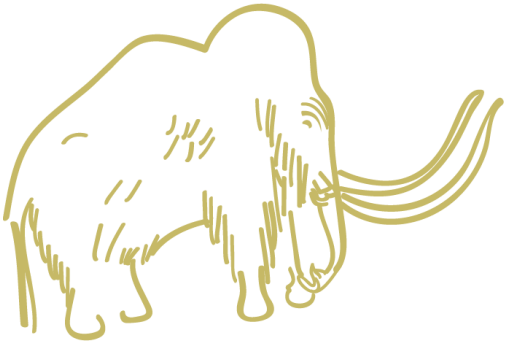

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XVIII° CONGRES UISPP PARIS JUIN 2018
18th UISPP WORLD CONGRESS, PARIS, JUNE 2018

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XII-1. New Technologies and Analytical Approaches in Traceology

Towards a polished and bevelled artefacts use-wear characterization method

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In this communication we will expose the results related to the establishment of use wear identification patterns originated in the course of stone axes and adzes production and use in the course of tree felling, woodworking activities involving carpentry and handicraft, hide processing and hoeing. Our main aim lies in provide a better understanding of which role did those objects play among the communities living in the North East of the Iberian Peninsula around the middle of the 5th and the 4th millennium cal BC, either as an object of work, tool, medium of exchange and/or symbolic item. We have designed an experimental program headed to replicate most of the activities in which this kind of artifact may have been involved according to ethnographic data, creating a reference collection that has enabled us to identify and interpret wear patterns and develop an accurate methodology applicable to the archaeological data. A series of statistical analysis were performed in order to assure the observed results, and a use-wear catalogue was completed to be shared with other researchers.

Keywords: method, polished and bevelled artefacts, use, wear

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Recent developments in quantitative microwear analysis using non-conventional 3D techniques

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The interpretation of microwear traces on archaeological finds mainly relies on comparison with experimental tools. This approach provides good qualitative results, however quantification methods are necessary because they make the process of producing functional interpretations more explicit and provide a basis for further methodological improvements. In our project, non-conventional 3D techniques are used for the quantification of microwear traces on lithic tools. High-resolution X-ray computed tomography or micro-CT is used to examine edge damages. This non-destructive method gives 3D structural information of both the surface as well as the internal structure. As the maximum resolution is influenced by the sample size (Cnudde & Boone, 2013), a resolution of maximum 5 μm can be obtained for typical sample size of minimum 2 cm. As a result, this method does not allow us to study micropolishes. However, motorized optical microscope systems are able to measure height differences on the surface of objects below micrometre level. Therefore, they are perfectly suited to analyse different micropolishes on flint tools. Preliminary 2D and 3D data show promising results for the combination of these techniques to study microwear in a quantitative way. An experimental reference collection built up for Mesolithic and Neolithic flint tools is used to work out a protocol using micro-CT and a motorized microscope system. This way, experimentally produced microwear traces are analysed and quantified resulting in a standard procedure to interpret different microwear traces known from experimental use. This protocol will subsequently be tested on archaeological finds from Final Mesolithic- Early Neolithic sites from the Scheldt valley, northern Belgium. The protocol also includes the traditional low- and high-power approach analysis of both the experimental and the archaeological pieces. Besides, it will be used in the investigation of the impact of patination and burning on the preservation of microwear traces.

Keywords: Microwear traces, quantification, 3D techniques, micro, CT, motorized optical microscope system

*Speaker

The use of shell by prehistoric foragers of the coast: A technological and functional study of shell artefacts from the Philippines

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Marine resources like shells have been exploited by prehistoric people since the early Palaeolithic and play an important role in coastal and island archaeology. Evidence for the manufacture and use of shell tools as well as ornaments made of shell dates back to over 40ka BP for Island Southeast Asia (ISEA). Specialized tools like fishhooks appear in East Timor and Okinawa as early as c. 23ka BP while edge ground shell adzes made of large bivalve shells like *Tridacna gigas* were produced were dated to the early Holocene in the Philippines and Island Melanesia. The study of assemblages from shell midden sites on Mindoro and Ilin Island in central Philippines dating from the Late Pleistocene to the mid/late Holocene revealed that *Tridacna* shell was used as raw material for flake production and also for heavy-duty tools. In addition to these, a substantial amount of intentionally fractured shells of the bivalve *Geloina coaxans* carrying secondary modifications and various edge-wear was observed. Several of these modified and used *Geloina* shells were directly AMS 14C-dated to between c. 28-32ka cal. BP making them one of the oldest flaked shell assemblages in Southeast Asia and the Pacific. In an ongoing traceological study we conduct a series of experiments that involve the use of fresh and fossilized shells for different tasks and activities, for instance cutting, scraping, splitting, and flaking. In addition, trampling experiments are done in order to compare and securely distinguish use-related breakage patterns and wear traces of utilized tools from post-depositional surface modifications. Our use-wear study is aimed at answering a very relevant question for the archaeological record of ISEA that shows a remarkable absence of formal and recurring lithic tool types. In the shell midden deposits from Mindoro, lithic tools were even completely absent with the exception of unmodified pebbles used as hammers to open larger marine shells and few small obsidian flakes. While several hypotheses have tried to explain the paucity of tool types in Southeast Asia with an assumed existence of a 'lignic' or 'bamboo industry', materials that do not appear in the artefactual record of the region, there is actual evidence for the use of shell, at least to the extent of fulfilling a complementary role in the toolkit of those early islanders. We will therefore test, to what extent shell tools can actually replace lithic tools and perform tasks that are usually observed with stone tools, and whether their functionality can add to explain the lack or need for a more sophisticated lithic technology in ISEA.

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Keywords: Island Southeast Asia, Philippines, shell artefacts, Late Pleistocene to the mid/late Holocene, Island adaptations, traceology

MEAT OR WOOD? A LSCM ANALYSIS TO DISTINGUISH USE-WEAR ON STONE TOOLS

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Traceological studies are based on the identification and analysis of the stone tools edges modifications as a result of the use. Traditionally, use-wear analysis have been performed trough Optical Light Microscopy (OLM) or even, Scanning Electronical Microscopy (SEM), basing the interpretations on subjective descriptions. Although there are general tendencies successfully followed and good results in this field, researchers have always been conscious about the need to advance towards a quantitative an objective method. In response to that concern, and thanks of the technical progress, functional analyses have improved notably. Techniques as Laser Scanning Confocal Microscopy (LSCM) are being applied successfully to functional analyses, thus improving the metrological studies.
The basic principle of Laser Scanning Confocal Microscopy (LSCM) is the shooting of parallel focal planes of the sampled surface, reconstructing out of focus areas and creating a topographical image. This topographical image is highly accurate. Unlike other techniques, LSCM provides a 3D image and a 2D profile that allow taking measures directly and immediately.

The aim of this study is to analyze an experimental lithic assemblage, made with chert, through Optical Light Microscopy (OLM) and Laser Scanning Confocal Microscopy (LSCM). The independent variables as raw material, worked material, activity and time have been controlled. The experimental collection has been created to become a comparative collection for certain Mousterian lithic assemblages. The chosen worked materials have been meat and wood, very common among Late Pleistocene hunter-gatherers. Traceological analysis has been focused on polish use-wear, trying to verify the improvements that LSCM can offer to the use-wear analysis. Our results show that the integration of different microscopy techniques notably improves the interpretation of use-wear surfaces on lithic stone tools. The analyses of use-wear performed

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through OLM provide a clear visualization of the polished morphology. However, LSCM allows for similar observations, but its main advantage rely on the possibility to take tridimensional measurements and provide statistical parameters that can, in a future, set the basis of a quantifier and objective methodology to characterize use-wear on stone tools.

Keywords: Use wear, confocal microscopy, experimental archaeology, Late Pleistocene

Szeletian (EUP) grindstones and pestles from Brinzeni I cave, level III (Moldova)

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, Terekhina Vera , Irina Pantukhina , Covalenco Sergei , Obada Theodore , Hussaini Qistina , Tung Wenyen , Ong Justin , Ong Nicole , Birarda Giovanni , Tortora Luca , Vaccari Lisa

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Research carried out by an international team in 2005-2017 combined a multi-scalar approach on experimental and archaeological GSTs integrating analyses at different scales, meso (3D Scanner), micro (optical and digital microscopy) and nano (SEM, Synchrotron FTIR and ToF-SIMS for the residue). Besides the identification of wear-traces, the research is focusing on plant residue such as starch (and spores and phytoliths) adhering to the functionally active parts of the GSTs. This paper is reporting on stone tools from the Szeletian level III of the Brinzeni I cave, on Prut river left bank (Moldova). Out of 35 water-worn cobbles, one pelitomorph limestone stone slab, composed of two fragments that refit, and one elongated narrow gres pebble, composed of two refitting pieces, were selected for the in deep testing analyses. The same lithology has been used for the experiments.
Optical microscopy revealed areas with linear traces in the shape of thin shallow lines with dark lateral edges and spotty polish on their sides. Similar use-wear traces were observed on two fragments of the broken elongated pebble. Residues analysis revealed starch grains on the functionally active areas of both tools.

These data make it possible to interpret the large flat slab as a lower grinding stone, and the elongated pebble as an upper stone used on both the ends (pestles). Observed utilization traces were confirmed by experiments carried out in two labs (IHMC, St. Petersburg and NTU, Singapore) during which rhizomes of cattail, acorn' kernels and other nut (plants selected on the base of their availability at the time of the cave-dwelling) were ground, and fine substance resembling flour was produced.

SEM analysis of the studied tools made it possible to single out zones of working surfaces with less developed use-wear and starches below 7 m. Results of digital microscopy and SEM scanned working areas had been further investigated by means of surface texture analysis using MountainsMap software.

Biogenic residues, namely starch grains of different morphology and size, were studied with

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the help of multi-scalar approach including Optical Microscopy (AXION DM, RAS Vladivostok), SEM/EDS, FTIR/ Synchrotron (ELETTRA, TS) and ToF-SIMS (INFN/UniRoma3) in order to define their structure and qualitative and quantitative composition.
Altogether the data collected on the grinding stones from Brinzeni I cave confirm the use of the stone tools for treatment of various plants, roots, and tubers by EUP (Szeletian) hunter-gatherers around 35 ka BC.

Keywords: Grinding stones, EUP, Traceology, Experiment, FTIR, SIMS 3D scan

A first attempt to quantify use-related polish on quartzite by using Laser Scanning Confocal Microscopy

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Several methods have been applied in the past to attempt to quantify use-wear on stone tools (e.g. digital image acquisition, atomic force microscopy, laser profilometry, focus variation microscopy, laser confocal microscopy). Despite this, quantification studies are still in their infancy and none of them have been systematically incorporated into the domain of traceology, due to the paucity of standardised methods (see Evans et al., 2014).
More efforts to develop this branch of study are needed, as the possibility of quantifying wear features, which are currently subjectively described, would allow to take a significant step forward in the development of the discipline. In fact, one of the most controversial aspects of traceology itself, very frequently emphasized by non-supporters of the method, is the preclusion of providing numerical quantifications of the surface modifications photographed by use-wear analysists.

While several attempts have been made to quantify wear on chert (or flint), only one case study is currently found in the literature involving quartzite and it focused on the use of scale-sensitive fractal analysis on a very limited range of contact materials (Stemp et al., 2013).

In order to fill this methodological gap, we performed a first trial to quantify polished surface on quartzite through Laser Scanning Confocal Microscopy (LSCM). The main objective was to understand if metrological analysis could be a viable option to ascribe the analysed polish to specific worked materials. If so, the interpretation of the worked material from the analysis of polished surfaces would be based on objective data and would acquire a more significant meaning.

Experiments focused on the performing of the same action (i.e., unidirectional scraping) on 5 materials (wood, bone, antler, fresh hide, dry skin, and cane) all conducted with flakes coming from the same quartzite cobble. Confocal Microscopy was used to obtain quantitative data of polished surfaces formed after the contact with the different materials. This data is mathe-

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matically described using standardised ISO aerial surface parameters, such as roughness and waviness, and are then statistically analysed to evaluate the ability for such measures to distinguish polishes. In this contribution, we present preliminary measurements of polished areas on quartzite, and we discuss the potential of the LSCM in the identification of the worked material.

A secondary, but not less important, objective was to compare the images taken with Scanning Electron Microscopes and LSCM of the same polished areas to better appreciate the visual characters of the polished areas. In fact, we noticed that both the optical and laser images of the LSCM are incredibly explicative of the micro-topography of the analysed surfaces.

Evans, A.A., Lerner, H., Macdonald, D.A., Stemp, W.J., Anderson, P.C., 2014. Standardization, calibration and innovation: a special issue on lithic microwear method. *Journal of Archaeological Science*, 48: 1-4.
Stemp, W.J., Lerner, H.J., Kristant, E.H., 2013. Quantifying microwear on experimental Mistassini quartzite scrapers: preliminary results of exploratory research using LSCM and scale-sensitive fractal analysis. *Scanning*, 35: 28-39.

Keywords: Quartzite microwear, Methodological enquiry, Surface metrology, Microscopy, Standardization, LSCM

Contributions to the interpretation of the contexts of use in archaeological sites of hunter-gatherers from image analysis (RIMAPS)

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Since the beginning of microscopic traceological studies one of the objectives pursued by traceologists was the search of quantitative variables which allowed the identification of use-wear patterns. Recently this issue has been revisited using methodologies developed in the field of Materials Science and the results are quite promising. These methodologies are based on the measurement of topographic or textural characteristics of lithic surfaces in order to identify use-wear patterns and to describe structural transformations produced as a consequence of specific prehistoric activities. Within this framework, the RIMAPS technique (Rotated Image with Maximum Average Power Spectrum) allows to characterize mathematically the typical topographic patterns of any surface by using digital images, independently of the optical medium used to capture these images.
Following this perspective, this work is aimed to offer the results obtained by the application of image analysis by RIMAPS on experimental lithic artifacts used for working hide, wood and bone as well as to assess the robustness of RIMAPS as analytical method for studying use-wear traces and the use context of lithic tools produced by hunter-gatherers.

*Speaker

The specific objectives are: 1) To provide a mathematic and topographic identification of use-wear patterns on experimental lithic artifacts manufactured using different raw materials; 2) To analyze the influence of different mineralogical-textural properties of rocks on the use-wear patterns formations through the use of mathematical models and 3) To compare the obtained results on quartzites and ftanites with those obtained on rhyolites.
Finally, we will intend to define quantitatively and topographically use-wear traces, detect and visualize use-wear patterns in those raw materials, which are more difficult to observe using traditional optical media, and to identify use wear trends which cannot be easily identified by simple observation.

Keywords: Experimental lithic artifacts, RIMAPS technique, Topographic patterns, Use wear patterns

Analysis of residues on stone tools by MALDI-TOF-MS: first results, challenges and prospects

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Mass spectrometry, usually in combination with gas or liquid chromatography, has been used to aid in the identification of food and beverage residues extracted from ceramic artifacts for several decades. It has also been applied to the identification of hafting adhesives on stone tools. However, it has not been developed for the systematic analysis of micro-residues on stone tools. Yet, developing a method of residue analysis applicable to large sample sizes is essential for the field to move beyond anecdotal evidence for stone tool functions, to the point where it can provide data for rigorous testing of hypotheses regarding human tool use behavior. In this paper we explore the application of matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF-MS) as a technique which, due to its high sensitivity coupled with relative ease of sample preparation, has the potential to be developed into a method which could be applied on a large scale. We develop a method requiring minimal sample preparation, and show that MALDI-TOF-MS can detect the presence of large (up to 60 kDa), intact molecules on experimental stone tools coated with blood and muscle proteins. However, even light washing of the tools dramatically reduces the signal detected by the mass spectrometer. The implications of this result are two-fold: first, it means that artifacts that have been washed are unlikely to contain identifiable residues. Second, as amount of residue diminishes, contaminants and signal noise become more prominent, complicating interpretation of the mass spectra. These results provide a baseline for future development of the method.

Keywords: residue analysis, mass spectrometry, lithics, Paleolithic

*Speaker

Investigating "black stains" on Paleolithic artefacts: looking for hafting adhesives with OLM, SEM-EDX, Raman and FTIR

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Although the debate regarding whether the organic material on ancient lithic artefacts may survive and be microscopically identified is still on-going, the study of residues is in fact already one of the key components of functional analysis. Indeed, the study of different kind of organic residues (e.g. bone, wood, plants, blood cells, starch granules etc.) on the archaeological lithic artefacts is currently being carried out by many authors.
Here we focus on a particular type of residue, which appears in the form of black stains on some lithic artefacts from different archaeological sites. These have been most commonly interpreted by researchers as being residues of adhesives (bitumen, tar or bark birch pitch, pine or other plants resin) used for hafting purposes.

To get insights into the nature of these black stains, we offer here our first systematic results obtained through a multi-technique approach. This starts with the application of optical and scanning electron microscopy to determine morphological features. A preliminary chemical characterisation is obtained then by means of energy dispersive spectrometry (EDX). Finally, molecular composition and structure of the sample is provided by means of vibrational spectroscopies such as FTIR and Raman.

This combination of non-invasive and non-destructive techniques has been used to analyse a reference collection including different substances which, alone or mixed with other products, can be used as hafting adhesives: tars and pitches, bitumen, beeswax, conifer resins, *Pistacia* resin, etc. Such a combination provides a detailed morphological and chemical characterisation of these substances, which is strong enough to identify preserved archaeological residues.

As archaeological case studies, we present here some examples of different Palaeolithic sites showing such black stains apparently related to tool hafting: Azokh Cave, in Nagorno Karabakh,

*Speaker

Gilvaran and Kaldar, in Iran, and Cova Eirós, in Spain.
Although the reference collection is still in construction, the combination of techniques demonstrated the feasibility of differentiating and identifying some of the analysed residues as adhesive bituminous substances. On the other hand, the methodology used enabled to rule out some of the stains as hafting residues.

Keywords: organic residues, adhesives, Palaeolithic tool hafting, multi, technique analysis

Experimental use-wear analysis on the Early Upper Paleolithic edge-ground stone axes in the Japanese Archipelago

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In the Japanese islands, the earliest edge-ground stone axes and/or adzes appeared at the beginning of the Early Upper Paleolithic (EUP: ca. 38,000-30,000 calyrBP) in the late Marine Isotope Stage 3 (MIS3), probably corresponding with the arrival of *Homo sapiens*. This tiny archipelago has yielded about 400 edge-ground axes (Hashimoto 2005), implying that axes played a pivotal role in adapting to the temperate island environments of late MIS3 (Izuho and Kaifu 2015). Thus, functional studies for the earliest stone axes will contribute to illuminating the adaptive technologies of first modern human immigrants to the Japanese Archipelago. In this study, we replicated edge-ground axes and used for wood-chopping experiments and the use-wears were observed.
Seven axes were manufactured in hornfels, slate, and nephrite and replicated with the edge-ground axes from the EUP sites in the central Honshu, Japan. The replicas were mounted on wooden juxtaposed hafts, fixed with plant bindings, and used for felling coniferous trees. The use-wear analysis is undertaken by the high-power and low-power approaches.

As a result, the grinding trace, micro-flaking, striation, abrasion, and use-wear polish are observed on the ground edges of replicas. Traces are mainly distributed on the dorsal faces of axes, which intensively contacted with worked materials. The use-wear polish, representing very bright and smooth appearance, can be distinguished from the polishes formed from grinding which were dull and rough in texture. Furthermore, the microtopography of use-wear polishes shows a flat appearance in intensive contact areas and undulates in lesser contact areas.
Previous studies on ground stone axes and adzes used for woodworking experimentations also suggest that the use-wear polish has a very bright and smooth appearance, but its microtopograhy is usually flat (e.g. Gaetner 1994; Saino 1998; Ishikawa and Saino 2000; Takase 2005, 2007; Masclans Latorre et al. 2017). These features are slightly different from the typical "wood polish" (Keeley 1980) on handheld tools. The heavy activities including wood chopping seem to produce use-wear polishes that are similar to the "wood polish" but lack the roundness on its topography. These results can make great contributions to the use-wear analysis on the archaeological edge-ground stone axes.

*Speaker

Keywords: Japanese Archipelago, Early Upper Paleolithic: Edge, ground axe, Woodworking, Experimental use, wear analysis

Quantifying lithic surface alterations by means of confocal microscopy: the case of the châtelperronian level of La Roche à Pierrot (Saint-Césaire, France).

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Lithic artefacts are one of the main material witnesses allowing us to study prehistoric populations' way of life. However, post-depositional processes have an impact on the artefacts to the point of modifying their surfaces, which can be visible on a macroscopic level. These surface alterations or post-depositional surface modifications are qualitatively described by archaeologists as "glossy patina", "edge damage", "rounding", etc. The aim of this presentation is to introduce a new methodology in the study of surface alterations going beyond the subjective studies undertaken until now thanks to microtopographic measurements using confocal microscopy. These surface alterations are widely visible at La Roche à Pierrot. This site is currently subjected to an archaeostratigraphic review as it setting off numerous issues regarding transition modalities between Middle and Upper Palaeolithic. Indeed, lithic industries of this transitional period, and particularly the ones attributed to the Châtelperronian are recognized for their complex surface alterations, which raises the question of their chronocultural integrity. A geological sample composed of local flint was set up in order to compare the impact of post-depositional processes in the immediate environment of the site as well as inside the excavation area. This innovative protocol allowed a quantified distinction of various states of alterations among geological and archaeological samples, especially regarding white patina and glossy patina. This research showed that the variability of surface alterations among the artefacts of a same spit, localized near the Neanderthal remains, is as important as the variability of surface alterations in the immediate environment of the site. Thus, use-wear analysis will benefit from a better understanding of surface alteration and their impact on stone tools, which usually hinders the reading of the worked materials. In addition, these results lead to become more careful concerning the association between the Neanderthal remains and the lithic artefacts at La Roche à Pierrot. Broadly speaking, this pilot study confirm the potential and the promising development of confocal microscopy in both taphonomical and use-wear studies of lithic industries.

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Keywords: lithic analysis, confocal microscopy, surface alterations, Châtelperronian, taphonomy

TALKING STONES: TAPHONOMY OF THE LITHIC ASSEMBLAGE OF PIRRO NORD 13 (APRICENA, FG, ITALY). A NEW APPROACH TO THE STUDY OF THE POST DEPOSITIONAL ALTERATIONS ON LITHICS TOOLS.

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The post depositional alterations (PdAs) are the result of different processes that affected the lithic industry between the end of their cultural life and the modern discovery. During this period, on the surfaces of the lithic artefacts all these processes were recorded. Some scholars noted that the different post-depositional alterations (PdAs) are identifiable using the same microscopes employed for the use-wear analysis and usually they are considered as a problematic for the correct interpretation of the use-wear traces. Other scholars suggest using the post-depositional alterations to understand the environmental processes that determined the site formation processes. In many cases, on the surfaces of a single lithic artefact is recorded more than one of these processes. In some cases, the processes recorded through the PdAs persisted for a limited span of time and were then replaced by other processes that were recorded through other PdAs. So, it is possible to determine the sequence of the different processes studying the overlapping of the different PdAs, using the same conceptual methodology developed for the study of rock art. As such, the PdAs sequences identified on the lithic industry can be used as an alternative line of evidence to assess the integrity of archaeological contexts and the sites formation process. In the case of PN 13 the data about the post-depositional alteration sequences collected during the use-wear analysis could identify the "taphonomic history" of the lithic assemblage to understand if all the assemblage was exposed at the same environmental processes or if there are some difference among the various lithic elements.

Keywords: post depositional alterations, use, wear analysis, site formation process

*Speaker

The impact of white patina in obscuring usewear traces: An experimental approach

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Lithic artifact usewear traces are a main source of information for reconstructing the behavior and diets of ancient hominins. While the mechanical uses of the stone tool traces have been relatively well-explored experimentally, limited work has been done to understand the acknowledged chemical modifications that lithic artifacts frequently undergo. One type of chemical modification commonly observed on lithic artifacts is patination - a process by which the outer rind is petro-chemically altered by chemical and mechanical weathering. Among these, a common type is known as white (porcelain) patina where the artifact's surface exhibits a granular, chalky white coating.
Here we present preliminary results of an experimental regime that allows us to understand the underlying factors which influence artifact patination and how they might affect lithic usewear. Understanding the underlying processes which form these patinas is useful as it will also allow us to have a better understanding of the natural processes which lithic artifacts have undergone in geological time and allow us to better deconstruct the behavioral processes underlying archaeological artifacts and sites.

Keywords: Patina, usewear, lithic

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Studying wear marks with multiscale surface metrology

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The interpretation of microwear found on stone tools is mainly based on qualitative description of surface alterations, the unavoidable subjectivity of this method is problematic. Quantitative methods to characterize surface alteration on stone tools, can avoid some of the subjectivity Recently metrology and tribology have been the focus of few studies and yielded promising results. This work provides a critical review of new theoretical principles for a quantitative study of wear marks, discovering strong correlations and confident discriminations with topographies, which could identify tool uses (e.g. Stemp et al. 2009 & 2017) and even rank characteristics of tool users.
Four commonalities of experimental works that successfully discriminated and correlated topographic measurements are reviewed (Brown et al. 2018): characterization of appropriate geometric properties, at the appropriate scales, using appropriate statistical analyses, and measuring with sufficient resolution.

According to Archard (1953), scratch depth and shape are functions of abrasive particle shape and spacing, force and hardness. Therefore, force variation and associated scratch depths, relate to users. Shape and spacing factors of scratches depend on abrasive particles native to the workpiece, and could include wear debris from the tool. The later might be distinguished by larger and more angular scratches. Scraping and chopping motions should cause scratches perpendicular to the cutting edge. Slicing or sawing should leave scratches parallel to the edge.

Traditional height parameters lack spatial information and are unable to distinguish the shape,

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spacing or direction of the scratches. Relative lengths change with scale, are sensitive to inclinations on the surface, and can therefore be appropriate for the geometric and scale criteria (Brown et al. 2018). The statistical treatment should test discrimination, e.g., F-test, and compare discrimination parameters, e.g., mean square ratios, at many different scales. This multiscale discrimination should cover the scale range available in the measurement, from the sampling interval (pixel size) to the dimensions of the field of view, in the attempt to find the scales where the confidence in discrimination is the strongest.

Archard, 1953. Contact and Rubbing of Flat Surface. J. Appl. Phis. 24 (8): 981–988.

Brown et al., 2018. Multiscale analyses and characterizations of surface topographies, in review, to be published in 2018.

Stemp et al., 2009. Quantification and discrimination of lithic use-wear: surface profile measurements and length-scale fractal analysis, Archaeom, 51: 366-82.
Stemp et al., 2017. Testing Area-Scale Fractal Complexity (Asfc) and Laser Scanning Confocal Microscopy (LSCM) to Document and Discriminate Microwear on Experimental Quartzite Scrapers. Archaeom. In press.

Keywords: Microwear, usewear, metrology, multiscale, topography, quantification

Au-delà de l'œil : quelle méthode pour aider à mieux caractériser les micropolis ?

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La caractérisation des micropolis d'utilisation à l'aide d'instruments autres qu'un microscope est une démarche déjà ancienne en tracéologie. Pourtant, cette approche est restée marginale alors que dans le même temps on assistait au développement spectaculaire de nouvelles méthodes d'analyse – notamment chimique et basées en particuliers sur les microspectroscopies Raman et infrarouge à transformée de Fourier (FTIR) – mais dont l'intérêt s'est porté essentiellement sur les résidus de matière travaillée plutôt que sur les usures elles-mêmes.
On a peu de doute sur le fait que le coût des instruments utilisés ainsi que les connaissances requises pour l'interprétation des résultats obtenus via ces méthodes ont été des freins majeurs à leur adoption. C'est pourquoi un projet est en cours qui vise à mettre au point une instrumentation ainsi qu'un protocole d'étude qui permettraient de simplifier les procédures d'acquisition et d'interprétation de données spectroscopiques relatives aux micropolis. On cherche notamment à ce que cette acquisition puisse se faire dans la partie visible du spectre électromagnétique (400-800 nm) et qu'elle puisse être pratiquée en routine dans les laboratoires.
Si elle venait à aboutir, cette démarche permettrait aux tracéologues d'augmenter leur capacité à interpréter les micropolis d'utilisation, tout du moins ceux qui restent difficilement déterminables à l'aide du seul microscope.

Keywords: Tracéologie, spectroscopie, caractérisation chimique, micropolis

*Speaker

Traces, fractures and iridescences. The identification of diagnostic projectile impact features on rock crystal

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The detailed analysis of rock crystal assemblages has experienced a strong impulse lately. Nevertheless, the increasing research focused on this material does not allow yet to clearly discern some of the main issues involved in its analysis. The characteristics of the crystal, specially the transparency, but also the generally small size of the crystals, anisotropic fracture, fragility, etc. make it a not very reliable material when performing conventional technological and functional analyses.
On a macroscopic scale, the combination of a wide variety of fracture directions and the great plastic deformation that the crystal bears, can generate several technical features that can be problematic for the interpretation of the piece, such as pseudo-retouches or flake finials with a similar look than projectile fractures.

On a microscopic scale, there is also a great number of features that need to be considered. Together with the diagnostic impact traces, there can appear lancets and other technical traces, as well as iridescences result of the crushing of the crystal. Residues are also an important factor to consider, derived from hafting as much as from the cleaning processes. Different stains, many times in the form of lines and with clear orientations, can easily be confused with use or impact striations.

In this work, we intend to address a comprehensive approach, both macroscopic and microscopic, to an assemblage of experimental rock crystal projectiles to discern the truly diagnostic features of the use of small rock crystal pieces as projectile points. Aiming to avoid misidentifications, we did not only follow a sequential experiment design, but also carried out a comparative analysis between impact fractures and knapping fractures, marks from bipolar knapping on an anvil and retouching fractures. Besides, in the elaboration of the experimental projectile assemblage we used two different targets (flesh with and without skin) to document possible differences in the quantity and disposition of the wear impact traces.

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As a result of this extensive and comprehensive experimental approach, we could discern the diagnostic impact features on rock crystal, and state that, although the microscopic traces possess a higher diagnostic value that the macroscopic ones, the combination of both approaches provides a more reliable identification of projectile elements.

Keywords: rock crystal, fractures, projectiles, microscopy, experimental archaeology, sequential experiment

Use-wear and residue mapping in Traceology. A multi-scalar approach combining Digital 3D, Optical Light and Scanning Electron Microscopy.

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Use-wear and residue analysis are two analytical disciplines which can provide clues about past tool function. Optical light (OLM) and Scanning electron microscopy (SEM) are between the most common techniques to characterize use-wear and residue patterns in stone tool surfaces. While the little depth of field of optical microscopes can be solved with SEM, the observation of use-wear and residue patterns at specific points can sometimes make it difficult to draw an overall picture of the functional context of the active edge. Recently, the introduction of focus variation systems equipped with stitching technology have made progress in this direction, allowing the creation of high-resolution active edge maps. In this work, we show two examples of the application of stitching technology using Digital 3D microscopy to characterize use-wear and residue patterns in experimental flint tools combined with OLM and SEM. Our results show that having a map of the active-edge of a tool allows to put in context the micrographs taken at higher magnifications and to a large extent, to improve the wear and residue characterization.

Keywords: Usewear analysis, Residue analysis, multiscalar approach, Digital 3D microscopy, Optical Light microscopy, Scanning electron microscopy

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Use-wear formation processes on pounding tools: quantifying surface changes using confocal microscopy, 3D techniques and GIS

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Since the publication of the groundbreaking work produced by Sergei A. Semenov (1964), functional studies of Paleolithic artefacts based on use-wear traces have developed rapidly and have become the main method for inferring the production and use of stone tools. These types of analyses were applied to flaked artefacts, grinding tools from late prehistoric periods, and more recently, to pounding tools from Early Stone Age sites. Despite this focus on use-wear, the criteria used for describing these traces were limited to mostly qualitative attributes observed with microscopes.

In this paper, we will present the results of an experimental programme designed to establish new qualitative and quantitative criteria for the recognition of bone processing activities related to marrow extraction on pounding tools from Olduvai Gorge (Tanzania). Our method to study use-wear formation processes on pounding tools (hammerstones and an anvil) is novel and based on a combination of conventional microscopy, optical 3D surface measurements obtained with a confocal microscope, and GIS analysis. This technique has allowed us to obtained high resolution quantitative data and conduct statistically robust analyses of microscopic use-wear traces highlighting the potential of implementing 3D techniques in functional studies of artefacts. Our results are broadly applicable and provide a methodological procedure that can be used for more accurate assessments of the function of archaeological pounding tools.

Reference

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Keywords: experimental archaeology, 3D surface analysis, confocal microscopy, use wear

Searching the distribution pattern. A use-wear approach from the gigapixels to improve the accuracy of the wear distribution and kinematics

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Traceology is one of the archaeological disciplines that allow a better approximation to the behaviour of human groups of the past. To do this, the microscopic analysis of the artefacts is used to document the various deformations suffered due to use. Prior to the analysis, several variables must be considered, such as the raw material, the type of tool or the context of the material to use the most appropriate optical mean.
Regardless of the raw material analysed and the traces observed, this kind of studies use the orientation and distribution of the traces to build their interpretations. The analysis of the penetration into the inner of the edges, the association of traces, their density or the degree of alteration are variables that improve functional interpretation.

Despite the importance of distribution patterns, these are analysed from the observation and / or documentation of isolated points of the edges, which can sometimes nuance and even hide crucial information to interpret the use. To make a better approximation to the distribution of traces, and avoid a bias in the information, in this work the use of gigapixel images is proposed to document the patterns of use-wear distribution.

The elaboration of these images - very time-consuming - from the experimental material allows them to be used as an instant reference for the distribution of the traces along the edges. In the same way, the fact that this documentation is made from the assembly of individual images at high magnifications allows the resulting image to be of high resolutive value. On the other hand, if scales with longitudinal and transversal information are included, these images allow to quantify the areas in which the traces of use are developed.
Thus, the construction of a reference catalogue of gigapixel images is presented as a relatively simple way to address the problem of the distribution and development of the traces of use along the edges, but also to improve the understanding of the kinematics of the tools.

Keywords: usewear, experimental archaeology, distribution patterns, gigapixel

*Speaker

Tracking the strings. High-power approach to the suspension systems of Homalopoma sanguineum shell beads

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Over the past few years, there has been a proliferation of works focused on the high magnifications traceological analysis on shell tools. In contrast, wear patterns identified in other types of shell objects, such as ornaments, are usually analysed at low magnifications.
Facing the study of technological and use marks of the ornaments elaborated on *Homalopoma sanguineum* has been considered as especially problematic. In the first place, it has been thought that it is not possible to use polishing distribution to identify the suspension system due to the physical characteristics of this species. Secondly, the high reflective capacity of its internal mother of pearl layer causes many difficulties during the study of perforations by optical microscopy.

Although the observation at low magnifications is enough to perform a preliminary characterization of this kind of marks, we believe it is necessary to perform high magnification observations to carry out an analysis with higher resolution and reliability.

In this paper, we propose a new methodological approach for a more effective and decisive identification of the polish distribution on shell ornaments. As a case study, ornaments in *H. sanguineum* from two sites dated to the Upper Palaeolithic of NE Iberia have been analysed: 50 ornaments from the Early Gravettian layer of Foradada Cave (Calafell, Spain), and 46 Upper Magdalenian shell beads from Parco Cave (Alòs de Balaguer, Spain). To carry out the analysis of the technical and wear traces, two microscopy equipment have been used in a complementary way. First, an Hirox KH-8700 digital microscope with a MXG-2500 REZ lens system; and secondly, an environmental scanning electron microscope (ESEM) FEI Quanta 600 was used at low vacuum.

Through this study we have been able to identify polishing, striation and micro-chipping patterns, whose associations have allowed the creation of a series of analytical criteria applicable to a wide range of ornamental assemblages.

*Speaker

Keywords: malacofauna, suspension systems, polish, ornaments, shell bead

La moisson des céréales à Dja'de (PPNB ancien, 9ème millénaire) : nouveaux résultats à travers l'analyse de la texture des micropolis de moisson de céréales.

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La domestication des céréales est un processus complexe dont la compréhension constitue encore un des enjeux fondamentaux de la recherche au Proche-Orient.
L'augmentation du nombre de lames faucilles durant la néolithisation a été interprétée comme un indice indirect des premières mises en culture des céréales. Les analyses fonctionnelles de ces lames ont montré une évolution dans l'intensité et l'apparence des traces qui a été mise en relation avec la culture des céréales et leur domestication progressive (les micropolis sont de plus en plus plats, ternes et striés). Cette évolution serait assujettie au taux d'humidité des tiges lors de la récolte, les études expérimentales ayant montré que les céréales n'étaient pas moissonnées au même stade de maturité selon qu'elles sont sauvages ou domestiques et que les micropolis de moisson de céréales domestiques sont généralement plus plats, ternes et abrasés que les micropolis de moisson de céréales sauvages. Ces variations visuelles sont toutefois si subtiles qu'elles ne suffisent pas à discriminer les traces de moisson de céréales sauvages de celles des céréales domestiques alors même que cette identification pourrait permettre une meilleure compréhension du processus de domestication.

Afin d'exploiter autrement ces observations, une équipe de tracéologues a développé une méthode d'analyse quantitative de la texture des micropolis dont l'objectif principal est de définir des critères quantitatifs permettant de distinguer les traces de moisson de céréales sauvages, sauvages cultivées et domestiques. La microscopie confocale, qui présente l'avantage d'obtenir des données tridimensionnelles, permet de caractériser quantitativement les états de surfaces des micropolis pour déterminer l'état d'humidité des tiges au moment où elles ont été récoltées et ainsi apporter des informations supplémentaires sur le processus de domestication au Proche-Orient.
Afin de préciser nos connaissances sur la phase transitoire correspondant à " l'agriculture prédomestique ", nous avons appliqué cette méthode d'analyse à un échantillon de lames-faucilles provenant des niveaux PPNB ancien (9ème millénaire) du site de Dja'de, période durant laquelle les habitants du village cultivaient des céréales de morphologie sauvage. Les résultats montrent que les céréales sauvages sont moissonnées à Dja'de dans un état de maturité plus avancé que

*Speaker

durant les périodes précédentes et durant le PPNB ancien de Mureybet et semblent ainsi montrer une évolution progressive des traits morphologiques des céréales sauvages cultivées durant la domestication.

Keywords: néolithisation, Syrie, Dja'de el, Mughara, faucilles, moisson, texture des micropolis, analyse quantitative, microscopie confocale, domestication

XII-2. Searching Traces, Finding People: The Role of Traceology for Reconstructing Human Behaviour

A Micro-wear Analysis of Natufian Gazelle Phalanx Beads from el-Wad Terrace, Mount Carmel, Israel

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The Natufian Culture of the Levant (ca. 15,000- 11,7000 years BP) is renowned for its rich bone industry. In this study, phalanx bone beads from the current excavations at the Natufian site of el-Wad Terrace (EWT) were studied through the application of a use-wear analysis methodology, integrated in an experimental program, to reconstruct their production sequence, mode of suspension, and use. The experimental program included controlled experiments of abrasion, polishing, and drilling, replication experiments, and suspension experiments producing an extensive database of wear. Based on the experimental program, the traces found on the archaeological beads were emulated. The basic method through which the sequence of production and use was inferred is on how the traces overlapped and crosscut each other. The results led to the reconstruction of a four-step procedure, in which the Natufian gazelle phalanges were transformed into beads, including scraping, cutting, drilling, and abrading. The beads were scraped and cut with flint tools and drilled using the pump drilling technique, followed by abrasion against limestone with water. Suspension and use-wear indicate that the beads were suspended using organic fibers that wore down the beads' holes, while the use created polish through the contact against skin or leather clothing. Use-wear analysis provides in-depth results on the production process of the EWT beads that allow the distinction of bead production from other Natufian sites to be observed, while the usage mode is similar. It is suggested that the Natufians utilized gazelle phalanx beads in daily clothing and, also, included them in burials to signal their age or social position within and between groups, as they transitioned into an agricultural lifestyle in the Levant.

Keywords: Natufian of the Levant, phalanx bone beads, manufacture, utilization

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Are the notches intentional or not? An exploration of artefacts from Tabon Cave with the help of use-wear analysis.

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Prehistoric stone tools in Southeast Asia are characterised, broadly speaking, by simple production techniques and the paucity of tool types. Among the assemblages, there are some exceptions, such as denticulates, which appear occasionally in the case of Philippine sites. These can thus be seen as unusual testimonies of the willingness of tool makers to control the shape and the properties of lithic implements. Nevertheless, plant processing experiments that we conducted showed that splitting plants such as bamboo, rattan, or palms creates large micro-scars on the edge of unretouched tool edges, making them look like intentionally retouched tools, especially denticulates. Here we will present the analysis of a selection of lithic artefacts with notches from Tabon Cave, Philippines. Use-wear is here a useful approach to intent to determine if these implements correspond to stone tool types, i.e. were intentionally retouched by the tool makers, or if they are in fact involuntary by-products of plant processing activities. This research is also an exploration of the antiquity of the concept of lever, as the plant processing technique mentioned above which is based on ethnoarchaeological observations implies the mastery of such a concept.

Keywords: use, wear, retouch, intentionality, plants, lever, Southeast Asia

*Speaker

Beaver mandible tools from Mesolithic wetland sites in Eastern Europe and Urals.

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Judging by ethnographic and scarce archaeological evidence, artifacts made from teeth and jaws of various animals played an important role in tool kits of hunter-gatherers of the forest zone. A series of about 500 halves of beaver mandibles was selected from Mesolithic wetland sites excavated in Eastern Europe and Trans-Urals. Technological and use-wear analyses were carried out. 100 mandibles of modern beavers which were not used as tools were studied for comparison in the Zoological Museum in Moscow.
Most studied Mesolithic beaver mandibles were used as tools. The end or side of the incisor was a working edge, while the body of a mandible served as a handle of the tool. The coronoid prong was broken off from all these mandibles. The joint prong was also broken off from about half of the studied tools. Many mandibles have a hole, pierced by a sharp hammerstone below the joint prong, or at the lower angle of the mandible. Use-wear, observed on mandible bodies includes smoothing and bright polishing of elevations usually with various striations running in different directions often crossing each other. Such traces were left by a hand which held the mandible as a handle of a tool. Use-wear traces observed at ends of preserved incisors resemble natural beaver wear, but are much more pronounced. Some incisors were sharpened with a fine grained abrasive slab. Used incisors are sunken in the mandible about 1-2 cm compared with unused modern beaver mandibles.

Sides of many mandibles were removed, and longitudinal grooves were cut with a flint burin through one side of incisors. The enamel side of such cut was longitudinally sharpened by whittling with a flint blade or a side of a burin producing a working edge about 20-30○ in cross section. Such tools were used for whittling wood especially making hollows. Use-wear includes rounding of the working edge, bright polishing at elevations of enamel surface and clearly cut striations running from the edge at an angle about 90±20○ to it across the enamel. When the working edge became dull it was sharpened, and the edge angle increased. When it reached about 45-60○ the tool was not suitable for whittling and was abandoned or used as side scraper for working wood, bone and/or antler. Finally the edge angle became about 90○, and the enamel was only about 1 mm wide. Most tools were broken at this stage. Besides these many beaver mandible tools display typical traces of pressure flakers at ends and sides of incisors indicating their secondary use. Best preserved tools show the following sequence of their use: 1 – chisel, 2 – whittling knife, 3 – scraper, 4 – pressure flaker.
Beaver mandible tools are a good example of human adaptive strategies when bone tools were repeatedly used for various purposes with minor modification of a natural shape of bone taking

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full advantage of its properties. Careful study of beaver mandibles can reveal such tools at sites where they were not recognized nowadays.

Keywords: Beaver, mandible, tools, Mesolithic, wetland sites, Eastern Europe, Urals

Beyond the functionality of prehistoric flints: case studies from Bulgaria

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This paper focuses on two spheres of prehistoric life, the revival of which has become possible through the micro wear study of flint assemblages. Such a study comprises meticulous use-wear analysis, functional verification via experimental replication, and an attempt at involvement of social proxy in the prehistoric lifestyle.

The first sphere is agriculture, the fully developed features of which date back to the very beginning of the Early Neolithic. An updated synopsis of the variety and use of sickles is offered in a diachronic perspective from the early Neolithic to the Bronze Age. Innovation in the agricultural toolkit is attested in the Chalcolithic when *tribulum* starts to be used for cereal threshing. Thus, the evidence and interpretation of prehistoric agricultural equipment from Bulgaria is inherently involved in the context of subsistence and activities related to field labour organization, food supply and festivity in prehistory.

The second line of evidence relates to a particular sphere of jewellery and prestigious items manufacture that is concerned with human personhood and refers to more spiritual aspects of life. Remarkable evidence of sophisticated objects and technological achievement in personal adornments is provided. To understand the narratives embodied within them, an attempt is made to reconstruct the range of abilities and skills developed by the people who produced them.

Keywords: Prehistory, agriculture, subsistence, personhood, spirituality

*Speaker

Bone tools from the antique sits of the Northern Black sea area (technology and function)

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Bone and antler artifacts continue to play important role during the antique time, but because of a long-held assumption about their archaism they are rarely studied in detail. Special experimental and traceological research of numerous artifacts from ancient Greek cities of Northern Black sea area such as Myrmekiy and Nymphaeus show that at that time new methods of treatment of raw material and new tools emerge in bone working handicraft, the sphere of their use is substantially expanded. Among tools made from long bones, ribs, mandibles, scapulae and animal teeth besides such tool as arrowheads, mattocks, awls, kocheds, spatulas, bits, battle axes etc. which were well known earlier, new tools appear. They include abrasive slabs for treatment stone, rasps, punches for ornamenting leather items, tools for softening and stretching belts, handles for metal tools etc. Etalons of use-wear traces for these tools were produced in process of experiments, technological traces of manufacture of the studied tools with the help of various instruments used for treatment of bone were documented, and methods of their production and use were clarified. Results obtained during the whole research complex during many years will be a reliable source for finding out the functional purpose of tools and modes of their use, and also for reconstruction of direct productive operations. Studies of the role which bone raw material played during antique time in correlation with analysis of archaeological context, data of allied sciences (ethnographic observations, paleozoology, paleobotany, paleography etc.) is one of new sources for characteristic of productive complexes of the antique epoch.

Keywords: Antiquity, Northern Black sea area, bone and antler artifacts, experimental and traceological research, technology, function

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Cereal adaptations and agricultural trajectories revealed through the analysis of Natufian (15,000–11,700 cal BP) sickle blades

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Use-wear analysis of sickle blades can reveal valuable information on ancient agricultural activities. Their study becomes crucial where botanical remains are scarce, as in the case of the Natufian culture of the Levant. A large-scale analysis of sickle blades from two Natufian sites was conducted, including el-Wad Terrace (Mount Carmel, northern Israel) encompassing both the early (ca. 15,000-13,500 cal BP) and late (ca. 13,500-11,700 cal BP) phases of this culture, and Salibiya I (southern Jordan Valley, southern Israel) dated to the late phase. The analysis shows clear evidence of the abundance of non-shattering domestic morphotypes, inferred from the high rates of dry cereal harvesting use-wear. A difference in the frequency of dry cereal harvesting tools between the northern and the southern sites is interpreted as an indication of the varying aspects involved in the process of cereal domestication and development of agricultural societies. These include the prevalence of different harvesting strategies employed to obtain high yields and crop stability, the effect of ecological constrains that are more favorable in the Jordan Valley, as well as the change in the shape of harvesting tools, from Helwan-backed blades to abruptly-backed blades, in the late phase – all which are related to the rate of domestication. The present study shows the complexity involved in reconstructing the process of cereal domestication, supporting the approach considering domestication as a long process, but not a linear one, with peak events of advanced domestication at one area and less advanced at another, even within the restricted area of present-day Israel.

Keywords: Sickle blades, Natufian culture of the Levant, cereal domestication, harvesting strategies, ecology

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Early Cycladic marble figurines and vessels (3rd Millennium BC) – A technological approach*

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From the late Neolithic (5th Millennium BC) and through the Early Bronze Age (3rd Millennium BC), the inhabitants of the Cyclades islands have largely used marble for the manufacture of figurines and vessels. Several common features characterise these productions: they are worked in the same workshops, occasionally painted and mainly discovered in tombs. The "standardisation" of different shapes successively elaborated, led to the establishment of morphologic and stylistic classifications. Some other studies attempted to identify techniques employed but were restricted to macroscopic observations and to experimental reconstructions. Tools and processes identified were then generalised to the entire groups of marble objects through the Early Bronze Age. However, important variations can be observed (level of skill, complexity of the shapes, size of the pieces, etc.), suggesting an evolution of several levels of expertise and equipment during the Bronze Age. It was then highly desirable to further investigate manufacturing processes through a new complementary approach. The latter comprises the study of archaeological data (tools potentially employed, manufacturing traces on the object's surface) and experimental reproductions of ancient techniques. In parallel, tribological analyses (using confocal rugosimeter and interferometer) were executed to characterise technical marks recorded on both the archaeological and experimental objects. The study was focused on the best-preserved traces, related to 4 operations: sawing, incising, polishing and, for the vessels, hollowing out.

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This preliminary study allowed us to reconstruct manufacturing sequences and a large part of processes and tools used by the Cycladic craftsmen. Marble industry appears more complex than traditionally considered, revealing the cohabitation of different types of production and levels of specialisation. Although the shape of figurines is quite standardised, variation in the manufacturing sequences has been observed, whether related to an evolution through the time or linked to different workshops. Contemporaneous marble and chlorite vessels were made using distinctive techniques of manufacture (especially hollowing out processes), suggesting that they could be the products of different workshops/craftsmen.

* This research is part of a joint project on manufacturing technique and colour decoration of Early Cycladic marble figurines and vessels, funded by the INSTAP Study Centre. Partners: National Archaeological Museum and Museum of Cycladic Art in Athens. Collaboration with the Laboratoire de Tribologie et de Dynamique des Systèmes (CNRS- Ecole Centrale de Lyon).

Keywords: Techniques, Lapidary craftsmanship, Bronze Age, Tool traces, Tribological analysis, Experimental reconstruction, Workshop, Stone, Marble, Multidisciplinary method

Early Mesolithic pressure blades: a functional analysis of a porphyry blade assemblage from Sujala, northern Finland

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In 2002 a Mesolithic settlement was discovered in northernmost Finnish Lapland by the Helsinki based archaeologists Tuija Rankama and Jarmo Kankaanp´a´a. In 2004 they invited a group of Scandinavian researchers to survey this area and conduct prelminary investigations. The site, characterized by a pressure blade industry, was excavated in 2004-2005 and was later dated to ca 9200 BP (8300-8200 cal BC). The material has its closest parallels to lithic industries in western Russia and relates to the contemporaneous Butovo/Veretye tradition. The site that belongs to the pioneer settlement of eastern Fennoscandia, marked the beginning of a joint Scandinavian research on the post Weichselian settlement of the Scandinavian peninsula. The research focused on the origin and spread of the pressure blade industry, and soon came to identify the change between the Early and Middle Mesolithic on the Scandinavian peninsula ca 8300 cal BC with a characteristic pressure blade industry, as a result of migration from Eastern Europe. This process was followed by, among other things, a discussion of the character of change focussing now on the Chaîne opératoire of this blade industry and its relation to the actual use of the blades. Blades and blade segments are characteristic and one line of inquiry has shown that one of the main ideas of this technology is to use blade segments as insets in slotted bone points. But a variable use of these blades and blades segments is expected, something that has called for a functional analysis. In northern Finland, Norway the Kola peninsula as well as in parts of Sweden, the blade industry belonging to this tradition is based on fine-grained igneous rock like porphyry and tuffites. Not much is known about the applicability of use-wear analysis on these types of easily weathered raw materials. In this presentation we account for a preliminary use-wear analysis of a sample of blade fragments from the Sujala site based on use experiments with porphyry blades.

Keywords: Use, wear, porphyry, pressure blades, Early Mesolithic, Finland

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Economy and mobility during the Mesolithic of south-western France: the place of expedient production in the technical and economic strategies of the last hunter-gatherers, contribution of functional analysis.

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Compared to Palaeolithic and Neolithic, Mesolithic appears as a singular period of European prehistory. Its originality is due in particular to its lithic industries, in which standardized arrow coexist with less invested tools, involved in activities generally described as "domestic".
These less invested tools, well identified in recent decades for Palaeolithic (De Bie&Caspar, 2000; Bicho&Gibaja, 2006; ...) and Neolithic (Perlès et al. 1990; Bostyn&Allard, 2006; ...), are just beginning to be identified in Mesolithic assemblages. This "expedient" production, however, seems to be an integral part of the technical and economic background of these last nomadic hunter-gatherer societies (Guilbert et al. 2006; Guéret, 2013; Stefanis et al. 2016). The goal of my research is in this sense to define its place within the Mesolithic panoply, but also within the economic registers and strategies of occupation of the territory.

These objectives take place in a limited context in the south-west of France, a sector made dynamic by the many fields currently invested (petrography, typology-technology, paleoenvironmental approaches...), making it possible to consider these populations from a palethnographic angle (Valentin, 2008). In this sense, traceology is a powerful analysis tool since it allows us to penetrate into the heart of prehistoric techno-economic strategies.

The first traceological results will be presented, namely the analyses of the lithic collection from the open-air site of Creysse (Dordogne), occupied during a very early sauveterrian phase (cal BC 9810 to 9380). The site delivered two locuses rich in lithic material, and particularly in untouched tools (Tallet et al. 2012). These results will allow us to support some of the functional data that already exist, which already make it possible to envisage its very probable domestic status, including the transformation of animal and plant resources, which makes it all its originality for the period (Chesnaux, *in* Tallet et al. 2012). My thesis also includes an experimental part focused on these domestic expedient tooling issues, including several experiments in butchery using unretouched tools, which allow us to consider ways of using and operating

*Speaker

these tools.
Understanding the status of this open-air site within the Mesolithic landscape of the Causses of Quercy, by means of a comparison with two other sheltered sites (Le Cuzoul de Gramat, Lot; Roquemissou, Aveyron) should be an additional key to identifying the patterns of occupation of this territory with its rich and compartmentalized resources.

Keywords: Mesolithic, technology, traceology, domestic economy, expedient technology

Eneolithic tool-rich graves of Maturus men from SW Poland

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The Neolithic period is characterized by offerings deposited in graves. From the beginning of the Eneolithic sacrificed objects are believed to be the indicators of social stratification. Analysis of flint artifacts from the largest Eneolithic cemetery in SW Poland show that tools indicate most significantly symbolic relevance of age and social role of the dead.
The site no. 10/11/12 in Domaslaw is located on the Wroclaw Plain and was excavated by the Polish Academy of Sciences between 2006-2008. Twenty four burials form a tight grave field, one more burial was found 84 m to the south. People buried there belonged to the society named Jordanów culture - a part of the Danubian tradition. Graves were either relatively contemporary with each other or ensure continuity (4250-4000 BC). So, we are sure that we are dealing with material from the same source in the social meaning.

The burial pits were oriented north-east - south-west and the bodies lay on their right side facing east (men) or on their left side facing west (women). Graves are preserved very well, showing original layout of skeletons and grave goods, such as vessels, copper jewelry and tools, bone tools and flint tools.
Two of twenty five graves contain skeletons of *Maturus* men, aged approximately 40-50 years. Both graves (nos. 13123; 13131) are the most rich at the necropolis in Domaslaw. Burial pits marked with traces of decayed wooden coffin and partly furnished by stones contain completely or partly preserved skeletons, footed vessels, double-handle amphorae, bath-shaped vessels, pieces of animal carcass, copper and shell jewellery, copper axes or antler T-shaped axe and numerous flint artefacts, respectively 52 and 59 pieces, including implements made from imported Jurassic flint found exclusively in these two graves. Most of flint artefacts form a tight group located next to knees or by the head of the deceased. Among them there are many tools of various function. Other flint tools were found in small heap or rows suggesting their original form such as sickles.

Keywords: graves, grave goods, flint artefacts, usewear studies

*Speaker

Evolution of the tool kit using for the processing of ornamental stone in the Upper Paleolithic of Southern Siberia

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In Southern Siberia more than 50 stratified objects, containing cultural layers of the different stages of the Upper Paleolithic are known to occur such as Denisova Cave, Anui, Malaya Syya, Gerasimova, Khotyk, Kamenka, Mal'ta, etc. The chronology interval covers 45 000-50 000 – 12 000-16 000 ka. The total collection of personal ornamentation is more than 250 items; half of them are made from soft stone material.
Microscopic analysis of the surface of stone artifacts from archaeological collections in South Siberia made it possible to carry out their traceological analysis. As a result of the research, a technological chains of production was established, the nature of their use-wear was determined. Differentiation in the technologies of production of artifacts of two categories (ordinary and geometrically complex products) is noted. Signs of the use of archaic and innovative technologies are singled out on the every stages of Upper Paleolithic. The facts of using a specific toolkit for each and the marked technologies are documented. Studies of archaeological museum's gatherings allowed to reveal the probable tools used in the production of the investigation of the collections. The evolution of the tools used in the manufacture of artifacts in the Upper Paleolithic period is fixed. The most striking changes in the use of the toolkit are marked in groups of tools associated with surface processing and drilling of the items of personal ornamentation.
This study is supported by the Russian Foundation for Basic Research, project No. 17-56-16016.

Keywords: traces, stone raw materials, technological chains, tool kit evolution, Upper Paleolithic, Southern Siberia

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Evolution of the tool kit using for the processing of ornamental stone in the Upper Paleolithic of Southern Siberia

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Keywords: traces, stone raw materials, technological chains, tool kit evolution, Upper Paleolithic, Southern Siberia

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Finding a standard procedure in impact-fractures analysis: the case of Grotta di Pozzo (L'Aquila – Italy).

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Grotta di Pozzo is a small cave at 720 m asl and 42◦ N in the Apennine range of Abruzzo (central Italy). Excavations were aimed at investigating the timing and mode of recolonisation of the central Apennine after the LGM. The archaeological sequence starts on the top of a fluvial-lacustrine deposit at 23 ka cal. BP, with layers including lithic industry of the Early Epigravettian. After 16 ka cal. BP, and up to 14.5 ka cal. BP, the lithics belong to the Late Epigravettian.
In this archaeological site is demonstrated the seasonal hunting of chamois, followed by ibex and red deer, as well as for marmot and black grouse. Recently, impact damage analysis has been carried out for the Epigravettian lithic industry in order to recognize possible projectile points. The results allowed understanding the hunting strategies of the final Pleistocene hunter-gatherers and the function of the archaeological site.
Despite the perspective opened by that investigation, doubts have arisen, notably concerning the methodology used to identify the projectile points, which was based on the literature and without experimentation. We present here a use-wear re-analysis of the lithic artifacts considered as projectile points, with a new methodology, making use of a large reference collection. The results will be compared in order to check the reliability of both approaches.

Keywords: Upper Palaeolithic, Projectile points, Hunter, gatherers, use, wear, Epigravettian

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Finish that bone tool – a closer look at different prehistoric grinding techniques

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The possible evidence of bone tool shaping using the grinding technique is already known from Lower Palaeolithic sites in Africa and appear to be unchanged in its general form until the end of Neolithic period in Europe. However, the differences between many identified traces observed on bone objects described as a result of grinding still raises many questions about used materials and techniques. The main objective of the presented study is to classify, analyse, interpret and correlate the macro and microscopic traces formed on the experimentally worked bone materials, caused by different kind of grinding techniques. During the experiments conducted directly for the purpose of this project, a wide variety of abrasion methods were tested, taking into the account many possible variables, such as: the kind of grinding slab, potential admixtures, the type of motion and the duration of work. The effectiveness and suitability of the investigated methods and materials were also examined. Data obtained during experimental works suggest the presence of characteristic macro- and micro-wear patterns associated with many variables which will be discussed in presented study and confronted with selected osseous archaeological materials associated with the Late Glacial and early Holocene sites of the Polish Lowland.

Keywords: grinding, technology, traceology, prehistory, bone, experimental archaeology

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Flint tools from upper level of tell Hotnitza in northern Bulgaria (Late Chalkolithic period)

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Tell Hotnitza is located in the central part of Northern Bulgaria, near the village of the same name in Veliko Tarnovo region.The upper level of tell is completely exploring in 1956-1959. It dates back to the late Chalcolithic - culture Kodjadermen – Gumelnitza - Karanovo VI (the end of V mill. BC). Flint artifact have not be examined until now. The studied collection in originates from twenty investigated dwellings (607 objects) and from the space between them (762 objects), total 1369 artifacts. The type of tools, use-wear traces, methods of treatment and the raw material used are specific for the Late Chalcolithic period in northeastern Bulgaria and the Black Sea coast. At the same time, there are some specific features, both in the flint tools processing and the existence of some separation of home crafts in the settlement itself. At this last stage of the existence of the settlement there is a deficiency of flint raw material, and tools weren't produced. Along with this, the quality of the raw materials of the most of objects is very high.
There are observed almost all types of productions - antlers, bone and shell processing, wood processing, and others though to varying degrees of development. It is noteworthy the lower, compared to livestock breeding tools, percentage of agricultural tools.

It is possible that the large number of chisels, scrapers and axes, are as a result of the specialization of this settlement in the production of bone figures and the predominance of hunting and livestock farming in its economy, but this field hypothesis can be verified after the study the stone and bone tools also the artifacts from other levels of the same settlement.

Keywords: Chalcolithic, use, wear analysis, flint tools, domestic production

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Flintworking in Chalcolithic cultures of farmers and cattle breeders of North-Eastern and Eastern Europe

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Complex studies of Chalcolithic production inventory of farming societies of the Balkan-Danubian region and their neighbors – cattle-breeders who lived at the left bank of the Dnieper make possible to consider that technological discoveries which promoted life quality to a higher step compared with previous periods were one of the causes of high development level of these regions of ancient Europe.

First of all discovery of metal melting which led to cardinal changes in many branches of Chalcolithic economy had major significance. But besides copper flint remained as a major raw material for production of many tools. Complex research of mass collections of flint tools and accompanying materials from settlements and burial grounds indicate substantial changes in Chalcolithic flint working of the region under study compared with Neolithic time. Change of sort of flint and employment of a new technology of its knapping were most important. During the Chalkolithic active mining of high quality large nodule flint starts at that territory: Dobrudzhian in the area where the culture Kodzhadermen-Gumelnitsa-Karanovo VI (Bulgaria) was spread; Volhynian at the territory of the Tripolye culture (Ukraine); Donetsk at the left bank of the Dnieper in the area of Novodanilian sites of cattle-breeders (Ukraine). Primary treatment of raw material took place in separately situated workshops and at settlements near raw material outcrops. Large nodules of these sorts of flint with application of proper technology of its treatment made possible production of tool blanks of a new type – super regular large blades with optimal technical properties which differed them substantially from blanks of previous periods of the Stone Age. Well developed technology was used for the production of blades with regular geometric proportions. Experimentators consider that such quality of knapping was possible only with the use of lever including use of copper pressure flaker. Quality of flint treatment indicates emergence of professional craftsmen in this branch of economy. New type of blank led not only to standardization of tools, but also to emergence of new specialized instruments. Thus use of new nodule sorts of stone, refinements of technology of its knapping, production of the optimal type of blanks – regular blades, specialization of productions and emergence of professional craftsmen can be considered as a new event which defined main trends of development of production of flint tools. Chalcolithic epoch was the time when quality of flint working reached its peak, and flint processing transformed from home activities into one of branches of commune handicraft.

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Keywords: Chalcolithic, North, Eastern and Eastern Europe, complex research, flintworking, super regular large blade, specialization of productions

For body or for spirit? Intriguing red polish on flint tools from Rzucewo Culture, Poland.

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Rzucewo Culture is a unique Late Neolithic phenomenon related mainly to exploitation of marine resources. For years these people were called *seal hunters* due to numerous faunal remains found in their settlements located on the southern Baltic Sea coast. It is also known for intensive extraction and processing of amber.
Rzucewo Culture groups left numerous flint assemblages produced mainly of locally collected flint pebbles with the help of scale technique. Technology of flint production was very simple and uniform from site to site.
Eponymous Rzucewo site itself delivered ca. 30.000 lithics and this assemblage contained several dozens of flakes, blades, pebbles and tools carrying very distinct red polish. It spreads over surfaces and/or edges of flints. Presented paper discusses results of technological, typological and traceological considerations aiming to shed light on the genesis of this phenomenon. It also attempts to evaluate whether this polish was of any importance for the subsistence or reflects extra-utilitarian cultural behavior.

Keywords: functional study, Rzucewo Culture, Neolithic, red polish

*Speaker

Functional study of the Copper Age lithic and metallic grave goods from the Humanejos cemetery (Parla, Madrid).

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The Humanejos site, in the Madrid region was occupied during the IIIrd and IInd millennia cal BC and has nearly 2000 domestic structures and around a hundred graves. Amongst their grave goods are plain bowls and small pots, personal ornaments like stone beads (in variscite and other rocks), and a limited but rich flint set, with arrowheads, daggers, blades and a retouched tabular flint plate. A hafted chisel, flat axes, awls and knives-daggers were found in the copper-based metal elements. Nine of those graves had rich and abundant Bell Beaker grave goods, such as more than 50 pots with the characteristic impressed decorations, of Maritime, Comb Geometric and Ciempozuelos styles. There were also personal ornaments like ivory/bone beads and gold plaquettes. Among the copper-based metal elements, a flat axe was discovered together with weaponry as tanged daggers, Palmela points and one halberd. Through the use-wear analysis, insights are made on the meaning of the grave offerings within their social context, especially considering if they were new pieces made just for the burial ritual or the equipment used in their everyday life by those individuals. On the other hand, the meaning of the typological and functional variation of the tools and weapons in the Bell Beaker and non-Bell Beaker tombs is considered.

Keywords: Traceology, lithic use, wears, metal use, wears, Bell, beakers

*Speaker

Key questions over forgotten tools. A functional view on the types of tool without known function of the LGM

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Lately, the new methodologies of functional analysis are allowing to make inferences of greater resolutive value on the behaviour of hunter-gatherer societies. These approaches to the function of the artefacts -using both residue analysis together with wear traces- do not only offer information about the type of activity carried out, but also about hafting methods, curation of tools and technical behaviours or even the intensity and character of the occupations.
In this work, the first functional results of the open-air site of Montlleó (Prats i Sansor, East Pyrenean range) are presented. This high-altitude site (1134msnm) is strategically located on a small hill that would allow an absolute visual control of the passage through the Cerdanya valley, both of human groups and herds of animals. The importance of its location lies in the fact that at the time it was occupied -during the LGM-, this was the only ice-free passage that allowed to cross the Pyrenees.

The set of analysed material consists of various allochthonous rocks (different varieties of flint, and rock crystal mainly) as well as local and presumably local raw materials (rhyolite, quartzite, quartz, etc.). The site is remarkable for its high number of backed bladelets and sidescrapers, but also highlight the *écailles*, endscrapers and abrupts, among which is a set of *raclettes*.
The analytical methodology followed in the study of this archaeological collection is focused mainly on the micro-wear analysis, combined in some cases with residue analysis. The combination of optical, electronic and digital microscopy equipment is used in a complementary way as a response to the different characteristics of the raw materials analysed. In this way, data on the differential selection of raw materials by means of function are obtained. This work allows to define the functionality of unexplored tools -like the raclettes- by means of their comparison with endscrapers in different stages of reduction and resharpening.

Keywords: usewear, LGM, Pyrenees, type VS function

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On the Minds of Bow Hunters

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Only seldomn are the data obtained from use-trace analyses applied to truly reconstruct ancient human behaviours. Even less effort is made when it comes to understanding our cognitive evolution. By 'squeezing blood from stones', evidence for bow hunting has been pushed back to more than 60 000 years ago in southern Africa. The time between roughly 60 000 and 100 000 years ago is currently held as the phase during which the ancient human mind can be shown to process information in similar ways to ours today. Here I use bow-and-arrow technology as a case study of how long-term, multifaceted exploration, starting with use-trace analysis, can lead to models in cognitive evolution and even archaeo-neulological studies. I argue that early bow hunting could have helped shape the human mind, contributing to us becoming masters in flexible thinking. Such cognitive plasticity, or intelligence, is represented in our ability to learn, teach, innovate and respond flexibly to new or complex situations. These abilities are anchored in our predispositions towards faster reaction times, greater working memory, inhibitory control and greater response to novelty.

Keywords: Bow hunting, Middle Stone Age, cognitive evolution, neuro, archaeology

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Questions of hafting technology, use and adaptation in the Neolithic lake-dwelling sites (a case study of antler sleeves from "Swiss collection"stored in Kazan, Tatarstan, Russia)

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"Swiss collection" in National Museum of Tatarstan Republic was probably obtained in 1882 by professor N.F. Vysotsky from lake-dwelling sites revealed on the lake Neuchatel. Collection consists of 94 antler sleeves – connection devices between wooden haft and stone axe, adze or cutting blade as well as many tools made from stone and bone (adzes, chisels etc.). Antler sleeve as intermediate device prevented wooden haft from splitting and valuable stone tool from damage. Experimental and technological research carried by J´org Schibler (2001) proved the presence of two detachment techniques of red deer antler during the Neolithic of Switzerland: by means of indentation technique and string-saw one.

The sleeves morphology and use-wear demonstrate high standardization methods applied by the experienced inhabitants of lake-shore settlements. Sleeves under study are characterized with a variety of shapes and types, among them: sleeves of cylindrical shape with hafting and mounting holes (4) or with one mounting hole (88) including the sleeves of 4 types depending on the presence or absence of clear-cut hafting part, functional of nonfunctional ledge, remnant of the burr.A specific technical method applied to sleeves with such a remnant was the drilling of holes for mounting to the sleeve to handle. There are also clear technical evidence of attempts to repair the sleeves – presence of the cut-marks, cutting notches and the grooves, probably made in the technique of string sawing.

Multidisciplinary paleo-environmental research performed by J. Shibler and co-authors(1997, 2007) allowed to reconstruct the Neolithic economy, changes of climatic and natural resources, production of stone and bone tools dynamics of these processes within the Neolithic societies in Switzerland has been verified by great number of the absolute data from 4300 to 2400 cal. BC. It has been found that the maximum use of antler sleeves by the Neolithic population occurred during the late stage of this period since 3100 BC. Cropped proportions of some of the sleeves from "Swiss collection" were probably related to their extreme deterioration therefore the period between 3800 and 3600 cal. BC, when there has been intensification in the hunting of red deer on the territory of Switzerland, may be proposed.

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Keywords: technology, traceology, Neolithic, Switzerland, antler sleeve, lake, dwellings

Searching for diagnostic projectile traces: use-wear analysis on experimental and archaeological Levallois points.

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Levallois points have been referred to as a techno-morphological type with a high morphometric and functional variability. These pointed artefacts may suit a broad functional range, such as butchering, multi-purpose, and projectile uses. However, the functional interpretation of these pointed tools as projectiles is a particularly significant argument in Palaeolithic archaeology as hafted projectile weaponry constitutes a major marker for identifying complexity in human behaviour.
Here we present a large-scale, systematic experimental programme that has intensively tested the use of Levallois points as part of thrown and thrusted stone-tipped spears. The primary purpose was to identify variation of micro-traces (microscopic linear polish, micro-polish and striations) and breakage patterns (diagnostic impact fractures [DIF]) in throwing vs thrusting activities and cross-compared the experimental results with archaeological data.

Trained human participants threw and thrust experimental stone-tipped wooden spears into animal carcass targets. For each throw and thrust, several variables were recorded. The influence that different experimental variables, such as tool morphology, delivery modes (throwing vs thrusting), and hafting system, can have on the formation of macroscopic and microscopic traces during impact use was investigated.
Experimental results integrating macroscopic and microscopic use-wear show that clusters of trace patterns (DIF plus micro-polish) provide useful markers for determining experimental hand-delivered projectiles. These experimental insights are significance because functional analysis of archaeological points from Abris du Maras (France) and Arma Delle Manie (Italy) show that those Levallois points had a sizeable functional variability. However, combined microscopic-wear and macro-fracture analysis of the archaeological artefacts also indicate that some of the Levallois points were used as projectiles in hunting activities.

Keywords: use wear analysis, diagnostic impact fractures, stone, tipped spears, projectile technology, Middle Palaeolithic, Neanderthal behaviour

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Sickles and "something more" in the copper age ditch enclosure of Camino de las Yeseras (Madrid, Spain). Threshing-boards, how micro-wear analysis discovers new production activities.

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Until recent dates, studies of lithic tools in Chalcolithic sites have been in the background, when they are still a very abundant record in many productive and funerary contexts. Nowadays, it is possible to go deeper into more aspects than the merely typological ones. Thanks to use-wear analysis it is possible to infer about the real functionality of certain lithic pieces, that until now were interpreted as sickles, using only typological analysis.
This research presents a partial study of laminar lithic tools and bifacial tools documented at Camino de las Yeseras site in San Fernando de Henares (Madrid, Spain). The lithic tools are very characteristic because they have been recovered in different types of domestic structures – houses, enclosures and different functionality pits. The results of their study is supported as well by the presence of millstones, rests of cereal grains, pollen and some other evidences of vegetal elements as spikes and straw.

We have made a techno-traceological study of laminar and bifacial pieces in order to identify their use and try to distinguish labors connected with faming activities. This research has provided important results able to infer that all bifacial pieces were not only sickles, but also threshing-boards. These traces on the tools confirm the implementation of a new farming technology on the site, which would favor a more efficient exploitation of vegetal resources, especially the importance of the cereal production that requires tools as complex and effective as the threshing-borders.
In conclusion, emphasize the important paper of use-wear analysis for some chalcolithic lithic tools, that typologically most of them are not only sickles, but incrusted in threshing-boards. Up

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to now, some few Iberian sites are known with threshing-boards identified, and with Camino de las Yeseras results it confirms a new agricultural technology for central Iberia cereal exploitation during Chalcolithic.

Keywords: Sickles, Threshing, boards, microwear, Chacolithic, Camino de las Yeseras

TECHNOLOGY AND FUNCTION OF LITHIC AND ORGANIC TOOLS IN PREHISTORIC ISLAND SOUTHEAST ASIA

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Recent traceological studies of Late Pleistocene and early Holocene assemblages in Island Southeast Asia show that seemingly simple lithic flakes were used for a large variety of complex tasks, including plant processing and as hafted armatures for composite tools. In addition, shell tools made from marine gastropods and bivalves, and the presence of bone technology and polished bone tools suggest an efficient use of alternative raw materials to complement or even replace stone tools in areas without, or with limited, chert sources. Fishing tools made of shell and bone in form of hooks and gorges as well as fully ground bone points appear from the Late Pleistocene onwards and c. 35,000 years ago until the early/mid Holocene across Island Southeast Asia while the first edge-ground shell adzes have been dated to the early Holocene and are found in sites ranging from the western Philippine islands to Island Melanesia and as far as the Bismarck Archipelago. This paper presents the traceological analysis of artefacts from several sites near the coast in Sulawesi and the Philippines and discusses their uses in a functional and regional context. The identified traces suggest an increase in the technological and behavioural complexity of the people occupying those sites since the Late Pleistocene. This development is associated with a new and distinct set of activities and the appearance of an organic and lithic technology that might reflect an increasing adaptation to maritime environments. The intentional tool preparation specifically for the purpose of plant processing and the increasing intensity of those activities during the Terminal Pleistocene and Early Holocene is quite extraordinary and distinctive for prehistoric technologies and activities in Island Southeast Asia.

Keywords: Southeast Asia, usewear, missing types, specialization, plant processing, organic tools

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Techno-functional Analysis on the Lithic Tools from the Wolseong-dong Site in Daegu, South Korea

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The excavation of the Wolseong-dong site in Daegu revealed a number of lithic tools made of hornfels and obsidian. Of these tools, this article selects 169 pieces of selected lithic tools for conducting use-wear analysis to identify such questions: What materials were these tools used on and how were they used?
In spite of the ratio of detected use-wear pattern is low, in the cases of poorly preserved hornfels tools, the wear patterns of the surfaces of end-scrapers, scrapers, and blades show that these tools were used for processing smooth animal materials, such as skin, while these of the surfaces of burins, micro-blades and burin spalls exhibit that these artifacts were used for processing harden animal materials, including bones and antlers. The use-wear analyses of obsidian tools suggest that most of these tools were used for processing harden animal materials. Notably, all analyzed obsidian burins were used for processing harden animal materials. In these tools, use-wear patterns can be observed various parts, which include cutting points and both edges. The locations of remained use-wear of obsidian burins exhibit the different functions of these tools, such as piercing, cutting, and scraping. It can be detected the pattern that the lower part of burin was attached to a handle made of bone or antler. In the cases of obsidian burin spalls, it can be observed the polished pattern that might be formed during the making tools, and re-used pattern of their edges. In addition, the surfaces of obsidian burin spalls show the complex patterns related to the function of these tools and the equipment of a handle. These patterns suggest that these tools had the same function with obsidian micro-blades, because the latter shows the identical pattern with the former. Particularly, obsidian micro-blades can be classified into blades and projectiles in accordance with their sizes.
Obsidian was less plentiful than those of hornfels, semi-processed materials, including blades and flakes, were brought into this site. These materials were made into various tools, such as burins produced by two methods, border debitage (Type I) and upper side debitage (Type II), burin spalls, and micro-blades. These facts suggest that the Paleolithic people made these obsidian tools with different strategy from hornfels tools.

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Keywords: Use-wear Analysis, Technology, Function, Experimentation, Hornfels, Obsidian, Burin, Burin spall, Micro, blade

Techno-functional analysis of bone and antler industry from Farneto (Bologna, Italy) and Sa Osa (Oristano, Italy) archaeological sites

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The aim of this study is the identification and reconstruction of past *Chaine Opératoire* and use of bone and antler tools, referring to two archaeological sites of Copper Age frequentation: *Sa Osa* site (Oristano, Italy) and *Farneto* rockshelter (Bologna, Italy). The collections respectively result from a preventive excavation rescue, and a museum old collection. Besides, a de-contextualisation and the nearly total lack of manufacturing wastes is recorded: the collections are mainly composed by finished tools. The applied methodology take instance from the bone industry technological and functional studies, which allow identifying the modalities of exploitation of osseous materials during prehistory. Observations under stereomicroscope (0.63x-4x) and metallographic microscope (50x-500x) highlight the presence of anthropic traces left during the manufacturing activities, as well as those occurred on the tool surface after the utilisation of it in past recurring activities. An experimental activity is also performed, in order to create a reliable reference collection to compare for the technological and use-wear resulting data recorded among the archaeological tools. The resulting data allowed the reconstruction of *Chaine Opératoire* and past use for the most recurrent tools typologies identified at *Farneto* rockshelter and *Sa Osa* sites' collections.

Keywords: Bone technology, Use wear, Animal Hard Tissues, Experimental Archaeology, Copper Age

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Use wear analysis of Bronze Age lamps from Crete

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Functionnal analysis of clay pots are underdeveloped, in comparison to the numerous typological and technological studies in every culture area. This is surprising, considering the fact that investigating the function of vases is a relevant indicator of daily life activities.
Lamps from the Aegean Bronze Age are good examples for such observations. Although some residue analysis have been carried out in a few of them, most of the studies focused on their shapes, considering they can be used as cultural and regional guide fossils.
My PhD thesis aims to understand the place of lamps in the lighting devices within Minoan households. Among lighting practices, the question of the quality of light produced is essential. From an experimental database to a use-wear traces analysis, from a use-wear traces analysis to residue analysis, my research aims to identify the type of fuels that were burnt as well as the light provided by these fuels. The first results show that microscopical examination of the soots can tell us about the type of oils and the fats that were burnt. Beyond the economical and environmental informations they give, these results also allow us to make assumptions regarding the lightning and the architecture in photorealistic 3D models.

Keywords: Use, wear traces, Functionnal approaches, lamps, Aegean Bronze Age, lighting

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Use wear patterns on lithic and bone artifacts: The case of the Horticulturalists groups from the Paraná Basin, Argentina.

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The technological strategies of horticulturalists groups known as guaraníes that inhabited the Paraná Basin (Argentina), is poorly known in the archaeological literature. This is due to the orientation of archaeologists to center the debate in its pottery decoration and form, mainly as a way to discuss migration routes, but also to establish certain aspects of the domestic life of these groups, lacking a general view of their technology, and hence, their subsistence strategies. This situation has begun to change in recent years, with the realization of other components of the guarani archaeological record as a way to approach more general aspects of their behavior, such as their technological and subsistence strategies. Hence the focus of this paper is to discuss the technological strategies of horticulturalist groups known as guaraníes. In order to do this, we analyze the lithic and bone assemblages coming from archaeological sites of two different but linked areas: the low Paraná wetland, and the upper Paraná river, through use wear analysis. Results show that similarities on their technological solutions can be discerned, despite environmental variability.

Keywords: lithic and bone artifacts, traceology, Paraná Basin, Argentina, amazonian horticulturalists

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Use-Wear analysis of a specific mobile toolkit from the Middle Paleolithic site of Abric Romaní (Barcelona, Spain). A complementary approach Using Optical light, Digital 3D and Scanning Electron Microscopy

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A micro and macro-wear analysis was carried out in a specific mobile toolkit belonging to level M of the Middle Palaeolithic site of Abric Romaní (Barcelona, Spain), which is dated at MIS 3, between 51 – 55 Ka BP. In an environment rich in local flint sources and in a technological context marked by an expedient behavior, a set of natural backed knives and debordant flakes was introduced already knapped to the site. A combination of technological, refitting and raw material unit analysis (RMU) has allowed to individualize them from the rest of the artifacts knapped in situ. All the flint varieties of the lithic assemblage are present among these tools, and they show bigger dimensions than the flakes produced on-site (average length of more than 40 mm). Given that the aim of the reduction sequences in level M, as in most of the stratigraphic sequence, is the production of small flakes of poor quality flint, the introduction of these finished tools is indicating the existence of a planned behavior in relation to raw material constraints and, to a major extent, with specific needs. The question is to explain if there is any functional difference between these flakes knapped outside and those produced on-site. Before facing this issue, we have performed a first evaluation of the potential of these tools for use-wear analysis. A total of 39 flakes were selected for this study, with the state of preservation as a major sampling criterion. To provide reliable data with which to compare the archaeological traces, we carried out a specific experimental program using the main flint varieties identified in the archaeological sample. Digital 3D, Optical Light (OLM) and Scanning Electron (SEM)

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microscopy were combined to characterize wear patterns in both archaeological and experimental implements. Our preliminary results shows that, despite the heavy patination on part of the sample, a limited array of tools have a good state of preservation and show use-wear evidences related to a variety of butchery activities. Difficulties regarding the observation of chemically altered surfaces and the need of controlled post-depositional surface modifications experiments will be discussed. The combined use of Digital 3D, Optical Light and SEM have turned out as a powerful microscopic observation method in use-wear analysis.

Keywords: Usewear Analysis, Mobile toolkit, Butchery, Digital 3D Microscopy, Optical Light Microscopy, Scanning Electron Microscopy

Use-wear Analysis of a late Middle Pleistocene quartzite assemblage: Gran Dolina site, TD10.1 level (Sierra de Atapuerca, Spain)

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Quartzite has been poorly studied from a functional point of view since the beginning of Traceology, mainly due to the paucities of standards. Moreover, lithic assemblages of ancient chronologies have not been frequently submitted to use-wear analysis due to preservation constraints.
In the case of the Middle Pleistocene Gran Dolina-TD10.1, the poor conditions of chert normally impede the preservation of wear. The chemical damage of chert mostly affects one of the varieties present at Atapuerca (Neogene chert). Although some chert artefacts were successfully found bearing use-wear evidence, it was not possible to apply use-wear analysis on the chert assemblage to a large scale. Therefore, quartzite is the second most abundant raw material at GD-TD10.1 and it is the sole material whose microscopic study may provide large functional information of the human occupations of the site.

51 quartzite artefacts were analysed with Scanning Electron and Optical Microscopy and functional interpretation was possible for 35 of them. The level of accuracy of the interpretations may vary, depending on the preservation of wear, of its degree of development and of the presence of post-depositional surface modifications. Sometimes, only the used portion of the edge was identified. In other cases, the kinematics was quite clear due to a relatively large presence of linear indicators. The identification of the worked materials, as in most studies, is truly challenging as many details are missing on archaeological specimens. Therefore, in most of the cases, the interpretation of the worked materials felt into broad categories of relative hardness (soft, medium, hard, very hard). In few cases, however, the presence of diagnostic characters of wear allowed more in-depth identifications of the worked material's type.

The functional results of the quartzite assemblage of GD-TD10.1 contributed to better evaluate

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the human occupations at the site, adding new data to the on-going interdisciplinary study. Several activities were identified, most of them connected to the butchering of large mammals. Hence, this study demonstrated the possibility of recovering functional data from relatively ancient material and from coarse-grained lithologies.

Keywords: Gran Dolina site, quartzite, use, wear analysis.

Use-wear analysis in the Early Stone Age: the case of Olduvai Gorge, Tanzania

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Use-wear analyses are based on the assumption that the different activities undertaken with lithic tools are reflected in a series of surface alterations that can be recorded and interpreted in order to determine the type of action and worked material. However, for ancient periods use-wear studies are significantly scant, due to a series of constraints, particularly related to conservation and post-sedimentary alterations.
This paucity of research is more remarkable for Early Stone Age archaeological sites in Africa. This contribution aims at presenting a number of use wear analyses carried out in some of the main archaeological sites, whose excavations are currently under way in Olduvai Gorge, Tanzania (SHK, FLKW, BK, DS). These sites are known to be some of the most exceptional examples in Africa for the study of human evolution and behavior. These sites contain both, Oldowan and Acheulean technologies, different varieties of raw materials (quartz, basalt and flint), different conservation status and represent a wide range of chronologies (between 1.9-1.2 m.a.) that make each site unique.

Animal carcasses are abundant in the archaeological samples, as the result of butchering processes to be corroborated, among other, by use-wear analyses. In addition, by means of the use-wear analyses, it is possible to identify other types of activities such as woodworking, vegetable-processing, or underground storage organs processing, in providing information about the possible functional variations of the lithic artefacts. Moreover, the results could help us to have a better understanding of the hominids activities carried out in these sites.
Before the archaeological inspection, an experimental programme has been designed in order to go deep into the special features of the different archaeological raw materials. Their results are presented together with the preliminary results of the archaeological use-wear analysis.

Keywords: Use, wear analysis, Early Stone Age, Olduvai Gorge, Human Behavior

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Use-wear analysis of lithic tools from Dja'de-el-Mughara: Technical activities and cultural traditions during the EPPNB in the Northern Levant.

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Starting from 12000 BC. deep social, economic, technical and cultural mutations took place that will lead to the emergence of sedentary societies in which the food economy will rely on agriculture and farming. This process – known as Neolithisation – can be observed in Northern Levant, particularly in the village of Dja'de that has been occupied during one millennium by hunters-gatherers who will eventually become farmers. This site contributes our understanding of the evolution of technical activities, particularly agricultural practices during this period. Regarding that specific context, where relationship between humans and their environment changed, studying the function of lithic tools represent a key research direction to improve our knowledge of major technical and economic changes occurring in that crucial period. During this process, it appears that the management of the tools becomes more complex: the use of the tools intensifies, the degree of sharpening increases, the recycling is more frequent, and the storage modalities evolve. This contribution presents some results of functional analysis of differents typological groups from Dja'de, combined with other aspects usually studied like technology and typology. The confrontation of our results with data from the other analysis made on the site (i.e. archaeobotany, anthracology, architecture, beads) will enable to propose some reconstitution about the the village activities, the techniques used by its inhabitants and the management of the lithic production, providing us a better understanding of the way of life and the organisation of pre-agricultural societies in Northern Levant.

Keywords: Dja'de, Neolithisation, EPPNB, Northern Levant, Syria, flint tools, usewear analysis, technology, typology, experimentations, agriculture, hunting, activities.

*Speaker

Variability in the use of the mousterian denticulates and notches of Navalmaíllo Rock Shelter (Pinilla del Valle, Madrid, Spain)

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Bordes defined a denticulate as a tool with one or more than one non-adjacent edges knapped with a succession of notches. Denticulates and notches are two of the more ubiquitous types of the Mousterian panoply of western Europe. New research suggests that these tools are more complex than expected, from both a typometric and functional point of view. They appear not to be as standardized as appeared before. Moreover, new functional studies point to denticulates as versatile tools.

In this contribution, we present the results of the use-wear analysis of a Mousterian sample of denticulates and notches coming from the Navalmaíllo Rock Shelter (Pinilla del Valle, Madrid, Spain). This site has preserved the remains of some Neanderthal occupations being a campsite where domestic activities have been performed. Navalmaíllo Rock Shelter is, in fact, one of the largest campsites of the Iberian Peninsula. Denticulates and notches dominate the group of retouched tools. The preference for quartz raw materials is a particularity of the site, not very common among other Mousterian sites of the Peninsula. This quartz comes to the site in form of cobbles and fragments taken from dykes collected from the immediate surroundings.

Use-wear on quartz has its own peculiarities due to the special features of the raw material. Nevertheless, the wear marks are usually better preserved than those formed on other traditionally considered being better materials like flint. Previous studies on a small sample from that

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site pointed to the versatility of denticulates in working on different tasks related to butchering and woodworking. The denticulates examined were used in both a transversal fashion (scraping) to work hard materials like wood or bone and, in less stent, in a longitudinal fashion. Then, we proposed further work on a larger selection to throw more light on the types of activity undertaken. The results of this study are now presented.

Keywords: Denticulate, Notch, Mousterian, Quartz, Neanderthal, Use, wear, Versatility, Iberian Peninsula

"Well, that's heartwarming, but..." Lawrence H. Keeley's Contributions to Traceology and Reconstructions of Human Behaviour (1972 -2017)

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In the preface to *Experimental Determination of Microwear Traces, A Microwear Analysis* (1980), Lawrence H. Keeley states that "It is my greatest hope that this book will encourage students to undertake work on stone implements of interest to them and to our profession." While a doctoral student at Oxford in the early 1970s, Keeley refined the high-powered technique for traceology (microwear analysis) pioneered by S. A. Semenov. When the results of his "blind test" with Mark Newcomer was published, researchers realized that it was possible to determine the function of ancient stone implements from microscopic examination of the wear traces on their edges. Beginning with his first student, Patricia Anderson, and the Lithic Analysis workshop he offered in Chicago at the University of Illinois in the late 1970s (attended by Annelou van Gijn, Doug Bamforth, and Nick Toth, among others), until his death in 2017, Keeley's influence on traceology has extended to the far corners of the world. In this brief retrospective, Lawrence H. Keeley's contributions will be outlined, and the highlights of his distinguished career will be summarized. From the time of his early research on British Lower Paleolithic assemblages to his long collaboration with Daniel Cahen and his UIC students on Mesolithic and Neolithic adaptations in Northern Europe, Larry was engaged in cutting-edge research that combined rigorous experimental replication, refitting, residue analyses, and microscopic examination of ancient artifacts. The results of these investigations provided remarkable new details and insights about the lives of ancient people, from ancient hominins at Kobi Fora, Kenya to foragers and farmers who lived in both the Old and New Worlds. In 1995, Lawrence Keeley received the Society for American Archaeology's Award for Excellence in Lithic Studies, however his real legacy is found in the outstanding research that is conducted by the new generations of scholars that he inspired.

Keywords: Lawrence H. Keeley, Traceology

*Speaker

Seal scrapers" from Sventoji – possible function and technology of production.

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During the excavations carried out at the complex of subneolitic sites in Sventoji, Lithuania (sites 1, 4, 6 and 23), 25 extremely interesting bone products has been discovered. Due to the characteristic of the use-wear and technological traces, which are macroscopically readable on their surface they were defined as "scrapers". Those dated ca. 3000 inch BC tools were made of harp seal tibia, about 70-80 % of them from right side bones. The presentations will show the results of experimental studies and multi-faceted traseological analyzes, which have become the basis for the interpretation of the possible function and technology of the production of these unique artifacts.

Keywords: Sventoji, use wear, bone technology, scraper

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