Understanding the Use-wears on Non-retouched Shells *Mytilus galloprovincialis. and Ruditapes decussatus* by Performing Wood Working Experiment: An Experimental Approach

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Understanding the Use-wears on Non-retouched Shells *Mytilus galloprovincialis. and Ruditapes decussatus* by Performing Wood Working Experiment: An Experimental Approach

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ABSTRACT: This paper is an experimental attempt to understand the use-wear comes on non-retouched shells *Ruditapes decussatus* and *Mytilus galloprovincialis.* These species have been selected due to their variation in shape, size and edge type. In wood working experiment *Celtus australis* wood is used to perform the activities like scrapping and cutting wood. The ESEM results show the usewears in the form of linear marks, edge rounding, edge facture, polish and micro-pitting. Experiments also showed some macro-fractures.

Keywords: *Ruditapes decussates, Mytilus sp.*, Experiments, Use-Wear, ESEM.

Introduction

From the prehistoric times, coastal people have exploited shells for various purposes to survive, from food to tool making due to its local availability. The absences of stone and metal tools, lead to questions about the evolution of tool technologies and site exploitation by the hominids for millions of years. In that circumstance, we have to think of other alternative materials to be used like perishable tools such as wood or may be the local available materials like shells. There are number of sites around the world where shell tools have been reported.

Carl von Linné was the first who recognized some shell maidens as material evidence for the culture of ancient peoples. After that more scholars came with their piece of work on shells. Till 1970's, studies are mainly based on the shell maidens and to understand their role in the past societies and their culture (Bar-Yosef, 2002). There have been many studies based on the manufacture of shell ornaments and tools but a very few have made an attempt to understand the traces coming over shells after production and use. Since then many scholars tried to understand the functional analysis of shell tools by early hominid like making experiments to produce tools out of the shells by retouching or snapping the tool. Some scholars like Bonomo (2009); Dockall (1996); Douka (2010); Lucero and Donald (2005); Prywolnick (2003); O'day (2002); Light (2002); Barton and White (1993); Tyree (1998); Ritter et. al. (1995) and Reiger (1981) analyzed the archeological shells and have reported the presence of use-wear or residue on them. Toth and wood (1989) and Cleghorn (1977) tried to retouch the shells to understand the tool typology of shells. Toth and wood (1989) and Choi and Driwantoro (2006) tried to use the retouched shell knife and check the cut-marks produced by them on the bones. Some like Schmidt et.al. (2001) and Cuenca (2009 and 2010) tried to understand the use-wear on archaeological samples and even how to predict them by performing some experiments.

Therefore, current experiment is an attempt to answer these basic questions concerning micro-wear on the shell tools such as, the prime feasibility of micro-wear studies on shells smooth and granulated structure. Our studies show that the microscopic traces are present and identifiable on shell tools. Though the experimental programs was a very short one, yet it allowed us to observe some general trends and shows the wear features vary systematically according to variation in type of shell, contact material and use action.

Method and Material

For the experiment, we have taken certain variables to control the experiment program which are shown in the table 1. *Ruditapes decussatus* and *Mytilus galloprovincialis* shell species have been used for performing the experiment. Similar species documented from the Mesolithic and the early stages of Neolithic in the Cantabrian Sea, Northern Spain (Cuenca, 2009). They are selected under the criteria of edge shape, hardness, shell structure, and its local availability. *Mytilus galloprovincialis* and *Ruditapes decussatus* collected from the local fish market to have a wide variety of options to select those which are having less alteration on the edge due to the natural or man handling. All the shell species selected are having their own natural edge sharpness. Therefore, no retouching or edge modification has been done.

Ref. no.	Type of shells	Worked material	species	Delineation		Working angle	motion	action	Hand	time
				d-h	d-s					
MY04	*Mytulus galloprovincialis*	Stem of fresh wood	*Celtis australis*	Convex	straight	70˚	Transverse bidirectional	Scraping wood	Right hand	10
CL02	*Ruditapes decussates*	Stem of fresh wood	*Celtis australis*	Convex	convex	90˚	Transverse unidirectional	Scraping wood	Right hand	5
MY03	*Mytulus galloprovincialis*	Stem of fresh wood	*Celtis australis*	Convex	straight	90˚	Longitudinal bidirectional	Cutting wood	Right hand	10
PE03	*Pecton maximus*	Stem of fresh wood	*Celtis australis*	Serrated	serrated	90˚	Longitudinal bidirectional	Cutting wood	Right hand	10
CL01	*Ruditapes decussates*	Stem of fresh wood	*Celtis australis*	Convex	convex	90˚	Longitudinal bidirectional	Cutting wood	Right hand	10

Table 1: Principal variables of wood working process

For the experiments, fresh wood (*Celtis australis*) have been used to understand the type of surface alteration caused by them. As the research is planning for small scale experiments, very few materials were used but have been documented in detail to understand surface modification and its development. We have performed transverse bi-directional work action for scraping action and longitudinal bi-directional for cutting action as shown in figure 1.

a) b)

Fig 1: a) Showing the transverse work action for scrapping the wood and b) Showing the longitudinal cutting action on *Celtus australis*

1. Cleaning process:

The cleaning procedures consisted of:

a) 10 minutes an ultrasonic bath in H2O2 to eliminate organic residues from shells before and after use,

b) 10 minutes an ultrasonic bath in the neutral phosphate-free detergent Derquim®, with ionic and non-ionic surface-active agents for, and

c) Rinse under cold running water to remove the extra neutral phosphate-free detergent Derquim® from the shell surface.

d) An ultrasonic bath in acetone for 2 minutes to eliminate the fatty residue resulting from the handling.

The steps (a, b and c) was used before and after the shell was used where as step d was performed before the microscopic analysis of the shells. After these various steps of cleaning the shells were and packed in different plastic bags to avoid future contamination and damages. This cleaning procedure has been shown to yield good results (Vergès, 2002; Ollé, 2003; Byrne *et al.*, 2006).

2. Preparation of Moulds:

Moulds and casts were prepared for the edges used to serve as reference for distinguishing micro and macro wear feature coming on the shells after use. Moulds were prepared with silicon based dental impression material, *Provil® novo Light* (Heraeus Kulzer, Inc.). The two components, a base and a catalyst in a ratio of 50% is taken on the impression material sheet and mixed under room temperature for 20-30 seconds so that it takes a uniform colour to prevent bad polymerization. Then the mixture was applied onto the shells using a spatula and left to dry. The moulds were not removed from the shells until they used for making cast to avoid any contamination inside the moulds.

3. Preparation of casts:

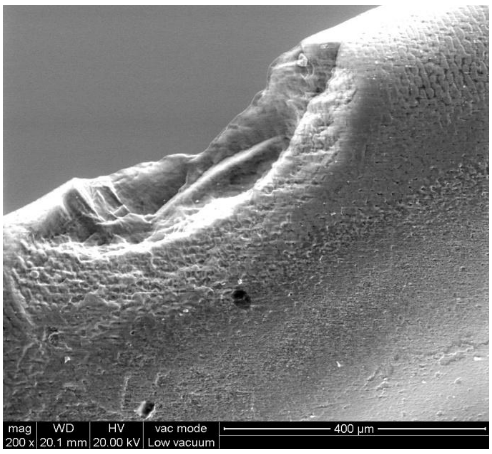
For preparing casts, a bicomponent rigid polyurethane resin, *Feropur PR-55* (Synthesia Española S.A.) was used. First a small amount of the mixture, mixed in equal proportion is poured in the mould with the help of thick opening needle syringe in the moulds as they were having very narrow opening for pouring the mixture in them. The moulds were kept standing still position and the syringe was moved inside the moulds so that the liquid penetrated the pores and then the rest of the mixture is poured rapidly as the resin starts hardening quickly. Casts have been considered very useful in sequential experiments as during successive uses edges can be damaged resulting in loss of control points. Casts allow us to observe fresh edges and add more control points at any stage of work (Vergès, 2002; Ollé, 2003; Ollé *et al.*, 2005).

Microscopic analysis

For the purpose of present study of usewear analysis on shell tools we investigated our samples under an ESEM (Environmental Scanning Electron Microscope) FEI QUANTA 600 from URV Scientific Resources Center. The samples were mound on a stub with the thermofusible glue in such a way that the edge of the sample is parallel to the stub. Before the ESEM observation, in order to find location, reference points were marked a little away from the tool edge with a 0.5 mm indelible felt tip pen and the same points were marked on a drawing of the specimen. The pen markings could easily be removed with a little bit of acetone. Then the tool was examined with the ESEM and observations were made on the microwear and images were taken. Then the cast studied in the same manner and then we analyze the same points for use-wear analysis that what changes have come on the used shells. The observations were made at a variable distances (from 10 mm to 30 mm) depending on the sample size in 20 kV. All the shell samples were analyzed in low vacuum pressure. For ESEM observations, three to four points of interest were located on each tool and then images were taken of each point of interest at several magnifications (ranging from 20x to 2000x). Higher magnifications were chosen to analyze the concrete detail whereas lower magnifications were used to study the distribution of the features.

Scraping experiment ESEM results

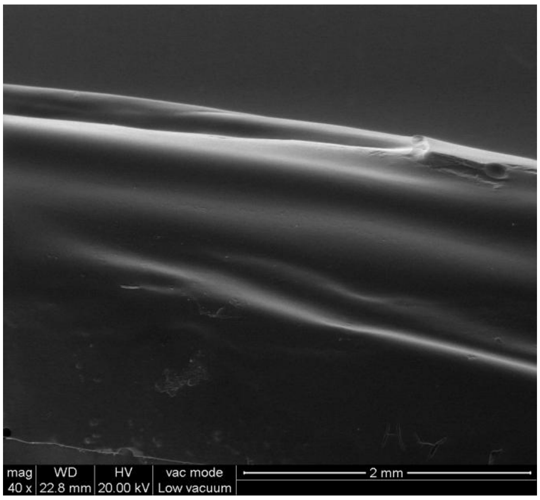
For this experiment, MY04 and CL02 were used. Due to the size of CL02 (3 cm), it was very difficult for prehension but was scraping quite well. After 5 minutes of use the sample broke into three triangle fragments as shown in figure 2b. As the sample is used for less time, very less use-wears occurred on the edge as shown in figure 2a. Just one edge fracture is observed which is having slight polish in the broken edge as shown in figure 3b. MY04 was good for scraping compare to CL02 and showed very good wears on the edge as shown in figure 3. *Mytilus galloprovincialis* first experienced the removal of periostracum and after that further use-wear developed on the exposed hypostracum. No striation marks have been observed in our experiment for wood working. It showed some polished on the edge whose texture was rough as shown in figure 3c and 3d.



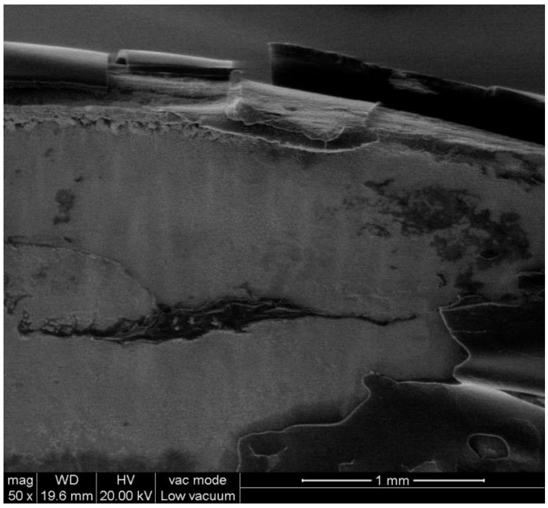
a

b

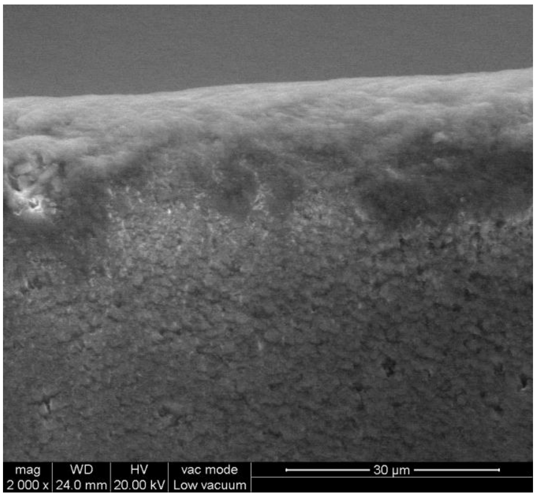
Fig 2: a) Use-wears and edge fracture on CL02, b) broken into three fragments after 5 minutes of use.



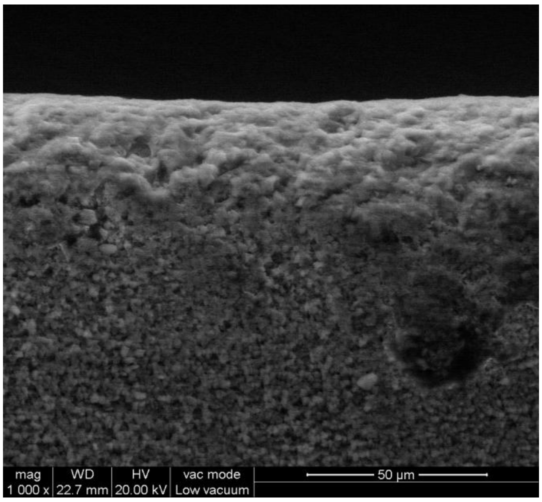
a



b



c

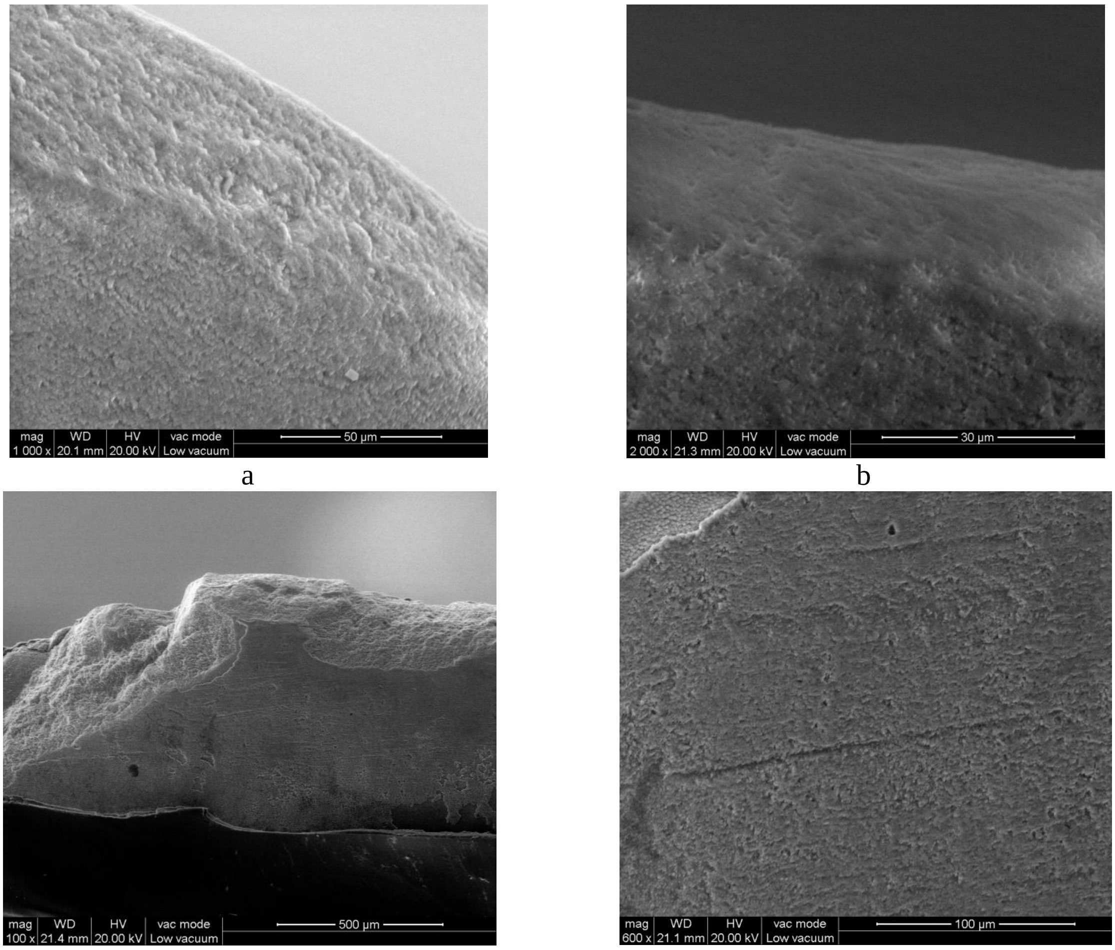


d

Fig 3: Use-wear on MY04 a) cast of unused edge with periostracum over the edge, b) removal of periostracum after use, c) formation of polish in band, and d) highly developed polish on the working edge.

Cutting wood experiment ESEM results:

Same as MY04 sample which have been used for scraping action, MY03 also experienced the removal of periostracum and after that further use-wear developed on exposed hipostracum as shown in figure 4b and 4d. Very striation marks have been observed. They were deep and parallel to the edge. Edge rounding also has been observed throughout the edge. Edge also showed some micro-chipping on the surface of the polish and edge rounding. Polish in some places are in bands and parallel to the edge with maximum width of 500 mm. the edge which was frequent in use with the wood is having very smooth polish whereas other part which comes occasionally in contact with the wood are occurred in patches with some grooves on them. Edge fractures have been observed on many places.



c d

Fig4: a) Use-wears on MY03; (a and b) various types of polish and edge rounding after use, c) edge fracture and d) detail view of striation at higher magnification.

In the case of CL01 the edge before use had granulated surface and after the use surface slowly started to peel with the use as shown in figure 5a and 5b. Continues longitudinal bidirectional use of edge like saw for cutting the wood, make the granulated surface of the shell in an even plain. Edge rounding was present from before but with working of the edge it become more distinctive, Polishes are very developed and occur mostly on the working edge by making the granulated surface smooth. Textures of polishes are very smooth as shown in figure 5d. Mostly striations are continues, parallel to edge, arranged closely to each other. Texture of striation is very fine and shallow. They basically occurred on the polish of the edge as shown in figure 5d. Surprisingly no macro-fracture is observed even being small in size and delicate; it worked perfectly for the desired time. Number of edge fracture has been observed throughout the edge as shown in figure 5c.

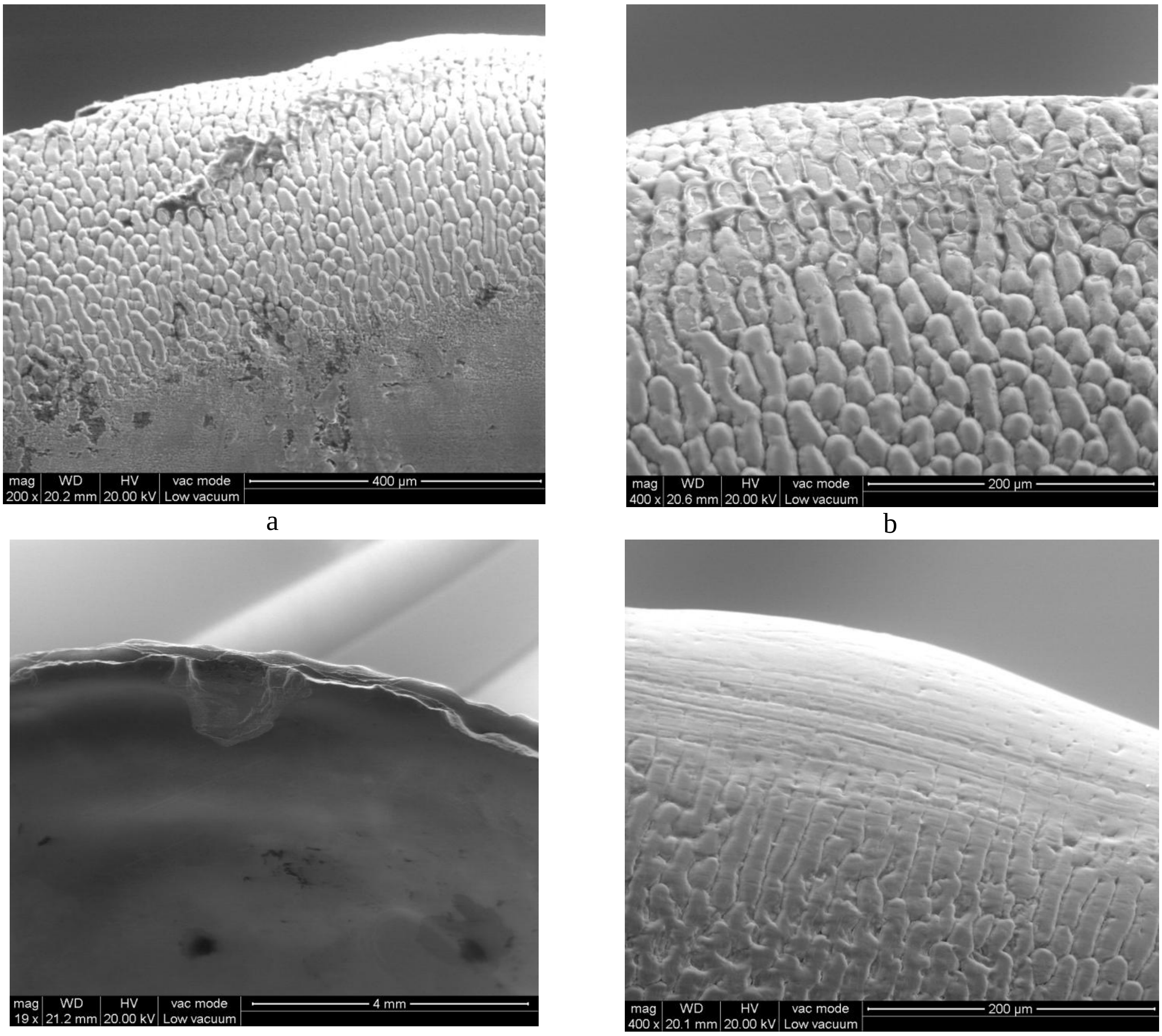


Fig 5: Use-wears on CL01; a) unused edge on cast, b) polish on granulated surface after use, c) edge fracture after use and d) edge rounding, polish and striation marks on them.

CONCLUSION

The experiments sought to answer only basic but important questions concerning micro-wear on shell tools. The prime question concerned the feasibility of micro-wear studies on different shell species. Our studies showed that microscopic traces of use-wear are definitely possible and yield fruitful results. As emphasized many times, this was not a wide experimental program devoted to explore in detail the traces by materials and by actions performed, but some major trends could be identified from our studies. The wear features included microfracturing, striations and linear features, polish, impact pits and edge rounding.

Micro-flake scars, striations and other linear features tended to be oriented in the direction of tool use. As the working edge was curve in all the cases, these features are parallel to the edge. Edge rounding was observed to be more intense on scraping tools and extending from the ventral onto the dorsal part due to greater contact with the worked material. Striations are more common in longitudinal action in cutting wood process but less in scraping action.

Polish has been considered to be one of the best indicators of contact material and distinctive of it on various tools. In our study trends in the appearance of polish showed that development of polish characteristics depends on contact material, use duration and useaction combined. Polishes are limited to higher relief areas in the micro-topography. Wood cutting samples showed more extensive distribution of polish than scraping of wood samples.

Macro-fracture also taken into account as it varies according to the type of shell used, its prehension and pressure applied to it while performing the experiments. Macro-fracture occurred most on the weaker shells species like *Ruditapes decussatus, Mytilus sp.* due to their shell size and strength.

This study is just a small step towards understanding micro-wear on various shell species. We need many more studies on this field in the future to understand wear formation on various shell species with contact to different materials in a better manner. Future studies would aim at widening the scope of the experiments to include more contact materials and use actions and undertake more experiments in each use material and use action category to understand the effect of different variables. Beside that as Biggs (1969) said, “Good cooperation between archeologist and malacologist is the only way to ensure the extraction of the fullest possible information on the ethnology of earlier population from shells”. Therefore, such studies will help to improve the understanding of functional studies on shell tools and their role in human life from the prehistoric past.

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