Looking for New Methodologies for Studying Bone, Antler and Tooth Industry First Setting of Image Analysis

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Looking for New Methodologies for Studying Bone, Antler and Tooth Industry

First Setting of Image Analysis

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Abstract: Here a small paper aiming to precise the goals and methods set into the laboratory of microscopy and imaging at the MAE of Nanterre (CNRS, University Paris Ouest NanterreLa Défense and Paris-1), dealing with bone technology and functional approach. Around the lab, methodologies and courses are dispensed. Students and researchers are trained. It makes emerging new methods and program of research based on the elaboration of web databases as referential for bone objects technology and function.

The paper comes from a poster presented at the conference, which the figure reproduces.

Keywords: Bone, Technology, Function, Methodology, Imaging

Let's first remind the research context where the study of bone artefacts study took place. While technology as a method started to be developed after Stordeur (1974), functional analyses became more systematically applied on bone, after D. V. Campana's work (1980 & 1989), with the aim of answering historical, anthropological and cultural questions (Stordeur and Anderson 1985; Sidéra 1989 and 1993; Lemoine 1997; Aimar*et al.* 1998; Christidou 1999; Cristiani 2003; Maigrot 2003; Legrand 2005, 2007; Buc and Loponte 2007; Tartar 2009; Buc 2011; Vornicu 2013; Petrullo 2014). Researchers often undertook low and high power analyses separately, rarely as a whole. Indeed, these two levels of analysis obviously do not focus on the same criteria and this makes the functional identification process very different from one method to the other. As D. Stordeur suggested in the 80's, and as one of us began (Sidéra, 1993) then R. Christidou developed (1999), we applied systematically both low and high power analyses in a continuous chain of magnification, from the largest to the most detailed view. At all scales of enlargement, each attribute of use-wear is characterized, i. e. *volume's deformations and surfaces alterations* (sidéra 1993), then associated, aiming to precise functions of bone tools whatever their morphologies are (Legrand & Sidéra 2007). This provides a complete overview, which emphasizes the use process through the elaboration of a *chain of use* (Sidéra & Gi-

acobini 2002; Sidéra 2012), and helps interpretation. Of course it is based on comparisons with an experimental referential as well as with well-referenced ethnographic artefacts (Legrand and Sidéra 2007).

AN OPTICAL AND IMAGING PLATFORM FOR RESEARCH

In the 90's, a new need emerged, in order to overcome the limits of this classical approach. Indeed, the functional characterization depicted above is a qualitative appreciation of use based on presence/absence and combination of diagnostic attributes (such as morphology of the volumes smoothing, flaking, crushing, shape and nature of the striations, micro-reliefs and surface smoothing, etc.). Thus, it appeared necessary to objectivize the functional identifications, or more simply, to complete the observation, testing other types of method based on measurement and automation (on the example of the methodological exploration done on phytoliths by G. Colliot and P. Anderson-Gerfaut in 1997).

Microscopy combined with imaging analysis, a domain borrowed from biology and medical studies, seemed at this time to be appropriate to reach these objectives, as it has given results for modelling fossil dental use-wear to rebuild diet (for example Grine 1987; Merceron*et al.* 2005). Obviously, it is necessary to distinguish taphonomic features (Morel 1986; Olsen 1989) from genuine use to eliminate the "noise". Indeed, this is a limit of this method, as different types and origins of traces overlap on the pictures, which need to be manually cleaned up for applying successfully imaging processing. In order to work on these questions, one of us (IS) created a technical platform dedicated to microscopy and imaging, the *Service d'Imagerie et de Microscopie Optique* (SIMO) at *Maison Archéologie et Ethnologie, René Ginouvès* (MAE, Nanterre, France; CNRS – Universités Paris Ouest Nanterre La Défense, Paris-1) (http://www.mae.u-paris10.fr/service-imagerie-et-microscopie-optique-simo/). Its equipment consists of three different types of microscopes: a Nikon SMZ1500 stereomicroscope, a Nikon E600 POL polarized light source microscope and a Nikon ECLIPSE M600 optical microscope. The all three are linked to cameras (Nikon DSRi1 et DSFi1) and imaging software (Nikon Nis Elements BR).

The partnership between the*Service d'Imagerie et de Microscopie Optique* and the lab *UMR*7055 *Préhistoire et technologie* leads to a specialized training of Master, Phd students and researchers from different European countries in Bone artefacts technology, use-wear analysis and imaging process in microscopy.

IMAGE DATABASES ONLINE FOR BONE TECHNOLOGY AND USE-WEAR

Microscopical studies create a huge image documentation, thousands of pictures from which only a few are published. This documentation represents a rich databank and deserves to be organized and published under other format as the usual paper. The Web is a good space for it.

In 2011, the *Service d'Imagerie et de Microscopie Optique* received a financial support within the frame of the *Institut du Numérique* (University Paris Ouest Nanterre La Défense), for creating an image database concerning archaeological bone objects corpus. This database proposes to researchers and students a new tool for bone industry studies, via representative photos of technological and use-wear traces and all kind of damages. One collection, Khirokitia (Aceramic Neolithic, Cyprus) is already available online http://bddmicroimages.mae.u-paris10.fr/login/.

To identify the technical traces, to understand the sequence of implemented techniques, and to match use-wear with a worked material and with a mode of use, comparison with a referential is necessary. Thus, since more than twenty years ago, we have been collecting bone objects coming both from experiments and ethnographic contexts, for documenting either the most frequent archaeological artefacts, i. e. awls and cutting edge tools, or particular types of tools, hooks for example. Ethnographic artefacts complete the experimental referential in illustrating more particularly long lasting used objects. Today, this collection comprises nearly 200 bone, antler and dental objects (Sidéra & Legrand 2006). It is reserved to specialists in a limited access at the lab UMR7055 *Préhistoire et technologie*. In the future, it will be available on the WEB. This is a part of the research program *Labex "Les passés dans le présent"*, hold by the University Paris Ouest Nanterre La Défense and CNRS. (plate Ⅻ)

WHAT DID IMAGING PERMIT AND WHAT CAN WE EXPECT?

We tested several functions on experimental and archaeological used bone offered by the software Nis Elements BR (Nikon).

The panoramic view, which gathers different shots on one picture, offers a good visual support of the development of use-wear, which helps the identification and its illustration.

The same principle of gathering different shots is applied to "*Z*" acquisition, with a motorized system and an automatic treatment. It permits to have a sharp picture, particularly useful for rugged relieves. This is the first step to get a 3-D view, which emphasizes the relief, and to reconstitute a micro-relief profiles in order to measure deviations between highest and lowest points. These last functions aim to compare different relieves' profiles in order to measure the

rubbing level according to categories of material worked: supple, soft, resistant, tough.

Obviously, this is only a start and much more can be done with the image analysis. The main idea is to be able to model bone use-wear in the future, working on pattern recognition, within the limits we discussed above. As a complement of image analysis, other types of optical methods can be applied to acquire more objective data. We tested spectroscopy with the aim to determine whether a structural shift is linked to use or a technical treatment, if bone was heated for example (Piquard 2013). This analysis confirms that the bone structure is modified but cannot reveal the origin or process of this modification (Piquard *op. cit.*).

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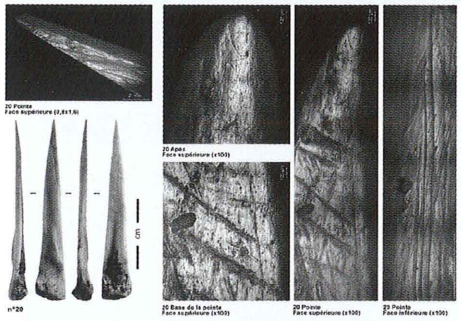
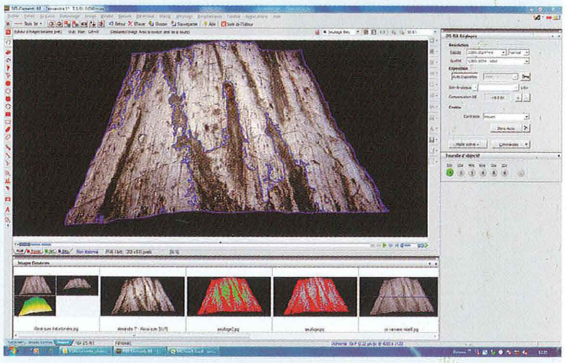


图像分析　Imaging process

全景绘制　Panoramic view

强度测验图　Intensity RVB profile



绘制 3D 图　3D view

参考数据库和语料库的技术骨架　Image database

翻译
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