What about shells? Analysis of shell and lithic cut-marks. The case of the Paraná wetland (Argentina)

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What about shells? Análisis de conchas y de marcas de corte. El caso del humedal del Río Paraná inferior (Argentina)

KEY WORDS: Shell, cut-marks, lithic and bone tools, Low Paraná River wetland, technological integration.
PALABRAS CLAVE: Concha, huellas de corte, artefactos líticos y óseos, humedal del Río Paraná inferior.
GAKO-HITZAK: Kuskuak, ebakidura-arrastoak, harrizko eta hezurrezko tramankuluak, Paraná ibaiaren beheko zatiko hezegunea.

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ABSTRACT

One feature that defines the archaeological deposits located in the Low Paraná wetland (Pampean Region, Argentina) during the Late Holocene is the abundance of malacological remains. Moreover, in the technological matter, assemblages are characterized by a low number of lithic tools and a great abundance of bone tools. In previous papers we stated that the technology in this region is defined by a strategy of complementation of both materials. The aim of this work is to include malacological remains as an alternative source of raw material, mainly in the use of cutting edges. For that purpose, we developed an experimental program in order to evaluate the technological possibilities of shells as tools used in bone processing. Particularly, we analyze the cut-marks made by shell and lithic edges. Our results show that it is possible to differentiate cut-marks made by both materials. However, to distinguish shell cut-marks in the archaeological record poses some problems, basically regarding bone tools and multiple taphonomical factors.

RESUMEN

Uno de los rasgos que define a los depósitos arqueológicos localizados en el humedal del Paraná inferior (Región Pampeana, Argentina) durante el Holoceno tardío es la gran abundancia de restos malacológicos. Por otro lado, en términos tecnológicos, los conjuntos se caracterizan por una baja cantidad de artefactos líticos y una gran abundancia de artefactos óseos. En trabajos anteriores planteamos que en el área la tecnología se define por una estrategia de complementariedad entre ambos materiales. Este trabajo tiene como objetivo integrar los restos malacológicos como una fuente alternativa de materia prima, fundamentalmente en el caso de la utilización de filos cortantes. Para ello, desarrollamos un programa experimental donde se evaluaron las posibilidades tecnológicas de las valvas como artefactos para el procesamiento de materiales óseos. En particular, se analizan comparativamente las marcas de corte producidas por filos líticos y de valvas. Los resultados indican que las marcas de corte producidas por ambos materiales son claramente diferenciables. Sin embargo, el reconocimiento de las huellas de valvas en el registro arqueológico es problemático, especialmente si tenemos en cuenta el conjunto de artefactos óseos y los múltiples factores tafonómicos.

LABURPENA

Paraná ibaiaren beheko aldeko hezegunean (Panpa eskualdea, Argentina) aurkitutako Holozeno berantiarreko depositu arkeologikoaren ezaugarri bat hondakin malakologikoen ugaritasuna da. Bestalde, termino teknologikoetan, harrizko tramankulu gutxi ageri da multzoetan, eta hezurrezko tramankulu ugari. Aurreko lanetan planteatu genuen, alor honetan, bi materialen arteko osagarritasun-estrategia gisa definitzen dela teknologia. Lan honen helburua da hondakin malakologikoak lehengaien iturri alternatibo gisa integratzea; batik bat, aho zorrotzen erabilerari dagokionez. Horretarako, programa esperimental bat garatu genuen, kuskuek hezurrak prozesatzeko zer aukera teknologiko dituzten ebaluatzeko. Zehazki, hezurrezko ahoek eta kuskuzkoek egindako ebakidura-markak aztertu eta alderatu genituen. Emaitzen arabera, material batez egindako ebakidura-markak eta beste materialaz egindakoak argi eta garbi bereizteko modukoak dira. Hala ere, erregistro arkeologikoan kuskuen aztarnak bereiztea ez da erraza; batik bat, hezurrezko tramankuluen multzoa eta faktore taxonomiko anitzak kontuan hartzen baditugu.

1. INTRODUCTION

This paper is framed in the general analysis of the technology of hunter-gatherer groups that inhabited the Low Paraná's wetland during Late Holocene (1100-700 years BP approximately). Micro-wear analyses carried out on bone and lithic materials from our study area support the idea of functional complementation: while lithic tools are related to bone tool manufacture, these are oriented to obtain and process resources (Buc Silvestre 2006). Surely, this scenario of technological integration would have included other raw materials as wood and shell. In fact, local historical chronicles make reference to the use of shells as tools in different activities (Dobrizhoffer *sensu*

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Furlong 1965, Paucke 1944). Nonetheless, the use of shells as artifacts is not evaluated in local archaeological studies.

Particularly, both archaeofaunal remains and bone tools recovered in the Low Paraná wetland present cut-marks which were traditionally associated to lithic edges. However, given the proved efficiency of shell edges (Choi and Driwantoro 2007, Toth and Woods 1989) and the high availability of *Diplodon* sp. in the area, shell edges must also be considered as mark agents. Shells would have been an important alternative raw material, basically, considering the scarcity of the lithic archaeological assemblage and the regional distribution of lithic sources (Loponte i.p. Sacur, 2009). Consequently, despite the general frame of lithic and bone investigations above mentioned, the main purpose of this paper is to evaluate the use of shells as cutting edges on processing -particularly on cutting- bone and antler. Our goals are twofold: on the one hand, we test the efficiency of shells as cutting edges for hard materials, such as bone and antler; on the other hand, we start to generate a database of cutting marks made by lithic and shell edges on bone, expecting to identify differences in morphologies that will serve to distinguish patterns in the archaeofaunal assemblage (following also Choi and Driwantoro 2007).

2. ARCHAEOLOGICAL BACKGROUND

The Low Paraná's wetland is located between 32º 05` LLS and 34º 29` LLS, in the central-west portion of Argentinean Pampean Region (Fig. 1). Hunter-gatherer campsites are located in fluvial banks that are the highest environmental points and are surrounded by inundated plains. The diet of these groups was based on the intensive and systematic exploitation of fishes (Silurids and Characiforms) and deer (*Blastocerus dichotomus* and *Ozotoceros bezoarticus*), and also of medium and small sized rodents (*Myocastor coypus* and *Cavia aperea*). Isotopic analyses on human remains suggest that almost 30 % of the diet involved vegetables (Acosta i.p., Loponte i.p.). This picture was finally completed with molluscs such as *Diplodon* sp. and *Ampullaria=Pomacea*, both annual resources grouped in fixed banks. This situation implies low costs of mollusc collection for human groups (Loponte i.p., for a detailed synthesis of the environment and resources bases).

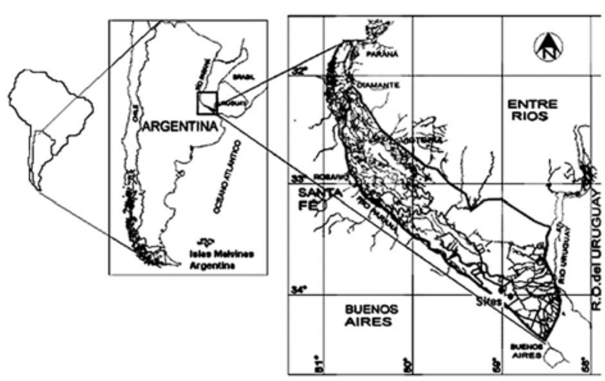

Figure 1. Study area: Low Paraná wetland (modified after Malvárez 1999).

All deposits have the same archaeological structure suggesting they were multi-activity areas with evidence not only of prey processing and consumption, tool manufacture and repair, but also of human inhumations (Loponte i.p.). The lithic assemblage is small, mainly composed of natural edged flakes, cores and grinding tools like manos and mortars (see Loponte i.p., Sacur). By contrast, there is a great quantity of different bone tools that include from harpoons, hooks of spearthrower and projectile points, to awls, pin-like tools and smoothers (Buc and Loponte 2007).

We think that lithic and bone material was worked in a complementary way (*vide supra*). Particularly, this paper is concerned on cut and sawing marks found in archaeofaunal bones. Even if most of the items are remains of faunal consumption, there are a great number of sawed bones interpreted as by-products of the manufacture of bone tools (see Acosta *et al.* i.p., Loponte and Buc i.p.). Moreover, in some cases, sawing was a technique used to decorate, or simply to mark bone tools (Fig. 2). Although it was traditionally assumed that bone incisions were done by lithic tools; in this work we explore the possibility of using shells as cutting tools.

3. MALACOLOGICAL REMAINS

The archaeological deposits of Low Paraná have thick lenses of *Diplodon* sp. Although most of them were recovered in their natural form, we also found some modified shells (Loponte i.p.). These include from symbolic items, such as *tembetás* (T shaped items used below lips) and beads, to apparently functional ones: shells with one or more right edges.

These accumulations are the result of relatively isolated discarding events during mollusc consumption made by hunter-gatherer groups. Consequently, shells would have been a raw material with high availability and no extra acquisition cost. In fact, historical chronicles mention the use of shells in different activities such as pottery

Figure 2. Bone tools with cut-marks as decoration.

manufacture, and leather or wood processing (Maradona 1974, Chiri 1972, Paucke 1944). Although several papers consider mollusc shells as raw materials for tools (Lammers-Keijsers 2007, Toth and Woods 1989),in our study area archaeological discussions have only emphasized their ornamental function (Chiri 1972), not considering their potential use as raw materials.

4. CUT-MARKS

Archaeological studies concerned in different subjects have dealt with the problem of cut-marks identification in bones. Considerable effort has been paid to analyze their morphology and patterning in order to discuss the presence/absence of certain human behaviours (e.g. Bunn and Kroll 1986; Shipman and Rose 1984, Binford 1981, Bunn 1981, Potts and Shipman 1981). Although the great majority of these papers are associated with lithic materials, a great number is focused on those features that can differentiate lithic from metal cut-marks (Christidou 2007, Greenfield 1999, Liesau von Lettow-Vorbeck 1998, Olsen 1988, Walker and Long 1977). Even if not only metal, but other materials were used as edges as well; much less attention has been paid to features left by shell edges.

Specifically on this matter, Toth and Woods (1989) made an experimental program cutting bone with shell knives and analyzed the traces they left. They conclude that "retouched molluscan shell knives are feasible butchery tools and can produce striations on animal bones that are similar to those produced by stone cutting edges" (Toth and Woods 1989: 254). Nevertheless, these conclusions are based on the analysis of retouched shells. Recently, Choi and Driwantoro (2007) performed an experiment testing natural shell edges, along with 12 lithic and non lithic materials (including dry bone flakes), in butchery activities. They used shells of a marine bivalve mollusc (*Veneridae*) from Florida. According to their work, in 60% of the cases, the natural fracture of shells produces blunt edges (nearly 90º) that can be used either in their cortex or inner surface. The authors distinguish two types of blunt edges that produce different cut-marks. One case is when the fracture forms an edge available both in the cortex and inner surfaces. In this case, the tool will be used in a tilted angle that will make a wide-open V groove in the surface (Choi and Driwantoro 2007: figure 6 C, H). The second case is when the edge is either on the irregularly broken cortex or the inner layer. This surface makes a wide, flat and shallow groove (Choi and Driwantoro 2007: Fig. 6D, I, L)[1].

Moreover, according to this work, shell striations are smooth (*sensu* Le Moine 1991) due to the pattern of perpendicular organized minerals in the shell cortex. This produces grooves with internal smooth bases, instead of longitudinal microstriations (Choi and Driwantoro 2007). Although the authors do not compare these marks with those left by lithic edges, we know that this is a differential aspect as lithic marks are well defined by their coarse striations (*sensu* Le Moine 1991). Multiple internal striations are product of the longitudinal movement made with rock grains which are randomly patterned.

None of both differences previously pointed out (morphology and profile of grooves) were recognized in Toth and Woods' (1989) paper because they used retouched shell edges that could have behaved like lithic ones. However, that work, like the one of Choi and Driwantoro, revealed that the performance of shell flakes is very efficient (almost as some lithic materials; Choi and Driwantoro 2007, Toth and Woods 1989). Therefore, for our study context of hunter-gatherers in the Paraná's wetland

[1] Because of their morphology, the inner layers produce thinner striations than those of the cortex (Choi & Driwantoro 2007).

during late Holocene, shell could have been an important raw material used to process animals for diet and technology; particularly to cut hard materials as bones and antler.

5. EXPERIMENTAL PROGRAM

For that purpose, we performed an experimental program cutting bones with natural shells and lithic flakes. Since lithic and shell are different materials, on the one hand, their edges have different morphologies; and on the other, they are composed of different elements singularly patterned. Therefore, the same activity (cutting) performed with different raw materials should leave distinguishable traces on the worked surface, bones in this case (see Fig. 3). Our

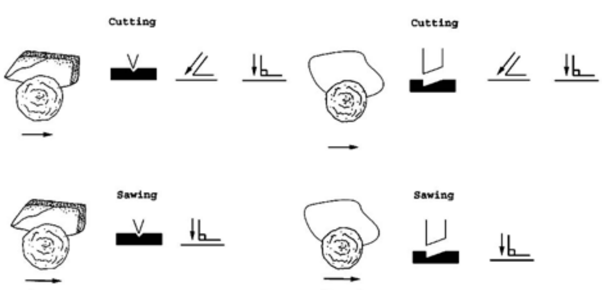

Figure 3. Cut-marks expectations (modified after Mansur 1986; Choi & Driwantoro 2007).

hypothesis is that sharp lithic edges will leave V-shaped profiles and coarse striations; while, more brittle asymmetrical shell edges will leave wide open V profiles and smooth striations.

In this exploratory programm, we used a total of nine shell bivalve edges (*Diplodon* sp.) to cut dry and fresh sheep bones (*Ovis aries*). One shell was used in its entire form (not fractured), but the rest of them were fractured, resulting in triangular tools with one 90º edge and the two others varying between 20 and 45º. On the other hand, we used eight lithic edges[2] with symmetric – or almost symmetric – profiles, and acute angles (between 20 and 25º). Raw material used was chert, a siliceous cryptocrystalline rock from Sierras Bayas formation, a quarry located in the south of Buenos Aires province. Although this location is more than 400 km away from the archaeological sites under study, there is solid evidence that this raw material was used in the Low Paraná wetland during late Holocene times (Sacur 2009, Loponte i.p., Buc and Silvestre i.p.). Table 1 synthesises the experimental data for both lithic and shell material.

Despite describing groove morphologies, we also expected to test the shell effectiveness in cutting and sawing bones like those one presented in local archaeofaunal samples. Given the brittle nature of shells, their edges were readily modified

Piece Nr.	Material	Worked material	State	Activity	Use time	Active Edge	Edge Angle	Bone Nr.
A8	shell	Bone	wet	Sawing	10'	modified	± 90	vE1
A7	shell	Bone	wet	Sawing	15'	natural	35	vE2
A11	shell	Antler	wet	Sawing	20'	natural	42	E18
A13	shell	Bone	dry	Cutting	20'	natural	32	-
Nº1	shell	Bone	wet	Cutting	12'	natural	33	-
Nº2	shell	Antler	wet	Cutting	9'	natural	25	E18
Nº5	shell	Antler	wet	Cutting	8'	natural	26	E18
A12	shell	Bone	wet	Cutting	5'	natural	27	vE5
C3	lithic	Bone	dry	Cutting	2'	natural	20,5	B1
C3	lithic	Bone	dry	Sawing	2'	natural	20,5	B2
C3	lithic	Bone	dry	Sawing	1'	natural	20,5	B3
C6	lithic	Bone	-	Sawing	20'	natural	21	-
C8	lithic	Bone	wet	Sawing	15'	natural	22	-
C4	lithic	Antler	wet	Sawing	20'	natural	22	E18
B21	lithic	Antler	dry/wet	Sawing	15´	natural	24	E9
B4	lithic	Antler	dry/wet	Sawing	35´	natural	36	E9
B14	lithic	Antler	wet	Sawing	1h 15´	natural	43	E8
B13	lithic	Antler	wet	Sawing	10´	natural	23	E8
B23	lithic	Antler	wet	Sawing	35´	natural	26	E8
B2	lithic	Antler	wet	Sawing	25´	natural	23	E8
E16	lithic	Antler	wet	Sawing	25´	natural	24	E8

Table 1. Summary of the experimental collection.

[2] We performed two experimental instances in the case of lithic flakes. In the first one we used five flakes to saw fresh bone and antler. In the second one, we used three lithic flakes to saw and cut fresh and dry bone.

after some minutes of work, very quickly in comparison to lithic tools. However, despite shell edges becaming rounded after 10 minutes of work, they do not loose their cutting effectiveness. In fact, one tool (A13) preserved its efficiency after 20 minutes of work.

Brittle shell edges are more easily chipped and flaked than lithic ones; and instead of this being a problem, it increases the tools' efficiency since it not only revives edges before dulling but also provides shell particles, which act as abrasives and facilitate the cutting activity. Moreover, in bone cutting and sawing, natural shell edges proved to be more efficient than those asymmetric dull edges (nearly 90º) obtained by direct fracture.

6. MICROSCOPIC TECHNIQUES

The analysis was made using three microscopic devices. A binocular microscope (Arcano XTL 3400) working at magnifications between 5X and 50X was used for initial examination, to provide general information about the extent and distribution of traces. Secondly, we used an incident-light metallurgical microscope (Zeiss Axiovert 100A). This microscope, working with perpendicular light, let us distinguish contact and characteristics of micro surfaces. However, its very short depth of field was a problem in this study given the high size of striations. For that reason, pieces were better seen under 50X, and only rarely we used 100X magnifications. Transversal cuts were seen under binocular and metallurgical microscope, but the best images were obtained under the last one. In third place, we used an environmental scanning electron microscope (ESEM) at 100X-150X to explore patterns defined by optical techniques in complete pieces. As this microscope works composing the image through the scanning of electrons discharged against the surface, we can obtain clearer images of sectors that cannot be appreciated with the short depth of field of the metallurgical microscope. To describe the microscopic patterns we mostly follow the terminology defined by LeMoine (1991) and Choi and Driwantoro (2007).

7. RESULTS

Microscopic analysis of bones used in our experiments leds us to distinguish differences in lithic and shell cut-marks morphologies.

Lithic striations are coarse, deep and have sharp walls; ESEM images clearly show their V profile (Fig. 4 and 5). Indeed, our images are very similar to those presented by other authors (Greenfield 1999, Liesau von Lettow-Vorbeck 1998, D'Errico 1993, Olsen 1988, Walker and Long 1977).

On the other hand, shell traces are smooth, and in the ESEM we could see that they have staggered walls and open V profiles (Fig. 6 and 7). In this case, our images are quite different to those presented by Toth and Woods after cutting bone with shell edges (Toth and Woods 1989: Fig. 4-6), and maybe this could be explained because of differences in the experimental programs. Toth and

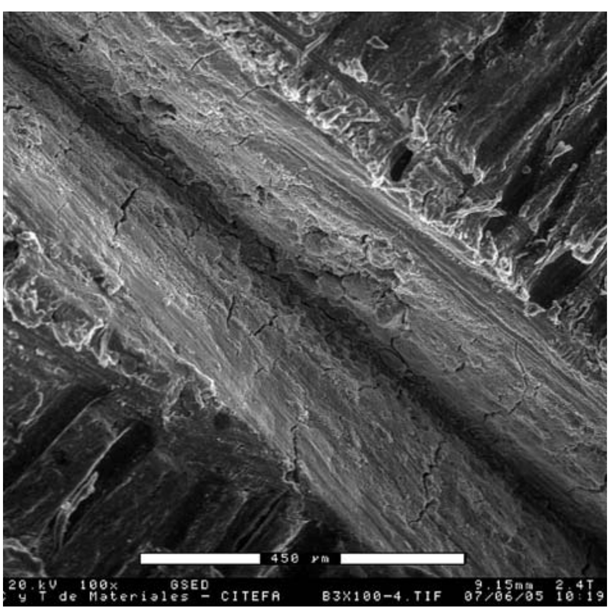

Figure 4. Lithic cut-mark left in bone (B3). Close V-shaped profile. ESEM. 100X.

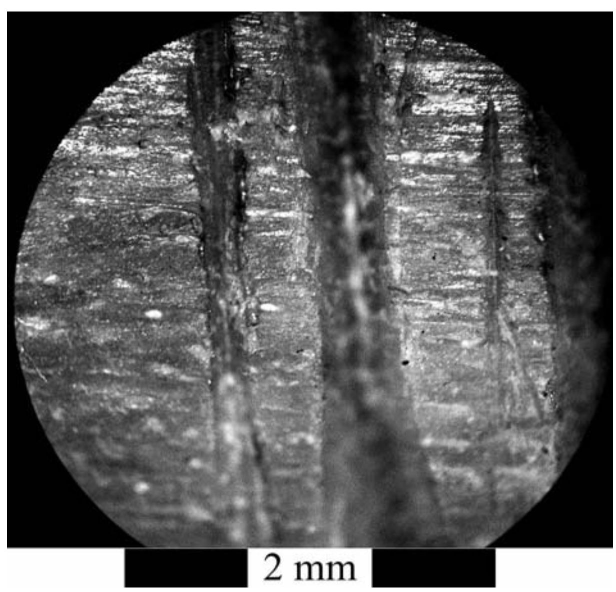

Figure 5. Lithic cut-mark left in bone (B3). Close V-shaped profile. Optical microscope. 100X.

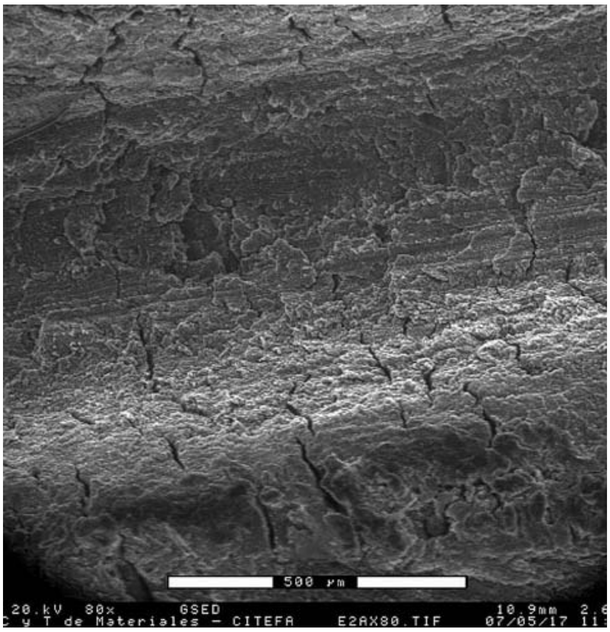

Figure 6. Shell cut-mark left in bone (VE2). Open V-shaped profile. ESEM. 100X.

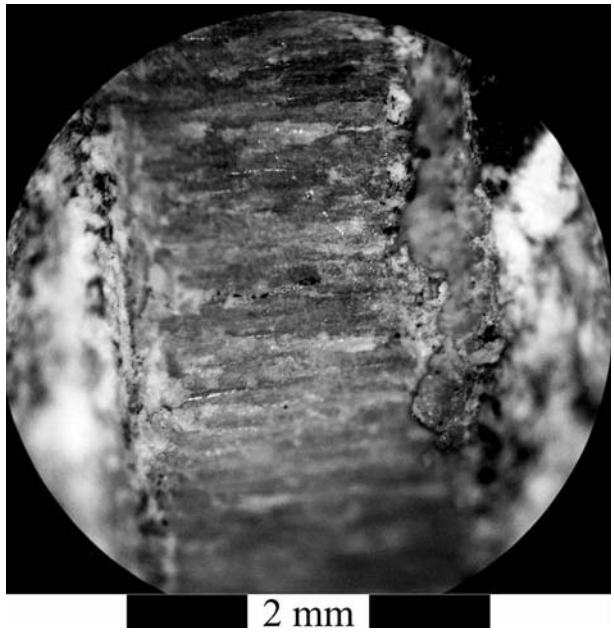

Figure 7. Shell cut-mark left in bone (VE2). Open V-shaped profile. Optical microscope 100X.

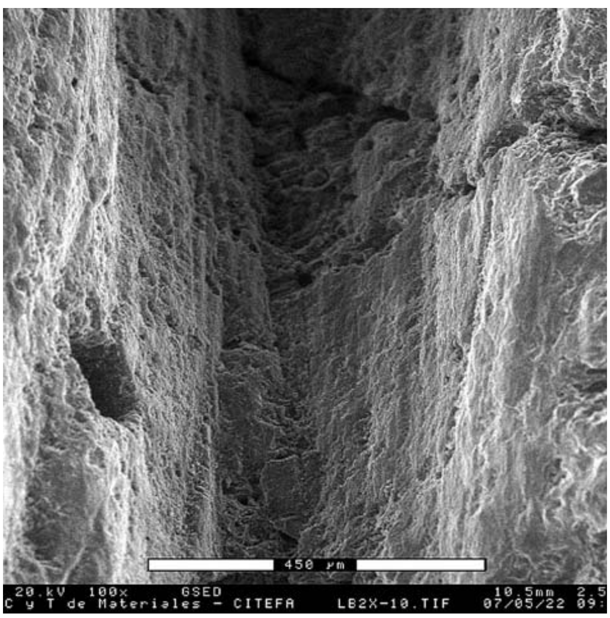

Figure 8. Archaeofaunal bone from LB2. Close V cut-mark. ESEM 100X.

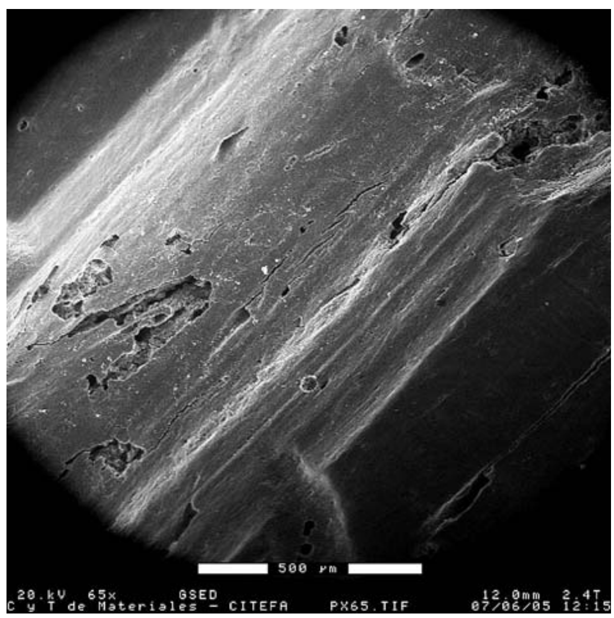

Figure 9. Archaeological bone tool (LB2 129). Open V-shaped cut-mark. ESEM. 100X.

Woods used American oyster and mussel as raw material, but retouched them to produce knives and this made edges with a very peculiar morphology. In our case, we used bivalve shells without modification. Therefore, our images are comparable with those presented by Choi and Driwantoro (2007), who also use natural shell edges. In fact, their figure L - a cut-mark made on bone with a blunt shell edge- shows exactly the same features that we recorded in our samples.

As we stated, like Choi and Driwantoro pointed out, most shell marks are either “wide open V grooves” or “flat and shallow canal groove” (Choi & Driwantoro 2007: 54). On the other hand, many authors defined lithic cut-marks as V-shaped (Greenfield 1999, Liesau von Lettow-Vorbeck 1998, D’Errico 1993, Olsen 1988, Walker and Long 1977). In order to test this idea, we made thin transversal cuts of both types of experimental cut-marks and performed a blind test. One of us analyzed the samples (n=5) in a metallurgical microscope and classified them as close or open V-shaped. Then, we confront these results with the experimental data, proving that those profiles classified as open V are associated with shells; while the close V-shaped marks were made by lithic edges (Fig. 10).

8. DISCUSSION

After these differences, we re-analysed some archaeofaunal bones and bone tools with cut-marks. We chose items from La Bellaca 2 (LB2), the site with the highest number of bone tools, and (paradoxically) the lowest quantity of lithic tools.

For example, the sawing mark of a metapodial from the La Bellaca 2 site, under the ESEM shows a close V profile, similar in depth and sharpness to lithic traces obtained in our experimentation (see Fig. 8 and compare with Fig. 4). On the other hand, we analysed one plat stemmed point (LB2 129, see Fig. 2) which preserves clear manufacture traces apparently not modified by use (see Loponte and Buc 2007). Under the ESEM these striations could be described as wide and with staggered walls, similar to shell traces obtained in our experimentation (see Fig. 6 and compare with Fig. 9). Nevertheless, in analysing bone tools, we must consider after-manufacture polishing: either final manufacture techniques or the wear formed by use might polish bone surfaces, even rounding previous cut-marks (Buc and Loponte 2007, Buc and Silvestre i.p., Buc 2005). Moreover, as these manufacture traces must have been made by scraping the surface – not cutting –, to define this kind of marks we need a deliberate experiment involving this action.

Therefore, the identification will be strong only in the case of cut-marks made on bones but not on tools, and should be linked to other lines of evidence, as the functional analysis of archaeological lithic and shell edges, for example. In our context study, the majority of lithic edges analysed show use-wear polish associated with bone and/or antler cutting (Buc and Silvestre 2006, Sacur 2004). In shell surfaces, on the other hand, it is known that their use on different materials left distinct traces (Lucero 2005, 2004, Lucero and Jackson 2005, Mansur and Clemente i.p., Schmidt *et al*. 2001). Although we could see that the natural laminar structure of shells was modified after use, this functional analysis will deserve a paper of its own. In this sense, opposite to other cases where the low quantity of bivalve shells on sites is assumed to represent only raw material acquisition (Lammers-Keijsers 2007), in our case study, it will be very difficult to identify natural shells used as cutting edges, given the great quantity of malacological remains present in archaeological sites. Additionally, despite the identification of use-wear patterns in shell experimental samples, analysis of archaeological remains must consider that not only the brittle nature of shells does not contribute to the preservation of features; but that there are taphonomic factors to contemplate as well.

9. CONCLUSION

In spite of difficulties mentioned in the analysis of archaeological samples (especially in the case of bone tool traces), in contexts like the Low Paraná wetland, it is very important to distinguish between lithic and shell cut-marks. Actually, in these contexts, considering shells as raw material

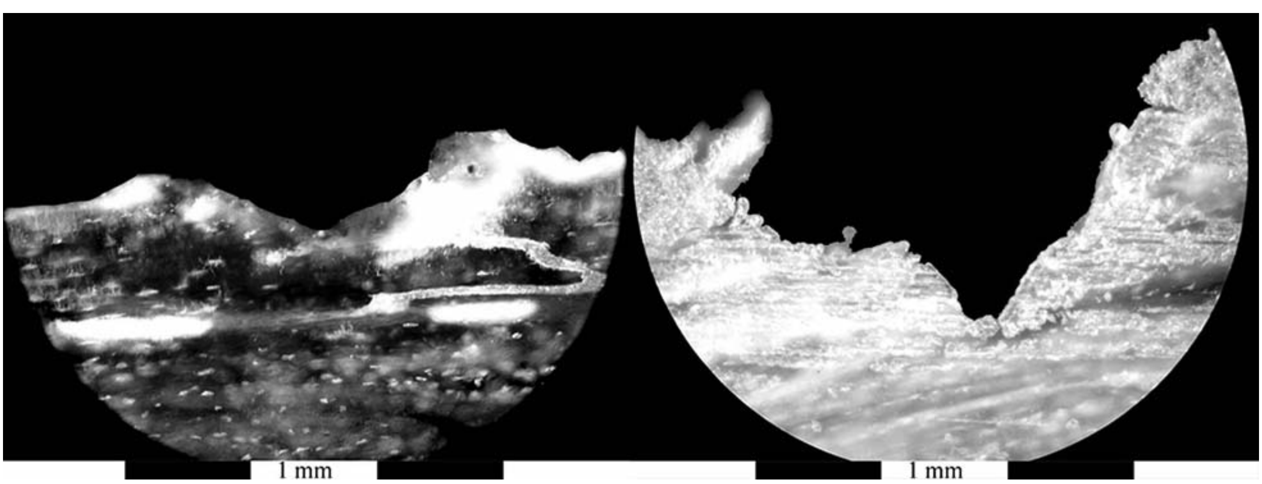

Figure 10. Transversal cuts of cut-marks. Shell open-V cut-mark on the left (made with A13); lithic close-V (B1) cut-mark on the right. Optical microscope 200X.

requires a specific study that should include other activities and materials that would have been linked in the technological system as a whole.

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