LIKE LISTENING TO A SEASHELL: A MIDDEN ANALYSIS FROM LA CONSENTIDA, OAXACA, MEXICO

Steven Powell

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LIKE LISTENING TO A SEASHELL: A MIDDEN ANALYSIS FROM LA CONSENTIDA, OAXACA, MEXICO

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Applied Archaeology

by
Steven James Powell
June 2020
LIKE LISTENING TO A SEASHELL: A MIDDEN ANALYSIS FROM LA CONSENTIDA, OAXACA, MEXICO

A Thesis
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June 2020
Approved by:

Guy Hepp, Committee Chair, Anthropology

Wesley Niewohner, Committee Member
ABSTRACT

Oaxaca is a state in Southern Mexico with a long history of human occupation. In fact, some of the earliest village sites in Mexico are found there, dating to the Early Formative period (2000 – 1000 BCE). These early settlements provide archaeologists an opportunity to study a time period which saw increasing development of social complexity in Mesoamerica. For this thesis, I examined shellfish remains recovered from middens during excavation at the coastal Oaxacan site of La Consentida conducted by Dr. Guy Hepp in 2012 as part of the La Consentida Archaeological Project. I examine this material for evidence of paleoenvironmental conditions and their change over time, archaic land use practices, and social practices including feasting and status differentiation.

This thesis will contribute to other regional studies through analysis of material collected from these middens. I examine this shell in numerous ways, including by speciation, measurement, contextual analysis, and archaeometric techniques documenting occurrences of feasting La Consentida. In the course of my analysis, I find that the inhabitants of La Consentida utilized the nearby estuaries and lagoons as sources of the shellfish found at the site, and the inhabitants consumed them as part of feasting behavior. They further utilized some of the remains in the production of shell tools and decorative items. I will discuss two shell beads, three shell pendants, and one shell cutting tool
recovered during excavations for evidence of manufacturing practices and tool use at La Consentida.
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The Early Formative period of Mesoamerica, spanning from 2000 – 1000 BCE, was a time of transition. This was the time period when the cultural traits that would come to embody Mesoamerican culture and tradition first began to form, developing the nucleus of what would later be expressed through the marvels that Spanish conquistadores would describe to the skeptical masses in Europe (Evans 2013; Hepp 2019a; Joyce 2010). This was not a quick process, and it was one interrupted by stops and starts as various polities and civilizations would blossom and grow, only to collapse as quickly as they were formed. The Olmecs, Toltecs, Aztecs, and Maya are perhaps best known among the Mesoamerican civilizations, but one of the frontiers of this cultural development was Oaxaca, with such well-known sites as San José Mogote, Monte Albán, and Tututepec each representing distinct periods of Mesoamerica’s long regional history.

Yet, this history still holds many mysteries despite the best efforts of diligent archaeologists. These mysteries include one of the most fundamental shifts undergone by humanity: the switch from small villages of relatively egalitarian inhabitants to an ascribed-status society with distinct social classes. What may have been the reason, or reasons, for such a change? Bar-Yosef and Belfer-Cohen considered sedentism to be a “point of no return” (1989:448). Inomata et al. (2015) argued that the development of sedentism in the Maya
lowlands to be a factor of more than the spread of agriculture. Robert L. Kelly devoted an entire chapter to studying the phenomenon in his book on the lifeways of hunter-gatherers, arguing that sedentism emerges from the “interplay between the distribution of food across a landscape and population density” (2013:252). Why did it happen on such a broad scale, to human societies all over the globe (Bar-Yosef and Belfer-Cohen 1989; Belfer-Cohen and Bar-Yosef 2002; Habu 2020; Inomata et al. 2015; Jiang and Liu 2006; Kelly 1992)? Why did some societies maintain their traditional hunting-and-gathering based food economies much later than would strictly be necessary, sometimes even to this day (Arnold 1992; Erlandson et al. 2008; Kelly 2013; VanDerwarker 2010; Wenzel 2014)?

This is what makes studying moments in time such as the Early Formative period in Mesoamerica so critical - they are one of very few windows into how this complexity came to be.

One unlikely source of information on this early social change comes from the refuse ancient people left behind in household and communal dumps, known to archaeology as middens. Much like the trash we produce today, this refuse contains much information about who we are and how we live. Such middens contain evidence of past subsistence practices and technologies, frequently providing clear examples of pottery, tools, and faunal remains demonstrating our ways of life (Ambrose 1967; Grenda et al. 1998; Waselkov 1987). By analyzing middens, archaeologists can recover bits and pieces that help us to reconstruct life in the past, especially when it comes to dietary choices. This can help inform
us of historic biodiversity and environmental health and provide strong evidence of longer-distance interactions and trade. At La Consentida, this has already proven to be informative, with middens providing carbon-datable material, pottery, figurines, and faunal remains that evince "interregional relationships, aspects of social organization, and dietary practices" (Hepp 2019a:61).

These variations in our diet are a fundamental aspect of human cultures, as different ingredients, techniques, and combinations are preferred by local people, with roots largely – though not exclusively – related to tradition and availability in the past. This availability is itself largely a factor of regional biodiversity and environmental variation, and therefore the local environment has a strong effect on the development of new cuisines (Joyce and Henderson 2007; Stahl 2014). One important example of this can be seen in shellfish, which tend to feature in cultures which exploited the coast and other bodies of water such as estuaries, swamps, lakes, and rivers. For some groups, shellfish have featured quite heavily in subsistence practices, with generations of people producing massive shell-mounds, including those found elsewhere in Mesoamerica (Blake et al. 1992; Voorhies et al. 2002). These shell-mounds were debated by archaeologists who questioned whether they were natural phenomena or merely washed ashore in storm events. Eventually, beginning in 1847, researchers in Denmark began studying them more thoroughly and conclusively demonstrated they were of human origin (Waselkov 1987). Today, these shell-mounds are valued around the world, and sometimes given special status due to their size or
historical value, such as the Damariscotta Oyster Shell Heaps in Maine, listed on the National Register of Historic places in 1969, and the Ōguruwa Shell Mound in the Tōkai region of Japan, listed as a National Historic Site in 1941. These middens leave behind the inedible shell and with it, concrete evidence of cultural practices and behaviors in addition to a wealth of testable material.

Shell has the potential to provide a wide variety of information, both contextually and independently, that can offer invaluable insight into the past. Few other types of material available to archaeologists offer the potential for such wide-ranging datasets—regarding quite so many aspects of the past. One can identify information on ocean temperature and salinity over time with resolution even reaching seasonality of shellfish harvest. Isotopic and radiocarbon testing of shell can help contextualize other artifacts and features at an excavation (Ambrose 1967; Claassen 1998; Waselkov 1987). In addition, analysis of shell can illuminate local resource harvesting strategies and intensity, social organization and trade, and population growth through time (Ambrose 1967; Erlandson et al. 1999; Grenda et al. 1998; Waselkov 1987). In this thesis I present the data produced by my analysis of shell from La Consentida and a discussion contextualizing these results in light of other evidence for life in the community.
CHAPTER TWO
BACKGROUND

Geography

Oaxaca, a state in Southern Mexico, is a mostly tropical savanna region (Köppen classification Aw) dominated by highland mountain ranges and plains in the northwest and low, coastal plains in the south. Rain is seasonal, with the rainy season between July and September providing most of the year’s precipitation. Prevailing currents flow to the northwest, bringing nutrient-dense, warm equatorial waters that support a rich variety of marine life. The terrestrial landscape also supports a rich and varied environment, including a wide range of flora and fauna. La Consentida itself sits within the confines of the modern Chacahua National Park, a densely wooded landscape reaching out to the coast and encompassing five lagoons. The forests frequently grow wild and obscure archaeological sites until you stumble across them, and the roots disrupt the soils as they grow. This bioturbation has an effect on the stratigraphy of the area, with the \textit{camote de agua} tuber notably disturbing deposits at La Consentida (Hepp 2015). The environment of Oaxaca is a potentially unstable one however, as rivers fed by seasonal rains cut through the high mountains and sweep sediment (including the contents of anthropogenic terraces) down with them, eventually depositing it into the ocean and filling in any inland lakes, lagoons, or bays into which they would have drained into in earlier times (Goman et al. 2005, 2010; Joyce and Mueller 1997; Mueller et al. 2012).
Paleoenvironment

The current local environment contrasts somewhat with the paleoenvironment reconstructed through several studies. Goman and colleagues (2005) and Mueller and colleagues (2012) have reported the effects and timing of this process. Goman and colleagues described the processes by which soil runoff, likely caused by agricultural practices and deforestation upstream, draws soils to the coast. Seasonal rains and severe storms further redistribute this soil up and down the coastline, closing off bays and lagoons, possibly leading to distinct changes in water salinity and modifying the impact of wave action and storm events. This had the result of significant local coastal landscape change as these lagoons and bays would in some cases desiccate, and habitat loss would affect species distribution and availability. Facies left by seasonal storms showed morphological distinctions which indicated that the habitat began to change as early as 3450 cal BP, contemporary with the Early Formative (Goman et al. 2005). Joyce and Mueller (1997) discussed how this erosion affected the valleys as well, eventually leading to river aggradation, likely a result of deforestation to allow room for agriculture. In a later article, Joyce and Mueller (2010) argued that this would have increased agricultural potential in the lower valley and led to a food surplus, which may have facilitated social changes, such as through the adoption or expansion of feasting practices.
Feasting

Feasting is a difficult practice to definitively identify in the archaeological record, as all evidence pointing to it is circumstantial and open to interpretation (Hildebrandt et al. 2009; Madgwick and Mulville 2015; Marquardt 2010; Miracle 2002; Rosenswig 2007). This is not to say that identifying feasting events is impossible. Rather, the process requires a careful, detail-oriented analysis of the material recovered and some abstract thinking. Some authors identify feasting via analysis of butchery and macroscopic and isotopic analysis of skeletal remains. Miracle (2002), for instance, suggested that differential butchery practices reflect underlying social hierarchies in Mesolithic Europe. Based on Medieval ethnohistorical evidence, he argued that different cuts would indicate status differences, with less desirable cuts relegated to those of lower social standing. He considered unbroken bones, with marrow intact, to be evidence of feasting when present in larger, single-use middens. Further, he considered isotopic analysis of animal bones which showed that they were brought to the site from sometimes great distances to be evidence of communal gathering and feasting practices. When animals are rare, either in practical terms or rare in the local diet, he argued they are more likely to be given higher status.

Other researchers, such as Russo (2004), have considered the spatial analysis of the midden and the midden’s composition. He argued that “when involving two or more people, food consumption is never solely a biological function but serves a myriad social ends” (2004:41) and that particular midden
shapes (circles, parabolas, and ovals) are possible evidence of these ends as evidence of feasting behaviors. He argued the spatial distribution would reflect this communal activity, with refuse discarded around a focal point in the center where the feasters would eat, similarly to how village sites may form around prestigious locations or buildings. Further, he considered other features to demonstrate feasting behaviors. Absolute quantity of shells and the presence of rare or labor-intensive foods, as well as evidence of excess and unconsumed foods are evidence of feasting. In addition, a lack of hearths, crushing damage, or other human activities within and around the midden demonstrate quick deposition. Finally, a lack of aeolian soil deposits or infiltration by fauna, such as terrestrial snails demonstrates quick capping of the midden in an effort to control the smell such an abundance of food rotting openly would create. Marquardt (2010) cautioned against an uncritical acceptance of these characteristics as fact, as they may instead reflect other strategies for land use and refuse disposal.

Twiss (2008) also presented an overview of feasting using modern ethnographic data to inform her perspective and identifying material correlates to the processes involved. Different practices related to feasting and food preparation behavior may influence the presence or absence of some of these material markers, such as unique disposal practices that may involve burial or burning. In addition, other behaviors associated with feasting may be present, such as a very large variety of intricate cooking and/or serving equipment, or the serving of large quantities of alcohol where it is present. There may be a
particularly wide variety of foods offered, and they may involve rare animal species, particular those which are large or hard to process.

Clark and Blake (1994) likewise argued that Early Formative feasting practices in the Soconusco region of southern Chiapas could be seen through highly decorated containers and tableware. In fact, they saw feasting and ceramics as so closely connected that they argued that ceramic technology was imported into lowland Mesoamerica to replace less sturdy pottery and gourds by self-aggrandizers in order to increase their social stature during feasting events through conspicuous consumption. They argued this was achieved by means of serving liquids, potentially with ritual significance and prestige value, as an adjunct to the feasting. Finally, Rosenswig (2007) provided four differential patterns related to everything from food preparation to consumption. He supported Clark and Blake's points, arguing that elite feasting is predicated on reinforcing social distinction through conspicuous consumption, and thus feasting events reflecting this distinction would display a greater variety of decorated serving ware which would serve to distinguish the elites. The land around elite compounds would also reflect this in a lack of preparation debris and a greater amount of consumption refuse as the community would prepare food elsewhere and coalesce around a central location.
Excavation Background

Preliminary excavations were conducted at La Consentida in 2009, and the excavation which recovered the material for this thesis was conducted in 2012. Significant landscape modification was recorded on the site in the process of building up a 300 x 100 x 5m earthen platform at the heart of the site with a volume of roughly 150,000m³ (Hepp 2015, 2019a). Probable borrow pits were discovered in an arc to the northeast, with most of the fill estimated to be from within 250m of the site (Hepp 2015). Prior radiocarbon dating results have returned a 2σ probability calibrated date range of 1950–1525 cal BC, and a 1σ probability of 1885–1565 cal BC, placing it at the beginning of the Early Formative and contemporary with the Barra phase of the Soconusco (Hepp 2019a, 2019b). Six additional radiocarbon dates were collected for this thesis (see Table 2). Two samples in particular help to provide chronological context for this thesis. One sample collected from the bottom of the F16–F9 midden in Op. LC12 E Unit 1A Lot 21 dated to 3350 ± 30 BP (Beta - 561874; plant charcoal; δ¹³C = -25.7), which calibrates to 2010–1770 cal BC (2σ probability, rounded to 5-year time increment) or 1975–1860 cal BC (1σ probability). A second sample collected from the top of the midden in Lot 11 of the same unit dated to 3350 ± 30 BP (Beta - 561873; plant charcoal; δ¹³C = -22.4), which calibrates to 1740–1530 cal BC (2σ probability) or 1685–1610 cal BC (1σ probability). Additionally, four shell samples were submitted for testing, but proved to be problematic. They are discussed in more detail in Chapter Four.
Population estimating procedures established for the Valley of Oaxaca (see Hepp 2015:185 for discussion) have provided an estimated population range of 45-112 individuals, with a midpoint of 80, with the caveat that these estimates are based on larger housing footprints than those found at La Consentida (Hepp 2015). The 2012 excavation involved nine operational areas, divided into 1 x 1 meter units. Vertical levels were excavated in lots of 5–20 cm following natural stratigraphic changes when available (Hepp 2019a). Surface sediments were largely disturbed via bioturbation, such as the previously mentioned camote de agua tuber.

Figure 2.1. Map of Oaxaca showing location of La Consentida in the greater context of Mesoamerican archaeological sites. Reproduced from Hepp (2015).
Excavated sediment was passed through 1 cm mesh screen, as well as 0.4 cm mesh screen in more sensitive contexts (Hepp 2019a). Operations D and E, which form the majority of the sample analyzed here, were opened to explore probable domestic contexts and middens atop substructural mounds, similar to those found at other sites in the region. Artifacts and ecofacts recovered from the site were subsequently transported to the INAH storage and research facility in Cuilapan de Guerrero where they remain.

Figure 2.2. Topographic map of La Consentida showing Platform 1 and Substructures 1–7. Reproduced from Hepp (2019a).
Figure 2.3. Topographic map with locations of 2009 and 2012 excavations. Dimensions of operation areas are approximate. Contexts analyzed in this thesis are Op. LC12 E, Op. LC12 D, and Op. LC12 A. Map reproduced from Hepp (2019a).
CHAPTER THREE
METHODOLOGY

I used multiple methods during the course of this analysis. The initial sorting and data collection consisted of three main segments, performed for each lot of each operation. Sorting and speciation were conducted first, and then MNI was calculated. Second, I weighed each species in aggregate and appropriate samples were measured to determine the size variation within each lot. Finally, I submitted two charcoal and four shell samples to Beta Analytic for radiocarbon dating. All samples come from Op. LC12 E Unit 1A. Each factor is important to measure in order to produce an accurate representation of the different species’ proportions in the record at each level, and when taken together, as a whole.

Minimum Number of Individuals

Determination of the minimum number of individuals (MNI) is a critical part of any zooarchaeological analysis, but certain difficulties must be kept in mind. First and foremost, it must always be stressed that there are multiple methods for calculating the MNI of an assemblage, and these are always estimations. In addition, due to the nature of shellfish remains and site formation processes, certain techniques may not be appropriate. For instance, calculating the MNI via the number of identified specimens (NISP) will dramatically overrepresent certain species based on the fragmentation or taphonomic conditions within an assemblage, and is fundamentally impracticable on large assemblages where
very large amounts of shell must be sorted. Likewise, using the non-repetitive elements (NREs) of a shell will lead to an underestimate if the NRE is destroyed or inconsistently present. Giovas (2009) provided an overview of these difficulties, arguing that calculations based on the NRE are problematic, but in many cases necessary based on the anatomy of a shell. For bivalves, with these difficulties in mind, I calculated the minimum number of individuals (MNI) using the beak or umbo (as appropriate) of each valve as the NRE. For gastropods, the NRE was dependent on the preservation levels of the shell. The vast majority of gastropod shells were found intact and were simply counted. When the shells were fractured, the apex, siphonal canal, or operculum were used as the NREs as appropriate.

Figure 3.1. Bivalve shell morphology. Image reproduced from (Cesari et al. 1990)
Weighing and Measuring

I measured the total shell weight for each species within each lot by weighing the speciated section on a digital scale to the centigram. Measurement of the size variance of each species at each excavation level was conducted using digital calipers in millimeters, as discussed by Mason and colleagues (1998). Measurements of a selection of the largest and smallest specimens were taken for each species for every level and an average was calculated. This average was compared between each level within and across units to discern...
any patterns to the size distribution. Specimens were chosen based on relative completeness, with those bearing terminal ventral edges being preferred, though this was not always possible in lots with little shell, or in instances of isolated specimens.

By calculating the MNI for each species, I have produced an estimate for the minimum number of shellfish contributing to each operation examined. Due to the highly fragmented nature of much of the shellfish remains however, the MNI is very likely a significant underestimate of the total number of shells present, and so shell weight was measured as well. Shell weight is an important analogue measure where the number of identifiable NREs is low and is likely to underrepresent the total number of individuals present (Giovas 2009). Comparison of the results between these two quantification methods allows for the production of a more accurate representation of the number of shellfish contributing to the midden.

Speciation

Identification of the genera and species (where possible) was achieved via modern biodiversity studies of the region and various internet resources with pictures of comparative samples such as the World Register of Marine Species (WoRMS) and the Smithsonian National Museum of Natural History’s Department of Invertebrate Zoology Collections. The listings provided by WoRMS are used as a definitive guide in instances where the taxonomy of a
species is in question or has multiple synonymized names. In addition, the findings of other archaeological excavations were used for comparison (Bastida-Zavala et al. 2013; Goman et al. 2005; Ríos-Jara et al. 2009; Zeitlin 1993).

It is unreasonable to assume that no changes have happened to the local or regional biodiversity with the introduction of foreign species to the area, either by accident or intention, since the Early Formative period. As discussed earlier, it is known that environmental change has indeed occurred along the coast as local bays and estuaries have shifted or closed off completely (Goman et al. 2005). However, these distributional changes should not be mistaken for complete replacement. Unless strong archaeological evidence is found to demonstrate a distinct break in the biological continuity of the region, it is safe to assume that even in cases of environmental disturbances, these disturbances are localized enough that the local flora and fauna are relocated along the coast, instead of becoming truly locally extinct. Thus, even though the modern coastline of Oaxaca is distinctly different today than it was in the Early Formative period, it is highly unlikely that the former biological community has collapsed and been replaced as a result of this, and instead we merely see shifting local distributions of organisms as conditions change.

Integrating the results of species analysis with the faunal analyses already conducted at La Consentida has further allowed me to reconstruct which paleoenvironmental biomes were exploited, with results discussed below. I also took care to determine any potential changes to environmental health through
time that may have occurred at La Consentida via comparison of scale of
remains, in terms of absolute numbers of shell and physical size of shell, and
shifting patterns of resource use. This provides an important piece of evidence in
the discussion of the timing of overexploitation and bivalve overfishing found in
later studies (Fernandez 2004; White 1989).
CHAPTER FOUR
RESULTS

The total shell assemblage across all units analyzed for this thesis weighed 15,180.27 grams (plus an additional 6,517.83 grams in concreted shell material) and contained a minimum number of 4,109 individuals. As discussed in the previous chapter, this number is likely an underestimate. The results of the speciation of the entire assemblage are summarized in Table 1, and Figures 4.1 and 4.2 below. This assemblage had already seen the non-shell elements (bone, stone, etc.) largely removed during prior sorting as well. These results nevertheless serve to illustrate the scale and multicomponent composition of the midden. The degree of fracture made speciating relatively straightforward, though 31 total shell fragments were too small to speciate.

Table 1. List of all Identified Species and their Presence Across each Context.

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<td>Mesomphix</td>
<td>lucubratus</td>
<td>Button snail</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cerithideopsis</td>
<td>californica</td>
<td>California hornsnail</td>
<td>-</td>
<td>30</td>
<td>78</td>
</tr>
<tr>
<td>Ceritheum</td>
<td>stercumscarum</td>
<td>Fliespeck cerith</td>
<td>-</td>
<td>33</td>
<td>27</td>
</tr>
<tr>
<td>Theodoxus</td>
<td>Theodoxus</td>
<td>Yellow-banded Nerite</td>
<td>-</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>luteofasciatus</td>
<td>Nerite</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Nerita</td>
<td>scabricosta</td>
<td>Ornate Nerite</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 4.1. Major contributions to the total MNI of the total assemblage, all units.
Figure 4.2. Major contributions to the weight of the total assemblage, all units.

With the *Mytella* genus of mussels representing 88% of the assemblage, this was by far the most common genus in the assemblage. The genus *Mytella* has three extant species in the region: *M. guyanensis*, *M. charruana*, and *M. strigata*, all of which may be found in rocky intertidal areas with infiltration into mangrove swamps in estuaries and lagoons, using rocky outcroppings and the prop roots of *Rhizophora mangle*, the red mangrove tree, as a stable substrate (Bacon 1975; Nishida and Leonel 1995). Differentiating between the three species is somewhat difficult, with relatively minor differences in color and shell morphology being the distinguishing factors. Given the high fragmentation and
concretion fouling (discussed in more detail in the following chapter), strict speciation is untenable, and so they are considered here in aggregate.

After *Mytella*, the most common shellfish species was *Saccostrea palmula*, the palmate oyster, distinguishable by its flattened umbo and strong fluting along the ventral margin. *Saccostrea* are commonly known as rock oysters, and is a genus in the family *Ostreidae*, the true oysters. They are found in the tropics as well as slightly beyond and attach to any stable anchoring point, though preferring rock as well as the prop roots of *Rhizophora mangle*, like the *Mytella* (Félix-Pico et al. 2015; Kathiresan and Bingham 2001; Lacerda et al. 2002). They are found intertidally and are able to tolerate a wide range of salinity levels, so they may also be found in brackish waters (Félix-Pico et al. 2015). Oysters are a common food item wherever they are found, and multiple species are regarded so highly that they are currently cultivated throughout the world with a total production at nearly 6 million tons per year, with total value approaching 7 million dollars (Nowland et al. 2020).

Another oyster species, *Striostrea prismatica*, was also identified based on the much greater height-to-length ratio, and more traditional layering structure lacking the fluting of *S. palmula*. Like with the *Mytella*, *Striostrea* and *Saccostrea* were counted together (as “*Ostreidae*”) to provide a more accurate picture, though in this case due to the minimal contribution of *Striostrea*, as the oysters were not as heavily fragmented as the *Mytella*. A minority of *Ostreaeidae* specimens were found complete and still closed; the significance of this will be
considered in the discussion on feasting. Barnacles were also included in the calculations of the assemblage for ecological purposes, as they were almost certainly not considered a food item due to their completeness and the great effort required to extract very little meat. They were likely present at the site only because they were attached to the Mytella and Ostreidae. They are commonly found attached to any stable substrate such as mangrove roots and mussels and are thus important for reinforcing interpretations of the local habitat.

Op. LC12 E

![Figure 4.3. Op.LC12 E excavation profile demonstrating lenses of shell (Unit E.1C). Reproduced from Hepp (2019a).](image)

Op. LC12 E (Figure 4.3) formed the vast majority of the assemblage analyzed for this thesis, constituting about 86% of the total examined material by
weight, and 92% by MNI. The composition of Op. LC12 E is dominated by *Mytella* (Figures 4.4 and 4.5), with small amounts of *Ostreidae* and gastropods being minor components. A minority of the shell found was burned, with over half of that (54%) coming from Op LC12 E Unit 2B. This shell was more heavily fragmented than was typical for the rest of the assemblage as well, likely because burning leaves the shells more brittle. The edges had been worn as a result of post-depositional erosion, likely from rain. Nevertheless, there were enough complete fragments to positively identify them as *Mytella*. Color preservation of the rest of the sample was excellent, aside from the concreted specimens which were essentially painted over with the dark gray material. Additionally, several shell artifacts were discovered in Op. LC12 E: one shell bead from Unit 1C, two shell pendants from Unit 1Z, and a shell tool with a cutting-edge showing evidence of use wear from Unit 2B, all described in a later section of this chapter.
Figure 4.4. Categorized contributions to the MNI of Op. LC12 E, all units.
Figure 4.5. Categorized contributions to the weight of Op. LC12 E, all units.

The true horizontal extent of the midden is currently unknown, as only a portion of it has been excavated. In Op. LC12 E, it spans Units E.0A, E.0B, E.1A, E.1B, E.1C, E.1Z, E.2B, and -5A. (Figure 4.3). The midden was identified as LC12 E F16–9 (Hepp 2015: Table 4.7). Vertically, the midden has clearly defined layers of shell intermixed with layers of soil, ceramics, and other faunal remains. One radiocarbon sample was recovered from carbon rich sediment in Unit 1C Feature F10 within the midden layer, and returned a date of 1885–1635 cal BC (Hepp 2019b).
Radiocarbon Dating Results

I submitted six samples, all from Op. LC12 E Unit 1A, to Beta Analytic for radiocarbon dating analysis in order to better establish the chronology of the Op. LC12 E F16–9 midden. I chose two charcoal samples, one from the top of the midden in Lot 11 and one from the bottom in Lot 21. Four shells were also tested, two from Lot 21 and two from Lot 15. The results of this testing are summarized in Table 2. It is worth noting the discrepancy in age between the charcoal and shell samples. There are several potential reasons for this, such as an incorrect local Delta R adjustment, the “hard water effect” whereby shells absorb older carbon dioxide or bicarbonates brought in from limestone or volcanic sources, or recrystallization processes undergone in situ (Douka et al. 2010). Additionally, one key factor is the selection of the marine versus terrestrial calibration curve for calibrating these shell dates (Ramsey 2009; Reimer et al. 2013). When calibrated with the marine curve, the dates seem to come back too young, likely due to the depleted δ^{13}C signatures of those samples. When the samples are instead calibrated according to the terrestrial curve, their dates come back more in-line with the charcoal dates from the Op. LC12 E midden. Given that the mussel shells submitted for analysis likely grew in a lagoon or other brackish context, the best calibration technique would likely be a compromise of these two curves. Their dates, as reported here, are thus to be considered with caution. Due to lack
of access to the original site for more rigorous testing, it is uncertain which of these factors, either alone or in concert, may be responsible for this difference.

Table 2. Radiocarbon Dating Results reported to 2σ probability with INTCAL13 and using the terrestrial calibration curve (Ramsey 2009; Reimer et al. 2013)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Lot</th>
<th>Lab Number</th>
<th>Material</th>
<th>Uncalibrated Date, BP</th>
<th>$\delta^{13}$C, %</th>
<th>Calibrated BC Date probabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>Beta - 561878</td>
<td>Shell</td>
<td>4900 ± 40</td>
<td>-9.3</td>
<td>3770–3635 (95.4%)</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>Beta - 561877</td>
<td>Shell</td>
<td>3650 ± 30</td>
<td>-4.4</td>
<td>2135–1935 (95.4%)</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>Beta - 561874</td>
<td>Charcoal</td>
<td>3550 ± 30</td>
<td>-25.7</td>
<td>1980–1860 (67.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1855 – 1770 (26.9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2010 – 2000 (0.8%)</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>Beta - 561875</td>
<td>Shell</td>
<td>3400 ± 30</td>
<td>-10.1</td>
<td>1770–1620 (95.4%)</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>Beta - 561876</td>
<td>Shell</td>
<td>3380 ± 30</td>
<td>-6.6</td>
<td>1750–1615 (95.4%)</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>Beta - 561873</td>
<td>Charcoal</td>
<td>3350 ± 30</td>
<td>-22.4</td>
<td>1695 – 1595 (76.8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1590 – 1530 (13.2%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1740 – 1715 (5.4%)</td>
</tr>
</tbody>
</table>

*
Op. LC12 D (Figure 4.6) produced the second largest amount of shell analyzed for this thesis, with just over 10% by weight and 7.7% of the MNI. Again, it was primarily composed of *Mytella* with a minority of *Ostreidae* (Figures 4.7 and 4.8). Interestingly, the relative gastropod MNI percentage is significantly higher in this unit, with *Cerithideopsis* and *Ceritheum* both quite common in the same lot of Unit 0A. These are marine species, and as such were almost certainly intentionally harvested, and do not represent the type of snail that would be attracted to an above-ground midden with openly decaying shell. Color was
preserved in these units as well, particularly for the gastropods, which still maintained a great degree of their distinctive patterning, facilitating speciation. One shell bead was recovered via in screened deposits from LC12 D Unit 0A. I discuss this in more detail in a later section of this chapter.

An accurate measure of the size of the midden is less tenable than in Op. LC12 E, but it spans both the excavated units, Op. LC12 D 0A and 1B, and so must be wider than 2 x 2 meters (see Figure 4.6). The midden follows the contour of the platform beneath it, and the same grade as the slope of the current surface, sloping down 30% to the east yet relatively flat in the north-south direction. It was roughly 30 centimeters thick throughout both excavated units. The sheet middens uncovered in Op. LC12 D are discrete deposits, distinct from the denser midden identified in Op. LC12 E.
Figure 4.7. Categorized contributions to the MNI of Op. LC12 D, all units.

- Mytella: 66%
- Other: 5%
- Ostreidae: 4%
- Gastropod: 21%
- Barnacle: 4%

Op. LC12 D MNI

Figure 4.8. Categorized contributions to the weight of Op. LC12 D, all units.

- Mytella fragments: 81%
- Other and Unidentified: 6%
- Ostreidae: 2%
- Mytella sp.: 11%
Due to time constraints, only a portion of the shell from Op. LC12 A was sampled (from LC12 A Unit 0I, see Figure 4.9), so it constitutes a very small fraction of the total assemblage, with less than 0.03% of the total weight and 0.2% of the total MNI (Figures 4.10 and 4.11). Op. LC12 A was a trench dug along the north-south axis of the site with the goal of bisecting the northern slope of Platform 1 and Substructure 1 to reach culturally sterile soil and document construction phases. The trench was 28 meters long, though discontinuous, and one meter wide for most of its length. As a result of excavation, it was discovered...
that the platform was not the result of construction atop a natural hill or rock outcropping, but deliberate mound-building involving hauled loads of sediment (Hepp 2015). As a result, the original context is not as well preserved as the other operations, and limited interpretation of the faunal remains can be drawn as a result. Human burials were also discovered during excavation of this unit, and the operation was expanded as a result.

Two significant findings of shell were located in Op. LC12 A Unit 01 Lot 9. A shell pendant was found in this unit, and this is the only analyzed unit to contain a terrestrial gastropod (*Mesomphix lucubratus*) shell. The *Mytella* specimens from this unit were bleached white. This bleaching is consistent with sun exposure, and along with the *Mesomphix*, it is likely that this deposit was exposed for some time and bleached before later fill was added on top of it.
Figure 4.10. Categorized contributions to the MNI of Op. LC12 A, all units.
Figure 4.11. Categorized contributions to weight of Op. LC12 A, all units.
CHAPTER FIVE
DISCUSSION

Paleoenvironment

In this section, I present a brief overview of the ecological implications that the shellfish species recovered from La Consentida support. Every species on earth has more-or-less strict ecological requirements, depending on the species’ adaptability. Analysis of the faunal remains of a site therefore provides evidence of the different biomes in the surrounding area, a fact which is very helpful in environmental reconstruction of the deep past. By understanding and keeping these requirements in mind, it is possible to reconstruct sections of past ecosystems.

The majority of bivalve remains support the argument that when aquatic resources were selected, the people of La Consentida heavily favored local brackish and estuarine environments, principally the mangrove swamps which are still extant and which have been reconstructed for the area prior to local environmental change (Goman et al. 2005, 2010). These mussels, known locally as tichinda, are still a large element of coastal Oaxacan cuisine today and are commonly served in tamales de tichinda or in caldo de tichinda soup (Dalton 2000). Mussels are very common along the Oaxacan coast where there is stable substrate, provided by rocks at the banks of an estuary or the prop roots of mangrove trees. Two nearby lagoons, Laguna Chacahua and Laguna de La
Pastoria, provide this in abundance with their large swamps and mangrove forests, and as such they are the most likely source of the *Mytella* found at La Consentida. The mussels grow quickly, and in prime habitats their density can reach over 11,000 per m² (Yuan et al. 2016). This resource can thus provide a significant source of protein that is easy and safe to collect without the time investment of hunting or fishing.

Almost all of the identified mollusk species found further support this, as all are found in mangrove habitats of the region. *Chione subrugosa*, *Phyllodella*, *Anadara*, and *Saccostrea and Striostrea* are all bivalves found in abundance in mangrove swamps of the eastern Pacific, with specific abundance varying along the coast (Félix-Pico et al. 2015; Kathiresan and Bingham 2001; Lacerda et al. 2002; Reid et al. 2008). In addition, gastropods such as *Cerithideopsis*, *Nerita*, and *Theodoxus* are found in abundance (Kathiresan and Bingham 2001; Lacerda et al. 2002; Reid et al. 2008). There is evidence that *Cerithideopsis* populations evolved concurrently with the development of mangrove trees as well (Reid et al. 2008).

The exploitation of mangrove swamps and brackish waters is consistent with the fish remains recovered from the site. Mangroves offer many species of fish protection from large predators and an abundance of food, and mangroves have an important role as fish nurseries, including for species that live in deeper water as adults (Kathiresan and Bingham 2001; Lacerda et al. 2002). These populations are typically composed of a few core species that make the
mangroves their primary residence, along with temporary populations of juveniles (Lacerda et al. 2002). In the assemblage from La Consentida, there is one definitively identified, and one probable fish species, both of which are found predominantly in mangrove swamps.

The definite species is *Ariopsis guatemalensis*, known commonly as the blue sea catfish or the widehead sea catfish. These are common demersal fish in brackish estuaries and swamps with soft substrates and low visibility waters, where they subsist largely on small prey fish and crustaceans, primarily shrimp and portunid crabs (Benítez-Mondragón 2019). They are not common in areas with high wave activity, and they may be present in freshwater environments as well.

The possibly identified fish species is the tropical gar, *Atractosteus tropicus*, which is a relatively common, well-regarded freshwater food fish popular across its range. The tropical gar can be found in waters low in oxygen, such as stagnant, overgrown swamps and slow rivers, due to its ability to supplement its oxygen intake with air (Meek 1904; Burggren et al. 2016). These fish are found in both Caribbean and Pacific-slope drainage basins, with a preference for large rivers and swamps with wide floodplains.

The presence at La Consentida of fragments of *Conus* deserves acknowledgement. Cone snails are typically found in tropical oceans, beneath the tidal zone and to a depth of roughly 1,000 meters. They inhabit a variety of substrates, including hard and soft bottoms as well as vegetal and coral reef
zones. Modern biological surveys show that the *Conus* have a preference for deeper subtidal habitats over five meters below the surface (Michel-Morfín 2019; Ríos-Jara et al. 2009). Due to the scarcity of *Conus* fragments, no strong statement can be made about their origin. In the absence of more evidence of resource use of the deeper continental shelf, it is possible that they were collected by beachgoers who were gathering other resources and found a shell washed ashore or brought in from elsewhere, rather than representing intentional exploitation of this environment.

**Feasting**

Feasting is a complex and ephemeral social practice, and as a result, it is one that is often overlooked or understudied in the archaeological record. When feasting is mentioned, it is typically glossed over, or at least the precise details of the analysis that led investigators to their conclusions about feasting are often lacking. Studies mentioning feasting include those discussing the aggrandizer model of social complexity, wherein it is argued that specific aggrandizers are responsible for the development and spread of feasting as a method of gaining social standing and prestige, eventually leading to the development of complex societies (Clark and Blake 1994; Cullon 2016; Hayden 1990, 2011). Given that La Consentida dates to the Early Formative, it is worth considering the site in this context as well.
On the other hand, many archaeologists hold views in line with Hawkes (1954), Binford (1968), and White (1949) that reconstructing social behavior is outside the strength of archaeology and we should instead focus on the more certain analysis of production techniques and subsistence economies, rather than lose ourselves in speculation. It is important to bear this risk in mind and understand that interpretation of social and political institutions may never be as complete or definitive as we may wish. Nevertheless, there are certain elements that bridge the gap between evidence of subsistence strategies and evidence of social behaviors. Russo (2004), Twiss (2008) and others mentioned previously have argued that subtleties of shell middens may indeed provide such evidence, focusing on spatial distribution and composition. The midden at La Consentida was analyzed with these subtleties in mind, though much of the midden remains in situ.

Op. LC12 E

Op. LC12 E is the largest midden investigated for this thesis, yet as mentioned in the previous chapter, it has not been fully excavated and so no assessment may be made of its exact topographical layout. However, the vertical stratification of the feature and its contents are known, and it is known to date to the beginning of the Early Formative period (see table 2), indicating feasting is already associated with this early occupation. The midden contained an assortment of shell; other faunal remains including those of fish, mammals,
reptiles, and possibly avian species; decorated ceramics including figurines, and an assortment of ground stone tools.

There was great overlap in the contexts of the shell, decorated ceramics, and other faunal remains. The shell and faunal remains were largely contained to the same levels, whereas ceramics are found across the midden at various depths, as may be expected during a continuous occupation. Op. LC12 E notably produced some of the most striking examples of decorated pottery from La Consentida, and ceramic finds occurred at all stratigraphic levels, indicating that occupation at La Consentida continued beyond the deposition of the faunal and shell remains in the midden. Refitting pieces were found at various depths around the shell and animal remains, indicating the middens were the result of a series of large feasting events in which distinct mounds of shell were produced (Hepp 2015). The stratigraphy of the site, where shell occurs in discrete lenses such as features F9-s2, F10 and F11-s1 (Figure 4.3), supports this interpretation.

Finally, the recovery of intact oysters is evidence of an excess of food, such as is likely to occur during a feasting celebration. These lines of evidence lend strong support to the hypothesis that the lenses of shell in Op. LC12 E represent a series of feasting events. Numerous examples of worked shell were found in this operation as well, including a bead from Unit 1C (FS# 10342), two pendants from Unit 1Z (FS# 10343 and FS# 10344), and a shell cutting tool fragment (FS# 10345), demonstrating use wear, from Unit 2B. These are discussed in greater detail in a later section.
Op. LC12 D

This midden was subject to a smaller excavation than Op. LC12 E, and less material was recovered as a result, though the findings are largely consistent between the two. Nevertheless, it is clear that these represent two disconnected middens. This midden contained shell; faunal remains consisting mostly of fish, reptile and mammalian remains; and an assortment of ground stone tools and ceramics including figurines (Hepp 2015). It is also possible that this midden was redeposited as part of a fill event to extend or raise the underlying platform structure.

One section of the southwest corner is of particular note, represented as F5 on the excavation profile. This is a small pit intrusive into feature F4 with a significant and dense shell accumulation. There is very little sediment in this feature, yet it contains significant amounts of fish bone and pottery fragments, including flat bases of serving ware and grater bowl fragments. This is quite convincing evidence that it also likely represents feasting events, in particular feature F5, with its assortment of dense faunal remains and a few pieces of decorated ceramics. Also of particular note is that a shell bead (FS# 7887) was discovered in the screened sample of this midden, in Lot 10 of Unit 0A, between 150–170 cmbd, and will be discussed in greater detail in a later section.

Op. LC12 A Unit 01 Lot 9

This unit was part of a trench which was not an exploration of a midden, but some faunal material was recovered. As mentioned previously, this is the
northern slope of a platform that was constructed by the inhabitants of La Consentida, and the fill that makes up the platform which this trench was designed to detect disrupts the original context of the recovered artifacts and ecofacts in some areas. Burials were also located further north than the analyzed contexts. This provides a useful counterexample to the previously studied operations, representing the cultural modification of the landscape absent large midden deposits, containing only some deposited midden, and so this highlights the land use strategies of the inhabitants.

Only a minimum of eight individual shellfish were recovered from the analyzed lot of this unit, although a small amount of shell was located in lots above and below it as well. As mentioned previously, time constraints prevented a full analysis of the shellfish remains from Op. LC12 A. This lot was chosen for analysis for several reasons: first, I chose it because it seemed to contain the most shell out of the excavated lots in this unit. Second, in this lot and the lot just beneath it, largely complete shells were found, allowing for speciation. Third, this lot produced an example of an *Argopecten* valve (FS# 7569) with a hole bored into it which required further analysis, during which I determined that this was a culturally modified shell, likely fashioned into a pendant, that was later discarded in the fill making up the platform. This artifact is discussed in greater detail in the next section.
Modified Shell Artifacts from La Consentida

Seven total examples of worked shell were located at La Consentida during the 2012 excavations. These include two shell beads, three pendants, one cutting implement, and one fractured semicircular object of uncertain purpose, possibly a fragment of an ear spool. The fashioning of decorative shell artifacts such as beads and shaped pendants is a specialized skill, and the presence of multiple intricate shell artifacts is evidence either that such specialized labor was conducted at La Consentida, or that interregional trade networks allowed for the import of these goods. No production debris has so far been located during excavations at the site, but this may be a factor of the sampling strategies of the excavation units, and so no definite statements about the origin of these pieces can be made, but its proximity to the feasting midden as well as the coast lend credence to the idea of local manufacture. Instead, discussion will focus on the physical characteristics of the artifacts, and what may be deduced from them.

Shell Beads

Two shell beads were recovered during excavation (see Figures 5.1 and 5.2), both similar in form and production. Hattula Moholy-Nagy (1989), in her work on shell beads in Tikal, distinguished between what she considered to be natural shell and formed shell: natural shell is still identifiable to its original form, and formed shell has had distinguishing characteristics removed during production. Using this distinction, the beads are both considered formed beads, as no definitive identification can be made of what bivalve species were utilized.
Formed beads tend to involve more extensive modification and more involved construction techniques, indicating a more complex industry.

The first of these beads, FS# 7887, was discovered during screening in Op. LC12 D Unit 0A Lot 10, which is the same lot as the majority of the midden in that unit, containing 86.5% of the material of Op. LC12 D. Fish bone and ceramics were also found in this lot. This bead is 6.5 mm wide, and the drilled hole is 2 mm in diameter. The second, FS# 10342, was discovered during this analysis in the shell materials from Op. LC12 E Unit 1C Lot 8. Also in this lot, ceramics, faunal remains, and a small figurine were located. This bead is 7.8 mm wide, and the hole is 2.23 mm in diameter. Though distinct in size, the two beads are very similar in construction.

Both beads have wear demonstrating biconical drilling and sanding along the edges. A distinct pattern of construction was followed for both beads of forming a cylinder and drilling a hole biconically, which is indicative of a shell bead industry’s existence either at the site or within La Consentida’s greater trade network (see Feinman and Nicholas 1993 for a similar argument at Ejutla). Evidence has been recovered at other sites in the central Valley of Oaxaca of the existence of shell bead industries as well (Flannery 2009; Pires-Ferreira 1975).
Figure 5.1. Shell beads FS# 10342 (left) and FS# 7887 (right) recovered during excavation.
Figure 5.2. Shell bead FS# 10342 demonstrating evidence of biconical drilling and sanding of edges.

Pendants

Three pendants were recovered during the 2012 excavations: FS# 7569, FS# 10343, and FS# 10344. The first, FS# 7569 (Figure 5.3) is a nearly complete Argopecten valve with a single hole drilled near the beak, recovered from Op. LC12 A Unit 01 Lot 9. It is 35.61 mm wide, and 32.2 mm long from beak to lip. It weighs 3.7 grams. This is possibly the oldest example of worked shell recovered based on the context. Excavators recovered it from an older fill used to build up
Platform 1, and therefore the context is not considered original. At first, excavators believed the hole came from a natural predation event, as this species is known to be attacked by a variety of predatory snails that bore holes through the victim’s shell. In naturally predated animals, this hole is either tubularly or uniconically drilled by the radula of the snail and may be present anywhere on the shell. Occasionally, there are scars elsewhere on the valve from where a snail was interrupted during drilling, or otherwise discontinued its drilling. Upon closer inspection, however, it appears that the hole in this specimen is biconically drilled, or at least retouched, and is evidence of human action (Figure 5.4).
Figure 5.3. Argopecten shell pendant recovered from Op. LC12 A 01 Lot 9.
Figure 5.4. Interior view of Argopecten pendant recovered from Op. LC12 A 01 Lot 9 showing evidence of human modification. 35x magnification.

The exterior of the hole also seems to indicate that the shell was placed on a level, horizontal surface during the initial drilling. When the valve is placed on a level surface, the hole is straight vertically, perpendicular to the margin of the shell. This would likely not be a result of natural predation, as the snail would be able to position itself in such a way as to bore directly into the shell, removing the least amount of material possible. Finally, additional material was removed
along the tops of the ribs on the ventral edge of the hole, which would not be
produced through natural predation, but would be produced by a drill if an
unintended part of the tool makes contact with the shell during drilling.

Figure 5.5. Exterior view of Argopecten pendant recovered from Op. LC12 A 01
Lot 9 showing the angle of the hole at the ventral end (top left of image) and
scarring on ribs (also top left). Compare with opposite edge of the hole at bottom
right showing more vertical edge and no scarring. 35x magnification.

The second pendant, FS# 10343 is a small (19.71 mm x 13.71) pendant
fragment fashioned from an Ostreidae shell (Figures 5.6 – 5. 9) This was
recovered from Op. LC12 E Unit 1Z Lot 6, just above the heart of the midden layer of this unit. The piece was shaped into a square or rectangle with at least two biconically drilled holes at the top. This pendant is incomplete, having broken along one of the two holes. The edges are very worn down, and the interior bevel of the incomplete hole is also worn. Because of its more fragile nature, it was not cleaned of concretion since this would risk destroying the artifact. One corner of the pendant was broken likely during screening or through bag wear, clearly showing the layers of the shell.

Figure 5.6. Ostreidae pendant recovered from Op. LC12 E 1Z Lot 6. The notch on the left side of the pendant is likely the result of drilling.
Figure 5.7. Ostreidae pendant recovered from Op. LC12 E 1Z Lot 6. Exterior side of drilled hole. 25x magnification.
Figure 5.8. Ostreidae pendant recovered from Op. LC12 E 1Z Lot 6. Interior, nacreous side of drilled hole. 25x magnification.
The final pendant, FS# 10344, is a highly weathered fragment, likely the lip of a Conus shell also located in Op. LC12 E Unit 1Z, though this was recovered from Lot 10, roughly half a meter below FS# 10343 and at the bottom of the excavated portion of this unit. Faunal remains were also recovered from this depth in Unit 1Z, in addition to lithic and ceramic material, including a figurine. This pendant is 31.95 mm long and 26.10 mm wide, weighing 4.6 grams (Figures 5.10–5.12). Wear along the edges indicates that the pendant was shaped into a rough teardrop shape by grinding at a ninety-degree angle to the
face of the pendant, as opposed to grinding along the length of the piece. A single hole was biconically drilled at the top of the pendant. This hole was evidently a weak spot, as the top of the pendant fractured, likely during construction based on the very sharp, fresh edge in the center of the hole. This fracture left the piece unwearable, perhaps leading to its discard. Additionally, there is a fracture on one side leading from the exterior edge to the drilled hole which resulted in the outer carbonate layer breaking off, possibly from vigorous grinding during shaping; this force may be what broke the drilled hole.

Figure 5.10. Reverse of Conus patricius pendant recovered from Op. LC12 E 1Z Lot 10. A fracture likely during manufacture is visible on right side of image.
Figure 5.11. Obverse of Conus patricius pendant recovered from Op. LC12 E 1Z Lot 10. Oblique lighting is used to show concretion that formed on the face of the pendant.
Figure 5.12. Conus patricius pendant recovered from Op. LC12 E 1Z Lot 10 demonstrating sharp interior edge of drilled hole. 20x magnification.

Shell Cutting Tool Fragment

The shell cutting tool fragment, FS# 10345 (Figures 5.13 – 5.15), was located in Op. LC12 E Unit 2B Lot 8, a very large midden layer with faunal remains including fish, bird, large mammal, and reptile elements. Ceramics and lithics were also recovered from this unit, as well as a sample of polished stone. This shell artifact is 29.89 mm long, 27.1 mm wide, and weighs 4.28 grams.
Fashioned from a fragment of the lip of Conus patricius, it has been ground into a sharp edge and bears significant wear in the interior and exterior faces of the cutting tool (Figures 5.14 – 5.15). This wear is a series of straight, deep lines gouged in the interior and exterior of the cutting tool edge. These scratches may be from the initial shaping of the cutting tool or related to use, but because the scratches are in a general crosshatch pattern, I believe that it is more likely to be related to use. Using the cutting tool in a back-and-forth sawing motion would leave scratches consistent with what has been observed.

Figure 5.13. Conus patricius shell cutting tool fragment recovered from Op. LC12 E 2B Lot 8.
Figure 5.14. Conus patricius shell cutting tool fragment exterior recovered from Op. LC12 E 2B Lot 8. 45x magnification.
Figure 5.15. Conus patricius shell cutting tool fragment interior recovered from Op. LC12 E 2B Lot 8 demonstrating use wear across and flake scars on the left side of the image. 10x magnification.

**Possible Ear Spool Fragment**

Excavators recovered one final shell artifact at the site: a broken, semicircular fragment of a gastropod shell whorl of unknown species that has been ground into a consistent, smooth shape (Figures 5.16 – 5.17). It is 14 mm wide and 6.6 mm tall, weighing 0.15 gram. This is likely part of a larger earspool which would have consisted of multiple whorls of a gastropod shell with the ear fixed in the sutures between them. Figurines recovered at the site depict
earspoons as well, indicating that such adornment was present at the site (Hepp 2015). This piece was recovered from a thick and wide fill layer in Unit 5D Lot 13 among a collection of large faunal remains. This lot was part of an early redeposition at the top of Substructure 1 (Figure 2.1) with some Classic Period reoccupation above it, indicating its antiquity.

Figure 5.16. Obverse view of shell fragment recovered from a fill in Op. LC12 B Unit 5D Lot 13 demonstrating grinding to thin the piece. This side was more polished and uniform, indicating the outward facing side of the spool.
Possible Nascent Shell Industry at La Consentida

Because of the close proximity to raw materials and the number and variety of shell artifacts recovered from La Consentida, it is possible that some or all of them were produced locally. A distinction must be drawn, however, between shell artifact production and a shell artifact industry as existed elsewhere at different times in Mesoamerica, such as at Terminal Formative / Early Classic Period Ejutla (Feinman and Nicholas 1993). Certain elements can be expected for a shell industry to exist (Allen et al. 1997; Feinman and Nicholas 1993; Trubitt 2003). Mary Beth D. Trubitt (2003) outlined three of the largest elements: the presence of raw materials, the presence of tools used to shape the artifacts, and the existence of workshops and refuse associated with manufacture.

Figure 5.17. Reverse view of shell fragment recovered from a fill in Op. LC12 B Unit 5D Lot 13 demonstrating grinding to thin the piece. This side was less polished, and another whorl would have stood atop.
La Consentida certainly has access to a variety of raw materials, and multiple chert and obsidian drills have been located there (Acuña 2018). Knowledge of manufacturing techniques is less obvious, and instead requires more abstract material evidence, such as the presence of intermediate forms, such as those with incompletely drilled holes or pre-shaped discs. No obviously intermediate form has been located as of yet at La Consentida, although as mentioned previously, because of the nature of the fracture and the lack of wear to the interior of the drilled hole, the *Conus* amulet FS# 10344 may represent a nearly finalized amulet that broke during the final stages of manufacture. Some concretion is present on the amulet on the nacreous side. The shell tool also coming from a *Conus* specimen is further support to this idea, as multiple artifacts can be made from an individual shell, especially one as large as *Conus* possesses. As of yet, no workshops have been identified however, nor have any associated refuse. Therefore, it is perhaps premature to conclude the existence of a large industry rather than individual manufacture, but the evidence is strong that at least some local production took place.

Concretion

One noteworthy element of the middens was a distinct layer of concretion occurring in both Op. LC12 D and Op. LC12 E contexts. All of the concreted material combined weighed 6,517.83 grams, with 6,089.73 grams coming from
Op. LC12 E. This concretion proved difficult to break apart without excessive damage to the shells within it, and thus few attempts were made to clean it for fear of damaging the shells themselves, with the exception of light concretion atop more robust shells. Even in these instances, the concretion was very difficult to flake off. Dental picks were carefully used for this purpose, with a toothbrush used to clear off any compacted dirt. Water was not used except on exceptionally well-preserved specimens free of any fire damage, and in those instances, it was used to rinse off dust rather than using a wet brush, which would risk damaging the shell through the grinding of wet dirt into the surface. At no point were the shells submerged and allowed to sit in the water. In the majority of instances, concretion was weighed independently, and in cases in which it was present on loose shell, it may have led to slight bias, though this was not a common enough occurrence to substantially compromise the results. The majority of species glued together by this concretion were *Mytella sp.* in varying states of preservation.

The source and exact composition of this concretion is uncertain at this time due to limited opportunity to export samples for testing, though it is very likely to be a mixture of calcium leached from the more degraded and burned shells, which would have mixed with ash from hearths and fires placed on or nearby the midden which were found during excavation or potentially from hearth-cleaning events (Hepp 2019a). Though not the majority, many shells were found which had evidence of direct heating, as if placed within a fire for a
substantial period of time; using examples provided by Milano and colleagues (2016), these shells were likely heated beyond 700 °C, indicating direct contact with flames. Thus, the concretion may have a connection with the cooking of the shellfish. Table 5.1 shows the distribution of this concretion, showing that most of the concretion is centered in the Units 0B, 2B, and 1B, tapering off to the north and south at a rather consistent lot, indicating a possible cooking location (see also Figure 4.3). Unit D.0A is a second concretion location included in the analysis.

Table 3. Concretion by unit

<table>
<thead>
<tr>
<th>Unit</th>
<th>Lot with highest concretion (percentage of Op total)</th>
<th>Weight of Concretion (percentage of sum total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.0B</td>
<td>8 (85.78%)</td>
<td>1,482.01 (22.73%)</td>
</tr>
<tr>
<td>E.2B</td>
<td>8 (75.97%)</td>
<td>1,412.40 (21.67%)</td>
</tr>
<tr>
<td>E.1B</td>
<td>8 (67.40%)</td>
<td>1,127.14 (17.29%)</td>
</tr>
<tr>
<td>E.1A</td>
<td>15 (81.95%)</td>
<td>838.64 (12.87%)</td>
</tr>
<tr>
<td>E.0A</td>
<td>7 (86.57%)</td>
<td>703.27 (10.79%)</td>
</tr>
<tr>
<td>E.1C</td>
<td>7 (52.14%)</td>
<td>456.73 (7.01%)</td>
</tr>
<tr>
<td>E.1Z</td>
<td>8 (39.68%)</td>
<td>68.17 (1.05%)</td>
</tr>
<tr>
<td>D.0A</td>
<td>10 (100%)</td>
<td>428.10 (6.57%)</td>
</tr>
</tbody>
</table>
When shells are heated to 825 °C, the shells undergo significant physical and chemical alteration; in particular, this can lead to the production of calcium oxide (CaO), more commonly known as quicklime. When mixed with water, such as would happen through the monsoonal rainstorms that affect the area to this day, hydrogen bonds to the calcium oxide and produces calcium hydroxide [Ca(OH)$_2$], also known as slaked lime. This is also the substance that, when added to corn, is responsible for the process of nixtamalization necessary for the production of tortillas.

When slaked lime is mixed with an aggregate such as silt or sand, this substance becomes lime plaster. Further, when the aggregate exhibits high levels of pozzolanic activity (such as though volcanic ash and pumice, or soils of volcanic origin), this produces a hydraulic-setting cement. The dense structure of the shell deposit itself would have acted to filter out larger sand grains yet allowing silt and ash through, strengthening the resulting concretion. This concretion trickled through to the base of the midden, gradually forming a very hard layer towards the base of the midden and would in turn cement the shells together as the drainage of the sediment changed.

It is therefore likely that this concretion is a result of the natural chemical breakdown produced from burning of the shells, along with crushing them into a powder as people tossed and subsequently traversed or compressed them in the midden by throwing more refuse on top. This would then have been hydrated by rain and mixed with silt or more complete shell fragments as an aggregate to
form a lime plaster or cementitious concretion which would harden during drier periods of the year, eventually being sealed off completely from the elements.

Cultural Modification of Saccostrea

A minority of the Saccostra valves examined had holes present on or near the umbo. Unfortunately, I initially considered these likely bag wear as the shells jostled together, so the exact number was not recorded. After I returned from Oaxaca, I began to consider alternate explanations, and now I believe that they are a result of human activity during processing. Today, the preferred method of opening an oyster is by using an oyster shucking knife to pry open the valves and sever the adductor muscle which holds the valves closed. Other methods exist, however, including the use of a punch to pierce the shell and force the valves apart. I believe the holes are evidence of this style of punching, with fragments of the interior nacre of the shell flaked off by a force applied from the outside, as demonstrated by the scars of the cone of force (see Figures 5.18 and 5.19 for two examples).
Figure 5.18. The flake scars left on the interior of a valve, probably from a punch used to open the oyster.
Figure 5.19. The flake scars left on the interior of a valve from a punch used to open the oyster.

It is likely that the preferred punch was similar to the bone and stone tools discovered elsewhere at the site (Acuña 2018; Hepp 2015). Not all oyster shells have these scars, and others were probably opened via steaming or boiling. In addition, some oysters were found completely intact, possibly discarded after cooking because they were already dead, or perhaps because they were considered too small to be worth processing and are evidence of an excess of food present during these feasts.
Harvesting and Processing

The abundance of mussels in this assemblage indicates their primary position in the harvesting preferences of the people of La Consentida. Because of this, it is important to analyze them in more detail. Greg White (1989) examined the changes in the pattern of shellfish harvesting over time at eleven coastal sites in MacKerricher State Park in Mendocino County, California. He noticed that mussel harvesting changed through time as the process became more intensive, switching from what he described as “plucking” – an earlier selective and discriminating harvesting technique whereby harvesters choose mussels within certain parameters – to a “stripping” method whereby large swaths of mussels are pulled from their hard substrate as a sheet. In crowded conditions, the animals will not have clear access to the substrate to attach, and so will instead glue themselves to the shells of their neighbor. This results in a large collection of mussels attached only on the edges and at sporadic points between. When these threads are severed, the animals can be harvested in large batches, almost like rolling up a carpet. This results in a much more efficient, yet imprecise harvest. More animals are collected, but less of these animals are within a preferred range, and the harvest will include many younger individuals which would otherwise not be worth the effort of collection and
processing and later cooking, discussed in greater detail in the following section. Similar techniques are seen all across the world, and Jones and Richman (1995) described many ethnographic accounts of picking and stripping techniques from the Pacific Coast of the United States to South Africa and Australia.

At La Consentida, because of the wide variety of sizes of individual mussels, it is clear that they incorporated a stripping technique, but other evidence supports this interpretation as well. Jones and Richman (1995) described an account of First Australians harvesting mussels via plucking and removing the barnacles at the time of harvest. At La Consentida, the rather large number of barnacles suggests that this was not done; not only are barnacles found loose within the midden, there were occasionally small and difficult to remove barnacles intact on the mussel shells. If the mussels were harvested via stripping, there is much less incentive to remove them of their barnacle fouling, as this would likely end up requiring just as much time – if not more – than would be required for the actual harvest, and ultimately saving no time over plucking.

Likewise, the palmate oyster, *S. palmula*, shares many ecological restraints with the *Mytella* of mangrove swamps and can be found in the same areas, competing for space amongst the prop roots of the mangroves (Félix-Pico et al. 2015; Kathiresan and Bingham 2001; Lacerda et al. 2002). Due to the majority of the remains coming from *Mytella* (see Figure 4.2), it is clear that this is the preferred species, but a stripping strategy for harvesting may explain the finds of *Saccostrea* and *Striostrea*. Rather than being a specific target, it is
possible that they are a form of bycatch, as the oysters may have gotten caught up in the holdfasts of the *Mytella*, only to be removed later when the harvest was processed further inland. Other species which require soft substrates like *Chione* and *Anadara*, if collected for food, would have been collected along the way or during other activities as they were found, likely outside of the primary harvesting zones.

Cooking

A multitude of direct and indirect heating methods are available for cooking shellfish, and they induce macroscopic and microscopic changes to the shell (Aldeias et al. 2019; Milano et al. 2016). Examining the microscopic changes of the shell is an involved process requiring a thin section and micrograph, which was not available in Oaxaca during the analysis, and so this discussion focuses on the macroscopic changes that would be induced through various heating methods.

The first and most obvious macroscopic change undergone by the shell as it is exposed to heat would be collection of scorch marks and gradual darkening of the shell, the precise degree of which is dependent on the temperature and time of exposure, as well as the heating method. Hotter and drier temperatures and longer heating times produce a significant darkening of the shell as the outer organic layers burn off, leaving carbon residues. Milano (2016) found that this
darkening reaches its greatest extent after heating a shell to 500°C for 60 minutes. As the temperature increases closer to 825°C, a shift happens, and the shell begins to turn white as the shell undergoes calcination, leaving behind calcium oxide. Thus, the coloration of the shell, along with associated microscopic structural changes, provide an indication of the level and duration of heat applied to the shell. Boiling in water hampers such chemical changes, as evaporation maintains a stable temperature around 100°C resulting in little macroscopic change to the shell (Aldeias et al. 2019; Milano et al. 2016).

At La Consentida, although some burned shell was recovered (see Figure 4.4), the majority of shells are noteworthy for preserving a great detail of their coloration, indicating a low level of heat, or no heat at all. Microscopic analysis would be required to conclusively determine whether the shells were heated, but absent that evidence the most likely explanation is boiling or steaming of the mussels. This not only cooks the meat, but the shellfish open as a result, facilitating extraction (Aldeias et al. 2019; Waselkov 1987).

Boiling stones have been recovered in close association with shellfish remains elsewhere in Mesoamerica as well (Clark et al. 2007; Rosenswig 2015; Voorhies and Anikouchine 2004; Voorhies and Gose 2007). Rosenswig (2015) described how 80 of the 94 stone cobbles recovered from the Cerro de las Conchas site were fire-cracked, and the remaining 14 discolored red from heat. Also in this stratum, he recovered modified Anadara grandis shell, as well as fishing supplies (Rosenswig 2015). Boiling also has the benefit of producing a
nutrient-rich soup which may serve as a drink. As mentioned previously, such a dish is present in contemporary Oaxacan cuisine as the *caldo de Tichinda* soup (Dalton 2000), and an ethnoarchaeological study was conducted on the modern process used in Costa Rica by Barbara Voorhies and Natalia Martínez-Tagüeña (2018), including in the production of soup. This dish may have been the ultimate goal of the feast, and perhaps served from some of the decorated pottery.
CHAPTER SEVEN
CONCLUSION

In this thesis, I have examined the environmental and anthropological implications that can be drawn from the shell component of middens at Early Formative period La Consentida in coastal Oaxaca, Mexico. AMS radiocarbon dates on charcoal from the bottom and top of the LC12 E F16–9 midden feature, in particular, provide a date range of 2010–1530 cal BC (2σ) or 1945–1610 cal BC (1σ) for the probable communal feasting activities that produced that deposit (see Table 2). The image that emerges is a complex one, demonstrating patterns and choices in the inhabitants’ land use and dietary preferences, social behaviors, and local artifact production, as they targeted specific animals that were found in a specific section of the landscape. When utilizing shellfish as resources, they principally chose to harvest mussels, and they did so through stripping large numbers of the animals from their substrate. These collections were then transported back to the site for processing, involving the removal of large barnacles and sorting out the bycatch such as oysters. These shellfish were then cooked via boiling or steaming, perhaps producing a soup, which was then consumed by the inhabitants at feasting events. The remains of these various shellfish, as well as those recovered from outside the mangroves such as Conus and Argopecten, would then occasionally become raw material from which a variety of artifacts would be made. The refuse would then be buried to
prevent the odor of decay. Sometimes these middens would be redeposited and repositioned, helping to build the platform that La Consentida stood upon.

This interpretation is consistent with prior research that has shown that the coastal environment was subject to change through time as anthropogenic changes to the landscape upstream through agricultural terracing led to erosion and subsequent deposition of sediment along the coast, closing off bays and forming protected mangrove swamps and lagoons (Goman et al. 2005, 2010). This thesis reinforces those findings and helps to contextualize the occupation of La Consentida within the timing of these changes. With extensive beds of mangrove-dependent species such as mussels and oysters available, La Consentida clearly had access to these protected bays and lagoons (Félix-Pico et al. 2015; Kathiresan and Bingham 2001; Lacerda et al. 2002; Reid et al. 2008). These findings are reinforced by the fish remains expanded upon elsewhere, consisting of a multitude of species that live in mangrove habitats (Hepp 2015, 2019a).

Isotopic analysis (Hepp 2015, 2019a) further demonstrates that shellfish resources were not the primary dietary component for the people of La Consentida, and that instead they represented a different type of contribution, one focused on feasting. These feasts principally involved steamed or boiled mussels in the possible production of soup, based upon the preservation and lack of macroscopic exothermic changes which would be apparent through the application of the high heat from a fire. This feasting, which appears to have
taken place at La Consentida beginning at the very start of the Early Formative period, has many material correlates consistent with feasting identified elsewhere in Mesoamerica and more broadly (Clark and Blake 1994; Hayden 1990; Hildebrandt et al. 2009; Joyce and Henderson 2007; Madgwick and Mulville 2015; Marquardt 2010; Miracle 2002; Rosenswig 2007; Twiss 2008). Among the evidence for these early feasts are the quick deposition demonstrated by the exceptional preservation of the shells, the absence of evidence of scavenger remains or activities in the midden due to quick burial of the refuse, decorated serving wares and figurines found within the middens, evidence of an excess of food demonstrated by unprocessed remains such as closed oysters, additional faunal remains demonstrating a wide variety of food consumed simultaneously, and the isotopic data showing non-reliance on these resources as staple foods.

I have also argued for the existence of shell artifact production at La Consentida through the existence of a variety of well-preserved and modified shell artifacts. While some such as the Ostreidae amulet FS# 10343 demonstrate considerable wear and a long use-life, the Conus amulet FS# 10344 was likely fractured during local production based on the lack of wear and nature of the break. The people of La Consentida had ready access to shell as a raw material and chert and obsidian drills (Acuña 2018), so it would perhaps be more surprising if they had not experimented with local shell artifact production. The Conus cutting tool FS# 10345 and its use wear demonstrate that shell was used for more than just decoration but was also used as tools in their own right.
All of this combines to form a coherent picture of life at La Consentida, one in which the various parts of the landscape were used to different ends, and a wide variety of resources available to the community were used. I hope that this analysis can be informative for interpretations of later excavations conducted at La Consentida, as well as for other Early Formative sites in the region as researchers investigate land use practices, subsistence patterns, feasting behaviors, or the emergence of shell artifact production.
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