Dry plants	
					Brief	Prolonged	Brief	Prolonged
38	13	25	15	13	2	4	4	3

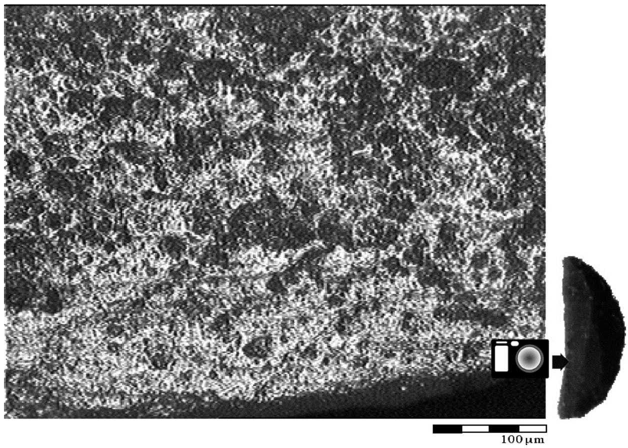
Table 2: Main data obtained from the observation of Chaves blades.

The blades were probably part of sickles, mainly used for harvesting. 16 of the blades, i.e. 64% of all those with signs of use, showed very developed microwear on the surface, high coalescence and remarkable brightness, a considerable volume, and unsystematic lines, indicating the approximate direction of movement. Microwear formed while used on vegetables becomes noticeable much earlier and reaches greater levels of development in comparison to use on other materials. The effects caused by humidity were so great on one of the tools, that it made functional identification very hard. On the other hand, in seven of the 15 artefacts bearing clear evidence for harvesting, microwear was not very developed, leading to the conclusion that the tools were not used for a very long time.

It was possible to analyze the humidity degree of processed plant remains on the marks of some of the blades (Unger-Hamilton 1989; Goodale et al. 2010): green plants are more humid, while more mature ones are drier. This information is useful to determine whether prehistoric communities were domesticating cereals (wild grains are not as strongly joined to the stem and must be cut when still green, while cultivated grains last longer on the plant). In our own tests (Domingo 2005a) half of the artefacts were used in the spring, to cut wild grains (Avena fatua) that were still green, and the other half in the summer, to cut dry, cultivated cereal (Triticum sp.). The results of experimental testing after three hours of use may be seen in Figs. 4 and 5.

Figure 4 shows marks from harvesting green plants. Volume, brightness, surface development and coalescence, were all great. On the other hand, Figure 5 shows marks from harvesting dry plants, in which volume and surface development are still considerable, but brightness and coalescence are very limited. It clearly appears that the greater the humidity of the harvested plant, the greater the brightness and coalescence.





Figs. 4 and 5: left, marks from cutting green wild oat on an experimental trapeze (200x); right, marks from cutting dry wheat on an experimental segment (100x).

The small size of the assemblage makes it difficult to extract conclusions on cereal mowing in Chaves just by the functional analysis of the artefacts. Nevertheless, farming has already been confirmed by pollen analysis (undetermined cereal, after López, 1992). Most sites in the Ebro Basin that include Cardial pottery show no sign of agricultural activities, so Chaves can be considered an exception that could be explained for its magnificent qualities. It is also difficult to tell if there is any dominant tendency in regards to the height at which the stem was cut–the closer to the ground, the larger the number of marks on the surface, due to the larger quantity of dust found on the stems. Experimentation on artefacts used for summer harvesting (Domingo 2005a, 76) in the Ebro Valley, which is semi-arid and exposed to strong winds, showed that the dust accumulated on the stems was very high regardless of the distance from the ground. On the other hand, in more humid areas, protected from the winds, such as the surroundings of Chaves, stems should be cleaner and the presence of microscopic marks caused by accumulated dust would have been less numerous.

Linear marks facilitate the study of kinematics. The stone tools must have been used with transversal or oblique movements from the edge. The pieces were placed on a sickle, parallel to the handle or on a slightly deviated axis. Some marks that ran parallel to the blade’s edge could be due to back and forth movements typical of plant handling later on in the process, after harvesting. Nevertheless, most artefacts lack any kind of directional lines, so conclusions cannot be definite. In sum, 15 blades were clearly used to harvest, probably cultivated cereals, as suggest by the associated evidence (pollen). Some have microscopic marks that seem to indicate that they were used in a later stage of plant processing after harvesting, although blades may have been employed indifferently for both uses.

Some characteristics may be observed with the naked eye, such as the gloss imprinted on some of the blades, although this phenomenon is not generalized. More characteristic is the chipping of active edges, as a result of wear. Due to chipping, microwear polishing really does not have a chance to develop or accumulate, since the lithic surface is constantly renewed by contact with vegetable material.

In lower numbers, meat cutting (4 artefacts) and hide cutting (1 artefact) marks have also been identified, although not without reasonable doubt. Morphologically, these tools show no differences to those used in plant processing. The blades were probably produced more or less “in a series” and were later destined for the most immediate task, predominantly, yet not exclusively, for harvesting.

As a complement to this study, blades from other sites along the Ebro Valley have also been studied. The published assemblage from Mendandia suffered a great deterioration of its surfaces (Domingo 2005b), bearing diagnostic marks in only three of the 21 Early Neolithic artefacts (one for cutting soft materials and two for cutting non-woody plants). A more recent study features ten blades from level VIII at Forcas II, Moro de Olvena, Esplugón, and Plano de Pulido. Five of them (two from Olvena, two from Esplugón and one from Forcas II) were used as harvesting tools for non-ligneous plants that were still humid and green. The lack of marks for cutting dry plants may be implying that there were no domesticated cereals. Limited numbers do not allow for definite conclusions.

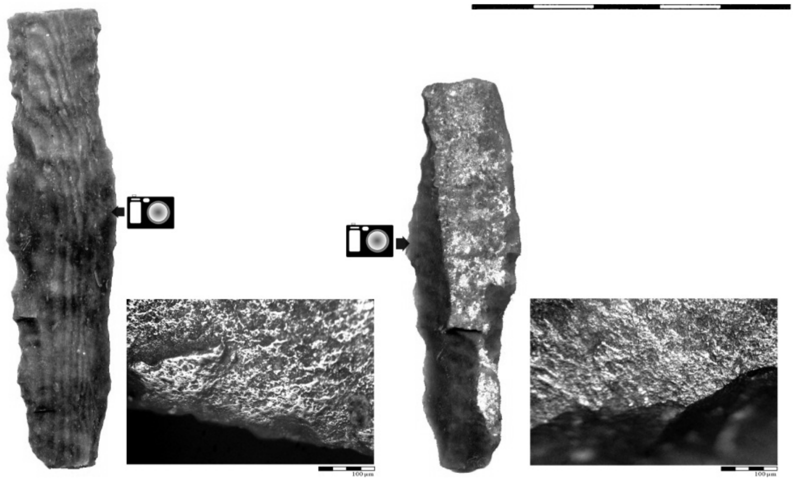


Fig. 6: Cereal cutting marks on two Chaves blades from the Early Neolithic; to the left, green vegetables; to the right, dry grain (blade 6 in Figure 3).

3. Conclusions

This study represents a first appraisal of the use of Neolithic blades in the Ebro Valley. Several specific studies were previously undertaken by Mazo (Baldellou & Utrilla 1995, 57-58), featuring a presumed Neolithic drill from Cueva del Moro de Olvena, which was actually employed as part of a sickle used to harvest non-woody plants. Gibaja (2002) studied a large assemblage belonging to sites from Catalonia. Of interest here are data from the lake site of La Draga (Girona) and levels C5 and C6 of Cova del Frare (Barcelona). Results are somewhat varied. In La Draga, tools used for harvesting represent about 25%, while in Cova del Frare differences between levels are extreme, barely 10% for level C5, yet more than 44% for level C6. This last level is the most similar to Chaves in terms of numbers analyzed (35 in Frare and 38 in Chaves), as well as in results obtained (42% of identified use in Chaves, 44% in Frare C6). The quantity of studied artefacts from Draga (555) and Frare C5 (101) largely surpass these numbers.

Lastly, the geometric microliths from Chaves (Domingo 2009, 2014) are different from those from other sites, because they were used more for non-woody plant processing (e.g., as evidenced by cereal polishing perceptible to the eye) than as projectiles. This evidence from geometric microliths fits in perfectly with what has been exposed here for the blades. Let us recall that Chaves was an exceptional site that worked as a permanent settlement, which was not the case for the remainder of the known sites along the Ebro Basin, generally small shelters, which were probably used seasonally for specific activities, hunting among them.

Acknowledgements

The author belongs to the Research Project HAR2011-27197 "Repensando viejos yacimientos, ampliando nuevos horizontes". We would like to thank V. Baldellou and P. Utrilla for facilitating and welcoming all kinds of research concerning the archaeological remains of the cave. V. Baldellou passed away some days before the reception of the final proofs. This paper, consecrated to his beloved Cave of Chaves, is dedicated to his memory. We also thank the organisers of the Conference for their friendly reception. It was a very profitable meeting!

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CHAPTER FIFTY NINE

LITHIC FUNCTIONAL STUDIES IN IRELAND: A CASE STUDY FROM EARLY NEOLITHIC RECTANGULAR TIMBER HOUSES

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Abstract

This paper summarizes the variable scope of previous and current use-wear research in Ireland, highlighting the underexplored character of activities within a Neolithic context while also presenting the results of a recent study on the flint assemblage from seven Early Neolithic rectangular timber houses (4900–4700 BP) at Corbally, Co. Kildare. The range of activities interpreted includes possible manufacturing tasks, involving the processing of animal by-products and more elusive evidence for plant/wood working. Specific material engagements, however, appear to be at play within these farming communities as suggested by particular artefact trajectories and depositional contexts.

Keywords: Ireland, functional studies, Early Neolithic, timber structures, flint.

1. Breaking the ground

Microscopic use-wear studies in Ireland have until recently been a rather limited practice of variable scope achieving fragmentary results. They have emphasized, almost chronologically, different periods through the decades (Table 60-1), following mostly standard high-power reflected light microscopy (Keeley 1980) with only limited contributions from SEM, use-wear quantification techniques and residue analysis. Particular artefact types (e.g. butt-trimmed forms and hollow/concave scrapers) have been targeted, seldom assessing representative full assemblages. Other alternatives to flint (e.g. chert and rhyolites) have received more attention in areas where flint pebbles of lesser quality and smaller size are available (e.g. Midlands, western coast). Traditional studies were limited to type/function, tackling both site (e.g. Mount Sandel, Co. Derry; Dumont 1988) and artefact-specific cases (e.g. broad "butt-trimmed flakes", Anderson and Johnson 1993), while a current comprehensive and wide-scale comparative study focuses on reconstructing toolkits emphasising artefacts' biographies in order to understand Mesolithic activities in an Irish wetland/coastal setting (Little 2011).

From a period specific viewpoint, while systematic functional studies for the Bronze Age are unknown, research on Irish Neolithic assemblages has focused exclusively on small flint/chert artefact selections (n=<10) or single artefacts (e.g. convex scrapers and hollow/concave scrapers; Table 60-1) for summary assessments.

2. An Early Neolithic case study

The Irish rectangular Neolithic house phenomenon, a rather short-lived occurrence spanning no longer than two centuries around 4900 BP, entails a repetitive and structured practice in terms of construction and material repertoire (Cooney 2000; Grogan 2002; McSparron 2008). This offers the refined chronological frame to observe the dynamics of lithic biographies in a settlement context linked to early agricultural practices. Recent research (e.g. Smyth 2007) has shifted the focus from arguments about house function based on size or layouts and artefact distributions towards the activities per se. It is in this framework that functional studies aiming at understanding the range of choices made in the performance of activities are pivotal in defining the roles that lithic artefacts fulfilled within these early communities.

Decade	Period	Site/Area	Focus/Raw Material	Research Aims	Methodology
1980's	Early Mesolithic	Mount Sandel, Co.Derry (Dumont 1988)	Flint assemblage: microliths, rods, backed blades, etc	Types use, site activities, comparative study with Star Carr, (Yorkshire, England)	Standard (Keeley 1980) Interferometry Experimental (English and "Antrim" flint)
1990's	Late Mesolithic	Bay Farm, Co. Antrim (Anderson & Johnson 1993; Anderson 1996)	Flint butt-trimmed and backed flakes, blades	Worked materials	Standard, Experimental
		Ferriter's Cove, Co. Kerry (Van Gijn & Keisers 1999)	Rhyolite/siltstone blades/flakes ("debitage/waste")	Modes of use and worked materials	Standard, Experimental
2000's	Late Mesolithic	Derragh Island, Lough Kinale, Co. Longford (Knutsson 2008a)	Chert blades/flakes	Modes of use Assessing formation of use-traces on chert	Standard Experimental ESEM Residues (diatom-non-diatom)
	Early Neolithic	Clowanstown, Co. Meath (Van Gijn 2009)	Chert/flint/sandstone assemblage (including groundstone)	Assessment: sample condition and potential	Standard Residues (phytoliths)
	Early and Middle Neolithic	Antrim Plateau, Co. Antrim (Bamforth & Woodman 2004)	Flint convex and hollow/concave scrapers caches	Upland/lowlands use patterns and activities	Standard
		Knocknarea, Co. Sligo (Knutsson 2008b)	Chert hollow/concave scrapers	Modes of use and worked materials	Standard Experimental SEM
		Tullahedy, Co. Tipperary (Knutsson 2011)	Chert blades and flakes	Modes of use and worked materials	Standard Experimental SEM

Table 1. Use-wear studies in Ireland through the decades.

In order to enhance our understanding of Neolithic practices, a small-scale approach focusing on activities within a formal "domestic" context was long overdue (Mallía-Guest 2011). Only 14% (n=42) of modified and unretouched artefacts was deemed suitable for use-wear analysis of the total flint assemblage (N=298) recovered from two adjacent clusters of Early Neolithic (4930 +/- 50 BP–GrA-13701, House 1; 4770 +/- 60 BP–GrN-28255, House 5) rectangular timber houses on the Curragh plain (Corbally, Co. Kildare) (Purcell 2001; Tobin 2004). Although not assessed in this study, the knapped assemblage also included fewer quartz, chert, mudstone and quartzite artefacts. As no floors survived, most of the artefacts were retrieved from foundation trenches and internal postholes with a biased distribution towards the earlier house cluster (Houses 1-3). In this context, extensive thermal damage (e.g. Houses 3-4) was a key detrimental factor. Given the recovery context of these artefacts and their markedly uneven distribution amongst the structures a view from a traditional spatial organization perspective was not possible.

The standard high-power (100x-400x) microwear approach (Keeley 1980) was followed using a Nikon Optiphot metallographic microscope, with the aid of a small experimental reference collection and long-standing research in Northwestern Europe (e.g. van Gijn 1990). Artefacts were not subject to chemical cleaning and the variables recorded included presence/absence and character of edge scarring, striations, rounding and micropolishes. Functional inferences on motion and contact material were derived from these features and possible activities interpreted against the traditional expectations for early farming communities both within the Irish and the wider European context.

3. Results and Discussion

Preliminary results indicate a strong association of use-wear traces with formally modified artefacts (76%), particularly convex scrapers and retouched blades or "knives" obtained by platform core technologies. This highlights the overall underrepresentation of unmodified flint blanks within the assemblage. All the artefacts show some degree of sedimentary alteration (e.g. heavily lustred scrapers) and differential white patination (e.g. blades), masking and/or obliterating any wear present. Amongst the used and probably used artefacts yielding interpretable traces (78%; Fig. 1), edges with intermediate working angles dominated with transversal motions (e.g. scraping, whittling) best represented and a few instances suggesting cutting/sawing activities (Fig. 1). Identifying contact materials was problematic, with a limited range of possible worked materials interpreted (Fig. 1-2). Amongst these, well-developed hide and bone as well as plant/fresh soft wood polishes survived showing an intermediate extent (Fig. 2). While hide-working traces are dominant (24%), well-defined woodworking wear (6%) is more elusive (Fig. 2-3), contrasting with its relatively frequent identification in earlier contexts and with scrapers from upland Neolithic sites, where hide-working ones are not well represented (Bamforth and Woodman 2004).

Retouched blades, for which no evidence of manufacture is found in situ, appear to have been involved in animal processing and possible siliceous plant cutting activities (Figs. 1, 2). The artefact yielding possible plant traces (Fig. 2) was associated with quern fragments in a foundation trench, reinforcing the connection with subsistence-related activities and specific depositional practices. Manufacturing tasks are best represented by hide-working traces and large convex end/end-side scrapers. Nonetheless, scraper size/contact material trends are unclear (Fig. 3). A number of scrapers worked a range of indeterminate hard substances but wood-working traces, usually associated with smaller examples, are poorly represented. Overall, while this study suggests a number of activities associated with an Irish Early Neolithic "domestic" context for which direct evidence is currently limited (e.g. hide and plant-based crafts), the underrepresentation of siliceous plant processing traces is puzzling.

Moreover, a variety of modes of use seem to have been at play specifically for scrapers providing new aspects of variability to traditional size/contact-material arguments that see large hide-working scrapers becoming wood-working examples through their use-lives (Bamforth and Woodman 2004) (Figs. 2 and 3). While no clear trends in terms of worked materials are present, some scrapers display more intense use damage towards one particular end, others show possible hafting traces, while a group of thinner, less intensively retouched end scrapers are transversally fragmented in a consistent manner. Heat-affected examples, for which use traces could not be interpreted seemed, however, intentionally discarded without evidence of exhaustion or breakage.

This situation, along with the presence of less definite use traces (48%) only ascertained to the level of soft or hard materials, underlines questions of assemblage preservation (e.g. sedimentary alteration) as well as processes related to group/structure dynamics. Specifically, aspects regarding the role of flint artefacts in reinforcing group identity are proposed by connecting certain artefact depositional practices (e.g. votive deposits) with particular artefacts' life-stories involving their use (e.g. possible plant processing blade/quern fragments) and also technological disparities between house clusters (e.g. bipolar versus platform technique products).

STRUCTURE	% SELECTED ARTEFACTS
HOUSE 1	45.2
HOUSE 2	24
HOUSE 3	12
HOUSE 4	14.2
HOUSE 5	2.3
HOUSE 6	0
HOUSE 7	2.3

MOTION	%
LONGITUDINAL	18
TRANSVERSAL	46
LONG/TRANS	9
ROTATIONAL	3
IMPACT/INCISION	3
INDETERMINED	21

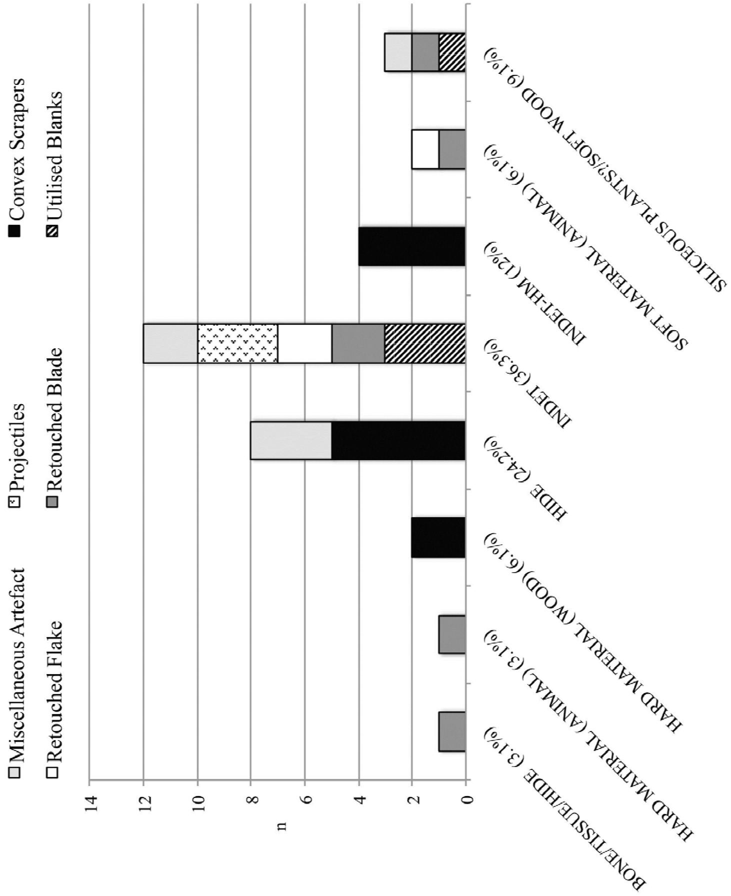

Figure 1. Distribution of contact materials by artefact type and overall working motions represented

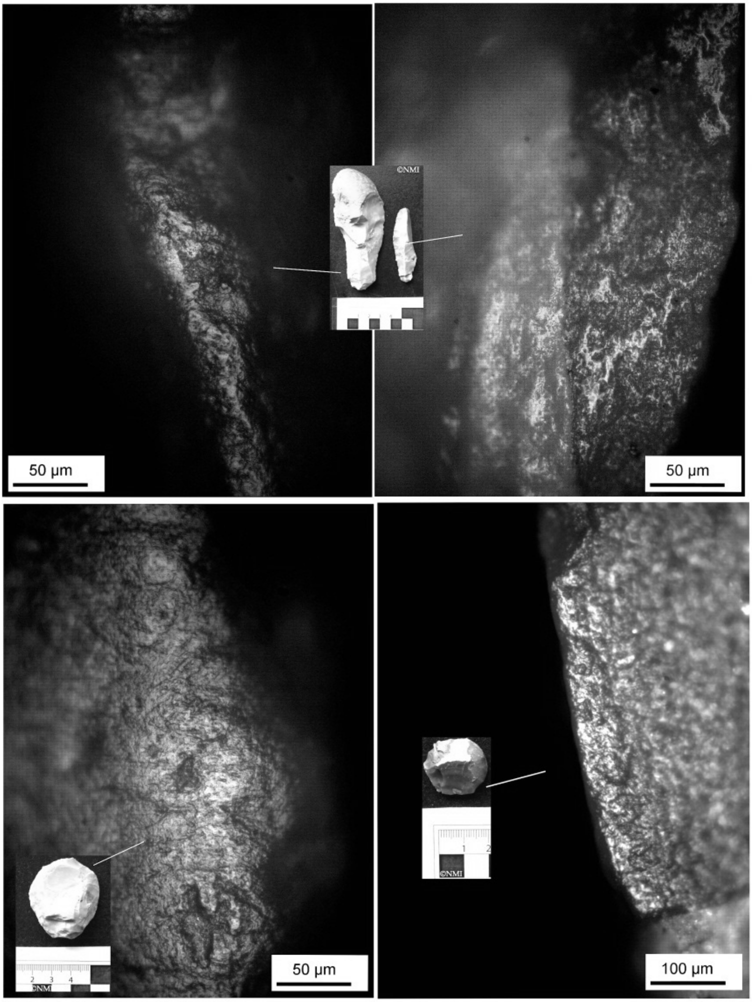

Figure 2. Blades (House 1) showing hide, bone-like (top left) and possible plant polish (top right) on ventral aspects, 200x. Convex scrapers (Houses 2-3) displaying altered hide polish (bottom left, 200x) and possible hafting traces (bottom right, 100x) on ventral aspects.

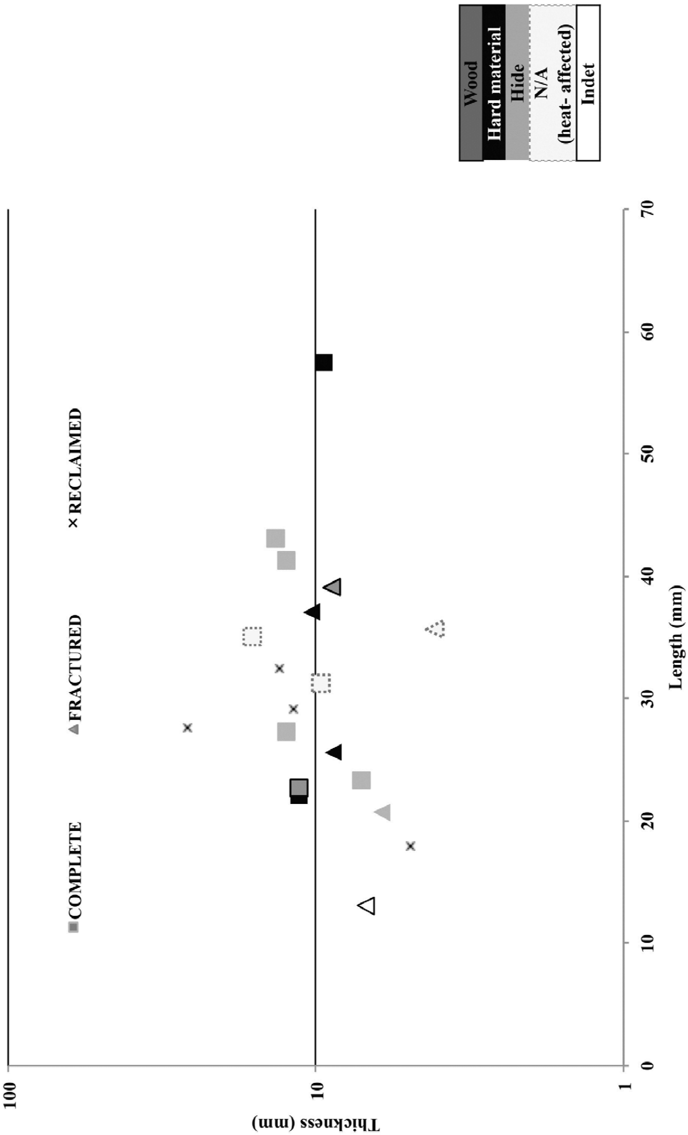

Figure 3. Convex scrapers thickness/condition and contact material

4. Conclusions

At Corbally, the deposition of very distinctive retouched forms seemingly embedded in subsistence tasks is highlighted. Explained either as foundation deposits or anticipatory provisioning, flint artefacts had an anchoring role for these early communities in the landscape as seen through the peculiar ways in which they were made, used and discarded.

Ongoing research aims at identifying these use choices and assembling flint artefacts' biographies from other domestic structures as well as less formal settlement evidence (e.g. spreads) for the Irish Early and Middle Neolithic, with a particular focus on the poorly explored Irish south and southeast. Current experimental work focuses on a range of craft activities, fracture patterns and hafting arrangements. At the local level, a case-specific approach tackling contemporary nearby activity is also currently undergoing, combining high-resolution SEM, laser profilometry and EDX residue analysis to assist the interpretations based on traditional optical microscopy and enhance the snapshots of past daily tasks in the Kildare lowlands.

Acknowledgements

My sincerest thanks to the National Museum of Ireland (NMI) and Margaret Gowen for kindly facilitating the material; the staff at UCD Material Science Centre for granting access to the equipment making this study possible and Dr Rick Schulting for contributing with the refined chronological data available for the site. I am indebted to my supervisor Dr Graeme Warren, members of UCD School of Archaeology and Dr Myrian Álvarez (CONICET-CADIC) for their warm and long-standing support.

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CHAPTER SIXTY

THE MATERIALITY OF FUNNELBEAKER BURIAL PRACTICES: EVIDENCE FROM THE MICROSCOPE

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Abstract

Flint and amber artefacts from Dutch Funnelbeaker (3400-2900 cal BC) megaliths were examined from a biographical perspective, also involving microwear analysis. It is shown that both flint and amber contributed to the materiality of Funnelbeaker burial practices, which above all stressed the collective identity of the local community. This is evident in the selection of agricultural tools for deposition. Agriculture was of course an important collective task. There are also indications that flint knapping took place around the tomb. A third observation concerns the enigmatic scratches on the transverse arrowheads and flakes, forming regular patterns that cannot have a post-depositional origin. Lastly, both the axes and the amber beads ended up in the grave in a used state, indicating a previous life. However, prior to deposition both items were reground, obliterating any traces of individual ownership before they could be deposited in the communal burial ground.

Keywords: Funnelbeaker culture; burial practices; microwear analysis; amber beads; flint

1. Introduction

Archaeological remains of the Funnelbeaker culture in the present-day Netherlands, dated c. 3400-2900 cal BC, are concentrated in the area north of the Rhine and Meuse rivers (Van Gijn and Bakker 2005). The most conspicuous aspect of the Funnelbeaker culture are the hunebedden, megalithic tombs which served as collective burial places (Bakker 2005; Van Ginkel 1988). They are located for the most part in the Province of Drenthe and contain large amounts of pottery, a find category that has been intensively studied over the years (Bakker 1979; Brindley 1986). Unfortunately, the stone material has so far been largely neglected: publications were limited to simple counts of typological categories.

Currently a project is underway to study the flint, hard stone and amber and jet finds from the megaliths. This project is part of a larger undertaking to understand the structuring role of these materials in Funnelbeaker society, examining artefacts from settlements, burials and special depositions from a biographical perspective (Van Gijn 2010, 2013; Wentink 2006). This paper will examine what kind of finds were deposited in the tombs, what was their use and how had they been treated prior to deposition in the megalith.

The contents of four megaliths were described typo-morphologically: Drouwen-D19, Drouwen-D26, Glimmen-G2 and Glimmen-G3 (Van Woerdekom 2011). Samples were taken for microwear analysis. Additionally, a selection of the flint from megalith Mander-O2 and all the flint material from the stone cist of Diever were studied for use-wear traces as well (Van Gijn 2010, Appendix I). So far, the hard stone objects like the querns have not yet been examined microscopically, but a systematic study was done of the amber and jet ornaments from the megaliths (Verschoof 2011, 2013).

2. The flint assemblage

Most of the flint assemblages from the hunebedden consist of waste and unretouched flakes (Fig. 1). The artefacts are produced on nodules of Scandinavian flint deriving from local boulder clay deposits. Most of this material has internal fractures due to glacial transport. The technology can be characterized as opportunistic: evidence for platform preparation is lacking and the cores have multiple platforms. Transverse arrowheads are by far the predominant formal tool type in the studied assemblages. Other formal tool types include axes, picks, strike-a-lights, scrapers and the occasional sickle blade (Van Gijn 2010; Van Woerdekom 2011).

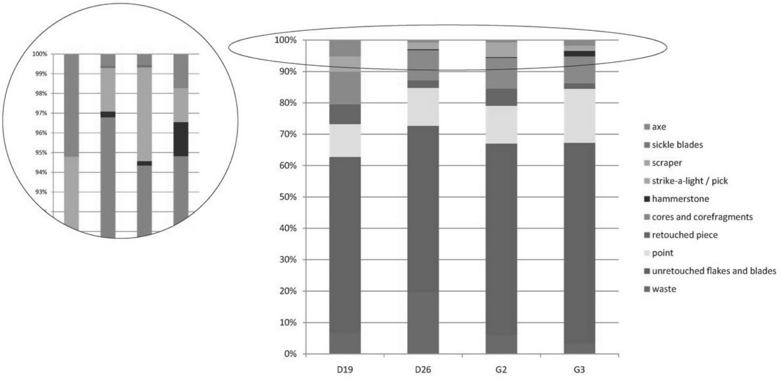

Fig. 1. Typomorphological composition of the flint assemblage from four megaliths (after Van Woerdekom 2011).

The microwear analysis showed that the majority of the transverse arrowheads and the picks did not display traces of wear. Both of these tool types were made in a very ad hoc manner, resulting in irregular shapes. In contrast, the axes, sickle blades and strike-a-lights all showed heavily developed wear traces. The axes were used on wood (visible in the use scars) and displayed evidence for hafting. They were frequently re-sharpened and some were even exhausted considering their very small size. Yet, before deposition in the megaliths they were re-sharpened one last time (Van Gijn 2010, Fig. 6.8; Wentink 2006, Figs. 5.4 and 5.5). Apparently, the used axes had to be transformed to "new" ones before they could be deposited in the tombs (Fig. 2).

The choice of tools to be put in the tombs is, I would suggest, not fortuitous: axes, strike-a-lights and sickles had an important role in agriculture, a communal activity par excellence. The axes were used for clearing the forest and undergrowth, the strike-a-lights to create the fire to burn down the stumps and the sickles to reap the harvest. As agricultural tools used intensively during an earlier part of their biography, they moved to a different realm at the end of their life history, to accompany the dead in the world of the ancestors (Van Gijn 2013, 27).

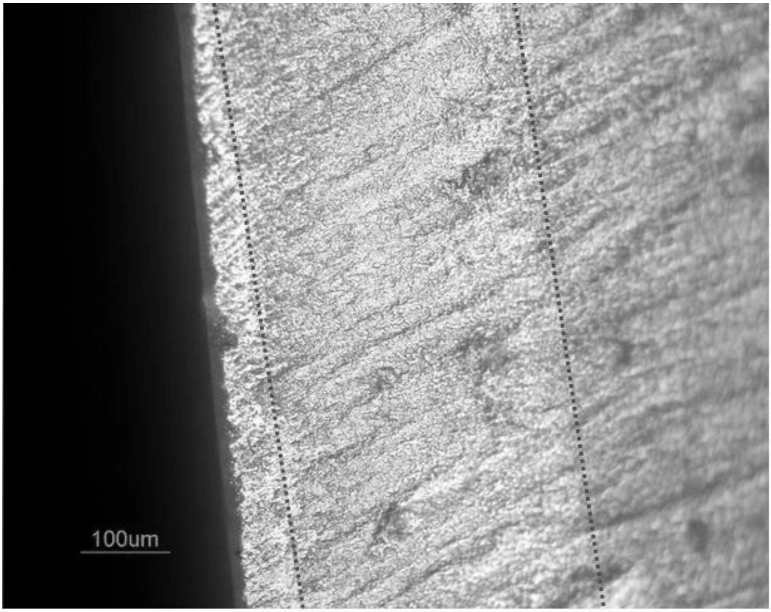

Fig. 2. Resharpening of a used edge of an axe from megalith D19 (from Wentink 2006) (orig. magnif. 100x).

There are some indications that the people not only selected specific flint objects to be put in the communal graves, but that flint even played an active role in the burial ceremonies. The presence of a great quantity of waste and flakes and hammerstones as well as the large number of unused (and often unusable) transverse arrowheads and picks can be seen as evidence for knapping activities around the tomb. Obviously this can only be corroborated by the presence of microdebitage or by refitting, but unfortunately the excavation techniques practiced in the past do not allow this. Yet, the composition of the flint assemblages studied so far is highly suggestive of flint knapping having taken place near the megaliths. This may not be so strange if we recall that flint knapping gives a characteristic, rhythmic sound, which possibly added to the overall sensory experience of the burial ceremony (Van Gijn 2010). Around the world burials tend to be noisy affairs (Huntington and Metcalf 1979) and drums are especially instrumental when attempting to contact "the world beyond" (Needham 1965).

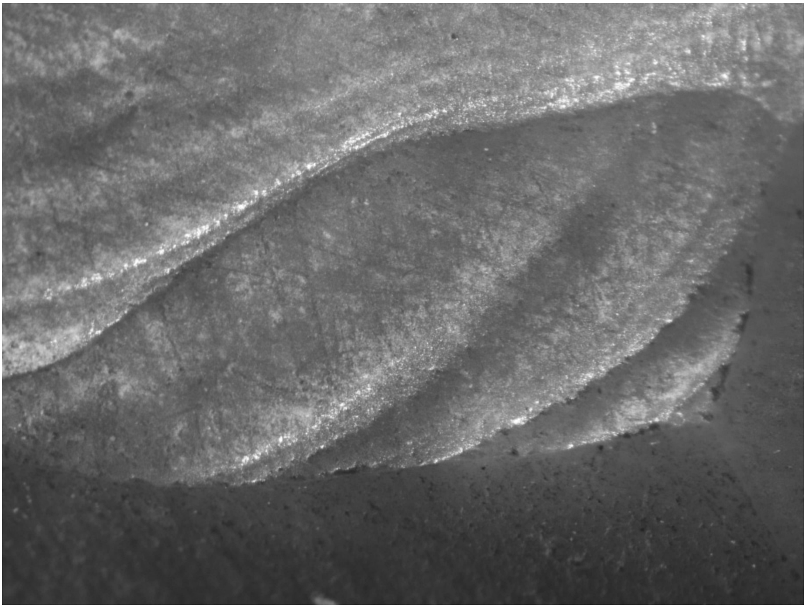

Fig. 3. Cross-hatched scratching seen on a flint tool from megalith G2 (taken with a stereomicroscope, 10x magnification) (Photo Laboratory for Artefact Studies, Leiden University).

The active role of flint in the Funnelbeaker burial ritual is also suggested by the mysterious scratches we continued to find especially on transverse arrowheads and flakes from the various megaliths. The scratches are always very regular and parallel, sometimes even forming a cross-hatched pattern (Fig. 3). Considering their regularity and restricted spatial occurrence on the tools it is highly unlikely that they were caused by post-depositional processes (see for more arguments Van Gijn 2010, 2013). The scratches can be replicated experimentally by scratching the flint surface with the kind of picks so frequently encountered in the megaliths. This is possibly the function of the ubiquitous picks but more experimentation is needed and archaeological picks should be re-examined for traces of wear.

3. The amber beads

Amber beads are occasionally given along as burial gift as well. It concerns flat, disc-shaped beads with a biconical perforation. The production method followed a simple sequence of cutting the amber, grinding it and applying the perforations (Verschoof 2011). As many of the beads were heavily oxidized, examination by metallographic microscope was frequently not possible and the extent of wear could only be inferred from the perforation and the general rounding of the bead (as seen by stereomicroscope). Despite the general poor preservation, it could be shown that the great majority of the beads displayed varying extents of wear. Interestingly enough, however, the flat surfaces of most of these beads were ground prior to deposition in the grave, analogous to the grinding of the axes described above. This could recently be corroborated by means of micro CT scans, showing the rounding of the perforation and the “illogical” (sharp) transition between the rounded perforation and the flat surfaces of the bead (Van Gijn and Ngan-Tillard, pers. observ.) (Fig. 4). This constitutes yet another indication that some objects had to be transformed before they could be deposited in the communal grave. As these beads were most likely personal ornaments it can be suggested that their previous life history, linked to a specific person, had to be removed to make it an appropriate object for the communal grave.

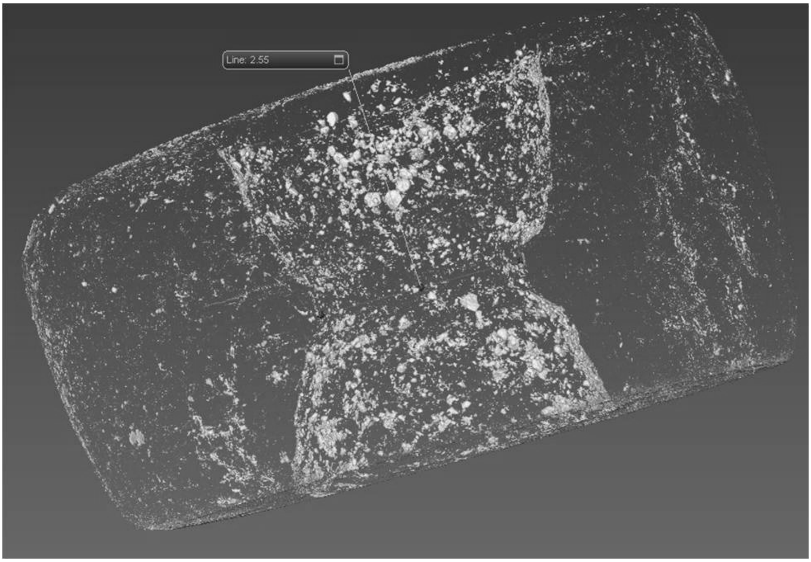

Fig. 4. Micro CT scan of a bead from megalith D26 (photograph D. Ngan-Tillard, University of Delft).

4. Conclusion

The megaliths of the Dutch Funnelbeaker Culture also yielded, apart from a great amount of pottery, numerous flint artefacts, various stone objects and amber and jet ornaments. A technological, typo-morphological, and microwear examination of the flint and amber component showed that these objects played a crucial role in the materiality of the communal burial practices. Most of these funerary items functioned in a domestic context before ending up in the grave. With respect to flint, those types of tools were selected which played a role in agriculture, a communal activity of great importance to the survival of the group: axes, strike-a-lights and sickles. This corroborates the communal nature of Funnelbeaker burial tradition. There is also evidence for the ritualization of flint. It is possible that flint was knapped during the burial ceremony, as part of the auditory experience of the event. Considering the large number of transverse arrowheads and picks without traces of wear, typological categories that are moreover lacking in settlement context, these objects may have been made near the megalith, again possibly in the context of special flint knapping sessions. Flint picks and transverse arrowheads seem to be linked in yet another, highly puzzling and presumably ritual, way: transverse arrowheads and flakes seem to have been scratched, possibly by means of the flint picks, to produce an intricate pattern of parallel or cross-hatched lines.

Some objects had to be transformed before deposition in the communal burial tomb. It may not be a coincidence that it is the axes and amber beads that were reground, obliterating their previous use. Both must have been linked to specific individuals: the amber beads as personal ornaments and the axes as personal tools. The axe can be considered as a very personal tool because in use, it virtually becomes an extension of the body of its owner (Clark and Chalmers 1998). Before these very personal objects, intimately tied to specific individuals, could be deposited in a communal grave, all traces of their previous life and individual ownership had to be obliterated. Whether the axes can be linked to men and the beads to women, I leave for others to speculate about. I think it is less important, as the key to understanding Funnelbeaker burial ritual seems to be the emphasis on the collective.

Acknowledgements

I thank Karsten Wentink, Corné van Woerdekom and Wouter Verschoof for sharing the TRB experience with me.

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CHAPTER SIXTY ONE

FUNERARY ADORNMENTS: OBJECTS BELONGING TO THE LIVING OR TO THE DEAD? A FEW EXAMPLES FROM THE ROMANIAN ENEOLITHIC

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Abstract

The wear degree of the pieces deposited in Neo-Eneolithic graves was noticed by numerous specialists. For example, in the case of the tubular beads, the constant presence of a large number of rounded edges presenting a small concavity, along with a smooth longitudinal facet that feels very fine when touched may probably result from the prolonged rubbing of the piece and the thread on which it was tied, onto the garment or onto the skin. In the case of the double biperforated elements or in the case of the buttons, as the wear is present exclusively in between the perforations, which, in addition, are deformed, in some cases up to a fracture, we can suppose that they were sewed. Sewing or a similar attachment system is also recognizable in the case of the trapezoidal platelets, as the wear depression, marking the passage of the thread, only affects one face of the item. So, it can be supposed that they were not created exclusively to be deposited as a funerary inventory and this can prove that they were worn during their lifetime as well.

Keywords: Adornments, Eneolithic, shell, lithic, wear traces

1. Introduction

In the specialty literature, it is generally accepted the assertion according to which the ornament plays a primordial role in the inter-human communication of the information with social or cultural character, thus being a multivalent symbol in the human society. It is true that inside the traditional societies, the possession and display of a certain type of ornament is submitted to strict rules, in which the aesthetic role is secondary, because the ornament becomes in this case a means of transmitting information regarding the ethnical, social, age class or gender affiliation (Preston-Whyte 1994; Sciama and Eicher 1998; etc), without also neglecting the function of the object for the ritual exchanges (*kula* type exchanges), like in Oceania (Burenhult 1995; Malinowski 1989; Trubitt 2003), a communication system, like the pearls belts–wampum in North America (Lips 1964) or the function of talisman, like the famous Maori kei-tiki (Starzecka 1996) etc. Considering this multitude of significations, the remarkable importance of the ornament in the reconstruction of the social structure within the Prehistoric communities has been underlined, in the identification of the geographic limits and, implicitly, of the practiced exchange system (Bonnardin 2009; Newell 1990; Rigaud 2011; Taborin 1993; Trubitt 2003; Vanhaeren and d'Erico 2006; etc.).

In the world "of the living", adornments have innumerable functions, but in "the other world" was the function the same? As an answer to this question, we can invoke the simplest hypothesis, the function of adornment accompanying the defunct. So, it can be an element that belonged to the defunct and was worn by him throughout his life. In the second case, the adornment may have been deposited following a funeral situation, signifying the status–the social identity of the individual during his life–or, on the contrary, protecting the individual in his new status, which would mean the affirmation, within the Neolithic societies, of the "passage rituals" (Van Gennep 1996).

2. Materials and methods

For the prehistoric period, the presence of adornments in funeral contexts is an inexhaustible source of reflection because due to the presence of these objects we can identify the symbolic behaviour of the prehistoric groups, but they can also reflect some socio-economic aspects of these communities. Starting from the funerary inventory of two Eneolithic necropolises located in the southeast of Romania, we aim to find out if the adornments present in the graves were created exclusively for deposition as funeral inventory. The Eneolithic sites from Sultana-Malu Roşu and Cernavoda are located in the northern area of the Balkan region, in the south-east of Romania, not far from the Danube River. In the case of Sultana-Malu Roşu there are two settlements belonging to two different communities that used the same necropolis. Both cultures belong to two large Eneolithic cultural complexes–Boian-Maritsa-Karanovo V (the first half of the V millennium BC) and Kodjadermen-Gumelniţa-Karanovo VI (the second half of the fifth millennium BC), which cover almost all the Balkan area (Lazăr et al. 2008). The necropolis from Cernavoda was used by the Eneolithic communities of the Hamangia culture (the first half of the V millennium BC) (Berciu and Morintz 1957, 1959).

The most important typological category is represented by the tubular beads (Fig. 1, a), made of *Spondylus* valves, present in both necropolises. These pieces have reached us in their final manufacturing stage, which has largely ruined the marks pertaining to the operations needed for their production. So, in the case of these tubular *Spondylus* shell beads, we cannot positively identify their production method. After the preform was finished, there was a perforation from a single side, enlarged, in some cases, followed by a perforation from the other side. Despite the microscopic study, the specific scratches of a perforation by rotation are visible only in few cases (Fig. 1, b), a fact that might represent, in our opinion, an intense usage that destroyed these scratches and that is associated to some strongly rounded edges of the extremity. The constant presence of a small concavity at the level of the extremities (Fig. 1, c-d), corresponding to a longitudinal side, plane and very fine at touching, at most of the tubular pearls, may probably result from the prolonged polishing of the piece by the attaching thread and the cloth. This suggests the use of the pieces previous to their deposal next to the defunct, in the tomb. On some pieces, the usage is also illustrated by the perforation contour modification, appearing asymmetries and depressions (Fig. 1, e-f), generated by the pressure of the suspended wire and by the piece's weight centre.

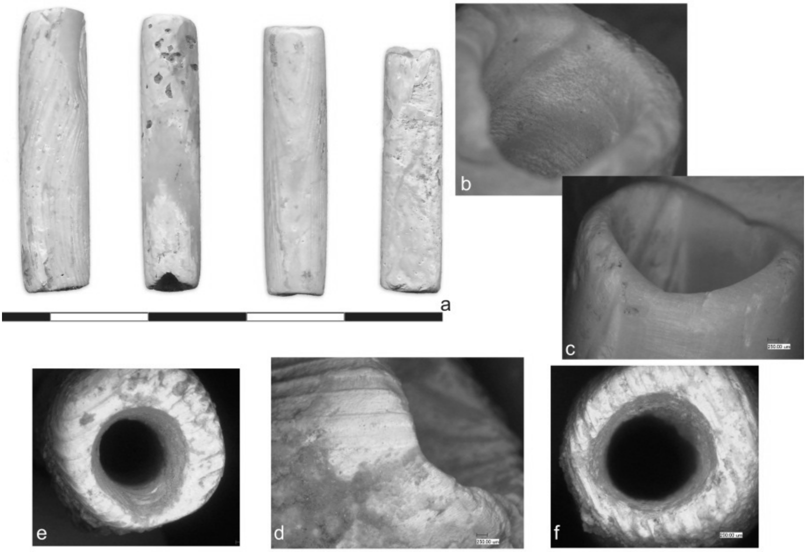

Fig. 1 – Tubular beads made of *Spondylus* valve from Cernavoda necropolis; b – interior perforation presenting a few circular striations, illustrating the perforation technique (50x); c, d – extremity with a concave facet (50x); e, f - deformation perforation, towards the concave extremity, illustrating the suspension direction (40x).

3. Results

Circular beads made of *Spondylus* sp. Our opinion is that they were obtained by cutting some long tubular beads (maybe after they were broken), as their extremities are irregularly cut and their perforations are asymmetrical, from whence the conclusion that they derive from already finished pieces. On some of the pieces, an area with strong polishing is obvious, placed in the perforation's proximity that may represent the friction surface with the attached thread. Exceptionally, among these tubular or circular pearls may be identified some samples made of marble, imitating the specimens of *Spondylus* sp.

Three-lobated beads (the necropolis from Cernavoda) – this morphology was obtained using oblique, progressively deepened cuts (Fig. 2, a). The lack of the characteristic marks specific for these cuts seems to demonstrate that the polishing of the piece was achieved during a subsequent stage. The perforation was carried out with the tool held obliquely in relation to the surface of the piece, from both sides, which determined the splayed morphology of the perforation's walls (Fig. 2, c). The way that the wall of one of the perforations broke (Fig. 2, b) and also the inner deformation of this wall for the other pieces can prove the way in which the pieces were held together. The lower face presents a strong polish; moreover, the area is very smooth and fine when touched, which allows us to conclude that it could be the area of contact and rubbing with a material.

Bracelets (Cernavoda)–from two items made of *Spondylus* sp., only one of the pieces is integrally preserved (Fig. 3, a-b). The edges of the pieces seem to have been obtained through percussion (Fig. 3, d), after which the surface was integrally polished. On the lower face, they present an intense polish, with striations perpendicular on the extremity (Fig. 62-3, e), which may have appeared subsequently to the wearing of the item. A third bracelet, made of marble (Fig. 3, f, g), imitates entirely a bracelet made of *Spondylus*.

Button (Cernavoda)–the piece (Fig. 4, a-b) made of *Spondylus* sp. was rigorously finished, so that we do not know the technique used to remove it from the valve. The perforation was carried out through bilateral rotation (Fig. 4, d). The inner wall of the perforation is deformed on the rim and the surface situated in-between the two facets of the perforation coming from both sides is smooth and strongly polished (Fig. 4, c, e). Actually it seems to be a much worn piece. A second button was made of limestone (Fig. 4, f). The perforation was made from two sides, creating the morphology in eight, by rotation. The wall between perforations seems to have thinned until fracture, probably due to friction and pressure, a fact that also sustains the idea of attaching by sewing.

Perforated platelet (Ceranavoda) (Fig. 5, a-b)–just as in the case of the other items made of *Spondylus* valve, the marks of the debitage, subsequent to which the blank was obtained, have not been preserved. The perforations were realized through circular rotation from both sides. Towards the extremities, on the upper side, the perforations present a depression (Fig. 5, c), which may have appeared due to intense wearing and which is also an indicator of the way the item was suspended.

Arch-shaped pendant (Cernavoda)–the shape of this piece obviously resembles that of a boar canine (Fig. 6, a). On the distal level, a perforation was carried out through rotation from both sides. The distal wall of the perforation is strongly affected and deformed, with a concave morphology of the walls (Fig. 6, b), which allows us to suppose that this is an area in which the item moved along in contact with the attached thread.

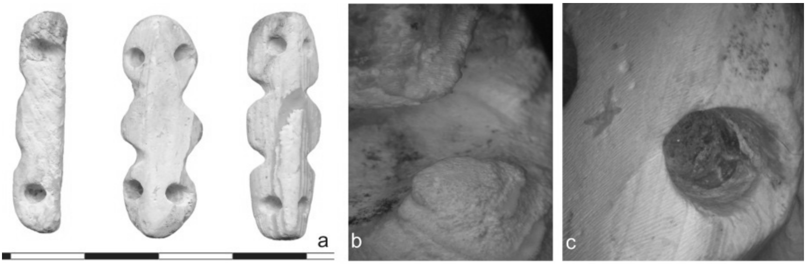

Fig. 2 - Three lobated beads made of *Spondylus* sp. from Cernavoda; b – fracture on the level of the perforation (50x); c – detail of perforation and lower face presents a strong polish (30x)

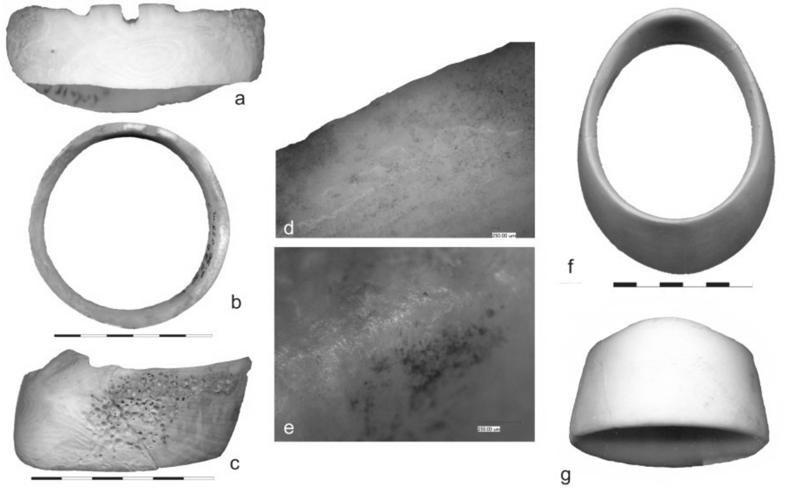

Fig. 3 - a, b – bracelet made of *Spondylus* left valve ; c – bracelet made of *Spondylus* right valve ; d – percussion marks of the edges (30x); e, f – interior aspect of the bracelets (200x); g, h – bracelet made of marble, imitating similar artifacts made of *Spondylus* valve

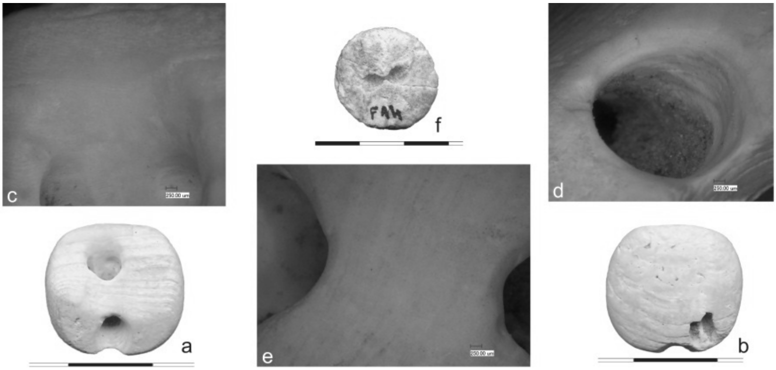

Fig. 4 – a, b - button made of *Spondylus* valve; d –button perforation detail (50x); c, e – perforation wear detail (50x); f – button made of limestone

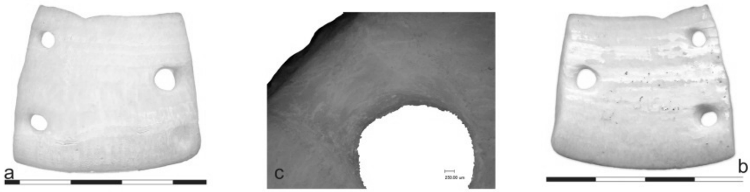

Fig. 5 - a, b – perforated platelet;c – wear of the perforation wall (50x);

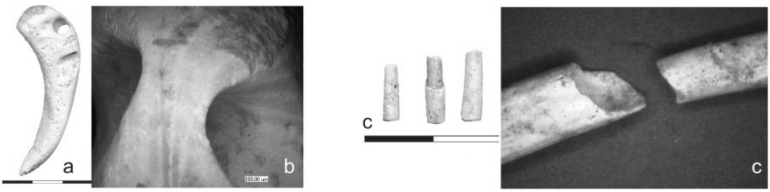

Fig. 6 - a – arc-shaped pendant; b - wear of the perforation walls (30x); c – beads of *Dentalium*; d - hypothetical disposal of the pieces

Ornaments also constituted the shells of *Scafopode–Dentalium* (Sultana) (Fig. 6, c). *Dentalium*, by its form and natural perforation, has the advantage of offering jewels ready to be used. Their profile is curved, but the pieces discovered in archaeological contexts have a straight profile, the fact that illustrates a segmentation procedure. Alas, most of the pieces present an advanced degradation stadium and post-depositional fractures at the extremities. Still, considering their allogenous origin, we do not think that we are talking about entire shells, but that they arrived here already in a finished state, as ornaments. Moreover, an important element according to which we are able to identify usage elements, is the rounding of the natural perforation margins, as we were able to see on some samples. Furthermore, we identified two joined pieces (Fig. 6, d), that may illustrate the attaching manner, one in the other's prolonging.

In the funeral inventory, bone was identified as raw material for a part of the tubular (Fig. 7, a) and circular (Fig. 7, e) pearls from the necropolis of Sultana. The bone was transversally sectioned by sawing, that produces a debitage side oblique to the piece's axe. In some cases, the sawing was followed by flexion (Fig. 7, b, c). The marks of the final polishing, made to regularize the surface of the pieces, consist of scratches oblique to the axe, superposed by a strong polish, probably due to utilization, because it is in the proximity of the perforation (Fig. 7, d). In the case of the circular pearls made of bone, we cannot identify the techniques used during the debitage operation, because their surface was thoroughly shaped. The central perforation was made by rotation from both sides. On one of the pieces, an area with strong polishing is obvious, placed in the perforation's proximity that may represent the friction surface with the attached thread (Fig. 7, g).

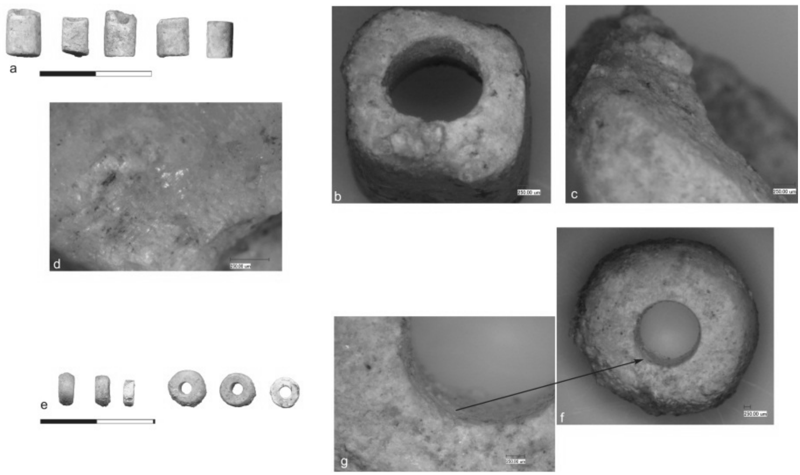

Fig. 7 - a – tubular pearls made of bone; b, c – segmentation made by sawing, followed by bending (50x; 100x); d – the macroscopic polishing area, in the perforation's proximity (200x); e – circular pearls made of bone; f – pearl detail (30x); g – perforation usage area detail (100x)

Marble served as raw material for the making of a pendant with a rectangular form (Fig. 8, a, b), endowed with a perforation executed by rotation from both sides, deriving from the necropolis of Cernavoda. The perforation, like the distal extremity above it, are deformed (the perforation has a prolonged morphology and the extremity presents a small sink), and the marks which are specific for a rotation action are entirely absent, a sign of prolonged usage (Fig. 8, c, d).

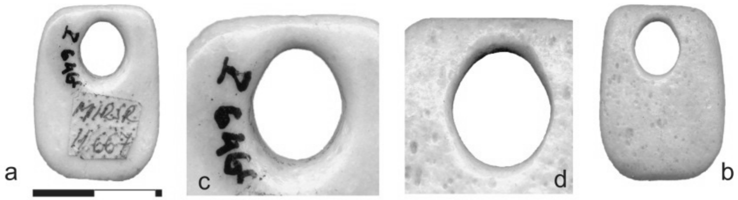

Fig. 8 – a, b – pendant made of marble; b, c - details of perforation

The lithic support was also used for the confectioning of two pendants discovered in the necropolis from Sultana. The first one, with a bi-lobated morphology (Fig. 9, a), is endowed with two perforations, executed from two sides, by rotation (Fig. 9, b). The relieving of the two lobes was probably made by sawing, but the subsequent polishing removed any mark. At the perforation level, the usage develops towards the inner wall (Fig. 9, c), in the space between perforations, thus the sewing theory, like a button.

The second pendant was considered by us to be a recycled piece (Fig. 9, d). Both extremities are concave, with a strong usage polishing, thus we may assume that at that level were perforations (that could ensure a transversal system), but their fracturing led to the making of a new perforation, this time in a longitudinal sense, by rotation (Fig. 9, e) from two sides. The inner wall between the perforations is strongly used and the perforation's walls are rounded, a fact that may signify that this was the friction area with a material (Fig. 9, f).

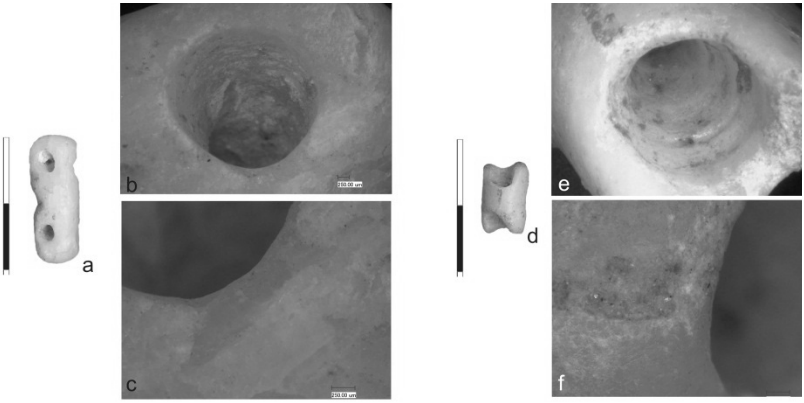

Fig. 9 - a - bilobated pendant, b – detail of perforation (50x), c – usage of the perforation wall (100x); d - pendant confectioned from lithic support, e – detail of the perforation, with inner rotation scratches (30x), f – usage of the perforation wall (100x).

4. Conclusion

Functional hypotheses. The wear marks are a valuable source of information. Their morphology, their location and their intensity allow us to think about the system used to tie the pieces together. According to the experiments realized by Rodière (1996), an object can change its colour because of being used. It seems that the yellowish shade that can be noticed in some areas of the adornment, where it should normally be white, may be the result of its rubbing onto the skin.

The constant presence of a large number of rounded margins presenting a small concavity, along with a smooth longitudinal facet that feels very fine when touched may probably result from the prolonged rubbing of the piece and the thread on which it was tied, onto the garment or onto the skin. The strong morphometric homogeneity, established on series in the production of the tubular *Spondylus* elements, suggests, as identified in other examples in the specialized literature, that these elements were embroidered into composite ornaments (Bonnardin 2008, 2009; Lennei, 2007). In the case of the doubly biperforated elements (three-lobated beads) or in the case of the button, as the wear is present exclusively in between the perforations, which, in addition, are deformed, in some cases up to a fracture, we can suppose that they were sewed. Sewing or a similar attachment system is recognizable as well in the case of the trapezoidal *Spondylus* platelet, as the wear depression, marking the passage of the thread, only affects one face of the item.

The fact that most of the pieces from the necropolis of Cernavoda and Sultana–Malu Roșu present traces of wear can prove that they were worn during lifetime as well. So, it can be supposed that they were not created exclusively to be deposited as funerary inventory. It is not obligatory for the ornaments which are present in graves to have been worn by those with which they were buried. They may be offerings of the relatives, maybe in the context of death, special circumstances or of some beliefs regarding the afterlife, etc. It is obvious that these ornaments had a special significance in the context of the treatment of dead people, but we cannot grasp these significances.

Acknowledgments

This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS – UEFISCDI, project number PN-II-RU-TE-2011-3-0133.

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CHAPTER SIXTY TWO

ASSOCIATING RESIDUES AND WEAR TRACES AS INDICATORS OF HAFTING METHODS: A VIEW FROM THE CHIPPED STONE INDUSTRIES FROM THE ISLAND OF GAVDOS, CRETE

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Abstract

Macroscopic and microscopic analysis of a sample of flint and obsidian artefacts from an excavated area with LN/FN/EB finds on the island of Gavdos has revealed use-wear traces and organic residues, very possibly of the hafting arrangement, on a black flint tool which appears to be the hafted element of a sickle. Here, the lithic assemblage is briefly presented, within its contexts, and preliminary results of the microscopic

and chemical analysis of the organic residues are provided. Finally, an effort is made to discern the correlation of direct indications of hafting methods and wear traces, while reconstructing the life history of the artefact.

Keywords: Use-wear traces, sickle, hafting arrangement, organic residues, resinous adhesive, Gavdos

1. Introduction

Gavdos is an island of ca 34 km^2 in the Libyan Sea, 21nm off Chora Sfakion in south Western Crete and 160nm from Libya in North Africa. It thus forms the Southern border of Greece, and the outh eastern European territory (Figure 1). The island is endowed with anchorages and was a nodal maritime crossing and station in antiquity. Numerous ancient terraces, long-used threshing floors and grinding tools, rock-cut winepresses and stone weights for oil processing point to an extensive rural exploitation of Mediterranean polyculture, mainly cereals, vine and olive (Kopaka 2002). Local landscapes are tectonically fragile. Among several "useful" geological materials are various pre-Neogene flints, cherts and metamorphic rocks, while Neogene sediments include marls and marly limestones, which provide plenty of clays for potting. Predominant tree species are cedars *Juniperus phoenicia* and *Juniperus oxycedrus* s. macrocarpa–the latter exploited in the past for its wood, fruit, and resin– and pines (*Pinus brutia*).

In the 1990s, a systematic archaeological survey conducted by the University of Crete with the KE' Ephorate (Kopaka forthcoming) showed that human presence on the island goes back to the Palaeolithic and Mesolithic periods (Kopaka and Matzanas 2009, 2011), and was intense in the Neolithic and the Bronze Age, and then in Hellenistic, Roman and Early Byzantine times (Kopaka et al. 1994/96, 244). An ongoing educational excavation started in the early 2000s in the southern sectors of Tsirmiris hill, where the tools under study come from, and continued northwards to focus on a Bronze Age building complex at Katalymata (Kopaka forthcoming).

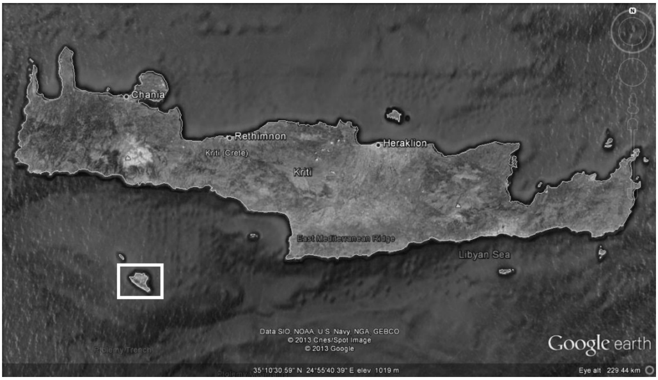

Fig. 1. Map of Crete and Gavdos.

2. The site

Test trenches were opened in 2003-5 in three neighbouring Sectors (I-III) on the Southern Tsirmiris hilltop (Figure 2), within a wider area of human activity in the Late/Final Neolithic (LN/FN) and the Bronze Age according to the pottery, lithics, stone axes and grinding tools. Sectors I-II relate to rows of collapsed rockshelters, of small to medium size. Sector II includes some built fittings, i.e. a modern terrace wall on solid ancient (originally EBA?) foundations, and a circular stone platform–with burnt EBA sherds, and a large, elongated obsidian blade on its upper surface. Two trenches in Sector III, next to another terrace wall, have yielded LN/FN pottery and chipped stone tools, among which is the flint implement (A/A1) that we are focusing on.

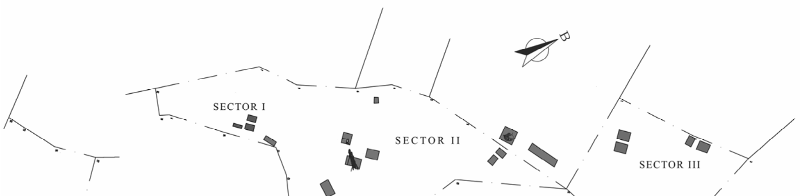

Fig. 2. Topographical plan of Sectors I-III.

2.1. Lithic assemblage and the tool A/A1

A total of 31 tools were identified among 81 chipped stone artefacts, in their majority made of local fine-grained flint of black and occasionally grey and beige colour. Some tools are made of black translucent obsidian, extremely fine-grained, most probably of Melian origin. The tool repertoire consists of marginally retouched flakes or blades, but also includes some scrapers, truncations, knives and splintered pieces, a couple of piercers and sickle elements, a denticulate and a notch (Table 1). Inferred activities involve the scraping or cutting of hides, the working of bone, and the reaping of siliceous plants (Papoulia and Chriazomenou 2013).

Tool repertoire	flint			obsidian		Total
	I	II	III	II	III	
marginally retouched piece	1	1	2	1	0	5
naturally backed knife	1	0	3	0	0	4
scraper	0	3	1	0	0	4
truncation	1	0	1	0	1	3
piercer	0	1	0	1	0	2
sickle element	0	1	1	0	0	2
retouched blade / bladelet	0	1	1	3	0	5
denticulate	0	0	1	0	0	1
notch	0	0	1	0	0	1
splintered piece	0	2	0	1	0	3
indeterminate	0	1	0	0	0	1
Total	3	10	11	6	1	31

Table 1. Tool repertoire of the lithic assemblage

Artefact A/A1 (25×14×3mm) is a laminar flake made of local black flint with unidirectional negative scars. A wide band of polish is macroscopically visible on the distal part of the right lateral edge bifacially in an oblique angle, and is more intrusive on the dorsal face (Fig. 3). Microscopic analysis of the used edge confirmed that the artefact was involved in working siliceous plants, most probably in the harvesting of cereals. Use-wear traces reveal that it had been extensively used in a

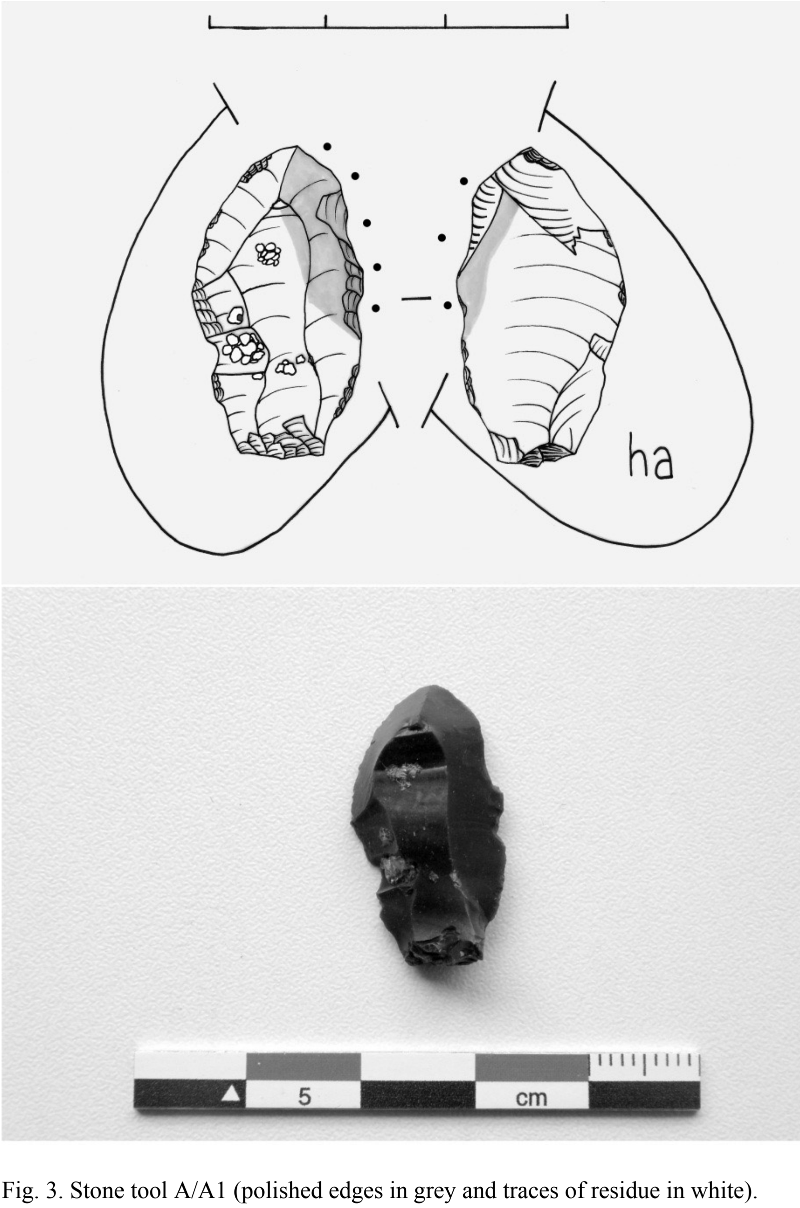

Fig. 3. Stone tool A/A1 (polished edges in grey and traces of residue in white).

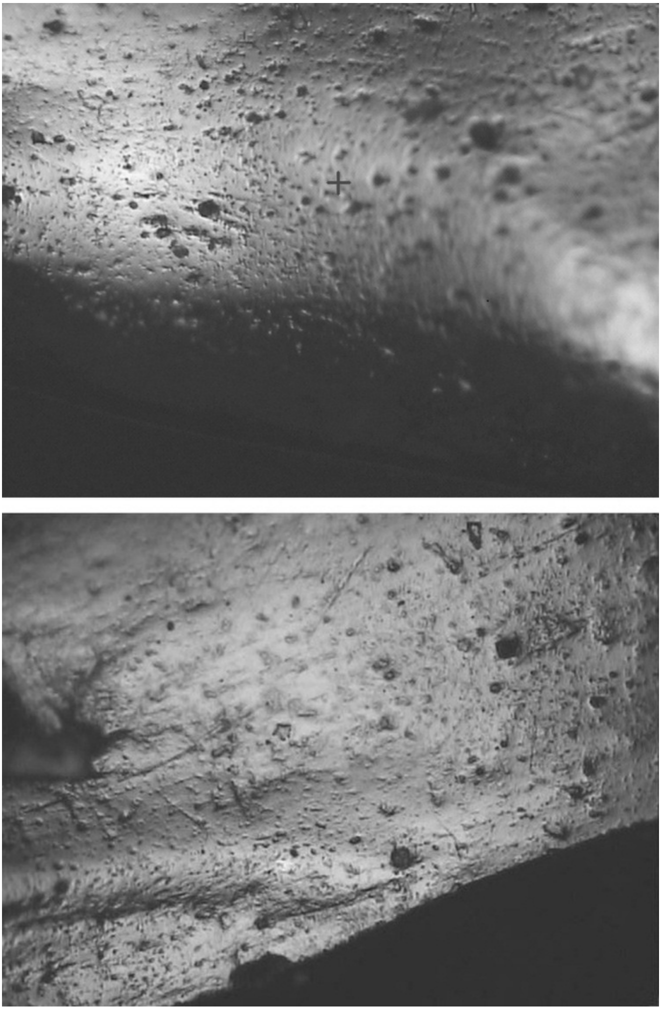

Fig. 4. Cereal-polish on the used edge of the dorsal face of tool A/A1 (100x).

longitudinal motion. The polish is smooth and flat, reflective and almost completely linked. Interestingly, the location, distribution and directionality of the polish on both faces suggest that it was part of a tool held in the left hand (Fig. 4). An abrupt and clear limit between the polished and unpolished parts forms a marked boundary which is considered an almost straightforward indication of hafting (cf. Rots 2005, 2010). The polish distribution shows that the tool was positioned laterally in a male haft, in an oblique direction to its axis.

2.2. Organic residues

The flint tool A/A1 also bears traces of a white/yellow to dark red/brown residue on the surface opposite to the polished edge. The substance is being analyzed using FT-IR (Fourier Transform Infrared Spectroscopy) by Prof. Nikos Chaniotakis and his team in the Laboratory of Analytical Chemistry of the University of Crete. Preliminary Raman measurements (Fig. 5) show that the Raman profile of the residue is that for amber and related resins (cf. Brody et al. 2001). Further laboratory analysis will confirm these first results and allow the specific identification of the resinous material–and other remains visible under the microscope, such as hair and/or plant fibres.

Artefact A/A1 was further examined under low and high magnifications (10-100x) in the same Laboratory in order to consider if this resinous material concerns the adhesive used in the hafting arrangement. We observed that a) the resin is present on the dorsal face and confined to the part that would have been inserted in the haft. The left lateral edge forms a small cavity where residue concentrated when applied (Fig. 6), while smaller blotches of resin are visible on the ridge and left lateral surface and edge, and a few dark red/brown spots appear on its ventral distal surface; b) the surface of the resin concentration is flattened and dull on the higher points, a trait which very possibly indicates where the haft element had been detached from (Lombard & Wadley 2007, 158); c) a very small piece of wood adhering to the resin is visible under low magnifications, again near the medial left lateral edge (Fig. 7); d) a layering of materials is visible: the resin is located between the surface of the stone tool and the wood fragment.

The association of these materials, their location and features provide evidence that the resin and wood fragment are the remains of, both, the wooden haft in which the stone tool A/A1 was inserted and the adhesive used to secure the stone tool within its haft. Although taphonomic processes should not be disregarded, we believe that our assumption is reasonably supported.

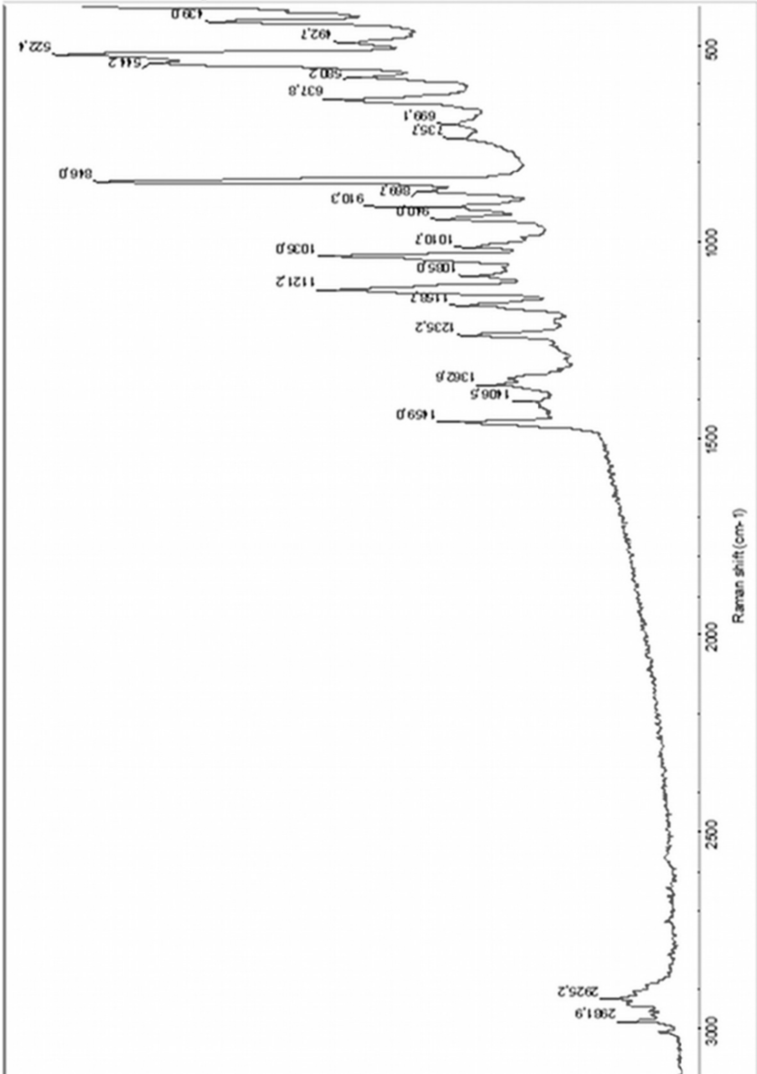

Fig. 5. Raman spectrum of the residue present on stone tool A/A1.

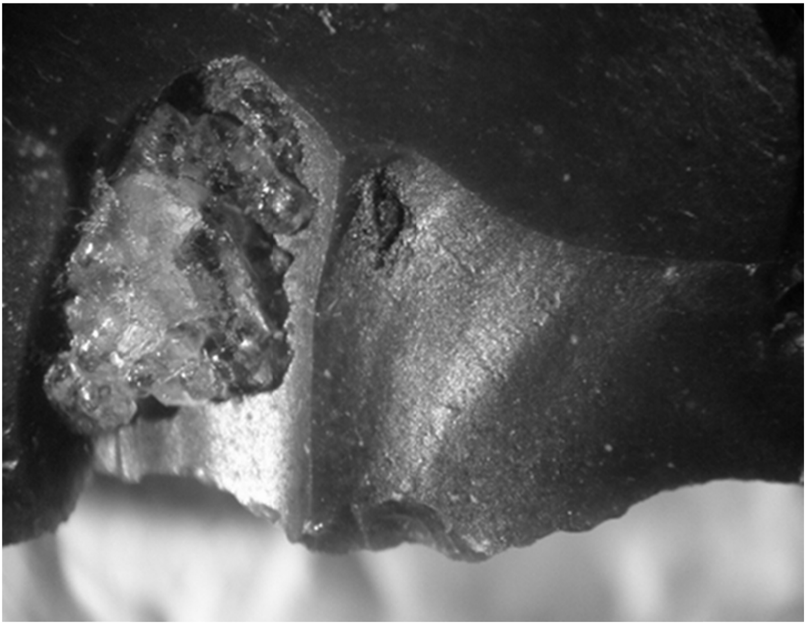

Fig. 6. Resin residue: note the flattened and dull higher surface (20x).

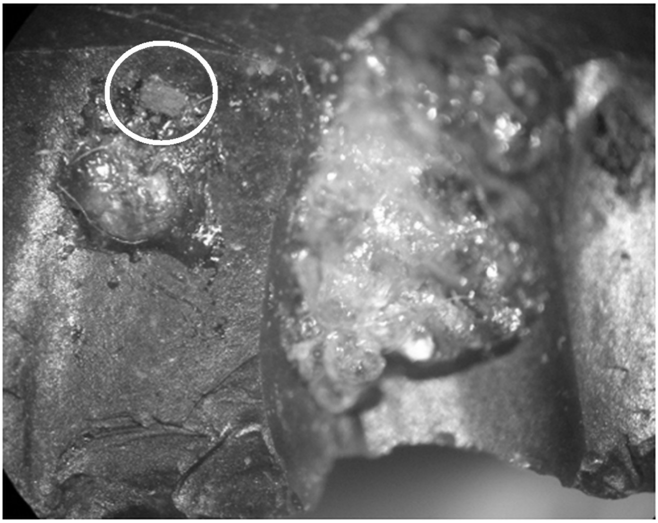

Fig. 7. Small fragment of wood adhering on the resin (25x).

3. Hafting wear traces

A hafting arrangement where resin is used to fix the stone tool in the haft combined with a low-pressure motion such as the harvesting of cereals is expected to produce limited hafting traces (Rots 2010). Yet, the following observations could further support our argument. On and near the used edge on the ventral distal face of the stone tool, resin residue is visible on a fracture, which occurred after use, as shown by the missing polish on that part (Fig. 8). This could have been caused by an eventual de-hafting of the tool, when resin would be heated and the artefact forced out of the haft (cf. Rots 2010). The extraction of the tool from its haft could have also caused other wear on its surface; however, it is not possible to differentiate such traces from traces formed by other processes, e.g. post-depositional modifications.

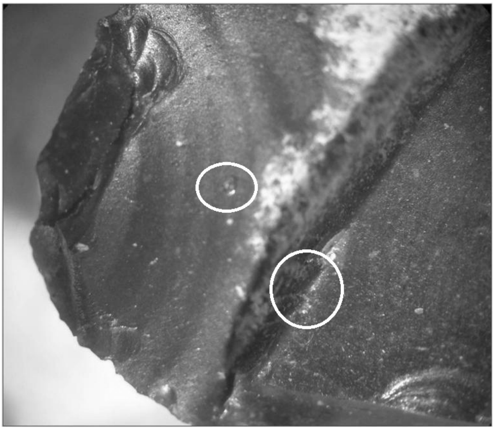

Fig. 8. Resin on the fracture on the ventral distal surface of the stone tool (20x).

4. Discussion

According to the above evidence, we could assume that artefact A/A1 was a sickle element inserted laterally in an oblique angle into a wooden male split haft, to which it was fixed with plant resin used as the adhesive material (Fig. 9). It may have eventually been removed from the haft, possibly with the intention of being replaced.

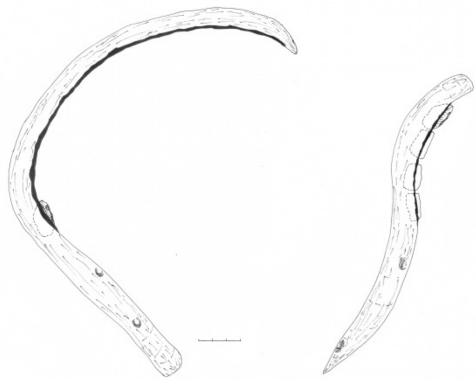

Fig. 9. Hypothetical reconstructions of the sickle with the stone tool A/A1.

In Gavdos, such vegetal glues could easily have been collected, mainly from the resinous tree species, which thrive on the island. Junipers would also provide wood of good quality for making the haft.

Producing a haft is a far more time- and energy-consuming task than stone-knapping. Technical knowledge of the choosing, curving and overall handling of wood, and familiarity with plant resins and their properties are, furthermore, essential for the preparation of an adhesive. Such an activity requires expertise in the control of fire and heat–an arduous procedure. Plant resins require special treatment, such as loading with other materials in order to retain their viscosity and avoid brittleness when cooled down (Keeley 1982, 800; Wadley 2005, 590).

In our case, a special kind of investment is to be traced in the manufacture of a tool held in the left hand. This reflects a rather complex system of production, where each tool was adapted to individual needs of usage, such as a left-handed person, or even a specific gesture of harvesting. Such composite tools could be conceived as personal belongings, and would therefore be curated. The making of a hafted tool, especially a sickle, often mirrors a collective interaction with raw materials at hand; chemical analysis will, we hope, identify native varieties of wood and resin, and other organic remains on the flake.

To conclude, the sickle element A/A1 from Gavdos informs us with a good degree of probability of its haft type and arrangement. Such finds are rarely reported from wider Aegean prehistoric contexts–in our opinion, not because they are lacking, but mainly because they are often overlooked.

The association of multi-stranded evidence provided by chemical and microscopic analyses is definitely crucial for any effort to read and reconstruct past biographies of tools, within their natural and human-made environments.

Acknowledgements

The study was carried out at the Laboratory of Prehistoric Archaeology of the University of Crete. Our sincere thanks go to Prof. Nikos Chaniotakis and Maria Fouskaki (Laboratory of Analytical Chemistry, University of Crete) for carrying out the chemical analysis and providing us the metallurgical microscope; and to our colleagues of the Gavdos archaeological project for their generous help in different stages of this work. Topographical measurements are by Stelios Spinthakis, and the excavation plan by Pinelopi Stefanaki. Photographs are by Eleni Chriazomenou and drawings by Christina Papoulia.

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Chapter Sixty Three

Raw Material Selection for Pounding and Grain Processing in the Single Grave Culture of the Netherlands: The Site of Mienakker

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Abstract

The site of Mienakker, dating 4100-3900 BP, is one of the three sites that are being studied within the NWO-Odyssee programme “Unlocking North-Holland’s Treasure Chest”. The site is located in the north-western part of the Netherlands, in the North-Holland province. This region is characterized by a total absence of mineral resources. The igneous rocks were probably collected from nearby areas, at beaches or in the glacial till deposits of Wieringen, while the sandstone probably has a southern provenance. Even though the choices of raw material are limited in the area, an intentional selection of raw material based on functionality seems to be evident. The two main rocks found in the site are granite and sandstone. While the first one was mainly used to process vegetal resources, mainly cereals, the second was mainly used for pounding and percussion activities.

Keywords: Raw material selection, Use wear, Hammerstones, Querns, Single Grave Culture

1. Introduction

Since 2009 research has been done on the site of Mienakker, within the project "Unlocking North-Holland's Treasure Chest" (NWO-Odyssee programme OND1335196). The aims of the project were to increase our knowledge about the settlements of the Single Grave Culture in the Noord-Holland province (Netherlands), focusing on the settlement distribution patterns, the human-landscape interaction and the study of the artefacts. Flint and stone have been analyzed macro- and microscopically, to understand the sequence of social and economic processes related to the production and use of the tools (Garcia-Diaz 2012). The flint technology from Single Grave settlements has always been considered as opportunistic compared with the artefacts found in the graves (Peeters 2001b; Drenth 2005). However, the analysis of the stone tools provides new information that refutes this interpretation.

The archaeological site of Mienakker is situated on an elevated area in a salt marsh environment, in an area characterized by a total absence of mineral resources. The site was discovered in 1986 after a test drilling campaign and was excavated in 1990. During fieldwork, more than 800 fragments of stone were recorded (Peeters 2001b; van Heeringen and Theunissen 2001). All the hard stone finds have been described in terms of their morphological characteristics following the specifications of the Laboratory for Artefact Studies at Leiden University. The use-wear analysis has been performed using a stereoscopic microscope with magnifications ranging from 10-160x and an incident light microscope with magnifications between 50-500x. Photographs have been taken with a Nikon DXM 1200 camera. In this article we will discuss the first conclusions from the analysis of the hammerstones, querns and grinding tools.

2. Querns and grinding stones

One complete quern, five quern fragments and one grinding tool were found in Mienakker. With the exception of one sandstone fragment all of them are made of granite. As mentioned above, Mienakker is located in an area where stone is not available. The nearby beaches and the glacial till deposits of Wieringen have been interpreted as the provenience area of the volcanic stones (Zandstra 1988). However, the origin of the sandstone is less clear. The source of sandstone has commonly been sought to the east or south (Lijn 1973). The querns and the grinding tool preserve flake negatives on the surface. The flake negatives reflect the production processes related to the querns. The fragment of granite was modified to

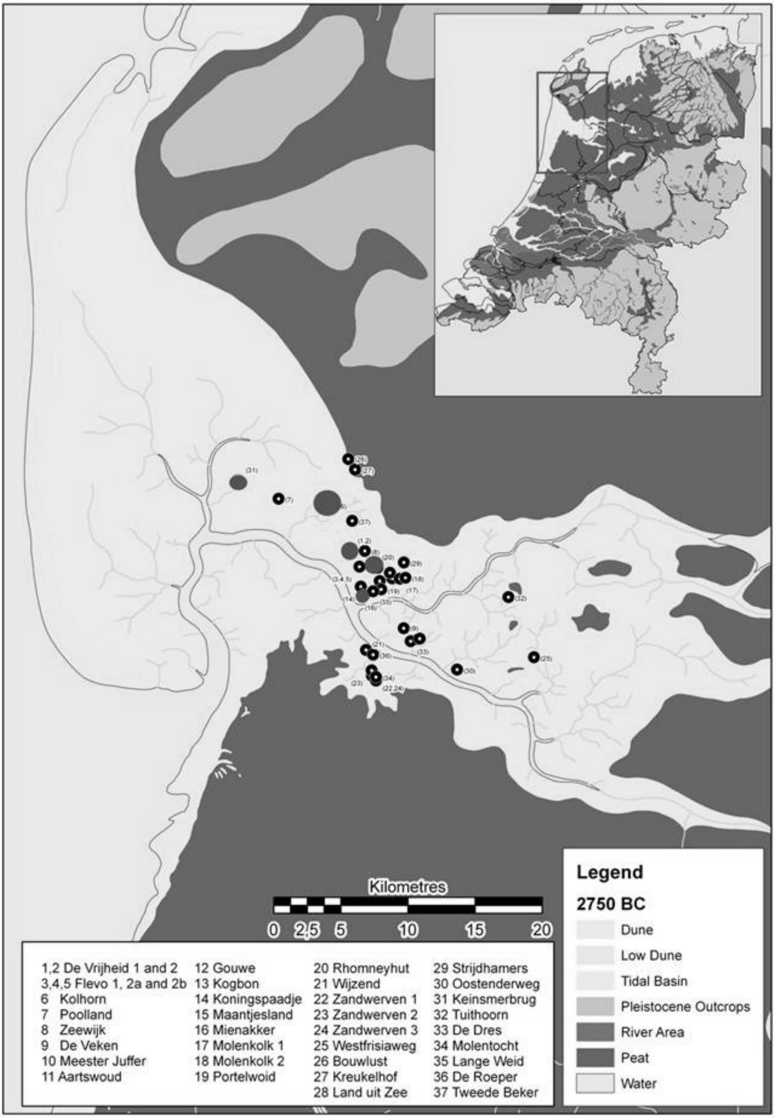

Fig. 1. Location of Mienakker and other Single Grave Culture settlements

obtain the desired shape of the quern by flaking the surface of the stone. Considering their morphology and the presence of use-wear traces, five of the artefacts were probably used as a metate. Milling traces have been described by other authors as a “granular, domed polish that is spread over the surface in small linked spot” (Verbaas and van Gijn 2007). Traces are generally developed on the higher parts of the surface. However, a prolonged use of the tool could generate a more extensive development of the traces. The formation of the polish occurs firstly in the shape of small and isolated spots of bright polish that would develop into more compact and articulated spots after a sustained use. In general, both surfaces of the tools were smoothed by work (Adams 1999; Verbaas 2005 (unpublished)). The use-wear traces on the bottom of the tools has been described as “resembling those resulting from contact with cereal”, with some important differences, probably due to the contact with the material on which the tool would be placed “to catch the cereals and flowers that fall off the quern, most likely hide” (Verbaas and van Gijn 2007).

One tool was used as the active part of the quern (mano). The polish, most likely related to cereal processing, is very well developed all over the surface. The mano has a rounded shape, with dimensions of 120 mm length, 111 mm width and 60 mm of thickness. Contrarily to the rest of the querns, the tool was used unmodified, taking advantage of its natural shape. The use-wear is developed on two faces, but mostly on the bottom of the tool. The used surface is macroscopically distinguishable as the face displays a polished and bright appearance. Microscopically, the use-wear is well delimitated even though the polish is not too close but characterized by the diagnostic cereal isolated points of bright polish described above. Finally, the polish displays a clear transversal directionality. Finally, the grinding tool displays two flat surfaces. Microscopically, both surfaces show an undetermined animal-like polish. Finally, on the sides, some percussion marks are present and the surface is quite rough. However, a bright patina covers the use-wear, so the use-wear has been classified as not interpretable.

3. Hammerstones

Eight hammerstones were recovered during fieldwork. Four hammerstones are made of igneous rocks, four of sandstone. Most of the hammerstones are rolled pebbles, with an elongated or circular shape. They probably specifically selected these natural shapes and then transported the stones to the settlement. The length of these hammerstones varies between 51 to 74 mm, with a width ranging between 32 and 62 mm.

Seven hammerstones show use-wear traces. Percussion traces are present on nine used zones, located on four hammerstones. Most of them have been used as bipolar hammerstones. Unfortunately, in only one case could the worked material be interpreted: to process some undetermined plant.

Fig. 2. Four hammerstones from the site of Mienakker related with percussion activities.

4. Discussion

First of all, there seems to be a clear relationship between the raw material selected and the final use of the tools. While tools used for milling and grinding were produced with volcanic stones, with a nearby provenience, the ones used for hammering and pounding were mainly made of sandstone, probably with a southern origin (Lijn 1973). Different explanatory hypotheses could be suggested. First of all, the available resources in the nearby areas would determine to a certain extent the selection of the raw material. From this perspective the geological resources in the vicinity could naturally influence the technical choices of each group (Adams 1999; Delgado-Raack et al. 2008). However, a second explanation would imply that within the range of rock types available, the group of Mienakker would select the more appropriate raw materials for the task at hand. Some authors have proven that the raw material has considerable consequences not only for the production process but also for the productivity of the tools (Adams 1999; Andrefsky 1994; Delgado Raack et al. 2008; Delgado Raack and Risch 2008). Consequently, easily accessible igneous rocks would be adequate for the milling and grinding processes considering the petrologic characteristics. Finally, the preference for distant raw materials as sandstone would probably have the force to establish social networks with other groups in its acquisition.

Another outcome of the analysis is that the technological traces observed on the surface of the tools suggest that tool production was also linked with the intended use of the object. The querns and the grinding tool display flake negatives on the surface, not only related with the shaping of the tool, but also with the edge revival of the implement. However, the *metates* were used without previous modification. The investment of work and energy related to the raw material selection and the production of the tools alludes to the importance of these implements for the different economic activities carried out within the settlement. Even though the total amount of stone tools that display use-wear traces is low (3.5%), the querns and the hammerstones are a significant group. Cereal processing played an important role in the site, as 20% of the stone implements displaying use-wear traces were related to this work (Garcia-Diaz in press). Additionally, querns are one of the most direct sources of evidence of the consumption of cereals within the Single Grave settlements, as sickle-blades are missing in the archaeological record (Garcia-Diaz 2012; Garcia-Diaz in press). Unfortunately, the poor preservation of the hammer and pounding stones and the limited development of the use-wear limit a better understanding of their significance in Single Grave domestic context.

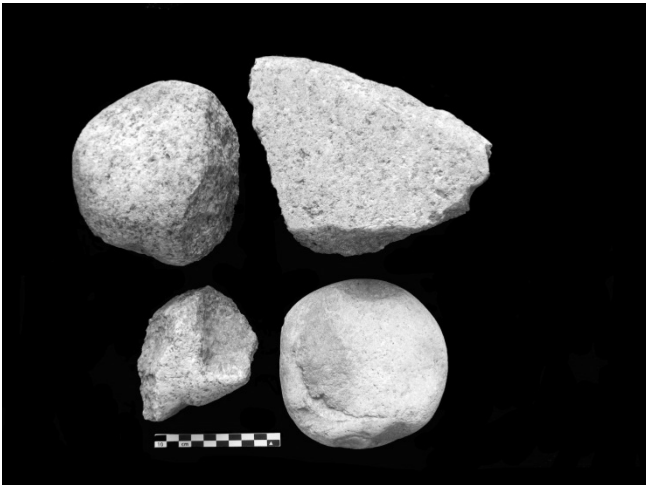

Fig. 3. Three *metates* and one *mano* recovered during showing use wear related with cereal processing.

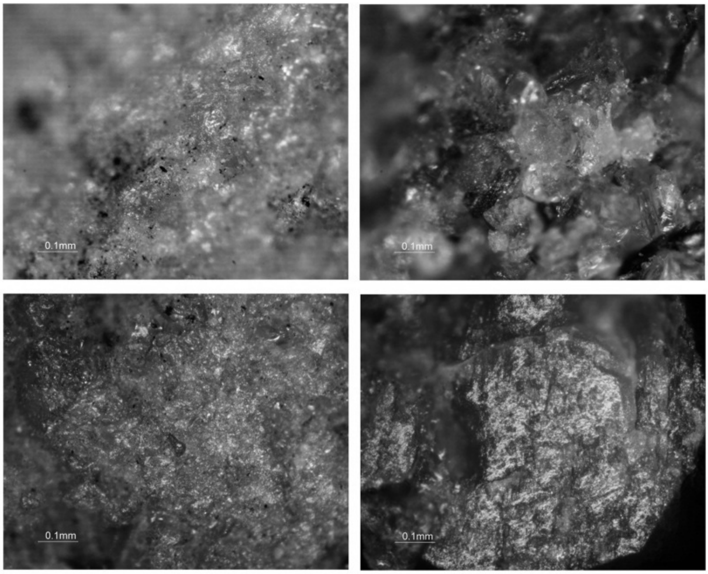

Fig. 4. Crystals alterations related with pounding and percussion activities, polish and rough surface related with pounding and percussion activities, Very well developed cereal polish on the active surface of the *metate* and polished surface of the *mano* as a result of grinding cereals.

5. Conclusions

The stone tool technology present in Single Grave settlement assemblages has been usually characterized as "opportunistic". However, the new information obtained through the analysis of stone tools, suggests that the technological definition of these groups should be revised and re-categorized to obtain a more accurate perspective of the real complexity of the Single Grave Culture groups in The Netherlands. Despite the fact that a comparison between other contemporary assemblages is still needed, the selection of raw material and the technological choices applied by the group suggest that the technology of these communities should no longer be considered opportunistic, but considerably more complex, reflecting a very accurate management of the landscape and technological knowledge.

Acknowledgments

I would like to thank Annelou van Gijn and Aimee Little, from the Faculty of Archaeology from Leiden University (The Netherlands), for their comments and suggestions. Joana Mol, from the same institution, helped me out with the raw material determination. The research has been performed within my PhD project, founded by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) and Leiden University.

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CHAPTER SIXTY FOUR

WHAT ARE PREHISTORIC TOOLS WITH VERY ROUNDED EDGES DOING IN IRON AGE STORAGE PITS?

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Abstract

During preventive archaeology excavations conducted near Paris (France), several flint artefacts with one or more very rounded edges were found in Iron Age storage pits. The recurrence of these finds (observed on many archaeological sites), coupled with a technological study of the objects, excludes the idea that their presence is merely anecdotal. On the contrary, traceological studies have revealed that most of these pieces are tools probably used in a specific context. The current hypothesis of these tools is that they were used on non-ligneous plant material by transversal action. Ongoing analysis will attempt to clarify the exact use of these tools.

Keywords: Storage pits, Iron Age, rounded edges, scraper

1. The study and its framework

A series of flint artefacts discovered during preventive excavations in the Ile-de-France region (France) were studied. The excavations are all recent and remain for the present unpublished, but it was deemed interesting to present our traceological observations of several tools for the UWA 2012 conference.

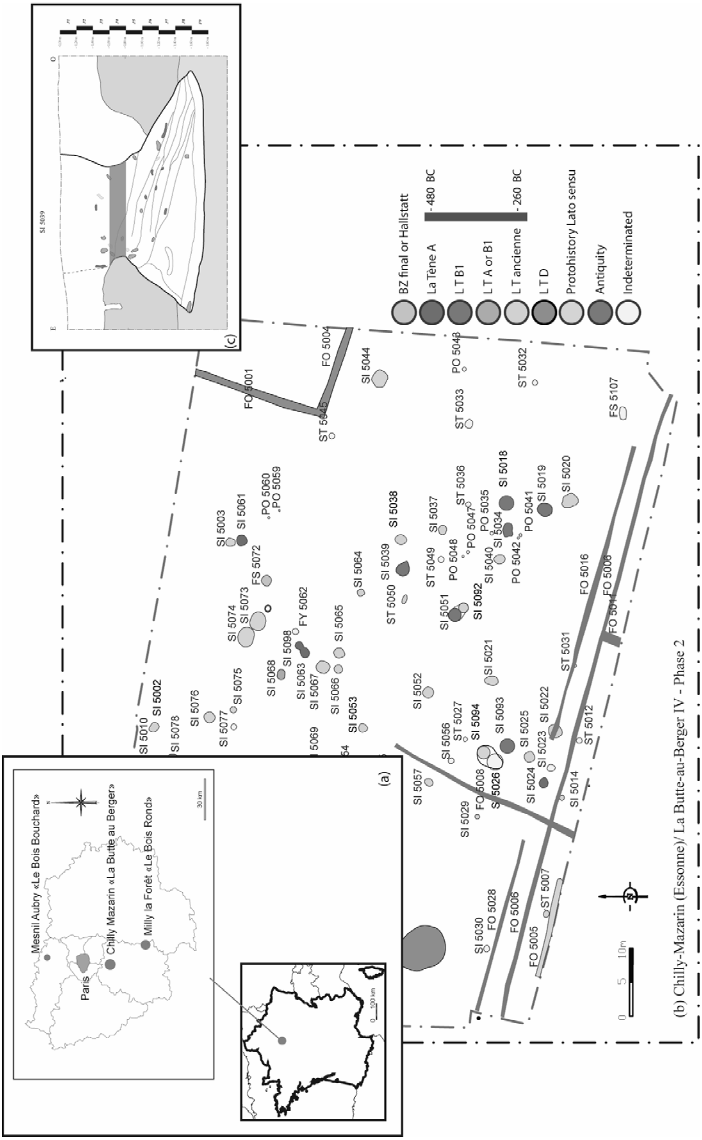

Fig. 1: Discovery contexts. Location of the excavations in Ile-de-France (a). the storage pits of Chilly-Mazarin, plan (b) and section (c). After a drawing by J. Bruant.

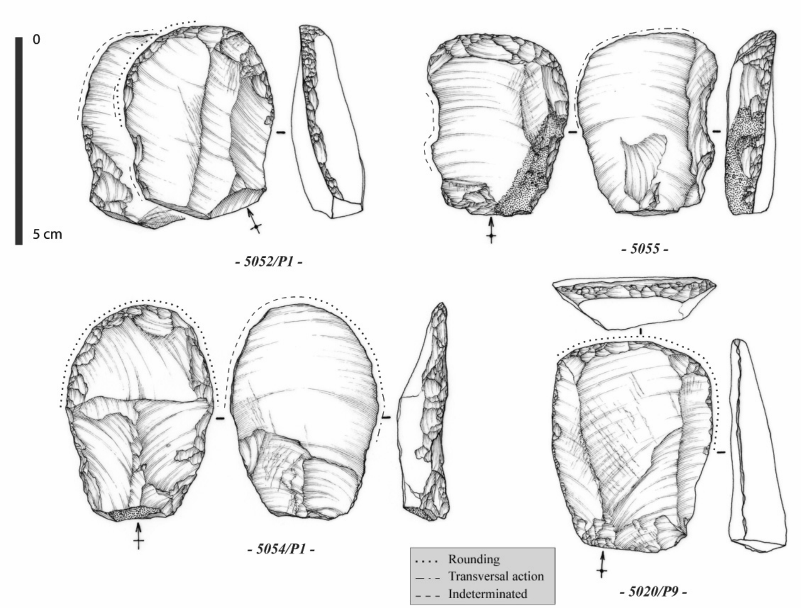

Fig. 2: Example of the lithic material discovered in the pits at Chilly-Mazarin, « La butte au Berger ». Drawings E. Boitard.

The worked flint artefacts were all found in Iron Age storage pits on the sites of Chilly-Mazarin la « Butte au Berger" (project manager: J. Bruant, Inrap), Milly-la-Foret "Le Bois Rond" (project manager: L. Mathery, Inrap) and Mesnil Aubry "Le Bois Bouchard" (project manager: C. Laporte-Cassagne, SDAVO) (Fig. 1). The shape of these objects is similar to small scrapers (Fig. 2) and all have one or several rounded edges (observed with the naked eye) that have intrigued the archaeologists that discovered them.

The discovery of worked flint within the context of Iron Age sites remains a problem (Cahen 1976; Le Guen et al. 2005), as it is not always possible to distinguish if they are residual or if they can be associated with the main chronological context of the site.

However, the recurrent presence of worn flint artefacts in pit fills and the technological study (J. Durand, Inrap) of those unearthed at the Milly-la-Foret site allows us to reject the hypothesis that these objects in Iron Age contexts are purely residual. J. Durand concludes that the objects date to different periods before the Iron Age, mostly to the Neolithic (Durand, in Mathery, pending) and that they were just opportunistically reused by the new inhabitants of the site.

The discovery of flint objects on sites dating from the Iron Age is not rare as underlined by the La Tène sites excavated in the Oise valley (France). Archaeologists noted the presence of flint as being “non-anecdotal” at Jaux “Le Camp du Rois”, and at Chevrières “La Plaine du Marais” (Oise, France) more than 6kg worth of flint objects was found in the ditches including scrapers and very worn flint blades (Malrain et al. 1996). According to the authors, part of the Chevrières material was knapped on the site, whereas the rest was recuperated material from more ancient contexts. However at Jaux the lithic material seems to have been all knapped on the site (Ibid.).

2. Microtraces on the rounded edges: a deficiency

We observed the microscopic and macroscopic traces of the rounded edges of the tools. In all cases, the rounding affected several millimetres or even centimetres of one or more potentially active areas of the flints (Fig. 3). The areas in question are either partially or completely convex and scrapers seem to have been the most appreciated tool (5 out of 9 pieces were blunted from Chilly-Mazarin).

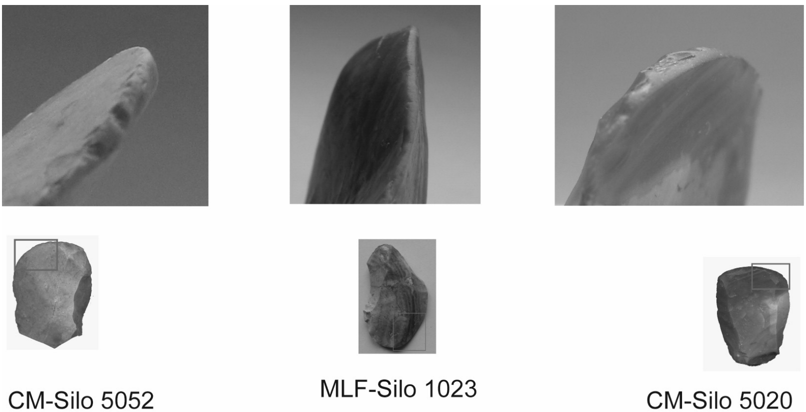

Fig. 3: Rounded edges of the flint tools, macroscopic view.

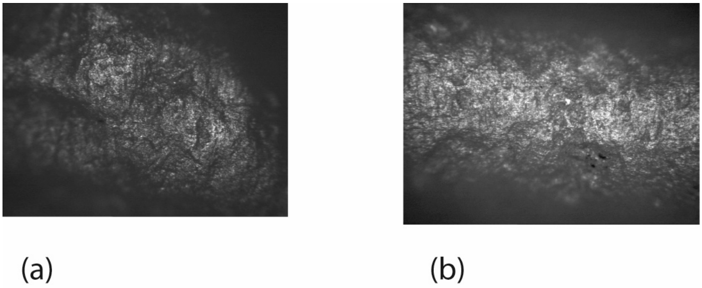

Fig. 4: Use wear of the rounded edges observed by microscope

The paradox is that if the rounding on the edges is perfectly observable with the naked eye, the polish which goes hand in hand with this type of wear is almost impossible to see even under a microscope (Fig. 4). These observations even made us think at the beginning of the study that the wear was in fact taphonomic. In other cases, the polished area evolves from a phaneritic aspect, slightly shiny and crude, to a much tighter, fluid and hard aspect (Figs. 4) similar to the traces made when working leather or skins. It is for that matter not excluded that certain tools could have been used for this, in particular the scrapers, in a first step of their life.

3. Experiments

Two experiments were carried out with the objective of understanding the formation process of the wear. One consisted in the harvest, the retting and the scutching of nettles and the second consisted in the grooving of a block of rock salt (Fig. 5). Unfortunately, both the experiments failed to reproduce the exact traces observed on the archaeological artefacts, for two main reasons. Firstly, after being dried and hammered the fibres disintegrated into small pieces and we were forced to stop the experiment. Secondly, it was not possible to observe any trace of use (just a small chip) even after more than 2 hours of continued use. This absence of traces is probably due to the fact that during the grooving of the rock salt a fine layer of salt was deposited on the flint surface, thus protecting it from all form of micro-flake or trace.

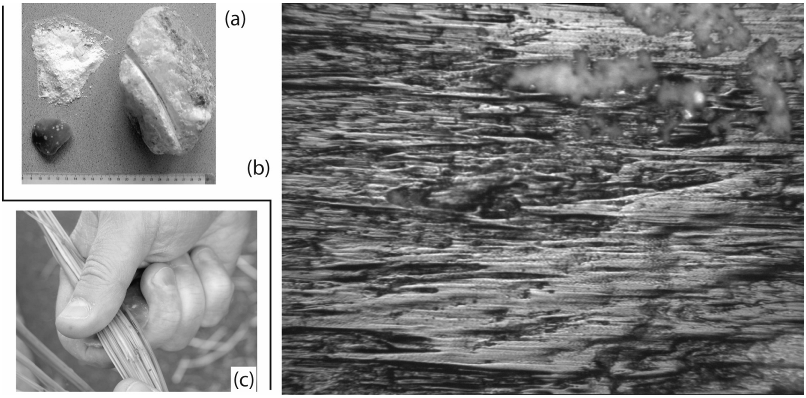

Fig. 5: Experiments: scotching of nettles (c) and grooving of a block of rock salt (a, b). Deposit on the surface of the experimental tool that was used to groove the rock salt.

4. How can we interpret our results?

The marked preference for using the convex edge of the tools and the way the edges were used indicates that the tools were used in a transversal action. The same interpretation was given by D. Cahen in 1975 when working on lithic material from the Iron Age sites of Tierceau and Massul (Belgium), where small perpendicular striations with polished edges were observed on the flint tools (Cahen 1976). According to D. Cahen, the exact use of the tools still needed to be determined. At Jaux, the authors suggest that the flint tools were used for agricultural work such as threshing (tribullum) (Malrain et al. 1996).

This interpretation of the link between these used tools and threshing opposes the conclusions of F. Robbe-Valloire and R. Gras (2007) who looked at the mechanisms of cutting straw with a tribulum in experimentation. They observed that the use of the tools did not provoke any abrasive wear of the flint, but an accumulated wear linked to the level of silica in the cereals could be observed. However, we need to take into consideration that the experiment was undertaken in a laboratory and that if it had been conducted in real conditions the results could have been completely different in particular because of the contact of the flint with the ground. If we cannot draw any real conclusions from the Robbe-Valloire and Gras experiment, the morphometry of the supports with their macro-rounded edges and the absence of traces that normally result from this type of use (M. Gurova 2001) seem more legitimate reasons to reject the hypothesis of the use of these tools as elements of the tribulum.

When this work was presented at the “UWA 2012” conference, B. Gassin suggested the possibility that the rounded edge tools could have served as firelighters. This hypothesis is seductive as this type of use produces important rounding on the edges (Beugnier 2005; Slimak & Plisson 2008). Nevertheless, amongst the microscopic and macroscopic traces typical of this use is the presence of striations and micro-flakes observed by V. Beugnier on material from the Mesolithic site of Verrebroek (Flandres, Belgium) and by H. Plisson on one of the artefacts from the Palaeolithic site of « L’enfant du Figuier » (Ardèche, France) (Ibid.). But these types of traces have not been observed in the case of our material. We cannot however exclude that the striations in particular could have disappeared during the artefacts’ time in the ground.

In addition to the rounded edges which are characteristic of our series, the microscopic observations have determined traces of use that probably correspond to the working of supple vegetal matter which have been revealed to be in certain cases rich in silica (Fig. 6). This polish is generally not found on the same edge as the macro-rounded edge. It is not possible for the moment to confirm that there is a link between the different types of traces. However, this configuration suggests the possibility that an activity such as the scutching of flax took place on these Iron Age sites as suggested by J. P. Caspard for certain Neolithic tools (Caspard et al. 2003; Martial et al. 2011).

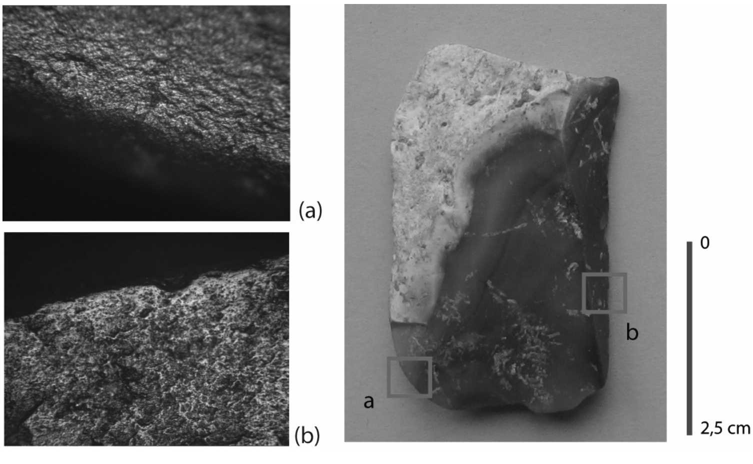

Figure 6: Use wear observed on one of the tools from the Iron Age storage pit (n0 1021) of Milly-La –Forêt. Heavy rounding of the left side edge (a), supple plant material polish on the right side edge (b).

The use of heavily rounded flint tools discovered in Iron Age contexts could be linked to the working of non-ligneous plant material using a traversal action. But the question remains open and awaits the study of new series or even new hypotheses to define the exact use of this wide range of Iron Age tools.

Acknowledgements

I would like to thank: Jean Bruant, Juliette Durand, Caroline Laporte-Cassagne and Laëtitia Mathéry, their research and their questions are the basis of this study. I would also like to thank Rebecca Peale (Inrap) for the rereading and the translation of this paper as well as Eve Boitard (Inrap) for drawing the flint objects. Last but not least, I would like to thank B. Gassin for the information given to me after the conference.

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Chapter Sixty Five

Flint Blade Use-Wear in Late Neolithic/Chalcolithic Collective Burials: Data from Pastora Cave (Eastern Spain)

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Abstract

The site of Pastora Cave, located in eastern Spain, provides us with an interesting funerary sequence for the Late Neolithic/Chalcolithic period (middle IV millennium until the last centuries of III millennium cal BC). The site was excavated in 1940, 1945 and 1950 and is one of over 130 known burial caves with multiple inhumations in the Valencia region from this period. Numerous human remains were found (55) with some rich and elaborate grave goods, especially flint blades made with foreign raw materials. In this work we present the results of technological and functional analyses of 61 blades from this site. The results show clear differences in size and technological characteristics that suggest several areas of production origins. We identified a lack of use wear for a significant number of these objects and propose hypotheses about the meaning of their presence in funerary contexts.

Keywords: Late Neolithic/Chalcolithic, blades, technological analysis, functional analysis, funerary context

1. Introduction

Pastora cave is a Late Neolithic/Chalcolithic burial site located in the municipality of Alcoi (Valencia region, Eastern Spain). The site is a 13 x 5m limestone cave in a small mountain at an altitude of approximately 860m above sea level (Fig. 1). Originally excavated in the 1940s and 1950, the site was used intensively as a burial site during the Late Neolithic, Chalcolithic and Bronze Age periods. The archaeology of the southern Valencia region is well known thanks to systematic surveys and excavation programs conducted in the past years by several collaborative research teams (University of Valencia, Universidad de Alicante, Arizona State University, Pennsylvania State University). A recent fieldwork and laboratory analysis from Pastora Cave was funded by the National Geographic Society (McClure and García; Grant #8281-07).

Pastora cave was excavated in the 1940s and became an immediate sensation in Iberian archaeology because of the wealth of grave goods, numerous human burials, and early documentation of trepanation on the Iberian Peninsula. Contemporary with sites such as Los Millares in southeastern Spain with clear evidence of social stratification, Cova de la Pastora along with other Chalcolithic burial caves are often seen as a Mediterranean manifestation of the emergence of social hierarchies (e.g., Chapman 2008; McClure et al. 2011).

The use of caves for human burial is a characteristic feature in the Valencia cultural landscape during this period, and over 130 other Late Neolithic or Chalcolithic burial sites are known. Primary inhumations in caves or rock shelters were often moved within the cave likely due to reorganization of space when more individuals were interred, and all burials were accompanied by a series of characteristic objects such as long chert blades and points, personal ornamentation, pottery, and carved bone ‘idols’. When Vicente Pascual first excavated the site in the summer of 1940, he found the cave full of deposits with only a small crawlspace to

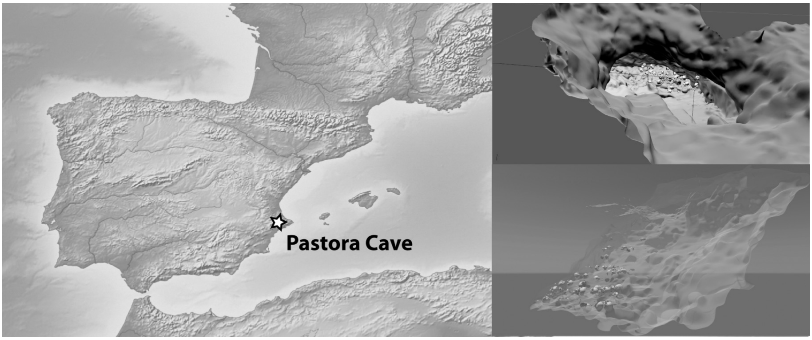


Figure 1. Location of Pastora cave.

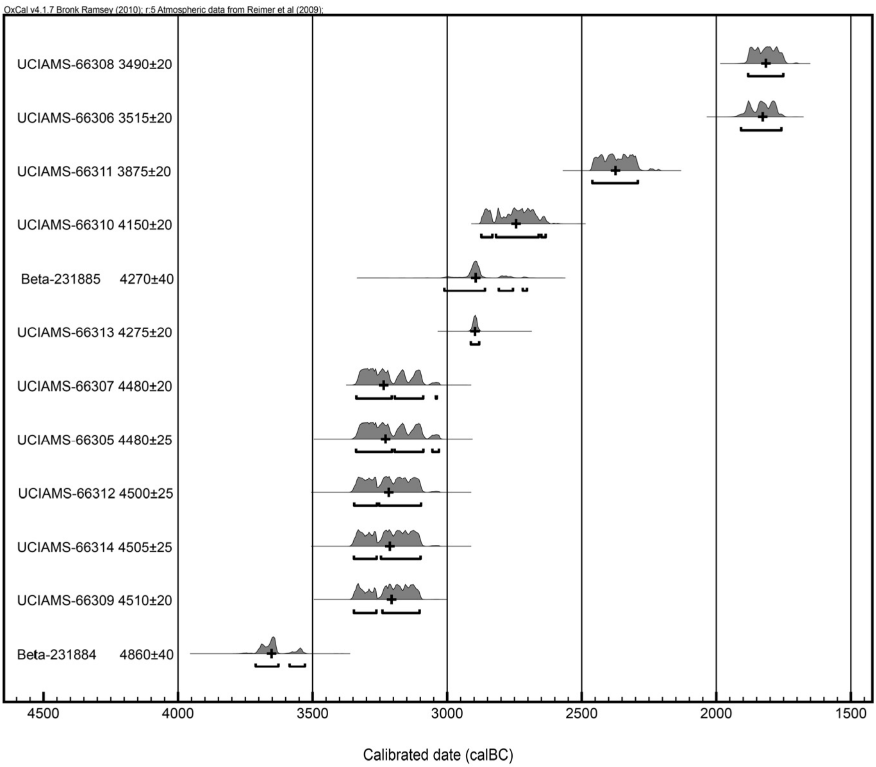


Figure 2. AMS radiocarbon dates from Pastora cave.

enter. AMS radiocarbon dates of 10 individuals from Cova de la Pastora revealed a longer history of burial at the site than anticipated, including the Late Neolithic, Chalcolithic, Bell Beaker Transition, and Bronze Age (Fig. 2; McClure et al. 2010). In this work we present the first results of microwear analysis in a set of long chert blades from this site and explore their role as singular grave goods or as functional objects in burial contexts.

2. Materials, methods and results

A total of 65 flint blades were recovered in Pastora cave (from old and new excavations). Previous technological analyses indicate significant variability in raw materials, technological features and sizes (Fernández et al. 2006; García Puchol and Juan Cabanilles 2009). There is a set of big blades (between 150 and 250 mm for length and 15-25 mm of width). Characteristic knapping techniques are distinguishable in several blades - one of the greatest expressions of craft specialisation in recent prehistory-. Indirect percussion and lever pressure have been recognized through morphological and technological features following the criteria described by some authors (Pelegrin 2003; Morgado and Pelegrin 2012). This information, together with the identification of several separate groups of flint, suggests these products came from several specialised workshops. At the moment we do not have discriminating data to identify these workshop locations. There is a general lack of data regarding this question throughout the Iberian peninsula and information is limited to mainly the south-east and the western regions (i.e., Meseta and Aragon), encumbering this type of analysis. At the same time, regional raw material data does not include most of the varieties of flint identified here.

Preliminary analysis has been conducted on 27 blades to examine macro-wear (notches, rounding of the edges, etc.) using a stereoscopic microscope (Leica MZ16A, 20x-40x), and micro-wear (striations, micro-polish, etc.) using transmitted light microscopy (Olympus BHMU, 50x-600x) to address several main goals:

1. Evaluate the state of conservation and the possibilities for our study.
2. Determine if these blades were used or were made exclusively for burial deposition.
3. Explain the traces and activities if identified.

The analyses resulted in several interesting observations. First, surface conservation was variable and it was possible to recognize several types of alteration. The most common is the patina of soil that makes it difficult to identify micropolish traces associated with the working of soft materials. Consequently a number of blades are affected by mechanical and chemical weathering. In the first case it is possible to observe a diffuse polishing and rounding surfaces in several blades. In other examples we identified the formation of patinas as result of chemical weathering.

Secondly, analyses regarding the second goal - to determine if these blades were used or were made exclusively for burial deposition - provided us with unexpected (?) and interesting data. Several analysed whole pieces showed no use-wear traces, while it was easier to find use-wear traces in fragmented pieces. Consequently we can say that the great majority of whole big blades were used exclusively as grave goods (Fig. 3), whereas other parts of the lithic assemblage were not (see below). This distinction is significant given the non-local origin of the big blades and the craft and skill required for their production.

Finally, a set of blades shows different use-wear traces. Seven blades present clear traces related to the working of plants in general (Fig. 4: 1-2), four linked more specifically with cereals. All of these blades are fragmented and they have several retouches on their edges, suggesting a significant degree of use in different activities (cutting wild or domestic plants, scraping bones and hides). Three other blades (1 whole, 2 fragmented) show diffuse traces (micropolish, few developed and small lateral notches), probably generated by cutting softer materials such as meat or hide.

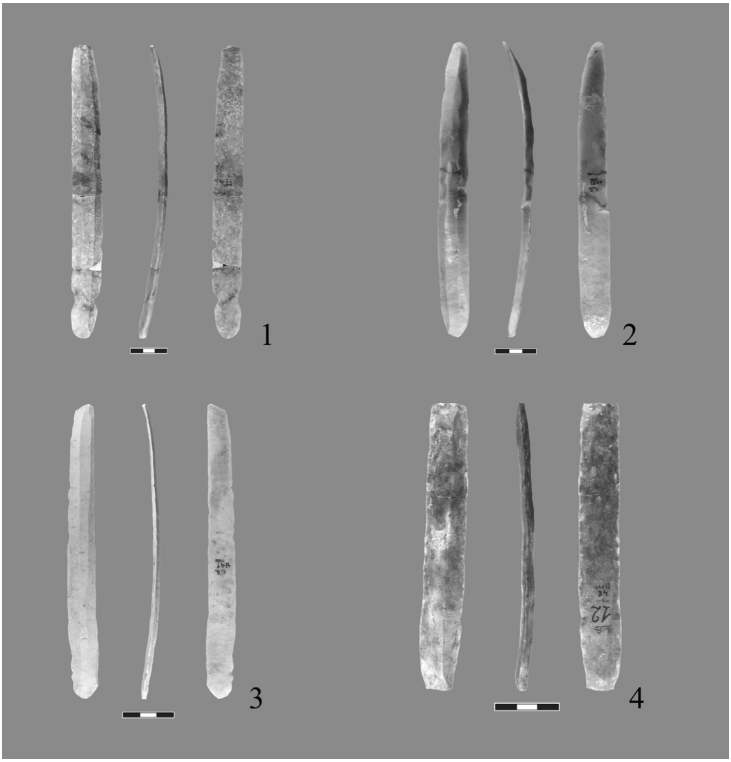
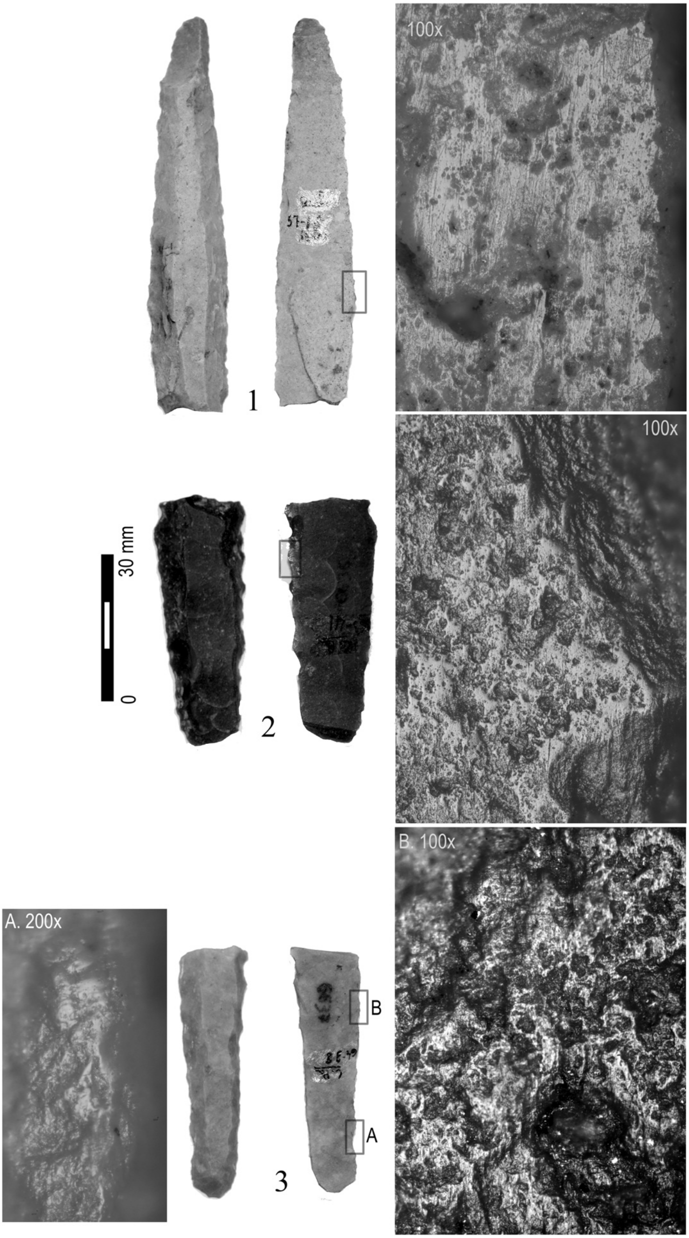


Figure 3. Large blades from Pastora cave (size in cm.).

Figure 4 (following page). Blades present traces related to the working of plants (1-2). 3: Blade use in different activities (cutting wild or domestic plants (b) and scraping bones (a).


100x
1
100x
30 mm
0
2
B. 100x
A. 200x
B
A
3

3. Conclusion

Use-wear analyses of a set of blades (big and middle sized) from Cova de la Pastora provide interesting information about the role of these objects in burial context. We can confirm that a number of them were not used (mainly the whole pieces) and their presence may be directly linked with their meaning as special object in the burials. These items, made from extra local raw materials, indicate the existence of craft specialization for flint knapping and organized networks. A special or symbolic meaning of these blades would help illuminate the reasons for their wide distribution from their workshop sources and their presence in their final use contexts. However, we also found that some of these pieces had evidence for varied use activities, suggesting that they were interred with the burials after a previous long life as used tools. Furthermore, several regional domestic contexts show a number of medium and large blades that would confirm our interpretation as work daily tools (García Puchol & Juan Cabanilles 2009). So the assemblage at Pastora Cave includes both used and unused blades of extra local origin. It is perhaps the widening consumption of this specialized craft -together with other exotic materials- in late Neolithic and Chalcolithic collective burials that is a key factor in explaining their expansion across established networks. Although several questions of workshop locations, sources, and distribution patterns remain open, by examining these processes we will be better able to understand the mechanisms of circulation (networks), the economic context and, finally, the social use of these singular pieces.

Acknowledgments

Fieldwork and laboratory analysis were supported by National Geographic Society (McClure and García Grant 8281-07), the University of Valencia, the University of Oregon, The Pennsylvania State University, the Museo de Prehistoria de Valencia and the Museum Arqueologic Municipal Camil Visedo Molto de Alcoi. Virtual reconstruction was made by Global Geomatica Valencia.

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CHAPTER SIXTY SIX

TECHNOLOGY AND FUNCTION OF THE CHALCOLITHIC DAGGER FROM CABEZOS VIEJOS (ARCHENA, MURCIA, SPAIN)

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Abstract

The Chalcolithic collective burial from Cabezos Viejos (Archena, Murcia) contained the remains of 23 individuals in two chambers, A and B. Burial goods are unequally present, B chamber featuring better quality and more abundant items than A chamber. A knife/dagger from B chamber, of exceptional size and quality, shows signs of careful technical elaboration procedures that might suggest its foreign origins. Use-wear analysis results indicate a multiple use in different activities.

Keywords: Chalcolithic, Collective Burial, Lithic technology, Use-Wear Analysis, Flint Dagger.

1. The site

Cabezos Viejos (Lomba and Zapata, 2005) is a southeast oriented cave, originated from a fissure in a gypsum-dominated geological setting, featuring extended visibility over the Segura river valley. The cave has a main chamber and a lateral chamber, close to the entrance. It remained hidden until 1995, when earthmoving works accidentally destroyed the ceiling. Subsequent weathering of the cave's sediments exposed the archaeological remains. After a short plundering episode over a limited area, the site was fully excavated between 2001 and 2003.

A MNI of 21 individuals was unearthed at Cabezos Viejos, distributed over two different areas, designated A and B. The main chamber and entrance (A) features an oval-shaped surface of 5,5 m2, 3,80 m long and with a maximum width of 1,95 m. An artificial trimming of the gypsum strata bound this area on the left side and by natural, vertical rock walls on the right. Remains of at least 14 individuals were found in this area. The second chamber (B) is a small lateral area close and to the right of chamber A, featuring a square surface of 2,5m2, entirely bounded by vertical rock walls. It contained the remains of 7 individuals.

The joint space of both chambers is approximately 8 m2. Human remains were arranged in different ways: flexed in primary position; flexed but relocated; partially or completely mixed up; or in clusters of selected skeletal remains. A number of burials include a set of elements, interpreted as burial goods: 32 knifes or blades (mostly unretouched), 41 arrow heads and 2 daggers (flint); 16 axes and 2 adzes (polished stone); 25 flat bone rods; 7 unperforated wild boar canine and a minimum of 11 necklaces, three of which include crescent-shaped ornaments made from shell. No metallic or ceramic elements whatsoever were found.

The arrangement of human remains led to the identification of certain patterns, which in turn led to the definition of several series of inhumations, characterized by the close spatial relation of their components. Furthermore, there was a clear correlation between such groupings, on one side, and the richness of the burial goods and the social distances they indicate on the other.

Nowadays, the surroundings of the site show a high degree of anthropization due to the presence of agricultural and industrial structures and facilities. The landscape has been strongly modified, and so far we couldn't find any remains of the settlement that must have originated the burials. The only reference of any interest is a saltwater source located close to a small ridge, within a 15 minute walking distance from the burial. Up until 40 years ago, this source generated a wet area where a number of aquatic plants thrived. Today, all that is gone and barely recognizable in the landscape.

2. Tool study

The object of this study is a foliate (166 x 53 x 9,5 mm) that stands out among the burial goods. Its beauty and size, and the fact that no similar specimens have been found in nearby contexts to this date, leads us to assuming that this is an item of remarkable relevance.

The raw material source is yet unknown, as no petrological studies have been carried out so far. But we do know that no production areas specializing in this type of artefact have ever been found in the territory that currantly constitutes the Region of Murcia. Based on the available data, we would have to refuse its local origin, though we cannot disregard the possibility that future works might identify areas with lithic resources suitable for the production of this type of tools.

2.1. Technological study

The technological approach suggests that the tool was made on a large flake or tab. The *chaîne opératoire* starts by sketching the tool, using direct percussion to shape out the initial morphology of the bifacial preform. Some hinged scars are produced during this stage, both on the upper and lower surfaces.

Polishing comes next, but only in the central area, parallel to the longitudinal axis of symmetry and also on both surfaces. The knapper might have used polishing as a technical resource to achieve a constant thickness along the tool's full length. Under the metallographic microscope, we could observe a flat, matte polish with abundant striations. The orientation of these striations changes along the central portion of the tool, from parallel to the central axis (Figure 1.8) to perpendicular and oblique. Certain parts even show a criss-cross of two or three orientations (Figure 1.7), which indicates a back and forth motion in different directions. On some zones, striations and linear traces seem to suggest a coarse grain abrasive, some type of mineral material judging from the flat texture of the polish. However, we wouldn't rule out a final polishing stage using some soft material such as leather, considering the matte and a slightly greasy aspect of some parts (Figure 1.12).

The tool's final morphology was achieved by means of bifacial pressure retouch over the entire contour of the tool, creating convergent edges with a pointed distal end and a rounded proximal end. Retouch tends to be short; longer retouch can be found in some parts, never reaching beyond the longitudinal axis of symmetry. It is generally a low angle retouch, being semi-abrupt on the distal end only. The diversity of the identified flaking types and the presence of semi-abrupt retouch on the distal end might be a consequence of rejuvenation throughout the tool's use. In morphological terms, retouch is mostly parallel or, to a lesser extent, sub-parallel.

The production of this type of leaf-shaped tools, with all their morphological and technical variants, has been documented in European Final Neolithic and Chalcolithic contexts. The sources of prior technical knowledge are studies such as those carried out by Ontañon et al. (1999), Plisson (2002), or Vaquer and Vergély (2006).

2.2 Functional analysis

This flint knife/dagger features complex functional evidence, since different, often overlapping types of marks are present. Use-wear analysis results from different tool parts are the following:

2.2.1. Distal part

The right lateral edge shows a poorly developed, compact shinny polish on some parts of both faces, which indicates work on hard materials like bone (Figures 1.2, 5). A further, intercalated type of more diffuse, grayish polish is related to soft materials like meat and/or hide. The scarce striations and linear traces are parallel or show a low oblique angle, suggesting a longitudinal cutting action. Light edge-rounding is also present, as a discontinuous soft polish that covers the distal third of the tool, indicating low intensity work. This might be interpreted as animal products processing, whereby the active edge has contact with hide, meat, viscera, sinew and also bone. Thus, the tool might be defined as a "butchering knife". In the opposite part, the left lateral edge, we observed the same type of marks, only more intense, which would indicate more use. The distal apex barely shows any marks, apart from some undefined brightness on high areas. Together with the presence of abrupt retouch flaking, this might result from a rejuvenation of the tip during butchery activities (Figure 1.1).

2.2.2. Medial part

Left edge. As we approach the medial part, the former marks are replaced by new evidence. Quite different marks were identified here, on both faces of both lateral edges. On a few portions along the edge there is a first type of discontinuous, very thick polish that causes edge-rounding on those portions. Abundant striations cross this polish, parallel to the edge. Considering its texture, thickness and striations this might well be the so called cereal polish (Figures 1.9, 10, 11). However, its matte appearance and the coarseness of some portions keep us from specifying any further than contact with soft vegetal material. We observed a second type of polish, intercalated and covering wider portions of the tool's medial part, coarse and grayish but not as compact, featuring abundant parallel linear traces and strong edge-rounding (Figure 1.3). This polish affects more extended, higher areas close to the edge, reaching inner areas as well, and is more continuous along the edge.

Both types of polish can be seen on the right lateral edge as well, though not so intensely. Furthermore, the first type of polish only exists on a few high areas close to the edge (Figure 1.6). The two types of polish are present on the lateral part, even if not continuously, but hardly appear on the cutting edge. This can be due to the fact that on a fairly large section of the left side the raw material is coarse grained and might have slowed the development of marks.

The second type of polish is not unlike the one observed on the tool's central portion, originated by intense technological polishing. The similarity lies mostly on the grayish shade and the abundance of linear traces. However, there are several differences:

- Both polish and edge-rounding are less developed on the central portion than on the other four faces of the lateral edges. This is not in agreement with the possibility that lateral marks were a consequence of central polishing.
- Linear traces are also more continuous and homogenous on the lateral edges.
- The orientation of linear traces and striations is not the same. On the edges, linear elements are homogenous and strictly parallel to the edge, whereas on the central portion they are rather well defined, low angle oblique striations, criss-crossed by other perpendicular striations (Photos 54 y 55).

- On the other hand, both the texture and extent of linear traces indicate thicker and coarser abrasive materials on the central portion than on the lateral edge.

On the medial portion, more intense marks on the lateral edges seem to be related to a specific use and not originated by technical procedures involved in the technological central polishing. We would offer the following interpretation: along its medial portion, the knife was initially used to cut vegetal materials – first type of polish, possibly obliterated by rejuvenation, to a considerable extent. Further on, the knife was used again to cut a more flexible material, like relatively dry hide; this masked part of the former marks. The abrasive aspect of polish on this medial portion might result from cutting the vegetal stems close to the ground, causing the introduction of abrading particles. Yet, we cannot rule out the use of added abrasives during hide-working. On this part of the tool, the left edge also shows more intense use than the right one.

Now, the intermittence of marks along most of the edge, which affects al three documented activities – butchering, soft vegetal and dry hide cutting – suggest several rejuvenation episodes, the remaining evidence being the result of prior uses. This fact is supported by the weak presence of polish on the cutting edges, where only a poorly defined shine is visible. The sole exception is a small section of the medial part's left lateral edge, where polish marks show a longer sequence and higher intensity on the cutting edge (Figure 1.4).

2.2.3. Proximal part

A large portion of this part features less sharp edges and a change in the rock's texture, which becomes coarser and thicker-grained. This might partly compromise the functional effectiveness of this particular section of the tool. The entire proximal perimeter shows only undefined shine and areas of flat, grayish polish, along with a lighter and more compact one, the latter only on higher zones. On occasions, these marks are associated with chaotically distributed striations. This set of traces can be interpreted as hafting evidence, resulting from contact with hard materials like wood or bark.

The whole tool, including the hafted area, shows small residues of a red colouring material. The amounts are very small and so widely distributed that we cannot link them to a specific use, as no significant concentrations exist anywhere on the tool. It might even be due to the sedimentary context it was unearthed from.

3. Discussion

This type of large blades or daggers is well known in French and, to a lesser extent, Spanish bibliography. Several functional studies have been carried out at other sites, due to the interest raised by such items. Concerning daggers, the work by Charavines and Portalban, in Plisson et al. (2002: 801-805) documents cutting of two different vegetal materials – one of which was not identified during experimentation – total or partially covered by the use of a flexible, abrasive material, possibly hide. This material is usually associated to a longitudinal activity but the diversity of traces makes it very difficult to pinpoint a single origin. Likewise, the study on large blades found in funerary contexts from Catalonia by Terradas et al. (2005: 356) points out a frequent use on cereal, along with dry hide, for a significant part of the collection. Butchering work – one blade from Cabana Arquetas – as well as scraping mineral materials – one blade from the Pericot dolmen -is less frequent.

The renowned Garma dagger, with a halberd like typology, also featured evidence of a double use: leather or dry hide cutting on one side and possibly butchering on the other (Ontañón et al. 1999: 223).

All of these tools share two very common characteristics – their multiple use in different activities, involving different materials, cereal and dry hide cutting being usual; and rejuvenation, which accounts for an intense use of the tools.

The Cabezos Viejo dagger shares these characteristics, showing several use cycles, as a butchering knife on its sharper end and as a cutting implement for cereal and dry hide on its middle section. As far as the Chalcolithic of southeast Iberia is concerned, this is an exceptional item, due to its dimensions and fine technology, as central polishing is not a common technical resource in this context.

Like other exceptional grave goods, this type of tool may be considered a prestige object. We consider that such prestige derives not just from its technical and morphometric character but also from the wide range of functional possibilities allowed for by its configuration, range that was widely exploited by its users.

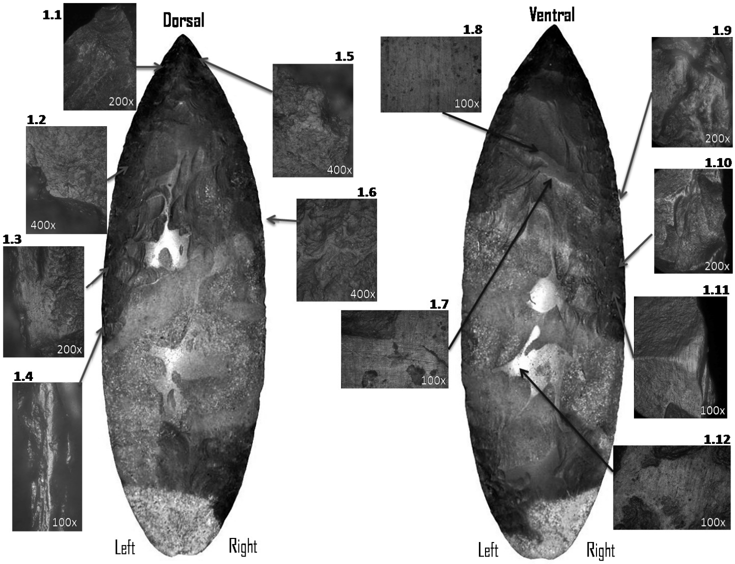

Figure 1. Technological and use-wear marks of the chalcolithic dagger from Cabezos Viejos (Archena, Murcia)

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CHAPTER SIXTY SEVEN

FIRST RESULTS ON USE-WEAR ANALYSIS OVER SEVERAL EARLY NEOLITHIC CONTEXTS FROM NORTHWEST AFRICA

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Abstract

This paper is a brief presentation about the functionality of lithic tools from several Early Neolithic sites in North-West Africa. In the last years, research teams have focused on this territory in order to study the origin of the first Neolithic communities. Data from the Northwest African coast are still scarce. Therefore this paper intends to fill the long existing gap between both shores of the West Mediterranean, an area that should be

considered as a singular entity during the Early Holocene.

Keywords: Northwest Africa, Early Neolithic, Neolithisation process

1. Introduction

The beginnings and development of the Neolithic in North-West Africa is a subject about which little information is available. The archaeological work undertaken in Morocco during the French and Spanish colonial periods was followed by a time of ostracism and neglect until the 1970s, when the team of Professor P. Daugas re-initiated research on the origins of this period in the region. In recent years, several Moroccan, German and Spanish teams have also engaged in investigation on this topic (Ramos, 2012). In previous studies, potential contacts, movements or influences between human groups living on the shores of North-West Africa and Southern Iberian Peninsula were not systematically analysed. However, the results of recent archaeological research at several Moroccan sites have led to new assessments and explanations concerning the Neolithisation process (Linstädter et al. 2012). Epipalaeolithic and Neolithic communities from both shores of the Alboran Sea have been evaluated from a much wider and more complex perspective. In this paper we present the first results from the analysis of the lithic industry from the Late Epipalaeolithic to Early Neolithic sites of Hassi Ouenzga, Ifri Oudadane and El Zafrin.

2. Hassi Ouenzga (Morocco)

It is a shelter located in the hinterland that was occupied during the Neolithic transition (Linstädter 2004). The archaeological assemblage is characterized by a Late Epipalaeolithic lithic inventory mixed with Early Neolithic pottery and a lack of domesticated species. This is probably the result of late local hunter-gatherer communities in contact with Neolithic groups. This period is dated between 7.6 and 6.8 ka calBP and named with the term “Epipalaeolithic with pottery” (Linstädter 2008). This rather unwieldy term refers to the fact that the actors behind these assemblages are local foragers, who adopt pottery as a first Neolithic innovation. The integration of food production in their broad-spectrum subsistence seems to follow at a later phase.

Therefore the more than 2,300 lithic pieces are clearly originated in the local tradition of bladelet-orientated industries. Frequent tool types such as points, truncations, notched blades and flakes and pieces with semi abrupt retouch, as well as occasionally occurring microliths, are typical in all Epipalaeolithic sites from the 11th to the 8th millennium calBP (Linstädter 2011).

The lithic assemblage of the Late Epipalaeolithic level provides a single reduction process, devoted to flake and blade production with the configuration of prismatic cores without shaping the platforms. In contrast, the Late Neolithic levels show two reduction processes: blade and flake oriented, using small nodules with no previous removal of the cortex.

We accomplished a use-wear analysis of 39 pieces from the "Epipalaeolithic with pottery" level. Use modifications were present in 31 of them. There is a clear relationship between the manufactured tools and their task. Non retouched blades were selected to cut soft material such as meat or hide; retouched blanks were used to scrape hide; backed bladelets and geometrics served as projectile points and blades or flakes with notches as well as denticulates worked hard vegetable or animal materials. Anyway, even if the number of analysed tools is low, we can conclude that the most represented activities in Hassi Ouenzga are related to the procurement (hunting) and the process of animal matter such as meat, hide, bone and antler.

3. Ifri Oudadane (Morocco)

This rock shelter is located in a coastal cliff, about 50 m above the present-day shoreline, to the west of the Melilla Peninsula and 5 km east from the Oued Kert River mouth (Linstädter & Kehl 2012). Its 2 m deep deposits can be divided into Epipalaeolithic, Early and Late Neolithic levels, dated by nineteen 14C-data. The lithic assemblage is sparse and consists mainly of unspecific flakes. However, some notched flakes and blades, scrapers and typical Epipalaeolithic backed points are present. The Neolithic transition occurred at about 7.6 ka calBP and is very well documented in the stratigraphy by the first appearance of pottery and domesticated species such as cereals, legumes and ovicaprides. Large notched blades indicate changes in the lithic tool production. The Early Neolithic occupation ended at 6.3 ka calBP due to a general trend of climate degradation affecting all occupation within the arid and semiarid Northern Africa.

We analysed 76 tools; 45 came from the Early Neolithic A (ENA) and 31 from the Early Neolithic B (ENB) sub-assemblages. Although the pieces from the ENB are more altered, at this level we must highlight the presence of a set of instruments that accomplished several activities that included the process of animal, vegetable and mineral materials. The blades, and more scarcely the flakes, were used for butchery, scraping hide, cutting and scraping wood and non-woody plants, and scraping mineral material. Three backed bladelets served as projectiles.

4. El Zafrin (Spain)

This open-air site is located on the Isla del Congreso, one of the Chafarinas Islands, 3.5 km off the eastern Mediterranean coast of Morocco (Rojo et al. 2010). Several structures have been identified. They are part of a larger habitat, including a complete hut. Four 14C ages have been obtained from samples of domestic fauna. These are all dated in the third quarter of the seventh millennium calBP (6.4-6.0 ka calBP). This site represents a final stage of the Early Neolithic in the region (ENC). The presence of ovicaprine (Ovis aries / Capra hircus) and other domestic species (Canis familiaris) suggests that farming was an important economic activity. Food procurement was supplemented with the hunting of monk seals (Monachus monachus) and the gathering of sea mollusks (Cheloniidae, limpets, sea snails). Different rock-types were knapped to manufacture stone implements. Simple morphotypes, such as notched flakes, denticulates, end-scrapers, side-scrapers and, above all, borers, were performed mainly on flakes, which were the main objective of all reduction processes.

Macro and microscope analyses were carried out on 235 artefacts. Ca. 900 pieces were previously examined by means of a binocular lens in order to establish a first selection. The results show that most implements were used to treat animal substances (meat, skins and bone). A fewer proportion of them were used as projectiles or to process vegetable and mineral matter. For a large group of tools, the substance worked cannot be determined precisely, apart from its hardness. In short, it can be said that five flakes and three blades were used for butchering; and 2 geometrics (segments) exhibit possible impact fractures or striations caused by their use as projectiles.

In relation to hide-working tools, three were used for scraping (two fragmented unretouched flakes and one end-scraper) and another three for cutting (two blades and one flake). Furthermore, four broken flakes were utilized to work bone matter. They were probably employed briefly for sharpening or finishing off implements, objects or ornaments, such as needles, punches, points, beads and handles. One flake was used for cutting, probably non-woody plants. A small end-scraper and a possible burin were used for scraping, perhaps wood. Finally three pieces, a flake, the concave side of a core and a borer, show evidences of having been employed on a very abrasive substance (hide or stone) and/or a very hard one (stone or valve).

5. Conclusions

A rich stone tools assemblage has been analysed in the present work, though quantitative differences among the three sites hinder potential comparison of the lithic collections. Settlements located inland have yielded a low number of pieces (Hassi Ouenzga and Ifri Oudadane with, respectively, 39 and 76 tools) compared to 235 items retrieved from El Zafrin. Nevertheless, preliminary results indicate a large variability in the range of tasks carried out with the lithic tools in all the sites. They show evidences of procurement and processing of animal and plant materials and, in a lower proportion, of minerals. Therefore the settlements are not specialized in accomplishing a particular task. Conversely, we have identified evidences of multiple activities dedicated to the procurement, manufacturing and repairing of artefacts and tools made of different raw materials.

It must be pointed out that no sickle pieces were recorded in Early Neolithic levels. They are only identified in the Late Neolithic layer of Ifri Oudadane. In order to explain this absence we suggest two hypotheses: 1) Early Neolithic populations did not cultivate cereals or 2) cereals had a minor role in the subsistence activities. If the latter is true, this may result in the lack of sickles in the sites. It is also possible that early farmers used other harvesting techniques or instruments with a low archaeological visibility, such as uprooting or cutting spikes by hand or with other kinds of tools, e.g. the mesorias, which are carved on wood and consequently not frequently preserved.

Archaeobotanical analyses carried out in samples from Ifri Oudadane have proved the existence of cereals such as wheat and barley, as well as legumes, such as peas and lentils, in Early Neolithic contexts (Morales et al. in press). Nevertheless the amount of domesticated species is rather low compared to wild gathered plants. This led us to the assumption that domesticated plants were only one facet of a broad-spectrum subsistence adapted to the uncertainties of the endemic semi arid environment of North Africa.

The sites presented here illustrate both hypotheses. In Hassi Ouenzga, a traditional forager economy is likely and the lack of harvesting tools may be justified by the absence of cultivation. The existence of a few remains of domesticated species in Ifri Oudadane seems to support the second hypothesis. El Zafrin, as an open-air site, is characterised by unfavourable preservation conditions for organic material and it is more difficult to interpret. Future interdisciplinary research will lead to clearer results concerning these topics.

Figure 1. Map of the sites: 1. Hassi Ouenzga; 2. Ifri Oudadane; 3. El Zafrin.

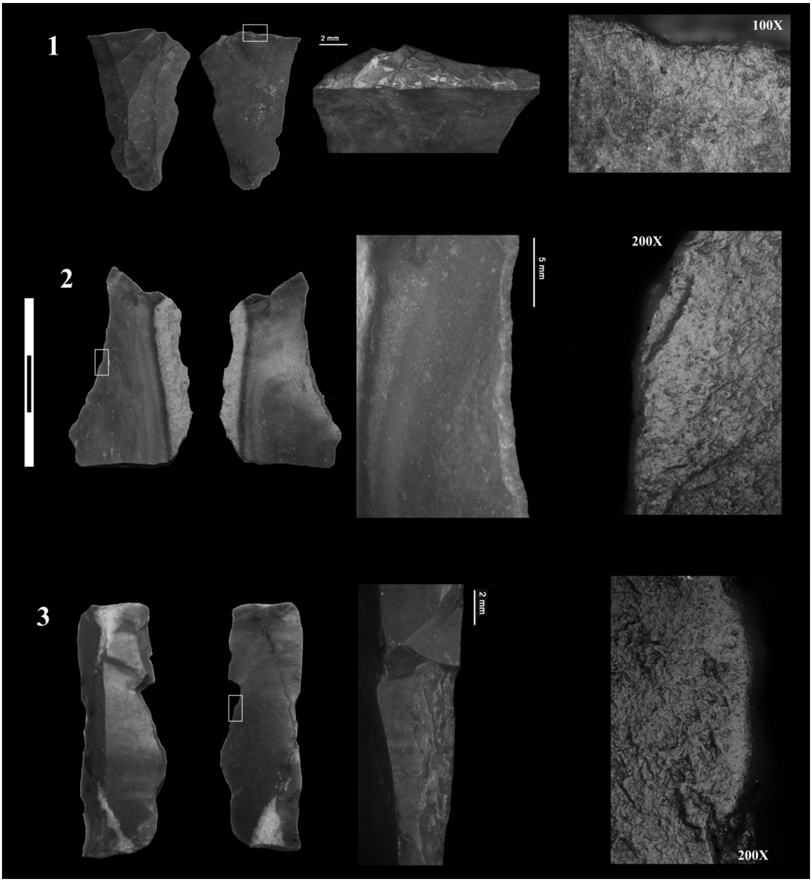

Figure 2. Used-tools from Ifri Oudadane Early Neolithic A level: 1: Scraping mineral matter; 2 Scraping wood; 3. Scraping dry leather

Acknowledgements

This research is a part of the project "Origins and spread of agriculture in the South-western Mediterranean region" The European Research Council. Archaeological fieldwork and sampling was funded by the Deutsche Forschungsgemeinschaft (DFG) in the frame of the Collaborative Research Centre 806. For supporting our fieldwork we would like to express our thanks also to Abdessalam Mikdad from INSAP (Institut National des Sciences de l'Archéologie et du Patrimoine) in

Rabat, Morocco, and to Josef Eiwanger, DAI (Deutsches Archäologisches Institut), Bonn, Germany for long-term, amicable cooperative work and for providing the sites data.

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