The Use-Life and Times of the Type-G Shell Hammer: A Descriptive and Experimental Analysis of Shell Hammers from Roberts Island (8CI41)

by

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of the requirements for the degree of

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Department of Anthropology

University of South Florida

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Date of Approval

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Acknowledgments

I would like to thank Drs. Thomas Pluckhahn, Victor Thompson, and Brent Weisman for allowing me to do the research for this project alongside their Crystal River Early Village Archaeological Project. Additionally, I would like to thank my friends, especially Matt Touchton, for all the help and support they've given me throughout my research and writing. Finally, I must again thank Dr. Pluckhahn as well as Dr. Daniel Lende for their guidance throughout the process of completing this project.

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Abstract

While the Type-G Shell Hammer has been identified and described as a distinct class of shell tool, little attention has been paid to its function or its use-life aside from small speculative asides made by the authors who have included it in their typologies. This study seeks not only to add a body of descriptive data to our knowledge of the Type-G Shell Hammer by analyzing a sample of tools collected at Roberts Island (8CI41) just downriver from the Crystal River (8CI1) site in Citrus County, Florida, but also to put forth experimental data that may help clarify some outstanding questions about the tool. While the experimental analysis is primarily focused on classifying the Type-G Shell Hammer as either an expedient or curated technology, it also seeks to shed light on its role in the productive activities of the people who used it. The results of both the experimental and descriptive analyses show the Type-G Shell Hammer to be a relatively fragile tool that often saw retouch in the form of new hafting holes or reworking into an unhafted pounder after breakage or exhaustion of the body whorl.

Chapter 1: Introduction

The use of marine shell tools among prehistoric peoples is to be expected in any area in which those people lived close to coasts and estuaries, with the Florida Gulf Coast being no exception. While the functions of certain types of shell tools are debated, the toolkit that is fashioned from shell where it is utilized is broad. Even in some tool types where there is a defined function; however, the problem exists of determining which materials the tools were put to use on. This project will address this very problem in relation to Type-G Shell Hammers (Marquardt 1992) collected at the Roberts Island site on the Crystal River in Citrus County, Florida. In addition, this project seeks to challenge the implication made by Marquardt that these hammers saw expedient use and discard. I will employ methods and theories of experimental archaeology in an attempt to answer these questions.

Research Site

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The research site for this project was Roberts Island (8CI41) on the Crystal River in Citrus County, Florida (Figure 1). The Crystal River is a short river fed by a karstic spring. The estuarine system created by the interface between the Crystal River and the Gulf of Mexico is home to a number of archaeological sites, including some that contain large shell and sand mounds as well as other monumental earthworks. The largest of these sites is the Crystal River site (8CI1), which is one of Florida's most well known archaeological sites (Moore 1903, 1907; Bullen 1951, 1953).

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The Roberts Island site sampled from in this study lies only a few hundred meters downriver from the Crystal River site and the Archaeological State Park established there. In

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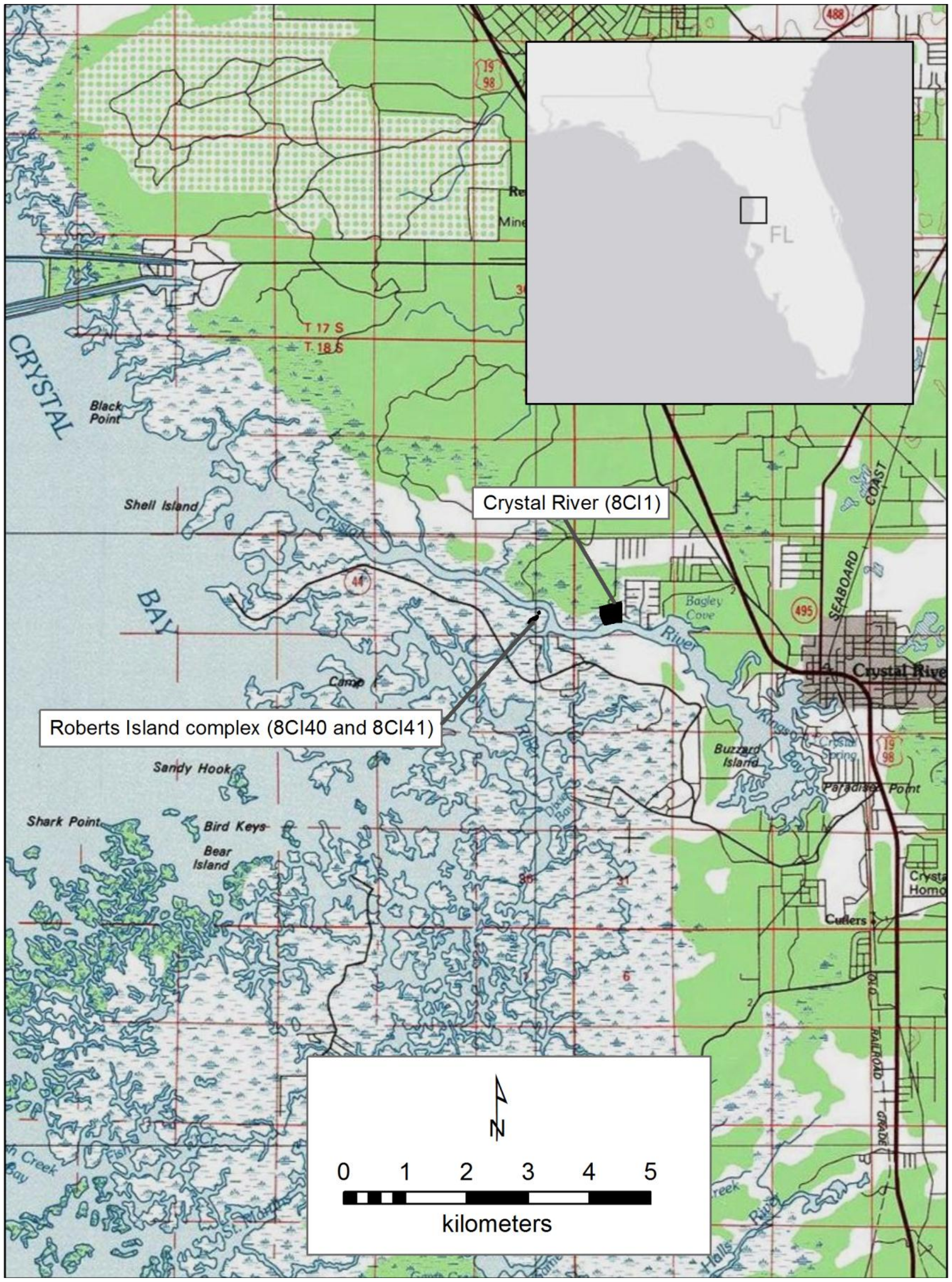
Crystal River (8Cl1)
Roberts Island complex (8Cl40 and 8Cl41)
CRYSTAL
BAY
Black Point
Shell Island
Sandy Hook
Shark Point
Bird Keys
Bear Island
Bagley Cove
Buzzard Island
Paradise Point
Crystal River
SEABOARD
COAST
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N
0 1 2 3 4 5
kilometers

Figure 1.

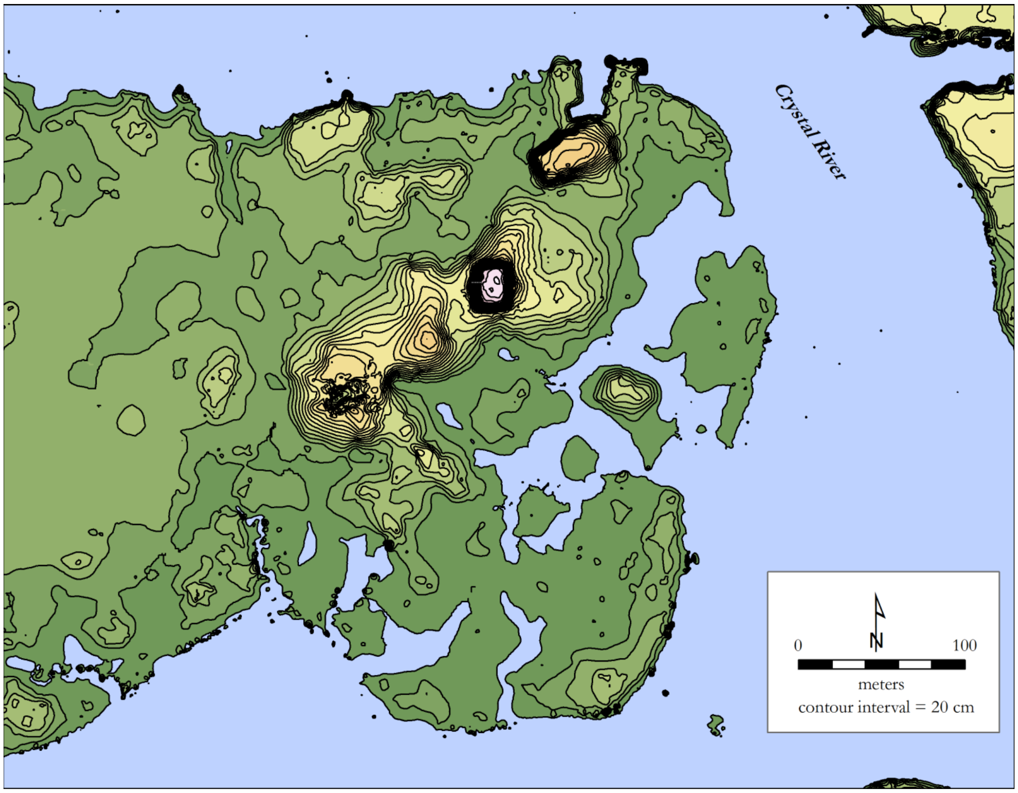

Figure 2.

actuality, Roberts Island, a Woodland period site dated ca. 1000 B.C. to A.D. 1050 (Pluckhahn et al. 2012), contains six recorded sites (8CI36, 37, 39, 40, 41, 576), five of which were recorded by Bullen in a series of surveys (Bullen 1953) along the main Crystal River site. The site was again visited by Brent Weisman in 1995 and a survey was carried out. Weisman's conclusions suggested that the Roberts Island complex may have served a dual purpose as both a ceremonial site as well as a village (Weisman 1995; State of Florida 2008). The site of primary concern for this study is 8CI41, which consists of a series of shell mounds connected by a midden layer that

Formatted: Indent: First line: 0", Space After: 10 pt, Line spacing: Multiple 1.15 li stretches near 150 meters along a northeast to southwest axis (Figure 2). A small, shallow inlet separates a solitary mound on the northeast of the island, designated 8CI40, from this sprawling midden area (Figure 2). ~~provide some. Figure 2.~~

This research project is part of a larger study known as the Crystal River Early Village Archaeological Project (CREVAP), the aim of which is to gain an understanding of cooperation and social complexity at Crystal River and associated sites (Pluckhahn et al. 2010 a). This National Science Foundation funded project is carried out under co-investigators Drs. Thomas Pluckhahn, Victor Thompson, and Brent Weisman. Certain aspects of the project have already led to published works, including the mapping of the main site carried out by Pluckhahn and Thompson (2009), among others (Thompson and Pluckhahn 2010; Pluckhahn et al. 2010 b)

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While the main site of Crystal River is the primary site being investigated in the CREVAP project, the Roberts Island site is also receiving attention from the investigators. The summer of 2011 saw total station mapping of the site's mounds and other features, a systematic shovel test survey, a trench and full unit excavated from the main mound and water court, respectively, and minor geophysical testing including ground-penetrating radar of the main mound. It was during this work at the site that the sample used in this study was collected.

Other than the recent work at the Roberts Island site, little to no published work has been conducted there. Hopefully the CREVAP project will shed some light on the function of the site and its relation to the Crystal River site just upriver.

Shell Tools in a Coastal Context

The archaeology of coastal, riverine, and estuarine environments presents its own diverse array of challenges to those who wish to study sites located within them. First and foremost of these is the fact that coastal and other aquatic environments often do not conform to settlement and subsistence models used for other contemporary terrestrial populations. Due to the intensive exploitation of the abundant aquatic resources around them, prehistoric coastal people often achieved a level of social complexity not seen in contemporaneous terrestrial societies (Thompson and Pluckhahn 2010).

One byproduct of this intensive use of aquatic resources is the accumulation of shell middens. Shell middens represent the subsistence patterns of coastal populations and their heavy reliance on shellfish as a major food staple. Shell midden accumulation is seen as a hallmark of a great variety of coastal societies worldwide (Waselkov 1987). While excavation of shell middens provides great insight into a population's subsistence strategies, it can also prove costly in terms of taxing resources and time in the field (Koloseike 1970).

Shell midden accumulation is not; however, strictly a product of a huge amount of shellfish consumption. It is also contributed to by debitage from shell tool manufacture and other forms of shell debris from a variety of activities. As much of the coastal toolkit, especially in marine environments, was composed of shell, large amounts of debris from shell tool manufacture and discard also contribute to the formation of shell middens. The extent to which these processes of manufacture and discard account for overall midden formation are still considerably overshadowed by that of shellfish consumption though.

In many coastal environments, shell has been known to replace stone as a primary material in the manufacture of prehistoric technologies. This is especially true in Florida, where stone resources are usually limited to porous limestone with low quality silicified coral in very small amounts. The replacement of stone by shell at coastal sites, compounded by the already low quantity and quality of viable tool stone in peninsular Florida highlights the role of shell tools at the Crystal River and Roberts Island sites as well as at sites throughout Florida (White et al.2002).

A comprehensive typology of Florida shell tools was first provided by John Goggin (1949). Goggin's typology built on earlier descriptions of Florida's shell tools by antiquarians and archaeologists like C.B. Moore (1900) and Frank Hamilton Cushing (1897). This typology was further refined and added to by William Marquardt in his chapter "Shell Artifacts from the Caloosahatchee Area" in *Culture and Environment in the Domain of the Calusa* (1992). Marquardt's shell tool typology focuses on compiling information on form, function, variation, and distribution with the intention of being used as a main source in the study of Florida's shell tools. In addition to the typologies mentioned previously which are often quite broad in their geographical scope, multiple small, localized inventories of shell tools have also been compiled, such as that of the Apalachicola River Valley (Eyles 2004).

Of special interest is the wide variety of forms that shell tools take, including analogues for most types observed in lithic assemblages. One factor that influences this range of shell tool forms is the many different species of shells used to manufacture the tools. Both univalve and bivalve mollusks are utilized heavily in toolmaking, with different parts of the shell lending themselves more easily to different types of tools. An example would be the use of univalve mollusk columella in chisel, pick, and hammer-like tools, both hafted and unhafted (Marquardt 1992). Additionally, shells harvested for tool manufacture were assessed in terms of their robustness and then assigned to be modified into particular tool forms based on their thickness and size with more robust shells seeing use as utilitarian objects (Luer 2008). It is also worth noting that not all shell artifacts are strictly utilitarian; shell ornaments are common artifacts, and many of these carry possible symbolic importance (Brown 1997).

Another similarity between shell tools and lithics is the presence of a hypothesized standard reduction process that applies to many species of univalve mollusks, most notably different species of whelks and conchs (Luer et al. 1986). In this process, univalve mollusks are reduced throughout their use-lives into a variety of different tool forms, many utilizing different parts of the shell. For instance, hammers, chisels and picks make use of the shell's columella, while knives, blades, adze/celts and a variety of vessels including cups, bowls and dippers will use the outer whorl and shoulder of the shell. Again, all of these tool types are present in Marquardt's (1992) typology.

This variety of forms and functions can also lead to confusion amongst archaeologists as to what exactly the tools and other artifacts are to be classified as (Walker 2000). For some artifacts, their form is quite ambiguous and so defies easy interpretation. As a result, a variety of competing and largely mutually exclusive types can be assigned to shell tools of the same general form. Thus, shell tools lend themselves extremely well to experimental functional analysis, such as is being carried out in this study and has been in studies preceding it (Reiger 1979; Keegan 1984; Pagoulatos and Veit 1993; Dietler 2008; Pearson and Cook 2012). An especially interesting experimental study by Dietler (2008) uses data from the replication of large whelk shell cutting-edge tools to support his hypothesis concerning the role of craft specialization in whelk tool production leading to social complexity amongst peoples from the Caloosahatchee area. This study highlights the value of experimental work in the study of shell tools and their role in coastal societies. In addition to Dietler's work, Pagoulatos and Veit (1993) also use experimental methods to define wear patterns in shell tools, which they then suggested were associated with different specific functions.

Another method that is seeing increasing use by archaeologists seeking to understand the functions of localized shell tool forms is to employ an ethnoarchaeological approach, using ethnographic analogues to supplement data on shell tool function. Walker (2000) does this in her attempt to provide a solid interpretation of a variety of shell artifacts associated with marine fishing, most notably composite shell hooks and shell net mesh gauges. This is a valuable technique due to the heavy exploitation of shell as a tool material that characterizes many human adaptations to a marine or estuarine environment. In the future, more work that concentrates on experimental functional analysis and the use of an ethnographic approach will be needed if we are to determine the true forms and functions of the myriad shell tools, not only in Florida, but in coastal sites around the world.

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*Type-G Shell Hammers and the Crown Conch (*Melongena corona*)*

The Type-G Shell Hammer is defined by Marquardt as one of "normal (as opposed to massive) size," and crafted from the shells of three noted species: *Busycon contrarium*, *Melongena corona*, and *Strombus alatus/pugilis* (1992). He suggests that these tools "may have been intended for expedient use," and notes that they "all have at least one hole, usually oblong, opposite the aperture, and may or may not have a shallow notch in the outer whorl" (1992). Before Marquardt's recognition and naming of the Type G hammer, Reiger (1981) briefly mentioned this tool type, noting that the form was observed and collected as early as the expeditions of C.B.Moore,- and later mentioned by John Goggin in 1949 in an unpublished manuscript *The Archaeology of the Glades Area, Southern Florida*. Bullen's (1953) investigations at the Crystal River site revealed this tool type in abundance, with the only artifact

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types occurring more frequently throughout the entirety of the excavated profile being chipped stone and pottery..

The descriptions of the Type-G Shell Hammer as defined by Marquardt, and more specifically the *Melongena corona* hammer that Reiger describes, show variation of the tool. The pattern of hafting of the hammers is variable, noted by Marquardt (1992) as utilizing either a notch and hole or two paired holes. Moore (1900) observed that the hammers had "two holes to permit a handle to pass through to the left of the axis." (392). In addition, the observed range of the tool is broad as well. Reiger, in the work cited above, describes the range of the *Melongena corona* hammer as consisting of the Glades area in Southern Florida, specifically "Russell Key, northwest of Chokoloskee," and Cedar Key on the Northern Gulf Coast of the state (1981:17). Further, he states that the *Melongena corona* shell hammer is not found between the two areas noted, creating a zone between the two areas where the artifact type does not appear. Marquardt's additions to the range of the Type-G Shell Hammer that he defines include sites within the middle zone that Reiger mentions, specifically including sites in both Manatee and Hillsborough counties.

The species that is most well represented in the samples taken from Roberts Island of Type-G Shell Hammers is *M. corona*. (Figure 3). The Crown Conch is known to reach lengths of 2to 5 inches from spiral apex to base, however, many specimens collected at the Roberts Island site were much smaller, with most individuals scarcely reaching 100 cm (Abbot and Morris 2001:226). The Crown Conch is notable for having small, sharp spines on the shell's shoulder as well as an additional row of spines near the base of the shell. The lip of the Crown Conch near the aperture is thin and undeveloped relative to other shells such as the Florida Fighting Conch

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(*S. alatus*). Aside from certain very rare specimens, the Crown Conch is a dextral shell, its aperture opening to the right of the columella (Abbot and Morris 2001:226-227).

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It has been suggested by a number of researchers that the Crown Conch has an adverse effect on oyster beds with which they share a habitat, due to their predation of the oysters (Hathaway and Woodburn 1961, Bowling 1994, Woodbury 1986). At least at the Roberts Island site, this relationship seems to be limited at best due to the extreme proportion of oyster shell that composes the midden and associated mounds. At Roberts Island the crown conch shell is distributed throughout the range of the site both spatially and temporally, though concentrations of the shell in certain areas of the site were noted.

In general, the body of data for the Type-G Shell Hammer is small, and while statements have been made concerning their function, distribution, and manufacture, these are largely conjectural. To my knowledge, this project will be the first that seeks to answer any specific questions about the *M. corona* Type-G Shell Hammer. My hope is that this research will make a substantive contribution to our understanding of this class of tool in regards to its use-life and manufacture.

Formal and Expedient Tools

One of the primary distinctions of tools that archaeologists make when considering types is that between formal and expedient tools. Definitions of formal and expedient tools abound; however, some do not draw the distinction between formal and expedient but rather between curated and expedient (Bamforth 1986). The difficulty of having two different classificatory regimes in place is that two different meanings of expedient tools are implied. On one hand, as was mentioned, Bamforth (1986) sets his opposition between curated and expedient tools. The definition of expedient tools thus provided is simply those that are

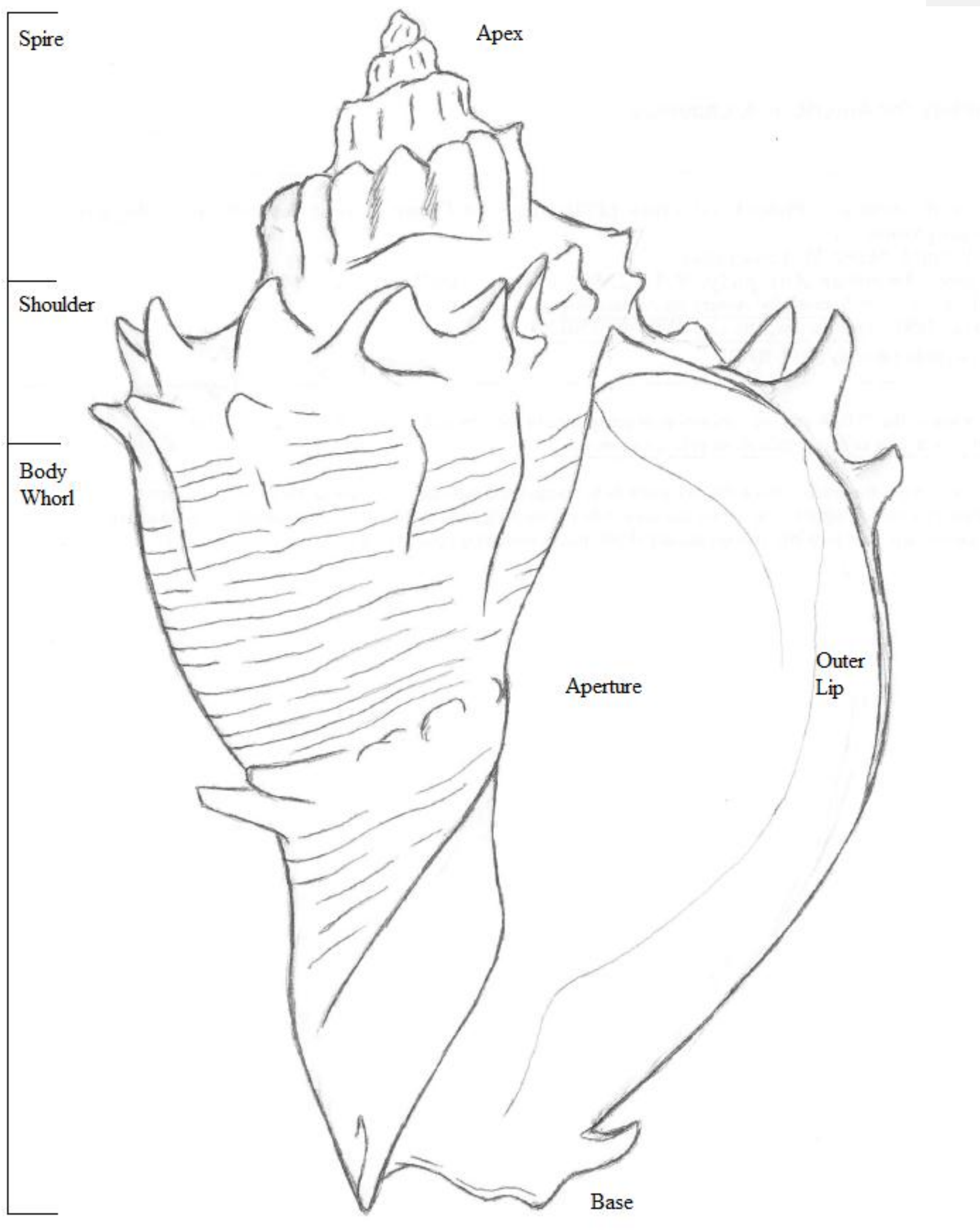
Spire
Apex
Shoulder
Body
Whorl
Aperture
Outer
Lip
Base

Figure 3.

~~substantive contribution to our understanding of this class of tool in regards to its use-life and manufacture.~~

~~*Formal and Expedient Tools*~~

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On the other hand, there are those that frame their opposition between formal and expedient tools. In this distinction, expedient tools are more stringently defined as those which receive only primary modification, meaning that they are simply removed from the parent material and used or even used as found with nearly no modification whatsoever (O'Day and Keegan 2001).

The importance of these two definitions of expedient tools for this project is that in the more loosely defined distinction between curated and expedient tools, the Type-G Shell Hammer might be considered an expedient tool, while in that made between formal and expedient tools;

the Type-G Shell Hammer would be squarely within the realm of formal tools. This is because in the curated/expedient paradigm, a non-expedient tool should have evidence of reworking and a specific function and this level of investment is usually tied to a lack of the raw material needed for a tool's manufacture (Bamforth 1986). The fact that the specimens reported by both Marquardt (1992) and Reiger (1981) are bereft of evidence of reworking suggests in this line of thinking that the Type-G Shell Hammer is an expedient tool. Couple this with the fact that at the sites where this tool type is observed they are seen in numbers, further suggesting that the shells used to manufacture them are not a scarce resource, and it becomes understandable that they might be considered expedient tools. In the formal/expedient paradigm, however, a non-expedient tool is any that receives secondary modification beyond simple removal from a parent material. In this case, due to the presence of a hafting apparatus on nearly all specimens, the Type-G Shell Hammer is a formal tool.

In the Roberts Island sample being studied here, there is compelling evidence of significant reworking of the shell hammers. This is most often represented by a secondary set of hafting holes being pecked out above the broken original pair. This suggests that upon failure of the hafting apparatus, the shells were reworked with a new set of hafting holes for continued use. If this interpretation proves to be true, it would greatly weaken the argument that the Type-G shell hammer is an expedient tool in any classification.

Experimental Archaeology

Artifact replication and experimental archaeology are useful tools at the disposal of archaeologists attempting to reconstruct behaviors related to tool use. Artifact replication refers to the creation of functional replicas of artifacts and features found in the archaeological record and can give insight into the ways in which tools, structures, and other things were crafted, as well as what materials were used in their construction when evidence of these is not necessarily preserved. Experimental archaeology is a body of methods and theory which encompasses artifact replication and also refers to the use of tools and other materials in experiments designed to gain information related to function, methods of use, and construction of all manner of artifacts and features (Coles 1979). The importance of experimental archaeology lies in our ability, through its use, to tentatively reconstruct past behaviors in a more visceral and observable way than can be done by simply examining what is extracted from the archaeological record (Saraydar and Izumi 1973).

Coles (1979) provides a wealth of information on the methods and theories of experimental archaeology. One of the most important aspects of his coverage of experimental archaeology; however, is his consideration of its limitations as a methodological and theoretical base. Among these limitations is the tendency for experimental studies to be inconclusive. Toni Carrell (1992) echoes this by stating that "a successful experiment, i.e., one that is repeatable, cannot prove incontrovertibly that past peoples did the same thing in the same manner, but only that they *may* have used the same technique." (6). In addition, Carrell notes that not all human behaviors are rooted in logic and that the relation of form and function are not always as logical either. The implication of this disconnect between behavior and logic is that while experimental archaeology may provide us with some insight into past human behaviors, the accuracy of that insight is questionable. Therefore, we can never say that anything is truly proved through experimental archaeology, though the insights gained from archaeological experiments are nonetheless useful in studies of historic technologies (1992).

Also of importance to experimental archaeology is proper replication of tools and materials used in the experiment. As stated by both Coles and Carrell, a proper replica is one which utilizes only those materials in its construction that would have been used by the people who originally created the tool in the past. This relates to the ethics of experimental archaeology that experiments and the replicas used in them should be representative of what is found in the archaeological record. Deviation from this may cause replicas to over- or under-perform in the experiment and thus skew our interpretation of the past. Realistically, perhaps for safety reasons or difficulty in procuring proper materials to conduct an experiment that truly representative of past conditions, it is conceivable that an archaeological experiment be carried out using substitute materials, so long as the primary variable in the experiment (i.e. the material you wish to study) is represented adequately (Outram, 2008).

Additionally, Furgeson (2010) notes that those seeking to use experimental archaeology should keep in mind the ability of the experiment to provide data relevant to the research question. This further emphasizes the fact that research and experiment design are of paramount importance to experimental archaeology.

The value of experimental archaeology to this project is that it allows for testing and observation of the Type-G Shell Hammer in a situation of real use as opposed to just examining wear in the lab and hypothesizing based on those observations. Experimental archaeology provides the opportunity to provide an answer to my research questions, albeit one that is only probable, instead of making suggestions and speculations based on what is seen in the original tools. The utilization of experimental method and theory gives greater insight into the way these tools were used and how that is reflected in the specimens from the research site.

Chapter 2: Methods

Sampling

A systematic sampling strategy was used for the collection of shell artifacts from the surface at the Roberts Island site. Shells were only collected if they were either whole, partial and worked, or consisted of a significant amount of the whole shell. The distinction between what was to be collected and what was not was made at my discretion. Specimens were bagged and numbered according to the field specimen (FS) numbering scheme used for the CREVAP project. Specimen numbers are non-contiguous in the FS log, being separated as they were collected on different days. In addition to the FS numbers recorded in the field, which often times were used to record clusters of multiple shells, a shell tool (ST) number was assigned in the lab to each shell collected.

Comment [tp10]: Well, we also numbered them by PP#

Sampling was done in two waves. The first wave, collecting shells 1-49 (The shell tool numbers are independent of the FS numbers, and both are recorded, as will be covered in more detail later), used a total station to record spatial distribution of the shells, and was done much earlier in the project. The second wave, collecting all other shells in the sample, used less rigorous methods of recording spatial distributions of the shells, employing only a mapping grade GPS and later, due to time constraints and the difficulty in obtaining reception, a handheld GPS unit. In the second wave of collections, transects were used for maximum coverage of the research site, with shells deemed worthy of collection being pinned and later, bagged.

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Descriptive Analysis

In the descriptive analysis of my sample, a variety of measurements were collected that were useful in creating a data set of sizes and variation of the shells, with many of these measurement fields also being used by Marquardt in his 1992 typology. The measure of length measured from the apex of the spire, or the closest approximation thereof, to the base of the shell on the columella. Width was measured from the outer lip at the shoulder to the point directly opposite on the body whorl. Thickness was measured at the point where the body whorl meets the columella at the shell's base instead of on the body whorl or the shoulder since many shells were missing both of those. Finally, working face width measured from the basal end of the columella where wear was present to the farthest area of the body whorl that exhibited wear similar to that of the columella. Each shell artifact received a one page entry that recorded not only the measurements, but also any additional observations that were deemed worthy of note (Figure 4).

Comment [tp12]: Should note that your nmeasurements generally followed the dimensions and procedures described by Marquardt.

The physical measurements were carried out using a set of digital calipers set to measure to the nearest tenth of a millimeter, while weight was taken using a digital scale measuring to the nearest tenth of a gram. These small units were the most appropriate considering the size of the shells, with an estimate based on the whole unmodified specimens ranging from 70 to upwards of 100 mm and up to and slightly over 100 g. These measurements, in addition to being compiled in the notebook mentioned before were also entered into a spreadsheet format for analysis.

Comment [tp13]: Specify that you measured to nearest tenth of a millimeter and nearest tenth of a gram?

Analysis included the creation of a hypothetical length to width ratio for *M. corona* that would be useful in determining the degree of wear of the modified shells. This was accomplished using the 57 whole unmodified specimens from my sample and the averages of the shells' individual length:width ratios. This ratio to be used was established at 1.4992:1, and was then

CREVAP

Shell Tool Observation Form

Site #: ____________________ Provenience: ________________________

FS#:______________________ Observer: ___________________________

Shell Tool #: _______________ Genus & Species: _____________________

Handedness: _______________ Tool Type: __________________________

Measurements:

Maximum Length (mm)	
Maximum Width (mm)	
Maximum Thickness (mm)	
Weight (g)	
Working Face Width (mm)	
Haft/Edge Angle (degrees)	
Number of Holes w/ Orientation	
Presence of Notches	

Working Face:

Blunt: __________ Beveled: ___________ Spalling: __________

Additional Observations:

Figure 4.

applied to the modified shells with a sufficiently complete width so as to obtain an accurate estimate of their unmodified length. The unmodified length was then compared with the observed length for these specimens, and the difference was recorded as a percentage of the reconstructed unmodified length. The result is an estimate of the percentage of wear due to use of the shell tool that can later be used in a comparative use-wear analysis with experimental replicas.

Comment [tp14]: Maybe a little more detail here. How many whole did you emasure to come up with this? Is the ratio an average of these?

Experimental Analysis

Having established a baseline interpretation of the degree of use of the Type-G Shell Hammer through the descriptive analysis, the purpose of the experimental analysis will be to either support of refute the hypotheses stated earlier. To do this, a number of functional replicas were created that will be tested on a number of different materials and then their wear patterns compared with those original specimens from the field sample.

To begin, replication followed suggestions made by Carrell (1992) that replicas employ materials representative of those thought to have been used in the originals. In this case, wood for the haft and some kind of organic fiber or rawhide for the binding are most appropriate. There is, however, a competing need to isolate the shell, being the study focus, as the primary acting variable of the hammer in the experiment. As a compromise between these two, I used standardized, ½ inch wooden dowel rods for the hafts and a blended cotton/polyester twine for the binding. This compromise is consistent with the suggestions by Outram (2008) presented earlier. These materials were chosen in accord with the assumption that having standardized materials that were more or less in line with native materials would be optimal for the experiment.

While the vast majority of shells contained in the sample are *M. corona*, it was difficult to find fresh specimens of the shell in the size needed for use in the experimental tests, and so a compromise was made. Instead of using *M. corona* for my tests, I used a related species, *M. melongena*. This Caribbean Crown Conch, when compared to the Florida Crown Conch, has a much shorter spire; however, the shell's morphology from shoulder to base is nearly the same. From the sturdy, spiraling columella to the ovoid aperture and from the secondary spines near the shell's base to the underdeveloped outer lip, the Caribbean Crown Conch was a more than adequate analogue for the Florida Crown Conch for the purposes of this test

The experiment involved testing the shell hammers on a variety of materials, most of them subsistence related. The materials tested included oyster shell (whole oysters), pecan nut, wood (oak), and bone (pig femur). These materials were chosen based on the likelihood of their use, or the use of a similar material, by the occupants of Roberts Island. Stone was not included as a material to be tested on due to the difficulty in procuring sufficiently porous limestone such as is present at Roberts Island. In addition, while there is stone at the site, it is notably scarce, and so it was not seen to be particularly relevant as a test material.

The hammers, examples of which are shown in Figure 4, were constructed in four sets, each with a small, medium, and large sized hammer, though the dimensions of the different sizes were not consistent across sets due to the limited amount of shells available and so were defined relative to each other. The hammers were then used in a vertical pounding motion against the material for a period of either 300 blows or failure, whichever came first.The resulting wear on the shell was photographed and recorded, and the shell bagged for closer laboratory analysis. In addition to recording wear of the shells themselves, significantly large

Comment [tjp15]: Another figure here with people using them?

Figure 5.

pieces of debris from both the shells and the testing material were collected, photographed, and bagged. An assistant aided in this phase of the experimental analysis in order to avoid the effects of arm fatigue on the results. With this assistant, strikes against the testing material were done in alternating 100 stroke increments, with myself performing the first and last 100 strokes, and the assistant performing the middle 100.

Following the experiment, the used shells were unbound and removed from the hafts and were transported to the laboratory for more intensive use-wear analysis. For this final section of the experimental analysis, the shells used for the replica shell hammers were compared to those in the original sample to examine the degree of the wear. A low-magnification digital microscope was used in the laboratory analysis of the shells to help observe details that would have otherwise gone unnoticed. Again, comparative measurements of size and weight were made using millimeters and grams, respectively. Finally, results were compiled in a spreadsheet format for ease of reference.

Chapter 3: Description of the Archaeological Assemblage

Sampling and Descriptive Data

In total, 203 specimens were collected in the field, representing a large range of tools including hafted hammers and possible cutting-edged tools, unhafted pounders, and whole unmodified shells. A complete tally of the shells collected shows a total of 70 hafted Type-G hammers, 1 possible hafted cutting-edged tool, 24 unhafted pounders, 50 unidentified shells and shell fragments, and 57 whole unmodified shells. (Figure 6). In addition, there is one shell which is unaccounted for due to its being borrowed from the sample during analysis. Of the entire sample, only 5 artifacts were of *B. contrarium*, representing about 2.5% of the sample, while the remaining 198 artifacts were of *M. corona* (Figure 7).

Comment [tjp16]: Will these be tabulated somewhere? If so refer to table or appendix

The shell analysis concentrated on those shell artifacts that showed visible signs of wear, and most importantly, had evidence of hafting (i.e., Type-G shell hammers). These tools were found to fall within a broad range of sizes, weights, and thicknesses. As well as being diverse in size, the shell tools were also highly variable in their degree of wear, with some looking as though they had seen very light work, while others were nearly worn down to the hafting holes, or in extreme cases, to near the shoulder. In addition, many shells showed signs of retouch and reuse, with a number of specimens having multiple sets of hafting holes and some showing evidence of wear after the failure of their body whorls, and therefore hafts.

Comment [tjp17]: Not sure we need to capitalize this, but if you want to, OK.

The measurements of length and width varied widely as the shells ranged from columella fragments and pounders to unmodified whole shells. The *M. corona* Type-G hammers ranged from 88.8 to 45.2 mm long and from 69.7 to 41.6 mm wide, while the *M. corona* unhafted pounders ranged from 90.7 to 46 mm long and from 74.5 to 43.2 mm wide. The 1.4992:1 ratio of

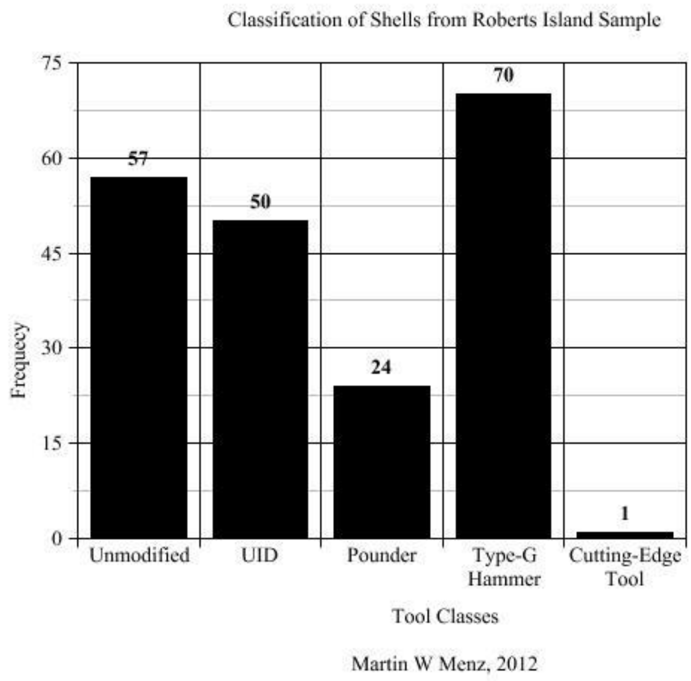
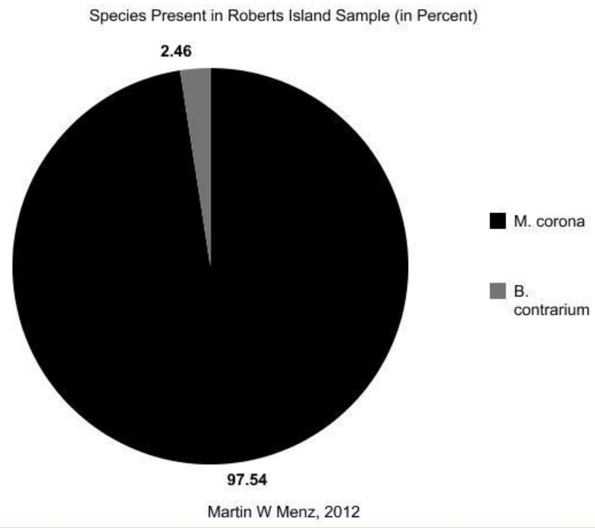


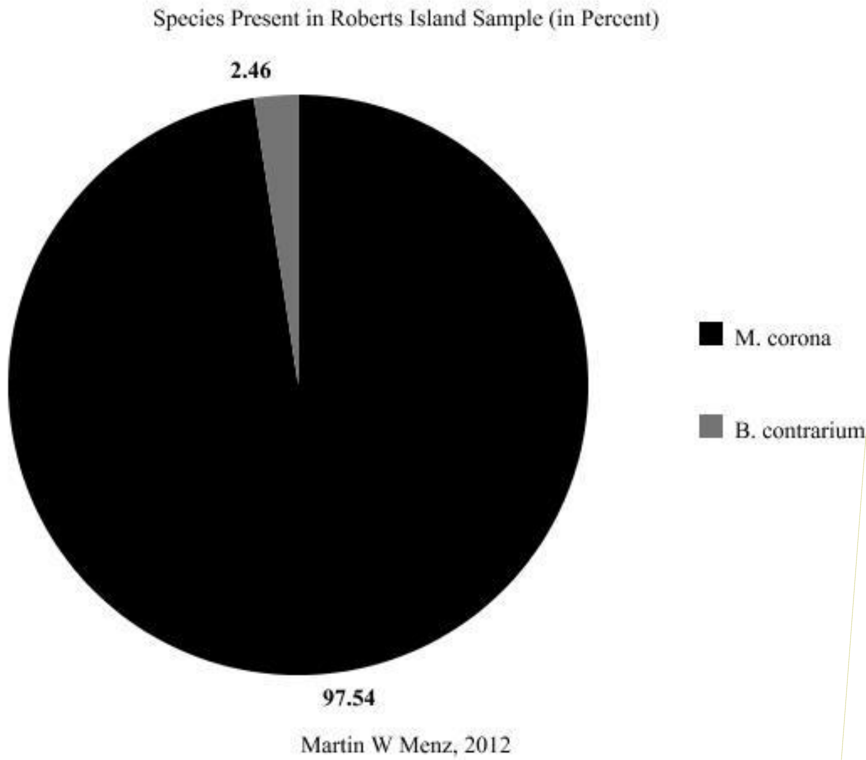
Figure 6.



~~Figure 7.~~

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Text 1 length to width that was established for the *M. corona* was then applied to those Type-G hammers and unhafted pounders that had enough of their whorl intact or a complete shoulder, from which a full measure of their width could be obtained, with the resulting reconstructed length estimate being recorded. The reconstructed length estimate for the Type-G hammers ranged from 104.5 to 62.4 mm long, and the estimate for those pounders for which a length reconstruction could be calculated ranged from 102.4 to 86.7 mm long, though there were only four such shells in the entire sample.

The measure of thickness also ranges fairly broadly in the Roberts Island shell sample. The fact that the measurement was taken at the base of the shell in the channel where the body whorl and columella articulate means that as the shell is worn through use, that channel can be expected to become thicker and thicker, and so the measurement would be skewed and show shells that had seen some use to be thicker in comparison to unmodified shells than they might actually be. This is problematic because the implication of a thicker, more robust shell is that it would have been selected for modification and use as a tool and skewed data carries the possibility of falsely confirming this when it might otherwise not be true for this particular sample (Luer 2008). The reality of it, however, is that the channel that was measured does not



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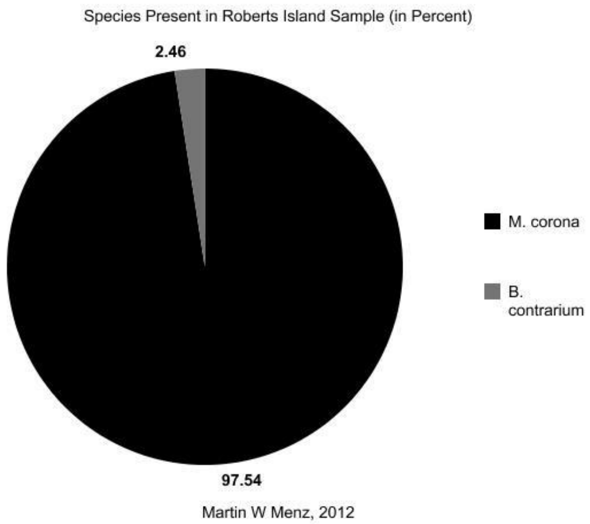

Figure 7.

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thicken as much as much as would be expected as the columella approaches the spire, meaning that while there will be some skew in the measure of thickness towards showing worked shells to be more robust, it is minimal, though the lack of body whorl on some unhafted pounders means that the measurement had to be taken closer to the columella than is desirable, and so this measurement is especially suspect for this tool type. The thickness of the Type-G hammers ranged from 8.3 to 3.2 mm with the average being 5.3 mm. For the unhafted pounders, the range was from 10.1 to 2.7 mm with an average of 6.9 mm.

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	Avg. Length (mm)	Avg. Width (mm)	Avg. Thickness (mm)	Avg. Weight (g)
Unmodified	80.14	54.27	3.99	54.63
Unidentified	77.54	53.74	4.02	51.23
Type-G Hammer	66.13	58.67	5.27	58.58
Unhafted Pounder	61.43	57.53	6.89	52.43

Table 1.

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Finally, the thickness of the unmodified shells ranged from 5.9 to 2.2 mm with an average of 4.0 mm.

Wear Patterns and Degree of Wear

In the Roberts Island sample, three types of wear patterns were evident, even as early as the sampling and collection phase of the project (Figure 7). The first of these, which I characterized as simply "blunt," is consistent with what Pagoulatos and Veit (1993) called "crushing," which includes chipping and grinding of the work face. It should be noted that this needs to be distinguished from "polishing," as the effects of time have dulled the worn bases of the Roberts Island shells to the point that even if the basal ends of some shells were polished by wear, we would not be able to tell them apart from those that had a crushing wear pattern. (Figure 8). Additionally, the experimental analysis suggests that crushing wear patterns were by far more likely than polishing patterns, but this will be covered in more detail below.

Comment [tjp18]: You need to tell us how many show evidence for each type of wear

The second of these types of wear is referred to here as a "spalling" pattern. Spalling refers to the driving off of large flakes or chips (called spalls) from the parent material. (Figure 9). The spalling pattern seen in the Roberts Island shells is similar to the "stepped chipping" pattern identified by Pagoulos and Veit (1993), but is greatly exaggerated, with some spalls being driven almost up the entire length of what remains of the tools' columellae. This type of wear is always associated with the blunt wear type in the Roberts Island sample and does not occur independently.

Comment [tjp19]: Photo?

The third type of wear, body whorl damage, is hardly a distinct type of wear at all, given that it falls under the definition of spalling. Additionally, not all body whorl damage is necessarily from use-wear, with modification of the body whorl to change a previously hafted hammer into an unhafted pounder being one example. While body whorl damage was not specifically recorded in the shell tool analysis sheets (mentioned earlier), it was often noted in the "notes" field of the sheet, especially when very obvious. As with the blunt wear pattern, the body whorl damage wear type was confirmed in the experiment.

Comment [tjp20]: photo

The reconstructed length estimates mentioned in the previous section were compared to the initial recorded lengths for the tools for the purposes of getting an idea of the percentage of the shells' overall length that had been lost due to wear. The resulting wear percentages ranged from 3% to 54% with an average percentage of 26.3%. With the exclusion of outliers, that average is modified to 26.6%. When the hafted tools are separated from the unhafted tools, their wear percentage averages come out to 25.7% and 28.9%, respectively. An independent sample t-test showed that the difference between these two averages was not significant at an alpha of .10 with a t-obtained value of -0.7674 to a t-critical of 1.282. It should be noted that some of the shells for which wear percentages were taken were missing portions of their spires, the losses of which were not taken into account when calculating their lengths or wear percentages. Despite this, the wear percentages derived for this project are at least a solid estimate of the degrees of wear of the Roberts Island shells, as the addition of the spire in most of the calculations where it was missing would have likely only influenced the degree of wear for each of those shells by a few percent.

Evidence of Retouch

Of all the evidence for retouch of the Type-G shell hammer present in this sample, one of the strongest and strangest examples is that of the tools that have more than two hafting holes, which I shall refer to as "rehafted." While it may be possible that they were bound to their hafts in such a manner that three or more holes may have been necessary, the fact that the secondary sets of holes are often set higher on the whorl (meaning closer to the shell's shoulder) than the primary ones suggests a purposeful retouching of the tool to avoid haft failure as the body whorl was worn down. Also, the specimens whose secondary hafting holes are not higher on the body whorl instead display evidence of haft failure that had already happened and as such the secondary holes would likely not have been a preventative measure against tool failure, but rather a means of repairing an already broken tool. Given that many of the shell hammers examined in this study have damage to the body whorl sufficient to compromise the hafting holes, this method of retouch would have been an effective strategy to avoid discarding the tools.

While the sample collected at Roberts Island only contained four rehafted Type-G hammers, it held a much greater number of unhafted pounders, which made up more than ten percent of the entire sample. These tools show evidence of wear similar to that of the hafted Type-G hammers, but their body whorls have either been partially or wholly stripped, exposing the columella. Based on evidence in the form of the rehafted Type-G hammers that the occupants

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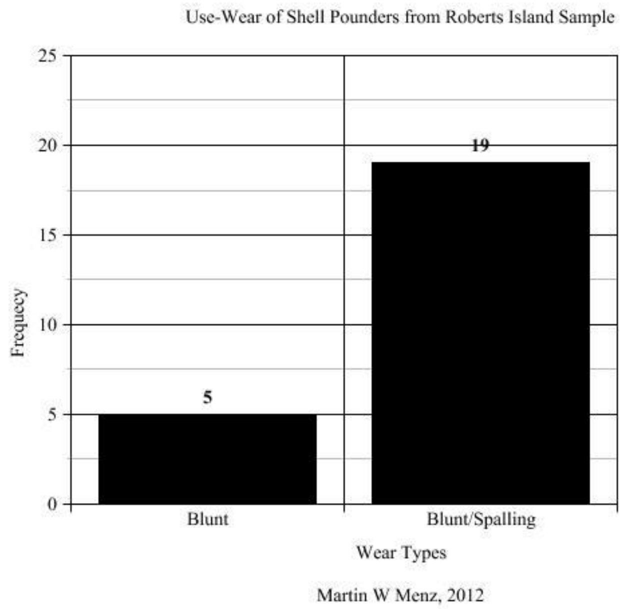
Use-Wear of Shell Pounders from Roberts Island Sample
25
20
15
10
5
0
Frequecy
19
5
Blunt
Blunt/Spalling
Wear Types
Martin W Menz, 2012

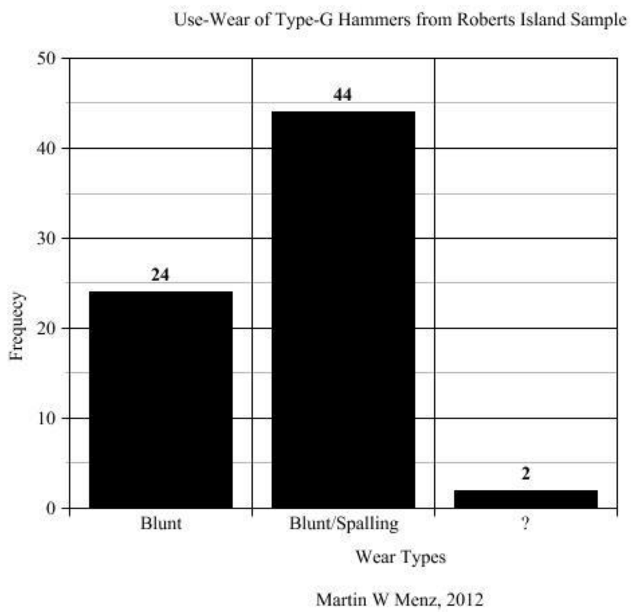
Use-Wear of Type-G Hammers from Roberts Island Sample
50
40
30
20
10
0
Frequecy
44
24
2
Blunt
Blunt/Spalling
?
Wear Types
Martin W Menz, 2012

Figure 8.


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A109 1280x1024 2012/04/04 13:27:27
FS 328 ST 107

Figure 9.


A020 1280x1024 2012/03/08 13:43:45
FS 332 ST 114
A043 1280x1024 2012/03/08 15:45:57
FS 286 ST 56

Figure 10.

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Comment [tjp22]: Elsewhere capped; juts be consistent

A Possible Cutting-Edge Tool?

Of the entire sample of more than 200 shells collected at Roberts Island, one stood out based on its pattern of wear. This shell, the working of face of which can be seen in detail in Figure 10, had what seemed to be a beveled working face on the columella and body whorl consistent with the cutting edges of whelk shell cutting-edge tools described by Reiger (1981), Luer (1986), and Marquardt (1992). This particular shell's classification as a cutting edge tool is debatable, however, due to the roughness of its bevel. The fact that the bevel is so rough may be due to the effects of time on the tool as it was collected from the surface and so was exposed to the elements since it was discarded. Another possible interpretation for the condition of the tool's working face draws on Luer's (1986) reduction sequence for the lightning whelk, *B. contrarium*, in which a cutting-edge tool whose bevel is no longer adequate for performing cutting tasks is employed as a hafted hammer. This could explain the blunted tip of the working face at the end of the bevel. Then again, it may well simply be a Type-G hammer with an unusual working face. If it is, in fact, a cutting-edge tool though, this could suggest that the *M. corona* has its own reduction sequence roughly analogous to that of whelks, with the possible addition of unhafted pounders late in the sequence.

Figure 11.

Chapter 4: Description of the Experimental Archaeology Experiment and Replica Assemblage

The replica *M. melongena* Type-G hammers that were tested displayed an extremely broad range of wear and effectiveness in processing their assigned materials. Of the three wear types described previously, all three were represented in the experimental replicas after use; though, interestingly enough, the blunt and spalling wear types were observed not together, but on separate sets of replicas, shell and bone, respectively. Below there are provided more detailed discussions of each material tested and the effectiveness and wear patterns observed in each test.

Comment [tjp23]: Add another sentence or two here, then describe separately?

Nuts

The hammers used to shell pecans had an extremely easy time of it, sustaining little damage from the activity, even over 300 strokes per hammer. Figure 1**2**~~1~~ illustrates the slight wear sustained by the shell hammers from cracking the pecans. In addition to showing almost no signs of wear, the hammers were also surprisingly effective at shelling the nuts, managing to crack the shells without utterly destroying the meat inside and the pace with which my assistant and I worked through the nuts was a quick one. As an anologue for the kinds of nuts that the inhabitants of

Comment [tjp24]: Can you quantify? What number had what type of wear? How much of shell was lost? Also, how about a photo?

Roberts Island may have had access to, the pecans demonstrated that this kind of work leaves little to no wear on the shell hammers in the short term, and it is expected that long term wear from use in shelling nuts would also be slight.

Wood

The hammers designated for use on wood fared slightly worse in regards to wear than did those used on the pecans. These hammers saw wear in the form of small to medium sized flakes of a few millimeters being driven off of the outer lip of the body whorl. This wear pattern, shown in Figure 13~~2~~, is consistent with some of the sample shells, in that the body whorl near the basal end of the shell was broken away before significant wear was sustained by the columella. Unfortunately, the shell hammers proved largely ineffective at processing the wood. For the purposes of this project, which was to test the function of the Type-G shell hammer, the shell tools were replicated without the beveled edges one would expect on a cutting-edge tool, and so further tests conducted using a tool of similar size, but with a beveled edge, may prove more successful in the processing of wood.

Comment [tjp25]: Same comments as above

Bone

The hammers used on the bone worked fairly well, managing to peck holes in the surface of the bone, rather than splinter or fracture the bone as was expected. The bone gave as good as it got, however, and the hammers sustained severe damage, with the body whorls and hafting holes of the small and medium hammers failing at 208 and 238 strokes, respectively (Figure 15). This pattern of body whorl damage leading to haft failure is consistent with many of the Roberts Island shells, as has been discussed previously, though the speed with which the hafting holes failed was surprising. The medium and large hammers also sustained considerable spalling damage to their columellae, though the spalls driven off were not as large as those driven off of many of the Type-G hammers or unhafted pounders from Roberts Island. In all three of the shell hammers tested on bone, the primary wear type observed was spalling, with little to no blunt patterns noted. Much of the breakage at the basal ends of the shells is sharp and angular. Figure 143 details the results of the bone test.

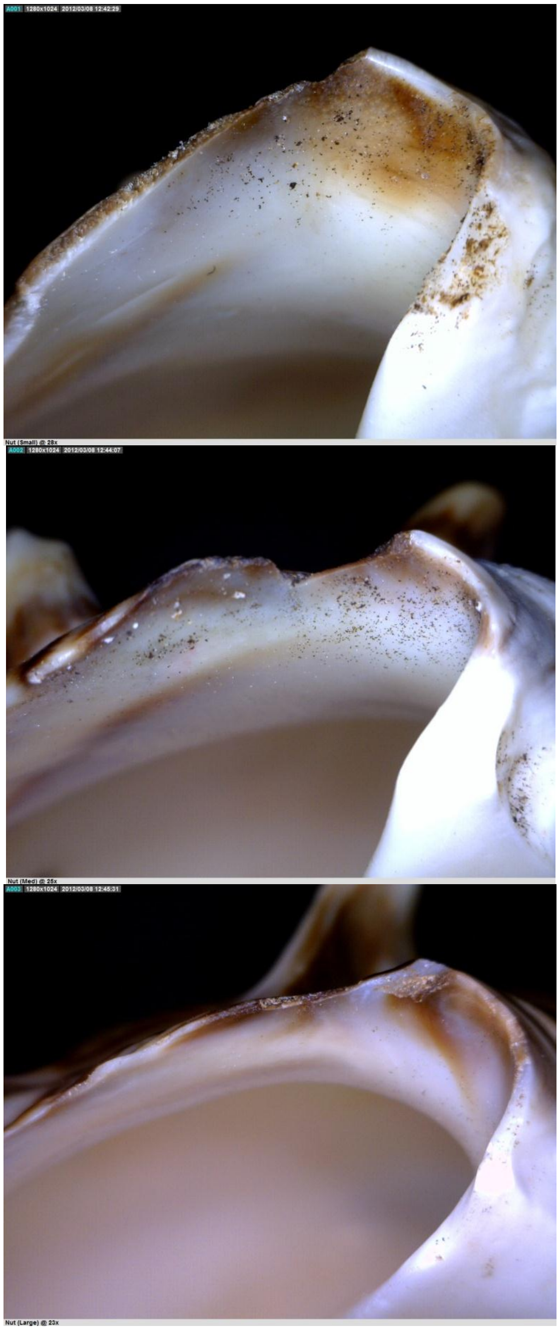

A001
1280x1024
2012/03/08 12:42:29
Nut (Small) @ 28x
A002
1280x1024
2012/03/08 12:44:07
Nut (Med) @ 25x
A003
1280x1024
2012/03/08 12:45:31
Nut (Large) @ 23x

Figure 12.

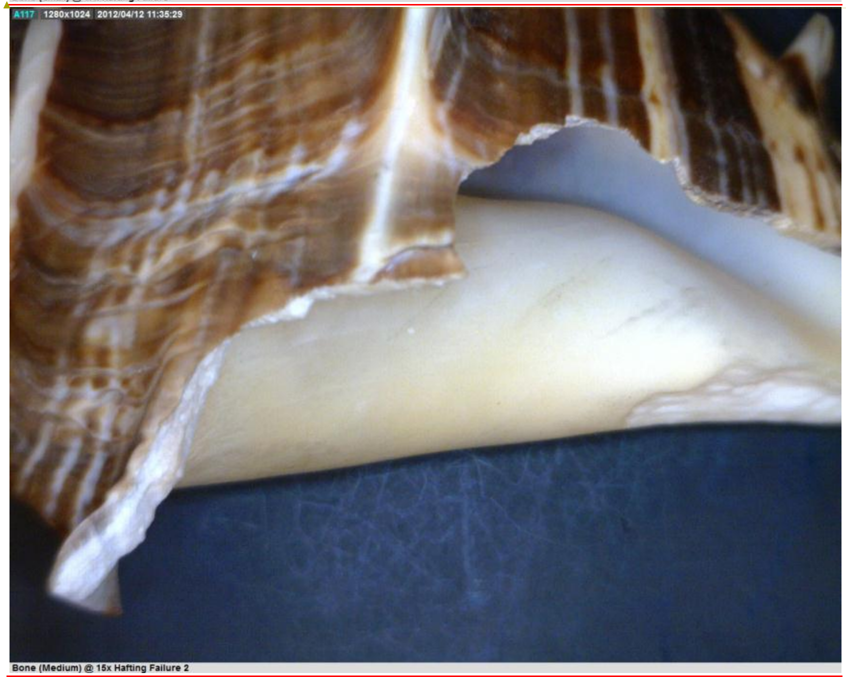

A004
1280x1024
2012/03/08 12:46:45
Wood (Small) @ 28x
A005
1280x1024
2012/03/08 12:48:16
Wood (Med) @ 23x
A006
1280x1024
2012/03/08 12:49:45
Wood (Large) @ 23x

Figure 13.


A007
1280x1024
2012/03/08 12:51:20
Bone (Small) @ 29x
A008
1280x1024
2012/03/08 12:53:55
Bone (Med) @ 23x
A009
1280x1024
2012/03/08 12:55:41
Bone (Large) @ 23x

Figure 14.

Bone (Small) @ 17x Hafting Failure



Bone (Medium) @ 15x Hafting Failure 2

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Figure 15.


A063
1280x1024
2012/04/03 14:45:43
Shell (Small) @ 20x Post Wash
A120
1280x1024
2012/04/12 11:53:48
Shell (Medium) @ 25x Retake
A066
1280x1024
2012/04/03 14:55:24
Shell (Large) @ 23x Post Wash

Figure 165.

Shell

Finally, the hammers used to shuck oysters were surprisingly effective at their assigned task, managing to pound open the oysters in only a few strokes in some cases. Shucking two-dozen oysters took about 15 minutes. With regards to wear, the hammers sustained something closer to the blunt pattern of wear as described earlier, with some light spalling and very slight damage to the body whorl across all hammer sizes (Figure 164). Overall, this test The oyster shell was brittle enough that small pieces of material that were broken off from the pounding mixed with the liquid from the oysters to form a kind of abrasive paste that gave the hammers their more ground, crushed wear patterns. Also, the brittle nature of the oyster shells seem to have aided in maintaining the integrity of the body whorl, as the force of the hammer blows more easily led to breakage of the oyster shell than was true for the bone. While some loosening of the hafts was noted over the course of the tests, no breakage of the body whorl near the hafts was observed.

Chapter 5: Discussion and Conclusions

Comparative Analysis of Archaeological and Replica Type-G Hammers

In the experiment, the original three types of wear identified in the Roberts Island sample were seen again, with the hammers tested on bone and oyster shell yielding results closest to what was observed in the Roberts Island shells. Interestingly, the hammers tested on bone and oyster each displayed a different type or types of wear. The bone hammers are characterized by jagged, sharp breakages of the body whorl and by deep spalls driven up the columella. The hammers used on oyster shell, on the other hand, had little in the way of body whorl breakage, but exhibited the blunt wear type, with the occasional light spalling, .

After examination under a low-magnification digital microscope, a few trends emerge amongst the Roberts Island sample which aid in our interpretation of the experimental hammers' wear patterns. For one, sharp, heavy spalling as is seen in the hammers tested on bone is predominantly seen in tools that are worn quite heavily relative to the overall sample. This may imply that as tools became older and more worn, their function changed, but it is more likely that as the tool aged, the effects of previous hammering simply caused the columella to weaken and fracture. Also, while heavy spalling is common within the Roberts Island sample, much of the wear on the basal ends of both the columellae and the body whorls of the shells is soft and blunted, even when spalling is evident. This would again seem to suggest that the cumulative effects of hammering over an extended period caused the tools to spall and fracture, as opposed to the hammers fracturing as the result of short periods of especially abusive use.

In light of these results, it seems that the primary function of the Type-G shell hammer, at least of those samples from Roberts Island, was to process shellfish. The experimental tests and the comparison of the wear on test hammers with those collected from the Roberts Island site supports previous speculation by other researchers to that end (Moore 1900). The hammers' performance in the oyster shell test exceeded all expectations. In addition to this, the wear pattern observed in the oyster shell test was most consistent with that of the Roberts Island shells, as they were the only replicas to be worn in a crushing pattern.

While the replica hammers performed well in the role of oyster-shucking tools, one might Pluckhahn (2012:personal communication) questions whether or not it would have been practical to employ these hammers for that function when oysters could simply be roasted. In light of this, a more appropriate interpretation for the consistency in use-wear between the Roberts Island shells and the experimental replicas tested on oyster shell might be that the Type-G functioned as a tool to break up clusters of oysters before roasting or that they even saw use in the manufacture of other shell tools (Keegan 1984; Deitler 2008; Pearson and Cook 2012). In either case, the tests presented in this paper represent what is, to my knowledge, the first attempt to discern the function of the Type-G hammer, and so while further research concerning this class of tool is needed, there is now at least some data concerning these hammers' function.

Implications of the Research

The results of both the archaeological and experimental analyses of this project suggest that the Type-G shell hammer, while more fragile than larger hafted shell tools, is not an expedient tool, a conclusion that is opposed to Marquardt's (1992) suggestion that the Type-G hammer saw expedient use. The fact that the tools underwent secondary modification in the form of being set onto a haft precludes the tool from being considered expedient in regards to the scheme of formal versus expedient tools. Also, the fact that there is evidence for retouch and remodification of the tools suggests that they are not expedient when looked at from the perspective of curated versus expedient tools. Instead, the descriptive and experimental analyses show these tools to be both formal and curated.

That these hammers exhibit a blunted, ground work face that was likely later spalled through progressive wear indicates that they were not as fragile under stress as might be believed, but that they instead had longer use-lives. This is further supported by the experiment, primarily the oyster shell test, which showed that the hammers were effective at pounding a relatively hard material for an extended period all while sustaining little in the way of structural damage to the shell's body whorl or columella that would undermine its function. The extended use-life of the Type-G shell hammer is further lengthened by its retouching to add new hafting holes when failure of the body whorl did occur or was likely to, as well as by the reworking of the shells into unhafted pounders after the body whorl had been rendered inadequate for holding a haft.

While I consider these conclusions to be sound ones drawn from the data, I should add that they are not universal to the sample. There are some shells from the Roberts Island sample that seem to have been discarded shortly after the failure of their body whorls and hafts, however, the data that I have presented allows me to at least suggest that there is a trend amongst the Roberts Island sample towards longer use-lives based on tool curation in the forms of retouch and remodification. Assuming that my interpretation of the data is correct, one implication is that for the *M. corona*, there is a sequence of use and reduction that resembles Luer's (1986) reduction sequence for the *B. contrarium*, but on a smaller, less complex scale, being reduced to only a few stages.

In addition to the larger implications for shell tool research in Florida, this study carries implications for the Roberts Island site as well. While the large number of shell hammers is not evidence of manufacture of objects of bone or wood, the presence of these tools could be evidence of use these hammers for the manufacture of shell tools or ornaments, a use that would presumably produce wear similar to that which I observed on the replica tools used for shucking oysters. However, there is relatively little shell debris at Roberts Island showing evidence of such intentional breakage, and none of the unfinished tools or ornaments or manufacturing failures that might be expected if this was a common industry at the site. Instead, it seems most likely that the hammers were used to shuck oysters and other shellfish for consumption. Consistent with this hypothesis is the very large quantity of opened oysters on the site.

Comment [tjp26]: Or something along these lines.

Comment [tjp27]: insert the couple sentences we talked about here, I think

On a more speculative note, the "rehafted" shell hammers and excessively worn hammers and pounders examined in this study raise a few interesting questions about the availability of *M. corona* and other univalve mollusks of suitable size for hafting, such as *B. contrarium* and *S. alatus/pugilis*. As was stated previously, curation of tools is often associated with a lack of raw material necessary for that tool's manufacture (Bamforth 1986). So, could the retouch and remodification of the Type-G hammers from Roberts Island be indicative of a lack of shells suitable for the manufacture of the tool type?

~~[~~Additionally, does retouch of the Type-G vary temporally? The samples collected from Roberts Island for this study were taken from the surface, and so come from a disturbed context, but additional Type-G hammers and other shell tool types have been uncovered during excavation, and so a study that looks at the frequency of retouch and remodification over time could yield interesting results.~~]~~ ~~(how well defined are the depositional horizons at Roberts Island?)~~ As was discussed earlier, the *M. corona* preys on oyster beds, and so their habitats

Comment [tjp28]: yes, this is good thought.

overlap. Based on this, one might expect to observe increased frequency of retouch and remodification to *M. corona* tools like the Type-G in levels in which less oyster is found relative to evidence of other food sources.

Hopefully this study and the data presented therein will serve as a foundation from which subsequent studies of shell tools, especially those that utilize experimental methods and that concentrate on tools from the Crystal River, will spring.

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Comment [tjp29]: This is like a chapter heading

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Comment [tjp30]: ?

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Appendices

Shell Tool #	FS #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Working Face (mm)
1	43	93.5	59.1	3.3	55	
2	44	82.1	84.1	6.9	82.9	32.2
3	45	66.7	61.5	4.4	60.4	17.9
4	46	77.7	49.8	4.1	46.2	
5	47	80	56.4	3.4	48.2	22.5
6	48	73.4	64.1	5	68.8	19.5
7	49	74.5	66.1	4.6	60.8	20.4
8	50	78.9	46.8	2.1	32.1	
9	51	69.7	36.3	2.4	22.9	
10	52	89.5	49.3	2.4	45.3	
11	53	78.7	47.6	5.3	57.9	
12	54	63.4	42.1	2.9	23.1	
13	55	76.5	63.8	2.8	57.5	
14	56	73.6	60.8	5.4	87.8	30.3
15	57	51	44.9	2.7	29.3	16.9
16	58	76.8	51.2	2.7	35.2	
17	59	82.4	56.7	4.3	67.7	
18	60	79.2	31.1	3.3	27.2	
19	61	68.2	57.7	4.8	59.8	12.1
20	62	59.7	53.9	3.3	39.1	
21	63	60	61.6	4.5	54.4	15.2
22	64	80.9	49.3	3	42.9	
23	65	54.7	30	2.9	16.8	
24	66	96.6	67.9	3.7	77.6	13.1
25	67	79.6	51.9	3.9	62	
26	68	93.3	57.2	3.7	71.5	
27	69	74.4	53.7	3.9	48.1	
28	70	79.4	57.1	3.4	59.1	
29	71	72.8	43	3.4	33.7	7.4
30	72	80.5	49.9	3.7	42.5	8.3
31	73	83.3	51.5	2.9	62.3	
32	74	60.1	44	5.2	37.4	13.5
33	75	66.8	55.3	4.3	48.5	18
34	76	58.4	65.8	4.5	70.8	15.1
35	77	78.9	49	3	55.9	
36	78	87.7	69.2	5.2	93.6	
37	79	67.6	64.5	5.2	66.7	15.8
38	80	74	61.3	4.8	61.6	17.4
39	81	45.2	49.9	4.7	39.6	19.7
40	82	99.8	59.7	4.1	67	
41	83	84.3	62	3.2	69	
42	84	63	63.9	5.7	78.7	15.4
43	85					
44	98	64	52.9	8.3	52.3	17.2
45	99	58.9	45.8	5.1	25.7	13.6
46	100	58.6	54.5	3.8	47.5	19.5

47	101	76.4	52.5	3.8	49.7	
48	102	104.6	59.4	4.5	61.2	
49	279	67.7	48.8	4.7	35.6	19.1
50	280	87.6	65.4	3.5	95.3	24.6
51	281	73.8	48	4.8	55.8	22
52	282	63.4	59	5	52.2	17.5
53	283	78.2	55.5	3.5	49.2	
54	284	87.7	56.2	2.8	60.4	
55	285	56.5	46.1	3.2	33.5	
56	286	59.4	67.3	3.2	89.5	27.6
57	287	50.6	53.9	6.6	33.4	13.3
58	288	80.7	55.7	2.2	65.3	
59	289	74.4	60.4	4	62.8	25.7
60	290	53.3	50.5	5.2	27.3	9.9
61	291	73.6	47.2	2.8	35.5	
62	292	76.3	50.8	4.2	41	
63	293	109	119.6	10.1	163.2	
64	294	72.8	26.6	6.3	40.8	14
65	295	65.9	50.5	4.1	46.9	20.6
66	296	66.4	51.9	10.1	44.6	16.2
67	297	103.6	97.8	5.7	79.3	
68	298	46.1	47.2	5.6	28.2	11.2
69	299	97.6	64.4	3.7	112.6	
70	300-1	51.5	61.3	6.7	65.1	16.3
71	300-2	75.2	56.6	5.5	47.4	11.6
72	301	69.7	46.7	5.5	43.9	
73	302	54.1	64.3	5.5	58.9	17.6
74	303	59.7	48.9	6.6	43.7	13.8
75	304	71.4	44.3	6.1	38.8	12.1
76	305-1	58.3	52	5.7	46.7	17.8
77	305-2	56.7	46.7	4.1	31.5	12.1
78	306	60.1	57.8	5.9	67.8	18.6
79	307	93.9	65.2	4	81.2	
80	308	52.3	55.9	6.2	61.3	33.65
81	309	57.5	34.6	3.2	14.2	
82	310	62.5	38.2	3.8	23.6	
83	311	56.8	63.2	6.1	62.4	25.9
84	312	56.1	59.5	4.3	53.8	21.9
85	313	88.6	56	4.7	48	
86	314	81.5	45.6	4.9	35.6	
87	315-1	57.5	58.7	5.7	44.5	14.2
88	315-2	96.9	34.9	3.4	56.7	
89	315-3	73.8	50.8	5.9	41.2	
90	315-4	66.8	48.5	4.4	41.6	
91	315-5	78.7	56	3.5	44.2	
92	316	83.3	57.7	4.3	59.7	
93	317	67.1	61.7	8	72.2	17.4

94	318	54.4	64	5.6	57.3	18.9
95	319	78.9	51.1	3.8	49.8	
96	320	83.6	48.9	4.8	59.5	
97	321	79.3	55.8	4.3	59.1	
98	322	98.3	67.8	4.7	95.3	
99	323-1	67.8	49.7	6	36	12.9
100	323-2	60.3	41.6	4.7	21.3	12.6
101	324	62.4	55.6	6.1	59.3	23.5
102	325	88.8	63.8	4.6	68.6	11.8
103	326	61.8	66.9	7	77.8	27.7
104	327-1	72.9	67.6	7.6	62	15.4
105	327-2	79.9	52.3	4.2	45	
106	327-3	90.6	62.9	4.2	65.2	
107	328	84	68.3	6.8	113.1	20.2
108	329-1	51.6	52.3	5.5	36.4	20.2
109	329-2	62.4	51.9	4.5	35.6	
110	329-3	104.2	63.2	4.4	67.8	
111	330	90.7	74.5	8.5	110.4	17.5
112	331-1	80.1	64.6	3.6	75.8	
113	331-2	62.7	33.2	3.1	23.4	
114	332	55.1	52.4	5.3	45.8	13.6
115	333	61.6	60.8	6.2	45	15
116	334	80.2	57.9	4.3	62.1	
117	335	74.1	48.6	2.5	34.5	
118	336-1	99.1	89.9	4.9	120.8	13.9
119	336-2	62.3	73.5	5.7	78	16.4
120	336-3	78.5	59.1	4.4	70.3	
121	337	70.5	68.3	9.2	75.5	14.8
122	338	63.4	66.8	4.8	66.7	27
123	339	89.2	63.8	5.1	68.8	
124	340-1	69.8	55.2	3.9	41.9	
125	340-2	70.1	51.2	3.2	48.1	
126	341	77.8	56.3	3.3	65.6	
127	342	62.4	47.6	4.3	32.3	12.5
128	343-1	45.7	74.8	3.8	29.5	
129	343-2	62.7	57.5	3.8	41.4	
130	344	84	68.3	3.8	91.5	
131	345	67.5	54.4	3.7	45.5	
132	346-1	76.1	48.5	3.9	52.3	
133	346-2	83.7	59.9	4	56.4	12.1
134	347	89.9	56	4.2	62.2	
135	348	75.1	54.2	4.2	50.5	21.6
136	349	79.1	67	3.2	58.8	
137	350	71.6	56.9	3.4	60.5	
138	351	83.4	69.7	5.4	82	25.9
139	352-1	46	67.1	7.6	60.7	12.6
140	352-2	73.6	63.6	7.7	48.3	16.1

141	353	51.1	64.5	6.3	74.3	40.9
142	354	55.3	59.5	5.5	63.4	19.1
143	355	61.4	54.8	4.4	36.2	
144	356	74.3	49.2	3.3	47	
145	357	81.5	57.6	5.3	78.4	11
146	358	99.2	68	4.7	90.7	
147	359-1	60.6	65.4	5.5	81.4	32
148	359-2	65.4	57.6	5.4	57.8	23.7
149	359-3	74.9	63.3	3.8	68	
150	360-1	63.6	56.5	5.6	61.6	27
151	360-2	69	53.6	3.8	46.5	15 (?)
152	361	65.7	38.8	3.3	19.5	
153	362	90.7	66.3	5.6	102.4	27.9
154	363	62.9	61.6	5	67.5	27.8
155	364	60.9	65.2	8.4	66.3	14.9
156	365	99	67.3	6.1	106.9	
157	366-1	62.9	59.5	8.3	66.7	17.3
158	366-2	79.9	61.9	3.7	38.3	
159	366-3	71.4	49.4	4.3	44.8	
160	366-4	71	47.4	3.6	30.4	
161	366-5	85.3	54.6	4.3	57.3	
	367					
162	368	76.3	64.8	5.8	81.4	24.8
163	369	77.9	40.3	3.1	21.1	
164	370	76	52.9	4.2	64.3	
165	371	72	44.4	3.5	25.9	
166	372	89.6	60.2	3.8	72.2	
167	373	78.5	47	4.5	45.5	
168	374	76.2	51.3	3.7	36.7	
169	375	90.8	61	5	65.4	
170	376	52.6	52.5	6.2	33.4	10.9
171	377	73.9	53	4.7	48.2	
172	378-1	70.1	55.5	3.1	46.8	
173	378-2	75.3	50.8	4	33.5	
174	379	55.1	48.9	5.5	33.1	17.1
175	380-1	78.6	60.8	4.3	62.3	
176	380-2	91	53.9	3.2	42.5	
177	381-1	65.9	60	8.1	60.6	12.1
178	381-2	95.6	59.6	5	72.2	
179	381-3	62.3	50.6	4.4	35.6	
180	381-4	81.6	53.6	5.4	43	
181	382-1	51.4	43.2	7.2	22	12.7
182	382-2	81.5	61	3.3	68.1	
183	382-3	64.1	43	3.9	29.8	
184	383-1	69.7	50.2	5.7	39.9	15.1
185	383-2	87.1	52.1	4.4	48	
186	384	76.9	53.4	4.5	57.5	

187	385	47.4	63.1	6.1	50.6	20.4
188	386-1	55	57.4	7.3	43.9	14.9
189	386-2	66	57.8	7.3	50.3	14.9
190	386-3	72.3	33.4	6.4	42.1	
191	386-4	71.9	46.1	5.5	41	
192	387-1	53.5	52.8	8.5	38.8	13.1
193	387-2	72.4	51.8	5.9	45.9	17.8
194	388	85.4	61.4	5.5	81.9	
195	389	95.9	59.9	4.2	66.8	
196	390	68.4	36.7	3.2	21	
197	391	61.5	46.4	6.5	39.1	15.6
198	392	67.8	54.9	5.7	55.3	25.9
199	393	45.2	57.8	5.3	58.8	42
200	394	59.4	59.6	4.4	46.7	15.4
201	395	72.4	58.6	4.1	69.8	
202	396	53.6	49.5	7.1	31.2	12.1
203	397	74.3	81.5	7.5	105.6	16.4

Shell Tool #	FS #	# of Holes	Notches	Wear Pattern	Species	Tool Type
1	43				M	UID
2	44	2	Possible	Blunt	B	Type G
3	45	1	No	Blunt, Spalling	M	Type G
4	46				M	Unmodified
5	47	1	No	Blunt, Spalling	M	Type G
6	48	2	No	Blunt	M	Type G
7	49	1	No	Blunt	M	Type G
8	50				M	UID
9	51				M	UID
10	52				M	UID
11	53				M	Unmodified
12	54				M	Unmodified
13	55				M	Unmodified
14	56	3	Possible	Blunt, Spalling	M	Type G
15	57			Blunt, Spalling	M	Pounder
16	58				M	Unmodified
17	59	1 (?)			M	UID
18	60				M	UID
19	61	1	No	Blunt	M	Type G
20	62	1 (?)			M	UID
21	63		No	Blunt, Spalling	M	Pounder
22	64	1 (?)			M	UID
23	65				M	UID
24	66			Blunt, Spalling	B	Type G
25	67				M	Unmodified
26	68				M	Unmodified
27	69				M	Unmodified
28	70				M	Unmodified
29	71	1	No	?	M	Type G
30	72	1	No	Blunt	M	Type G
31	73				M	Unmodified
32	74			Blunt, Spalling	M	Pounder
33	75	2	No	Blunt, Spalling	M	Type G
34	76	1	No	Blunt, Spalling	M	Type G
35	77				M	Unmodified
36	78				M	Unmodified
37	79	1	No	Blunt, Spalling	M	Type G
38	80	2	No	Blunt	M	Type G
39	81	3	No	Blunt, Spalling	M	Type G
40	82				M	Unmodified
41	83				M	Unmodified
42	84			Blunt, Spalling	M	Type G
43	85					
44	98			Blunt	M	Pounder
45	99			Blunt, Spalling	M	Pounder
46	100	1	1	Blunt, Spalling	M	Type G

47	101				M	Unmodified
48	102				M	Unmodified
49	279	2	No	Blunt	M	Type G
50	280	1	No	Blunt	M	Type G
51	281	2	No	Blunt	M	Type G
52	282	1	No	Blunt, Spalling	M	Type G
53	283				M	Unmodified
54	284				M	UID
55	285				M	UID
56	286	2	No	Blunt, Spalling	M	Type G
57	287		No	Blunt, Spalling	M	Pounder
58	288				M	Unmodified
59	289	2	No	Blunt	M	Type G
60	290	1	No	Blunt	M	Type G
61	291				M	Unmodified
62	292				M	Unmodified
63	293				B	UID
64	294				M	UID
65	295	2	No	Blunt, Spalling	M	Type G
66	296		No	Blunt	M	Pounder
67	297	1	1		B	UID
68	298	1		Blunt	M	Type G
69	299				M	UID
70	300-1		No	Blunt, Spalling	M	Pounder
71	300-2	1	No	Blunt	M	Pounder
72	301				M	Unmodified
73	302	2	No	Blunt, Spalling	M	Type G
74	303	1	No	Blunt	M	Type G
75	304		No	Blunt, Spalling	M	Pounder
76	305-1	2	No	Blunt, Spalling	M	Type G
77	305-2	2	No	Blunt, Spalling	M	Type G
78	306	2	No	Blunt, Spalling	M	Type G
79	307				M	Unmodified
80	308	2	No	Blunt, Spalling	M	Type G
81	309				M	Unmodified
82	310				M	Unmodified
83	311	2	No	Blunt, Spalling	M	Type G
84	312	2	No	Blunt, Spalling	M	Type G
85	313	1 (?)			M	UID
86	314				M	Unmodified
87	315-1	1	No	Blunt, Spalling	M	Type G
88	315-2				M	UID
89	315-3				M	Unmodified
90	315-4				M	Unmodified
91	315-5				M	Unmodified
92	316				M	Unmodified
93	317	2	No	Blunt, Spalling	M	Type G

94	318	1 (2?)	No	Blunt, Spalling	M	Type G
95	319				M	Unmodified
96	320				M	Unmodified
97	321				M	Unmodified
98	322				M	Unmodified
99	323-1		No	Blunt	M	Pounder
100	323-2	1	1	Blunt	M	Type G
101	324	2	No	Blunt	M	Type G
102	325	2	No	Blunt	M	Type G
103	326	3	No	Blunt, Spalling	M	Type G
104	327-1	1	No	Blunt, Spalling	M	Type G
105	327-2				M	Unmodified
106	327-3				M	Unmodified
107	328	1	No	Blunt, Spalling	M	Type G
108	329-1	1	No	Blunt, Spalling	M	Type G
109	329-2				M	UID
110	329-3				M	Unmodified
111	330		No	Blunt, Spalling	M	Pounder
112	331-1	1 (?)			M	UID
113	331-2				M	UID
114	332	1	No	Blunt, Spalling	M	Type G
115	333	1	No	Blunt, Spalling	M	Type G
116	334				M	Unmodified
117	335				M	Unmodified
118	336-1	1	No	Blunt	B	Type G
119	336-2		No	Blunt, Spalling	M	Pounder
120	336-3				M	UID
121	337		No	Blunt, Spalling	M	Pounder
122	338	2	No	Blunt, Spalling	M	Type G
123	339				M	Unmodified
124	340-1				M	Unmodified
125	340-2				M	Unmodified
126	341				M	Unmodified
127	342	2	No	Blunt	M	Type G
128	343-1				B	UID
129	343-2				M	UID
130	344				M	UID
131	345				M	UID
132	346-1				M	UID
133	346-2	2 (?)	No	Little Wear	M	Type G
134	347				M	Unmodified
135	348	1	No	Blunt, Spalling	M	Type G
136	349				M	UID
137	350				M	Unmodified
138	351	2	No	Blunt	M	Type G
139	352-1		No	Blunt, Spalling	M	Pounder
140	352-2	1	No	Blunt, Spalling	M	Type G

141	353	1	No	Blunt, Spalling	M	Type G
142	354	1	No	Blunt, Spalling	M	Type G
143	355				M	UID
144	356				M	Unmodified
145	357	2	No	Blunt	M	Type G
146	358				M	Unmodified
147	359-1	2	No	Blunt, Spalling	M	Type G
148	359-2	2	No	Blunt, Spalling	M	Type G
149	359-3				M	Unmodified
150	360-1	2	No	Blunt, Spalling	M	Type G
151	360-2			Blunt	M	UID
152	361				M	UID
153	362	1, Possibly 2	No	Beveled	M	Type B
154	363	2	No	Blunt, Spalling	M	Type G
155	364		No	Blunt, Spalling	M	Pounder
156	365				M	UID
157	366-1	1	No	Blunt, Spalling	M	Type G
158	366-2				M	UID
159	366-3				M	Unmodified
160	366-4				M	Unmodified
161	366-5				M	UID
	367					
162	368	2	No	Blunt	M	Type G
163	369				M	UID
164	370				M	Unmodified
165	371				M	UID
166	372				M	Unmodified
167	373				M	UID
168	374				M	UID
169	375				M	UID
170	376	2	No	Blunt, Spalling	M	Type G
171	377				M	UID
172	378-1				M	UID
173	378-2				M	Unmodified
174	379	1	No	Blunt, Spalling	M	Type G
175	380-1				M	UID
176	380-2				M	UID
177	381-1		No	Blunt, Spalling	M	Pounder
178	381-2				M	UID
179	381-3				M	UID
180	381-4				M	Unmodified
181	382-1		No	Blunt, Spalling	M	Pounder
182	382-2				M	Unmodified
183	382-3				M	UID
184	383-1	2	No	Blunt	M	Type G
185	383-2				M	Unmodified
186	384				M	UID

187	385		No	Blunt, Spalling	M	Pounder
188	386-1		No	Blunt, Spalling	M	Pounder
189	386-2		No	Blunt, Spalling	M	Pounder
190	386-3				M	UID
191	386-4				M	Unmodified
192	387-1		No	Blunt	M	Pounder
193	387-2	2	No	Blunt	M	Type G
194	388				M	Unmodified
195	389				M	UID
196	390				M	UID
197	391	1	No	Blunt, Spalling	M	Type G
198	392	2	No	Blunt	M	Type G
199	393	3	No	Blunt, Spalling	M	Type G
200	394	2	No	Blunt, Spalling	M	Type G
201	395				M	UID
202	396		No	Blunt, Spalling	M	Pounder
203	397		No	Blunt, Spalling	B	Pounder

FS#	Length (mm)	Width (mm)	W(1.4992)	% Wear	Hafted Tool	Pounder	M or B	Notes
44	82.1	84.1	?			x	B	No Ratio
45	66.7	61.5	92.2	28	x		M	
47	80	56.4	84.6	5	x		M	
48	73.4	64.1	96.1	24	x		M	
49	74.5	66.1	99.1	25	x		M	
56	73.6	60.8	91.2	19	x		M	
61	68.2	57.7	86.5	21	x		M	
63	60	61.6	92.4	35		x	M	
66	96.6	67.9	?		x		B	No Ratio
71	72.8	43	64.5		x		M	Anomaly
72	80.5	49.9	74.8		x		M	Anomaly
74	60.1	44	66	9		x	M	
75	66.8	55.3	82.9	19	x		M	
76	58.4	65.8	98.6	41	x		M	
79	67.6	64.5	96.7	30	x		M	
80	74	61.3	91.9	19	x		M	
81	45.2	49.9	74.8	40	x		M	
84	63	63.9	95.8	34		x	M	
98	64	52.9	79.3	19		x	M	
99	58.9	45.8	68.7	14		x	M	
100	58.6	54.5	81.7	28	x		M	
279	67.7	48.8	73.2	8	x		M	
280	87.6	65.4	98	11	x		M	
281	73.8	48	72		x		M	Anomaly
282	63.4	59	88.5	28	x		M	
286	59.4	67.3	100.9	41	x		M	
287	50.6	53.9	80.8	37		x	M	
289	74.4	60.4	90.6	18	x		M	
290	53.3	50.5	75.7	30	x		M	
295	65.9	50.5	75.7	13	x		M	
296	66.4	51.9	77.8	15		x	M	
298	46.1	47.2	70.8	35	x		M	
300-1	51.5	61.3	91.9	44		x	M	
300-2	75.2	56.6	84.9	11		x	M	
302	54.1	64.3	96.4	44	x		M	
303	59.7	48.9	73.3	19	x		M	
304	71.4	44.3	66.4			x	M	Anomaly
305-1	58.3	52	78	25	x		M	
305-2	56.7	46.7	70	19	x		M	
306	60.1	57.8	86.7	31	x		M	
308	52.3	55.9	83.8	38	x		M	
311	56.8	63.2	94.7	40	x		M	
312	56.1	59.5	89.2	37	x		M	
315-1	57.5	58.7	88	35		x	M	
317	67.1	61.7	92.5	27	x		M	
318	54.4	64	95.9	43	x		M	

323-1	67.8	49.7	74.5	9		x	M	
323-2	60.3	41.6	62.4	3	x		M	
324	62.4	55.6	83.4	25	x		M	
325	88.8	63.8	95.6	7	x		M	
326	61.8	66.9	100.3	38	x		M	
327-1	72.9	67.6	101.3	28	x		M	
328	84	68.3	102.4	18	x		M	
329-1	51.6	52.3	78.4	34	x		M	
330	90.7	74.5	111.7	19		x	M	
332	55.1	52.4	78.5	30	x		M	
333	61.6	60.8	91.2	32	x		M	
336-1	99.1	89.9	?		x		B	No Ratio
336-2	62.3	73.5	110.2	43		x	M	
337	70.5	68.3	102.4	31		x	M	
338	63.4	66.8	100.1	37	x		M	
342	62.4	47.6	71.4	13	x		M	
346-2	83.7	59.9	89.8	7	x(?)		M	
348	75.1	54.2	81.3	8	x		M	
351	83.4	69.7	104.5	20	x		M	
352-1	46	67.1	100.6	54		x	M	
352-2	73.6	63.6	95.3	23	x		M	
353	51.1	64.5	96.7	47	x		M	
354	55.3	59.5	89.2	38	x		M	
357	81.5	57.6	86.4	6	x		M	
359-1	60.6	65.4	98	38	x		M	
359-2	65.4	57.6	86.4	24	x		M	
360-1	63.6	56.5	84.7	25	x		M	
362	90.7	66.3	99.4	9*	x		M	Beveled
363	62.9	61.6	92.4	32	x		M	
364	60.9	65.2	97.7	38		x	M	
366-1	62.9	59.5	89.2	29	x		M	
368	76.3	64.8	97.1	21	x		M	
376	52.6	52.5	78.7	33	x		M	
379	55.1	48.9	73.3	25	x		M	
381-1	65.9	60	90	27		x	M	
382-1	51.4	43.2	64.8	21		x	M	
383-1	69.7	50.2	75.3	7	x		M	
385	47.4	63.1	94.6	50		x	M	
386-1	55	57.4	86.1	36		x	M	
386-2	66	57.8	86.7	24		x	M	
387-1	53.5	52.8	79.2	32		x	M	
387-2	72.4	51.8	77.7	7	x		M	
391	61.5	46.4	69.6	12	x		M	
392	67.8	54.9	82.3	18	x		M	
393	45.2	57.8	86.7	48	x		M	
394	59.4	59.6	89.4	34	x		M	
396	53.6	49.5	74.2	28		x	M	

397	74.3	81.5	122.2	x	B	No Ratio

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