

## DETERMINING FORM AND FUNCTION: AN ANALYSIS OF USE-RELATED WEAR ON *STROMBUS GIGAS* SHELL TOOLS

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The objective of this paper is to present the findings of my research on shell artifacts in southeast Florida. Collected data comes from my analysis of 21 *Strombus gigas* shell tools in the collection of the Anthropology Department at Florida Atlantic University. These samples were recovered from the Boca Weir and Jupiter Inlet sites, both of which are representative of a southeast Florida village complex. A *Strombus gigas* shell artifact typology is presented along with supporting analysis of macro/microwear variables. The methods of Masson (1988), Eaton (1974), Keegan (1984), and Andrefsky (1998) serve as a framework and source of reference for this study.

### Background

There are many varieties of shell resources in southeast Florida including *Busycon contrarium*, *Strombus costatus*, and the subject of this study, *Strombus gigas*. Also called queen conch, this large herbivorous mollusk of the class *Gastropoda* is an abundant specimen on the southeast coast of Florida and in most Caribbean coral waters. According to Masson (1988), shell celts from southeast Florida indicate a regional adaptation to *Strombus gigas*. Some researchers have designated this adaptation as an adjustment to the lack of viable lithic resources in this particular region. Experiments by Eaton (1974) have demonstrated that shell celts have a density comparable to moderately compacted stone lending support to the perception that they are a practical substitute for lithic raw materials.

### Celt Technology

Although shell tools can be manufactured from the lip, outer whorl, and columella portions of *Strombus gigas*, only 'lip tools' are represented in this sample. Both Eaton (1974) and Rouse (1941, in Keegan 1984) identify four categories of *Strombus gigas* 'lip tools': adzes, celts, blanks, and scrapers. Although hafted and unhafted axes and scrapers were recognized along with blanks, exclusive adze tools were not among the artifacts recovered from the Boca Weir and Jupiter Inlet sites. Many researchers have referred to blanks as preforms. Although blanks lack a true beveled edge, Keegan (1984) has

observed end battering and believes that many celt blanks were complete functional tools. A fifth category of 'lip tool' was identified in this study. Rouse (1941, in Keegan 1984) refers to these as ceremonial/ritual hammers. They are often called 'three pointers' after their lithic counterparts of the Greater Antilles (Coomans 1965, in Keegan 1984).

### **Morphological Characteristics**

Fortunately, Masson (1988) has developed an analogical morphology borrowed from lithic analysis to serve as a framework for the study of shell artifacts. What follows is a summary of her morphological descriptions. Figure 2 is reproduced from Masson (1988) and illustrates the areas of the tool defined below. The ventral face of the celt refers to the former interior surface of the shell while the dorsal face refers to the former exterior surface. When the celt is viewed on a level surface, ventral face up and distal end away from the examiner, the left and right lateral edges are easily determined. Unless modified to the contrary, the left lateral edge is generally thicker than the right lateral edge. The working edge, located at the wider distal end, is called the bit has a ventral and dorsal bevel. The narrower end, which is also the base of the celt, is called the proximal end. Longitudinal direction refers to the measurement associated with the length of the tool from distal to proximal end. Latitudinal direction runs from one lateral edge to the other and lies perpendicular to the longitudinal axis. In addition, Keegan (1984) lists three distinct shell morphologies based on growth and lip form that are a natural source of variation. These morphological classifications are as follows: 1. Full, thick-lipped ("Old"), 2. Full, thin-lipped ("Adult"), 3. Pre-lip ("Juvenile"). Shell morphology will become more variable during ontogeny as a result of the phenotypic expression of genotype (Keegan 1984). Before an accurate recording of measurements could be taken, it was first necessary to determine which attributes would be included in the study and what type of attribute scale would be used to order them. A ratio scale was chosen due to its completeness and range of operations. I differed from Masson (1988) in my methods of measurement and instead chose to follow an approach set forth by Andrefsky (1998). When measuring length, the maximum linear distance of the tool was recorded. This was accomplished by stretching a string along the worked edge of the tool following any contours. The string was then measured in order to yield maximum edge length. Using string allows for accurate distance measurements on surfaces that may be curved or sinuous (Andrefsky 1998). The same method was used to record the width or maximal expanse of the tool that is perpendicular to tool length. Left and right lateral thickness is a measurement of the tools' edges at their greatest point. The bit forms the edge angle where both ventral and dorsal bevels are

intact. Maximal weights of the tools were also recorded.

### **Post-Depositional Modification/Organic Decomposition**

Shell, like any organic material, is subject to deterioration and decomposition. The combination of humic acids and groundwater in the soil produce a leaching of the shells calcium carbonates which causes the shells surface to become white and chalky (Allerton 1981 in Masson 1988). With the progression of time, traces of usewear become increasingly harder to differentiate. 38% of the FAU celts suffered from the effects of leaching. Another form of post-depositional modification is called concretion. Concretion occurs from the cementing of the soil attached to the surface of the shell. Once enveloped, it is impossible to record accurate measurements (Masson 1988). Only 14% of the FAU celts displayed significant signs of concretion. Masson (1988) noted a third type of non-cultural impact termed peeling. This appears as the loss of some of the growth layers on the ventral/dorsal surfaces. 52% of the FAU celts exhibited the effects of peeling. A few of the celts were just beginning to show signs of peeling while several others were already at a very advanced stage. Keegan (1984) observed another form of decomposition that occurs at such an advanced stage that the shell has deteriorated to the point of resembling severely oxidized iron. None of the FAU celts experienced this type of post-depositional modification.

### **Artifact Manufacture**

Keegan (1984) notes that *Strombus gigas* 'lip tools' can only be manufactured from morphologically 'adult' or 'old' shells. The artifacts examined in this study exhibited a relatively even distribution between the two. There were no celts manufactured from morphologically 'juvenile' shells because, unlike mature specimens, 'juveniles' lack the presence of a well-developed lip. There are at least two major steps involved in producing a *Strombus gigas* celt: Conch lip removal and the ensuing modification to form a completed celt. The experimental work performed by Keegan (1984) and Masson (1988) was used as a guide in understanding these processes. Keegan (1984) illustrates the external and internal structures of the queen conch discussed below. Lip tool manufacture begins with the detachment of the lip from the shell to produce a blank. Keegan (1984) performed replication experiments using two slightly different methods. His first method involved placing the conch aperture side down and then striking the dorsal surface with a *Strombus gigas* hammer. This produced a system of fractures along the outer margin of the lip where contact with the ground had been made. His second method yielded improved results. The dorsal side was placed on the ground while the lip remained slightly elevated. A *Strombus gigas* hammer was then

used to strike the interior of the aperture. Keegan (1984) describes this procedure as wedging the conical hammer into the aperture to strike behind the area of lip thickening. This technique left the lip unfractured with a portion of the body whorl still intact. Masson (1988) achieved conch lip removal without the use of a *Strombus gigas* hammer. She accomplished this by slamming the conch aperture side down onto limerock. Her second method required slamming the conch shells against one another. Regardless of the method employed, it is important that the blows be directed where the spire margin canal attaches the lip to the whorl at the shell's posterior end (Masson 1988). Materials used to modify detached lips into finished tools exhibit a local variability that is dependent upon the raw materials available. Modification involves light percussion flaking/shaping and subsequent grinding of the lateral edges and bit. Masson (1988) notes that percussion flaking/shaping reduces the amount of grinding necessary to produce a finished tool. Percussion flaking/shaping that utilizes harder blows has a tendency to produce less consistent breaks than do strikes of moderate force (Keegan 1984). Percussion implements used include *Strombus gigas* hammers and columella tools, other conchs, limestone, and imported materials such as chert (Masson 1988). A variety of artifacts used to grind shell celts have been found at south Florida sites. Imported sandstone and locally abundant limestone proved efficient in the grinding of lateral edges and bits (Masson 1988). Shark skins have been found in association with shell tools indicating that they may have been used in the grinding process. Pumice and coral rasps are also believed to have functioned as abrading implements in the absence of more suitable grinding materials. Methods used in lithic technology to shape the bit involve a risk of breakage not found in the grinding of shell celts. This is why the choice to grind the more time consuming bit first or to grind the lateral edges first seems to have been a random decision (Masson 1988).

### **Typology**

For the purpose of this study a functional typology was developed that can be used to classify *Strombus gigas* shell tools. This typology is supported by microwear analysis, macroscopic observation, and patterns of association. Interrelated variables such as morphology, hafting, edge angle, patterns of breakage, and organic residue were incorporated to provide a comprehensive ordering scheme.

### **Function**

Replication and usewear experiments have proven shell celts to be efficient woodworking implements. Eaton (1974) has determined that shell celts are effective in cleaving, chopping, chipping, adzing, and scraping both wood

and bone. Woodworking, particularly in the manufacture of dugout canoes, produces the most visible evidence of usewear. Some researchers have suggested that shell celts may have been used for butchering and working hide. This, however, is difficult to prove because these functions leave behind little evidence of use (Masson 1988). Artifacts in this study have been categorized as axes, scrapers, blanks, or ceremonial/ritual hammers. The resulting percentages of each type in relation to one another are as follows: Axes – 62%, Scrapers – 24%, Blanks – 9%, and Ceremonial/Ritual Hammers – 5%. It should be noted that the ceremonial/ritual hammer recovered from the Jupiter Inlet site was not found within a ritual context or in association with other ritual implements. Consequently, its' designation as a ceremonial/ritual hammer is based on morphology alone and subject to speculation. In addition, 50% of the blanks examined in this study exhibit evidence of use and are believed to have functioned as *Strombus gigas* hammers. Marquardt (Figure 14: 1992) refers to these as gastropod hammers, unhafted. Although this designated function correlates with Keegan's research (1984), the onset of organic deterioration made distinguishing between human and naturally produced wear virtually impossible. These types are broken down further according to an assortment of variables. Support for these classifications is presented in the ensuing sections of the paper.

### **Stages of Growth and Tool Function**

Scrapers, manufactured from morphologically "old" shells, are among the largest and heaviest tools in the study and would appear to be the most practical woodworking implements. Appearances can be deceiving. Masson (1988) has found that the elasticity of shell is such that the older shells are more easily broken. Based upon this evidence one would expect to find the greatest degree and number of impacts and breakage on morphologically "old" shells, yet these tools exhibited no evidence of impact or breakage. This evidence, along with the perception that a larger tool is easier to manipulate, was used as a basis for their classification as scrapers. Further evidence is presented in the discussion on edge angles. Axes were manufactured from both morphologically "old" and "adult" shells. This type of tool undergoes high levels of stress and produced all observed impacts and breakage in the study. The difference between the two may reflect the density of the worked material. Blanks were manufactured from morphologically "old" shells for undetermined reasons and may have been selected arbitrarily. The ceremonial/ritual hammer was manufactured from a morphologically "old" shell and is most likely due to the shear size and visibility of the tool. The nature of use will inevitably necessitate that a tool be reworked, oftentimes changing its' form and function. The possibility exists that these tools are

transitional forms and could conceivably have been used in other capacities at one time or another.

### **Hafting**

Many researchers have acknowledged that hafting increases the efficiency of both shell and stone tools. 19% of the artifacts were identified as hafted axes and another 5% were classified as hafted scrapers based upon macroscopic observation and low power (<100x) microscopy. This evidence appears as grooves/indentations along the lateral margins of the tool. With the exception of the hafted scraper, these tools produced some of the greatest evidence of impacts and breakage in the study. It's unlikely that these impacts resulted from a hand-held function. (Masson 1988). Further evidence of hafting is provided by the presence of a resinous organic residue in association with haft marks. Resinous substances are often used to secure the lashings of hafted implements. Some of the grooves/indentations conform to what Masson (1988) describes as side-lashed. However, in light of the absence of replication experiments and a larger sample, this designation is subjective.

### **Edge Angle**

Variability of the edge angles observed in this study reflect different functions that I have assigned into four groups based upon angle measurements and macroscopic observation of impacts and breakage patterns. An edge angle of 28-41 degrees was observed on 48% of the artifacts and is associated with a chopping function. This group also received 70% of the attributed impact scars and breakage patterns. An outlier with an edge angle of 60 degrees was placed into this group as a result of its' sizeable impact scar and similarity in tool design. Edge angles of 45-59 degrees were observed on 19% of the artifacts and are associated with a cutting function. This group received 30% of the attributed impact scars and breakage patterns. An outlier with an edge angle of 40 degrees was placed into this group due to its' lack of scarring or breakage, however, the absence of significant wear may just reflect the degree of use. An edge angle of 60-70 degrees was observed on 24% of the artifacts and is associated with a scraping function. Andrefsky (1992) notes that artifacts with wider edge angles can be pulled or pushed over materials such as hide with little chance of puncture or laceration. In general, the heaviest, widest, and thickest tools also had the most obtuse edge angles. 9% of the artifacts lacked a ground bit hence, their classification as blanks.

### **Wear and Breakage Patterns**

Masson (1988) defines wear as impacts that do not produce artifact fragmentation. Macroscopic observation and low power (<100x) microscopy were

used to classify 76% of the sample according to distal impact scars, battering, and distal nicking/edge breakage patterns. Distal impact scars were observed on 29% of the sample. 67% of the identified distal impact scars were observed on celts with edge angles of 28-41 degrees supporting their classification as chopping tools. All distal impact scars occurred between the center and right lateral edge of the tools. These same tools had a thicker right lateral edge relative to the left side. Masson (1988) notes that the increase in mass on a particular side absorbs more of the force and receives the most impact scars. Excessive battering resulting from tool use after the working edge had been dulled occurred on 43% of the artifacts. This evidence appeared as multiple layers of minor fractures on the working edge when viewed at a magnification of 100x. Distal nicking/edge breakage was used by Masson (1988) to replace hinge and step flaking which do not affect shell celts. This evidence was also viewed under low power and appeared as nicks or chips in the working edge that were too small to be classified as impact scars. 48% of the artifacts exhibited evidence of this type of wear. Diagonal breaks, snap breaks, and longitudinal splits were used to classify 67% of the specimens in this study. Masson (1988) notes that diagonal breaks follow the natural cleavage of *Strombus gigas* lip structure. Diagonal breaks were observed on 19% of the artifacts and, like distal impact scars, occurred on sides with the thickest lateral edges. A diagonal break occurred to both the left and right side of one artifact indicating that it was still used after one diagonal break had already flawed the tool. The type of break could not be determined for 24% of the artifacts. Snap breaks occurred on 57% of the sample, mostly to the middle area of the tool. Shafer (1982 in Masson 1988) believes that this is evidence of hafting. However, only 17% of the identified snap breaks occurred on artifacts determined to have been hafted. The lack of a larger sample makes this determination difficult to justify. Longitudinal splits occurred on 14% of the artifacts and also correlated to lateral edge thickness. Masson (1988) notes that this type of impact is unique to shell celts and reflects the brittle nature of shell composition.

### **Microwear Analysis**

This study utilized both low (<100x) and high (>100x) power microscopy to analyze distinctive and diagnostic wear traces (residues, polishes, striations) as they appear on the surface of shell celts. The integration of the three provides a more comprehensive understanding of the tools' function and of the material worked than do analyses which place emphasis on a single variable. Organic residues were observed on 71% of the artifacts in this study. 200x magnification proved most effective in the analysis of residues. The most common substances were resinous, calcareous, and dark reddish or reddish/

brownish in appearance. Residues appear mostly in areas of intensive use where they became imbedded within the nicks, scars, and striations of the shells' surface. The residues all appear to be of a plant-based nature, however, without a chemical analysis of the substances this is difficult to determine. As previously indicated 60% of the hafted celts displayed residues in association with haft marks. The formation of polish is the result of progressive smoothing by abrasion and is most evident under high power microscopy. Polishes were observed on 62% of the artifacts. Artifacts were viewed under varying degrees of lighting that ranged from moderate to bright so as to maintain a degree of objectivity. Polishes viewed under 200x magnification appeared as glossy reflective patches on the tools' surface that were indistinguishable from one another. Observation under 400x magnification produced noticeable directionality of the polish formation that coincided with the identified striations. Although types of activity could be inferred from this study, distinctions between polishing agents could not be accurately determined without the use of a computer imaging analysis program. Evidence of striations on the tools' surface was most evident at a magnification of 400x. Striations were observed on 62% of the artifacts in three generalized directional patterns that indicate tool function. 54% of this group had striations that were perpendicular to the working edge and indicate an overhand motion associated with a common everyday cutting/slicing function. 23% of the group displayed striations that were disposed at 90 degrees to the working edge and are associated with a whittling function. 8% of the tools had striations that were disposed parallel to the working edge and are attributed to some manner of sawing activity. The remaining 15% of the tools exhibited an unrecognized and random distribution of striations that most likely occurred after deposition by natural agents. The fact that polish formations correlate with striation directionality suggests that these artifacts were definitely modified through human use as tools. Organic residues were also found on 85% of the artifacts displaying striations. The significance of this has not yet been determined.

### **Conclusion**

The parallels between lithic analysis of both stone and shell tools were made apparent by the research of Masson (1988). This study has also concluded that shell tools exhibit patterns of wear that can be classified and examined according to methods designed for the study of lithics. Affinities between morphologies, edge angles, and patterns of wear and breakage indicate that *Strombus gigas* shell tools exhibit a relatively low degree of polytypism and high levels of polymorphic variability. Unlike Masson (1988) who observed an increased thickness and subsequent greater degree of impacts and break-

age on the left lateral edges, this study found the distribution of lateral edge thickness to be relatively even with evidence of impacts and breakage occurring predominantly on the right side. The relative weights and sizes of the tools examined in this study, with regard to their functional classifications, do not agree with previous shell tool research (replication experiments). It must be noted that this usewear study was conducted upon an extremely small sample without the benefit of first hand replication experiments and lacks a chemical analysis of the organic residues. The researcher believes that the findings presented within this body of research are justified in this particular instance and lend support to the perception that shell tools are highly variable and should be examined with this notion in mind. Rapid advancements in technology and the development of expert systems are providing new insights into an expanding field of shell tool research. Shell artifact research, in general, should be recognized for its importance and usefulness in determining both the material and non-material culture of the artifacts' manufacturers. Comprehensive studies on shell artifacts can now be combined with data from other disciplines to help determine the overall role of these objects within the individual societies. The researcher also believes that an anthology containing past and present shell artifact research from southeast Florida that includes relevant studies from other regions should be compiled and correlated for the express purpose of providing future researchers with comparative data.

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