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Introduction

Innovation in the production and use of equipment in hard animal materials: Origins and consequences in prehistoric societies, from the Palaeolithic to the Mesolithic

Since the earliest stages of prehistory, humans have struggled to adapt to changing environments through the use of many different materials. Amongst these, bone and hard animal material in general played an important role, along with stone and probably other perishable materials as well, such as wood, which have not survived to the present day. Particularly during the Upper Palaeolithic, various osseous materials (bone, antler, ivory, tooth …) were used as raw material for making equipment used for processing, hunting and personal or "symbolic" ornaments, mainly because the economic and technological basis of Pleistocene hunter-gatherers revolved around the use of the entire faunal spectrum.

1. The study of prehistoric societies in light of their inventions

Human history is nourished by inventions. In prehistory, they span the evolution of societies and permit the identification of cultures through their structured technical system. The analysis of technical or functional innovations is thus an effective research orientation for the study societies without writing, since it allows us to understand how innovations upset within preexisting system and forcibly lead to its restructuration. The new stability that results then characterizes a new cultural phase, until tensions, originating from inside or outside the society, create the conditions that lead to the emergence of other new inventions. By studying this invention/stabilization cycle, we obtain a better understanding of the construction and "periodicity" of prehistoric societies.

Along with the complexity of the mechanism of innovation, another process with very similar archaeological consequences must be taken into account: the process of diffusion. As it is sometimes very difficult to distinguish between invention and borrowing, especially when they occur within a short period of time, this issue raised by Leroi-Gourhan is often neglected. Leroi-Gourhan (1945) believed that the existence of an "inner" environment, ready to integrate a new technical element was essential, whereas its nature was of minor importance. Nonetheless, the particular nature of each case study must be identified (invention, borrowing, real innovation or new emergence), in order to reach a valid cultural interpretation, referring back to the hypothesis of communication and movement between human groups. It is therefore fundamental to decipher, in each case, the nature of a morphological or technical innovation.

The different solutions chosen by different human groups according to technical, economic, social, or even symbolic (in the true sense of the term, meaning "sacred") parameters, represent the cultural identity of the authors. Research leading to the identification of transformation processes and methods thus has, from a palaeohistoric point of view, a tremendous informative potential.

2. The exploitation of osseous materials and the study of inventions: a very productive field

As it was subject to multiple innovations, the exploitation of osseous materials (bone, ivory, antler) is a very productive field for research on the appearance and diffusion of inventions.

Though this technology was known since the early stages of Lower Palaeolithic and Middle Paleolithic, it remained limited to bone fracturation and to direct shaping of elements such as teeth and phalanges. At the beginning of the Upper Palaeolithic, during the Early Aurignacian techno-complex, the exploitation of osseous materials shows significant changes: new materials were worked (especially antler), new techniques were used (such as sawing and grooving), and new concepts were applied to manage productions (such as debitage by segmentation or by bipartition) and shaping (from slight, it becomes partial or total) procedures employed (Averbouh, 2002; Tejero et al., 2012). One of the most important innovations we observe in the Aurignacian hunter-gatherers' groups in Eurasia is the emergence and diffusion, at around 40Ka years ago, of a newly and complex technology of hunting weapons made on osseous (namely antler) raw material (Tejero, 2014). The antler projectile points substitute the hunting weapons made on lithic and/or wood at the time that Anatomically Modern Humans (AMH) arrives at Eurasia from their African original niche. In the Gravettian, significant changes were made: debitage by extraction, mainly of rods, appears in different European contexts. However, it does not substitute definitively the aurignacian technical traditions during certain phases of the Gravettian in France (Goutas, 2004, 2009) or in Moravia (Klima, 1987; Goutas, 2015).

Thus, it is within the first half of the Upper Palaeolithic, that the main inventions concerning the work of osseous materials are done: various techniques and the five major transformation processes. These will govern the transformation of hard animal materials during the following periods.

From an analytical perspective, the identified innovations refer back to each end of the analysis grid: the technique and

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transformation schemes. The technique, considered here in the sense of "technème" (Averbouh et al., 1999, Averbouh, 2000), represents the first practical technical element (the conjugated action composed of a gesture, a tool, and a material). The transformation scheme designates the general conception of the exploitation of a block (and thus the main principles of acquisition, transformation and function of the final objects). Situated between the two, processes correspond to the practical part of the work (combining multiple gestures and often multiple techniques aiming at a given goal), and the method of debitage or shaping corresponds to the conception of these major practical operations.

3. The GDRE PREHISTOS and UISPP work-session's themes

In recent decades, different lines of research on hard animal material industry (initially typological, later technological and functional) have expanded vigorously. Nevertheless, our understanding of production and use of hard animal material is still sketchy, as few studies have focused the latter two approaches. New methodologies for analysing hard animal material industry, inspired from lithic technology, are available since the last fifteen years for osseous technology (Averbouh, 2000, 2001). They have allowed this industry to participated side by side with lithic material to propose new chrono-cultural seriations or to refine existent (Goutas, 2004, 2015, Tejero, 2013). The challenge for the coming years should be to propose a more realistic reinterpretation of prehistoric societies in order to question the pertinence of our palaeohistoric reconstructions.

This GDRE – UISPP Work session propose analysis of various aspects of osseous industry, in particular the emergence and development of certain technical innovations. These are considered to be a reflection of the evolution of societies, and they facilitate the identification of different cultural units that are structured via their technical systems. This is thus one of the major thrusts of research into these preliterate societies as it allows to understand how they changed the terms of a pre-existing system and -necessarily- led to their restructuring. The resulting new stability characterised a new cultural stage before once again, intra or extra-social tension bred the conditions for new inventions. We hope that the invention/stabilization cycle mechanism can help to improve our understanding of the development and periodization of prehistoric societies. This broad issue has been studied by the members of the GDRE PREHISTOS (CNRS) for several years (www.gdreprehistos.cnrs.fr). The major changes (at all levels) that affected Palaeolithic and Mesolithic nomad communities is what led us to choose this chrono-cultural framework for this GDRE PREHISTOS work-session associated to the « Exploitation of Hard Animal Materials » session of the 17th UISPP Congress.

The first two themes of the GDRE – UISPP Work session deal with two major conceptual inventions, one technical, the other functional. They are also the two major thrusts of research by the GDRE Prehistos. In order to enrich debate, in addition to the two proposed issues, a « free topics » third axis has been proposed.

3.1. Theme 1: appearance and diffusion of "debitage by extraction"

The first theme concerns debitage by extraction which consists of selectively extracting a defined portion from a piece of raw material in order to obtain blanks with standardized forms and dimensions, which in turn facilitate the manufacturing of standardized tools. This debitage procedure is conceptually similar to the laminar debitage procedure (Averbouh, 2000: 154; Goutas, 2009) in stone working in that it allows blanks of a similar shape, artificial and standardized, to be produced. The "baguette", whose shape is close to that of blades, is the best known of these blanks. This capacity to produce series of identical blanks and then finished objects lead to the standardized mass productions that characterize the evolution of some categories of objects, such as projectile points.

Therefore, the extraction processes involved in producing a blank are potentially numerous; some have already been identified, such as the longitudinal delimitation of "baguettes" by convergent grooving associated with detachment by indirect lateral percussion (Stordeur-Yédid, 1979), or the delimitation by longitudinal parallel grooving and transversal cutting at the end of the blank, associated with detachment by indirect lateral percussion (Averbouh et al., 1999, Averbouh, 2000), or partially delimitated extraction, with a marginal preparation of the fracture line by grooving on at least one side wedge together with longitudinal detachment of the blank by splitting (Goutas, 2003). In the same manner, beyond the particular conception it imparts to the debitage of a block, and thus to the category of blank produced (flat or voluminous) the debitage by extraction method can be applied to a wide range of possible variations, such as the type of blank (baguette, disc, "plaquette", etc.) or the location of the extraction on the block, the number of blanks produced, the process of debitage used, etc.

Meanwhile, the practical means of employing this method and the technical procedures used varied during this long chronological period. It is precisely these aspects and the appearance of this invention that can be explored by a collective research program covering a broad chrono-cultural and geographic scale, enabling us to address the movements of populations and ideas between western, central and eastern Europe.

As the small number of communication concerning this theme points out, this invention seems still poorly known and only a few cases has been described in terms of technical and economic parameters.

3.2. Theme 2: appearance and diffusion of bevels in hafting systems

The second theme concerns the production of bevels in hafting systems. This functional invention played a major role especially for hafting projectile tips by ensuring greater adherence and flexibility between the item and the shaft (Knecht, 1991; Cattelain, 1995). This major functional innovation, which also seems to have emerged during the Early Upper Paleolithic, has for the moment been observed on projectile points and armatures.

Both typological and technological characterization of the bevel such as location, extent and position of the unifacial or bifacial bevel on the piece, technical realization… is lacking, as for the objects on which they occur they need to be listed, and an eventual relationships between this hafting system, the animals hunted and the hunting techniques employed (Cattelain, 1997; Pétillon, 2006; Pétillon and Letourneux, 2006).

Once again, the objective of this GDRE Prehistos work-session associated to the UISPP Congress session was therefore to get examples of bevels in hafting systems from Paleolithic to the Mesolithic site. But communications on hafting system did not concern this specific case.

3.3. Theme 3: free topics

Communications covered by this "open" theme line lie within the session's main theme framework. Several communication topic raised questions about sociological or economic phenomena (without discarding environmental factors that may be involved) which generated technical changes, inertias or continuities in the evolution of the prevailing *know-how* in work on hard animals during the Paleolithic to the Mesolithic.

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