Ancient and Modern Bone Artefacts from America to Russia

Cultural, technological and functional signature

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Functional Analysis of Prehistoric Bone Instruments from the Uruguayan Atlantic Coast

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Abstract

In this paper we present the results of the microscopic analysis on a set of working tools made of hard animal tissue raw materials (bone and antler). These artifacts were found in La Esmeralda, a prehistoric shell midden settled in the Uruguayan Atlantic Coast. This work is the first attempt to use microscopic techniques to detect and interpret use and technological traces on bone tools recovered in Uruguay. Even though not every tool was analyzed with these techniques, in some cases we have obtained interesting results, which open new perspectives and expectations regarding to this subject.

Introduction

The presence of tools made from animal raw materials is common in prehistoric archaeological sites in Uruguay. Despite their abundance, these tools have been rarely studied scientifically, and the information currently available is very fragmentary. The studies that have been carried out have focused mainly on typological features, without exploring the functions these tools served (Pintos 2001). Based on those studies, Pintos proposed a relationship between the anatomical element and the tool's shape due to the frequency of sharp bone tools made from metapodials of pampas deer (*Ozotocerus bezoarticus*). The choice of this bone as a blank would have been conditioned by its shape, size and resistance. Since these variables would have been related to the tool's use, this work also dealt indirectly with the functionality of tools (Pintos 2001).

In our work, we are proposing an approach that enables us directly to recognize the past use of tools, in order to start exploring aspects such as the poli-functionality, shape versatility in relation with function, the opportunistic use of minimally shaped tools, and also the taphonomic issues that influence this type of analysis.

Tools made from animal raw materials in the production system.

Animals provide a range of resources, and tools made from their raw materials are related to production processes in two main ways. On the one hand, bone tools are the result of the exploitation of faunal resources. On the other hand, they can be used to produce such materials as pottery, vegetal materials, and other goods.
The double nature of bone tools requires a two-phase archaeological approach in order to understand the way in which these artifacts are articulated with the whole productive process.

The techno-typological approach, including the identification of species, anatomical elements and manufacture processes, is essential to evaluate the different uses of animals and their relative importance in animal management, as well as to recreate those activities involved in tools manufacture. The functional approach, with the objective of determining the kind of materials and the ways in which bone tools were used, is the only way to determine the productive processes involved.

In order to undertake this dual approach (technological and functional) it is necessary to implement an experimental program which examines the manufacture as well as the use of tools. The replication of manufacture activities allows us not only to understand the processes involved, but also to evaluate time and manufacture costs, and to understand why certain anatomical elements were used. The experimental use of these replica tools shows the diversity of use traces left by different materials and movements (twisting, pressure, scraping, etc). By analyzing these traces we can interpret the patterns found in the archaeological assemblage.

Methodology

Except for some authors, such as D'Errico (1993; D'Errico *et al*. 1995) and LeMoine (1994; 1997), who use the scanning electron microscope (SEM), the observation devices used by the majority of specialists to analyze use traces in tools made on bone, litic and other materials, are generally the same (Astruc 2002; Christidou 1999; Clemente 1997; Clemente *et al.* 2002; Stordeur and Anderson-Gerfaud 1985; Keeley 1980; Legrand and Sidéra 2007; Maigrot 2003; Mansur-Franchomme 1983; Plisson 1985; Semenov 1964; Sidéra 1993). Commonly, using a binocular magnifiers (stereoscopic microscope), with a magnification between 5 and 90x, the active parts of tools can be identified and certain diagnostic macroscopic traces can be analyzed such as, for example, impact fractures left on points used as thrown weapons (Dockall 1997; Fischer *et al.* 1984; Stodiek 2000; Palomo and Gibaja 2003; Pétillon 2004; 2008; Pétillon and Letourneux 2003). With the metallographic microscope (a.k.a. reflected light microscope) and magnifications between 50 and 500x, polished surfaces can be analyzed in detail and the specific traits can be characterized as products of particular worked materials. These traits include: striations, pecking, depressions or holes, etc. that give to surfaces an appearance that is more or less rough or even, of different brightness, etc.

Modern replicas of prehistoric tools allow us to create a comparative base in order to deduce the function of prehistoric artifacts based on the reproduction of the traces of use. We base the analysis of bone materials on the study of a wide experimental collection at the Laboratory of Traceology and Experimental Archaeology "S.A. Semenov", of the Institute of Material Culture, Russian Academy of Science, Saint Petersburg[1]. This collection of several hundred experimental tools made on bone and antler encompasses a variety of morphologies and a wide range of worked materials (non-woody plants, wood, bark, fur, leather, pottery, etc.). It is the result of several years of experiments carried out by a large group of students and researchers headed by G.F. Korobkova (Korobkova and Shapovskaia 2001). The observation of this experimental work has enabled us to gain a valuable training in the recognition and characterization of the wear traces in these materials[2]. In fact, as use traces are always the same, functional analysis then can be applied to bone materials from any geographical and chronological context.

When analyzing an artifact, we must bear in mind all those process it could have gone through, from the raw material acquisition, its transformation into the final product, its use or consumption, and its subsequent abandonment, since all can be reflected in the surface, even more in a material such as bone. In order to distinguish technological traces from those caused by use or taphonomic processes – including excavation and/or manipulation traces made by the researching team –, we must know how the tool was manufactured (Clemente 1997).

The microscopic observation of bone tools poses some difficulties. Commonly, taphonomic processes affect bone surfaces. For example, dragging and pressure from sediments with abrasive elements can cause the development of polishes and deep striations; in the same way, roots and temperature alterations (produced by the contact with fire) can leave marks on bone surfaces. Many times, these taphonomic modifications threaten the microwear analysis, and sometimes make it impossible to be carried out.

In this research, we used the microscopic observation equipment of the Archaeology and Anthropology Department of the Institution Milá y Fontanals (CSIC). We used a stereoscopic microscope Olympus SZX7, up to 90X and a metallographic microscope Olympus BX51 (100-400X).

Materials

The Uruguayan Atlantic coast has a rich archaeological record, but not all sites offer conditions good enough for bone tool preservation. In general, sites are composed of lithic materials and pottery, while bone is very rare or absent. This is due to those processes related to site formation, location and the post-depositional processes. In some sites mollusk (*Amiantis purpurata*) tools were recovered, which have been analyzed from a morphlogical point of view (Mañosa 2005) but not analyzed with microscopic techniques yet as there is no experimental reference collection.

The bone tool assemblage we analize here comes from La Esmeralda, a prehistoric location on the Uruguayan Atlantic coast (Figure 1). The site presents unique preservation conditions for bone material from the coastal (Moreno 2006). As a result, the deposit offered the posibility of studying the first bone tool assemblage recovered in the coast.

La Esmeralda is composed of various shell middens with different states of erosion and preservation. Radiocarbon dates place the occupation of this site around 3000-3200 years BP (Bracco 2001; Bracco *et al* 1999; López *et al* 1997; López *et al* 2002).

Shell middens are mainly formed by accumulation of the cockle valve *(Donax hanleyanus*), which constitutes more than the 90% of the mollusk species present at the site (López and Villarmarzo 2003; Villarmarzo 2007). The excavations carried out in the main shell midden (Estructure A) allowed us to recover a quite well preserved bone assemblage (Moreno 2005; 2006) composed by marine (fishes, marine mammals, turtles) as well as terrestrial species (pampas deer, armadillos, *ñandú*, undetermined canines), penguins (*Sphenicus magallanicus*) and other unidentified birds. The recovered bone remains are, in the majority of the cases, the material result of subsistence activities related to feeding, as cut marks, thermo alteration, and intentional fracture of bones confirm (Moreno 2005). Some unidentified attritional agent caused the concentration of small animal remains, particularly birds, in specific zones of the shell midden (Moreno 2005). A third subset of remains is composed by tools manufactured on bone and antler materials. In total, 11 fragments of tools made of antler and metapodials of pampas deer were found.

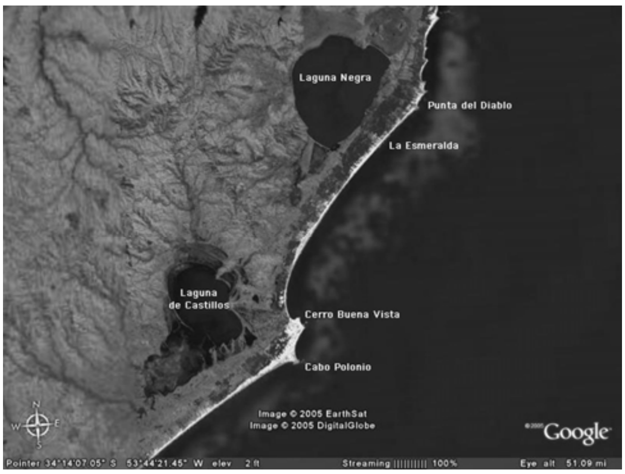

Figure 1: site location map.

Instruments made on antler

Eight items made from antler were found. Among them, five are antler points and the three remaining are fragments without the apical end.

Four fragments of tools made on antler show alterations potentially resulting from technological or use activities:

LE276: a black and white burnt fragment, broken on both ends, that preserves the cortical surface in the 50% of the piece (Figure 2a). At the thinnest end, it has an even surface that is very bright with random striations which are very heterogeneous in width. This variability in the traces could indicate that the piece was used on different materials (Figure 2b). Around 8-9mm from the end, we recorded one sector with larger and thinner grouped striations, which do not show so much size variability and are arranged in a parallel way. These striations could correspond to technological traces (Figure 2c; Le Moine 1997).

LE236: a burnt fragment, broken on both ends, that has lost its cortical tissue (Figure 3a). The surface shows striations probably caused contact with sediment grains (Figure 3b), as they are located in the elevated topography areas on the fracture zone. Another kind of striations was also recognized. They are longitudinal and bright, probably of technological origin. Lastly, we identified a worked surface, where the polish is placed above the previous traces (Figure 3c).

LE509: a fragment broken in one end but that maintains the point intact and the complete cortical surface (Figure 4a). The piece is burnt (black in color), but the point is charred. On the exterior convex surface, we found perpendicular striations running obliquely to the longitudinal axis, which can be attrinuted to use (Figure 4b). This piece also shows another group of longitudinal and oblique striations, but they are more shallow, some of them light and other ones dark (Figure 4c). In the external face, near the broken edge, there are wide bright bands visible to the naked eye. Under the microscope, we can see that these bands are composed of striations oriented parallel to the axis of the piece, probably technological in origin (Figure 4d). On the internal concave face, in addition to striations, we also record rough surfaces, polishes and depressions. This kind of traces could be due to the use of the tool on leather (Figure 4e).

LE538: a fragment broken on both ends, burnt and charred, that maintains the entire cortical surface (Figure 5a). We found striations arranged in a random way, depressions and bright surfaces. These features can be due to post depositional processes, manufacture or use activities, or either a combination of these causes (Figure 5b).

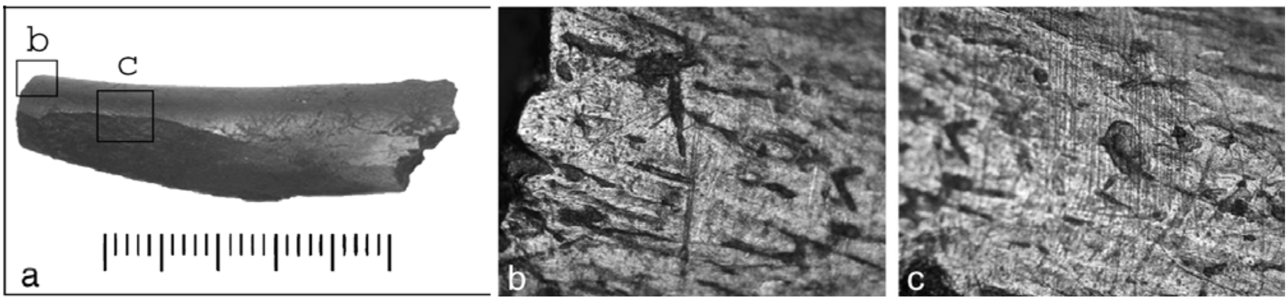

*Figure 2: **a)** LE276; **b)** smoothed area in the thinnest end next the distal fracture with grooves of no preferential direction, with a predominance of those transverse to the longitudinal axis of the piece (100x); **c)** larger grooves arranged at 8-9mm from the previous ones that probably indicates a rotation movement (100x).*

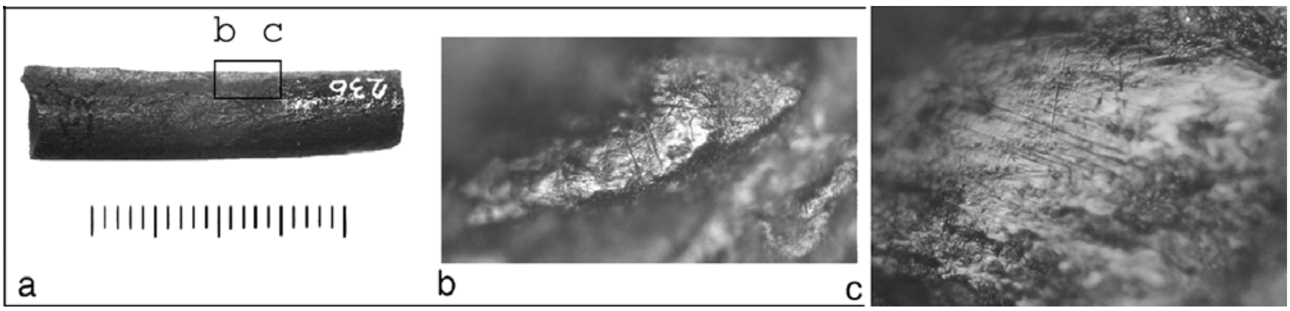

*Figure 3: **a)** LE236; **b)** grooves caused by sediment grains, post-depositional disturbance in the fracture edges (400x); **c)** probable use traces superimposed to technological grooves of the surface polishing (400x).*

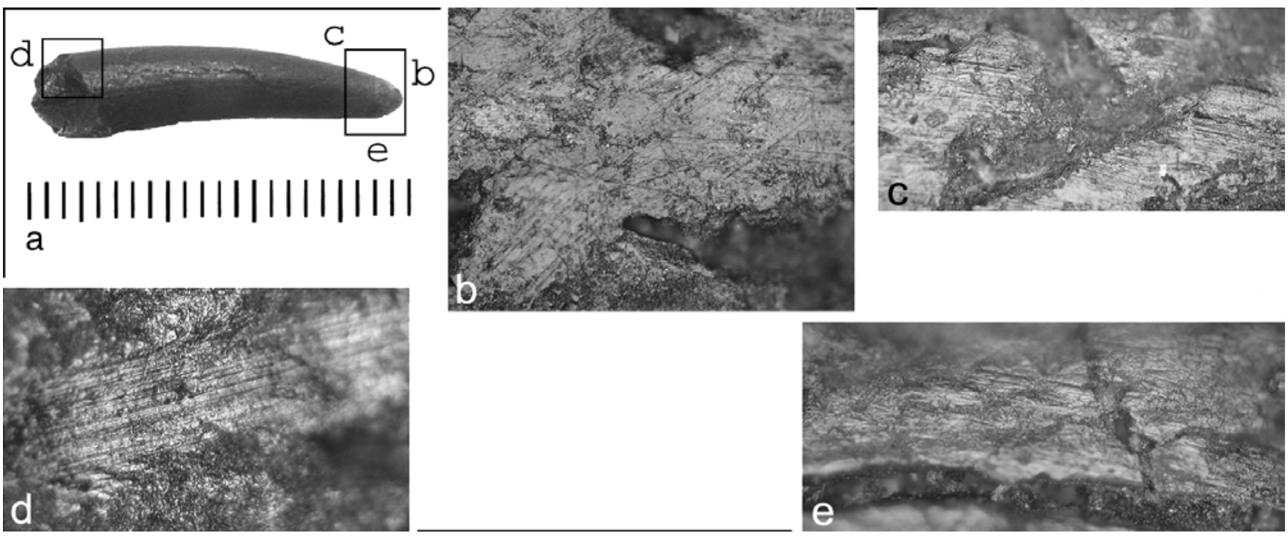

*Figure 4: **a)** LE509; **b)** grooves crossed and oblique to the longitudinal axis, which can be assigned to use (400x); **c)** longitudinal and oblique grooves that are more shallow, some with a light background and others with a dark background (200x); **d)** wide bright bands probably made during manufacture by (200x); **e)** traces due to the use of the instrument working on skin (400x).*

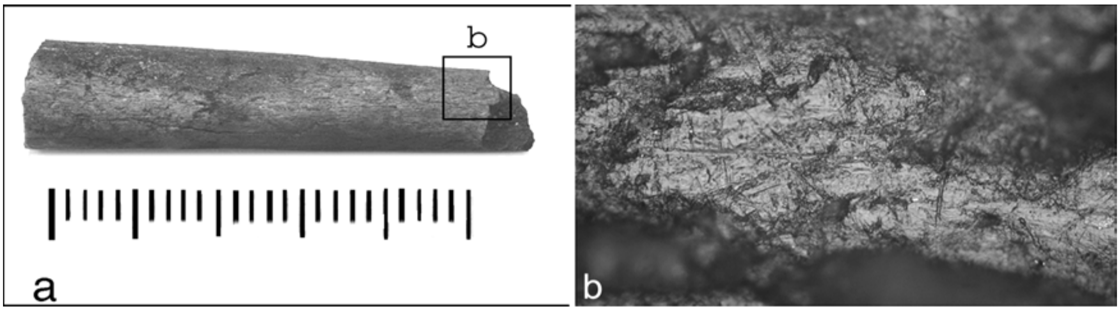

*Figure 5: **a)** LE538; **b)** undeterminated traces (400x).*

Instruments made on metapodials

Only three fragments of tools made on metapodials were recovered, and none of them showed use traces when observed at high magnifications. At low magnifications and naked eye, technological traces are observed in the three cases.

LE141: a fragment of a sharp instrument that preserves only the distal part (Figure 6). Even though we could not observe traces at high magnifications, at low magnifications and naked eye the surface appears bright and with a flat texture that appears to be the result of final polishing. On one side, the tool shows a negative of flake detachment; then, the point was reactivated.

LES/N: a fragment with a high degree of manufacture and root marks concentrated in only one face of the piece. It is broken on both ends, and has a type of fracture that corresponds to an impact against something hard, suggesting that this piece may have been used as a projectile point (Figure 7; Pétillon 2006).

These striations are parallel and longitudinal in relation to the tool axis. Above them, we can observe a posterior polishing which gives brightness and a soft texture to the piece.

Figure 6: LE141, fragment of a sharp instrument made on pampas deer metapodial.

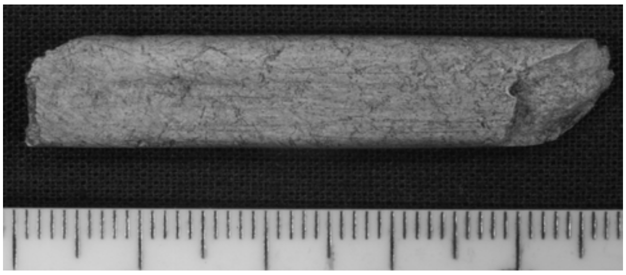

Figure 7: LES/N, fragment of a probable projectile point (impact fracture?) made on pampas deer metapodial.

Conclusion

Even though the results obtained are partial and non conclusive, and only in one case traces could be interpreted in functional terms so that we could deduce the use of the tool (LE 509), this analysis allowed us to advance the technological and functional characterization of tools and to test the consequences of the taphonomical conditions on them. In this particular case, we must emphasize the role of taphonomic modifications (thermal alterations, contact with grains of sediments) played on remains' surfaces, which have prevented us from conducting a more thorough study and obtaining more conclusive results.

This is the first high-magnification analysis performed to observe traces on prehistoric bone tools in Uruguay, and it is interesting as a way of initiating a new line of analysis and testing its limits and possibilities, not only in terms of the raw material but also regarding the type of sites and the specific processes of site formation. For the moment, functional studies are being conducted on bone tools from continental archaeological sites which, because of their better preservation, are providing more conclusive results than those achieved in La Esmeralda. The continued application of this analysis on other assemblages from other contexts will be very usefull for the study of functionality in the bone industry in general, in order to integrate bone tools within the whole production process and to know more in depth the variability in the use of animals in the Uruguayan prehistory.

Note 1: *Our thanks to G.F Korobkova † and T.A. Sharovska for letting us the access and study of this vast experimental collection; and the constant help of E.Y. Girja during the stays (2000; 2005) in the Institute of History of the Material Culture of the Russian Academy of Sciences, Saint Petersburg.*

Note 2: *Then we continue to conduct experiments with bone tools and canines in order to resolve isolated questions (Clemente* et al. *2002; Clemente and Gyria 2003).*

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