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TECHNOLOGY, SOCIETY AND CHANGE:

SHELL ARTIFACT PRODUCTION AMONG THE MANTEÑO

(A.D. 800-1532) OF COASTAL ECUADOR

by

Benjamin Philip Carter

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ABSTRACT OF THE DISSERTATION

Technology, Society and Change:

Shell Artifact Production among the Manteno (A.D. 800-1532)

of Coastal Ecuador

by

Benjamin Philip Carter

Doctor of Philosophy in Anthropology

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Professor David L. Browman, Chairperson

In this dissertation, I contribute to the methods and theory of the scientific study of archaeological materials and to the reconstruction of South American culture history.

In terms of methods, I contribute in four ways. First, I demonstrate the use of simple technological aids that allow the rapid collection of accurate and precise data that is entered directly into a digital database. This method has allowed me to include a sample of 7650 shell beads, 996 lithic microdrills, and 636 other associated artifacts from six archaeological sites for a total of over 100,000 individual observations. Second, I rely upon relatively simple statistics (mean, median, standard deviation, frequency, etc.), their associated tests (mainly ANOVA and chi-squared) and an analysis of the distributions of measurements. The later helps me avoid the pitfalls of these simple statistics, while retaining their inherent interpretability. Fourth, the shell beads are analyzed using the *chaîne opératoire* approach to technology, which not only provides a useful tool for

understanding production technology but also places production squarely within social interaction. Third, this research has shown that shell beads, an often ignored material, are ideal for the methods chosen and yield a significant amount of information about production and, therefore, social processes.

Theoretically, this dissertation attempts to model how culture change occurs and the effect of external changes on local production of a particular craft item, shell beads. The most important theoretical contribution of this dissertation is the concept of a disposition, which can be thought of as a statistical distribution of cultural rules (or norms or *habitus*). It is the theorized variability in these distributions (represented by measures of dispersion, e.g. standard deviation) that are missing from many discussions of cultural change and that I believe contributes directly to social change. I use disposition to interpret change in craft production and, therefore, in social interaction.

In terms of South American prehistory, this dissertation contributes through the inclusion of a detailed update of current knowledge of the ecology and archaeological occurrence of Spondylus, a highly valued mollusk, in South America. This dissertation also presents a culture history of the production of shell beads among the Manteño, who used seagoing sailing vessels to transport and exchange these items. This helps develop a much more accurate and intricate understanding of South American prehistory.

I believe that this dissertation makes significant methodological and theoretical contributions to scientific archaeology as well as to the current understanding of South American prehistory.

Chapter 1. Introduction

In the 1970s and 1980s archaeologists working in Ecuador and Peru recognized the significance of the marine bivalve Spondylus in the prehistory of western South America (Marcos 1977-78; Murra 1975, 1982; Paulsen 1974). Analyses of the archaeological, ethnohistoric and ethnographic occurrences of Spondylus indicated that it had been traded throughout much of western South America beginning approximately 4500 years ago. This trade system extended throughout much of western South America, from Ecuador to Chile, and reached as far north as West Mexico (Anawalt 1992; Hosler et al. 1990). The trade in Spondylus was centered in southwestern Ecuador, at the southern limit of the natural distribution of Spondylus, where large sailing vessels plied the waters, carrying goods throughout the region (Marcos and Norton 1981, 1984; Norton 1986). Although archaeological finds of Spondylus have dramatically increased since the 1980s, there has been little attempt to understand the diachronic and synchronic variation in the presence and use of the bivalve. Recent Spondylus research has focused upon iconography (Cordy-Collins 1990, 1999, 2001; Pillsbury 1996, 1999). However, despite the lack of published syntheses regarding Spondylus, the outline originally proposed in the 1970s has taken on its own life and has become part of the basis of local indigenous as well as governmental movements (Bauer 2007; Sandweiss 1999). One of the main goals of this dissertation is to rectify this disjuncture between the commonly known story and the archaeological facts by producing a cultural history of South American (and some Central American) Spondylus. I am able to show that, not only does the cultural history of Spondylus need to be reexamined, but that many of our assumptions about living

Spondylids are, at least, incomplete if not incorrect. It must be noted that a great deal of the information discussed herein was not available to early researchers.

Based in the dynamic changes in trade in Spondylus and other shellfish, another goal of this research is to analyze local production in the face of socio-political and economic developments in the region. While Spondylus was a significant trade good during much of prehistory, tiny shell beads, known as *chaquira*, made from Spondylus become increasingly popular in elite burials in north coastal Peru beginning at around 100 B.C. Because of a dearth of evidence for the production of these beads, especially the red, orange, and purple ones, between 100 B.C. and A.D. 700 (although see Masucci 1995), this analysis focuses upon the production of these beads during the Late Integration Period (c. A.D. 700- 1532).

To provide broad coverage of what is known as the Manteño archaeological culture, six sites were chosen for the study. These sites provide an excellent temporal and spatial sample of Manteño shell bead production. The sites belong to two geographically and environmentally distinct regions- the southern portion of modern-day Manabí province and from the Santa Elena Península- and to two temporal divisions, Late Guangala/Early Manteño (c. AD 700-1300) and Late Manteño (c. AD1200/50- post 1532).

To understand production technology at the six sites, 7782 beads (7650 of which were shell; see Figure 1-1 and Figure 1-2) were analyzed using five qualitative and five quantitative measurements. The primary tool used to perforate shell beads, lithic microlithic drills (N=996; see Figure 1-3 and Figure 1-4), were similarly examined in four quantitative and three qualitative dimensions. Because the shell bead industry did not exist in a vacuum, however, but was related to the production of other shell artifacts, all available non-bead shell (and non-shell bead) artifacts as well as tools potentially associated with the production of shell artifacts were cataloged (N=636; See Appendix C). Studies based upon shell artifacts are few (e.g., Allen et al. 1997; Arnold and Munns 1994; Feinman and Nicholas 1993; Francis 1982; Halstead 1993; Isaza Aizpurúa and McAnany 1999; Kenoyer 1984; Masucci 1995; Mester 1990, 1992 [1985]; Miller 1996; Vidale et al. 1993) and none of these include samples close in size to the one discussed herein. This sample is unusual in the shear number of artifacts, observations per artifact and number of sites included. The size and complexity of this sample is necessary, however, for the approach used to understand the dynamics of bead production among the Late Integration Manteño. First, it is necessary to have large sample sizes to perform statistical tests on subsets of the beads and drills (i.e., >30, but normally hundreds or thousands). Second, a frequency distribution is necessary for the theoretical approach I have chosen.

It is this theoretical approach that provides another main goal of this dissertation. This approach stems from my dissatisfaction with analyses of ‘style’ and, indeed, with the inability of scholars to agree what they mean by ‘style.’ ‘Style,’ as culturally significant variation, is in the eye of the beholder be that an individual in the past or the present. ‘Style’ is not just the design variation that we observe, but a way of doing (Hegmon 1992; Hodder 1990) - as technological choices enacted within social contexts (Dobres and Hoffman 1999, 2000; Gosselain 1998; Lemonnier 1986, 1990, 1992, 1993; Wallaert-Pêtre 2001). However, if one sees artifact production as a social enterprise then other social factors must be taken into account. Economic and political factors are normally discussed, but these are only two of the subsets of our social life. Such a view leaves the door open for all artifactual variation, including operational sequences (i.e., chaînes opératoires), to be identified as ‘style’ and for that stylistic variation to be influenced by all sorts of social factors.

Before we can understand stylistic variation, we must understand how social interaction happens. Are our actions, even technological actions, determined by social structure (e.g., Lévi-Strauss 1963)? Do we mindlessly follow cultural rules or norms or are we free to choose our own actions (e.g., Elster 1989)? We must understand our actions as the product of the interplay between structure and individual, through a process that Anthony Giddens called structuration and Pierre Bourdieu called practice (Bourdieu 1977, 1990, 2000; Giddens 1979, 1984). People act in certain ways because they are both limited and enabled by social structure, but it is by these same actions that they produce and reproduce social structure through everyday action.

The key here is that structure exists only in that social actors have similar dispositions, or beliefs about the way life is or should be, but they do not necessarily ‘agree.’ However, the tendency is to imply that consistency (in material culture, for example) is due to structure and variation to individual choice. That suggests the social actor, here the artisan, cannot choose to follow the structure, they can only choose to diverge from it. Similarly, even when an actor chooses to diverge from the structure, those choices are patterned.

The model proposed herein sees dispositions as statistical distributions with a measure of central tendency (MCT; e.g., mean) and a measure of dispersion (MD; e.g., standard deviation). The MCT of a disposition represents the individuals ‘ideal’, in other words how they would behave or how they expect others to behave in a perfect world, and the MD represents the amount of variation from the 'ideal' acceptable to the individual. Disposition, however, is only one of the factors, though perhaps the main one, of social interaction. Social interaction and, therefore the production and reproduction of the social structure, is based upon four factors, including predispositions, dispositions, social structure, and social context. Predispositions are based upon the biological individual. Social structures are the cumulative dispositions of the people around the social actor. Context includes personnel, material, spatial, temporal, and environmental contexts. All of these factors can be thought of as distributions with a MCT and MD. In other words, none of the factors are determinant, but do have a central point and acceptable variation from that point. These probability statements come together when social interaction occurs. If the distributions of the factors 'fit' well together, then stability (i.e., reproduction of social structure) is more likely. I suggest that normally, stability is more common than change and, indeed, because of the way these factors work together, pushing and pulling each other, individuals within society will seek stability because it makes the world understandable. Change happens when one (or more) of the distributions no longer 'fits' with the others because of internal or external developments.

The model developed herein is useful because it helps explain both the overall pattern and the pattern of variation present in the shell bead assemblage. It shows how broader regional changes led to a transformation in production strategy, not deterministically, but through a process by which the bodily and social dispositions of shell bead artisans (and perhaps the broader community) changed, not deterministically, but unavoidably. In other words, one of the factors that kept Manteño shell bead artisans making *chaquira* was the high demand from elites in the highlands of Ecuador and the north coast of Peru. The loss of these consumers did not produce an immediate drop in the supply of shell beads, but production of the smallest of the beads slowed and the MCT gradually increased in size. Finally, production of small regular beads gave way almost completely to the production of large irregular beads made from beach-worn shell.

The role of Spondylus in all of this is that many of the earlier *chaquira* were red, orange, pink and purple colors of shell that probably came from Spondylus shell. As less *chaquira* was produced and shell beads became larger, they also tend not to be these colors, i.e., they are not made from Spondylus. Spondylus continued to be used in great quantities by communities in Peru, but after c. AD 1200/50 they were not consuming shell beads, but using it as whole shells, as inlay in wooden figures (e.g., among the Chimú; Jackson 2004), and as small figurines (among the Inka; e.g. Reinhard 2002). There is even sufficient evidence to suggest that the Inka actively participated in trade networks within southwestern Ecuador (Dorsey 1901; McEwan and Silva I. 1989).

This dissertation proceeds in the following manner. First, I describe the environmental and geographic setting of southwestern Ecuador to set the stage for the rest of the analysis. This is followed by a description of the sites and the assemblages used. Next, I address the issue of the cultural history of Spondylus, which is followed by a discussion of the theoretical dimension of social change. Next, I describe the data collection and the intensive statistical treatment of the data to reveal patterns. This is all brought together in the interpretation and conclusion.

Figure 1-1. In-process and completed beads from Loma de los Cangrejitos. Note the regularity of these beads, especially 'e' compared to those in Figure 1-2.

Figure 1-2. A sample of beads from Mar Bravo. Note the irregularity of these beads.

Figure 1-3. Lithic microdrills from Loma de los Cangrejitos.

Figure 1-4. Lithic microdrills from López Viejo. Note the length of these drills compared to those from Loma de los Cangrejitos.

Chapter 2. Environmental Background

The people who used the material remains that we now recognize as the archaeological culture known as Manteño (a.k.a., Huancavilca; see below) were a result of a long history of occupation of the littoral of southwestern Ecuador as well as social, economic and cultural interaction with neighbors and farther-flung trading partners. While the environment did not determine the Manteño, it did play a role in the formation of their society. This section discusses the geological, ecological and historical environment in which the Manteño developed and thrived from approximately A.D. 800 to Spanish contact at 1532. The Manteño occupied the western portion of modern Guayas province, known as the Santa Elena Península, and the central and southern areas of Manabí province. Though the geology and ecology of central Manabí are very similar to the other two areas, especially the Santa Elena Península, beads samples were not analyzed from this area because the bead sample was large enough. Extension of this study into this area, though desirable, will have to wait. The ecology of this central Manabí, therefore, is not covered in this chapter.

2.1. Geology

The geology of the two regions considered here, the Santa Elena Península and southern Manabí differ significantly. Within this region there are three basic geographical areas, the relatively flat Santa Elena Península, the Chongón-Colonche Mountains and, to the east, the Guayas Basin (Figure 2-1). Southern Manabí is dominated by the mountains and the Santa Elena Península by relatively flat plains rising slowly into the mountains.

The geology of the Santa Elena Península is mainly composed of bedrock known as tablazo or uplifted sea bed composed of calcareous concreted sandstone, limy shales, and sandy limestone capped by layers of sand and gravel (Figure 2-2). Tablazo deposits contain extensive, though irregularly distributed, deposits of chert (Masucci and Macfarlane 1997; Sheppard 1930).

Uplifted seabed results in a fairly smooth terrain punctuated by large chert outcrops (Masucci and Macfarlane 1997; Sheppard 1930a, 1930b), which are probably part of the Santa Elena Olistostromic Complex (Figure 2-2), a disorganized mix of sandstone, conglomerate, mudstone and chert. This formation provides much of the relief seen within the first 20 km of the southern coast of the Santa Elena Península, including La Puntilla at the very end of the Península, Punta Ancon, the Chanduy Hills and those around El Azúcar. Between this and the Chongón-Colonche Mountains lies the Tosagua Formation (Figure 2-2), which is a group of three different varieties of conglomerate (Masucci and Macfarlane 1997:770-772, Figure 771; Sheppard 1930a:270-271).

Southern Manabí, however, is significantly different in geology than the Santa Elena Península. The Chongón-Colonche Mountains are composed of igneous, rather than sedimentary, bedrock. Mainly these include the Cayo and Piñón Formations (Figure 2-2). The Piñón Formation lies beneath and to the east of the Cayo Formation and is composed of mainly basaltic lavas. The Cayo Formation is a mixture of volcanic bedrock, including volcanic breccias, tuffs and basaltic lava, and marine sedimentary rock, including green slatey mudstone, siltstones and cherts (Masucci and Macfarlane 1997:770). Along the coast, the interspersion of more durable volcanic and some harder sedimentary materials with softer sedimentary material and the subsequent erosion of the softer materials leaves periodic headlands projecting into the ocean, which often create shallow bays facing the west and northwest. Punta Piedra Verde, at the base of which sits the archaeological site Salango 140, and Salango Island are examples of this (Sheppard 1930a:268-270).

2.2. Climate and weather

The climate southern Manabí and the Santa Elena Península is essentially dry, with declining aridity as one goes towards the peaks of the Chongón-Colonche Mountains. It is highly influenced by ocean currents and variation within the flow of these currents. The summary presented here is broad and is derived from a wide variety of sources (Sheppard 1930b, 1933; Terán et al. 2004:3-8; Zambrano 1998).

2.2.1. Ocean currents

The coast of Ecuador is dominated by the ocean currents flowing just of its shore (Figure 2-3). Of primary importance are the Panamanian and Humboldt Currents. Normally, the warm Panamanian Current flows south from Central America and heads west just north of Ecuador, while the cold Humboldt Current flows north up the coast of Peru and heads west just south of Ecuador. Between these two major currents, the Cromwell or Equatorial Countercurrent flows in the opposite direction to the east. The transition between major currents along the Ecuadorian Coast means that Ecuadorian waters are extremely rich in nutrients, like along the Peruvian coast, and in biodiversity, like warmer waters to the north. This means that sea surface temperatures range widely over a fairly short distance (Figure 2-4). The biota of Ecuadorian waters is an eclectic mix of cold and warm water species (Terán et al. 2004). These ocean currents have followed the regime discussed here for the last 5000 years (Sandweiss 1996; Sandweiss et al. 1996).

2.2.2. Precipitation

Generally speaking, the prevailing southwestern winds bring cool humid air over the coast. As the air passes over the warmer land, it rises, leaving the coast with minimal precipitation. However, the Chongón-Colonche Mountains are able to catch much of this moisture, as a heavy mist locally known as *garua*, making them much more verdant than the surrounding lowlands (Figure 2-5). To the east of the Chongón-Colonche Mountains, the Guayas basin, the largest coastal river system on the west coast of South America, receives much of the precipitation captured along the western slopes of the Andes.

In normal years, a drop in sea surface temperature beginning around September and a corresponding peak in temperature during the months around March roughly correspond to weather seasonality (Figure 2-6). The prevailing cool dry weather dominates much of the year from around May through December, when it yields to a hotter and rainier season (Figure 2-5). The cool dry weather is derived from water dominated by the Humboldt Current, while the warm wet weather is due to a move southward of warmer waters. The wet season may result in an increase in *garua*, but with little true rain, yielding as little as few inches of precipitation at the tip of the Santa Elena Península (Jørgensen and León-Yánez 1999; Sheppard 1930b, 1933). Precipitation totals gradually increase from the coast to the peaks of the Chongón-Colonche Mountains (Figure 2-5).

If oceanic currents do not behave normally, the temperature of the ocean changes resulting in changes in the weather and subsequent changes in both marine and terrestrial biota. When the El Niño Current, a portion of the warm Panamanian Current moves southward, it tends to flow over the denser cool water of the Humboldt Current depressing the upwelling effect along the coast of Peru for which the Humboldt is so well known (Figure 2-6). Air flowing over this water is warmer and still moist, allowing more of it, sometime much more of it, to fall on the land. This increase in rain causes the arid coastal environments to spring to life and the landscape is coated with a layer of verdant vines clinging to everything. Trees that have lain dormant for years spring to life. Rivers, normally dry or with limited flow during the wet season, rage with torrents of water coming out of the mountains. Modern infrastructure is hit hard as bridges and roads are washed away or covered by mudslides (Sheppard 1930b, 1933; Terán et al. 2004).

2.3. Ecoregions

In terms of broad ecoregions, the six archaeological sites lie mainly within the Ecuadorian Dry Forest. This ecoregion is bounded by the much wetter tropical ecoregions of Western Ecuador Moist Forests to the north and the Guayaquil Flooded Grasslands to the north and east and to the south by Coastal Mangroves (Figure 2-7) (Baquero 2001; National Geographic Society 2001; Sheppard 1935; Tirira et al. 2004:2-3). Further to the south lay the ecologically similar, yet still distinct, Tumbes-Piura Dry Forest (Riveros Salcedo 2001). Two small patches of Ecuadorian Dry Forest are distinct from the main body of the ecoregion, including part of Puná Island and a patch to the east of Guayaquil Flooded Grasslands.

The descriptions provided of ecoregions provided below are modern. The coast of Ecuador has felt the effects of the intensive harvest of woody species for the production of charcoal and for local use as well as the effects of livestock that did not inhabit the region before the arrival of the Spanish. Therefore, the area probably had a greater proportion of larger trees than described below. The precise environmental reconstruction is difficult, however. It is likely, however, that each of the ecoregions described below extended to lower altitudes than those in which they currently lie.

2.3.1. Ecuadorian Dry Forest

The Ecuadorian Dry Forest is distinct from similar dry forest habitats in Mesoamerica, Brazil and the Caribbean, but floristically similar to the Tumbes-Piura Dry Forests (Best and Kessler 1995). The Ecuadorian Dry Forest is marked by a variable rainy season with 90% of all rainfall concentrated in the months from December to May. Yearly rainfall ranges from 300 mm at the end of the Santa Elena Península to 1500 mm in the Chongón-Colonche Mountains (Baquero 2001; Riveros Salcedo 2001).

The Ecuadorian Dry Forest ranges from extremely dry at the extreme western tip of the Santa Elena Península to wet at the peaks of the Chongón-Colonche Mountains. The marked aridity of most of the area is the most distinctive feature. Low rainfall, even in the December to May rainy season causes vegetation to be low highly ramificated branched shrubs that gradually increases with height in areas with greater precipitation (Sheppard 1930b; Stahl 1991; Valverde 1991).

Within the general moniker of Ecuadorian Dry Forest, four subsystems have been identified, including from driest to wettest, Ecuadorian and Tumbes coastal thorn scrub to semidesert, Ecuadorian lowland dry deciduous forest, Ecuadorian semi-deciduous forest on coastal hills and Ecuadorian seasonal evergreen forest on coastal hills (Figure 2-8). Also included within the area of interest are mangrove forests (NatureServe 2003; Stothert 1995; Tirira et al. 2004).

2.3.1.1. Ecuadorian and Tumbes coastal thorn scrub to semidesert

The very end of the Península, to the west of the modern town of Santa Elena, is the driest and can be described as desert (Navarette 2005; Stothert 1995:Figure 1; Svenson 1946:417), but may be more appropriately the drier extent of the Ecuadorian and Tumbes coastal thorn scrub to semidesert (Figure 2-8). Relatively few woody plants grow in the area and even these are stunted, especially on the south side of the Península where they are exposed to the dry southwest wind (Acosta-Solis 1968:48; Svenson 1946:417). Grass savannas tend to predominate in the flatter areas (Acosta-Solis 1968:51-54). The area is so dry that, historically, agriculture has not been easy (Ferdon 1981:620). Currently, the tip of the Península contains salt ponds that supply much of the commercial salt for the rest of the country (Sheppard 1932). Prehistorically salt ponds may have been created or salt may have been harvested from the estuary (Lindao Q. and Stothert 1995:51-52). The commercial salt ponds have become important stopping places for numerous migratory birds and have a high number of resident birds as well (Hasse 2005). These migrations are probably not recent and may have occurred prehistorically as well. An estuary to the west of Punta Carnero enhances the diversity present in the area. The Mar Bravo site lies along a dune between the salt ponds and the ocean and to the west of the estuary.

Beyond Santa Elena, the Ecuadorian and Tumbes coastal thorn scrub to semidesert follows the coast to a distance of c. 10-15 km inland, farther along low lying areas. For the first 10-20 km, much of the flatter areas are mainly covered with grasses and small shrubs (Acosta-Solis 1968:48-54). Streambeds, however, tend to have taller vegetation, but this is also limited by the seasonality of the rivers. Farther inland, this system is characterized by a sparse growth of low scrub brush and cacti, interspersed with grasses and the rare emergent tree to 12 m of height. Exposure to southwest coastal winds also keeps most shrubs dwarfed (Acosta-Solis 1968:48; Svenson 1946:417; Tirira et al. 2004: Appendix 2, p. 97). It is within this system and the next that wild cotton (*Gossypium barbadensis*) is found (Lindao Q. and Stothert 1994:21; Svenson 1946:418). El Niño events may cause explosive growth in many types of plants especially vines and vine-like plants, such as *Ipomoea pescaprea* (a.k.a., *matacabra* or goat killer). Both Puerto de Chanduy, just beyond the shore, and Loma de los Cangrejitos, four kilometers inland, lie within this zone. In southern Manabí, this ecological system exists, but is limited to the immediate waters edge. Both Los Frailes and López Viejo lie near the transition from this system to the next (Cisneros-Heredia 2006).

2.3.1.2. Ecuadorian lowland dry deciduous forest

Farther inland, the vegetation becomes more dense and taller. This area is called the Ecuadorian lowland dry deciduous forest (Figure 2-8). This type of forest is characterized by deciduous trees that can grow to a height of 20 m. It differs from the above because the vegetation is taller and denser and cacti are less conspicuous, though still present. The trees are often thorny and either tend to be tall with large crown, such as the visually dominant Ceiba (*Ceiba trischistandra*), or short and highly branched. Vegetation may be more vigorous near seasonal streams, but the species are the same. This is the largest coastal terrestrial system in southern Ecuador and northern Peru. This system covers the majority of the inland area from an elevation of 10 m up to 300 m on the leeward side of the Chongón-Colonche Mountains and essentially covers other small ranges (Acosta-Solis 1968:54-61; Cisneros-Heredia 2006; Harris et al. 2004; NatureServe

2003: CES401.285; see also Navarette 2005; Tirira et al. 2004: Appendix 2, p. 87; Valverde 1991).

Due to the proximity of the Chongón-Colonche Mountains to the coast in southern Manabí, this system arises very close to the coast, sometimes right at the water's edge. The archaeological sites of Los Frailes, Salango and López Viejo are within, or perhaps just at the dry edge of, this terrestrial system.

2.3.1.3. Ecuadorian semi-deciduous forest on coastal hills

As one goes towards the interior and up the Chongón-Colonche Mountains, the systems get progressively moister. The Ecuadorian semi-deciduous forest on coastal hills (Figure 2-8) is watered by the moist ocean air. *Garua* waters the vegetation and partially shades it from the desiccating effects of the equatorial sun. This system begins at approximately 300 m and includes deciduous trees and evergreen undergrowth. Epiphytes begin to appear in this system (NatureServe 2003: CES401.288; Valverde 1991). If not for modern deforestation, this system would have been within less than one kilometer from Salango, and less than 10 km from López Viejo and slightly farther from Los Frailes. Salango is much wetter than even Puerto López, one ridge to the north, because it lies within the Puerto López-Ayampe moisture trap zone (Harris et al. 2004). South of Salango, where the mountains meet the ocean, this system arises at water's edge.

2.3.1.4. Ecuadorian seasonal evergreen forest on coastal hills

The Ecuadorian seasonal evergreen forest on coastal hills lies in the upper reaches of the Chongón-Colonche Mountains from 500 up to 800 m (Figure 2-8). This forest captures and even greater amount of *garua* and is less exposed to drought. The majority of trees are evergreen with few branches beneath the two levels of canopy at 10-14 and 15-18 m, but emergent trees can rise to 27 m. The under story is open, as in lowland wet forests. Palms and numerous epiphytes are present. Importantly, balsa (*Ochroma pyramidale*), used to make sailing vessels, and Cana brava (*Guadua angustifolia*), used for a variety of construction, grow in this system (Acosta-Solis 1968:54-61; Francis 2000; Lindao Q. and Stothert 1994:38-40; NatureServe 2003:CES401.287; Svenson 1946:418; Valverde 1991). This zone begins at approximately 80 m above sea level (as opposed to nearly 500 m farther from the coast) near Salango (Harris et al. 2004), making access to the seasonal evergreen forest much easier than at the other sites, especially those on the Santa Elena Península.

2.3.1.5. Mangrove forests

Along much of the coast in this area, mangrove (*Rizophora* sp.) forests exist in small pockets, often where rivers enter the ocean and create brackish waters. Mangrove forests support a wide variety of aquatic life in the dense tangle of branches and roots that are affected by the twice daily rise and fall of the tides. Aquatic resources include fish, mollusks, crabs, and shrimp. Unfortunately, many of the small coastal mangroves of the Santa Elena Península and Southern Manabí have been replaced by pools for raising shrimp for the international market (Acosta-Solis 1968:40-41; Dinerstein et al. 1995:36-37; Lindao Q. and Stothert 1995:23-25; NatureServe 2003:CES402.599; Tirira et al. 2004:96).

Mangroves probably existed prehistorically at the mouth of the Zapotal River as they did until 1952 (Lindao and Stothert 1995), near Loma de los Cangrejitos and Puerto de Chanduy and to the east along the coast and into the Gulf of Guayaquil, which still contains sizable, though highly fragmented, mangrove forests. From Playas to Tumbes, mangrove forests probably dominated the coast throughout prehistory. If mangrove forests existed in late prehistory near Mar Bravo, they were probably quite small (Ferdon 1981; Sarma 1974; Stahl 1991:349-351; Stothert 1988). Historically, mangroves existed on the north side of the Santa Elena Península (Stothert 2001:321). The evidence for mangroves forests near Salango, Los Frailes and López Viejo is less clear, but they may have existed in small patches also.

2.3.2. Prehistoric relationship with the local environment

The key environmental factor in southern Manabí and on the Santa Elena Península was water. There were three basic ways in which people dealt with the dryness along the coast, including expanding access to water, access to different environments and a focus upon the sea.

First, the people of the coast of southern Manabí and the Santa Elena Península developed a number of ways to increase their access to water. In many locations, seasonal wells are dug into dry stream beds, near flowing water, or in other locations to access water present below the surface (Lindao Q. and Stothert 1995:25; Mester 1990: 53, Figure 3.3; Saville 1910:14-15; Sheppard 1930a:271-272). U-shaped water retention features known as *albarradas* were built as far back as 2700 years ago and have been recorded for much of the Santa Elena Península, especially around the modern towns of La Libertad, Santa Elena and *Salinas* (Stothert 1995) and site of Mar Bravo (see section 4.3). *Albarradas* have also been recorded near Loma de los Cangrejitos (Lindao Q. and Stothert 1995; Marcos 1981, 1995b).

An *albarrada* is open on one side, which usually faces up hill in order to collect water during the short rainy season. The *albarrada* can then be used for two purposes, as a source of water and, along the edges, a place to plant crops. As the *albarrada* dries out, crops are placed closer and closer to the center. When the crops have grown, the *albarrada* is often cleaned out and the clay and silt that has collected at the bottom of the *albarrada* is placed upon the outer walls of the *albarrada*, making them thicker and higher. *Albarrada*s were often communal resources (Marcos 1995b; Masucci 1992; Stothert 1995).

People also accessed a variety of environmental zones in order to obtain needed goods. The people residing at all of the archaeological sites discussed in this dissertation had access to all of the environmental zones discussed above. Though the moist zones are more distant from the sites on Santa Elena Península than from sites in southern Manabí, the Zapotal River may have acted as a route to access inland resources. During the Guangala phase, coastal resources, such as large fish, were transported 25 km up the river to El Azúcar (Reitz and Masucci 2004) and it is likely that resources from the hills also were used. Historically, the coastal communities of the Santa Elena Península were connected through familial ties to the inland communities giving them reasonable access to inland goods (Lindao Q. and Stothert 1995).

Finally, one of the main adjustments to aridity is reliance upon marine resources. The Pacific Ocean along the coast of Ecuador is particularly rich in marine resources because it lies at the intersection of the cold Humboldt Current, with its especially rich upwelling cold water, and the warm water of the Panama/El Niño Current, which, though not particularly rich, does yield fairly high biodiversity. The fauna of the coast is a mixture of southern ‘cold’-water species and northern ‘warm’-water species, but also accompanied by the nutrient richness of the upwelling water from the south. This richness, in ichthyofauna especially, results in a fishery that is not specialized for any single species of fish (such as in Peru, where sardines [*Sardinops sagax*] and anchovetas [*Engraulis ringens*] are the main species harvested), but that often yields a very wide variety.

2.4. Summary

The environment of southwestern Ecuador is mainly governed by the converging ocean currents and associated moisture regimes. This results in a relatively arid region to the south with increasing moisture to the north where the Chongón-Colonche Mountains rise to meet the incoming moisture. This makes the northern region, especially inland portions, more easily arable than regions to the south. Along the Santa Elena Península, this results in a greater focus on marine resources and less on agriculture. This does not diminish, however, the use of marine resources in southern Manabí. On the Santa Elena Península, the residents also developed a variety of methods to deal with the aridity, including increasing their access to ground water and preserving rain water. Importantly, they were also able to access inland resources through a variety of social connections. Clearly, the environment affected life on the coast of Ecuador, but it is also clear that it did not determine it nor did it necessarily limit, in the strictest sense, people’s use of the environment. It did, however, provide options that were more attractive than others.

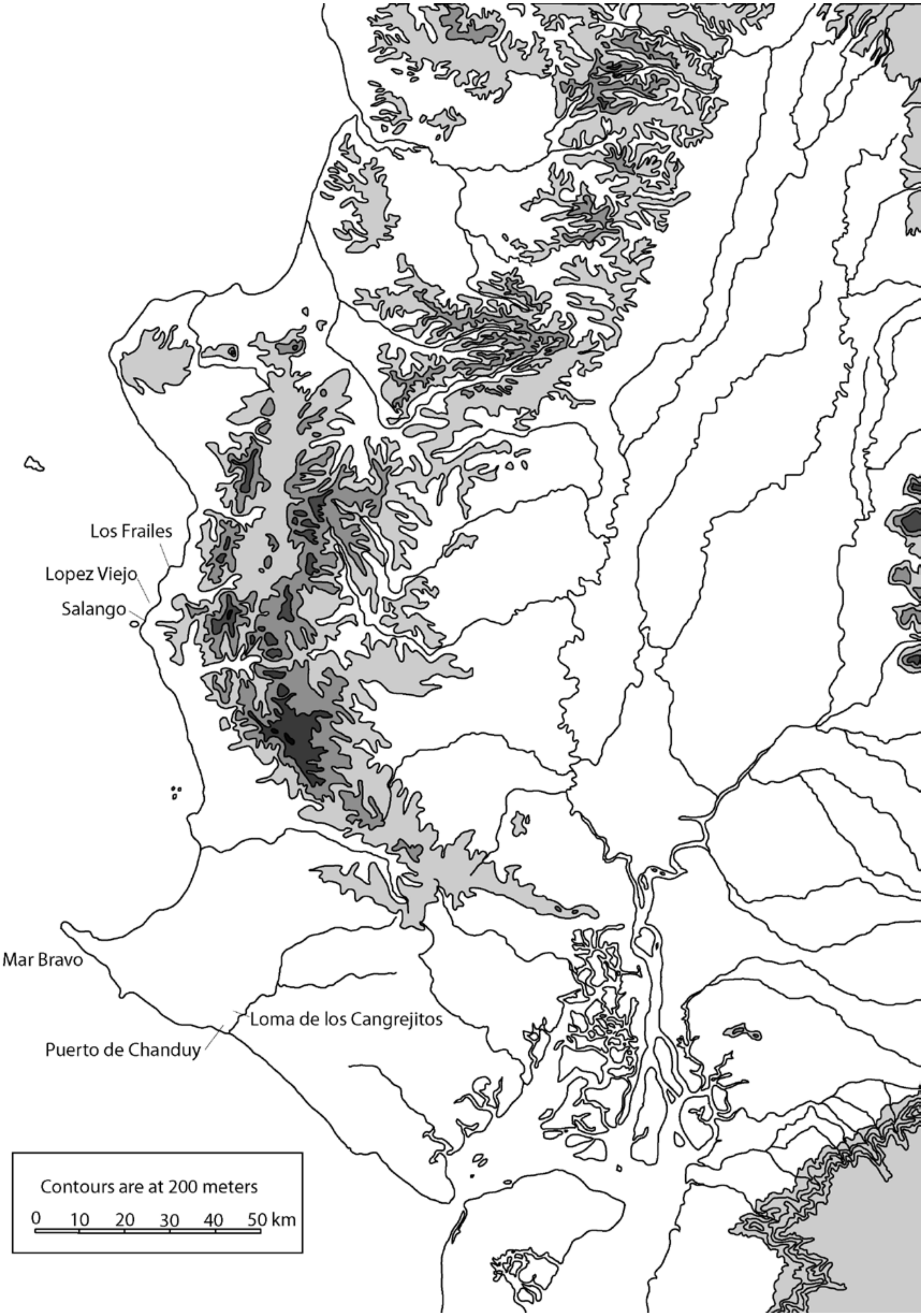


Figure 2-1. Map of Southwestern Ecuador, showing the coast, Chongón-Colonche Mountains, river systems and sites mentioned in the text.

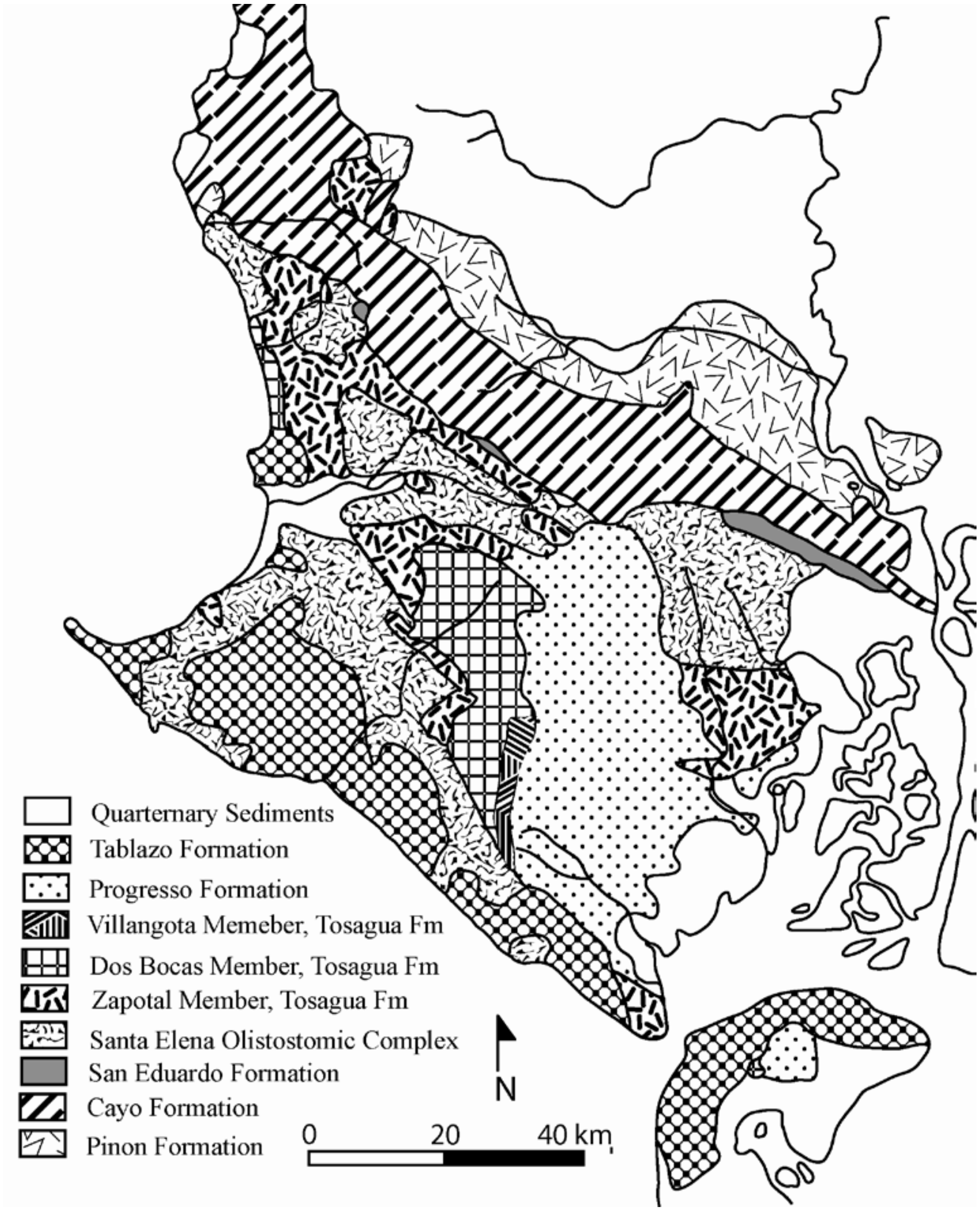


Figure 2-2. Geological Map of Southern Manabí and the Santa Elena Península**. Redrawn from Masucci and Macfarlane 1997:Figure 3.**

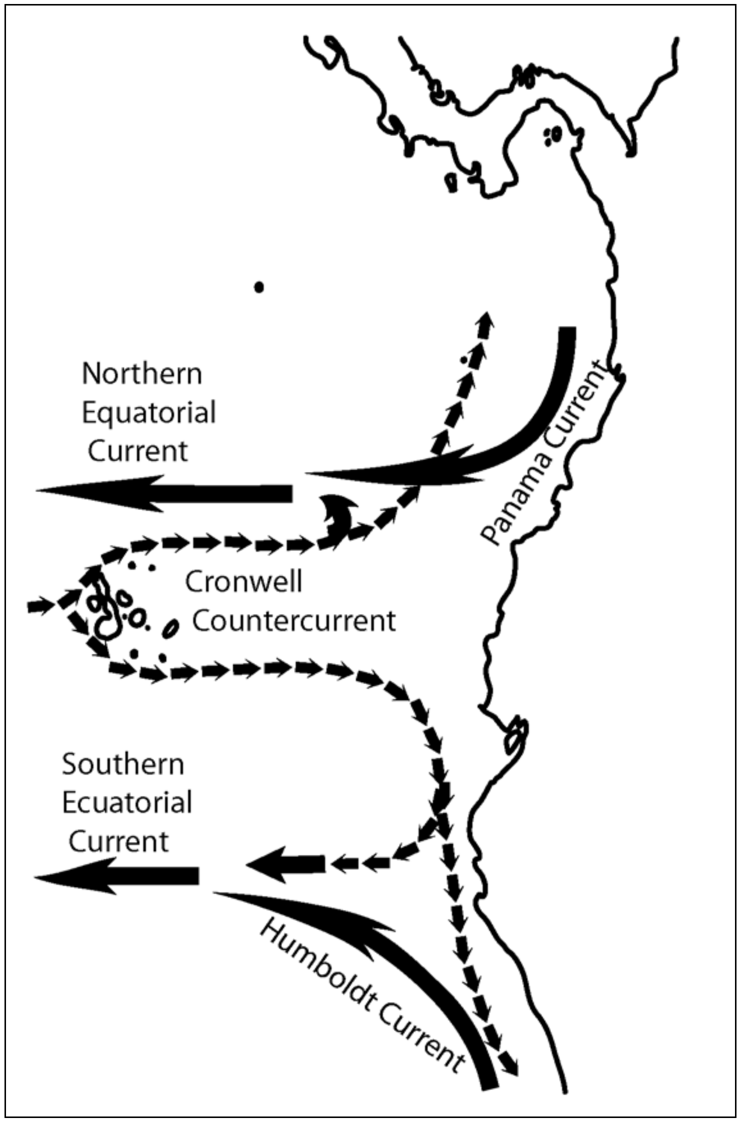


Figure 2-3. Map showing major currents affecting the climate of the coast of Ecuador. Solid arrows represent surface currents and small arrows represent subsurface currents. Redrawn from Terán et al. 2004: Figura 2.2.

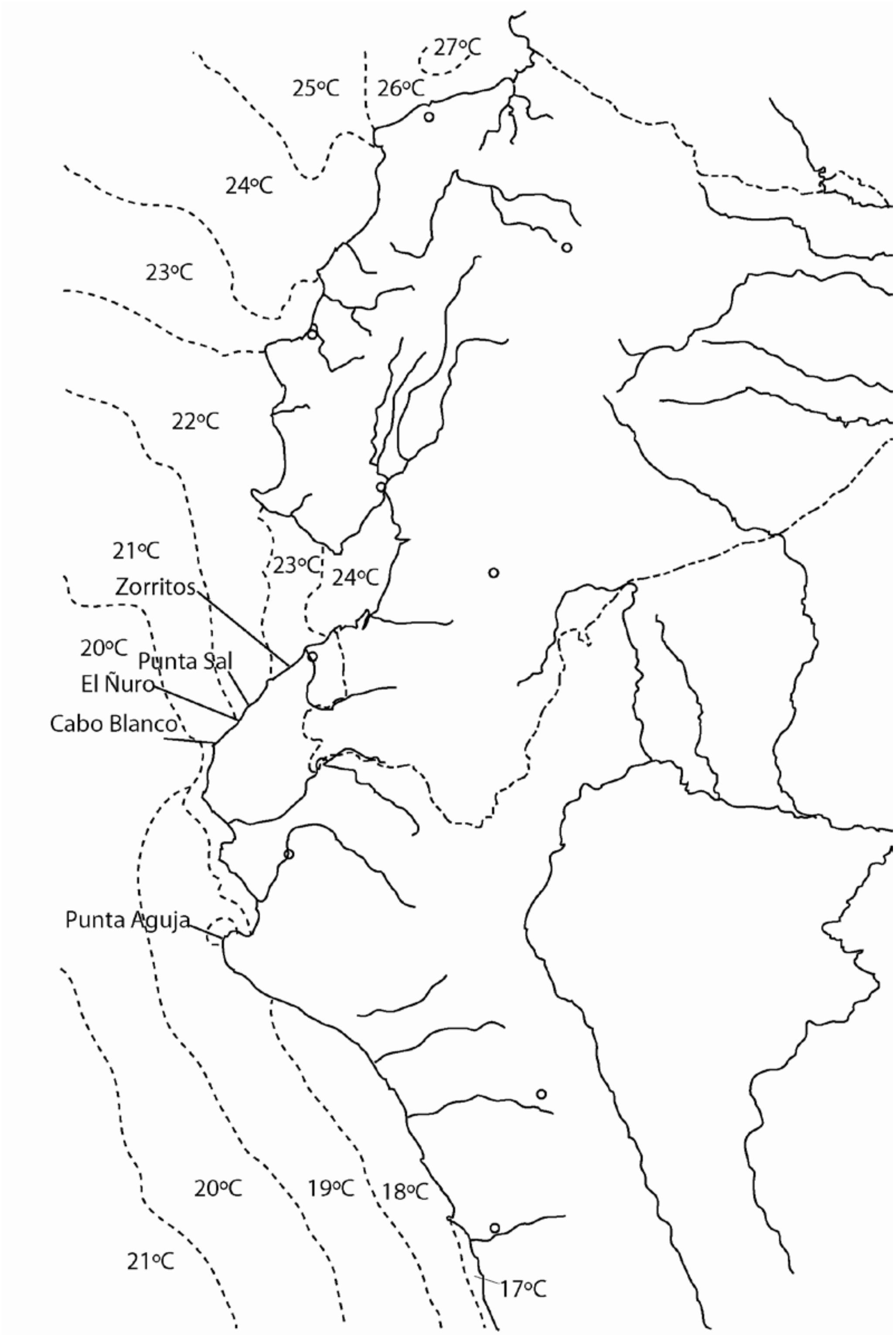


Figure 2-4. Map showing average sea surface temperatures. Redrawn from Terán et al. 2004: Figure 2.3

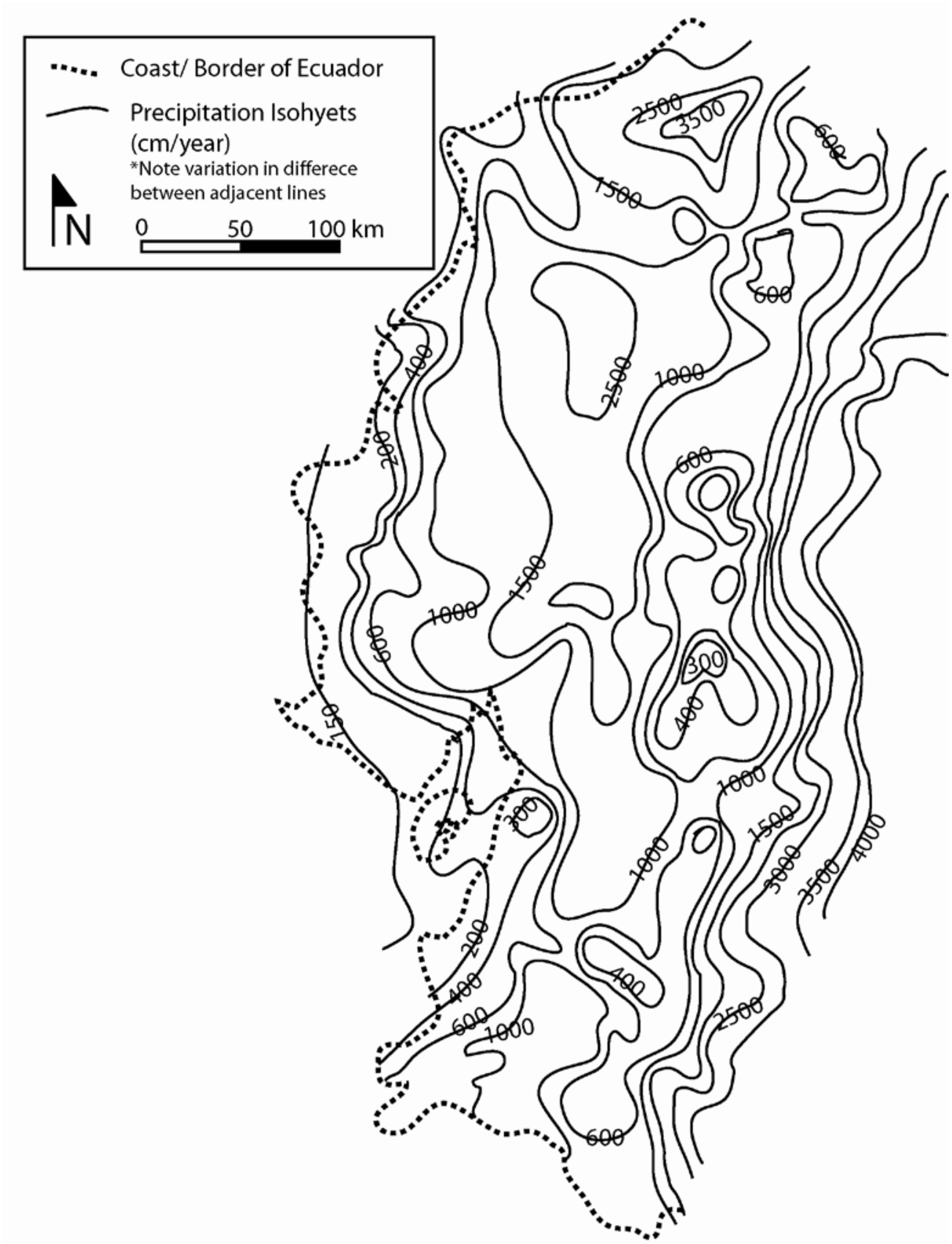


Figure 2-5. Precipitation isohyets for coastal Ecuador. Redrawn from Jørgensen and León-Yánez 1999: Figure 1.

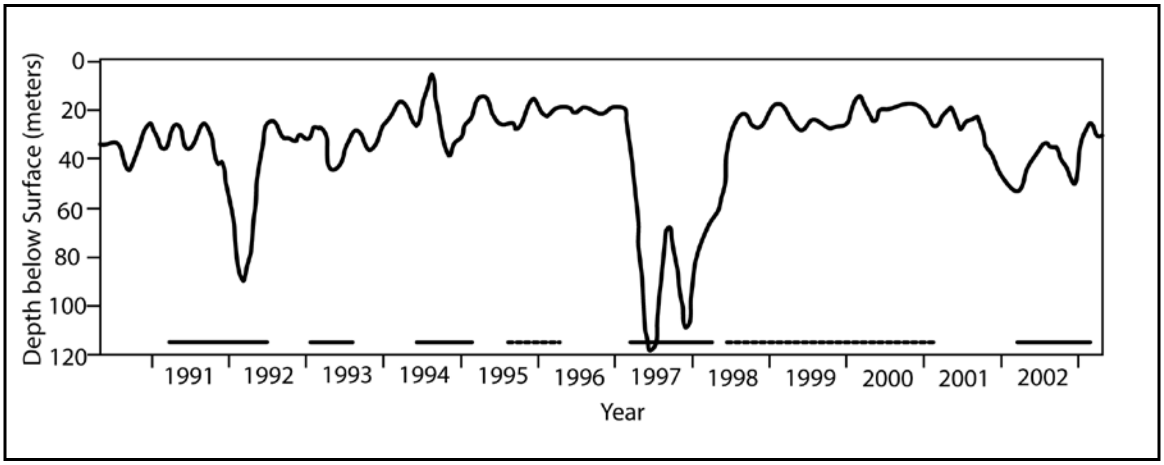


Figure 2-6. Sea surface temperature and depth of 20ºC thermocline approximately 20 km offshore from La Libertad, Ecuador. Lines across the bottom, solid represents an El Niño and dashed represents a La Niña. Redrawn from Garcés-Vargas et al. 2005: Figure 1.

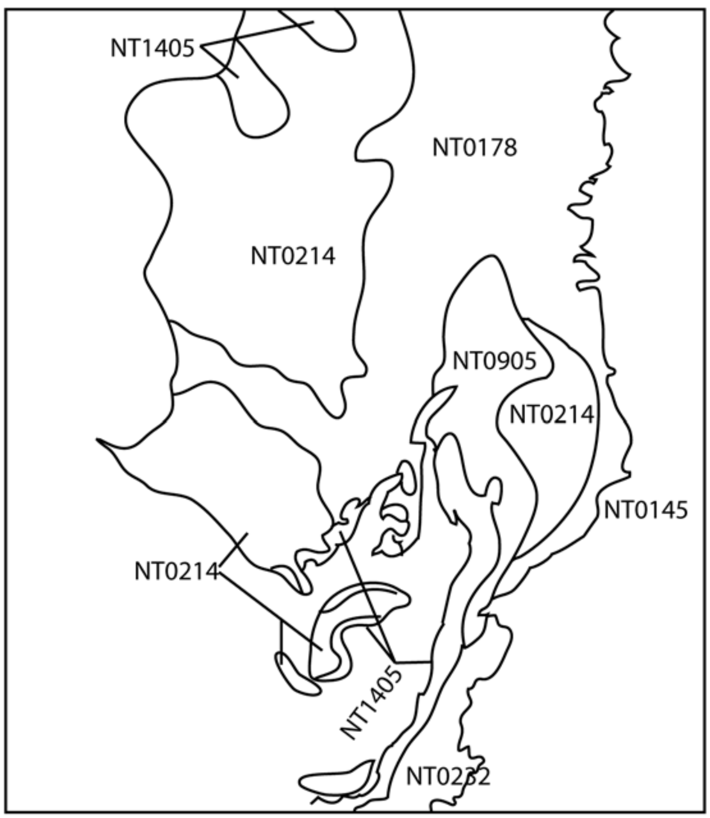


Figure 2-7. Ecoregions of Ecuador and Extreme Northwest Peru. See text for Ecoregion codes indicated in figure. Redrawn from National Geographic Society 2001.

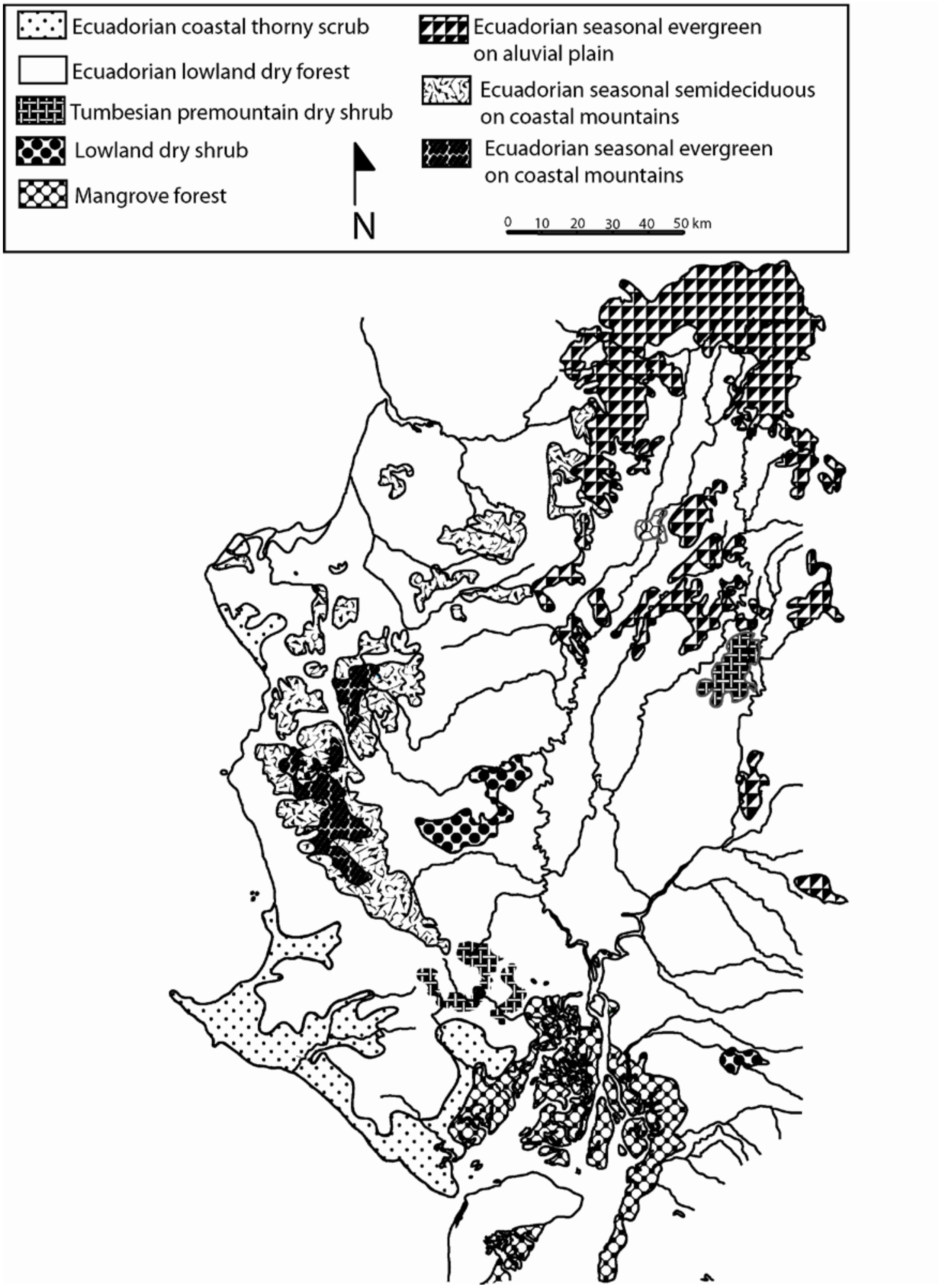


Figure 2-8. Terrestrial Ecosystems of Coastal Ecuador. Redrawn from Terán et al. 2004: Mapa 4.

Chapter 3. Cultural Background

3.1. The archaeological culture known as Manteño

In the broadest sense, the people who produced the Manteño material culture occupied the coast of Ecuador from just north of Bahia de Caráquez south to the mouth of the Guayas River Basin (Figure 2-1) (Stothert 2001:303). The Manteño phase dates from approximately A.D. 800 to 1532. Current research, especially at Loma de los Cangrejitos, indicates it is very difficult to draw a non-arbitrary line between the preceding Late Guangala and Early Manteño, but a shift in material culture does occur between c. A.D. 700-900 (Masucci 1998, 2000a, 2000b; see also Mester 1990). The end date of this archaeological culture is the arrival of Spaniards, but many cultural practices continued even after the appearance of the European invaders.

As with all archaeologically identified cultures, there is a great deal of variation along with a comparable amount of similarity between the material remains from archaeological sites attributed to the Manteño. Where one draws the lines for the geographical limits of the Manteño culture, and hence the limits of neighboring groups, varies. Although the lines have been drawn at Bahia de Caráquez and the mouth of the Guayas River, the lines probably represent more of a statistical shift in use of material culture, not of dramatic cultural distinctness. Within this area, some archaeologists argue for the existence of two or three separate traditions, one called the Huancavilca (or Manteño del Sur or Guancavilca) south of the modern town of Colonche (see Figure 2-1) along the Santa Elena Península and another called Manteño (or Manteño del Norte) located to the north of the Chongón-Colonche Mountains in what is today southern and central Manabí province. Some also distinguish the Punáes, residents of Puná Island (see

Figure 2-1), from the other two groups (Estrada 1957, 1979; Holm 1982; Marcos 1995a; Stothert 2001; Zevallos 1995:251-253).

Much of what is considered typical Manteño material culture comes from sites in central Manabí. This includes the well-known dark grey to black burnished wares with elaborate incised designs, including the ceramic vessels (jars and some pedestal plates) that are often modeled in human or animal forms or with human faces on the neck (Jijón y Caamaño 1997; Saville 1907, 1910). Other diagnostic attributes include black burnished bowls and bell-rimmed jars, decorated spindle whorls, large burial urns, copper implements (needles, fish hooks, and tweezers, especially) (Stothert 2001). Many of these traits are found at sites in southern Manabí and on the Santa Elena Península.

3.2. One or more?

The division of the Manteño into sub-traditions, or even separate traditions is based upon two arguments. First, the archaeological complexes on the Santa Elena Península and southern Manabí are, in fact, different in some significant ways. Second, ethnohistoric descriptions separate the Huancavilcas from their coastal neighbors to the north.

There are three issues, however, that complicate the separation of these two groups. First, the identification of an archaeological complex with ethnohistoric people is difficult because sources often address different aspects of the culture in question. One focuses primarily upon preserved material culture from excavated archaeological sites and the other often ignores such artifacts, concentrating instead on ethnohistoric documentation. Second, it is becoming clearer that at least some of the dissimilarity between the Manteño and Huancavilcas is chronological. Third, as discussed above, there is a clear difference in the environment of the two areas, which often results in different eco-technological adjustments. The old question of whether differences are cultural or related to environmental variables is relevant.

One of the main differences between the Manteño in the north and those in the south is the use of stone in construction and for carved monuments. Initially, the term Manteño (i.e., from Manta,) was used to describe the inhabitants of sites with *corrales*, large (up to 55m x 16m) rectangular structures with foundations of stone located in the central part of the modern province of Manabí. The larger *corrales* probably represent communal structures and the smaller ones households. Some of the *corrale* sites also yielded fairly large quantities of stone carvings including stone seats and columns (Jijón y Caamaño 1997; McEwan 1992 [1982], 2003; Saville 1907, 1910; Schávelzon 1981). Such use of stone is unusual for Ecuador.

These Manteño cultural traits were originally identified by Saville at Cerro de Hojas and Cerro Jaboncillo. Similar sites have been identified at Cerro Agua Nueva, Cerro Jupa, Cerro Montecristi, Cerro Paco and Agua Blanca (McEwan 2003; Saville 1907, 1910). These sites are much larger than sites on the Santa Elena Península, with the possible exception of the site under modern day La Libertad (Bushnell 1951; Stothert 2001:321-322), and are notable in their presence on hills, often many kilometers from the coast, where the increase in *garua* probably allowed greater agricultural potential (Stothert 2001). These inland sites are often larger than coastal sites, though many of the later now sit beneath modern population centers, such as Manta (Schávelzon 1981), Puerto López and, possibly, Machalilla. Though these coastal sites had stone *corrales*, very little evidence remains (Currie 1995b; Nurnberg et al. 1982). The Manteño landscape was modified in a variety of ways, including terraces, low burial mounds, pit tombs and wells (see site descriptions).

On the Santa Elena Península, little stone work has been recovered. A fragment of a stone foundations and a piece of a stone seat were identified at La Libertad (Bushnell 1951; Stothert 2001:322). Structures with stone foundations along with terraces, roads and fortifications have been described for Puná, but few details have been published (Estrada 1979:29; Stothert 2001:316). Stone sculptures have been recovered from Instead of stone sculptures, many large wooden carvings, similar to totem poles, were recovered in the hills near the eastern end of the Chongón-Colonche Mountains (Zevallos 1995). These are arguably the Huancavilca equivalent of the stone sculptures from Manabí.

As well, Estrada indicated that there were more funerary urns, grinding stones, net weights, money axes and other copper implements in the Huancavilca area than in the Manteño del Norte area, but fewer mold-made figurines, decorated spindle whorls and ceramic pestles (Estrada 1962). It is unclear, however, whether these differences are due to excavation strategy, differential preservation, site function or other variables (Stothert 2001). Ethnohistorically, the Huancavilcas extracted their own teeth, or at least modified them (Szaszdi and Leon Borja 1980; Zevallos 1982).

Some of the differences between Manteño archaeological sites are temporal. Sites occupied towards the beginning of this period, such as Los Frailes and Loma de los Cangrejitos (and probably López Viejo) indicate little stone work, even in Manabí. Instead, the prevailing architectural feature is middens that were modified to create low mounds, which were often sealed with a series of white, yellow or tan floors (Masucci 2000a, 2000b; Mester 1990). The material from these sites also appears to be transitional between what is traditionally thought of as Manteño and groups of the earlier Regional Development Period.

A single radiocarbon date from Cerro de Hojas, a *corrales* site, yielded a highly imprecise date of 560+/-200 or around A.D. 1400, with the large standard deviation making the date nearly useless (Stirling and Stirling 1963). This tentatively suggests that the *corrale* sites were built only 100 years or so before the arrival of the Spanish. Eight radiocarbon dates from Agua Blanca, another site with stone architecture, available on the Andes C-14 website (Soltysiak et al. 2003) range from 280+/-80 BP to 820 +/-50 BP, but it is unclear how these dates relate to the construction of the *corrales*.

3.3. Manteño social structure

We know relatively little about social structure among the Manteño, but ethnohistoric records, as well as settlement patterns, argue for at least two groups.

Late in prehistory, it is probable that there was some sort of social hierarchy, especially at the stone *corrales* sites. Certainly, the stone seats of central and southern Manabí argue for leaders, whether they were familial/clan, religious or economic, but the sort of power these people wielded is uncertain. Paramount lords may have controlled four to seven towns and had differential marriage rights (McEwan 1992 [1982]; Stothert 2001). Control of large sailing rafts may have been one way elite produced and maintained their separation from others (Marcos 1995a). At smaller contemporaneous as well as earlier sites, differentiation in space may indicate social differentiation, but not necessarily a rigid hierarchy. It may be that the Manteño *señoríos*, a small polity often comprised of four towns, were allied with each other to form what has become known as a League of Merchants (Jijón y Caamaño 1930; Norton 1986). Even if this is true ethnohistorically, and can be projected into the past, it does not necessarily mean that any more than 'big man' hierarchies existed. Marcos has argued that a Huancavilca state formed that was based largely upon trade (Marcos 1995a), but this is based upon the unproven intensification of trade in Spondylus. As I show below, such intensification is not necessarily evident. Similarly, the best evidence for hierarchy is the size and complexity of the *corrales* sites, which appear to be quite late in the sequence (see below). It is possible, therefore that chiefdoms did develop in the later part of the sequence, but a state seems highly unlikely.

3.4. Manteño subsistence

The subsistence economy of the Manteño was heavily reliant upon marine foods and agricultural crops. The majority of their protein was derived from the ocean, in the form of fish, mollusks and seabirds; evidence for the consumption of marine mammals is limited. Domesticated animals, including mainly Muscovy duck, guinea pigs, and dogs, along with wild animals, especially deer, contributed to their diet (Stahl 1988; Stahl et al. 2006; Stahl and Norton 1987). Though wild foods were certainly utilized (e.g., Lindao Q. and Stothert 1994), agriculture played a key role in Manteño subsistence. Important crops included "yucca (sweet manioc or cassava), maize, beans, peppers, squashes and gourds, peanuts, sweet potatoes, tomatoes, papayas, guavas, cherimoyas, *guanabanas*, *ciruelas*, avocados, tomatoes, cacao, pineapples, medicinal plants, tobacco, and herbs and spices" (Stothert 2001b:305).

Agriculture in central and southern Manabí would have been more predictable, even year-round, whereas on the Santa Elena Península agricultural success varied with rainfall, even considering the various water retention features (see above). Therefore, maritime and littoral resources may have been more important to the people on the Santa Elena Península. Notably, most of the sites on the Santa Elena Península at this time are relatively close to the ocean or high in the moist Chongón-Colonche Mountains, but there are few in the intervening region.

3.5. Manteño religion

Large ceremonial buildings are known from ethnohistoric descriptions; the stone *corrales* from the Manabí sites may have been such structures. Large structures lacking stone foundations have been identified at El Morro, Rio Chico, and Puná (Castro and López 1995; Harris et al. 2004; Stothert 2001b:316). They also reportedly existed on La Plata, Salango and Santa Clara Islands, but little archaeological evidence of these has been recovered. The purpose of these buildings is not yet clear, however.

Manteño burials appear to be variable, perhaps both chronologically and spatially, and include shaft and chamber tombs, bottle-shaped tombs, pit graves, urn burials, and cremations. Grave goods mainly include fine pottery, but other artifacts, such as shell beads and tools for making them, may be included. There appears to be little definitive evidence of social stratification in burials (Holm 2001 (1962); Marcos 1981; Saville 1907; Saville 1910; Stothert and Cruz Cevalos 2001; Ubelaker 1981; Zevallos 1995).

3.6. The Manteño Spondylus-Balsa cartel

The Manteño were involved in long distance trade. The key to this trade was the large sailing vessels steered by raising and lowering planks jutting through the raft into the water, known as *guaras*. These crafts were made from the extremely light and buoyant, but strong, balsa (*Ochroma pyramidale*) wood. Because of the unique steering system, the vessels were able to sail into the wind, thereby making travel in all directions possible, even with the prevailing southwesterly winds.

The most significant evidence of long distance trade is the ethnohistoric recording of the raft encountered by Bartolomeo Ruiz, captain of one of Pizarro's vessels (Szaszdi 1978). The raft was quite large and impressive to the Spanish. The home port of this vessel was Salangome, which has been equated with the quadripartite polity located at Tusco (modern Machalilla), Serácapez (modern Puerto López), Calango (modern Salango), and Calangome (archaeological site of Agua Blanca) (Currie 1995a, 1995b; Norton 1986). In the rich cargo the vessel was carrying were "shells from which they make coral red and white beads, and they had the vessel almost laden with them" (Currie 1995a:511, citing Samano 1844). These shells have been identified as Spondylus (Norton 1986).

Such sailing craft were not limited to the Ecuadorian coast, however, but were present ethnohistorically as far south as Sechura and Paita (Edwards 1965). Therefore, it is likely that in late prehistory many different groups plied the waters of the Gulf of Guayaquil, but it may have been the Punáes, occupants of Puná Island, who held the strategic position. Historically, most balsa was harvested in the Guayas Basin (Fletcher 1949; Francis 2000) where it was much more plentiful than in other places. Though places such as the Chongón-Colonche Mountains did have balsa that was floated down the numerous rivers, it seems that it was not present in great quantities (contra Norton 1986). Puná Island, in the middle of the mouth of the Guayas River, is ideally located to control maritime trade into the Guayas Basin. It is also well known that the Punáes were rather bellicose, warring often with their neighbors to the east and south. They had even sacked Tumbes just before the arrival of the Spaniards (McEwan 2003; Peterson 1959; Volland 1995).

Although it has been argued that balsa trees are limited to Ecuador and southern Colombia (Norton 1986:136), it appears that this is, at least today, incorrect. Although most commercial balsa comes from the Guayas basin (Fletcher 1949), it is also clear that it grows farther south into Peru and even Bolivia (Ferreyra 1983; Francis 2000). While balsa may have been available farther south, the Manteño were one of the main groups to use this resource in the form of large sailing vessels especially useful for trade.

It has often been argued that the Manteño traveled as far north as West Mexico (Anawalt 1992; Callaghan 2003; Hosler 1988; Hosler et al. 1990; Marcos 1977-78), perhaps even west to Polynesia (e.g., Langdon 2001) and south up and down the Peruvian coast. While many of the details of these alleged voyages are still unclear (e.g., Hocquenghem 1993; Hocquenghem et al. 1993), it is still widely believed that the Manteño were major maritime traders and played a key role in the dispersion of many goods, not just the oft-discussed Spondylus, throughout the region.

3.7. Arrival of the Inka

One of the most important prehistoric events on the coast of Ecuador was the arrival of the Inkas. While the total effect of their arrival is uncertain, it is clear that towards the end of the Manteño period there were major changes. Based upon ethnohistoric and archaeological information, the Inka did have a presence on the coast of Ecuador. Inka artifacts have been recovered from Cerro de Hojas (Saville 1907, 1910), Isla de la Plata (Dorsey 1901; McEwan and Silva I. 1989), Agua Blanca (McEwan 2003), Puná Island (Isaacson and Aleto 1989), and San Marcos (Stothert and Cruz Cevalos

2001). Ethnohistoric accounts differ as to whether or not the Inka conquered the Manteño, or if they did, how much control they exerted (e.g., McEwan 2003; McEwan and Silva I. 1989). The Inka did, however, avoid the extremely wet parts of the Ecuadorian coast to the north, such as Esmeraldas (e.g., DeBoer 1996).

3.8. Summary

Many archaeological issues related to the Manteño have yet to be resolved. Cultural developments late in the sequence need to be better addressed. When did the construction of *corrales* sites begin and what relationship did this have with broader regional changes? Building stone architecture is clearly a break with previous architectural patterns. These sites appear to be associated with greater socio-political differentiation, but the details are unclear. Considering this, ethnohistoric records need to be used cautiously and projected backwards in time only when supported by the archaeological record. Even the time depth of the balsa raft, though clearly prehistoric, is unclear. Does the presence of Valdivia ceramics on Isla de la Plata, suggest the full development of sailing balsa rafts? Similarly, ethnohistoric documents clearly demonstrate significant social differentiation. If this is associated with the construction of the stone *corrales*, however, the prior social and political organization of the Manteño prior is unclear, but it does appear less differentiated and the sites appear smaller.

Chapter 4. The Sites

4.1. Loma de los Cangrejitos (MV-C2-4)

4.1.1. Background

Loma de los Cangrejitos is situated on a ridge jutting out into the flood plain of the Zapotal River (Figure 4-1). The site sits on top of the tablazo ridge approximately 15 m above the flood plain of the seasonal river. During wet years, when the river is more than a trickle, it attracts large quantities of crabs (the *cangrejos* of Cangrejitos) that burrow into the soft mud. These have been observed up to five kilometers inland; i.e., one kilometer further inland than Loma de los Cangrejitos (personal observation 1998; Zevallos 1995:200). The ridge is the only one along the Zapotal River that projects out into the floodplain allowing for good views to the north, south, and east, but especially towards the ocean. The ocean lies a little more than 4 km to the south and it is quite likely that the mangrove estuary that was still present in the 1930's (Lindao Q. and Stothert 1995) was an important resource for the prehistoric people living at Loma de los Cangrejitos. The mangroves provided food in the form of fish, shrimp, crabs and, probably shellfish as well as a port for small, and perhaps large, boats.

The site sits ideally located for easy access to the coastal and riverine environments while sitting high up on the only physically imposing point along the river. It is quite likely that the modern town of Chanduy, which lies to the east of the estuary, was also populated prehistorically. Indeed, the second site discussed below, Puerto de Chanduy, lies within the modern town of Puerto de Chanduy, and was extensively utilized during the Manteño period. Up river from the site lies the modern town of San Rafael (a.k.a. Gagüelsán) near which lies a reported Manteño cemetery (Lindao Q. and

Stothert 1995; Marcos 1981). Within the general area of Loma de los Cangrejitos, numerous sites from a variety of time periods have been recovered. The most famous site is Real Alto, a site which has played a pivotal role in discussions of the origins of ceremonial centers, agriculture, etc… (Chandler-Ezell et al. 2006; Damp 1979; Lathrap et al. 1975; Lathrap et al. 1977; Marcos et al. 1976; Pearsall 1979, 2003; Pearsall et al. 2004; Zeidler 1984). Otherwise, Loma de los Cangrejitos (Marcos 1981; Zevallos 1995) and a Guangala site on the Pampa de Pichilingo (Marcos 1970) have been published. Farther up river, the Guangala occupation of El Azúcar has been well-published. To the east along the coast, other sites, reportedly of similar size to Loma de los Cangrejitos, have been documented (Estrada 1979).

Loma de los Cangrejitos has been divided into three sections, a cemetery, a ceremonial area and a habitation area (Figure 4-2). The cemetery is located at the end of the ridge to the east closest to the river, while the ceremonial area is in the middles and the habitation areas spreads to the west and southwest as the ridge widens and connects to other smaller ridges. These three sections are separated by distinct saddles in the ridge. The saddle between the ceremonial area and the cemetery is only drop of a few meters, but the saddle between the habitation area and ceremonial area drops approximately 10 m and is reinforced by the construction of a large earthen wall along the edge of the ceremonial area.

The site was excavated from 1967 to 1969 by Carlos Zevallos, with a team of students, and then in 1970 and 1978 by Jorge Marcos (Marcos 1981; Zevallos 1995:199-229). The main focus of the excavations by Zevallos, then assisted by Marcos, was the cemetery. The burials from the cemetery have been divided into three phases according to their contents (Table 4-1). The Phase A burials are located towards the end of the ridge, while Phase B burials are further from the river, close to the saddle between the ceremonial area and the cemetery, but also impinge upon Phase A burials where the two zones meet. Phase C burials are from a low burial mound placed over Phase A burials. Marcos dates Phase A to A.D. 900-1150, Phase B to “entre finales del siglo XII al XV” (i.e., approximately A.D. 1200 to 1400; Marcos 1981:54) and Phase C burials, based upon the presence of Spanish artifacts, is dated “hasta fines del siglo XVI” (Marcos 1981:54; i.e., A.D. 1500- 1600).

Most of the graves contained multiple burials, usually a male, a female and a young child, but the type of burial changed through time. Phase A burials are fairly shallow rectangular graves in which burials were placed in a prone position. Phase B burials are in boot-shaped shaft tombs whose entrance was often capped with large carved capstones. Phase C burials are either prone or cremation burials (Marcos 1981).

Although many of the tombs had significant quantities of burial goods, excavators did not identify any social hierarchy represented in the burials and considered most variation in grave goods to be temporal. The amount and type of Spondylus and copper artifacts found with these burials changes through time. During Phase A, Spondylus was recovered in “large quantity, as white and red beads, pendants, atlatl hooks, containers for lime for coca consumption made from whole shells and tops for lime boxes of wood or gourd” (Marcos 1981:55, my translation). Atlatl hooks made from a bird with a large crest and made from Spondylus are particularly characteristic of Phase A (see Figure C-81). In Phase B beads continued to be present, but other Spondylus artifacts were not recovered. The beads were variable with the smallest beads often made of red

Spondylus. Some of the beads were found in various stages of manufacture. Spondylus artifacts are absent during Phase C (Marcos 1981).

Axe money is extremely thin pieces of copper that are roughly axe-shaped, which are thought to have been used as a currency (Hosler et al. 1990). During Phase A all burials contained axe money of the larger size (c. 8 cm in length) with reinforced edges. These are normally located either in the hand or in the mouth of the individual. However, in Phase B, small axe money (c. 2-3 cm in length) in packets of 20 is more popular than the larger size. During Phase C, only the small axe money is present in the earliest burials of the phase, otherwise axe money has disappeared along with Spondylus artifacts (Marcos 1981).

Zevallos noticed some particularly special offerings within some of the rectangular burials dating to Phase A. Within the tombs, they found "the repeated presence of the tool kit employed to make *mullos* or *chaquiras*, as the Spanish called them," (Zevallos 1995:205) including small chert drills, margins of *Spondylus princeps* shells, some in-process Spondylus, sandstone saws, and copper chisels. These were often placed in a ceramic plate, sometimes outside it (Zevallos 1995:205).

In addition to these shell working toolkits other types of artifacts were recovered dating to the earliest phase. Other Spondylus artifacts included, a whole bivalve used as a container for lime (allegedly used for coca mastication; Zevallos 1995:206, Figura 61e) and atlatl hooks in the form of birds (Zevallos 1995:205) similar to those recovered in our excavation at Loma de los Cangrejitos (see Figure C-81). Other types of Phase A artifacts included distinctive ceramics, both Manteño and Guangala, suggesting that the 'Manteño' material culture developed out of the preceding 'Guangala' tradition. Human long bones with the shaft sharpened to a point and the end carved in a variety of forms, including human and zoomorphic figures, were also found. Similar objects have been recovered from Ancon (Bushnell 1951:111-112).

Also within the cemetery, Marcos identifies a ceremonial area in the center of the Phase B burials. It is composed of a flat area with the remains of a large post (60 cm in diameter) in the center of the flat area: the post was probably similar to the ceremonial post recovered historically (e.g., Zevallos 1995). A 29 meter ramp led up to the ceremonial post. Next to the post were offerings that included pottery, a mano and a young child. Nearby, a large (4 m in diameter and 50 cm deep) pit filled with clay and a rectangular structure (6m x 8m), which, to the excavators, suggested the production of specialized burial pottery for the cemetery (Marcos 1981).

To the northwest of the cemetery and further in on the ridge lies the ceremonial center. Though five 'pyramids' (mounds) have been investigated, only one has been reported, 4E-1. Mound 4E-1 looks out over the Zapotal River towards modern-day Chanduy, the estuary, and the ocean. The mound was excavated by two trenches bisecting it north/south and east/west revealing a very distinct stratigraphy. The excavation was extended to include more of the central area of the mound. Mound 4E-1 was built over an "arroyo angosto" (Marcos 1981:58) or dip in the side of the ridge that was filled with Late Guangala ceramics (Guangala 4-8; Marcos 1981:58). Marcos indicates that the midden material was moved from elsewhere and used to fill the indentation, and he interprets areas that were burned in situ as attempts to harden the earth. I see this more as an in situ midden that was probably leveled to create the surface for the mound. The evidence of in situ burning would have resulted from cleaning or burning the midden. On top of this, a series of floors were constructed which were then cut by the base of a wall of whitish adobe blocks that Marcos sees as similar to those from the North Coast of Peru. On top of this even more fill was placed in order to augment what was now a mound that rose above the surface of the ridge (two m on the north side and four on the south side facing the ocean). On top of the mound (c. 4.8 m by 8m), Marcos identified four rows of six postholes ("cuatro hileras de 6 grandes postes" [Marcos 1981:59] although only four rows of three post holes are shown in the diagram). An offering of a Muscovy duck with a necklace of "lapislázuli" was buried beneath one of the central posts. Also on top of the mound, a large grinding stone with traces of cinnabar was found.

4.1.2. Excavations from which shell beads are analyzed

In 1998, Maria Masucci brought a group of students from Drew University, along with the author and Franklin Fuentes, an Ecuadorian archaeologist, and local workers together to survey the Zapotal Valley. The purpose of the research was to study the transition between the Regional Development Period (Guangala Phase) and the Integration Period (Manteño Phase). Heavy rains of the 1997-1998 El Niño event made roads difficult to access and survey virtually impossible, however. In order to have a productive field season, we went to Loma de los Cangrejitos because it contained middens that were known to have both Late Guangala and Early Manteño pottery. It was difficult to even see the ground due to extensive overgrowth stimulated by heavy rain. Therefore, we relocated the excavations by Marcos (we were later able to relocate many other excavations that have not been reported) and decided to collect our own data. We found the open trenches from the excavation of Mound 4E-1 with the help of Pablo

Torres, who originally assisted Zevallos and Marcos at Loma de los Cangrejitos. After clearing out the vegetation, we cleaned up the eroded face of the excavation so that it was vertical. From this we could see that we had found Marcos' excavation. Since the excavation was already open, it was an ideal place both to train students in archaeology and to collect data on the Guangala-Manteño transition. This excavation was labeled MV-C2-4f, even though it is an extension of Marcos 4e excavation. We returned with a field school from Drew University for further investigation in 1999.

4.1.2.1. MV-C2-4f

A six by one meter excavation area was set up along the line that had been cleaned from Marcos' excavation. Each of six students was responsible for a one by one meter excavation unit identified as B1-B6, number from south to north (Figure 4-3). The students were assisted by a group of 12 excavators from El Azúcar. Generally speaking two workers were assigned to each student, but often, because of the cramped conditions, some workers were invariably assisting with other tasks. Excavation was carried out by following the natural stratigraphy where possible and arbitrary 10 cm levels when not possible. A wide variety of features were noted, but, other than a probable large root intrusion in B3 and B4 and a couple of post holes, many of them were probably simply variation in the midden matrix. A series of floors was excavated first, but the number of artifacts from these levels is fairly small and most of the material discussed herein is from the midden below.

4.1.2.2. MV-C2-4k

In 1999, excavations by a subsequent field school from Drew University led by Maria Masucci at the site included two test pits within the habitation area approximately

200 m from MV-C2-4f. This area, known as MV-C2-4k, is on the north-facing slope of the ridge where there is extensive evidence of occupation. The slope along the ridge, to the north of the dirt road entering the site, is littered with middens similar to MV-C2-4k. The slope was fairly clear and some holes created by feral pigs digging for food indicated the presence of fairly large shells and sherds, along with carbon and some shell beads, suggesting that preservation might be good. Two test pits were placed three meters apart (TP1 is farther up the slope than TP2) on a line approximately 20º East of magnetic North. The slope was gentle, dropping approximately one meter over eight meters around the two test pits, increasing gradually until at approximately 25 m from the excavation the ridge drops precipitously into a ravine. The two test pits were placed around what seemed to be a slight rise indicating a midden. The midden showed evidence of deflation (the top was sandier with more small pebbles) and perhaps evidence of secondary deposition. If the deposition was secondary, this was probably due to the material being cleaned out of the living area, presumably along the flat top of the ridge, and thrown down the slope.

Both test pits were excavated to 60 cm below ground surface and were essentially excavated in arbitrary levels that followed the slope of approximately 10 cm (precise measurements are recorded in Masucci 2000b) because there was no clear stratigraphy to follow. The matrix was a dark ashy grey mottled with white *caliche* (lime) and black carbon. All material was passed through stacked screens of ¼ inch and ⅛ inch mesh. Some small beads passed through the screen but were spied by the sharp eyes of the Ecuadorian excavators. At approximately 60 cm below ground surface (bgs), sterile soil was encountered, where we excavated another 20 cm to ensure that sterile had been reached. During the initial excavation, the very high concentration of lithic drills and small beads was noted.

4.1.2.3. MV-C2-4n

Also in 1999, after we cut away some brush, we were able to get a better idea of the layout of the site and decided to open a small excavation near the ceremonial mound. MV-C2-4n consisted of two test pits located at approximately 50 m to the north east of MV-C2-4f and on the north side (away from 4f) of a slight rise between the two excavations. These two test pits were aligned to follow the slope, again with TP1 farther up the slope (i.e., closer to 4f) and two meters apart. The slope was slightly less than at MV-C2-4f. The material in this excavation did not seem to be as fragmented and deflated as in MV-C2-4k and it had slightly different content. This excavation can be cross dated to the upper levels, including the floors, at MV-C2-4f an interpretation confirmed by the radiocarbon dates (see below).

Both units were excavated to sterile at 70 cm bgs in TP1 and 50 cm bgs in TP2. All material was passed through stacked screens of ¼ inch and ⅛ inch mesh. Shell working debris did not seem to be as significant a part of the shell assemblage as from the midden of 4f and 4k. Many large sherds were recovered, some of which were refit between the two units, suggesting that deflation was minimal and time depth represented was probably also fairly short.

4.1.3. Dating

Marcos proposed three periods of occupation at the site, A (A.D. 900-1150), B (A.D. 1150-1400) and C (A.D. 1400-1600; Marcos 1981). The radiocarbon dates from our excavations (Figure 4-4, Figure 4-17) augment and modify this preliminary sequence.

There was little datable material in the upper levels of the excavation at MV-C2-4f. The midden material beneath the floors at MV-C2-4f clearly date to Period A and indicate that perhaps the beginning of Period A should be dated earlier, perhaps around A.D. 750. One radiocarbon date (Beta- 124408) from B1-7 appears to be to about 100 years more recent than expected; an AMS date from the same context (AA-31706) yielded a date more consistent with the others from MV-C2-4f. With the exception of the one potentially aberrant date, the dates from excavation unit B1 are quite consistent, suggesting that the creation of the midden was relatively quick. The date from B6-6 (Beta 124411) does appear to be a little earlier than expected, but why is difficult to ascertain. Considering 95% confidence intervals, there is a great deal of overlap.

MV-C2-4k appears to date to approximately the same time period as the midden at MV-C2-4f (Figure 4-4, Figure 4-17). The date from TP2-6 (Beta- 141684) is significantly earlier than the dates from one level above and one level below. Based upon similarities in ceramics (Maria Masucci, personal communication, 2000), the dated material from TP2-6 is likely intrusive. The early occupation of MV-C2-4k probably dates to the same time period as the midden from MV-C2-4f. The midden at 4k accumulated later than the midden at MV-C2-4f, however. Note that the radiocarbon samples came from the lowest three levels of 4k. Carbon from the upper four levels was not tested because of concerns about intrusive modern carbon.

Three dates from MV-C2-4n are internally consistent. The other, from TP1-4 (Beta-141685), clearly should be more recent than the samples stratigraphically below it, but is not. This suggests that this is an aberrant date. The lowest levels of TP1 at MV-C2-4n clearly post date the midden from MV-C2-4f and hence, may be contemporary with levels of floors above the midden. Ceramics also suggest that MV-C2-4n was deposited after MV-C2-4f, although this midden was probably created relatively quickly. MV-C2-4n is the only part of the site included in this analysis that could potentially date to the Period B (A.D. 1150-1400). The material from MV-C2-4n certainly dates to the early part of Period B.

4.1.4. Sample

As a part of a preliminary study for this dissertation, I studied the lithics and shell beads, as well as some other artifacts that were in the specials bags, from all three of the excavations mentioned above. Counts and weights were recorded for general lithics, lithic microdrills, obsidian, and shell beads (Table 4-2). These were compared to the volume of excavated soil. I standardized the counts of lithic microdrills, beads and obsidian by both volume excavated and by general lithics (i.e., all chipped stone artifacts except obsidian and lithic microdrills). By doing this, I was able to compare the three excavations and show that MV-C2-4k had many more lithic microdrills and beads than the other two locations which had approximately the same amount when standardized.

For the detailed analysis, I recorded the information discussed in Chapter 7 and analyzed in Chapter 8. Due to intrusive features in B3 and B4 as well as time limitations, a detailed inventory was not recorded for these units. Units B1, B2, B5, and B6 probably best represent the MV-C2-4f excavations. All of the beads from MV-C2-4n are included in this analysis. At total of 571 shell beads and 2 beads of other materials were analyzed from Loma de los Cangrejitos (Table 4-3).

4.2. Puerto de Chanduy (MV-C2-3)

4.2.1. Background

Puerto de Chanduy is a small fishing community on the eastern side of the estuary at the mouth of the Zapotal River (Figure 4-1). It overlooks the ocean just to east of Punta Chanduy, which forms a small bay. Bushnell mentions a site at Real/Puerto de Chanduy, but indicates that the remains are “scanty and of doubtful age” (Bushnell 1951:95). His reason for doubting the age of the site, however is that he saw Guangala and Manteño materials mixed, which made it ideal for Masucci’s study of the transition from Guangala to Manteño. Estrada mentions excavations carried out by himself and by Betty Meggers and Clifford Evans at Puerto de Chanduy and gives some of the ceramic types found. Though he clearly believes this is a Huancavilca (a.k.a. Southern Manteño) site, he says little else (Estrada 1979:21-22, 67-80; see also Meggers 1966:Plate 4).

4.2.2. Excavation- MV-C2-3a

While excavating at Loma de los Cangrejitos (MV-C2-4f), Masucci was informed of new erosional damage to the Puerto de Chanduy site, which she had visited in 1996. Knowing that the site had already been severely damaged by the construction of a modern road, Masucci decided to investigate. After viewing the damage, she decided that the best course of action was to obtain a sample of the site, since it was in grave danger and since artifacts eroded out of the side of the midden suggested that the site dated to a similar time period as Loma de los Cangrejitos. Therefore, Masucci, along with Franklin Fuentes and excavators from El Azúcar, began an excavation at the site.

Because little time remained in the field season, excavation at MV-C2-3a was fairly rapid. Two contiguous units were excavated, A6 and A7. The upper 80 cm appeared to be mixed due to the presence of modern artifacts, including plastics. Therefore, the top three layers were excavated in fairly large chunks and very rapidly retaining only selected bones and ceramics. At 80 cm, excavators slowed continuing more carefully while remaining mindful of time constraints. Beyond 80 cm, excavations attempted to follow the natural stratigraphy, but often continued in arbitrary 10 cm intervals and then in 20 cm intervals as the end of the work season approached. The extremely high density of fish bones slowed excavation. It was decided that only A7 would be excavated to sterile. From approximately 60 cm (levels A7-3 and A6-3), all material was screened through stacked ¼ and ⅛ inch screens except for the last two levels (A7-23 and A7-24) because the excavation unit began filling with water. This was a very difficult excavation to carry out within a single week and hence, the material between the different levels is probably mixed. However, it does appear that most of the material came from continuous, though perhaps seasonal, use of the site as the ceramics are relatively consistent and the radiocarbon dates are as consistent as they can be.

4.2.3. Dating

The radiocarbon dates from Puerto de Chanduy (MV-C2-3a) are more internally consistent than those from Loma de los Cangrejitos (Figure 4-5, Figure 4-17). These dates suggest that the midden at Puerto de Chanduy was initiated at around A.D. 1000. Recall that excavation of the lowest levels was halted due to the incursion of water, so cultural deposits may have gone even deeper. The most recent date from A7-7 suggests that it was deposited some time between A.D. 1300 and 1400. It is quite likely, therefore that Puerto de Chanduy was mainly in use during Marco’s Period B, though there is definitely overlap with Period A and, perhaps, with the early part of Period C as well.

4.2.4. Sample

The sample of artifacts from Puerto de Chanduy is not unbiased. This was a relatively quick excavation and some material may have been lost. However, since Masucci was aware that the shell artifacts would likely be used for this dissertation, special attention was paid by the excavators to the collection of shell beads. Therefore, although the excavation was rushed, it is likely that this sample is comparable to that from Loma de los Cangrejitos. The top 80 cm was mixed and little, except diagnostic artifacts, was retained. Therefore, this analysis concentrates on the levels below 60 cm (i.e. level 4 and below). A total of 792 shell beads and 37 other beads were analyzed (Table 4-3).

4.3. Mar Bravo (MV-A3-362)

4.3.1. Background

The site of Mar Bravo (MV-A3-362) is located on the southern coast of the Santa Elena Península and, as such, is near the northern extreme of the Gulf of Guayaquil (Figure 2-1 and Figure 4-6). It sits on a high dune just beyond high tide line along a coast which is known for being fairly tumultuous (hence the name Mar Bravo, i.e., 'fierce or strong sea'). Behind the site lie extensive salt drying ponds of the Ecuadorian national salt company, Ecuasal. The prehistoric inhabitants of the site would have been nearly surrounded by water: the ocean to the south and a large estuary to the north. It is difficult to know the prehistoric characteristics of the estuary and, therefore its uses. It may have been used for salt drying as it is today and/or held large quantities of life, such as waterfowl, fish and mollusks. The estuary may not have been mangrove, which is common in the area, because common mangrove species such as *Anadara tuberculosa* and *Cerithidea pulchra* are absent (Stothert and Carter 2000:12). Since aridity is especially high at this location on the Santa Elena Península, it is likely that the inhabitants were mainly concerned with the ocean, which is confirmed by extensive evidence of fish and shellfish collection and use (Sánchez Mosquera ms).

The site was originally located by Bushnell, who mentions a site he calls Buena Clama (Bushnell 1951:118, Figure 1). This name, however, has gone out of use and the name of the general area has been applied. This may have been a site identified by Lanning as "No.123, en Punta Carneiro" since it is the closest site to Punta Carneiro. Stothert identified the site as OGSE-362 (Stothert 1980), which under current standards translates into MV-A3-362. The site is currently limited to the east by the road to La Libertad and the Ecuasal building to the west (Stothert and Carter 2000). Currently, the site is almost completely covered by laboratories where shrimp larvae are grown.

4.3.2. Excavations

In June of 2000, Stothert was approached by the owner of one of the laboratories, G, C y F Marino. He stated that burials had been found and also showed her some artifacts. As he was planning on building another structure over one of the last remaining sections of the site, he asked if she would like to excavate. Stothert recruited the present author, who was in the area for reconnaissance research at Loma de los Cangrejitos, to assist and from June 26-30. Stothert and the author, along with local excavators from El Azúcar (Emilio Mejillones, William Jagual, Luciano Jagual, Alfonso Merejildo and Luis Merejildo), two archaeology students staying with Stothert, and Kathleen Carter all excavated an area (MV-A3-362a, a.k.a. sector A) 24 m^2 to varying depth. Stothert, along with local assistants and her students, continued the excavation after the author's planned departure.

In 2001, Stothert returned to the site, with a financial support from the Foundation for Exploration and Research on Cultural Origins (FERCO), and excavated sectors B, C, D and E. While these sectors varied in their material composition, they are still considered mainly the results of domestic activities. One of the main features was the ever-present clay floors. These floors could be up to 40 cm thick in central areas located on the top of the dune and extend up to 10 m towards the sides where the floors are much thinner. Across the site, but especially in Sector A there were levels of very dense deposits of fish scales and other levels of dense deposits of a small gastropod, probably *Ceritheum browni*, which dwells in intertidal sands and rocks.

Overall, the site represents a late prehistoric and post-Contact occupation by the people who used the material culture known as Manteño. While the different sectors of the site do have different features and, therefore, may represent different functions, the presence of general refuse in all areas also suggests that most of the artifacts are probably from general household waste.

4.3.2.1. Sector A (MV-A3-362a)

The matrix was extremely sandy, making deep excavations difficult. It was composed mainly of millions of bones, most of them fish (98+% by NISP and 80+% by MNI; Sánchez Mosquera ms) as well as large quantities of the mollusk *Cerithium* sp. (Stothert and Carter 2000:11). A series of yellow clay floors were also encountered and a few adobe blocks, but mainly the excavation consisted of ashy and sandy midden. Because of the short time available for the excavation of the site, only a portion of each excavation level was screened through stacked ¼ and ⅛ inch screen. The excavators, however, were the same as worked at Loma de los Cangrejitos and were well aware of my interest in small shell beads, so all efforts were made to recover these thereby minimizing, though not eliminating, a potential bias against small beads. Features recovered in Sector A include the yellow clay floors, dog burials, secondary burials, a variety of pits filled with clean sand or midden debris, an overturned large pottery urn used as an oven and other features of unknown purpose (Stothert and Carter 2000).

4.3.2.2. Sector B (MV-A3-362b)

Sector B is a low-lying area that revealed evidence of activities near the estuary, which may have been the area in which boats were beached. Features located within the c. 25 m^2 sector included “shallow cultural deposits consisting of thin layers of refuse, thin clay floors, post holes, ashy hearths, an infant burial, several carefully sealed pits, a well that penetrated through bedrock to reach the water table, and a very elaborate grave” (Stothert 2002:2). Stothert also noted a higher frequency of Spondylus shell margins in Sector B (Stothert 2001:9).

4.3.2.3. Sector C (MV-A3-362c)

Sector C contained a series of yellow floors placed upon an elevated section of the site. Features associated with this sector include an infant burial, dog burials, urn burials, post holes in the floors, ovens made from pottery vessels, fire pits and many pits filled with either clean sand or refuse and perhaps including offerings. The floors tend to occur later in the occupation of the site, after substantial midden had accumulated, and may indicate a conversion of the use of the site (or of the sectors excavated) from habitation to mixed habitation and ceremonial. Some of the lined pits were arranged in a line suggesting organization of storage features (Stothert 2002).

4.3.2.4. Sectors D and E (MV-A3-362d and 362e)

Excavation in sectors D and E were more limited, but revealed patterns similar to those found in other areas. Sector D was to be one of the main areas excavated during the 2001 season, but prior to excavation, the municipality of *Salinas* purchased the plot and leveled it for a parking lot. Stothert was able to excavate a small area and recovered ceramic ovens, a multiple secondary burial, pieces of the yellow floor, post holes, lined pits, and midden similar to the other areas (Stothert 2002).

4.3.3. Dating

Stothert has indicated that the ceramics from the site suggest an occupation late in the Manteño (or Libertad; Paulsen 1970) sequence (Stothert and Carter 2000:17, Stothert 2001:3). The presence of green glass beads, including one attached to a copper ring, at a depth of approximately 50 cm suggests that the site was occupied well into the sixteenth century. Radiocarbon dates tend to indicate, however, that the major occupation occurred just prior to the historic period (Figure 4-8, Figure 4-17). Of the eight dates obtained for Mar Bravo, seven of them cluster very tightly between approximately A.D. 1275 and 1450 (see Figure 4-8). The one earlier date comes from the same level (MV-A3-362a, H10-11, Level 4) as one of the glass beads, indicating possible mixing of contexts. Dates from the levels above and below Level 4 are equivalent (corrected, but uncalibrated date= 530+/-60 BP). All of this suggests a fairly consistent and relatively short occupation of the site between A.D. 1300 and 1550. Glass beads and other Spanish artifacts suggest, however, that the site continued to be occupied after the arrival of the Spanish. Therefore the dates should probably be extended to approximately A.D. 1600. It must be noted, however, that this is a fairly large site (C. 300 m by 50 m) and artifacts that probably date to early time periods are present at the site, but were not recovered in our excavations.

4.3.4. Sample.

All beads, drills and associated material from excavations at Mar Bravo were analyzed. The main bias from the excavation of the site is the fine screening through 1/8 inch mesh of only a sample of matrix. This may have biased the sample against small artifacts. It is extremely important to note that small beads were no more likely to be present in the screened sample than in the unscreened samples, however, suggesting that screening practices may not have directly affected the beads sample. A total of 2084 beads were analyzed from the excavations at Mar Bravo and an additional 37 beads of other materials (Table 4-3).

4.4. Los Frailes (OMJPMH-101 to OMJPMH-113)

4.4.1. Background

The archaeological site of Los Frailes lies just to the south and slightly to the west of the modern town of Machalilla. It is bordered on the east by the road to Puerto López and on the west by a rise that forms a point extending out into the ocean (Figure 4-9). The site extends to the south and includes four earthen dams before encountering large hills. One hundred meters to the north lies a shallow semi-circular bay that is the current home to Machalilla’s fishing industry. Today, the archaeological site and Los Frailes beach are included within the Machalilla National Park (Mester 1989, 1990, 1992).

Initially, Emilio Estrada located a site called Crucitas in the approximate location and dated it to a phase between Guangala and Manteño (Mester 1990:52-3). Ann Mester relocated the site, preferring the name Los Frailes (The Monks) after the nearby beach. Survey in 1982 was followed by excavation in 1984-5 as a part of her dissertation (Mester 1990). She identifies different portions of the site by different numbers, including OMJPMH-101 through OMJPMH-113. The site contains a series of low (1-1.5 m high), rectangular mound platforms in distinct groups, numerous walk-in wells and *albarrada*s (described as annular or U-shaped earthworks by Mester 1990:57).

4.4.2. Excavations

Mester's work focused upon the excavation of mound A within the sector of the site designated 108. The coding she used, therefore designates this excavation as OMJPMH-108A. She also excavated a midden (labeled OMJPMH-108F) approximately 50 m from 108A (Mester 1990:87). Excavations at 108A included areal excavations, Cuts 1 and 2 (i.e., OMJPMH-108A1 and 108A2), and vertical excavations to reveal stratigraphy, designated Cuts 3, 4 and 5 (108A3, 108A4 and 108A5). This yielded an exposure of 44.5 m^2. The majority of the excavation was a series of floors and trenches pertaining to various construction episodes. Other features included a burial within a bell-shaped pit, a bell-shaped storage pit, and a 'workshop' pit. The excavation at OMJPMH-108F measured 2m by 2m (Mester 1990).

A workshop, located within a large pit in 108A2, is the focus of Mester's discussion about shell working (Figure 4-10). This pit is quite unusual; its vertical walls are excavated into the sandstone bed rock to a depth of four meters and it is approximately four meters in diameter. Most 'Manteño" pits are bell-shaped pits, two of which Mester also located. Mester believes that the pit was originally excavated as a well, which are common in the area both archaeologically and ethnographically. The pit was filled in with 20 cm of intentionally deposited soils lacking artifacts and approximately then 50 cm of artifact-rich material. Then a structure was built within the subterranean pit. Mester has determined that there were three phases of use within the pit, each of which involves numerous floors and are probably separated by major remodeling. Lastly, another phase of use represents a non-subterranean structure that utilized the pit as a foundation. Many of the floors within the structure were clean of artifacts while wall trenches around the edges contained many artifacts. Many of the mother-of-pearl artifacts recovered at the site are from the 'workshop'; of the 298 mother-of-pearl artifacts recovered at the site, 145 (48.7%) were from the workshop, including 72 plaques and 40 other artifacts made from *Pteria sterna* (Mester 1990: Table 5.28, Appendix B) and 33 artifacts made from *Pinctada mazatlantica* (Mester 1990: Appendix B) were from the workshop. Mester indicates that within the workshop she recovered "significant numbers" (Mester 1990:178) of mother-of-pearl shells showing cut marks or grinding, and "pearl shell plaques in <u>all</u> stages of manufacture and the tools to work the raw shell" (Mester 1990:177). Other than mentioning lithic microdrills, Mester does not provide data about the nature of the tools associated with mother-of-pearl artifact production.

4.4.3. Dating

Los Frailes appears to date to about the same time period similar as Loma de los Cangrejitos. The error for the dates reported by Mester (Mester 1990:Appendix C) is much larger than those from the three sites already discussed, on the scale of 100 years versus ~50 years making dates difficult to compare directly (see Figure 4-11). Although Mester discounts the date from MH108A4/862 as an outlier (Mester 1990: Appendix C), it may be that, like the top levels at MV-C2-4f at Loma de los Cangrejitos, it is a date for a later occupation. Because much of the workshop stratigraphically precedes the construction of the mound (Mester 1990:83), it is quite possible that the mounds were not built until slightly later than the construction of the subterranean workshop (at somewhere between A.D. 800 and 1000). Although the radiocarbon dates are difficult to interpret due to their large error, the construction of the site seems roughly similar to Loma de los Cangrejitos with an early phase topped by a later one that is composed of relatively clean floors which accumulated to build low mounds.

It should also be noted that, based upon the radiocarbon dates and the associated ceramics, Los Frailes is probably not the Tuzco described by a native captive and reported in the Samano-Xerez Relaciones (Mester 1990:17; Samano 1844 [1526]). Tuzco would have been an active community at the time of contact and there is no solid evidence for occupation at Los Frailes into the Contact Period.

4.4.4. Sample

Unfortunately, the sample of artifacts from Los Frailes is problematic. Many of these artifacts have lost their provenience and can only be attributed to Mester's excavation. Mester provides a summary catalog of shell artifacts from Los Frailes that includes the mother-of-pearl artifacts and the shell beads, but since her measurements are fairly rough (to the tenth of a centimeter) the artifacts could not be securely matched with the catalog descriptions. Non-shell artifacts were not cataloged by Mester. For this reason, all artifacts (any shell or shell-related tools), except the especially numerous and well-studied mother-of-pearl artifacts, were catalogued once again.

Mester she indicates that 78 Spondylus beads were recovered (Mester 1990:173-177; see Table 5.27, Figure 5-2 and Figure 5-4). However, I have analyzed a total of 86

Spondylus beads from the site. Mester reports that more than 20 microdrills were recovered from the site and I have analyzed 35. Because of a lack of provenience for each artifact, it is unclear why this discrepancy exists. Even with these incongruities, Los Frailes is included in this sample because it provides a comparative sample for Loma de los Cangrejitos, where Spondylus bead production was so important. It should be realized, however, that of all the samples, this one can be interpreted with the most limited reliability.

4.5. López Viejo (OMJ-PLP-15)

4.5.1. Background

López Viejo lies within the modern town of Puerto López (Figure 4-12), one of the largest fishing communities in southern Manabí. It sits high upon a hill in the middle of the town. The range of coastal hills is set slightly further back from the ocean in this area, meaning that Puerto López is much drier than Salango (see below), located one small ridge to the south.

The site of López Viejo was first mapped in 1979 (Nurnberg et al. 1982) and excavations were carried out at the site (Figure 4-13), but these were not published. This changed with the research conducted by Elizabeth Currie in the 1990's (Currie n.d., 1995a, 1995b, 2001).

4.5.2. Excavations

Research at López Viejo was carried out by Elizabeth Currie with the assistance of Ecuadorian archaeologist Freddy Acuña in six field seasons from 1992 to 1999 (Currie 1995a, 1995b, 2001). When the site was originally mapped in the 1970's, much of the site remained intact. More than one hundred stone structures were identified within a 16 hectare area (Figure 4-13). Much of this is now covered by modern occupation, but the remains of the site can be seen eroding out of many ditches and erosion channels. It is quite likely that even in the 1970's much of the lower reaches of the prehistoric town had been destroyed. Currie and Acuña focused their excavations on the southern edge of the site that remained relatively intact in the 1990's. In particular their efforts concentrated on an irregularly shaped mound that contained four large deep pits. While the pit in Trench C yielded the remains of 24 to 32 individuals, the other pits, in Trenches A, E and G revealed no human interments (Figure 4-14). The size of the pits is not given, but a profile of the pit in Trench C (Currie 2001: Figure 8) suggests that the pits were a couple of meters in diameter by around three to four meter deep. These pits are not thought to have been constructed as storage pits. Based upon the presence of large ceramic vessels that were probably broken immediately before deposition and the recovery of large quantities of items not usually found in middens, it is unlikely that these pits were used as middens (Currie 2001:71). A more appropriate interpretation may be that these pits represent ceremonial activities that involve feasting and the offering of special objects. The pits cut into a 60 cm layer of ash that was capped with clay forming the base of the mound.

4.5.3. Dating

Currie (2001) indicates that the excavations at López Viejo represent an occupation between the late 12th century and the first half of the 13th century A.D. (i.e., c. A.D. 1150-1250). Unfortunately, there are no radiocarbon dates from the two contexts considered herein, F and I. Figure 4-15shows three radiocarbon dates from López Viejo, but the context of these is unclear. Only one of the radiocarbon dates, from near the base of pit C, has been published (UB-4322; Currie 2001:79). The other two dates were obtained directly from Queens University Belfast (James J. McDonald, personal communication 2007): the associated context numbers, compared to those reported by Currie (2001), seem to indicate that the samples came from pits A (UB-4321) and E (UB-4320) The majority of the data considered herein is from Trench F, but its proximity to and similarity to the other excavations indicates that they are generally contemporaneous. Radiocarbon dates, therefore, suggest that these remains were deposited at around AD 1200-1250.

At López Viejo, Currie indicates that the pits were stratigraphically later than the mounds, while at Los Frailes, Mester has determined that the construction of the workshop pit preceded the construction of the mound. Considering the dates, it is possible that much of the data from Los Frailes and Loma de los Cangrejitos precede Manteño mound construction and the material from the pits at López Viejo post date the initiation of mound construction (c. A.D. 1000 to 1150). The dating of Trench I is unclear, but this material is presumably from midden deposits from the occupation of the mound and therefore also from approximately AD 1200-1250.

4.5.4. Sample

Ecuadorian archaeologist Freddy Acuña assisted the author in the retrieval of the sample from the store rooms of the Museo Salango and to the best of our knowledge all of the shell beads, lithic microdrills and other associated artifacts recovered from both Trench I and Trench F are considered in the present analysis. A total of 2828 shell beads, 460 lithic microdrills and 252 associated artifacts were examined for this study

4.6. Salango 140 (OMJPLP-140)

4.6.1. Background

It would be an interesting anthropological study to investigate how the tiny town of Salango became so important in discussions of Spondylus procurement and trade. The modern village of approximately 1400 people sits in a small valley one ridge to the south of the larger López Viejo (Bauer 2007). Large hills rise up on both sides of the small alluvial terrace upon which the town sits. This means that the area surrounding Salango is much wetter and greener than even Puerto López (e.g., Harris et al. 2004). The village sits just above the high tide line and the focus of much of modern day life is the ocean, as it most likely was prehistorically. Salango Island, to the south of the town provides a fairly well sheltered bay.

The site in the present study, OMJPLP-140, is located on the lower reaches of the hill on the southern edge of the town (Allan 1989; Norton et al. 1983). The northern edge of the site is occupied by the grounds of a modern fish processing factory. The other main site OMJPLP-141 has received much more attention than the site discussed herein (Lunniss 2001, 2006; Norton et al. 1983).

4.6.2. Excavation

In 1979, when the excavation team working on La Plata Island returned to Salango, they placed a test pit in OMJPLP-140. A single week allowed only three arbitrary 10 cm levels to be excavated. When a team returned in March 1980, the site was partially destroyed by the removal and leveling of material in order to construct auxiliary buildings for the fish factory. Parts of the site had been bulldozed and, although a variety of cleaning and mapping attempts were made, the main excavations were in units 18-21m

W/ 6-8m N, excavated to bedrock in order to understand the stratigraphy and dating of the site, and 21-24m W/ 4mS-4mN, in order to collect more data (Allan 1989).

The stratigraphic unit, 18-21m W/ 6-8m W, was excavated to a depth of over 3.5 m using cultural stratigraphy for the first 11 levels, or the first two meters, but time considerations limited the excavation of the next eight layers to arbitrary levels.

A series of burials, including one of a Spaniard, was recovered from the site, but these have not yet been published.

This site has been considered a specialist workshop site since the 1980's, when information about it was initially published (Norton 1986; Norton et al. 1983). The terraces of site 140 were seen as a supplemental part of the Manteño occupation at OMJPLP-141, the more famous of the Salango sites (Lunniss 2006, 2001). The Manteño occupation of 141 has not been published, however. The main reason for the interpretation of the site as an area of specialized Spondylus processing is "the large quantity of large shells in all strata. Within this material, Spondylus calcifer cores with the margin removed predominate, followed by *Spondylus princeps*, *Pinctada mazatlantica*, *Ostra grandis*, *Strombus peruvianus* and *galeatus*, *Malea ringens* and other species with lower frequencies" (Norton et al. 1983:65, my translation). In the post-Contact levels the margins of Spondylus hinges had not been removed, but all of the pre-Contact Spondylus hinges lacked their margins. No data are provided to support this statement, but Allan (1989) indicates that unmodified Spondylus was represented by 15 whole valves (i.e. both hinges) and 88 hinges (weighing a total of 11.2 kg) of *Spondylus* from 0-2mN/21-24mW and 65 hinges (weighing 5.1 kg) from 2-4mS/21-24mW (Allan 1989: Table 6). He does not indicate from which levels these shells originate, but that most of this excavation probably dates to post-Contact. He also reports worked Spondylus (Allan 1989: Table 7) and does include levels (Table 4-4). The amount of worked Spondylus is small and the amount of whole valves and hinges is large in 2-4mS/21-24mW and 0-2mN/21-24mW. In the excavation of 6-8mS/18-21W, most of the fragments of Spondylus listed by Allan (1989: Table 5) are from levels 8 (40 fragments of *S. calcifer* and 30 fragments of *S. princeps*) and 11 (3 fragments of *S. calcifer* and 35 fragments of *S. princeps*). It is unclear if Allan's fragments are cores or any type of fragment. It is impossible that all of these are cores for that many cores would take up a vast amount of space. Level 8 is a 10 cm thick ashy layer and Level 11 is a 35 cm thick level composed of a white floor containing many pits. It seems unlikely that 70 cores would have fit into a 10 cm layer, even if it does cover six square meters. Also, cores are listed as specials (1989: Table 7), but not a single core is given for 6-8mS/18-21mW. If the fragments from 6-8mS/18-21mW are not all cores, then the data do not support the hypothesis of a differentiation between pre-Contact and post-Contact occupation of the site. Indeed, with no actual numbers given for Spondylus cores, it is difficult to address the hypothesis at all.

The status of OMJPLP-140 as a Spondylus workshop is unclear. It is uncertain how many Spondylus 'cores' with their margins removed were even present at the site. The identification of ovens for making lime at OMJPLP-140 may also suggest that shells were brought to the site to be calcined, not for artifact production (Norton et al. 1983:67).

4.6.3. Dating

The upper levels of the site, due to extensive burning and disturbance of the midden during a time of upheaval most likely after Spanish contact, are difficult to interpret. The middle levels are seen as dating to the prehistoric Manteño phase and the very bottom levels, reached only in 18-21m W/ 6-8m W, have some evidence of earlier occupation, in levels 14-19 (Allan 1989: section 8.1). No beads, a single lithic microdrill and a single cataloged object from these levels are studied herein, lessening the likelihood that the artifacts studied were from non-Manteño contexts. Therefore, all of the material is related to the Manteño occupation. Based upon the presence of Spanish artifacts, glass beads, a lead ball and iron fragments from 2mN-4mS/21-24mW suggests that this area dates to some time after Contact.

Although five radiocarbon dates were obtained for this study, descriptions of their contexts have been lost (Figure 4-16, Figure 4-17). As a part of my work in Ecuador in 2004, I scanned all of the notes for the excavations of OMJPLP-140 present at the Salango Museum. A hard drive crash accompanied by the corruption of the back-up CD destroyed all of these scanned images, leaving me without good context descriptions for the radiocarbon dates. Only five carbon samples were available from the collections. All of these were dated, but were not chosen for their ability to address chronological issues at the site. It is surprising, therefore, that these dates are relatively consistent, falling between AD 1300 and 1600. The majority of the artifacts discussed herein date to the circum-Contact period, perhaps as early as the fourteenth century, and certainly post-dating contact.

4.6.4. Sample

It is unclear how complete the sample is from Salango 140. No records could be found regarding the original number of beads and other artifacts that have been cataloged for the current study. A total of 1290 shell beads, 34 other beads and 24 microdrills were analyzed. An additional 254 artifacts were catalogued (Table 4-3). While some artifacts may be missing, based upon field notes , it is probable that the majority of the shell beads, lithic drills and other artifacts are included in this analysis. Unfortunately, since the scanned excavations records have been lost due to a hard drive crash, context by context analyses are difficult with this set of data.

Phase	Dates	Location	Burial Type	Spondylus	Axe money	Other
A	900-1150 A.D.	Near end of ridge	rectangular	Beads and various other artifacts	Large size	Shell working tools Carved bone points
B	1150-1400 A.D.	Closer to ceremonial area	Boot-shaped shaft tomb	Only beads	Small size in packets of 20	
C	1400- 1600 A.D.	Over Phase A burials at near Phase B burials	Burial mound with some cremations	Absent	Some small in early burials.	

Table 4-1. Phases of occupation identified by Marcos (1981) at Loma de los Cangrejitos.

	Area			
	MV-C2-4f	MV-C2-4k	MV-C2-4n	Total
Lithics (n)	3812	1602	658	6072
Lithics (w)	4165 g	1334 g	1168 g	6667 g
Drills (n)	358	213	42	613
Drills (w)	117 g	45 g	9.9 g	172 g
Beads (n)	249	309	97	655
Beads (w)	16 g	13 g	5.7 g	35 g
Obsidian (n)	315	79	24	418
Obsidian (w)	69 g	13 g	8.1 g	90 g
Volume excavated (m^3)	5.70	1.40	1.20	8.30

Table 4-2. Lithics, beads, lithic drills, obsidian and volume excavated at Loma de los Cangrejitos.

	Shell Beads	Other Beads	Lithic Microdrills	Cataloged artifacts
Loma de los Cangrejitos	571	2	444	21
López Viejo	2828	9	460	252
Los Frailes	86	12	35	76
Mar Bravo	2084	37	24	105
Puerto de Chanduy	792	37	9	18
Salango (140)	1290	34	24	254
Total	7651	131	996	726

Table 4-3. Total number of shell and other beads, lithic microdrills and cataloged objects analyzed for this dissertation by site.

Sector	Level	Description of worked Spondylus
0-2S/21-24W	2	"Spondylus princeps with coloured edges removed."
2-4S/21-24W	4	"8 Spondylus princeps & calcifer with the coloured borders removed"
	4	"Piece of cut Spondylus princeps"
	6	"Piece of worked Spondylus calcifer"

Table 4-4. Worked shell from OMJPLP-140, Salango, from Allan 1989.

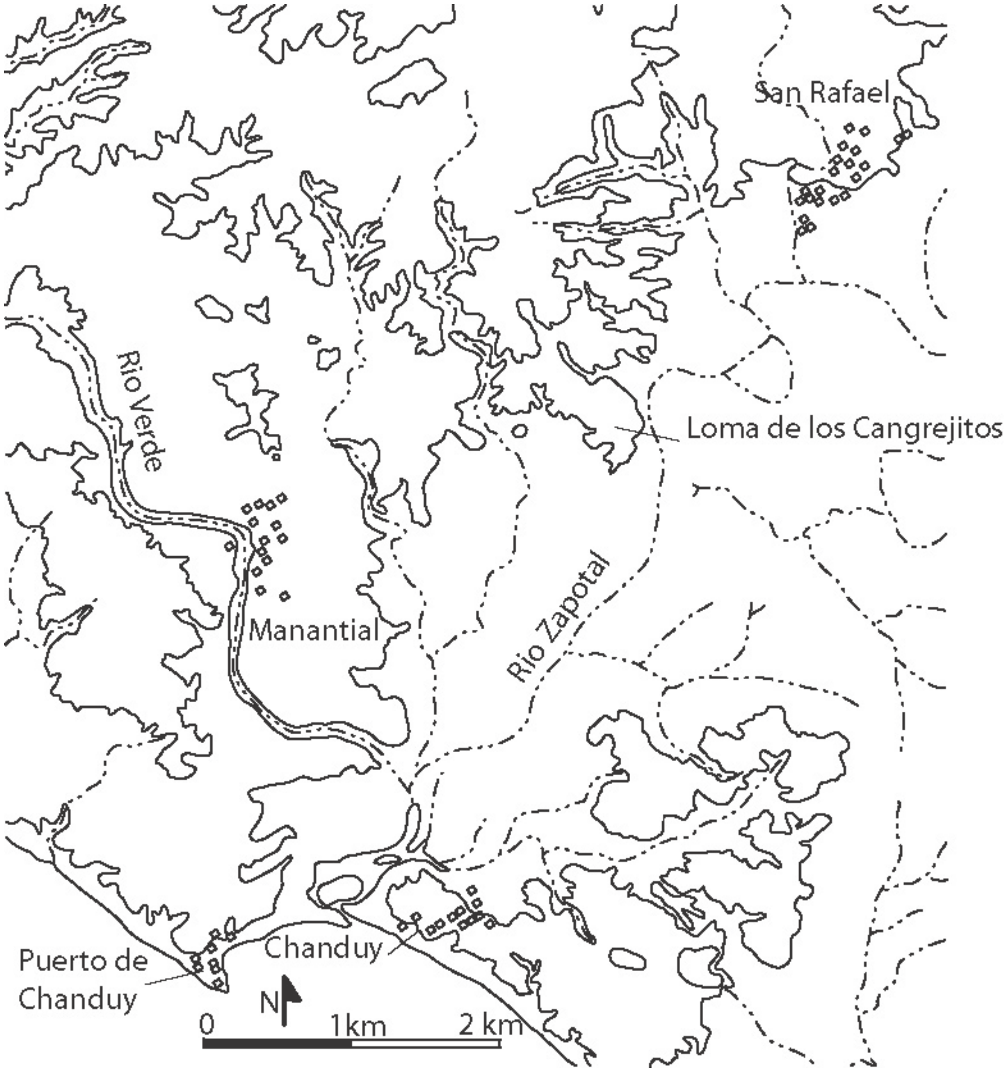


Figure 4-1. Location of Loma de los Cangrejitos and Puerto de Chanduy.

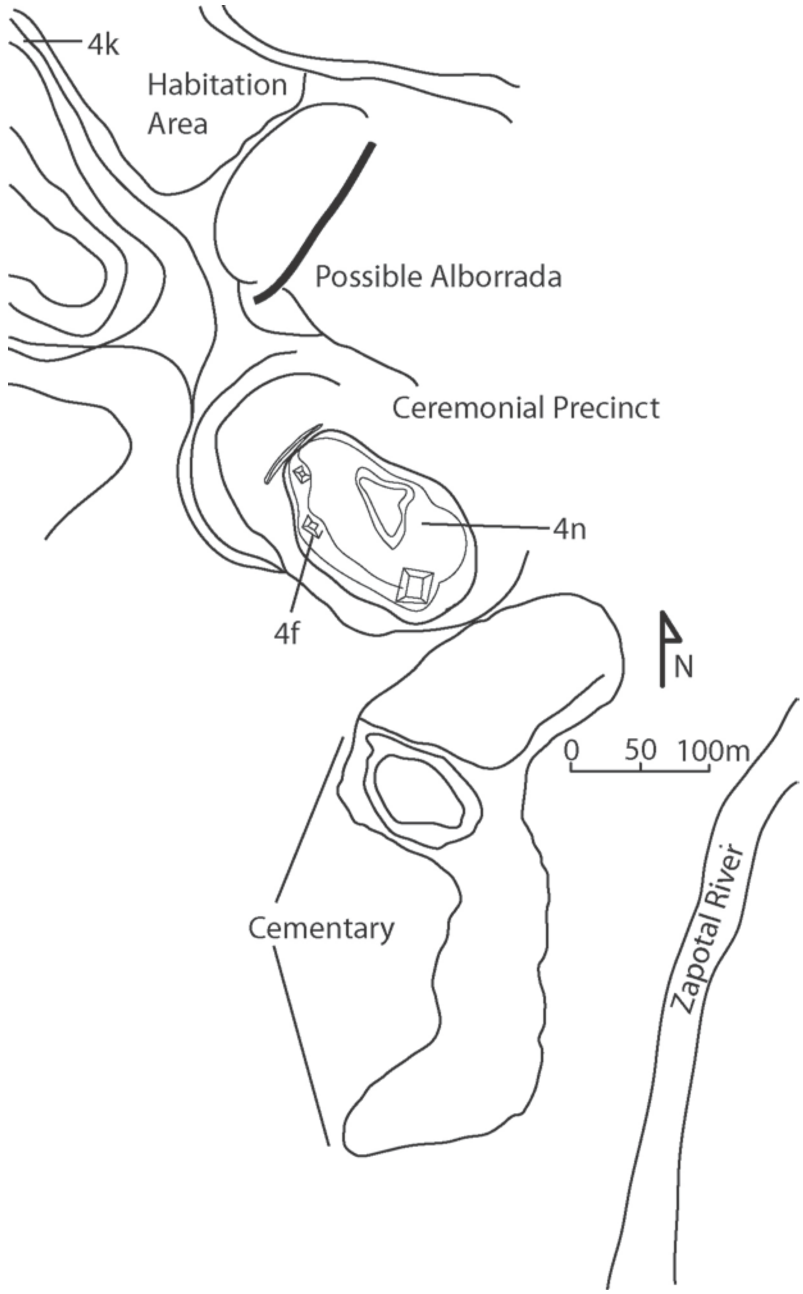


Figure 4-2. Sketch map of Loma de los Cangrejitos. Redrawn from Marcos 1981.

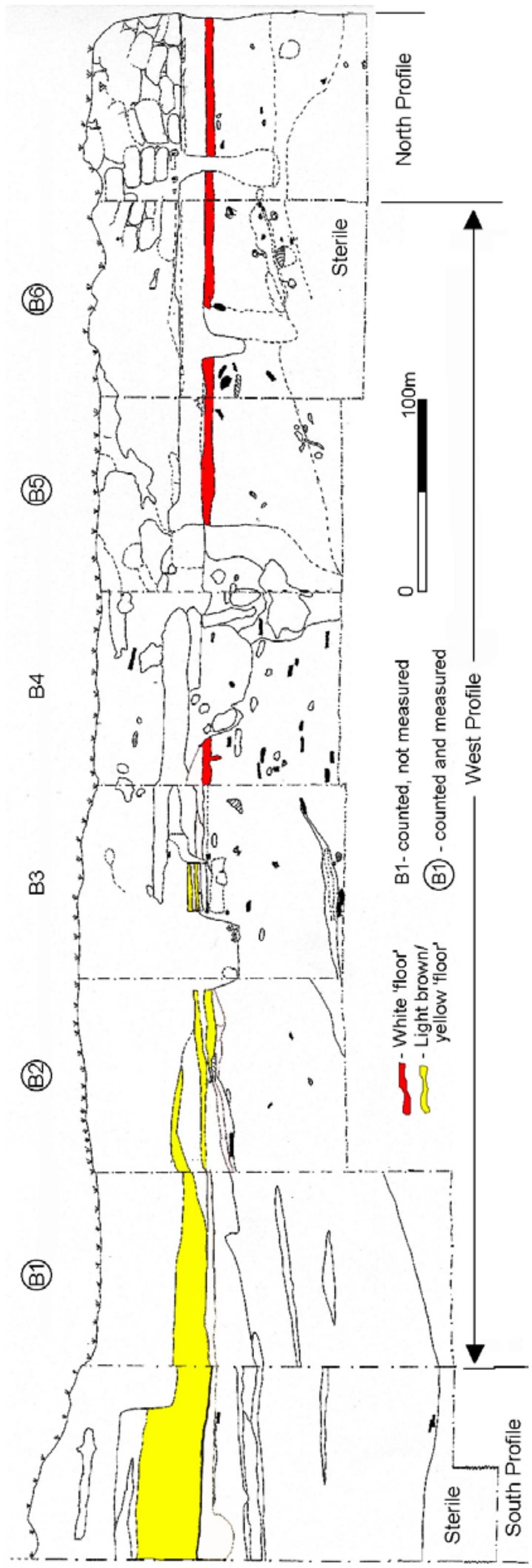


Figure 4-3. West profile of MV-C2-4f indicating the white and yellow floors and the midden beneath.

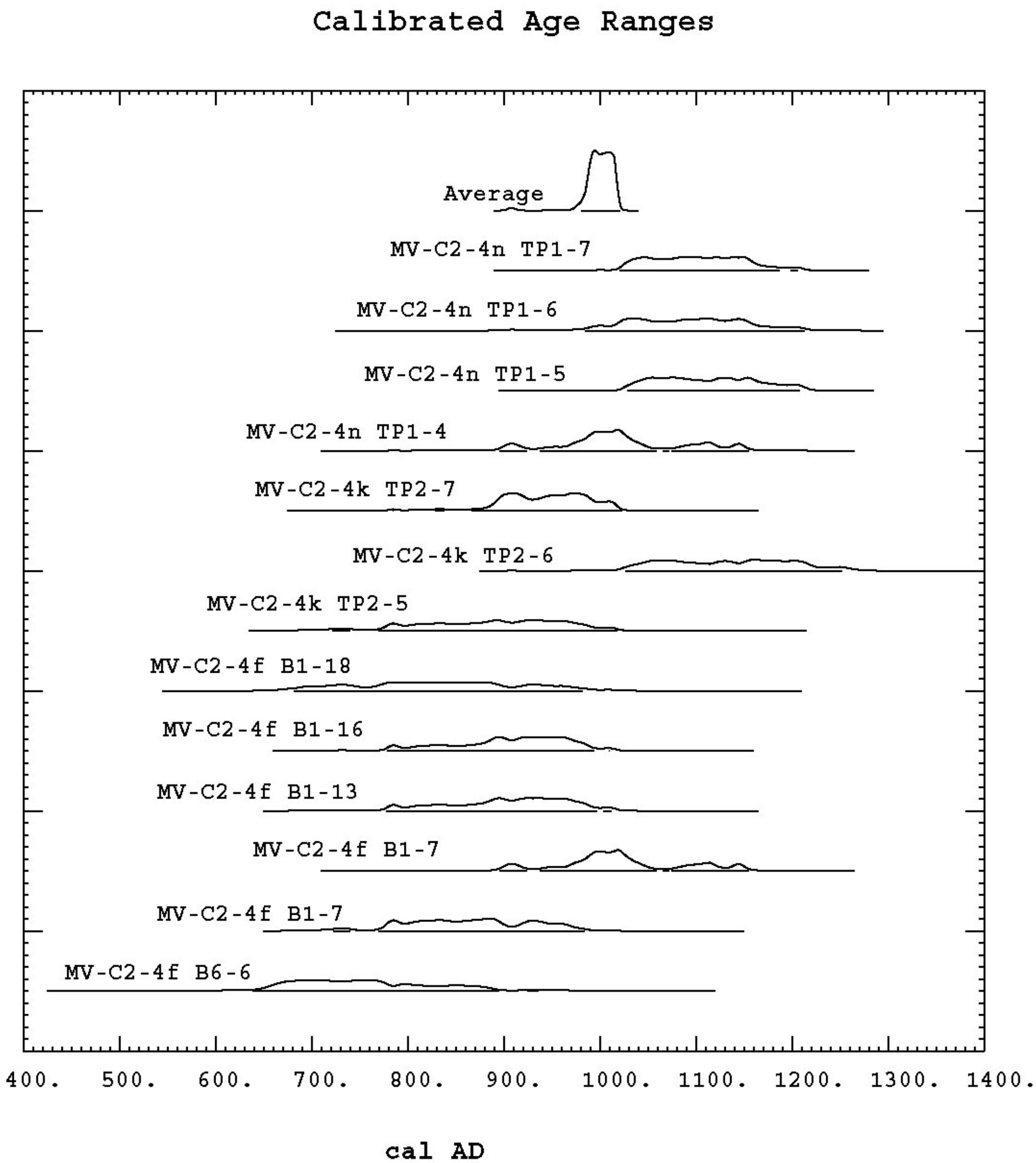


Figure 4-4. Calibrated Radiocarbon dates for Loma de los Cangrejitos, showing probability distribution (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

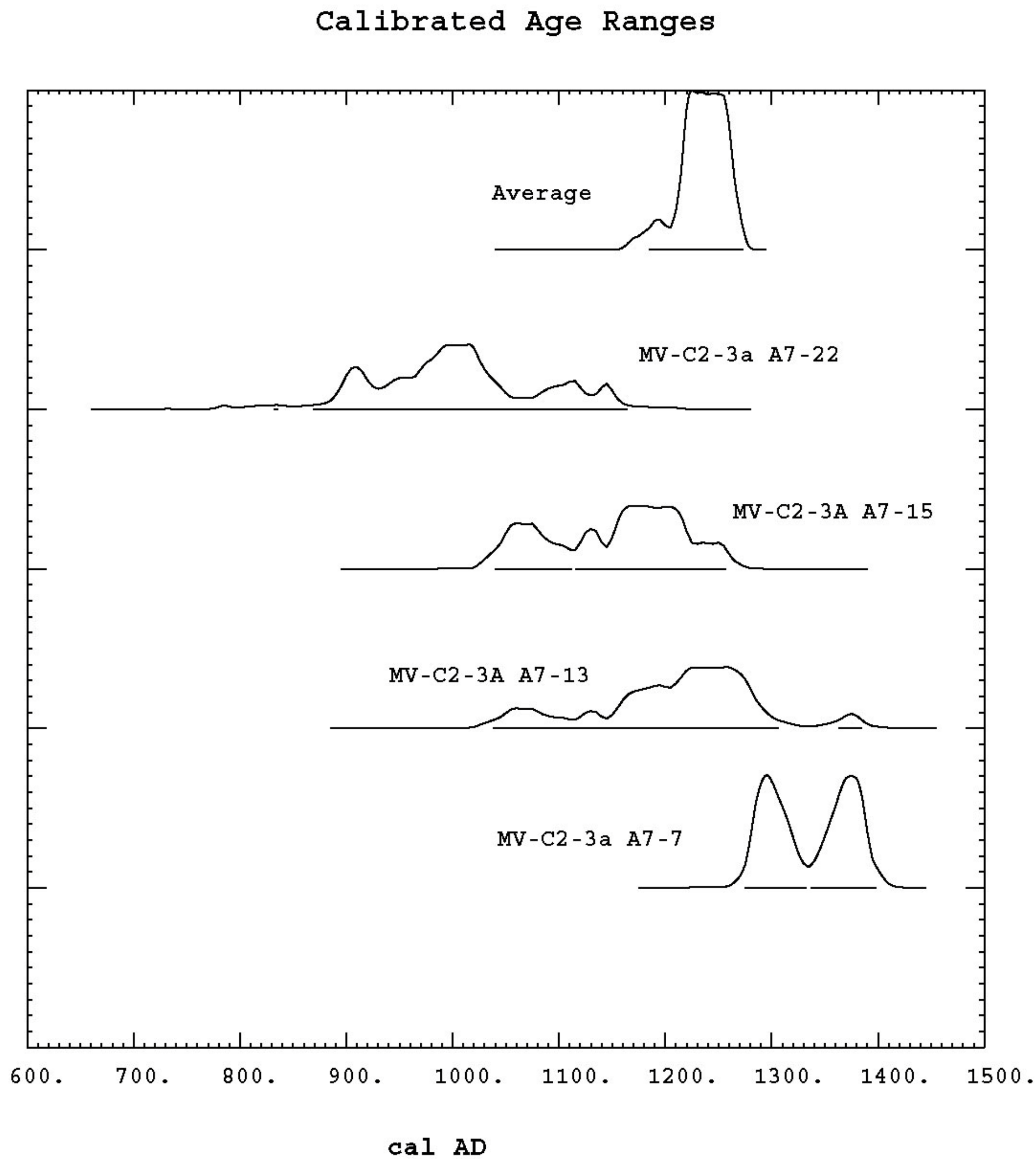


Figure 4-5. Calibrated Radiocarbon dates for Puerto de Chanduy, showing probability distribution. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993)

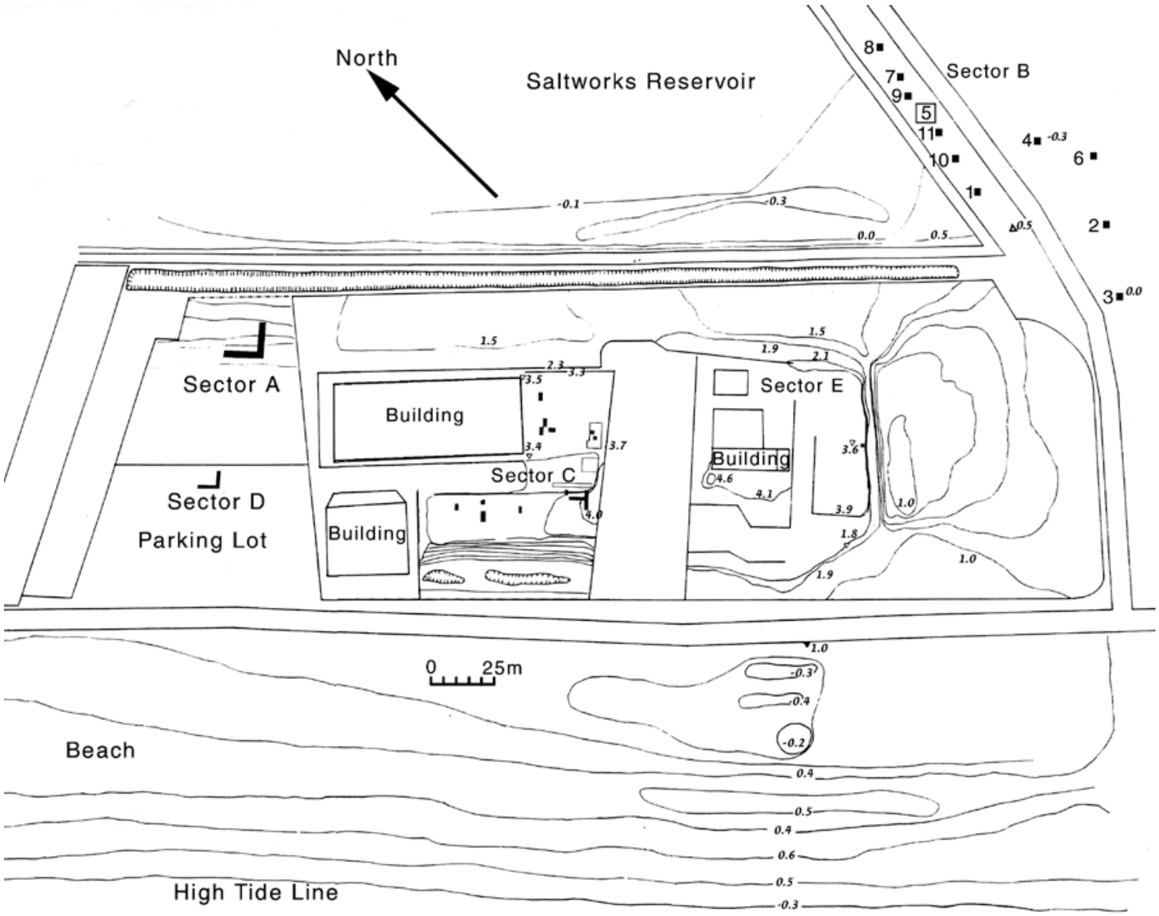


Figure 4-6. Locations of Excavations at Mar Bravo. Drawn by Franklin Fuentes for Karen Stothert.

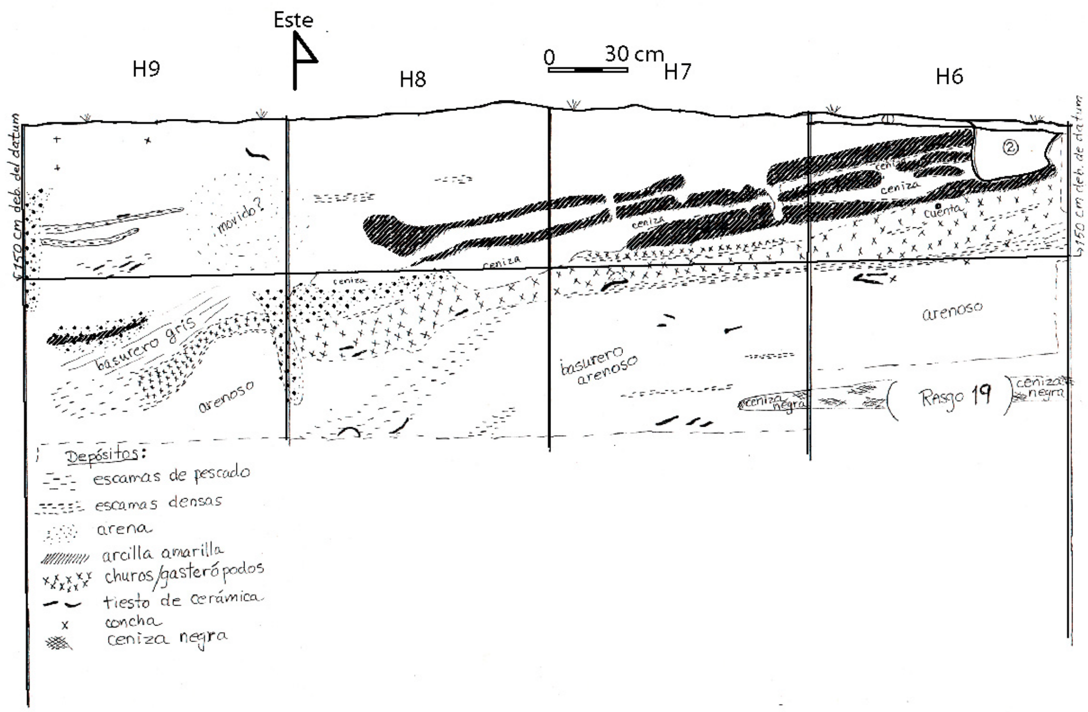


Figure 4-7. Eastern profile of the excavation in Sector A, showing the yellow floors, layers of fish scales and layers of gastropods. Courtesy of Karen Stothert.

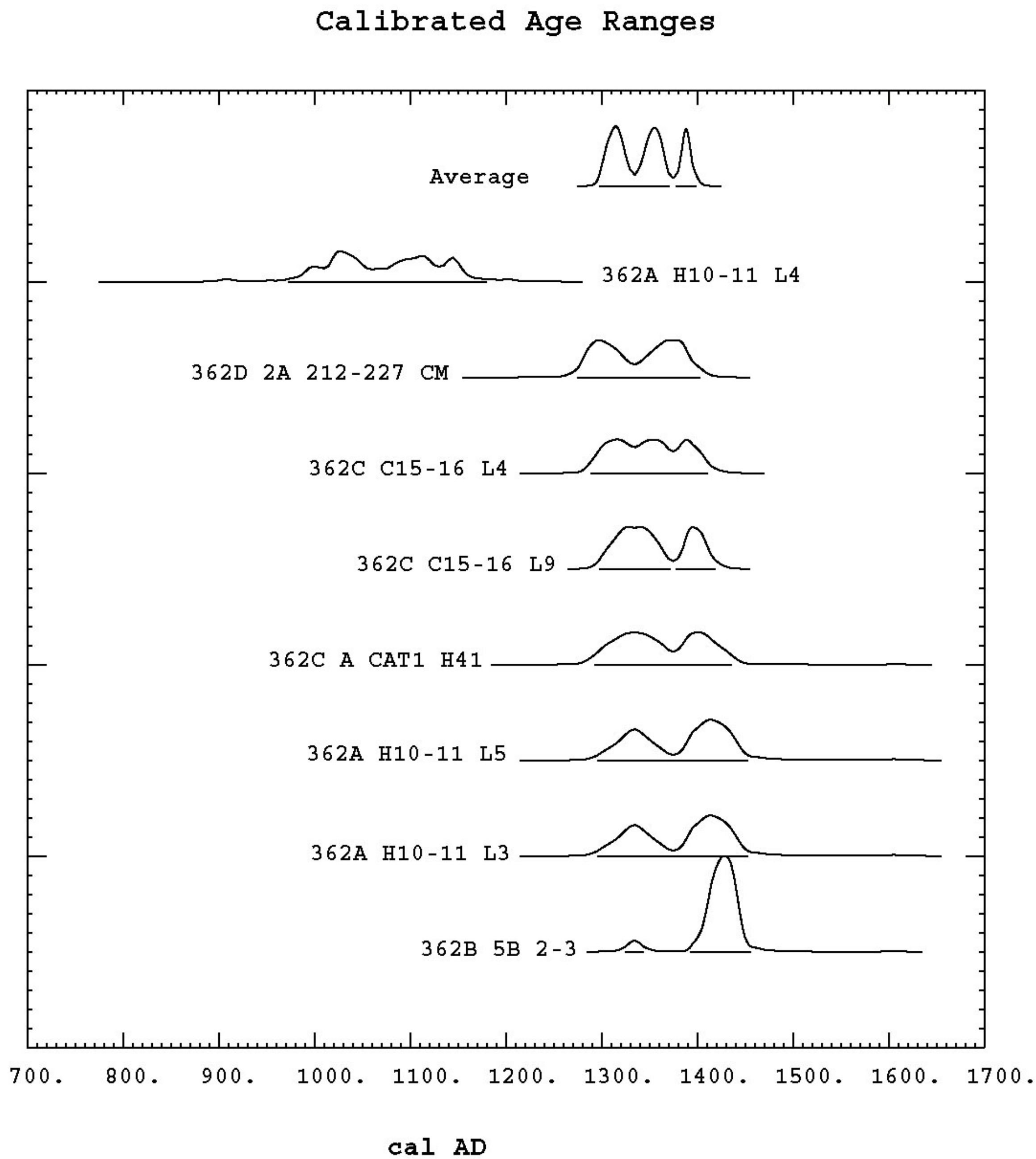


Figure 4-8. Calibrated Radiocarbon dates from Mar Bravo, showing probability distribution. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

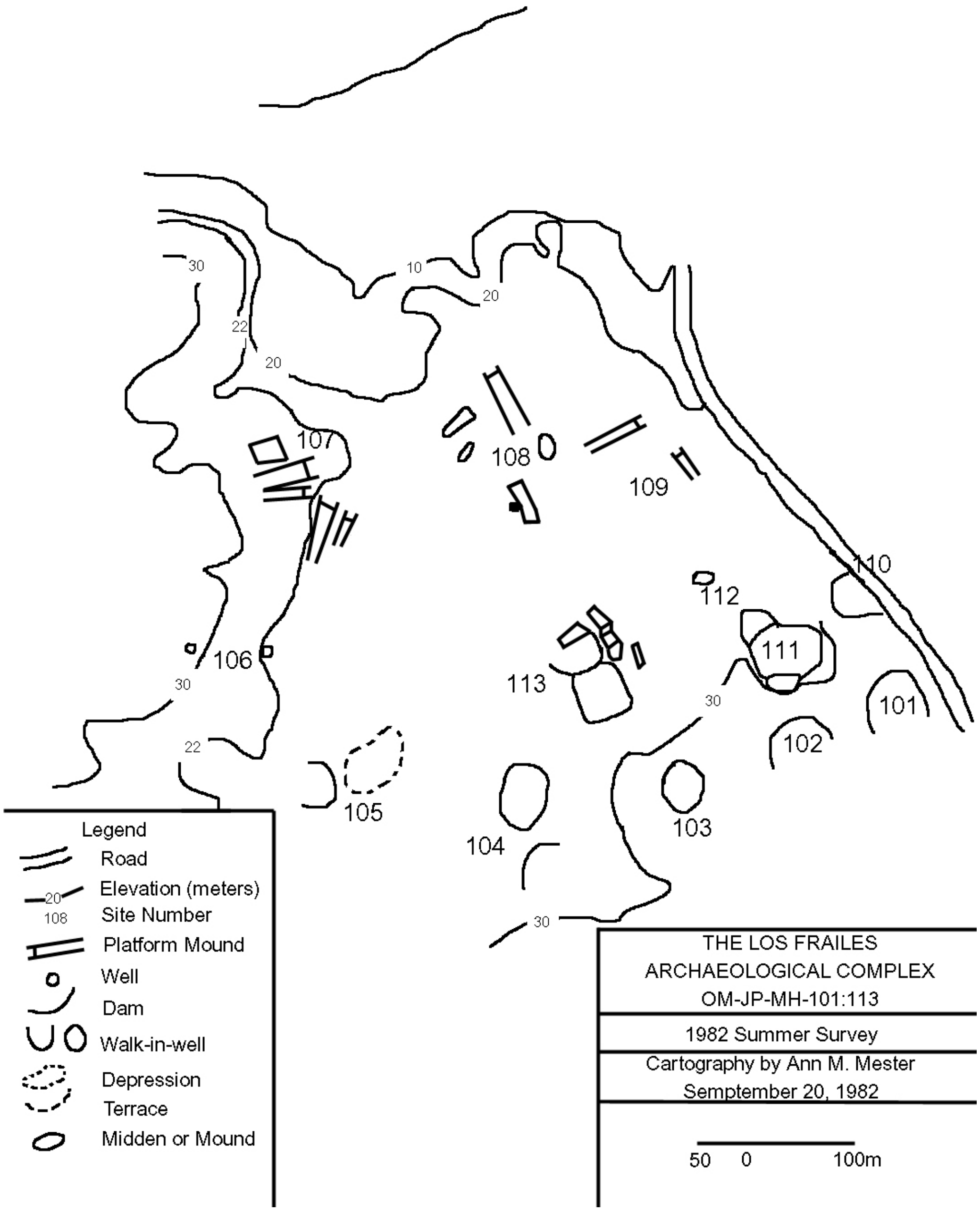


Figure 4-9. Sketch map of Los Frailes. Redrawn from Mester 1992: 331.

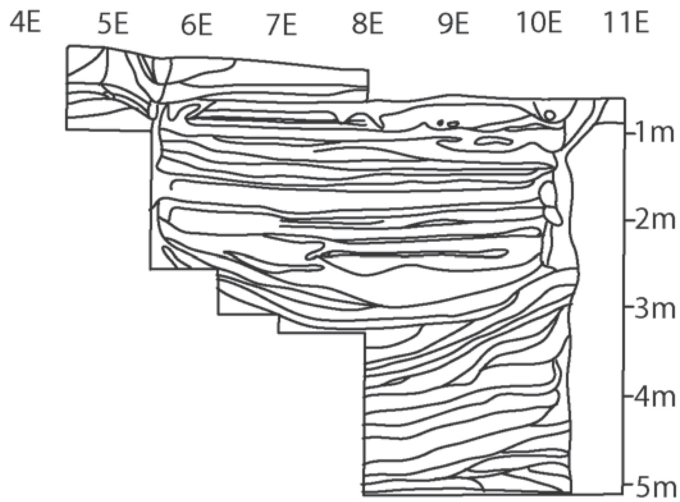


Figure 4-10. Eastern Profile of the subterranean workshop. From Mester 1992: 331

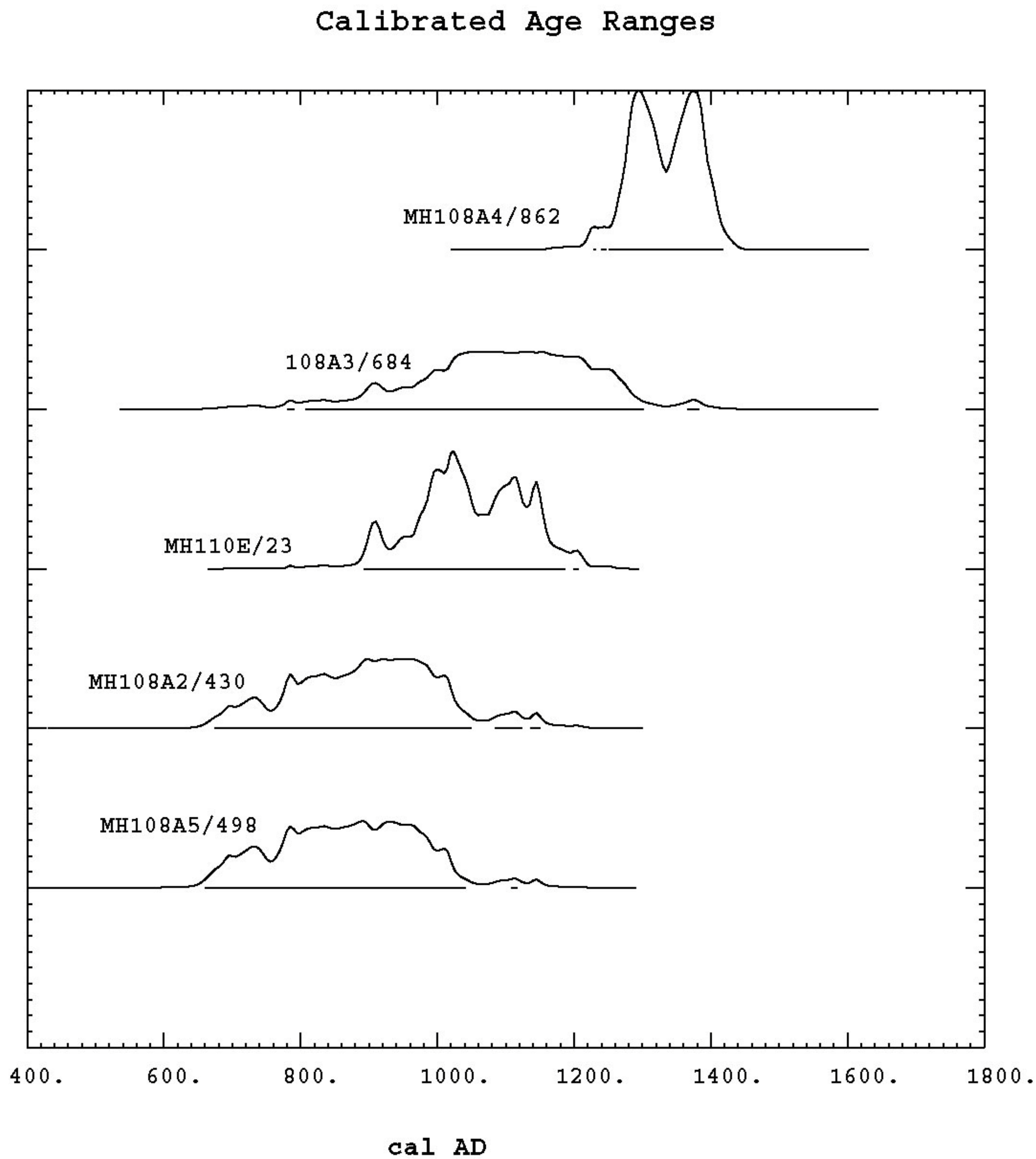


Figure 4-11. Calibrated Radiocarbon dates from Los Frailes, showing probability distribution. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

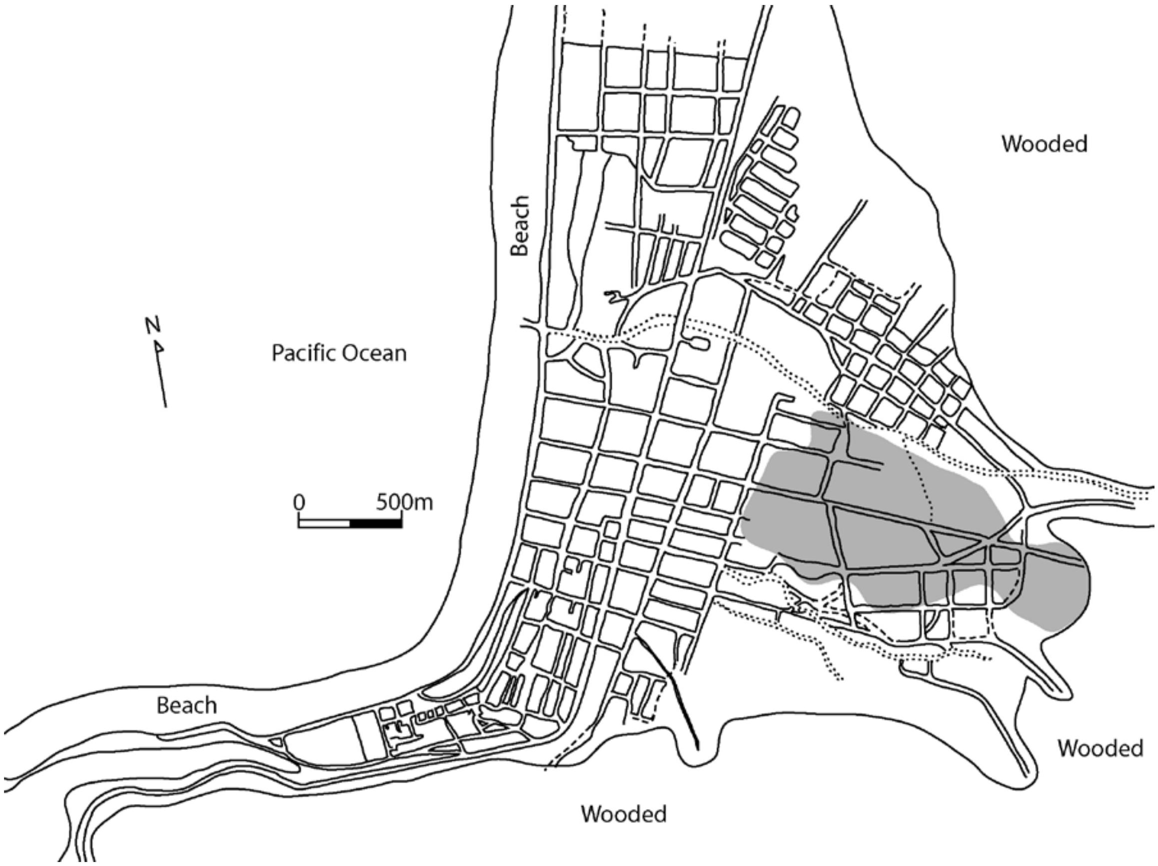


Figure 4-12. Map of modern Puerto López, showing the location of López Viejo as the shaded area in the central right of the map. From Currie 2001: Figure 2.

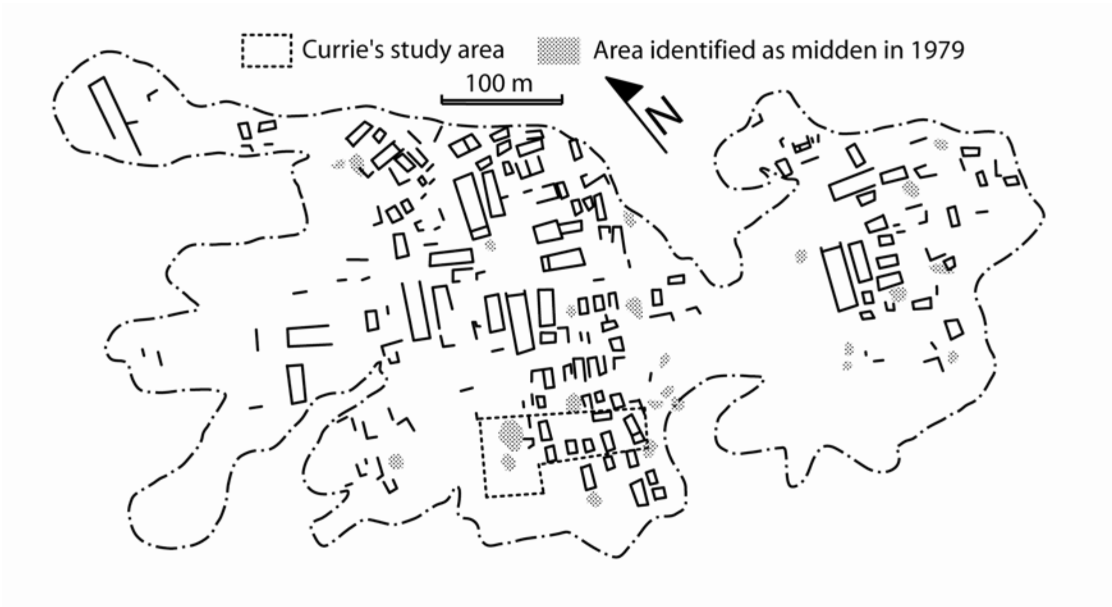


Figure 4-13. Map of López Viejo. From Currie 2001: Figure 3.

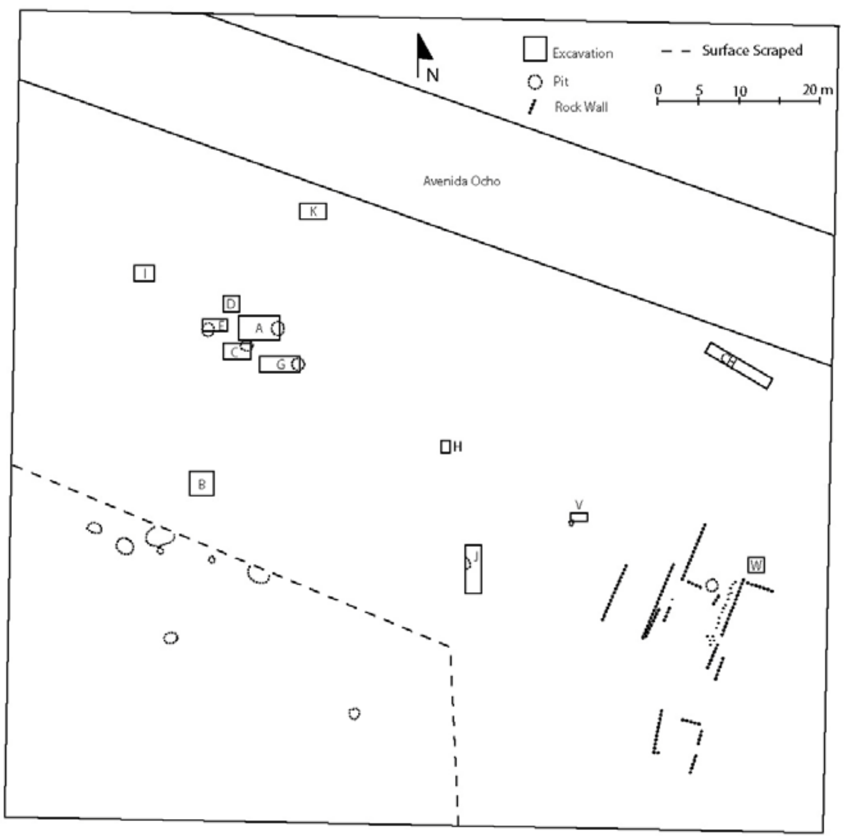


Figure 4-14. Map of excavations at López Viejo, showing the location of the two excavations analyzed for the present study, G and I. From Currie 2001: Figure 4.

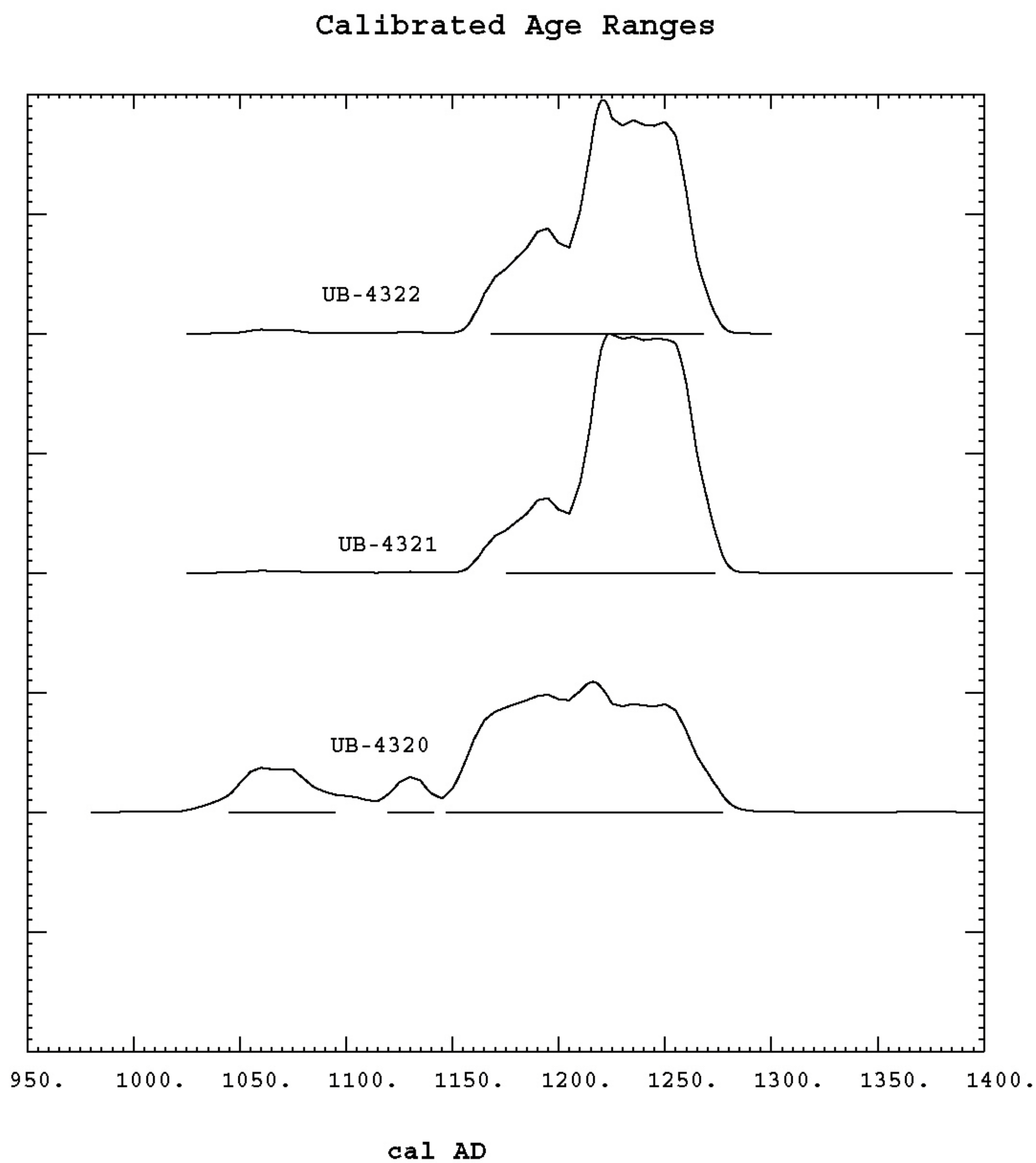


Figure 4-15. Calibrated Radiocarbon dates from López Viejo, showing probability distribution (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

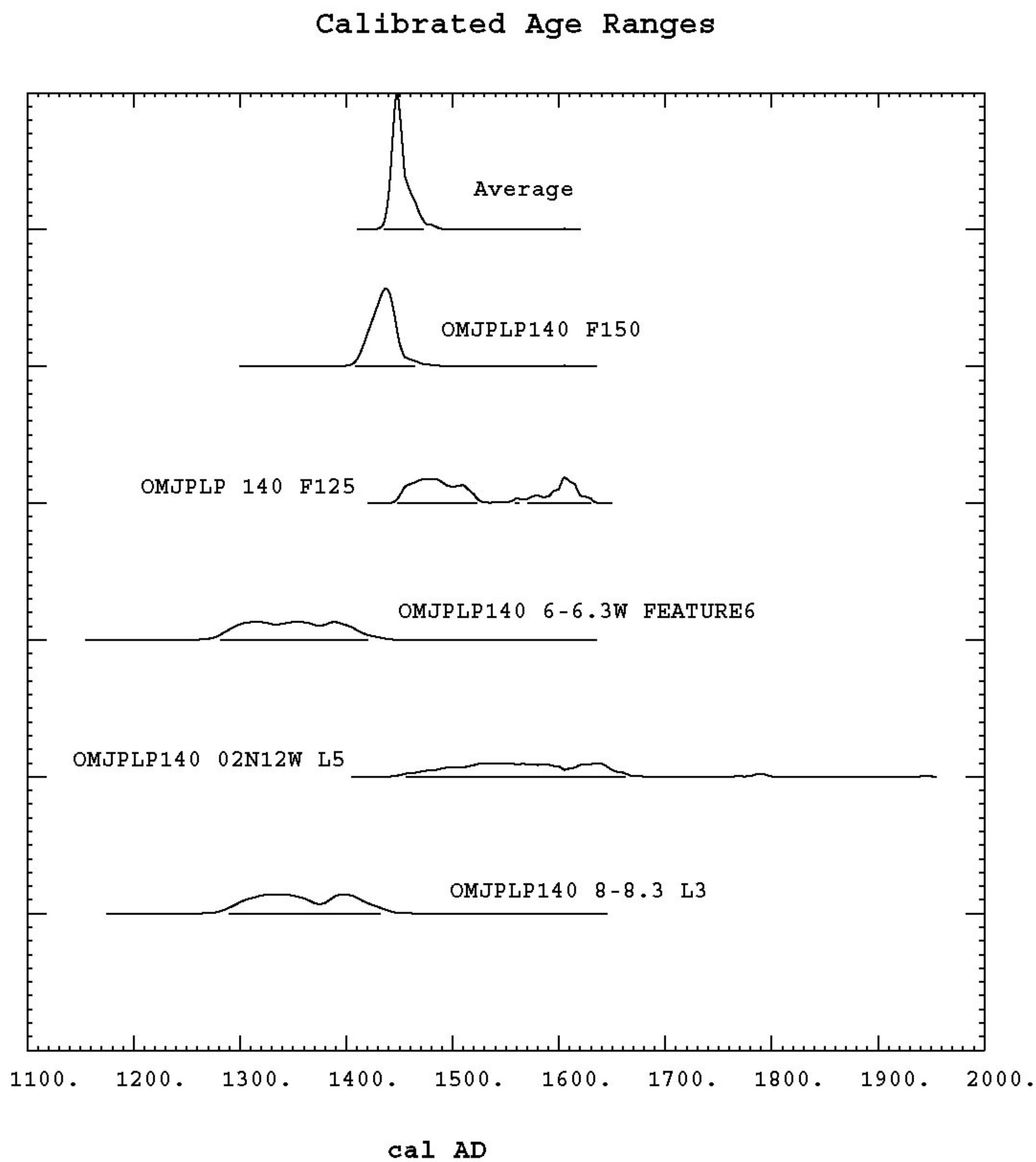


Figure 4-16.Calibrated Radiocarbon dates from Salango, showing probability distribution (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

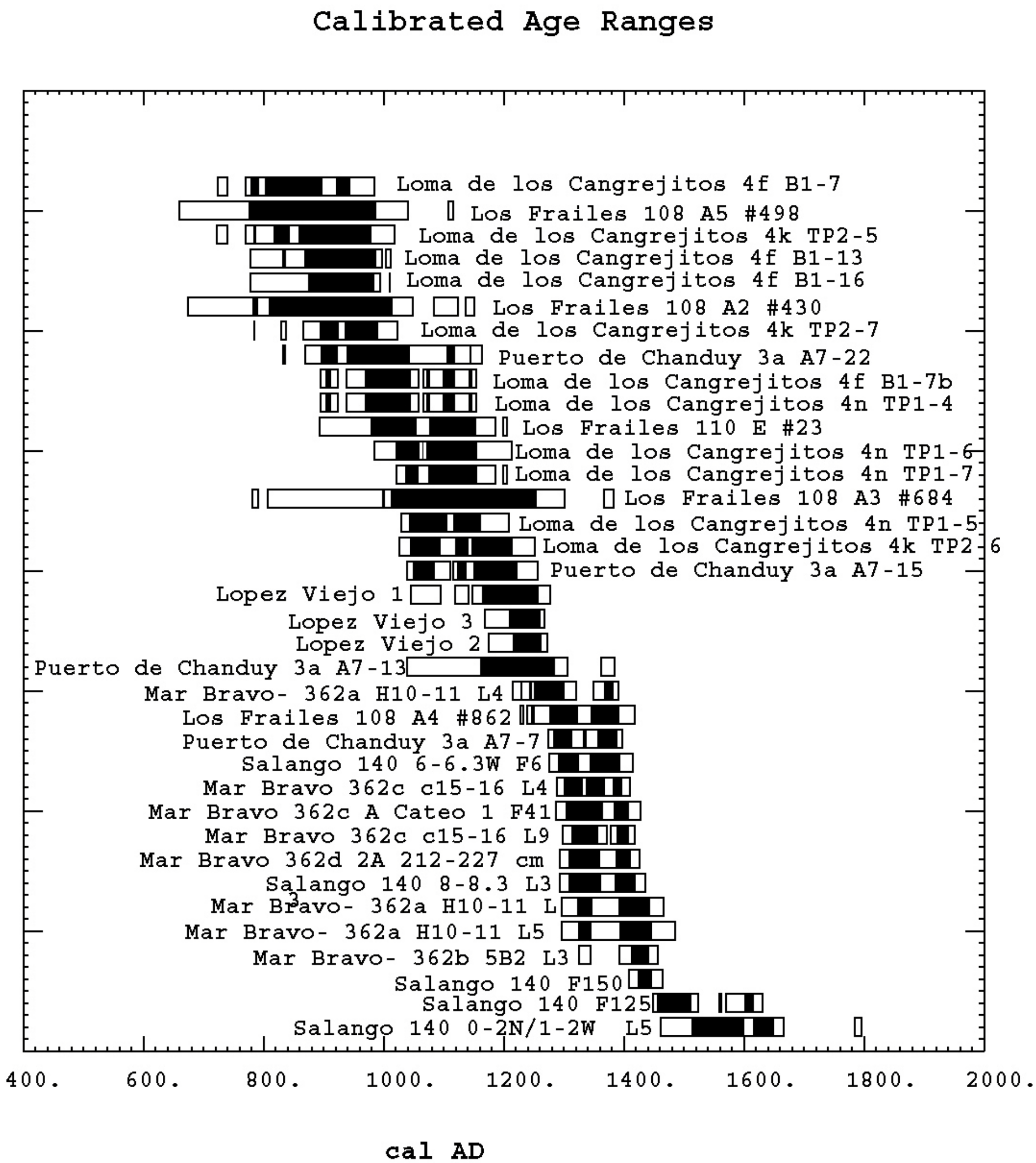


Figure 4-17. Calibrated radiocarbon dates from all six sites studied for this dissertation. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

Chapter 5. The Life and Times of the Thorny Oyster, *Spondylus* sp.

As indicated in the introduction, Spondylus played important roles for many cultures of western South America. Much of the basic biological and ecological information about Spondylids is still limited today even though it entered the archaeological spotlight over 30 years ago. To remedy this, I update both biological and archaeological histories of this valued shellfish.

5.1. Animal

The following presents, first, an updated discussion of the basic biology of Spondylus and, secondly, two ecological issues crucial to the archaeological interpretation of Spondylus in South America. The first ecological issue is that archaeologists often state that Spondylids were recovered from great depths by specialized divers. Recent information suggests that they may be available in shallower waters, though knowledgeable divers may have been needed for other reasons. The second ecological issue is that it is often stated that the southern limit of its natural range is Ecuador. The Gulf of Guayaquil is often cited as the line in the sand. This means that any Spondylus located in Peru must have come from Ecuador, thereby establishing the antiquity of trade between the two modern nation states. Old and new evidence strongly argues for the presence of Spondylids in waters more than 100 km south of the Ecuador-Peru border.

5.1.1. Basic biology

The term Spondylus refers to the marine bivalves in the family Spondylidae (a.k.a., Spondylids) that includes a single genus, *Spondylus,* and over 90 species scattered throughout the tropical waters of the world, including the Eastern and Western Pacific

Ocean, Eastern and Western Atlantic Ocean, the Indian Ocean, the Gulf of Mexico, and the Mediterranean Sea (Healy et al. 2001; Lamprell 1987; Lamprell and Dekker 2001; Lamprell et al. 2001a; Lamprell et al. 2001b). In many of these regions, prehistoric and modern people have used Spondylus for mainly non-utilitarian purposes, especially as personal ornamentation (Akira 1987; Allen et al. 1997; Halstead 1993; Malinowski 1984; Shackleton and Elderfield 1990; Séfériades 1994; Weisler 2001).

The family Spondylidae and genus *Spondylus* are defined as:

> Family Spondylidae. Medium-sized to large shells, strongly sculptured with spinose radial ribs; auricles small; without byssal notch; shells attached to substrate near the umbo of the right valve. Genus Spondylus Linnaeus, 1758. Muscle scar large, posterior to center of shell; cardinal area of hinge larger in right valve; ligament deeply sunken in a triangular pit. Adult with two crural ridges adjacent to the ligament. (Keen 1971: 96)

Spondylids are distinct from other bivalves because most of the species live cemented to a hard substrate by their right (lower) shell, not via the more common fine, very strong threads (called byssus) utilized by some stationary bivalves (e.g., mussels; contra Pillsbury 1996:318). Spondylidae also have unique hinge teeth that form ball and socket joints rather than the more common toothed format, which makes the two valves very difficult to separate without breaking one (Waller and Yochelson 1978; Yonge 1973). These bivalves have another uncommon feature: eyes (Davidson 1980, 1981). Few other bivalves, mainly the closely related Pectinidae, have pallial eyes, which probably serve as sensors to detect predators so that the valves can close before the soft parts are in danger (Dakin 1928; Yonge 1973:182). Spondylids often have long distinctly colored spines covering the exterior of the shell. Colors are most often very vibrant, deep ‘warm’ colors, such as red, orange and yellow, as well as purple. The coloration often extends into the interior of the bivalve giving the shell a colorful margin (Keen 1971; Olsson 1961). The margin is commonly known among archaeologists as the 'lip', but this is anatomically incorrect; Spondylids have 'lips' elsewhere (Yonge 1973).

Recent research has reduced to three the number of Spondylidae in the Panamic Province, an area of moderately warm tropical water that extends from the Gulf of California to Northern Peru. These include *Spondylus calcifer* Carpenter, 1857, *S. leucacanthus* Broderip, 1833, and *S. princeps* Broderip, 1833 (Skoglund and Mulliner 1996). While there has been some disagreement on the number of species, most previous studies were based upon a limited number of museum specimens for shell compendia (compare Abbot 1974; Keen 1971; Lamprell 1987; Olsson 1961), while recent research (Skoglund and Mulliner 1996) is based upon more extensive museum collections as well as direct collection in the Gulf of California. The differences between the three Panamic Province Spondylids are presented in Table 5-1 (Skoglund and Mulliner 1996: Table 1).

Of the three species, I will discuss only two, *S. princeps* and *S. calcifer* (see Figure 5-1, Figure 5-2 and Figure 5-3). *S. leucacanthus* was most likely not used by prehistoric peoples. It often resides beyond the depths of prehistoric divers at an approximate depth of 25-90 m with an anomalous shell found up to 15 m and is mainly white with very little of the highly desirable red, orange, or purple shell from which many shell artifacts were made (Skoglund and Mulliner 1996: 96). This does not mean the odd *S. leucacanthus* shell was not used for the production of artifacts, merely that the other two species would have been easier to obtain and more desirable.

Like most Spondylids (except *S. leucacanthus*, which is free-living), both *S. princeps* and *S. calcifer*, live cemented to a substrate, usually rocks, other bivalves, or reefs. This means that the right (lower) valve, the side cemented to the substrate, is easily identified because of the attachment scar and because it is less concave than the left (upper) valve (see Figure 5-3). Normally, *S. calcifer* is attached to the substrate over a fairly large area of the right valve but *S. princeps* is often attached by only a small area. Today this means that often only the left (upper) valve of *S. calcifer* is sold at roadside stands in Ecuador (often in the form of ash trays), while *S. princeps* can often be found with both valves still articulated (personal observation 2001). It was indubitably difficult to extract the right valve of *S. calcifer* prehistorically (Skoglund and Mulliner 1996: 102). Archaeological research should be able to confirm whether or not both or just the left valves were harvested prehistorically (Hocquenghem 1999).

All Spondylids serve as a framework upon which other sea life lives. Spondylus spines are not meant for direct defense, but to attract plants and animals, which by living on the Spondylids provide them with camouflage (Fabara 2003:26; Feifarek 1987; Jones 2003; Lamprell 1987:9). These epibionts vary, however. The shell of *S. calcifer* tends to be heavily marred with a wide variety of epifauna, including boring sponges, worms and small boring clams (see Figure 5-3; Keen 1971:96; Olsson 1961: 153), while *S. princeps* tends to have less invasive, but no less disguising, epifauna, including mainly coralline algae (Skoglund and Mulliner 1996: 99, Figure 27), but also marine worms (polychaetes), mollusks, sponges, and more (see Figure 5-7) (Gonzalez et al. 1993). This means that archaeologically recovered *S. princeps* are often much ‘cleaner’ than *S. calcifer*, because organic epibionts have decomposed, but calcareous ones have not. The epibionts provide a natural camouflage (Figure 5-4) that would have necessitated divers to use specialized knowledge to identify Spondylus in its natural habitat (Hocquenghem 1999:59, citing Bearez 1996:134-135; Norton 1986: 133).

5.1.2. Vertical distribution

One of the basic assumptions that many archaeologists make is that Spondylus was particularly difficult to acquire because it lived at depths below 20 feet (see Table 5-2 for a list of what different researchers have cited). Researchers have claimed that, due to the difficulty of retrieving Spondylus from such depths, its value was increased (Cordy-Collins 2001:35; Marcos 1995:101), diving for it was particularly ‘expensive’ (Hocquenghem 1999:60; Marcos 1986:198), specialized divers were needed for its extraction (Cordy-Collins 1990:306), or even that ocean going vessels were needed to harvest Spondylus (Zeidler 1991:254).

Later writers cite the seminal articles of Paulsen (1974) and Marcos (1977/78) when they refer to the habitat of Spondylus, but, in light of current knowledge, both of these articles were excellent initial efforts that need to be updated (Table 5-2). Paulsen (1974:597) states: “Spondylus… clings to reefs 20 to 60 feet below the surface of the ocean, and hence, under aboriginal conditions can be collected only by experienced native divers.” Both *S. calcifer* and *S. princeps* live in shallower depths, however. The citations for Paulsen’s statement include Keen (1958: 76, 336), Olsson (1961: 152), and an undated personal communication with Presley Norton. Keen, however, only mentions that what she called *Spondylus princeps unicolor* Sowerby, 1847, a subspecies of *S. princeps*, is present in the Gulf of California from 7-30 m (approximately 23 to 98 feet). Olsson (1961:152) makes no comment at all about the depth at which Spondylus can be found. One must assume, therefore, that Presley Norton, in his personal communication with Paulsen, stated that these shellfish were found between 20 and 60 feet.

Marcos (1977/78; see also 1986a, 1995) cites Morris as a reference for the statement, "The habitat of both species is moderately deep waters, 80-200 feet (25 to 60 m; Morris 1966), except for S. princeps unicolor of the Gulf of California with a habitat ranging between 7 to 30 m (Keen 1971). The extraction of Spondylus from its habitat involves a tremendous expense of energy." The mention of "moderately deep waters" is a direct reference to the terms used by Morris, which he says means from 80 to 200 feet. An extremely general statement such as this in a shell field guide should be considered only a general guide, especially considering that contradictory information was available in Paulsen's article (Paulsen 1974). Later Marcos would cite 15 to 30m, but this also appears faulty (Marcos 1995a:101). Both new and old information indicate that Spondylus is from much shallower water (Béarez 1996; Norton 1986; Skoglund and Mulliner 1996).

Our knowledge about the depths at which Spondylus live has been greatly improved since the publication of Paulsen (1974) and Marcos (1977/78). First, work on La Plata Island indicated that Spondylus was present only at great depths. While Presley Norton and Jorge Marcos were excavating on Isla de la Plata in 1978 and 1979 (see Marcos and Norton 1981), conchologist Donald Shasky was asked to work as a SCUBA diver tasked with a malacological survey around the island paying special attention to Spondylus (Shasky 1980:9). In the two seasons of work at Isla de la Plata, Shasky was only able to recover 14 specimens of *Spondylus sp.* at depths between 68 and 135 feet (approximately 20 to 40 m). While he believed that all of his catch was *S. princeps*, Skoglund and Mulliner (1996) identified four of the five specimens from Shasky's research stored at the Santa Barbara Museum of Natural History as *S. leucacanthus*. They identified the other specimen as *S. princeps* from 32 m (Skoglund and Mulliner 1996:97). Shasky's initial research on La Plata may be what has resulted in this assumption that professional divers were needed. Even Shasky (1980), however, indicates that he believed that the Spondylids from Isla de la Plata were not collected by divers, but must have been collected using nets.

Even though Shasky worked with Presley Norton, the latter presents quite different information. Based upon his own personal observations while diving in the area, he states that *S. calcife*r could be found at depths of 6 m to 50 m and *S. princeps* from 15 m to 70 m (Norton 1986: 134). Note that this is different than what Paulsen (in the early 1970s) states above based upon a personal communication with Norton. Norton (1986:134) also states that 15 m is the maximum depth prehistoric divers could have reached free-diving. Perhaps the *S. princeps* around Salango, where Norton and others established the Salango Museum and Research Center, were present below 15 m for precisely that reason: populations had been depleted by overharvesting to above 15 m (Hocquenghem 1999:59, citing Bearez 1996:134-135).

The depth at which Spondylids can be recovered is distinct for each species: *S. leucacanthus* is the most inaccessible at 18 to 90 m, while *S. princeps* (3 to 28 m) and *S. calcifer* (intertidal to 18 m; see also (Villalejo-Fuerte et al. 2002:105)) are much more accessible (Skoglund and Mulliner 1996). Diving to three meters to harvest *S. princeps* would seem to indicate that professional divers are not needed. If Spondylus beds were over-harvested, experienced divers may have been needed to harvest deeper specimens.

Certainly obtaining *S. calcifer* from the intertidal zone would not have been very difficult.

Although the applicability of Skoglund and Mulliner's research in the Gulf of Mexico to the coast of Ecuador can be questioned, it is supported by local research as well. Philippe Béarez spent many years at the Salango Research Station in Salango, Manabí, Ecuador studying the fish of the area for his thesis (Béarez 1996), which led to a productive career studying the ichthyofauna of the region. Although shellfish were not his specialty, Béarez spent a great deal of time diving to observe the fauna of the Ecuadorian littoral and their habitat. In doing so, he also observed Spondylids. He suggests that *S. calcifer* was probably present in the intertidal zone and could have been harvested without diving. He noted that today Spondylids are practically absent in depths less than 5 m, but thought this was the result of recent overexploitation. He also believes that due to the turbidity of the water in the region (around Salango), the epibionts living on Spondylus, and the high degree to which they are attached to the substrate would make diving for Spondylus particularly difficult (Hocquenghem 1999:59, citing Bearez 1996:134-135). Perhaps Salango, where Béarez was located, was not the ideal location to harvest Spondylus.

Even more recently, anthropological and marine resource management research has supported Béarez's information. Dan Bauer, in his doctoral research on marine resource utilization by the people of Salango, reports that both *S. princeps* and *S. calcifer* are currently available on the reefs and rocky outcrops between four and 20 m (Bauer 2007). Similarly, Monica Fabara, in her Masters thesis on the feasibility of managing the Spondylus stocks in and around Salango, states that Spondylus "occurs naturally in most rocky shallows along the coast in depths to at least 30 m for *S. calcifer* and 55m for *S. princeps*" (Fabara 2003:25).

Our current knowledge of the habitat at which Spondylus lives is still limited. It seems most likely that *S. calcifer* is found at relatively shallow depths (approximately intertidal to 18 m) but is well disguised by epibionts and extremely well cemented to rocks. In order to harvest *S. calcifer,* therefore, an individual would have had to first locate a specimen then pry the entire shell off the rocks (which would have been fairly difficult) or harvest only the left shell (which, because of the ball and socket nature of the Spondylid hinge, also would have been fairly difficult). It is safe to say, therefore, that *S. calcifer*, was mainly harvested in shallow depths with some sort of prying tool.

It is unclear how deep *S. princeps* lives, but it may be as shallow as 3 m (Skoglund and Mulliner 1996 Table 1). What is clear is that *S. princeps* is less solidly attached to the substrate with only a small portion of the shell attached, and the substrate may be smaller rocks or even pebbles (Skoglund and Mulliner 1996: Table 1) which can simply be picked up along with the bivalve. Epibionts of *S. princeps* are different than those of *S. calcifer*, tending to be less invasive and include algae as well as fauna (Gonzalez et al. 1993), but disguise the shellfish to a similar degree. Harvesting *S. princeps* may or may not have been difficult depending upon local conditions, especially the depth at which it can be found. If one had to dive to only 3 m (approximately 10 feet) to grab the shellfish, which even if attached to a large rock could have been removed relatively easily, and bring it back to the surface, harvesting would have been fairly simple.

Although it has been suggested that the presence of auditory exostoses on skeletons may indicate Spondylus divers (e.g., Currie 2001), these bony lesions are more generally associated with exposure to cold water in general and to retrieving significant quantities of subsistence goods from cool water. They are particularly present in populations who utilize marine resources, especially though diving (Kennedy 1986), but this should not be equated with specialists who dive for Spondylus shell. The low rate of auditory exostoses from *Ayalán* , Ecuador (2.9%) indicates that these people probably did not enter the ocean a great deal, but increasing rates of auditory exostoses closer to the ocean at Sicán (Lambayeque) and Moche period Pacatnamú (0-28.6%) indicates that people living near the coast had the highest rates, not that they were specialized divers (Kennedy 1986; Ubelaker 1981). The cooler waters of the Peruvian coast should be more highly associated with auditory exostoses. The presence of these bony growths on Manteño period skeletons, probably indicates that people were immersing themselves in ocean water, but not that they were Spondylus divers.

5.1.3. Horizontal distribution

The second environmental issue that needs to be addressed is the geographic distribution of Panamic Spondylids. Often it is stated that the fact that when Spondylus is recovered in Peru it means that there was some form of contact with Ecuador. This is based upon the oft-cited fact that Spondylus is present only to Ecuador (Table 5-3) (Cordy-Collins 2001; Hocquenghem 1993; Marcos 1977-78, 1986; Marcos and Norton 1981; Murra 1975; Norton 1986; Paulsen 1974; Zeidler 1991). It appears, however, that Spondylus is distributed as far south as northwestern Peru.

There is no doubt that Spondylids live in warm (average sea surface temperature is between 80-85 ºF [27-29 ºC]; Olsson 1961:24) tropical waters of the Panamic province of the Pacific Ocean. The Panamic Province is defined as from Magdalena Bay in the Gulf of California to Punta Aguja (see Figure 5-5; Keen 1971:4) or Cabo Blanco, Peru (see Figure 5-5; Olsson 1961:24). Near Punta Aguja, the cold Peruvian Current (average sea surface temperature is between 58- 65 ºF [14-18 ºC]; Olsson 1961:24, Teran et al. 2004:5) comes from the south and turns westward. North of the Colombia/Ecuador border, the warm south-flowing Panama Current also turns westward. In between these two large current systems is the subsurface Equatorial Countercurrent (Cronwell Current) flowing eastward. As it nears the coast the countercurrent bifurcates and each arm swings around to join the large current systems. As a result, warm waters dominate south to approximately Cabo Blanco in Peru, and cold waters dominate in the south as far north as Punta Aguja (see Figure 5-5). In between Cabo Blanco and Punta Aguja lies the Paita Buffer zone (Olsson 1961; see also Diáz and Ortlieb 1993) where water conditions are intermediate and may vary significantly, especially during ENSO events where the upwelling of cold water along the Peruvian coast slows or stops, allowing the warmer water to pass over it to the south. Between July and September, cold Humboldt waters may move north nearly to the equator, while the warmer waters push south from around December to April. A great deal of local fluctuations (seasonal and otherwise) in water temperature, salinity and nutrient content (Murphy 1923:68; Terán et al. 2004; Terán et al. 2004:3) may result in variability in the range of Spondylids in the past and present.

Spondylids lived in the waters off northern Peru; even some of the older shell compendia indicate this. Keen (1971:96) specifies that *S. princeps* inhabits the waters off northwestern Peru, although in the first edition of her book on sea shells from California to Colombia, she indicates that Spondylids are only present to Ecuador (Keen 1958). Paulsen (1974) used the earlier edition in her seminal article as a source regarding the habitat of Spondylus and many archaeologists cite this article when discussing the range of Spondylids. Olsson (1961:152-3) gives Zorritos (see Figure 5-5) and Caleto Sal (see Figure 5-5) as locations were *S. princeps* was recovered, as well as "Indian graves in the Chira Valley; Chiclayo". It is unclear whether he means that *S. princeps* was recovered from the ocean at Chiclayo (see Figure 5-5) or from prehistoric graves from that city. Since Chiclayo is approximately 10 km inland and Spondylus is well known in graves in the area, the later is more likely. This is important because the most current Peruvian mollusk guide (Alamo and Valdivieso 1997:108) cite Chiclayo as a location from which *S. princeps* was recovered without the indication that it was an archaeological sample. It is fairly clear, however, that their information comes directly from Olsson. Olsson gives neither *S. princeps* nor *S. calcifer* in his list of principle species in the Paita Buffer Zone (1961:37-40).

Based upon available museum specimens, Skoglund and Mulliner give the southern extent of the range of *S. princeps* as Isla La Plata, Ecuador (the specimen collected by Shasky [1980]), which is clearly incorrect. Skoglund and Mulliner (1996:102) did examine two museum specimens of *S. calcifer* from Caleto Mero, Peru (see Figure 2-85). Paredes et al. (1999: Table 5) list both *S. calcifer* and *S. princeps* as present in Peru, but give no further provenience.

In a regional study for The Nature Conservancy, Teran et al. (2004) indicate that both *S. calcifer* and *S. princeps* are present in multiple location in Ecuador and in

Northwest Peru to Punta Sal (see Figure 5-5) (see also Hocquenghem and Peña Ruiz 1994:211; Terán et al. 2004). At Punta Sal, *S. calcifer* population density is high enough (3-4 specimens per m^2 at 10-12 m) that modern commercial exploitation is encouraged (Robles and Méndez 1989:60-61). Although *S. calcifer* is present farther south at El Ñuro, density is lower (Robles and Méndez 1989:69). Therefore, both *S. calcifer* and *S. princeps* have been located in the Punta Sal area.

Spondylids have not been located south of Cabo Blanco, which would indicate that they do not survive in water that is, on average, colder than 20ºC (68ºF; see Figure 5-5). Most of the Peruvian coast to the south averages 17-18 ºC and average temperature of the Ecuadorian coast is between 22-24 ºC (Terán et al. 2004:map 12b). *S. calcifer* requires a solid rock or coral substrate and would be limited to rocky areas, but *S. princeps* should be more widely available because they tend to live on sandy bottoms that are more widely available (Terán et al. 2004:map 12b).

Dan Sandweiss has suggested that Spondylus may be present to the south during ENSO events based upon a single live Spondylus specimen recovered in Callao, just north of Lima and approximately 1000 km from Punta Sal, after the ENSO event of 1925 (Lumbreras 1987; Sandweiss 1992:152; Sandweiss and Rodríguez 1991:note 9; Sandweiss et al. 1983:283). Sandweiss (Ravines et al. 1982:219) references an undated personal communication from Violeta Valdivieso stating that an old fisherman said that he found a live Spondylus in Callao in 1925. Valdivieso (Alamo V. and Valdivieso M. 1997) does not include this reference in her own work, however. Paredes et al. (1998; 2004) in a study of molluscan movement after an ENSO event do not list Spondylids as one of the species present in central Peru after El Nino events (see also Diáz and Ortlieb

1993). Sandwiess admits, however, that even if Spondylus did briefly colonize the waters off Callao, the amount of raw shell that this would provide would be insignificant (Sandweiss 1992:152).

In summary, warm waters certainly extend south of the modern border between Ecuador and Peru and there is evidence of the presence of both *S. calcifer* and *S. princeps* in the area and commercially harvestable quantities of the former. Therefore, it can no longer be stated that either Spondylid is located only in Ecuador as beds of these shellfish are present off the coast of extreme north coastal Peru. We can no longer assume that every archaeological find of Spondylus in Peru is evidence for contact with the people who lived in what is now Ecuador. In light of this, the area around Tumbes, Peru needs to be investigated more thoroughly to identify the role that prehistoric residents played in the acquisition and trade of Spondylus. Considering the meager archaeological evidence (see below; Hocquenghem 1999 and Hocquenghem and Pena-Ruiz 1994) it is quite possible that much of the Spondylus was acquired, worked and traded in areas near Tumbes. Although this only shifts Spondylus acquisition and trade a couple of hundred kilometers to the south, it means that our limited understanding of the archaeology of Tumbes severely hampers our ability to understand prehistoric use and trade of Spondylus.

5.2. Archaeological evidence for prehistoric use of Spondylus.

The prehistoric use of Spondylus throughout the Andes is not much better understood than thirty years ago, when it first stepped into the limelight (Marcos 1977-78; Murra 1975; Paulsen 1974). Since then, only a single article has been published on archaeologically recovered Spondylus (Glowacki 2005) and it is limited to Huari. Many articles, however, have been written on Spondylus iconography (Cordy-Collins 1990, 1999, 2001; Davidson 1980, 1981; Pillsbury 1996, 1999). Certainly no large-scale regional and temporal reviews have been attempted. In order to address the position of the Manteño in the Spondylus trading network, such a review must be completed.

In this section, I attempt to identify the occurrence of Spondylus at archaeological sites in western South America, mainly in Ecuador and Peru. This account takes Paulsen's (1974) roughly accurate original chronology as the base line, with a few major changes. She provides three general periods in which Spondylus (and Strombus, which will not be discussed here) were traded out of their natural range. Period A (2800-1100 B.C.) included the production of Spondylus artifacts on the coast, with trade into the Ecuadorian sierra, particularly to Cerro Narrío, but none south to Peru. During Period B (1100-100 B.C.), trade was extended south into the Peruvian coast and highlands. Trade continued to expand into her Period C (100 B.C. to A.D. 1532) reaching from Quito to Lake Titicaca (Paulsen 1974). The general increase in the consumption of Spondylus through time that Paulsen identified does in fact appear to hold, although there are exceptions. Using the chronology discussed herein, I also attempt to identify the types of Spondylus artifacts and ecofacts being traded in each period. In particular, since this dissertation is focused upon shell bead production, the occurrence of shell beads is a major consideration.

Although Paulsen's chronology is employed as a baseline, there are a couple of major changes. It appears that the initiation of Spondylus trade into the Ecuadorian highlands occurred later than originally thought and at approximately the same time that Spondylus trade in Peru was initiated. I have divided Period C into three subphases (C1-

C3) in order to identify distinct periods of Spondylus production and consumption. Lastly, contrary to established opinion, archaeological evidence indicates that Spondylus consumption may have actually decreased during the Inka period.

5.3. A note on dating.

The dating provided herein is imperfect because of the various ways in which researchers have reported dates for artifacts and/or their contexts as well as the age of some of the references. Particularly, many of the older references provide radiocarbon dates that were not corrected for isotopic fractionation; even some more recent references do not indicate if samples were corrected. Because we cannot distinguish corrected and uncorrected dates, the only recourse is to use the dates as provided. Therefore, there may be some unintended errors. Some dates also are reported in radiocarbon years and these have been calibrated using Calib 5.1 (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993), but many of these also lack C12/C13 ratios, which may introduce more error. Over all, however, I believe that most of the dates are supported by other dates and, therefore, are acceptable.

5.3.1. Period A (before 1100 B.C.)- Dispersed Low-Level Consumption

5.3.1.1. Coastal Ecuador

The main evidence for Spondylus use in coastal Ecuador prior to 1100 B.C. comes from Middle Valdivia (2900- 2400 B.C.) sites. The Early Valdivia shell mound site of El Encanto (see Figure 5-6 for locations of sites mentioned in this section) on Puná Island lacks Spondylus shell (Porras G. 1973) as do the Valdivia I contexts from Real Alto (Damp 1988). Reports of the excavation of San Pablo in the 1950’s do not mention Spondylus artifacts (Zevallos 1995:33-45; Zevallos and Holm 2001 (1960)).

The earliest well-dated Spondylus is from Valdivia III (ca. 2900-2600) at Real Alto, on the Santa Elena Península in Ecuador. A single complete valve of *S. princeps* was found in the ramp to the charnel house within the ceremonial area (Marcos 1988:188; Zeidler 1991:254)[1]. Within the residential area, a single Spondylus rim fragment lacking the red border was found in association with a tool kit, including ground saws, reamers, chipped stone scrapers and knives and within a shell-working area (Zeidler 1991:254). A single burial (Entierro B-LXXII) within the Valdivia III Ossuary Mound contained forty small Spondylus beads, but no further details are given (Marcos 1988:170).

Much has been made of the Spondylus cores present at Real Alto. Marcos (1977-78:108) states that "at the earliest Valdivia occupation at Real Alto (c. 4700 B.P.) many cut-up segments of the white part of the Spondylus shell are found. The red rim of the shell is generally absent at Real Alto…", but this does not agree with Zeidler's statement that Spondylus appeared during Valdivia III (Zeidler 1991:254), nor with the apparent lack of Spondylus in Valdivia I contexts (Damp 1988). I have been able to find no data regarding these cores. To the excavators, the lack of the colored section of the shell indicates that it was exchanged as a raw material (Lathrap et al. 1975:48; Marcos 1977-78:108-109, 1995a:105). This does not necessarily indicate anything more than that it was removed from the site (or from the excavated part of the site), however. At this point the only archaeological evidence of where the removed section may have gone is the beads from Burial B-LXXII from the Ossuary Mound. It is also possible that Valdivians were using it for purposes that would be archaeologically invisible, such as interring the red parts in agricultural fields as occurred ethnohistorically (e.g., Murra 1975).

[1] Karen Stothert (Stothert 2003:363, note 11) has pointed out that specimens used to identify the Spondylus/Strombus dyad at Real Alto (Marcos 1977-78; Marcos 1988:188) date to separate phases of contruction (Valdivia II and III) and are not contemporaneous.

Cerro Narrío and Cueva de los Tayos were the hypothesized destinations for the colored margins (Lathrap et al. 1975:48; Marcos 1977-78:108, 114; Paulsen 1974:599-600), but it is clear that the original dates (e.g., c. 2500 B.C. for Cerro Narrío; Marcos 1977-78:108, 114) were incorrect and neither site is contemporaneous with Valdivia (see below for their correct placement).

The Valdivia 8 sites of San Isidro, in Manabí, and San Lorenzo del Mate, to the north of Guayaquil, yielded plaques for necklaces and masks made from Spondylus (Marcos 1995a:105-106). While little is known about these masks, which are often a *S. princeps* shell with two large holes for the 'eyes,' they are well represented in museums.

At the Valdivia type site (G-31; see Meggers et al. 1965; Blower 1995: 232) Spondylus occurs in domestic contexts throughout the sequence. Early Valdivia (up to 2900 B.C.) contexts contained only 8 specimens, while Middle (2900-2400 B.C.) and Late Valdivia (2400-1900 B.C.) contexts contained 97 and 235 specimens, respectively. Although Blower (1995:232) interpreted this as an increase in Spondylus use through the Valdivia sequence, a seriation of the shell assemblage indicates that Spondylus use, in terms of the percent of the malacological assemblage that the bivalve represents, was relatively constant: 16 % and 15% of all shell for the Middle and Late Valdivia (Meggers et al. 1965:Figure 9). Types of Spondylus artifacts recovered from G-31 include abraders and polishers (these may be rectangular/trapezoidal pieces discussed below), one perforated disk or bead and one rectangular pendant (Meggers et al. 1965:37-41). It is perhaps more interesting that lithic microdrills (called "Jaketown Perforators"; Meggers et al. 1965:28, Fig. 13), which are often used to drill shell, were recovered from G-31. Although microwear analysis indicates that only a couple of them were used for drilling, the shape and form is the same as those used later in prehistory. People clearly knew how to make lithic drills early in Ecuadorian prehistory (Meggers et al. 1965:28, Figure 13), but it has not been recovered from known Peruvian sites (with the exception of Siches, a Middle Preceramic site; Dan Sandweiss, personal communication 2007). A wide variety of sandstone saws that could have been used for cutting shell were also present in the excavations at G-31 (Meggers et al. 1965:29, 32, Figure 15). A small pot with four images of *S. princeps* was recovered from Salango (site 141) from a Valdivia 6/7 context (Norton et al. 1983:42). Lunniss (2001) later indicated that "around the upper half of this vessel was an appliqué decoration highly suggestive of the spines of Spondylus princeps" (Lunniss 2001:47). If this is indeed a representation of Spondylus, it is one of the very few known cases in coastal Ecuador of Spondylus represented in any preserved medium.

The Middle Formative of coastal Ecuador is generally poorly known and their use of Spondylus is also unclear. We know little about the Middle Formative Machalilla (B.C. 1500-1050; Meggers 1966; Meggers and Evans 1962; see also Lippi et al. 1984; Pearsall 2003).

Spondylus artifacts recovered from La Cabuya (G-110) include Spondylus abraders and polishers (a total of 5 identified as Spondylus or Strombus). The identification of these artifacts as abraders and polishers is equivocal; they may be trapezoidal plaques. Also recovered were "unfinished pendant blanks" of Spondylus, though a quantity is not given (Meggers et al. 1965:113, 116). Machililla levels from site OM-PL-I1-12 on Isla de la Plata yielded over 200 features including Spondylus offerings, though no details of these offerings are given (Marcos and Norton 1981:146, 1984:13).

5.3.1.2.Ecuadorian highlands

Evidence for Spondylus exchange comes from the Ecuadorian highlands. A great variety of Spondylus artifacts were recovered from Cerro Narrío, in the Paute Valley in southern Ecuador, including "complete Spondylus shells without spines, square and round cuentas, chaquiras, pendants, collars, earspools and highly polished rim fragments" (Blower 1996:89; see Uhle 1922:236-238). The contexts of Cerro Narrío are not securely dated, however (see Blower 2001:87-89; Bruhns 1989:57, 2003). Pirinkay, also in the Paute Valley, yielded only Spondylus beads and pendants, but provides more secure dating (Bruhns 1989). Pirinkay was occupied from 1400 B.C. to A.D. 200 and the occupation of Cerro Narrío appears to be contemporaneous (Bruhns 2003). Shell artifacts from Pirinkay date to all phases of the site, but Bruhns (2003) notes that Spondylus artifacts are most numerous in the early levels at both Pirinkay and Cerro Narrío. She believes that other sites in the area, including Chaullubamba, Monjashuaycu, and others, date to the same time period, but no data are available on shell from these sites. It has been rumored (e.g., Blower 1995:86-87) that Spondylus was worked at Cerro Narrío but there apparently was no evidence for this (Bruhns 2003:153). Putushio, a 'Formative' period site (occupied from 2100 B.C. to A.D. 1500; based upon radiocarbon dates from Temme 2000: 125 calibrated with Calib 5.0), has revealed evidence of Spondylus offerings (Bruhns 2003:162), but the contents and contexts of these offerings has not been published (Temme W. 2000).

A large number of unique Spondylus figurines have been recovered from the southern highlands of Ecuador and are generally dated to Cerro Narrío times (Uhle 1922:238-240). The figurines (called *ucuyaya*) are curved because of the convex shells from which they are made and came in a variety of sizes with the smaller one being made from the red to orange *S. princeps* and the larger ones from the purple *S. calcifer* (Blower 1995:87-88; Bruhns 2003:143-144). The popularity of the *ucuyaya*, as well as the prevalence of Spondylus at Cerro Narrío and Pirinkay, is highly suggestive of extensive contacts with the coast. There are a number of other lines of evidence for contact with the coast including ceramic similarities, iridescent paint, red chalcedony, crystal beads (traded to the coast from the Paute Valley) and marine shell (Bruhns 1989). This agrees with an increase in Spondylus use in the Middle to Late Formative of coastal Ecuador (i.e. after 1400 B.C.), but eliminates Spondylus as evidence for trade between coastal Valdivians (i.e. Early Formative) and the people of the Paute Valley.

A Catamayo site near Loja, to the south of Cuenca, yielded a whole Spondylus shell with two jadeite artifacts (Guffroy 1987:192-193; Stothert 2003:359, note 7).

Further potential evidence of early Spondylus trade comes from the Ecuadorian Amazon basin at Cueva de los Tayos (Porras G. 1978). A variety of Spondylus artifacts were found, including a trapezoid, three perforated discs, a circular crown, six cylindrical beads, a ring, a feline mask and a serpent-bird pendant (Blower 1995:89; Porras G. 1978:37-48, Fig. 4A-4F). Two Spondylus valves from the cave were radiocarbon dated and yielded a date of approximately 1020 B.C. (Porras G. 1978:63), after Paulsen's Phase A and long after the end of the Valdivia phase. This date damages Marcos' (1977-78) suggestion that the people from Cueva de los Tayos traded with Valdivians, but even the single date is questionable for a couple of reasons. It is likely that the contexts were mixed due to guano mining (Bruhns 2003:158). Bruhns (2003: 158) suggests that the cave may have been used over a long period of time for ritual purposes and since the context of the artifacts is not given, we cannot even be sure that the radiocarbon date provides information about anything other than the time of death of the two Spondylus valves. It is interesting, however, that a 3000 year old Spondylus did reach the Amazonian side of the Andes, but this does not indicate any sort of formalized trade between peoples of the Ecuadorian coast and the Amazon Basin.

5.3.1.3. Coastal Peru

There is sparse evidence for Spondylus use in Peru during the Preceramic (3000-1750). Spondylus has been mentioned at the Preceramic sites of Aspero and La Paloma, but the quantities are very limited and the contexts are unclear and other large Preceramic sites, such as Huaca Prieta, Asia, or El Paraiso, lack evidence of Spondylus (see discussion in Blower 1995:95-6; Moseley 1992:104; Quilter 1989:24; Zeidler 1991258). Recently, Spondylus was reported from Caral (c. 2900-2000 B.C.), a major monumental site in the Supe Valley. The samples are from within workshop areas (in Sector K in the extreme east of the lower middle of the city), but details have not yet been reported (Shady Solís 2005).

The most secure evidence for Spondylus use in Preceramic Peru is from La Galgada. It consists of two large rectangular Spondylus beads from two separate necklaces worn by two females in the same burial (C-10:E-10). The burial dates to approximately 2000 B.C. (Greider et al. 1988:86-89). Because La Galgada is located approximately 74 km from the Pacific Ocean, the presence of any marine shell indicates some form of exchange or movement of goods. If Spondylus was present in the ocean along the coast north of Cabo Blanco as I suggest above, then the nearest source of Spondylus laid a minimum of 600 km away as the crow flies. Zeidler (1991) indicates that the beads from this burial (rectangular plaques with two laterally drilled perforations) were very similar to those from Valdivia 8 (c. 2100-2000 B.C.). A few beads do not amount to organized trade, as Zeidler (1991:260) admits. How the beads got to La Galgada from their origin somewhere to the north of Cabo Blanco is unclear, but the process could have involved a great deal of time and many intermediaries in down-the-line trade and did not necessarily involve seafaring by Valdivia peoples (see Zeidler 1991). A single Spondylus bead from Los Gavilanes, dated to approximately 1750 B.C. and described as a square bead perforated longitudinally (Bonavia 1982), may be similar to the beads from La Galgada. The evidence for Preceramic (i.e. before 1750 B.C.) Spondylus trade consists of three beads (and whatever is present at Caral) and, therefore, does not support a hypothesis of trade that is more direct than down-the-line exchange.

During the Peruvian Initial Period (1800-1000 B.C.), the same time period in which Spondylus was recovered from Cerro Narrío, consumption of this shell seems to have increased, but remained relatively low. The Initial Period occupation of La Galgada yielded four shell medallions that are mainly mother-of-pearl and generic white shell, but these artifacts have Spondylus inlays, and are dated by a radiocarbon assay (on the cloth to which they were attached) to 1610 B.C (Greider et al. 1988). Six Spondylus beads, a cut and polished fragment and 50 fragments of Spondylus were recovered from Garagay, one of the many U-shaped ceremonial centers near Lima. The site was occupied between 1500- 600 B.C. (Burger 1992:63; Ravines et al. 1982), but more precise dates for the contexts from which the Spondylus came are unavailable making it possible that this find belongs in Period B. A pair of Spondylus shells was also recovered from Punkurí, understood as an Initial Period site although dating is problematic (Burger 1992:89-90).

Lathrap (1973:180) suggests that a Spondylus effigy vessel from the Initial Period site of Kotosh establishes supports the hypothesis of trade in Spondylus by 1500 B.C.

A Spondylus shell was recovered from a grave at Ancón dating to approximately 1200 B.C. (Matos Mendieta 1968). Excavations of Willey and Corbett (1954) at Ancón yielded no Spondylus from similarly dated material, while excavations of later material at the site did (see also Blower 1995: Appendix A; Ravines and Stothert 1976) making it possible that the Spondylus was intrusive in the context excavated by Matos Mendieta.

The later importance of Spondylus within the Cupisnique tradition is foreshadowed by the use of objects made from *S. princeps* valves at Monte Grande, a "Formativo Inferior" (1500-1000 B.C.) site in the Jequetepeque Valley (Elera 1993; Tellenbach 1987). A medallion in the form of a monkey, reminiscent of those from La Galgada, is the only Spondylus artifact shown (Tellenbach 1987:5, Fig. 9a).

5.3.1.4. Period A (before 1100 B.C.)- Summary

Paulsen indicates that prior to 1100 B.C. Spondylus was being used by Formative cultures of coastal Ecuador and was being traded into the highlands of Ecuador by 2500 B.C., but not into Peru. Current evidence suggests that trade into the highlands probably did not start until c. 1400 B.C. and it appears that some form of trade into Peru began at approximately the same time. Current evidence, therefore, does not support the idea that Valdivians were long distance seafaring traders (Marcos 1977-78; Zeidler 1991). It is more likely that the people of the Middle Formative Machililla (1400-850 B.C.) were the first to be involved in long distance trade. This trade may have involved both raw materials and finished artifacts, but considering the local style of many of the artifacts, it is most likely that mainly raw material was being traded. Finished artifacts may have been exchanged locally.

5.3.2. Period B (1100- 100 B.C.) Chavín and Cupisnique

5.3.2.1.Coastal Ecuador

Evidence for Spondylus consumption on the Ecuadorian Coast during Paulsen's Period B is admittedly sparse. The Late Formative Chorrera (very roughly 1600 – 500 B.C.; Meggers 1966) is better known than Middle Formative Machililla due to recent analyses of Engoroy (a local Chorreroid complex) contexts from Salango (Lunniss 2001) (see Figure 5-7 for locations of sites mentioned in this section).

At Salango, Engoroy phases I-IV are dated roughly to 600-100 B.C. (Lunniss 2001:292). A phase I structure contained a hole in which a single juvenile *S. princeps* was interred with two discs of blue green tuff (Lunniss 2001:75-76). The fill of a phase I infant burial contained a single tubular red Spondylus bead (Lunniss 2001:108 Fig. 73e). An irregular pit from phase II contained a single Spondylus bead (Lunniss 2001:78). Towards the end of phase II, a single red Spondylus bead and a group of Spondylus artifacts including two red Spondylus beads and two unfinished red Spondylus beads were deposited in two separate pits (Lunniss 2001:148-149). Two late phase III figurines were accompanied by a single purple Spondylus bead and a cut blank of Spondylus shell (Lunniss 2001:129-130). Four phase III/IV (i.e., closer to 100 B.C. than 600 B.C.) burials contained Spondylus artifacts: the fill of burials 4784 and 3642 both contained a single red Spondylus bead; burial 4471 had a sea-worn *Spondylus calcifer* shell placed over the skeleton's knee; a single red Spondylus bead was found beneath the jaw of burial 3899; and under the head of burial 840 was a fragment of Spondylus (Lunniss 2001:115). Three

Spondylus 'tusk'-shaped figurines were recovered from Engoroy levels at Salango. One was white Spondylus from Middle Engoroy (600-300 B.C.), another was white and orange Spondylus from Late Engoroy (300-100 B.C.), and a third was red Spondylus but had lost its contextual association (Lunniss 2006). A total of 342 shell beads were recovered from the site and although Lunniss (2001:151) indicates that most were Spondylus, but this is unclear because 139 of the beads came from two strings of white beads. Although Lunniss recognizes the ceremonial importance of Spondylus within the Engoroy contexts of Salango, he indicates that there is no direct evidence of "export-oriented Spondylus collection" (Lunniss 2001:322) or of processing. The amount of non-local material is minimal and long-distance trade probably was not the focus of the Engoroy inhabitants of Salango. Bushnell also recovered a Spondylus shell amulet from an Engoroy burial at La Libertad (Bushnell 1951:87, 94, Fig. 38).

On the Santa Elena Península, three Spondylus shells (*S. calcifer* based upon the photo on the front of *Miscelanea Antropologica Ecuatoriana*, Vol. 8) were located at the base of a huge U-shaped earthen water retention feature known on the Santa Elena Península as an *albarrada* (see above). Other fragments of Spondylus along with many other species of mollusk, probably the remains of meals, were found mixed into the walls of the *albarrada*. The initial construction of the *albarrada* and deposition of the Spondylus is dated to the Engoroy period based upon a single radiocarbon date (2720 +/-70 B.P.) and ceramics typology (Stothert 1995).

Finally, Chorrera people used ear spools shaped like napkin rings that were often shaped from Spondylus shell (Holm 2001 [1980]).

5.3.2.2. Ecuadorian highlands

Many of the sites discussed above (e.g., Cerro Narrío and Pirinkay) continue to be occupied into this period, though, as mentioned above, Spondylus use in the Cuenca area appears to decline during this time (Bruhns 2003). At La Chimba, to the north of Quito in the northern Ecuadorian highlands, Spondylus was used at a constant level throughout the occupation of the site (c. 700 B.C. to A.D. 250; Stahl & Athens 2001). Of the four types of shells recovered (Spondylus, a shellfish tentatively identified as *Strombidae*, pearl oyster, and a conical shell), the former two are the most prevalent. Nearly all of the remains are small angular fragments, but do include a couple of Spondylus beads. Though 476 fragments of all types of shells were recovered, their total mass was only 352 g meaning that, on average, each fragment weighed less than ¾ of a gram (Athens 1995; Stahl and Athens 2001).

In the southern highlands of Ecuador, Chinguilanchi was occupied after the Narrío phase (see Cerro Narrío above) and yielded an interesting Spondylus cache. The subsoil of a floor near an 'altar' was filled with *Spondylus pictorum* (probably *S. princeps*) shells containing green, white and red *mullu*[2]. Beneath the altar itself, approximately 40 Spondylus shells were recovered with *mullu* inside the shells (Uhle 1922:208). Due to the lack of absolute dates and a very broad relative date, it is difficult to determine the precise chronological relationship of the site and its Spondylus.

5.3.2.3. Peruvian highlands, Chavín

As Paulsen (1974:601) stated, the advent of Chavín is associated with an increase in Spondylus use. In particular the iconographic use of Spondylus dramatically increases.

[2] Note that the term mullu is often equated with Spondylus, but we now know that this is not accurate (e.g., Blower 1995; see discussion below).

At the site of Chavín de Huantar, Spondylus imagery is present on the Tello Obelisk, which probably dates to the Urabarriu phase (1000 B.C.-500 B.C.; Burger 1992: 150, 165; Rowe 1967:Fig. 6). The imagery clearly depicts anthropomorphic *S. princeps*. The use of Spondylus imagery on a large stone sculpture from a religious complex suggests that it played an important role within religious ideology. Within the Gallery of Offerings at the Old Temple, also dated to the Urabarriu phase, an undisclosed number of cut fragments of Spondylus were recovered, along with food remains and human bones, and approximately 800 broken vessels that appear to have been brought to the site from great distances, perhaps by pilgrims. Some of the pottery was Cupisnique (Burger 1992:138).

Spondylus has been recovered from many Janabarriu phase contexts (400-200 B.C.). Imagery includes a representation of the 'supreme deity' or 'Smiling God' holding an unmistakable *S. princeps* shell in the left hand and a Strombus sp. shell in the right (Blower 1995:218; Burger 1992:1174; Rowe 1967:Fig. 21). This image was placed in the decorated patio of the New Temple and would have been visible to all gathered there. On the opposite side of the building a cornice pictures two individuals moving to the left, the one on the left holds a Strombus trumpet (20 such trumpets have been recovered) and the one on the right holds an *S. princeps* shell (Rick 2005). Spondylus is also depicted on ceiling slabs within the Room of the Ornamental Beams of the New Temple (Burger 1992:176).

During the Janabarriu phase, Spondylus use extends beyond the ceremonial center. It has been recovered from beneath the platform and retaining wall of a terrace around the ceremonial center, from small villages above Chavín and from elite contexts within the Janabarriu settlement (Burger 1992:168, 1984; Miller and Burger 1995). From a cache beneath the floor of the Late Janabarriu phase platform, seven artifacts (one discoid bead, one ovoid pendant, two tabular pendants and three large cut fragments) and 31 fragments of Spondylus were collected. From the same platform, excavators recovered four fragments and eleven artifacts of Spondylus: one cylindrical bead (not the same as a cylindrical bead as defined herein), one ovoid pendant, one circular pendant, two discoid beads, three tabular pendants, and three cut pieces (Burger 1984:214, Charts 14 and 15, Figure 432).

In the highlands of Peru north of Chavín de Huantar, the discovery of Spondylus at the site of Kuntur Wasi appears is unique for this time period because it contained a large number of small Spondylus beads, unlike other contemporaneous finds. A Kuntur Wasi phase (approximately 750-500 B.C.) burial (Tomb 4) of a woman contained 849 beads of various sizes and forms along with another 3653 tiny beads of stone and Spondylus and various other high status items, such as gold (Kato 1993:222-223). No quantities are given for Spondylus, but it is clear that a large proportion of the beads were made from this shellfish. The recovery of such a large quantity of Spondylus in a tomb may be related to the presence of some of the earliest gold working. Kuntur Wasi shows clear affinities with both the coastal cultures (i.e., Cupisnique; see below) and with the highland Chavín.

5.3.2.4. Coastal Peru, Cupisnique

Similar in both age and imagery to Chavín, the Cupisnique culture of the North Coast (mainly between the La Leche and Chicama rivers) appears to presage the importance of Spondylus and many other cultural traits of later North Coast cultures. Recently, it has become clear that Cupisnique, though related to Chavín, is a distinct culture heralded by earlier occupations at Monte Grande described above (Elera 1993; Shimada 1994:62-63). At the Cupisnique Clásico site of Puémape (Formativo Medio-Temprano; 1000-500 B.C.), burials were recovered with necklaces that included beads made from *S. princeps*, nacreous shell, lapis lazuli, turquoise, and rock crystal (Elera 1993:246). A Cupisnique Clásico style stone vessel also shows an eagle holding what may be a Spondylus valve on the end of a serpent (Elera 1993:249, Fig. 10; Lapiner 1978:Fig. 118), though this representation is not as unequivocal as later ones and those from Chavín de Huantar. At the site of Morro de Eten (Cupisnique Tardio, 500-200 B.C.), layers of ground Spondylus were recovered (Elera 1993:252) surrounding a large stone: the shells were apparently burned and broken (Heyerdahl et al. 1995:61, citing Elera 1986, his unpublished BA thesis). Interestingly, limited excavations at Caballo Muerto, the largest Cupisnique site, did not yield any Spondylus remains (Donnan and Mackey 1978:39-44; Pozorski 1979:Table I; Pozorski 1980; Pozorski 1995). A few Cupisnique stirrup-spout bottles that look remarkably like Spondylus shells have been identified (Cordy-Collins et al. 1999:105; Paulsen 1974:601). In contrast to the Chavín, the Cupisnique tradition seems to have included the use of Spondylus in ground form and as beads and to have portrayed the shellfish in ceramic.

To the north, fragments of Spondylus have been recovered from Cerro Ñañañique in the Upper Piura basin, a U-shaped earthen platform structure that roughly dates to 900-400 B.C. (Guffroy 1989). Neither the number nor the context of these remains has been published. Other fragments may have also been recovered from Cerro Vicús (Richardson et al. 1990:438).

The Paracas necropolises were created about the same time as Chavín and Cupisnique, approximately 450-175 B.C. A number of mummy bundles were recovered with Spondylus necklaces (Nos. 253, 114, 290, 319, 310, and 383), but exact information about the nature of these necklaces is limited (Blower 1995:218; Paul 1990:39; Tello 1959; Tello and Mejía Xesspe 1979).

5.3.2.5. Period B (1100-100 B.C.) summary

Between 1100 and 100 B.C. reverence for Spondylus in the Peruvian highlands and coast increased dramatically. This is one of the few time periods when Spondylus is represented iconographically. The contexts from which shell material has been recovered (e.g. at Chavín and Morro de Eten), indicates that the raw material was the ritually significant aspect of Spondylus. The recovery of Spondylus beads at a few sites may foreshadow the next period of Spondylus usage. There is no convincing evidence from Ecuador to suggest that coastal leaders were in charge of organized long distance trade.

5.3.3. Period C1 (100 B.C.- A.D. 900)- The Age of *Chaquira*

5.3.3.1. Coastal Ecuador- Regional Development Period

The earliest evidence for shell bead production comes from Guangala sites in the El Azúcar Valley (Masucci 1995) (see Figure 5-8 for locations of sites mentioned in this section). The occupation of the majority of the sites dates to the middle part of the Regional Development Period (i.e., A.D. 100-600). Six of the thirty-five sites contain dense scatters of worked shell, bead fragments, and lithic artifacts, including chert drills. Another eight sites had surface scatters of worked shell. Excavations at Site 47 yielded large quantities of both shell beads and lithic microdrills. Incredibly, of the 634 beads recovered only 37 (5.8%) were finished while 597 (94.2%) were ‘in-process’. Though approximately the same number of beads was recovered from Loma de los Cangrejitos, a major shell bead production site during the Manteño phase, where 164 out of 571 (29%) were finished. Also, a total of 1257 lithic drills were recovered from Site 47 compared to 444 from Loma de los Cangrejitos. In other words there were more drills per bead at Site 47 (198 drills per 100 beads at Site 47 versus 77 drills per 100 beads at Loma de los Cangrejitos). The reason for these differences is difficult to determine and may be due, in part, to differential site formation and post-depositional processes, but it is clear that Site 47 was an important shell bead manufacturing site. The amount of Spondylus recovered from the site is fairly small: only 45 of the 634 beads (7%) showed any sign of pink or red that would indicate Spondylus, which is very different from Loma de los Cangrejitos where 458 out of 571 (80%) showed colors that may be from Spondylus (defined as red, orange or purple). Significantly, Masucci also notes that identifying fragments of red shell to genus is problematic. Therefore, she combines Spondylus with *Chama frondosa*, which also has a red shell. Even considering this, other shellfish are much more numerous than *Spondylus*/*Chama* at the site. *Strombus gracilior*, *Anadara tuberculosa*, *A. grandis*, *Malea ringens* and *Hexaplex sp.* all have higher fragment counts and MNI than *Spondylus*/*Chama* (total fragments=300, MNI=27). Masucci also identified two size classes for beads, a smaller size (.4-.8 cm in diameter, .1-.5 cm in thickness, and .1-.2 cm for the diameter of the perforation) and a larger size (1.5-2.0 in diameter, .7-.9 cm in thickness, and with a perforation diameter of .4-.5 cm). The smaller beads correspond to those used in the Moche pectorals discussed below and the larger beads may have been destined for ‘local’ consumption near El Azúcar or other sites closer than Peru, such as the Jambelí Islands (see below).

Supporting evidence comes from Bushnell's excavation of the Carolina site, where "many beads of various forms were found at La Libertad [i.e., Carolina]. The commonest are barrel-shaped, cylindrical or discoidal, and most of them are of colored *Spondylus* shell" (Bushnell 1951:62). They are also common at the eponymous Guangala site. He recovered a Spondylus pendant and lithic microdrills, though he indicates that these are fairly uncommon at both the Guangala site and La Libertad, but more common at the site he calls Real or El Puerto de Chanduy (Bushnell 1951:68, 81). It is not yet clear how his excavation may relate to the Puerto de Chanduy material discussed in this dissertation dated to the Early Manteño period. A bone necklace spreader that keeps the strands of beads separate and parallel, as in the Moche pectorals discussed below, was recovered from the Guangala site (Bushnell 1951:79, Fig. 33). Although he does not indicate that the shell weights that he recovered were made from Spondylus (Bushnell 1951:Figs. 24a, 34a), they are very similar to those found at later period archaeological sites in the area .

The Early Guangala (c. 100 B.C.) site located in the modern town of Valdivia (site 172; Stothert 1993) and another located inland at Las Balsas (Stothert and Sánchez Mosquera 1998:216) both lack evidence of shell bead production, suggesting that this activity may be temporally or spatially limited. Shell bead production may have begun c. 100 A.D. or it may have been limited to the Santa Elena Península.

Levels at Isla de la Plata (OM-P1-I1-14) dated to the Bahia phase, another local cultural manifestation of the Regional Development Period, yielded Spondylus beads, but no further information is given (Marcos and Norton 1981:147, 1984:14). The often-cited torpedo-shaped stones that are usually interpreted as diving weights (e.g. Cordy-Collins

1990) are also present in the Bahia levels on La Plata, but no further information is available.

Study of the Jambelí, a Regional Development phase people who occupied the area around the mouth of the Guayas River and the southern neighbors of the Guangala, also has revealed evidence of Spondylus. Interestingly, the sixteen Spondylus shell beads recovered from Las Huacas on the Jambelí Islands on the southern side of Gulf of Guayaquil were of the larger size identified by Masucci; diameter ranged from 1.4-1.5 cm, thickness from .5-1.0 cm, and the diameter of the perforations from .4-.5 cm. Other Spondylus artifacts recovered from Las Huacas include a disk, an atlatl hook in the shape of a bird, another bird 'ornament' that appears to me to be a richly carved atlatl hook and an anthropomorphic pendant (Estrada et al. 1964:493).

5.3.3.2.Coastal Panama- Tonosí

Excavations at Cerro Juan Diaz revealed four group burials dating to the Tonosí phase (c. A.D. 400-700) that contained a total of 1200 artifacts made from Spondylus (Cooke and Sánchez H. 1997:77-79). Feature 1 contained 3 individuals accompanied by 400 tubular beads of Spondylus and Feature 2 contained 13 bundles with 1-3 secondary burials in each bundle and 34 Spondylus beads. Feature 94 is included in this group, but it is unclear how many Spondylus artifacts are from this feature. Feature 16, a burial of 18 individuals, apparently contained the majority of the 1200 Spondylus artifacts, though specific numbers are not given (Cooke and Sánchez H. 1997:63-67). Feature 16 contained a variety of Spondylus artifacts, including frogs and crocodiles as well as other animals none of which are similar to Guangala artifacts suggesting that the Guangala were not the makers of these artifacts. The elongated tubular beads, some more than 4 cm long, from Cerro Juan Diaz (Cooke and Sánchez H. 1997:Fig. 8) are much longer than any from Ecuador, also suggesting local production. A lithic microdrill would never be long enough to perforate the length of such a bead, suggesting that a different material, perhaps organic or metal, was used. Cooke also reports that similar shell remains have not been encountered at sites in Panama dating to earlier period or later periods, with the possible exception of Playa Venado. Later evidence for Spondylus production at the Cerro Juan Diaz includes a shell workshop (see below).

5.3.3.3. Ecuadorian and Colombian highlands

The evidence of Spondylus use in the Ecuadorian highlands is very limited, but unparalleled none-the-less. At La Florida, a Chaupicruz phase site (c. 100-450 A.D.) in the Quito suburbs, six extremely deep shaft tombs revealed 674,643 tiny shell beads along with other shell ornaments, including mother-of-pearl plaques and whole shell beads of *Trivia radians* and *Conus perplexus* similar to those encountered in Manteño sites (see catalog). Even considering the consumption of shell beads by the Moche, the sheer quantity of beads from La Florida is astounding. The majority of the beads were purple (310,961 or 46.1%) or white (282573 or 42%, including some that were copper stained) and a smaller fraction are red (79014 or 11.7%). Doyon identifies these groups as all pertaining to Spondylus, suggesting that no other types of shells were needed since the same shells from which the red and purple beads came could also have yielded white beads. While this may be true, the definitive identification of any white bead to a species is extremely difficult and, as Masucci has noted, it may not even be possible to identify the red as *S. princeps* and the purple as *S. calcifer* as Doyon does. Tubular beads were made exclusively from red shell, which is different from the case at Loma de los

Cangrejitos. Beads appear to be one of the artifact classes that distinguish the highest level elite in the shaft tombs from their companions. Shell beads tend to be located towards the interior of bundle burials, often in the pelvic cavity of the individual.

In the Colombian Andes, tiny Spondylus beads have been recovered from Malagana (c. 200 B.C. to A.D. 200) sites, but few details are given. The beads came only from the riches graves, which had been looted for their beautiful golden artifacts (Bray et al. 2005:157, 180, Figures IV.16, IV.74, IV.75). The beads appear to have diameters of less than five mm (Bray et al. 2005:Figure IV.74).

5.3.3.4. Coastal Peru- Moche and beyond

During Period C1, Spondylus consumption increases dramatically with the development of Moche culture on the North Coast of Peru and Huari (or Wari) culture in the Peruvian highlands. Although originally it was thought that the Moche used little Spondylus (Cordy-Collins 1990), it is now clear that they were the first Peruvian group to use it on a wide scale.

At the world famous site of Sipán in the Lambayeque Valley, large quantities of Spondylus artifacts and ecofacts were recovered. The funerary platform at Sipán was occupied between A.D. 1 to 300 (Moche I, II and part of III) and built in six sequential stages. One of the richest tombs (Tomb 3), contained an individual now know as the Old Lord of Sipán, dates to the earliest construction phase. The other two high status tombs (Tomb 1 and 2), known as the Lord of Sipán and the Priest respectively, date to a more recent construction phase (Alva 2001; Alva and Donnan 1993).

These three tombs contained many layers of rich cloth, metal regalia, and other offerings, amongst which were Spondylus shells. Tomb 3 contained approximately 11 valves, Tomb 2 had 31 valves and Tomb 1 revealed more than 14 valves (Alva and Donnan 1993:Figs 56, 57, 167, 183; quantities based upon figures). The valves appear to vary significantly in size, with some being quite large, like those from later Sicán tombs (see below) Tombs 1 and 3 included gilded copper artifacts inlaid with Spondylus (Alva and Donnan 1993:Figs).

All three tombs also included shell bead pectorals, which are necklaces with multiple rows of tiny shell beads arranged in an arc across the wearer's chest with each strand separated from another by a separator. A separator is a rod of metal, bone, shell or other material that is perforated in a line to keep the strings of beads separated from each other. Each pectoral utilized many thousand of tiny shell beads (*chaquira*).

The Old Lord of Sipán in Tomb 3, the oldest of the major tombs, was interred with five pectorals of *chaquira* and three more of other shell artifacts (Alva and Donnan 1993:Figs). It is unclear how many of these pectorals contained red or pink beads indicating Spondylus because they had been mixed prior to excavation. In the illustration provided by the authors, however, a purple pectoral is pictured, perhaps indicating the presence of numerous purple beads (Alva and Donnan 1993:Fig 183). The Old Lord was also buried with pectorals at his feet made from larger, mainly white, plaques with two parallel perforations running the length of the bead (Alva and Donnan 1993:Fig 183). Another three pectorals at his feet were made of long rectangular pendants with tentacle-like appendages at the ends giving them an octopus look (Alva and Donnan 1993:Fig 183). One remarkable pectoral has red shell inlaid into the white shell (Alva and Donnan 1993:Figs. 235, 237, 238). The Old Lord was also interred with beaded bracelets which contained some red and purple shell beads (Alva and Donnan 1993:Figs. 239-241).

Tomb 1, the tomb of the Lord of Sipán, contained nine shell bead pectorals, along with one metal, but only five of them contained red or pink *chaquira* which would indicate Spondylus usage (Alva and Donnan 1993:Figs). A male who accompanied the Lord of Sipán in the tomb, and probably to the afterlife, also bore a red shell bead pectoral (Alva and Donnan 1993:Figs). The Lord also wore a bracelet that contained a few tiny red and purple beads along with turquoise and gold ones (Alva and Donnan 1993:Figs).

Tomb 2 contained two pectorals that were composed exclusively of white beads (Alva and Donnan 1993:Figs). An individual sacrificed with the Lord of Sipán also wore a bead pectoral. Of the other nine tombs that have been located at Sipán, some also contained shell bead pectorals (Tombs 7, 8, 9), bracelets (Tomb 7) , as well as metal artifacts inlaid with shell (Tomb 5, 9) and whole valves (Tomb 10) (Alva 2001).

The excavation of a looted Moche I tomb at La Mina in the Jequetepeque Valley also yielded 19 fragments of *S. princeps*, one fragment of *S. calcuter* [sic; *calcifer*], and small shell beads (none identified as Spondylus). Considering the intricate wall painting and other aspects of this tomb, it was quite likely occupied by a high status individual with many more grave goods than those that were recovered (Narváez V. 1994).

The Moche III cemetery at Pacatnamú is one of the largest excavated to date and contains extensive evidence of Spondylus use, mainly limited to beads (Donnan and McClelland 1997). Nine burials out of the 84 excavated at the site contained Spondylus artifacts or artifacts that may be Spondylus (Table 5-4), all of which contained women or children even though males (n=28), females (n=27) and children (n=27) were similarly represented in the excavated sample. The criterion used for identifying the beads as

Spondylus is unclear, but it may be that 218 Spondylus beads were used in seven different burials (Donnan and McClelland 1997).

Moche use of Spondylus valves as offerings and as raw material continues through Moche V (A.D. 550- 650/700) as evidenced at the sites of Pampa Grande (Haas 1985; Shimada 1982:164-165; Shimada 1994) and San José de Moro (Castillo and Donnan 1994; Donnan and Castillo 1994). The transition from Moche IV to V is dramatic, characterized by the absence of southern Moche occupation, even at the site of Moche (Huaca del Sol and Huaca de la Luna), and the movement of northern Moche people to the necks of valley systems. Pampa Grande was one of the largest of the urban Moche V settlements and included the immense Huaca Fortaleza (or Huaca Grande) and 29 other mounds along with a dense urban occupation generally not seen in earlier periods. Extensive archaeological research at Pampa Grande has yielded only limited evidence of both elite and commoner burials: even heavy erosion that revealed the base of Huaca Fortaleza did not indicate any burials within the structure. As compared to Sipán, archaeological work did not focus upon nor encounter high status burials (Shimada 1994: 240-242). Remains of Spondylus at Pampa Grande come from two main contexts: atop Huaca Fortaleza and from workshops in the area.

Huaca Fortaleza is composed of three terraces of increasing height and linked by a long, at times steep, ramp. The long straight ramp contained within walls from the ground to the first terrace had three spots were access was limited (checkpoints). When the second checkpoint was remodeled, “single *Spondylus* sp. shells (both valves, articulated)” (Haas 1985:397) were placed on the floor in front of the walls used to restrict access. Another complete, articulated Spondylus shell was uncovered beneath a ramp separating the eastern portion of the first terrace. A Spondylus necklace was placed on top of the bones of a child and an immature llama beneath an access ramp to a complex of rooms on the third and highest terrace. The necklace is not like the Sipán pectorals, but a ring of 46 trapezoidal pendants along with 20 turquoise beads, five tubular Spondylus beads, and two tubular azurite (more likely sodalite; Shimada 1994:214) beads. Just beyond the top of the ramp, a similar necklace was recovered in a shallow sub floor pit. This necklace contained 52 trapezoidal Spondylus pendants, 25 turquoise beads and 10 azurite (sodalite?) beads (Haas 1985:404). Another necklace was located on top of the second largest mound at the site, Huaca 2, in a small pit adjacent to a larger pit containing the remains of a llama (Haas 1985:407).

Haas (1985:Table 2) also reports four fragments of 'imitation *Spondylus*' in ceramic in the two rooms immediately behind the ramp. He describes these fragments as belong to a "thick ceramic bowl with an exterior studded with small knobs" (Haas 1985:Table 2). Such a description does not necessarily identify the ceramic artifacts as imitation Spondylus, although they may come from object similar to the Moche V stirrup-spout bottle at the Museo de la Nación that is more clearly modeled in the shape of two Spondylus shells (Shimada 1994:Fig. 9.14).

The Spondylus workshop uncovered by Shimada (1994; see also Anders 1981) at Pampa Grande is the best of the limited evidence for Spondylus-working in prehistoric Peru. A surface scatter of Spondylus fragments was located at the southeast corner of Huaca 11 (a.k.a. Spondylus House), within Compound 15. The scatter lay in room 1, a multi-terraced room approximately 8 x 8 m. Excavations yielded thirty-two whole Spondylus shells along with numerous other fragments of shells. Amongst those fragments of shell roughly trapezoidal pieces with their spines removed were recovered. These are clearly precursors to the trapezoidal pendants recovered from Huaca Fortaleza. Tiny spines that had been removed from larger shells or pieces of shells were also present in high numbers. A fist-sized cobble was the only tool recovered from the room (Shimada 1994:213-216). Spondylus artifacts may not have been finished in this room as no finished pieces were recovered nor were any of the sandstone abraders presumed to be used for the final stage. Scatters of Spondylus next to Huacas 10 and 13 indicate that Spondylus production was restricted to high status areas. Both the placement of the physical workshop within a non-residential area with relatively restricted access, and the location of the recovery of finished artifacts (on Huacas), suggests the tightly controlled production and use of Spondylus.

The excavation of a floor with 45 Spondylus fragments, in the non-elite southwest corner of Sector K of Pampa Grande, may indicate that some Spondylus was not tightly controlled by the elite. The fragments may be Chimú in date, however, as they are associated with more Chimú than Moche V pottery (Shimada 1994:273, note 134). Spondylus fragments were also recovered from a small, isolated structure at the edge of sector J and may also indicate a Spondylus workshop dating to the post-Moche V occupation (Shimada 1994:145).

San José de Moro, in the Jequetepeque Valley, was occupied by the Moche from approximately A.D. 400-700. Though a single Moche III burial of a neonate included a Spondylus shell over each hand (Castillo and Donnan 1994:119), Moche V contexts were much richer in Spondylus. Moche V tombs were larger and contained an antechamber and multiple burials, with a single principle burial predominating. Two of the principle individuals have been identified as Sacerdotistas (Priestesses) in the Moche Sacrifice Ceremony (Donnan and Castillo 1994). Details of these burials have not been completely published yet, but the first (elder) Sacerdotista was buried with Spondylus shells in each hand and on her chest (Donnan and Castillo 1994:419), and the picture of the second Sacerdotista seems to indicate Spondylus shells in her hands as well (Donnan and Castillo 1994:Lámina XVI). Necklaces and bracelets of shell are also mentioned (Donnan and Castillo 1994:417).

The principal individual in the one, well-published tomb (M-U30) from San Jose de Moro, was interred with a necklace that included Spondylus beads and with Spondylus valves in both hands (Castillo and Donnan 1994:124-125). The authors indicate that this is the pattern for all five large tombs (including the two Sacerdotistas) (Donnan and Castillo 1994).

The site of Moche, including Huaca del Sol and Huaca de la Luna and their environs, show little evidence of Spondylus use during the Moche period (Donnan and Mackey 1978). Contexts mainly date to Moche III and IV, with smaller, more difficult to access occupations underneath. While burials such as those from Sipán have not been uncovered at Moche, some of the burials from the elite sector between Huaca de la Luna and Huaca del Sol have copper masks with unspecified shell inlay (Shimada 1994:102). It is quite likely that Huaca del Sol contained elaborate burials such as those from Sipán but these were destroyed by the colonial looting of the site. The many Moche (mainly III and IV) burials in the urban sector between the Temple of the Sun and the Temple of the Moon reveal no Spondylus and little shell (Chapdelaine 2001; Donnan and Mackey 1978).

Many more Spondylus artifacts from Moche contexts are known from looted material. The Museo Arqueológico Rafael Larco Herrera, in Lambayeque, contains three more pectorals of tiny Spondylus beads and a group of sixteen strands interwoven to make a thick necklace (Cordy-Collins et al. 1999:130-133).

Although it is clear that Spondylus shell, both natural and modified, were important to the Moche, it is surprising that it is not represented in their art. Cordy-Collins (1999, 2001) has argued that Spondylus is represented in Moche iconography as a stemless cup held by the Sacerdotista in Sacrifice Ceremony imagery. However, of the images provided by Cordy-Collins only two show the Sacerdotista holding stemless cups (Cordy-Collins 2001:Fig. 3.3), while others hold a stemmed chalice (Cordy-Collins 2001:Fig. 3.3, upper register; Fig. 3.10 upper register). Stemmed chalices were recovered from the tombs of both Sacerdotistas at San José de Moro (Castillo 2001:306, 314, Fig. 7; Donnan and Castillo 1994:420). Cordy-Collins relies heavily upon the association of Spondylus with femininity, based in Cupisnique/Chavín, Inka, Maya, and Kogi analogies, and that the Sacerdotista is the only female shown in Moche scenes. She also argues that the Priestess is pictured with diving weights, but they are present only in a few of the images and it is not clear that a diving weight is being pictured. Considering the accuracy and the importance with which other sea creatures are portrayed in Moche art (e.g., Bourget 1994), it is likely that, if the Moche were involved in the acquisition of Spondylus, they would have portrayed it. *Strombus*, which is often thought of as the other half of the dyad (Marcos 1977-78; Paulsen 1974), is pictured in many Moche vessels. In this light, we can continue to state that the Moche did not appear to have represented Spondylus unequivocally on pottery or murals.

Spondylus occurs in contexts from other Peruvian coastal cultures contemporaneous with the Moche, but quantities are much smaller and Spondylus shells and objects made from it do not seem to be as central to religious and social interaction. It is interesting that research in the Upper Piura Valley, an area that both had its own cultural entity, known as Vicús, and that was occupied later by the Moche, has resulted in very little discussion of the archaeological occurrence of Spondylus (Guffroy et al. 1989; Guffroy et al. 1989; Kaulicke 1991; Makowski et al. 1994). To the south, the one burial comparable to those from the Moche area is from the site of Cerro de Trinidad in the Chancay valley, occupied during the contemporaneous Lima period: this burial surrendered a "whole Spondylus shell, smoothed and ground, a necklace of 48 Spondylus beads, and about 200 more formerly sewed to a headdress, some Spondylus necklace spreaders and a copper-and-gold face mask" (Paulsen 1974: 602). The Museo Arqueológico Rafael Larco Herrera owns a ceramic vessel attributed to the Lima period that pictures a *caballito* (reed boat) with a rider holding a Spondylus shell (Cordy-Collins et al. 1999:107). The site of Nievería, which probably dates to Middle Horizon 1B (Menzel 1964), also yielded a variety of Spondylus artifacts (Gayton 1924-1927320-321), but dating is problematic.

5.3.3.5. Peruvian highlands

In the North Highlands, the Condebamba Valley was occupied both by the local populace at Marcahuamachuco and Cerro Amaru (c. A.D. 350-800) and later by the Huari, mainly at Viracochapampa (A.D. 600-800; see Period C2). Much larger quantities of Spondylus have been recovered from these sites than at other Huari sites. At Cerro Amaru (c. A.D. 350-800), part of the mausoleum floor was covered with a layer of burnt cut pieces of Spondylus (Topic 1991:159; Topic and Topic 2000:197). Also at Cerro Amaru, Max Uhle, in 1900, dredged 3000 *chaquiras* (small shell beads) and approximately 90 plaques (rectangular or trapezoidal pieces?) of Spondylus, along with 18,000 beads of semiprecious stones from one of the wells (Topic and Topic 2000:197; Topic 1992:243). The best dates for the construction of these wells is around 350 A.D. (Topic and Topic 2000: 197), suggesting that these offerings were prior to the Huari occupation of the site.

Within the Castillo of Marcahuamachuco, 9.6 kg of Spondylus shell was recovered from a pit located in an unusually wide gallery on the SE side of the site (Topic 1989). The shallow pit (40x65 cm and 35 cm deep) contained a minimum of 20 valves of Spondylus with their edges and exteriors ground. Rectangular pieces were the most numerous type of Spondylus artifact and, although they were fragmented, a minimum of 270 rectangular pieces are represented based upon the presence of 75 reconstructable shells and 187 'upper' margins. Approximately 10% of the rectangular plaques were perforated. The most interesting aspect of this pit is the presence of fragmented miniatures (all less than 2 cm) made from a bluish-green stone. Three types were recovered. The first was shell or fan-shaped with rounded corners with three or four spikes or 'feet' and an incised line around the 'equator'; approximately eleven were present. The second was the same shape but with a grid pattern incised on the surface and without the 'feet'. A minimum of 15 of these artifacts were present. The third, blue-greenish artifact was triangular with an incised line and represented a minimum of 87, but perhaps as many as 120 (Topic 1989). The first, and possibly the second, represents a Spondylus shell. Theresa Topic (1989:3) says of the first: "These small carvings have all the essential elements of Spondylus shells and are undoubtedly meant to represent them". Photographs of these objects, courtesy of Theresa Topic, convince me that the second may be more like Spondylus than the first. The third may represent stylized female genitalia (Topic 1989; Topic 1989).

Within the Recuay tradition (c. A.D. 1-800 or 250-700) of the northern Peruvian highlands there is little indication of Spondylus usage at a level close to the Moche with whom they interacted (Lau 2002-2004; Lau 2005). This is somewhat surprising considering the proximity of the earlier site of Chavín de Huantar, where Spondylus was quite obviously sacred.

5.3.3.6. Period C1 (100 B.C.-700 A.D.)- Summary

During the period from 100 B.C. to 700 A.D., there is a dramatic increase in the consumption of tiny shell beads known as *chaquiras*. Currently there is only evidence for the production of these beads among the Guangala people of the Ecuadorian coast. Consumption appears to have been dominated by the Moche of the Peruvian coast and perhaps by Chaupicruz phase people of the Ecuadorian highlands. While the whole shell appeared to remain important to the Moche, other artifacts of Spondylus and fragments of Spondylus appear to have gone out of style. Considering the prominence of the shell and of beads made from it, it is surprising that the Moche, known for their realistic depictions of nearly everything, did not represent Spondylus in any other medium. Towards the end of this period, especially at Moche V Pampa Grande, there is increasing evidence of Spondylus working and a change in the use of Spondylus. Spondylus at Pampa Grande was repeatedly used as offering in (to?) structures. This is similar to the Huari use of Spondylus (see below), which because of overlap between the two periods could be placed in either this section or the next. It is quite likely that the production of *chaquira* among the Guangala is associated with the acquisition of copper from Peru. While the tiny shell beads were being made by coastal Ecuadorians, it is also apparent from the evidence at Pampa Grande that production of other types of Spondylus (and perhaps redistribution of shells and fragments of shells) was beginning to be controlled.

Spondylus was used in fairly large quantities at Marcahuamachuco, in the northern highlands of Peru. The placement of offerings in wells and buildings may have been the inspiration for Huari offerings.

5.3.4. Period C2 (A.D. 900-1100): The Spread of Production

5.3.4.1. Coastal Ecuador- Manteño and Atacameño

The evidence described in Chapters 6 and 7 clearly indicates extensive acquisition and production of shell, including Spondylus, during the Manteño phase of the Integration Period. Manteño begins at approximately 800 A.D. and ends with the arrival of the Spanish. Early Manteño, which coincides generally with the time period in question (i.e., c. 700-1100 A.D.) shows the greatest evidence of shell bead production, especially at Loma de los Cangrejitos and López Viejo (see Figure 5-9 for locations of sites mentioned in this section). At the latter site, approximately 10,000 beads were recovered, 2837 of which are studied for this analysis. Loma de los Cangrejitos yielded less (573 beads are studied herein) because the excavations were more limited. Lithic microdrills and other shell-working tools and other types of shell artifacts were also recovered from both sites. Unlike the beads from the Guangala site of El Azúcar, the majority of the beads from both Loma de los Cangrejitos (458/531 or 86.3%) and López Viejo (1567/2805 or 55.9%) contained at least some red, orange, and/or purple indicating

Spondylus. Also included during this time period are two additional sites: Los Frailes where mother-of-pearl artifact production was much more significant than Spondylus artifact production ,and Puerto de Chanduy a fish processing site that contained only finished beads with little evidence for production at the site.

Evidence for the use of Spondylus during the earlier part of the Manteño phase includes La Libertad (Sites A and B) and Ancón (Bushnell 1951). Bushnell recovered a burial from the La Libertad site containing “a large number of very small cylindrical beads of copper and *Spondylus*-shell” (Bushnell 1951:99). He also indicates similar evidence for shell beads from Ancón (Bushnell 1951:118). Estrada illustrates some artifacts similar to those found at the Manteño sites considered herein, but says nothing about Spondylus (Estrada 1979). He does illustrate a necklace separator from Jelí, near the modern town of Engabao, or Playas.

At San Marcos, on the northern edge of the Santa Elena Península, Stothert recovered shell beads and Spondylus artifacts from graves. Spondylus artifacts included an atlatl hook in the shape of a feline (Stothert and Cruz Cevalos 2001). It is unclear how many artifacts were made from Spondylus, but beads are included (personal observation, San Marcos Museum, 2004). The dating for this site is based upon similarities with Loma de los Cangrejitos (perhaps as early as A.D. 700) and the presence of Inka vessels (as late as A.D. 1500).

At the Ayalán cemetery, near the town of Playas on the north coast of Gulf of Guayaquil, 6003 beads were recovered of which 5243 were small discoid beads. Of the smaller beads 4013 (76.5%) were white or off-white, 140 (2.7%) were irregular off-white and had a stone-like texture, 441 (8.4%) were a solid color (red, orange, lavender, pink, yellow or black) and 649 (12.4%) were white and colored. The burials at the site date between 500 B.C. and A.D. 1600, but most of the radiocarbon dates cluster between A.D. 700-1100 and, therefore this site is placed within Period C2, while recognizing that some of the material may pertain to periods before and after this. This matches Ubelaker's identification of the site as a Late Integration Period site (Ubelaker 1981). This site has cultural affinities with both Manteño (Huancavilca) and Milagro-Quevedo cultures (Stothert 2001:310), which is not surprising considering its location between these two major cultural areas.

Production did not spread just within the area of the Manteño, however, but reached north to Atacames, where there is extensive evidence for Spondylus use and some production that had not existed in previous periods as well as a shift of sites towards the ocean side (Guinea 1989, 1995). Most of the evidence for extensive Spondylus and shell bead use comes from Tola 69 (Cabada 1989), which Guinea (1989:Appendix 1) dates to the Early Atacames phase (700-1100 A.D.). Although ceramic beads were more numerous than shell beads, 1581 discoid shell beads were recovered, of which 32% were white and 68% were red or orange. In-process beads were also present (Cabada 1989:Fig. 5), but it is unclear what proportion of the total shell beads were finished or in-process. Lithic microdrills are absent from the site. Seventy-seven necklace separators were also recovered, but only 2 of them were made from Spondylus.

It is interesting to note that Spondylus made up approximately the same percentage of the shell assemblage from both Early and Late Atacames (A.D. 1100-1526) phase excavations. A total of 18.59 kg of Spondylus was reported from six tolas (mounds): between 12.4% and 24.9% by weight of the shell assemblages from Tolas 86, 86b and 79 dating to the Early Atacames phase were Spondylus, while 21.6-22.9% by weight of the shell assemblages from Tolas 75 and 101, dating to the Late Atacames phase were identified as Spondylus. This may indicate that Spondylus utilization was relatively unchanged during these two phases (Guinea 1984, 1989).

To the east of the Manteño, the people whose material remains are called Milagro-Quevedo occupied much of the Guayas Basin between c. A.D. 700 and 1600. They used large earthen platforms as burial grounds and ritual spaces, and built raised fields in seasonally inundated areas (Delgado Espinosa 2002; Muse 1991; Zevallos 1995:261-290). They were major consumers of shell beads, though it is unclear how many of these are made from Spondylus. At Yaguachi Viejo (a.k.a. Jerusalen; Delgado 2002), Zevallos excavated a mound at 'Hacienda Isabel' that yielded multiple burials in large, stacked pottery vessels. With these burials, numerous shell beads were recovered, many of which were red or purple. Some were recovered in situ, providing evidence that they were parts of compound objects consisting of many rows or beads strung together, as with many Moche artifacts (described above). The bead assemblage included mainly the small discoid *chaquira* and an arched claw-shaped bead (perhaps similar to the '*colmillo*' beads from Cerro Juan Diaz; see below). Beads came mainly from the burials of individuals between 10 and 15 years of age. Although many thousands of beads are pictured strung together, their exact provenience is unclear, though Zevallos does indicate that they came from upper levels at the site (Zevallos 1995:286-290). Based upon the presence of *chaquira*, I suggest that Zevallos' sites belong to this period or the previous, although Zevallos' indication that they come from upper levels of the mound may suggest a later date. Delgado also recovered shell beads with burials from the nearby Milagro-Quevedo site of Vuelta Larga, but little other information is given except that most come from adult burials (Delgado Espinosa 2002). No shell beads were recovered from Peñon del Rio, a smaller Milagro-Quevedo site (Muse 1991).

5.3.4.2.Coastal Panama- Cubitá

Much farther north, there is evidence for the production of Spondylus artifacts at the site of Cerro Juan Díaz, Panama. Operation 8, dated stylistically to the Cubitá phase (A.D. 700-900), but with a single radiocarbon date a little later, c. 1100 A.D., yielded much evidence for working Spondylus. Shell artifact production at Cerro Juan Díaz appeared to focus more upon gastropods, including *Strombus galeatus, Conus patricius*, *Melongena patula* and other gastropods (76.8% of shell fragments by count and 79.1% by weight), while Spondylus made up a much smaller portion of the shell-working assemblage (12.3% of shell fragments by count [n=1057] and 15.3% by weight). Of the in-process and finished shell beads recovered, non-discoid beads, including '*bastón*' (n=171 or 59.6%) and '*colmillo*' ('tusk'- n=34 or 11.8%) style beads, were present in greater quantities than discoid beads (n=82 or 28.6%) (Mayo and Cooke 2005). Although the people of the Cubitá phase at Cerro Juan Diaz were producing Spondylus artifacts and shell beads, it is also clear that these types of artifacts were not priorities as they were at the Manteño sites.

5.3.4.3.Coastal Peru- Sicán

The Sicán (a.k.a. Lambayeque) were centered in the Lambayeque and Leche Valleys, though their influence was more extensive. Sicán culture developed out of the preceding Moche V with influence from Cajamarca and Huari cultures. Little is known about Early Sicán (c. A.D. 750/800- 900) because few large structures were built during this time, especially compared to the Middle Sicán period (c. A.D. 900-1100) when most of the large corporate structures within the Batán Grande area were occupied. Late Sicán (c. A.D. 1100- 1375) is dominated by the monumental site of El Purgatorio (or Túcume Viejo) near the modern village of Túcume (Heyerdahl et al. 1995; Shimada 1990). Evidence for Spondylus use during Late Sicán is equivocal because most of the Spondylus consumed at the site comes from later Chimú and Inka contexts.

Evidence for Spondylus use among the Sicán comes mainly from the elite tombs of Batán Grande (a.k.a. the Poma District) uncovered by Izumi Shimada in 1991-92 and 1995. Two tombs of two very high ranking individuals were located at the base of Huaca Loro, where the low, rectangular North Platform intersects with the main body of the pyramid. The East Tomb was excavated first and yielded the largest quantity of Spondylus yet recovered in a single interment. Along with a large amount of other grave goods, two large piles of each Spondylus and *Conus*, equaling 179 whole *Spondylus princeps* and 141 whole *Conus fergusoni* shells, were interred in the tomb. These Spondylus shells were particularly large specimens, each weighing approximately 1 kg and 16-17 cm in diameter (Shimada 1995:Figs. 31, 37, 79 and 82; Shimada et al. 2000:Figs. 2.8, 2.9, p. 37). Most other measured Spondylus shells are closer to 10 cm. Also a group of beads, probably from a pectoral, were recovered from the thorax area of the burial. Beads included turquoise, sodalite, amethyst, transparent quartz crystal, calcite (pink), fluorite (white and clear green), agate (reddish brown), amber, and Spondylus shell (Shimada 1995:68; Shimada et al. 2000:38). Upon the golden gloves, worn by the buried individual, were two sets of bracelets of tiny turquoise and shell beads (Shimada

1995:Fig. 55, p. 72; Shimada et al. 2000:Fig. 2.11, p. 40). Offerings within Niche 1, the largest and deepest niche, included four groups of beads. To the South, one small and one large (22.5 kg including large amethyst and clear crystal beads), and in the northwest another two were recovered, one predominantly of Spondylus (c. 10 kg) and the other predominantly of sodalite (c. 23kgs). From the photos it is quite likely that all of these bead groups included some Spondylus beads (Shimada 1995:Fig. 33, 34, p. 58, 60). Another group of beads, predominantly turquoise but with some that are clearly Spondylus and weighing 22 kg., were recovered from within the central chamber of the tomb (Shimada 1995:Fig. 78, p. 93). One woman, who was interred with the principal individual, also wore a beaded pectoral in death (Shimada 1995:Fig. 67, p. 87; Shimada et al. 2000:41). Spondylus beads within the tomb and niche include a wide variety of beads, including tiny *chaquira* and larger beads along with both cylindrical and discoid beads. Shimada (1995:157) claims that the quantity of whole Spondylus and Spondylus beads from the East Tomb is the largest collected to date at any site in Peru.

Though proximate, the West tomb is unlike the East one: it is deeper (15 m compared to 11 m), covered more area (10m x 6m versus 3m x 3m), contained more human burials (24 individuals versus 3 individuals), and yielded more metal objects both associated with the principal individual (22 v. 7) and from the chests buried with him (64 v. 23). Some of the East Tomb artifacts, however, appear to have been more finely crafted than those from the West Tomb (Shimada 1995; Shimada et al. 2000; Shimada et al. 2004). The two tombs differ in their shell contents also. Similar to the principal individual in the West Tomb, the East Tomb individual was buried with an unspecified number of pectorals made of a variety of beads of different materials, including

Spondylus, amber, turquoise and sodalite and with bracelets on golden gloves. It is unclear if the bracelets included Spondylus. One of the two women buried in the niches of the central chamber also wore a bead pectoral, but the material is unspecified (Shimada et al. 2000:44). The second woman was buried beneath a bundle of unspecified beads (Shimada et al. 2004:377). Compared to the 147 whole Spondylus shells in the West Tomb, there were only two whole Spondylus shells in the East Tomb. An incomplete staff with a Spondylus finial carved on the end was also included in the burial (Shimada et al. 2000; Shimada et al. 2000:44). Another eleven *S. princeps* shells were placed along the line of sight between the only two males in the tomb, the juvenile male in niche 6 and the principal individual (Shimada et al. 2004:377). The East Tomb is not as well published as the West Tomb since it was excavated five years later, so as a result the information about beads or Spondylus may not be complete. Available evidence indicates that the East Tomb contained fewer whole shells and shell beads, even though it contained much greater quantities (though perhaps poorer quality) of metal goods and more accompanying interments.

A large, partially looted tomb at Huaca Las Ventanas was also excavated. The inverted stepped pyramidal tomb yielded neither gold or silver objects nor a principal burial. It did reveal three complete burials and six other damaged burials approximately 10-12 m below the surface. These burials had few grave goods, but they did include a few shell beads, though it is unclear if Spondylus ones were included. At the bottom of the tomb fine ceramics, beads of amber, arsenical copper *naipes* and other copper objects were recovered. Between eight meters down and the bottom (at 15m) on the west side of the tomb a series of offerings were recovered, including a large group of shell beads.

Perhaps more importantly, the steps of the tomb were lined with painted textiles on a *tumbaga* base. One of the best preserved pieces represents the Sicán Cosmovision: in the middle is the Sicán Deity with *tumi*, a T-shaped knife apparently used in making ceremonial sacrifices, and a trophy head in his hands with a serpent arching over his head while outside two felines face the Deity with their limbs in the 90° position (see below). Around the felines are numerous three-, four- and five-pronged crescents, some of which still bear their original red paint (Shimada 1995:Fig. 121). These crescents probably represent Spondylus valves (see below).

Other evidence for Spondylus usage during the Middle Sicán phase includes dedicatory offerings inside columnar boxes at Huaca Rodillona. Columnar boxes are essentially a exterior box of adobe bricks, infilled and capped with a thick layer of adobe mud that form the basic structural unit for Sicán monumental construction. Within the top of many Sicán pyramids the bases of large columns are placed within these adobe boxes, within which dedicatory offerings were left. Of the seven excavated by Shimada, each had a single whole Spondylus shell along with thirty to fifty bundles of I-shaped arsenical copper and every other one also contained a dedicatory human burial (Shimada 1990:341, Figs. 24 and 25). Shimada (1990:366) estimates that 400 whole Spondylus shells would have been used at Huaca Rodillona.

Outside of the Lambayeque and La Leche Valleys, the evidence for Spondylus use is limited. Although the later occupation at Pacatnamú was originally dated to the Chimú period, it apparently fits more properly into the Lambayeque (Sicán) period (Donnan 1986, 1997). A woman inside a mummy bundle (Burial 1) from H1M1, a mound to the southeast of Huaca 1 within the Major Quadrangle, had one of two articulating valves of Spondylus tied to each of her hands with sheer fabric (Verano and Cordy-Collins 1986:89, Fig 6). Broken and charred Spondylus was recovered from beneath the floor of a U-shaped structure (*audencia*; similar to the U-shaped structures at Chan Chan) along with the remains of four youths. A 12-14 year-old individual was buried with four Spondylus beads in a burial chamber approximately 5 m in front of the u-shaped structure (Bruce 1986:98-100). Miniature textiles, but without wooden figurines as at later Chimú sites, were also recovered from Pacatnamú (Bruce 1986:98; see also Keatinge 1982:216 and below).

Imagery involving Spondylus, and specifically Spondylus harvesting, is common on elite items in museum collections that may belong to the Sicán phase. The dating of these may be questioned. Cordy-Collins (1990) uses 13 different examples of Sicán (Lambayeque) art to highlight that society's interest in the acquisition of the sacred shell (see also O'Day 2000:Fig. 3.9). These objects include earspools of gold, silver and an unidentified metal (six single examples and one pair), a pair of gold 'ornaments', a silver cylinder, an inlaid wooden bowl, a pair of silver repoussé disks, a spatula and a textile. Each show a diving scene involving that is more or less stylized. The least stylized versions shows a tule or balsa 'boat' represented by a fairly accurate depiction of a tule reed vessel with upturned prow, a log raft with a sail or superstructure or by a simple line. Beneath the vessel a diver is attached to line that extends to the deck of the boat. Often in the hands of the divers is a three- or four-pronged crescent. The pronged crescent rarely has five prongs and may include a crescent within the pronged crescent. The divers are almost always pictured with no headgear and no clothing at all. Often they wear a belt, though this may just be the rope around their waist, with either a fringe or a diving weight

(Cordy-Collins 1990). It is interesting to note that the only other individuals picture nude in Moche, Sicán or Chimú iconography are prisoners. The individuals in the boat often wear clothes and headdress. The divers are often in a particular position that I am calling the 90° limb position; they are pictured from the side with their legs and arms at a right angle to their body and their knees and elbows are bent at right angle so that their forearms and lower leg are parallel to their torso. The divers often have eyes pointed on both ends.

Dating the museum pieces discussed by Cordy-Collins is difficult; even those that are known to have come from Cerro Sapame in the Poma District of Batán Grande may have been Chimú since they had a significant presence after the demise of the Sicán. Some, however, include the signature of Middle Sicán, the Sicán Lord (or Sicán Deity), and therefore definitively date to that time period. Others, however, seem to me to be more similar to Chimú iconography at both Chan Chan (Pillsbury 1996; Pillsbury 1999) and the outer Huacas (El Dragon, Esmeralda and Tacaynamo; see below). The wooden bowl seems Chimú considering their penchant for wooden items with shell inlay (see below) and the lack of any inlay fragments in any Sicán burials (Shimada 1990, 1995; Shimada et al. 2000; Shimada et al. 2004).

The gold ornaments figured by Cordy-Collins (1990: Fig. 4) shows two divers beneath a straight bar representing a boat and holding objects with a wide squat blade the size of the divers head. Uhle, in his excavation of Site H at Moche (probably Chimú in date; see below) recovered two wooden objects that look like these objects. Cordy-Collins (1990:399) suggests that these were used to pry Spondylus off the rocks. However, *S. princeps*, did not need to be pried of the rocks. It is worth noting at this point that many of the large *S. princeps* from Huaca Loro do not show attachment scars. Though *S. calcifer* would have been much more securely attached to the substrate and, therefore, harvesting this species may have required a prying tool, since it does not have the spines pictured in these images and was only used as raw material for making small artifacts, not as a whole shell, it is unlikely that it is the species pictured in this imagery.

The Late Sicán (1100-1375) polity was centered at Túcume (El Purgatorio), but because it is overlaid by later Chimú and Chimú-Inka occupations, the Late Sicán material has not been well studied (Heyerdahl et al. 1995; Shimada 2000). The few Lambayeque (Sicán) burials uncovered by Narvaez (Heyerdahl et al. 1995:172-175), yielded no evidence for Spondylus usage at the time, nor was there any found in the Lambayeque period remains under the Stone Temple or in the residential Sector V (Heyerdahl et al. 1995). There is, however, abundant evidence of Spondylus usage from both Chimú and Chimú- Inka periods (see below).

A single Spondylus shell was found in a group of looted burial goods from the Banderas site on the southern edge of the Moche Valley that included 'Early Chimú' vessels that are distinctly similar to those from Late Sicán (Donnan and Mackey 1978:230).

At Cerro Ñañañique on the Upper Piura, the Formative Period site was reoccupied between the tenth and fifteenth centuries A.D. One of the main grave goods was tiny shell beads, or *chaquira*, but neither the color nor the source of the beads is discussed (Guffroy et al. 1989).

The occupation of Pachacamac, a principal oracle when the Spaniards arrived, probably began during the Lima Period (A.D. 200-500), but it was not until the successive periods, Wari (A.D. 550-900) and Yshma (900-1470), that many of the mounds and other structures were built. Spondylus has been recovered mainly from offerings and construction fill, but from a few other contexts as well (Eeckhout 2004:28-30). These contexts date to the later part of the Middle Horizon (c. A.D. 900), the later part of the Late Intermediate Period (c. A.D. 1300) or the Late Horizon Occupation. The dating of the site is difficult because of its long occupation and the complexity of the archaeological record (Michczynski et al. 2003). Although some of the remains are contemporaneous with Moche, most of the Spondylus recovered dates to the end of the Late Intermediate Period and to the Late Horizon (i.e., Inka). Spondylus was recovered as whole complete valves, ground valves, fragments, powder, beads, worked fragments and spines (Eeckhout 2004: Table 7). Most of the remains are small (a few valves or some fragments), but from one context, that probably dates to the Middle Horizon, 106 valves were recovered in three pits stacked upon each other face down (Franco Jordan and Paredes 2000:613). This is a clear indication of the importance of Spondylus at Pachacamac. The door to the Pachacamac Temple (a.k.a., Painted Temple) was adorned with Spondylus (Shimada 1991), but this is probably an Inka Period artifact. At this point, much of the data on Spondylus from Pachacamac seems to date to the Inka period (see below) and that relatively little dates to pre-Inka times (Díaz Arriola 2004; Frame et al. 2004; Hitchcock and Bartram 1998).

At the Nazca ceremonial site of Cahauchi, in southern Peru, Spondylus artifacts and ecofacts are rare, but present. The main occupation of the site is Nazca 3 (c. A.D. 40-150), but Spondylus from dated contexts are from the Nazca 8 (c. 830 A.D.) Room of the Posts. Spondylus fragments were recovered from the sole niche in the ceremonial room (del Carmen Rodriguez de Sandweiss 1993; Silverman 1993; Silverman and Proulx 2002:66-67). The Museo Arqueológico Rafael Larco Herrera in Lambayeque has five necklaces from funerary contexts in the Nazca area that are made from rectangular to trapezoidal pendants along with some irregularly sized and shaped beads and a necklace with three valves with their spines ground off.

Excavations at Nievería, in the Lurin Valley, yielded a variety of Spondylus artifacts (Gayton 1924-1927). Generally speaking the site dates to the Middle Horizon, probably c. 800 A.D. (Menzel 1964), but since many of the artifacts recovered by Uhle from the site were from looters, the context of the artifacts is very unclear.

Farther to the south in the Ica Valley, the site of Pinilla yielded Spondylus artifacts. The relevant cache (A) dates to Middle Horizon III (Paulsen 1968: 3; c. A.D.1000, Menzel 1964: Plate I) and includes "unworked *Spondylus* fragments, as well as 9 'bifid' objects" (Paulsen 1968:2).

5.3.4.4. Highland Peru- Huari and beyond

In the Central Highlands, the Huari (or Wari) expansionist state developed at the beginning of the Middle Horizon (c. A.D. 540-900; Glowaki and Malpass 2003). The dates for Huari overlap Periods C1 and C2, but have been place here because it is during the later part of the Middle Horizon (c. A.D. 700-800) that expansion changed a people of the southern highlands into an empire that included coastal areas and the northern highlands.

The earliest occupation at the site of Huari, the Moraduchayuq compound, yielded numerous worked Spondylus. Contexts with Spondylus include: room 135, which contained 2 Spondylus shell artifacts that probably came from the cists with stone lids;

room 133, which contained 2 pieces of worked Spondylus, also from looted context; and room 148, which contained 82 pieces of worked Spondylus in a cylindrical hole in the floor. The Cheqo Wasi sector of Huari, of a similar age to Moraduchayuq, also contained Spondylus remains, especially trapezoidal pendants, some of which may have been intentionally broken and/or burnt, larger pieces of Spondylus that may be ‘blanks’ for the trapezoidal pendants and Spondylus discoid beads. Quantities for Spondylus artifacts are not given, however (Benavides 1991:66). The Vegachayoq Moqo Sector was the primary ceremonial area during the Huari occupation, at the end of which it was interred. Only within the material used to cover the area was Spondylus found (Bragayrac 1991:75). Spondylus was also recovered in small or undisclosed quantities from the nearby Huari sites of Conchopata (Pozzi-Escot 1991), Maraniyoq (Valdez et al. 2006) and Jinkamocco (Schreiber 1991). Excavations at Azángaro revealed only six Spondylus beads and 24 Spondylus fragments (Anders 1986:211). Aqo Wayqo, a rural Huari site yielded 12 (Ochatoma P. and Cabrera R. 2001:99) or 13 (Ochatoma P. and Cabrera R. 2001: unnumbered figure after page 100) trapezoidal or rectangular plaques made from Spondylus.

At the largest Huari site, Pikillacta (occupied between approximately A.D. 600-800; Glowacki 2005) in the Southern Highlands of Peru, Spondylus has been recovered from interesting contexts. *S. princeps* shells were interred with two famous collections of a total of 40 (20 each) small turquoise figurines interred in separate sand-filled pits within a gallery room near the center of the site (Cook 1992). This may be Unit 36 discussed below (McEwan 2005:153). The second collection was buried with “Spondylus (2 whole valves, 8 worked pieces, and 5 worked rectangular fragments)” (Cook 1992:344). Within a hall with niches (Unit 47), two small pieces of Spondylus shell (along with camelid remains) were used as an offering before the door to the room was sealed and a single piece of Spondylus shell (with camelid bones) was recovered from a deep pit. In another room with niches (Unit 36; see above), two plaster lined offering pits were excavated resulting in the recovery of a total of five *S. princeps* valves were recovered. The ball and socket hinge had been cut from each valve and their exterior spines had been removed and the resulting surface polished. One valve had been broken into two pieces (McEwan 2005:30-32, 47-48).

Even farther to the south at the Huari outpost/embassy of Cerro Baúl, in the borderlands between Huari and Tiwanaku, Spondylus has been recovered within the palace and the brewery (Moseley et al. 2005). It is interesting to note that I have been able to find no references for Tiwanku use of Spondylus.

In contrast to the Moche example, Huari burials do not seem to include any quantity of Spondylus, but this may be partially because Huari tombs were looted historically and prehistorically leaving little for archaeologists (Isbell and McEwan 1992). Cook (1992, 2001) has suggested that the ‘burial’ of the turquoise figurines is similar to human burials. Therefore, one could assume that human burials also contained Spondylus. The Spondylus from the mausoleum at Marcahuamachuco, partially supports this, except that the occupation of Marcahuamachuco was local, not Huari. Even considering this, however, the quantity of Spondylus from Sicán burials is much greater than for Huari burials. This does not necessarily argue for a decreased significance for Spondylus among the Huari. Indeed, since they are further removed from the source it would be more difficult and costly to acquire smaller amounts. However, considering the evidence from Huamachuco, it seems that access, at least for the northern part of the Huari Empire, may have been quite good. The Huari (including the residents of Condebamba Valley) appear to have mainly used whole and fragmented Spondylus shell and made few artifacts out of it.

5.3.4.5. Period C2 (A.D. 700-1100) summary

Between A.D. 700 and 1100, the main consumer of Spondylus switches from the Moche to their successors, the Sicán. While the Sicán are still interested in *chaquiras*, they appear to be more concerned with wealth accumulation in general. In this sense, Spondylus is placed within graves in piles of hundreds large shells along with mounds of copper arsenic artifacts (especially *naipes*) and waste and multiple gold and silver objects. Shell *chaquiras* remain a grave good, but are accompanied by beads made from materials from all over South America and by shell beads of a variety of sizes. Shell beads also tend to vary more significantly; while all of the Moche beads were tiny disc beads, some of the Sicán beads cannot be called *chaquira*. The consumption of shell *chaquira* spread up the Ecuadorian coast and there is evidence for an increase in production both in Ecuador as well as into Panama. Consumption spreads to include the central Peruvian highlands. The northern highlands, which had participated in the Spondylus trade since the Early Horizon, continued to be a major consumer and may have helped spread the reverence of Spondylus to the Huari. The Huari (c. A.D. 600-800) appear to have used Spondylus mainly as offerings in structures, a trait shared with the people from Moche V (A.D. 550- 650/700) Pampa Grande and Middle Sicán (A.D. 900-1100), as well as Marcahuamachuco.

It is also during this time that the representation of Spondylus as a three- or four-pronged crescent is especially prevalent. However, because many of the objects with these representations are from looted contexts, it is unclear how many are of Sicán or Chimú origin. Many of these objects do have the Sicán Lord pictured, and therefore do date to Middle Sicán and, while other objects show similarities, it is unclear if they belong to Sicán or Chimú times.

5.3.5. Period C3 (A.D. 1100-1532) Control Shifts South

5.3.5.1. Coastal Ecuador

One of the most famous pieces of evidence for the involvement of the Manteño in the Spondylus trade is the recovery of a cache of 'upwards' of 600 *S. princeps* valves at OM-PL-IL-14 on Isla de la Plata (see Figure 5-10 for locations of sites mentioned in this section). Beneath the floor of Spondylus shells, Manteño vessels were recovered associated with mold made Chimú (or possibly Sicán?; Shimada 1995:157-158) blackware and Inka sherds (Marcos and Norton 1981; Marcos and Norton 1984). The precise dating of the Spondylus cache is unavailable, but it is interesting to note that one of the radiocarbon dates acquired from OM-PL-IL-14 gives a date of 1437-1615 A.D. (data from Allan 1989; Calibrated with Calib in 2007) while the other is even more recent. The date coincides with the presence of Inka pottery (Marcos and Norton 1981; Marcos and Norton 1984) as well as the burial of an Inka official nearby (Dorsey 1901). The cache of Spondylus shells may, therefore date towards the end of this period.

This enhances the evidence from Salango 140, which is nearly lacking in Spondylus shell beads, but did give up 15 whole Spondylus shells and 153 valves and over 16 kg of fragments of Spondylus shell. Although a great deal has been made of the removal of the colored portion of the shell (Norton et al. 1983), Allan (1989) lists only nine Spondylus shells as having the colored edges removed. Allan's data, however, may be incomplete as Norton indicates that *S. calcifer* with the margin removed were the most predominant type of shell remains. Isla de la Plata would have either been a source or storage area for *S. princeps* while Salango was a source for *S. calcifer*. It is also quite likely that shells were burned at the site to produce lime, ostensibly for coca chewing (Norton et al. 1983:67).

The surface of Loma de los Cangrejitos was also littered with Spondylus 'cores' which may have been from the most recent and relatively small occupation of the site. Marcos (1981) indicates that Chimú ceramics were recovered from some of the tombs and even the upper levels of the 4f excavation may pertain to this later period.

5.3.5.2. Ecuadorian highlands

The evidence for Spondylus exchange in the highlands of Ecuador is sparse. Fresco recovered approximately 2800 *chaquiras* from Ingapirca, a Cañari site later built upon by the Inka. The majority of the beads were white, but some purple (i.e., probably *S. calcifer*) beads were also recovered (Fresco 1984:143). The only context discussed from which beads were recovered is from the primary individual in Tomb I from within the Pilaloma sector (probably what Blower (1995:200) calls the Temple of the Moon). The dating of the tomb is unclear, but probably antedates the arrival of the Inka (c. A. D. 1480), but no earlier than A.D. 1100. Room D of Pilaloma also contained "chaquiras of mullu" (Fresco 1984:89), but no further details are given.

Three burials at Tomebamba, an Inka construction in what is now Cuenca, yielded Spondylus. The first (IXA) was an individual of undetermined gender older than 20 years with “various mullus or beads of Spondylus” (Idrovo Uriguen 2000:235). The second (Tomb XIIA) was a partially looted tomb that contained two individuals over 20 years of age with 40 “mullus of Spondylus” (Idrovo Uriguen 2000:237-238). The third tomb (XIVA) contained a badly deteriorated skeleton along with many beads, including an unspecified number made from Spondylus and a Spondylus pendant (5 cm by 4 cm). A piece of Spondylus, perhaps from a human figurine, was located in Tomb IIQ, which contained a female older than 20 years along with various grave goods including two gold figurines. A llama figurine of Spondylus, like those from the high peaks, was also deposited in Pit IIQ in the Qoricancha sector of the site (Idrovo Uriguen 2000:276).

5.3.5.3. Coastal Peru- Chimú

Although the Chimú had begun to establish a presence at their capital of Chan Chan well before the end of the Middle Sicán (c. A.D. 1100), major constructions probably did not start until A.D. 1200 (see discussion in Shimada 2000). Eventually, Chan Chan, the capital of Chimor would become the largest prehistoric city in South America . The Chimú used and venerated Spondylus on a level similar to the Sicán, but appear to have used it in two new ways, ground and inlaid into wooden objects. Evidence of shell working indicates that at least some of the inlay was made by the Chimú.

At Chan Chan, Spondylus use, especially in burial contexts is widely, but very generally, reported. Though it is clear that Spondylus was an important offering at Chan Chan extensive looting at the site and lack of quantified data hampers our understanding. Even the chronology of the site is in question. Some suggest that it was initiated as early as A.D. 850-900, while others maintain a later date for the initiation of construction at the monumental city. It is clear, however, that most of the large *ciudadelas* (compounds of the highest elite, kings?) were built within a few hundred years between A.D. 1200 and 1400 (see discussion in Shimada 2000; Shimada et al. 2000). The Chimú were conquered by the Inka around A.D. 1470.

Spondylus excavated from secure contexts at Chan Chan are relatively limited. Within the forecourt to the burial platforms of both Ciudadelas Bandelier and Liberinto, stone-lined pits filled with ground Spondylus were located within the central U-shaped room (Conrad 1981:96). Within Ciudadela Tschudi, two U-shaped rooms on the summit of the secondary stage addition both had small stone-lined bins filled with ground Spondylus. Quantities of Spondylus were also found in large walk-in wells in Ciudadela Tschudi (Pillsbury 1996:323 citing personal communication with Arturo Paredes). In Ciudadela Gran Chimú, excavations of two U-shaped structures revealed burials and "associated with the skeletal remains from the U-shaped structures was an assortment of other items, including large quantities of shell beads, mishpingos (*Nectandra* sp. a bean used in necklaces) and a pair of *Spondylus princeps* shells" (Andrews 1974:252). Within Ciudadela Rivero, a ½ cm thick layer of ground Spondylus was found at the north end of a bench along the west wall of the forecourt of the burial platform (Day 1973:212 as cited in Blower 1995:188). Within the burial mound in Liberinto, also known as Las Avispas, a small, centrally located room between the forecourt and the burial platform contained a stone-lined bin containing crushed Spondylus (Pozorski 1979:123). Also within the Las Avispas burial platform, "abundant fragments of fine blackware pottery, woven textiles, carved wood (often with shell inlay), metal adornments, and carved and whole shells (including Spondylus and *Conus fergusoni*) were found in and immediately around the chamber area of the platform" (Pozorski 1979:134). It is quite likely that the burial contexts at Chan Chan were similar to those described below for Huacas Tacaynamo and El Dragon.

In the areas around the *ciudadelas*, known as SIARs (Small Irregularly Agglutinated Rooms), a cobble-line pit from under the intersection of two walls, yielded six complete Spondylus shells (Topic 1981:158).

Two of the many relief friezes at Chan Chan contain Spondylus imagery. The first, located in the Ciudadela Uhle and known as Los Buceadores (the Divers), shows the same divers as Cordy Collins (1990) has demonstrated for Sicán/ Lambayeque iconography. In both Section B and C of the frieze, divers are shown attached to a rope, lacking clothing except a belt around their waist (though this may simply be the rope), with almond-shaped eyes and in the 90° limb position shown in Sicán (Cordy-Collins 1990:Figs. 2, 3, 8, 12, 13 and 14) and Chimú (Longhena and Alva 1999:56; O'Day 2000:Fig. 3.9; Pillsbury 1999) imagery. In Section C, there is one badly eroded three-pronged crescent (though it is more pointed at the bottom like a tulip flower) but in Section B, there are at least 14 three- and four-pronged crescents. Considering the evidence from Sicán contexts (Cordy-Collins 1990) it is quite likely that these represent Spondylus (see also Pillsbury 1999). Similar four-pronged crescents, along with nude individuals in the 90° limb position are shown on the Plataforma de las Virgenes relief, also in Ciudadela Uhle. Finally, some tri-pronged crescents can also be seen in the lower bands of a frieze at Huaca Esmeralda, approximately 2.5 km east of Chan Chan (Pillsbury 1996:Fig. 13).

Perhaps even more interesting than the evidence of Spondylus use at Chan Chan is that from Huaca El Dragon (a.k.a. Huaca Arco Iris) and Huaca Tacaynamo. These huacas are a few kilometers to the northeast of Chan Chan and only approximately 500 m from each other. Prehistorically, they may have been just outside the city, but people do not appear to have lived near these structures. These two huacas appear to have been peripheralized, perhaps because the principal individual was of lower rank than those interred in Chan Chan (Jackson 2004), but it could have equally been that these individuals were placed outside of the cities because they were considered dangerous. Both huacas are similarly constructed square, stepped platforms of adobe bricks with a higher central platform accessed by a ramp. The central platform at El Dragon is surrounded by a series of ‘cells’ or small door-less cubicles. These cells were originally interpreted as places that the living accessed from above in order to perform religious ceremonies (Schaedel 1966), but it seems clear now that the purpose was probably for the burial and religious purposes that mainly included interaction with the dead.

Both of these huacas yielded numerous wooden figures that mostly likely portrayed the burial scene with litter bearers and other players (Jackson 2004). Similar figures from a Chimú burial at Huaca de la Luna were arranged as if enacting a burial ceremony (Jackson 2004:Fig. 3; Longhena and Alva 1999:Fig. 193; Uceda C. 1997). Many of the figurines at Huacas El Dragon, Tacaynamo (Iriarte B. 1978; Navarro Santander 1991), and de la Luna (Jackson 2004:300, Fig. 3; Uceda C. 1997) and from elsewhere (Longhena and Alva 1999:152; Rowe 1984:151-164)were inlaid with mother-of-pearl and Spondylus. It is within this context that extensive evidence of Spondylus use was uncovered.

At Huaca El Dragon, a fairly large quantity of shell was recovered. A total of 1563 shell objects were recovered; 1008 of Strombus (64.5%), 520 of Spondylus (33.3%)

and 35 of mother-of-pearl (2.2%) (Schaedel 1966:Chart 5). It is unclear how Schaedel identified the Strombus as such and it may be Conus (Montoya Vera 1998) or another white shell. Presumably the Spondylus is identified by color (i.e. red or purple). Due to looter damage, Schaedel only considered a few contexts to be undisturbed; of the contexts containing shell this includes only part of Cell 11. The rest of the contexts are considered either disturbed prehistorically or recently looted. It is quite likely that what he considered prehistorically disturbed was from prehistoric use near the time of the construction of the Huaca. Schaedel considered it mainly a religious center and many of the burials intrusive from later periods, but it is quite likely that all of the material is from the same use period. Cell 11 contained a large proportion of all shell (751/1563 or 48%), Spondylus (220/520 or 42.3%) and Strombus (sic. Conus; 516/1008 or 51.2%). Spondylus in Cell 11 included 200 pieces that were "cut, in preparation", 5 valves and 15 whole shells (i.e. both valves). Neighboring cell 10 contained 406 Strombus (sic. Conus) fragments. All of the 35 mother-of-pearl, most for inlay, were recovered from cells 10 (n=20) and 11 (n=15; Schaedel 1966:Chart 5). The shell that is "cut, in preparation" are quite clearly fragments in the process of being made into artifacts, including trapezoidal fragments with and without spines (Schaedel 1966:Fig. 9) like those recovered from Pampa Grande and Marcahuamachuco (see above; Shimada 1994). The 15 whole shells were from the undisturbed contexts that also included 24 Strombus [sic. Conus] that were wrapped in textile and a deposit of *Nectandra* sp. (*ishpingo/mishpingo* or other similar names) seeds (Schaedel 1966:424). An undisturbed juvenile burial was also accompanied with 10 whole closed Spondylus shells, 10 *Strombus* [sic. *Conus*] shells and *Nectandra* sp. seeds. One of the Spondylus shells was tied with a thread (Schaedel 1966:424). Cells

10 and 11 included other evidence that they were ceremonially important. Of the 25 complete wooden figurines from Huaca el Dragon, 15 were from these two rooms, which also included metal artifacts (59 of the 88 metal artifacts or 67.0% were from these contexts), ceramics and the remains of 7-8 individuals. Although Schaedel interprets cells 10 and 11 as shell workshops, it seems that the most likely interpretation of the remains in cells 10 and 11 is that individuals were interred in the ‘cells’ with a variety of offerings, including in-process Spondylus. Conspicuously absent from cells 10 and 11 are small cylindrical shell beads (*chaquira*) and tools for making the other artifacts. The beads that Schaedel (1966:Fig. 9; 435-436) discusses appear to be pendants, not the cylindrical beads used in necklaces and pectorals. It is quite possible also that many of the completed inlay pieces had fallen out of their original location in the wooden idols.

Twenty whole *Spondylus pictorum* [sic., probably *S. princeps*] valves were recovered from Huaca Tacaynamo, some of which were heavily modified including complete removal of spines. Others retained the small stone to which the shellfish had cemented themselves in life (Iriarte B. 1978:276-277). A large quantity of in-process and finished artifacts made from Spondylus were also recovered. A total of 1983 fragments were recovered, including mainly “irregularly cut, angular” (my translation; 582 or 29.3%), trapezoidal (small- 193, large 109 or 302/1983 or 15.2%), rectangular (long- 380, short- 443 or 41.5%), triangular (184 or 9.3%) and margins (fracturados, menos de la mitad, 41 or 2.1%; Iriarte B. 1978:279). A total of 25 Conus shells and 1228 worked pieces of Conus were also recovered. Iriarte divides completed artifacts into three types nacar (mother-of-pearl), concha (unclear if Spondylus is meant), and caracol (Conus?). Most of the finished artifacts are of mother-of-pearl (243 out of 312 total or 77.9%), not ‘concha’ (54/312 or 17.3%) or caracol (15/312 or 4.8%). Though Iriarte divides these into 34 different forms, it is clear that they were either intended to be used or were used on the wooden figures discussed below. Iriarte (1978: 282) indicates that the backside of most of the shell artifacts had some bitumous glue with which it was secured to the wooden figures. He also notes the similarity between the artifacts from Huacas El Dragon and Tacaynamo (Iriarte B. 1978:282).

Further evidence for Spondylus use at Huaca Tacaynamo is of a different nature. Like Huaca El Dragon, it yielded a number of wooden figurines inlaid with shell. Three of the twenty-five figurines are described as prisoners because of their exposed genitalia, lack of headwear and positioning of the arms; one has intentionally broken arms, another with hands and neck bound with string and the other with his hands behind his back as if bound (Jackson 2004). They all lack the inlay of many of the other figurines, except their eyes and two have felines and chevrons (spinal columns) painted on their backs, which Jackson (2004: 311) convincingly associates with sacrifice. Indeed, the prisoners whose arms were intentionally severed are also perforated by a hole that runs from the upper left chest through his lower right back. A third symbol won by the prisoners is a three-pronged crescent similar to those in Sicán and Chimú iconography (Cordy-Collins 1990; Pillsbury 1996), painted on both front and back of the three prisoners (Jackson 2004:311, fig. 9). Jackson indicates that, since Spondylus is an important burial offering, these prisoners similarly are being presented as offerings during the burial ceremony of an important individual. A wooden Chimú figurine from the Museum of Civilization in Quebec is obviously not a prisoner, but has four-pronged crescents on his headgear.

Jackson also asserts that the heavily inlaid miniature litter backrest recovered from El Dragon represents Spondylus diving (Jackson 2004:Fig. 5). While it is certain that the imagery represents diving and is reminiscent of imagery associated with Spondylus diving (Cordy-Collins 1990; Pillsbury 1996), no Spondylus appear on the litter.

The best evidence of undisturbed Chimú burials with Spondylus are from the site of Moche (Tello 1997). Tomb 7 in Unit 12 of Platform I of the Huaca de la Luna held a 13-14 year-old along with 45 Spondylus valves and 287 complete Conus along with 700 fragments of these two shells. Five hundred six of the fragments were contained in a textile bag. Along with these were textiles, metal objects and a maqueta. The maqueta is a wooden courtyard with altar and 28 individuals portraying a burial scene. The wooden figures from Huacas Tacaynamo, El Dragon and Cerro Blanco, though larger than those from the maqueta in Tomb 7 (and a similar one in Tomb 6), were displayed in a similar way (Bourget 1997; Iriarte B. 1978; Schaedel 1966; Tello 1997; Uceda C. 1997).

Three burials from the Chimú occupation of Cabur in the Jequetepeque Valley each contained a single *S. princeps* near their heads and/or hands (Sapp 2002:Fig. 5.3). These were young children (6-9 years old) that were apparently sacrificed at the same time and interred in the Huaca Quadrangle at the site. Two of the children were buried with a total of 6400 small (2-5 mm in diameter; these could be considered *chaquira*) beads that probably came from necklaces, anklets and bracelets. Sapp indicates that these were Spondylus beads, but does not indicate how he came to this conclusion. Also at the site, twenty-two complete Spondylus valves and 152 pieces of Spondylus were recovered from the site. Most of these came from the Huaca Quadrangle (21 out of 22 or 95.5% of the complete valves and 143 out of 152 or 94.1% of the pieces[3]), where the sacrificed children were interred. Though the burials are securely dated, because there was major looting at the site, it is difficult to know whether the other artifacts belong to the Lambayeque, Chimú, or Inka occupation of the site (Sapp 2002:136-141; Appendix B).

At the top of Cerro Blanco, above the Huaca de la Luna, Uhle located a site (Kroeber's Site H) with friezes and five "carved wooden figures of litter bearers and bearers of great covered jars" similar to those from Huaca El Dragon (Menzel 1977:41, Fig 96). Also, "above all, there was, as at the Huaca El Dragon, a great quantity of exotic shells imported from the Gulf of Guayaquil. Two kinds of shells were present at the shrine of Cerro Blanco, Spondylus princeps and Conus fergusoni" (Menzel 1977:41). The shells were both whole and worked. He found hundreds of whole and cut Spondylus cascading down the summit of Cerro Blanco (Cordy-Collins 1990:396, citing Uhle's unpublished notes). He also recovered metal, feather, and textile objects. When Steve Bourget (1997) returned in 1995, he found that the site was almost completely destroyed by looters and the elements. One tomb, though looted, contained a sub-adult along with Spondylus and Conus shells that were both whole and cut into plaques along with some Chimú sherds. On practically all sides of the destroyed temple, shells, including Spondylus and Conus, were found (Bourget 1997). Also recovered were fragments of miniature feather textiles, probably similar to those pictured by Anne Pollard Rowe (1984). It is also now clear that these sites do not represent workshops as once suggested (Blower 1995:211; Cordy-Collins 1990:396, citing Uhle's unpublished field not; Schaedel 1966; Shimada 1994:96-7; Topic 1982:273-274; personal communication y

[3] In the description of the excavation in Appendix B, Sapp describes two valves (from A1) and 21 pieces (from A2 and A4). Only one other valve is mentioned from the other test pits.

Feldman), but are funeral areas where Spondylus, whole, as plaques, and as inlay in wooden figurines, was deposited.

Bourget (1997) has included Cavalario de los Inkas (and possibly a burial site in Huanchaco to the north of Chan Chan) to the list of similar Chimú sites that includes Huacas El Dragon, Tacaynamo and the temple at the top of Cerro Blanco (Bourget 1997). These sites include burials of children or young women (as did the burials in Las Avispas [Pozorski 1979]) some of whose faces bore traces of cinnabar, juvenile llamas often with their feet bound, wooden figurines, and similar textiles. The majority of the sites also had *Nectandra* sp. seeds, copper artifacts, and little silver fish. Based upon similarities of the friezes at Huaca Las Balsas (at Túcume) and Huaca Gloria (at Chotuna) may also be included in the list of huacas showing this pattern (Donnan 1990; Heyerdahl et al. 1995:Chapter 5). It may also be possible to include sites to the south, such as Manchan, which also include similar figurines (Mackey and Klymyshyn 1990).

Further evidence for Spondylus use during the Chimú period is from the Virú Valley, where 25 Spondylus shells, were recovered from the fill near the floors of a U-shaped room at V-124 (Andrews 1974; Collier 1955:44). Burial 1 at V-304, approximately 500 m west of V-124, was recovered with a Chimú pot and two articulated Spondylus shells (Collier 1955:47). It is worth noting that most of the other sites in the Virú Valley did not yield any Spondylus (Collier 1955).

The widespread use of Spondylus, miniatures and a combination of the two is supported by museum material. Anne Pollard Rowe (1984) illustrates a series of artifacts that were said to have been recovered from Chan Chan and that were given to the American Museum of Natural History by J. Pierpont Morgan in 1896. A single valve of

Spondylus with part of the “salmon pink” spines removed from near the umbo is included in this set (Rowe 1984:Fig. 171). Beaded artifacts include a circular necklace (pectoral), a bib-shaped necklace (a pectoral variant), a pillow and a bag. The first necklace (35 x 43 cm) is circular around the neck, but the lower edge that would drape over the chest steps down in two steps from both sides to the lowest point. The colors of the beads of this necklace include green (probably stone), white, purple and orange. The pectoral (35 cm in diameter) contains black, white, orange and salmon colored beads as well as mother-of-pearl bangles (pendants) around the outer perimeter. The bag (15 x 17.5 cm) is covered in salmon beads with orange beads along the border. The pillow (21 cm square 6 cm thick) has white, purple, and orange beads. The orange, purple and salmon beads are most likely from Spondylus shells (Rowe 1984:Fig. 165-167).

Rowe (1984) presents another interesting set of artifacts that were found together in Chancay, though the style of the weaving is North Coast and specifically Chimú. The set, which are miniatures, contains feather and cotton textiles (four squares [miniature mantles?], a loincloth, a tunic, and a tabard), silver artifacts (drum, double spout vessel, musical instruments, tree, and other objects), and a silver and textile miniature shoe. Non-miniature objects include a feather ‘crown’, some wooden implements (though these may be miniature staffs), some silver objects, and beaded textiles, including three bags, two slings, and a pair of bracelets (Rowe 1984:151-164). It is likely that these miniatures belonged to wooden figures like those discussed below. The beads used are salmon pink, purple and yellowish. Rowe (1984:Plate 25) also illustrates a comparative necklace with similar colors and it is clear to me that both the salmon pink and purple beads are very similar to Spondylus beads discussed in this work. Also, on the only feather and textile square from the same grave that is shown in color (Rowe 1984:Plate 23) also has 26 small silver squares attached inside two outer layers of feathers. On 11 of these silver squares are ‘three-pronged crescents’ that are so clearly portrayed in Sicán/Lambayeque iconography (Cordy-Collins 1990). A similar object is pictured by Rivero and Tschudi (Rowe 1984:Fig. 154). Some of the other squares have a person on them with the same eyes and in the 90° limb position. A silver bib necklace from unknown provenience also shows 23 three- and four-pronged crescents that most likely represent Spondylus.

At the Chimú period Sector V at Túcume, Sandweiss uncovered what he labeled a Shell-Bead Workshop. He states that “the entire shell reduction sequence was present – from whole shells, to cut shells, to perforated, square shell disks awaiting the final step of grinding into a circular shape, to finished beads” (Heyerdahl et al. 1995:145). The accompanying illustration (#117), however seems to indicate that large chunks were ground to make the tiny beads, whereas the evidence shown herein (see Chapters 6 and 7) suggests that is highly unlikely. Illustration 117 also shows a Spondylus shell as the beginning of the sequence, but beads were clearly made of other species (*Argopecten purpuratus* and *Chione subrugosa* are listed). Sandweiss only illustrates a single large (approximately 10 x 30 cm) grinding stone. No tools for drilling beads are present. Lacking the evidence for drilling beads, it is difficult to say that Room A in Sector V at Túcume was a shell bead workshop.

The evidence for Spondylus usage among the Chimú is extensive. The evidence from the capital of Chimor, Chan Chan, is patchy because of the severe damage to the burial platforms due to looting. However, supported by the evidence from area sites, Huacas Tacaynamo, El Dragon and Esmeralda, and from other contexts, such as the temple on Cerro Blanco and the tombs from Huaca de la Luna, as well as museum pieces the way Spondylus was used at Chan Chan is much clearer. Figures inlaid with shell (including Spondylus) were probably used to portray burial ceremonies. Some of these figures were clothed in extremely rich textiles. The actual ceremonies appear to have included special classes of interments, such as only young women or young children, juvenile llamas, textiles and Spondylus and Conus shells. These shells were normally either whole or in rectangular or trapezoidal plaques. Ground Spondylus was found in other contexts, such as part of a floor and in bins in burial platforms or *audiencia*s. To date (with the exception of the grinding stone from Túcume) we lack any unequivocal evidence of the tools used to modify Spondylus. Spondylus was also represented by the Chimú at levels not seen previously, nor after the fall of Chimor. Some beaded artifacts have been determined to be Chimú, but these may be more appropriately labeled Sicán (Lambayeque). Determining the source of these looted artifacts is often difficult. Outside of these looted artifacts, there is relatively little definitive evidence for bead production or use among the Chimú, while there is extensive evidence for the use of raw shell (whole, powdered, crushed, etc…) and as inlay in wooden (and other materials) artifacts.

5.3.5.4. Highland and coastal Peru- Inka

Sometime in the mid to late fifteenth century, the Inka conquered Chimor, dismantling the empire by sending Minchançaman, the last Chimú leader, to the Inka capital at Cuzco (e.g., D'Altroy 2002; Rowe 1946, 1948). Although the region around Chan Chan remained a tax-paying entity, it appears to have been largely abandoned and may have suffered from looting at this time, though the majority of looting occurred during the early years of Spanish rule. Our current understanding of Spondylus use among the Inka is based mainly on ethnohistoric sources, though more and more archaeological evidence is also coming to light. These two sources indicate different patterns.

Spondylus is not as ubiquitous in Peru as one might think during the Inka period. The large majority of Spondylus recorded from Inka contexts is from the coast. This does not seem to be due to a lack of excavated contexts, but due to a true lack of Spondylus in the highlands. There are two caveats to this, however. First, many of the ceremonies mentioned that involve *mullu* (Murra 1975) would leave Spondylus remains in places where they are unlikely to be recovered archaeologically; for example, springs and fields. Secondly, it is often said that the Spaniards were so effective at sacking elite tombs that there are few left for archaeologists to excavate. However, they looted tomb on the coast as well and we still have been able to recover extremely rich burials.

Although seashells and particularly Spondylus (though often via the term *mullu* or mullo which could be various things; see below) are often mentioned as being part of offerings at huacas, which in this sense can be practically any place where offerings are made, but include springs, special stones, hills and mountain passes, fields and tombs, rarely are they recovered from such locations, even in the area of Cusco, the Inka capital (Bauer 1998; Isbell 1997). In Cusco, "a small anthropomorphic figure, also of shell, red on the front side and white on the back" (Valcárcel 1946:181) was recovered from the fortress of Sacsahuaman. This figurine is probably similar to those found on Andean peaks (see below).

Burials at Machu Picchu, one of the royal estates built by Pachacuti Inka Yupanqui (Niles 2004), lacked Spondylus but the buried individuals are not believed to have been elites who would have had the greatest access to wealth goods (Salazar 2004). Although a wide variety of stone, ceramic, and metal artifacts were recovered from Machu Picchu, no Spondylus artifacts were recovered (Burger and Salazar 2004).

Spondylus was not recovered at Ollantaytambo (Protzen 1993) or Huánuco Pampa (Morris and Thompson 1985), two of the largest Inka sites in the highlands. Excavations were more extensive at the latter site. The Mantaro Valley project recovered only five fragments of Spondylus from all contexts and only a single piece from Wanka III (i.e. post-Inka conquest) contexts (Owen 2001), even though nineteen elite Wanka III burials were excavated (Hastorf 2001:fig. 7.6).

Spondylus is present in the southern part of the Inka highlands but in minimal quantities. One Spondylus valve and some Spondylus beads (unspecified number with other types of beads) were recovered from Chullpa 1 and from a burial urn between Chullpa 1 and 2, respectively, from the site of Cutimbo, near Lake Titicaca (Tantalean 2006). On the south side of Lake Titicaca, a small llama figurine of Spondylus, of probably Inka origin, was recovered with very few Inka artifacts near the surface at Pampa Koani (Kolata 1986:751). In the southern highlands of northwest Argentina, a single tubular bead was recovered during excavations of elite and nonelite contexts in the Calchaquí Valley (Earle 1994:450). Similarly, a single fragment of Spondylus was recovered from the Lluta Valley in northern Chile (Santoro et al. 2004).

The Late Horizon saw the archaeological distribution of Spondylus reach greater altitude than ever before. Spondylus appears on high peaks as part of Inka offerings. Juan Schobinger also recovered an Inka figurine and two llama figurines made from Spondylus with a child mummy and other gold (one human and one camelid) and silver (single human) figurines on Cerro Aconcagua, Argentina (Schobinger et al. 2001). The frozen mummy from Aconcagua also wore a necklace that included 47 Spondylus beads, 17 lapis lazuli beads and 15 malachite beads. One of the Spondylus beads is in the shape of a beetle from the Buprestidae family (Bárcena 2001). Near Cerro Aconcagua, a small (c. 3 cm tall) female figurine made of white Spondylus was also located at a small Inka tambo (Schobinger 2001).

From Cerro Copiapó, Chile, a male figurine and llama figurine in typical Inka style but carved out of Spondylus instead of the usual gold and silver (Gentile L. 1996) were recovered (Iribarren Charlín 1978; Reinhard 1992). The child mummy from Cerro El Plomo, Chile, was interred with a Spondylus llama and feminine figurine, both in the Inka style (Mostny 1957). A single male figurine (c. 3.5 cm tall) made of Spondylus in Inka style was also recovered from Volcán Taapacá (Reinhard 2002:85).Other Spondylus figurines have been recovered from Huarancate, Pichu Pichu, Sara Sara, and Ampato, all in southern Peru (Chávez 2001).

Moving to the coast of Chile, Junius Bird reported that a ‘quantity’ of thick red Spondylus shell beads were found on Alacrán Island, but were not recovered by him and any date for these finds is unavailable (Bird 1943:191). They are included here, however, because a single similar bead was recovered from Playa Miller (Bird 1943), an Inka site on the mainland site a few kilometers south of Alacrán Island and near the mouth of the Lluta Valley mentioned above. These quantities are relatively minor and it is more probable that they were brought there via Inka trading, such as through the Chincha merchants (Rostworowski de Díez Canseco 1970, 1999; Sandweiss 1992), rather than via Ecuadorian traders. It is often stated that Spondylus was traded from Chile to Mexico, but, on the southern end, this consists of a single bead for a burial just south of the Peru/ Chile border. The llama and human figurines from the high peaks are found much farther south, but this is more a statement about the worship of high peaks by the Inka than about Spondylus trade.

As one moves farther north up the coast, however, the consumption of Spondylus during the Late Horizon appears to increase. In the Ica Valley of Peru, a youth was buried with “parts of necklaces of Spondylus shell pendants” along with whole valves. Other wedge-shaped pendants (trapezoidal plaques?) were also scattered about and may have been from other interments of youths (Menzel 1977:12-13).

Further north, within the Chincha area, Spondylus is found mainly in contexts from after the Inka conquest (Kroeber and Strong 1965:51-52). Of the eight Inka graves (E12, E13, E15) at Pampa de Canelos, near La Centinela, three contained 2-5 Spondylus shells (Kroeber and Strong 1965:30). Fine beads and Spondylus pendants (3850, 3851, and 3852) were included in Late Horizon burials from Site D (Kroeber and Strong 1965:51-52). Pre-Inka burials included white shell pendants, some with green stone inlay, along with ornaments in the shape of animals or birds. Inka burials are characterized by “pendants of Spondylus which are regularly rounded oblong, never in the form of animals, and without inlay” and “fine evenly-rolled beads of pink Spondylus, white shell, violet shell [*S. calcifer*?], and black material” (Kroeber and Strong 1965:51-52). Uhle felt the distinction was clear enough that some graves were dated based upon the nature of the shell finds recovered with the burial. While the context of the finds is unclear, many of them seem to be of an elite nature. At the Late Horizon fishing village of Lo Demas, less than 1 km from La Centinela, only a single Spondylus fragment was located

(Sandweiss 1992:152). The great increase in Spondylus usage after the Inka conquest supports Sandweiss' contention that Chincha merchants had some control over ocean-going trade and Spondylus (Sandweiss 1992:142), which they probably were given by the Inkas as a reward for their partnership and as punishment for the Chimú who had probably controlled much of the coastal trade (Sandweiss 1992:10). Although the balsa trees for the large rafts were not available in the Chincha area, the Chincha did have them (Rostworowski de Díez Canseco 1999:43), small versions of which were even available south to Playa Miller in Chile where models of wooden balsas were recovered (Bird 1943:Fig. 9, 10, 15). Due to oceanic currents, they probably could only travel at certain times of the year, however (Hocquenghem 1993, 1999; Rostworowski de Díez Canseco 1999). Most of the large Inka sites on the coast are in the Chincha area, including Tambo Colorado in the Pisco Valley, Inkawasi in the Cañete Valley, and La Centinela (Hyslop 1984; Hyslop 1985). The other large Inka occupations appear to have been in the Lima area and in the Lambayeque Valley and to the north.

Farther north, near the modern city of Lima and including the Lurin and Rimac Valleys, the pattern appears to be similar. This area, which includes the famous Pachacamac oracle, is littered with Late Horizon burials, many of which contain Spondylus. When the Spaniards arrived at Pachacamac, the door to the Pachacamac Temple was adorned with whole Spondylus valves on a cotton fabric background (Shimada 1991:XXXIV).Two burials that Uhle identified (Uhle 1991 [1903]:37-39) as Inka nobles included whole Spondylus; Burial A included one whole shell (i.e., both valves), one whole valve, and a polished and perforated shell and Burial B included a single shell of *Spondylus pictorum* [sic *princeps*]. More than other archaeological sites in the area, Pachacamac has a relatively unbroken use of a variety of Spondylus artifacts and ecofacts since the Middle Horizon. Late Horizon material includes whole valves, fragments, spines, and *chaquira* (Eeckhout 2004:28-29, Table 7). A ground Spondylus was also recovered from inside the textiles of an Inka mummy burial (Franco Jordan and Paredes 2000:616).

The increase in Spondylus use during the Late Horizon is more obvious slightly to the north of Pachacamac, around the city of Lima, where Spondylus is widely present in Inka contexts, but virtually absent in pre-Inka Yschma (Ichma) contexts (Díaz and Vallejo 2004:297-298). This is true at Armatambo, a large mound site located at the southern edge of Lima along the coast, though no details about Spondylus finds are given (Díaz Arriola 2004:590-591). A Late Horizon mummy bundle from the inland cemetery of Rinconada Alta contained 4 whole Spondylus valves along with two beads, one cylindrical and the other in the shape of a crescent moon (Frame et al. 2004). Frame et al. (2004:849) also indicate that Spondylus is present in many of the burials from Rinconada Alta. A similar pattern was present in the cemetery site of Puruchuco, not much farther up the valley. From 1999 to 2001, 1286 (552 completely intact) burials were excavated at Puruchuco. Two of the 'false head' mummy burials contained Spondylus shells; one, from tomb 40, sector 15, yielded 5 valves (Cock and Goycochea Díaz 2004:Fig. 1) and the other, nicknamed the Cotton King because of the amount of cotton buried with him, also yielded 5 Spondylus valves (Cock 2002). Melissa Scott Murphy (2004) studied 207 mummy bundles from Puruchuco and Huaquerones (Farfán Lobatón 2000). Spondylus shells were predominantly found with false-head mummy bundles (fifteen of the twenty-two [68.2%] studied had Spondylus), while the mummy bundles without had fewer

(12/185 or 6.5%). One to fourteen shells were present in the mummy bundles with Spondylus burials (Melissa Scott Murphy, personal communication 2007). It appears that Spondylus, even in an area where it is relatively common, such as at Armatambo and Puruchuco, is limited only to those of fairly high rank (Díaz Arriola and Vallejo 2002).

Just up the coast within the Pampa de San Pedro (a.k.a. Barrio de las Esteras) sector of the Ancón site, a Late Horizon mummy bundle contained two articulating Spondylus valves containing separate offerings (Ravines and Stothert 1976:158, 164). One of the shells was wrapped in raw cotton and a thin cloth then placed near the left shoulder. It contained raw cotton, and unidentified fruit and *lucuma* leaves. The other was deeper inside the bundle and was encompassed by a band tied around the head of the mummy. It contained raw cotton and fruit seeds (Stothert 1979:11, 13). The Spondylus here is not seen as a luxury item because it is so common during this period that everyone had access to it (Ravines and Stothert 1976:170).

However, from the Lima area to north, there are very few Inka sites (Hyslop 1984, 1990). North of Ancón and south of the Lambayeque area, there is only one Inka site with evidence of Spondylus use; Chiquitoy Viejo in the Chicama Valley along the Inka Road. Chiquitoy Viejo, though certainly occupied by elite during the Late Horizon, due to the similarity of architecture, etc. they were probably not Inka (compare Conrad 1977; Hyslop 1990:250). The presence of carved wood, textiles, and feathers also suggest a Chimú-like burial platform. Spondylus was present at the site, but no type or quantity is given (Conrad 1977:13).

At Túcume, the capital of the Late Sicán polity with a major Chimú component was also occupied by the Inka. At the Temple of the Stone, two clothed Inka style figurines made from Spondylus (6.4 and 5.4 cm tall), similar to those recovered from the high peaks in Chile, Argentina and Peru, were buried to the east of the doorway (Heyerdahl et al. 1995:109, Fig. 78-80). Inka Period mummy bundles from the South Cemetery often clasp Spondylus valves in their hands (Heyerdahl et al. 1995:177, Fig. 156), but there is no indication as to exactly how many burials had Spondylus. A mummy bundle from Room 1 of Huaca Larga contained a silver pectoral that "had 16 strings of *Spondylus* shell beads" (Heyerdahl et al. 1995:96), but how many beads there are in a string is not indicated. The Inka occupation of La Raya, the mountain that towers over the site, is also interesting in that it may have been a physical manifestation of Inka domination. Sandweiss indicates "Spondylus occur more frequently on La Raya than anywhere else at the site, except in the burials" (Heyerdahl et al. 1995:186). The Lambayeque area also includes two local administrative centers along the Inka Road; Tambo Real and, the larger but practically unknown, La Viña (Shimada 1982:Fig 16).

Recently, an Inka Spondylus and Conus craftsman was recovered from La Viña. The following is based upon my own personal observations of the collections in 2004, personal communication with Izumi Shimada and the Museo Nacional Sicán website (Museo Nacional Sicán 2007). The burial included Spondylus shells in all stages of the production of small figurines. *S. princeps* shells are present with their spines removed, probably by percussion with a hammerstone, which were then ground on the large shale tablet recovered from the burial. Lines were etched into the exterior surface of the shell forming the well-known trapezoidal plaques, leaving some material on the edge that is crescent shaped as well as the hinge. The crescent-shaped piece was probably used, but the hinge was probably waste. The plaques were probably snapped off from the hinge because the area from which they were removed on the hinge is rough. The etched lines were made with one of the at least sixteen shale saws that were recovered; one of the saws fits one of the incised shells perfectly. Once the shell was cut into plaques, it was then reduced to the correct size if necessary and made into a variety of miniatures, representing fish (44 recovered), llamas (5 recovered), humans (3), hot peppers (7), and two other gourd or squash like forms (16 very small bottle-gourd shaped objects and 8 larger zucchini-shaped objects).

One of the least known areas of Peruvian prehistory is the extreme North Coast of Peru, including the Tumbes, Piura and Sechura Valleys. While our understanding of the region has increased recently (Hocquenghem 1993), the area is still poorly known archaeologically (Hocquenghem 1999; Hocquenghem and Peña Ruiz 1994; Richardson et al. 1990). Interesting Spondylus artifacts have been recovered from Cabeza de Vaca, but little is known about their context because the artifacts were collected by non-archaeologists. The site has not been excavated. This is clearly a shell-working location because many species of mollusk, including Spondylus, were recovered with various cut marks similar to those from La Viña (Hocquenghem and Peña Ruiz 1994:Fig 3, 4, 5). Both *S. princeps* and *S. calcifer* are indicated as present and photos indicate cut marks on *S. princeps*, but it is unclear if any of these may be *S. calcifer*. If *S. calcifer* is present at the site in different stages of production, this would be the only indication of such efforts in Peru. Artifacts and ecofacts of Spondylus include whole specimens, complete valves with the exterior spines removed and the surface polished, 'cores', complete side pieces, cut pieces, pieces separated by percussion, cut and unpolished pieces, figurines, silhouettes of figurines, unfinished figurines, fragments of figurines, figurines, 'petos' (a thick needle-like shape, perforated and bifurcated at the thicker end; I saw similar artifacts at the Museo Arqueologico Brüning, Lambayeque in 2004), and beads. One of the beads was shaped like a bird with its head up, wings spread backwards and sitting on a rectangular band; these are very similar to those recovered from a Late Chimú burial at Moche (Donnan and Mackey 1978:353)and one in the Museo Arqueologico Brüning (personal observation, 2004). Interestingly, *Anadara grandis*, *Ostrea sp*. (probably *Pinctada mazatlantic* or *Pteria sterna*), *Strombus peruvianus*, *Conus fergusoni*, and *Melongena patula* were all also used to make a variety of artifacts. The figurines made from *S. princeps* include human figures llamas, fish, and vegetables similar to those from La Viña (see also Hocquenghem and Peña Ruiz 1994:Figures 6a, 6b, 7a, 7b). One of the figurines is probably an in-process Inka figurine (see also Hocquenghem and Peña Ruiz 1994:Figure 7a). Also included is a variety of birds (see also Hocquenghem and Peña Ruiz 1994:Figures 6a, 6b, 7a), some of which may have been atlatl hooks like those from the catalogue herein and like specimens observed at the Museo Arqueologico Brüning, Lambayeque in 2004. Finally, a few geometric plaques are included (triangle, rectangle, etc.), foxes, diving birds (similar to those inlaid into wooden Chimú figurines), a representation of a miniature balsa (Kauffmann Doig 1987:57) and a bird bead (similar to those in Cordy Collins et al. 1999). Included were slate tablets (for grinding), slate saws (for cutting), and hammer stones. The slate points indicated (up to 10 cm in length) would be useful for large perforations such as eyes for figurines, but not for the tiny perforations necessary for beads. The “rock crystals” located at the site may be lithic drills. The dating of this site is questionable, as both Inka and Chimú sherds were recovered, but the similarity of many of the Spondylus artifacts to those of the Inka shell worker from La Viña certainly indicate that the site was occupied in the Late Horizon. Other artifacts indicate that it may have been occupied earlier also (Hocquenghem and Peña Ruiz 1994).

Less than one day walk up the Tumbes River lies another site, Rica Playa, believed to have been on the Inka Road also contained evidence of shell working. It is clear that Spondylus was worked there, but the dating is problematic and the details are cloudy, mainly because artifacts were only collected from part of the site that was disturbed by the expansion of a road (Blower 1995:226; Hocquenghem 1993; Hocquenghem and Peña Ruiz 1994).

5.3.5.5.Period C3 (1100-1532 A.D.) summary

This period is dominated by two of the largest prehistoric empires of South America. On the consumption side, the Chimú appear to have been interested in raw Spondylus shell in all forms, whole shells, fragments, and even crushed or powdered. Secondly, although Spondylus had been used as inlay previously, the Chimú appear to have liked to use it as inlay in the wooden figures popular during the period. Control over the raw material may have lain in the hands of either the Chimú or the Manteño, or a combination thereof. The representation of Spondylus as a three- or four- pronged crescent is nearly seamless between Sicán and Chimú, though this may in part be due to problems with dating of looted or museum artifacts.

After the Inka conquest of the Chimú, and perhaps before as well, the Inka seem to have taken control of the production of Spondylus artifacts for their own purposes. Although there are some *chaquira* still circulating, it does not appear that they were produced during this period. Instead Inka craftspeople made small figurines of people, in the typical Inka style, and of animals, especially the llama. Production sites may have been centered on the extreme north coast of Peru between the Lambayeque Valley and the Tumbes Valley. Human and llama figurines have been located at a wide variety of sites, but mainly at the high peaks in Peru, Chile and Argentina. Beyond these places, human figurines have been recovered from Túcume and Tomebamba (fragment). The Manteño do not appear to have continued to produce the tiny shell beads and may have become the suppliers of raw material for the Inka Empire. The Manteño did continue to make shell beads, but they were of a wide variety of material, including beach-worn fragments, and were much more irregular; very few of these beads were made from Spondylus. The Inka seem to have removed all control over the Spondylus trade, and perhaps all maritime trade, from the hands of the conquered Chimú and placed it in the hands of polities just to the south of the Chimú, namely around modern day Lima and Chincha.

5.3.6. Ethnohistoric records

When using ethnohistoric documents, researchers must be cautious of losing information in the translation process. Spondylus and *mullu* are often used interchangeably stating that *mullu* is the Quechua word for Spondylus. However, Blower (2001) has shown that there is too much contradictory information to use the two terms interchangeably. *Mullu* definitely applies to Spondylus, it also includes a wide variety of items. The term *mullu* can apply to shell of a variety of colors, including orange, purple, yellow, red, white, gold, and bluish-green as well as to other kinds of materials, including a variety of herbs, other food items and sea shell mixed with llama blood. Blower (2001) even argues that the term *mullu* may be applied to a “concept of a Spondylus vagina and represent the verbalization of the image, and possibly the concept, or even a lewd action, in everyday life" (Blower 2001:220). Murra (1975: note 1, my translation) states up front that he is using *mullu* to indicate Spondylus, not "the limited sense that the word *mullu* has in reality (necklace bead)." Although it is clear that some *mullu* is Spondylus, translating each and every occurrence of the term as Spondylus is erroneous (see also Marcos 1977-78:106), but this is done repeatedly when discussing the use of Spondylus among the Inkas and their predecessors.

Ethnohistoric documents indicate that the primary use of *mullu* was to make it rain. From this Murra (1975[1971]:257) states, "millions of human beings, Andean agriculturalists, needed quantities that we can consider industrial." He indicates that it was either used ground, powdered or in the form of small beads (Glowacki 2005:259; Murra 1975:259, note 1). However, if we question his direct translation of *mullu* as Spondylus, it becomes much unclear how much Spondylus was consumed in the highlands, but it may not be the millions intimated by Murra.

Mullu was obviously valuable as indicated in the often cited account by Pablo Jose de Arriaga, a Jesuit missionary in Peru during the early seventeenth century who stated that a piece of *mullu* the size of ones fingernail cost four reales (Blower 2001:210; Murra 1975:260). This account only states that *mullu* is a large sea shell that people have small pieces from which they may make beads (Arriaga 1968 [1621]:45). It is not clear from the text that the *mullu* identified is Spondylus.

It is often cited, based upon the Huarochirí Manuscript (Saloman and Urioste 1991), that Macahuisa, the son of the god Pariacaca, refused to eat the food that Tupac Inka Yupanqui offered to him demanding instead "I am not in the habit of eating stuff like this. Bring me some thorny oyster shells!" (Saloman and Urioste 1991:116) see also (Blower 2001:215; Glowacki 2005; Murra 1975; Paulsen 1974:603; Pillsbury 1996; Rostworowski de Díez Canseco 1999). While Saloman and Urioste (1991:116) translate *mullu* as 'thorny oyster shells' (i.e., Spondylus), there is no evidence to indicate that this *mullu* is in fact Spondylus. The 'cap, cap' sound of the god eating *mullu*, however, suggests that it is something durable, such as shell.

The final and most convincing piece of ethnohistoric evidence for the prehistoric use of Spondylus is the Samano-Xerez Relacion, which was probably written by Pizarro's secretary. This account records the capture of a large vessel off the coast of Ecuador in 1525 by Bartolome Ruiz, Pizarro's captain (Currie 1995b:49; Marcos 1977-78:106-107; Murra 1975259-260; Norton 1986:137; Rostworowski de Díez Canseco 1999:40). The ship had two levels, a lower level of large logs (most likely balsa) that were awash in the ocean water and an upper level upon which the people and the cargo were placed out of the water. Atop this were masts and sails. The ship, carrying 20 men, had a capacity of 30 toneles or approximately 25 modern tons (Currie 1995b:49). It was carrying a wide variety of trade goods, including

> "many items of silver and of gold personal ornament to exchange with those with whom they were going to trade, including crowns and diadems and belts and gauntlets (ponietes) and leg armour (greaves?) and breastplates and tweezers and jingling bells and strings and bunches of beads and rosecleres (other beads of a clear, rosy colour [Mester, 1990]) and mirrors mounted with the said silver, and cups and other drinking vessels; they carried many mantles of wool and of cotton and shirts and *aljubas* (tunics?) and *alaremes* (not translated) and many other garments, most of them embroidered and richly worked in colours of scarlet and crimson, and blue and yellow, and of all other colours in different kinds of work and figures of birds and animals and fish and trees; and they brought some tiny weights to weigh gold, like Roman workmanship, and many other things. On some strings of beads there were some small stones of emerald and chalcedony, and other stones and pieces of crystal and *ánime*

> (not translated). All this they brought to exchange for some shells from which they make coral red and white beads, and they had the vessel almost laden with them ...” (Currie 1995b:49)

It appears that this vessel was from the Salangome, a chiefdom composed of four settlements, Calangome (Agua Blanca), Tusco (Machalilla), Seracapez (López Viejo), and Calango (Salango; Currie 1995b:51; McEwan and Silva I. 1989:Fig. 3; Norton 1986:140). It is not clear where this vessels was intercepted, although Marcos (1977-78: 106) gives the location as the south coast of Esmeraldas, the northern-most coastal province of Ecuador. The vessel carries extremely valuable goods to trade for Spondylus as well as Spondylus shells (from which they will make beads). The vessel must be at least partially done with its trading expedition, and probably close to done considering that the vessel is laden with Spondylus shells. It is also quite possible that their trading expedition was not exclusively for Spondylus, but for some of the other goods as well, such as emeralds or amber (see, e.g., Shimada 1995: 167, Fig. 131) or perhaps even northern gold. Although this vessel has often been interpreted as a Manteño vessel headed north, perhaps even to Mexico, in search of Spondylus, but this isn’t necessarily so. We now know that there were shell working sites along the Panamanian coast also (Cooke 1998; Cooke and Sánchez H. 1997; Mayo 2004; Mayo and Cooke 2005).

All of this does argue for the great importance of Spondylus to the people of Ecuador and Peru. The people of the Ecuadorian coast sailed large ocean-going vessels made out of balsa logs with second level where people and goods stayed dry (Edwards 1965; Estrada 1979, 1988; Norton 1986). These vessels had large sails and were controlled via *guaras*, large steering boards lowered into the water and placed symmetrically around the vessel. By raising and lowering the *guaras*, the crew could control the direction of the vessel (Estrada 1979:47-56; Rostworowski de Díez Canseco 1999:40-41). Because these vessels are essentially large rafts, they could carry a great deal of cargo and were extremely difficult to capsize. The distribution of these vessels is known. The key is the balsa logs that were light and durable. Pedro Guitiérrez de Santa Clara indicated that these vessels were used in Paita to Tumbez, Peru and Puná Island and Puerto Viejo, Ecuador (Edwards 1965:68). The ethnohistoric range for sailing rafts is from the Ecuadorian province of Manabí to the Sechura Bay in Peru and perhaps farther south (Edwards 1965: map 1). Smaller versions of these boats were in use a few decades ago in Paita and Sechura (Edwards 1965: Plates 14, 18,19 and 20, Maps 2 and 3) and in Ecuador (Estrada 1979:47-56, 1988). It is also very clear that Valdivians may have traveled to Isla de la Plata, an Ecuadorian island approximately 23 km from the coast, as early as 2000 B.C. This indicates they either had ocean-going sailing rafts or canoes large enough and crews experienced enough to make the fairly hazardous trip (Marcos and Norton 1984:12). Large canoes were in use in Ecuador and to the north at that time of Contact (Edwards 1965).

No matter which direction this vessel was headed, it is clear that the main or one of the main products that were traded were Spondylus. In this case, it appears that, since red and white beads were to be made, that *S. princeps* was the species with which they were most concerned.

5.3.7. Extreme northwest Peru

Of all the regions in Peru, the extreme northwest coast is one of the least studied and the research that has been carried out has been done mainly by non-archaeologists. Extreme northwest Peru is separated from the rest of coastal Peru by the formidable

Sechura desert and is divided by the only mountain range on the Peruvian coast, the Amotape Mountains. The third strike against the region is its status as a border region with Ecuador, a border which had been the reason for numerous conflicts between the two countries until 1998, when a treaty, symbolized by Spondylus (Sandweiss 1999), was signed. The area includes the valleys of the Tumbes, Sechura and Piura Rivers. Of these three areas, the Upper Piura has been researched the most, mainly due to the presence of the large Moche (or Moche-like) site of Loma Negra (Guffroy 1989; Guffroy et al. 1989; Guffroy et al. 1989; Kaulicke 1991).

The Tumbes Valley has been the least studied, but may be the key to understanding the trade network for Spondylus. Two important pieces of information suggest the relevance of this region to Peruvian and Ecuadorian prehistory, especially where Spondylus is concerned. First, the Spondylus workshops located by Hocquenghem and fellow researchers (Hocquenghem 1993, 1999; Hocquenghem and Peña Ruiz 1994) provide important evidence of Spondylus (and many other types of shell) working in later prehistory (probably including in both Chimú and Inka empires). It is quite likely that Tumbes was an important node in the road network that was the key to supplying the Inka Empire. It was one of the two main roads from the coast into the highlands, presumably because of its proximity to the supply of Spondylus (Jenkins 2001). However, excavations in the Tumbes area have been limited to those carried out in the 1950's and 1960's by a team from the University of Tokyo (Izumi and Terada 1966). Excavations at Pechiche and Garbanzal yielded Piura 3 ceramics. The dating of the sites, especially Garbanzal appear to be very questionable, however. Radiocarbon dates suggest dates between A.D. 1060 and 1145, but the authors believe these are contaminated and suggest dates between 500 B.C. and A.D. 500 (Izumi and Terada 1966; Richardson et al. 1990). No Spondylus was recovered from either Pechiche, which dates earlier than Garbanzal, or from Garbanzal. The question is then, what is the time depth of interest in Spondylus in the Tumbes area. Some believe that it does not extend back beyond c. A.D. 600 (Hocquenghem et al. 1993).

It is clear that there are a great many archaeological sites in extreme northwest Peru that have not been investigated. Mark McConaughy (Richardson et al. 1990) has recorded numerous large sites in the Chira Valley. Pederson indicates that there are a great number of sites in the Tumbes Valley and, especially, on the road between the Tumbes and Chira Valleys (Hocquenghem 1993; Peterson 1959). The later, especially skirts that Ecuador, Peru border making any sites in the area difficult to research. Again, the time depth of these sites is unclear.

Now that the prehistory of Spondylus is well understood, we can place the production of shell (Spondylus and other) beads in context. We must, first, however deal with some theoretical issues about artifact variability and change.

	S. leucacanthus	*S. princeps*	*S. calcifer*
Exterior Features			
Color	White to orange, coral red	Dusty rose, purple with orange spines	Purple/orange, orange/yellow, all orange, all purple
Spines	Long, straight, narrow	Medium length, spatulate	Short, spatulate to absent on adults
Radial ribs	Hardly apparent	pronounced	Course threads
Attachment area right valve	Free living, occasionally attached to a dead shell or rock	Attached to rock by small area	Most of bottom valve attached to rock
Interior Features			
Hinge teeth left valve	Delicate, narrow, white, heavy in gerontic specimens	Delicate, wide, brown	Large, brown
Hinge teeth right valve	Delicate, wide, white	Delicate, narrow, white	Large, white
Adductor muscle scar right valve	Deep with callus	flat	Flat to deep with callus
Color band	Narrow, usually present near hinge, occasionally around margin	Broad, around entire margin	Broad around entire margin
Margin crenulations	More pronounced, less regular than in *S. princeps*	Finer, more evenly spaced than in S. leucacanthus	Strongest, extending further into shell
Habitat	Sand, 18 to 90 m	Rock, 3 to 28 m	Rock, intertidal to 18 m

Table 5-1. Comparison between the three Panamic Spondylids. From Skoglund and Mulliner 1996:Table 1.

Author	Statement	Citations
Paulsen 1974:597	Spondylus- 20 to 60 feet (6-18 m)	Keen 1958:76 Olsson 1961:152 Norton, p.c.
Marcos 1977/78:103	Both- 80 to 200 feet (25 to 60 m)- except *S. princeps unicolor* in Gulf of California (7-30 m)	Morris 1966 Keen 1971
Marcos and Norton 1981: 148	*S. princeps*- 15-50 m *S. calcifer*- 5-10 m	Underwater survey
Marcos and Norton 1984:14 English translation of 1981	*S. princeps*- 15-50 m *S. calcifer*- 3-7 m	Underwater survey
Marcos 1986:199	*S. calcifer*- on rocks intertidal to 10 m *S. princeps* – sandy bottom from 15 to 16 m	Abbott 1974 Keen 1971 Olsson 1961 Marcos and Norton 1979 (1984)
Norton 1986: 133	*S. princeps*- 15 m to 70 m *S. calcifer*- 6 to 50 m	Keen 1971 Olson [sic]1923 1961 Personal observation
Cordy-Collins 1990:306	Spondylus- 25 m deep beds	None
Hocquenghem + Peña Ruiz 1994:211	*S. princeps*- 25-30 m	None
Marcos 1995:101	*S. princeps*- 15-30 m cemented to the rocks *S. calcifer*- 4-7 m similarly cemented	Keen 1971:96 Abbott 1974 Lamprell 1987 Waller 1978
Pillsbury 1996:317	*S. princeps*- 15-50 m- *S. calcifer*- lesser depth	Keen 1971:96-98 Marcos 1977/78 Marcos and Norton 1981:148 Norton 1986:133-134
Pillsbury 1999:151	Spondylus- 15-50 m	None
Hocquenghem 1999: 58-60	Spondylus- at least 15 m *S. princeps*- *S. calcifer*- now- below 5 m Prehistorically- intertidal to ?	Norton 1986 and personal communication Béarez 1996: 134-135 See discussion
Cordy-Collins 2001:35, see also 1999:17-18	*S. calcifer*- ? *S. princeps*- as much as 50-60 m	None
Glowacki 2005: 258	*S. calcifer*- relatively shallow depths *S. princeps*- up to 50 m	Hocquenghem 1993 Marcos 1977-78, 1986, 2002 Paulsen 1974 Rostworowski 1970, 1975

Table 5-2. The depth at which Spondylus can be recovered as indicated by major articles on the shellfish.

Author	species	From	To	Citations
Marcos 1977/78:101	*S. princeps*	Gulf of California	Northern extreme of Peruvian coast	Abbott 1974, Keen 1971, Olsson 1961
	S. calcifer	Gulf of California	Panama- perhaps to Peru	
Marcos 1986:199	*S. calcifer*	Gulf of California	Punta Parina, Perú	Abbott 1974 Keen 1971
	S. princeps	Baja California	Santa Elena Península	Olsson 1961 Marcos and Norton 1979
Norton 1986: 133	*S. princeps*	Gulf of Panama	Gulf of Guayaquil	Keen 1971
	S. calcifer	Gulf of California	Cabo Blanco, Peru	Olson [sic]1923 1961 Personal observation
Cordy-Collins 1990:306	Spondylus		Not native to cold Peruvian coastal waters- nearest source is coastal Ecuador	None
Hocquenghem 1993: 702	*S. princeps*		Costa ecuatoriana de Manabí	None
Hocquenghem + Peña Ruiz 1994:211	*S. princeps*		Aguas calientes de la costa ecuatoriana	None
Marcos 1995:101	*S. princeps*	Gulf of California	Gulf of Guayaquil	Marcos 1977/1978, 1988b
	S. calcifer	none	None	
Pillsbury 1996:313, 317	Spondylus		Normally found in warm waters north of the Santa Elena Península	Abbott 1974: 450-451 Keen 1971:96-98 Lamprell 1986 Olsson 1961:149-153
Anawalt 1997	Spondylus	Gulf of California	Gulf of Guayaquil	None
Hocquenghem 1999: 56-57	*S. princeps*	Baja California	Golfo de Guayaquil	None
Pillsbury 1999:151	Spondylus		From Ecuadorian coast	None
Cordy-Collins 2001:35	*Spondylus*		Not native to the cold waters of Peru- closest is Gulf of Guayaquil	None
	S. calcifer		Hasta Cabo Blanco	
Glowacki 2005: 258	*S. princeps*	Panama	Northwestern Peru	Abbott 1974: 450-1
	S. calcifer	Gulf of California	Ecuador	Keen 1971:96-8
	S. calcifer	Gulf of California	Ecuador	Keen 1971:96-98 Marcos 1977/78 Marcos and Norton 1981:148 Norton 1986:133-134
	S. princeps	Panama	Northwestern Peru- south to Callao during ENSO	See above Sandweiss 1992: note 79 Sandweiss 1982:219 Sandweiss and Rodriguez 1991:58-59

Table 5-3. The natural distribution of Spondylus as indicated by major articles on the shellfish.

Burial number	Sex	Age	Beads	Spondylus	Locations

2	Female	35-45	136	18 pink/white Spondylus	Neck
			18	11 pink/white Spondylus	R. wrist
			14	12 pink/white Spondylus	L. wrist
8	?	8 mo.	3	3 reddish/white shell	Neck
38	Female	50+	5	1 pink	Neck
42	Female	30-40		Spondylus ornament	
53	Female	50+		Spondylus labret	In skull
68	?	9 mo.	25	19 tubular shell	L. wrist
			30	24 tubular shell (Spondylus)	
69	?	1	143	54 (Spondylus)	Neck
			14	10 small shell (Spondylus)	R. wrist
			4	4 small shell (Spondylus)	L. wrist
71	?	4-5	2	2 (Spondylus)	Neck
			1	1 (Spondylus)	R. wrist
			1	1 (Spondylus)	L. wrist
76	Female	19-22	30	24 small shell	Neck
			34	34	R. wrist
			103	0	L. wrist

Table 5-4. Possible Spondylus artifacts from Moche III burials from Pacatnamú . Note: All Spondylus artifacts are beads unless otherwise noted. All information from Donnan and McClelland 1997.

Figure 5-1. An immature *Spondylus princeps* from Salango, Ecuador. Shell is approximately 8 cm across, not including the spines.

Figure 5-2. An immature *Spondylus calcifer* that was attached to a group of mussels from just below low tide at Puerto Peñasco, Gulf of California. Shell is approximately 8 cm across, not including the spines. Collected by Chris Brown, Photo Courtesy of Chris Brown.

Figure 5-3. A gerontic Spondylus calcifer found attached to rocks just below the low tide line. From Puerto Peñasco, Gulf of California. Note the extensive pitting and calcareous growths left by epibionts. Collected by Chris Brown, Photo Courtesy of Chris Brown.

Figure 5-4. Photograph of live S. princeps showing the dramatic camouflage of the epibionts as well as the colorful margin. Photo Courtesy of Peggy Williams.

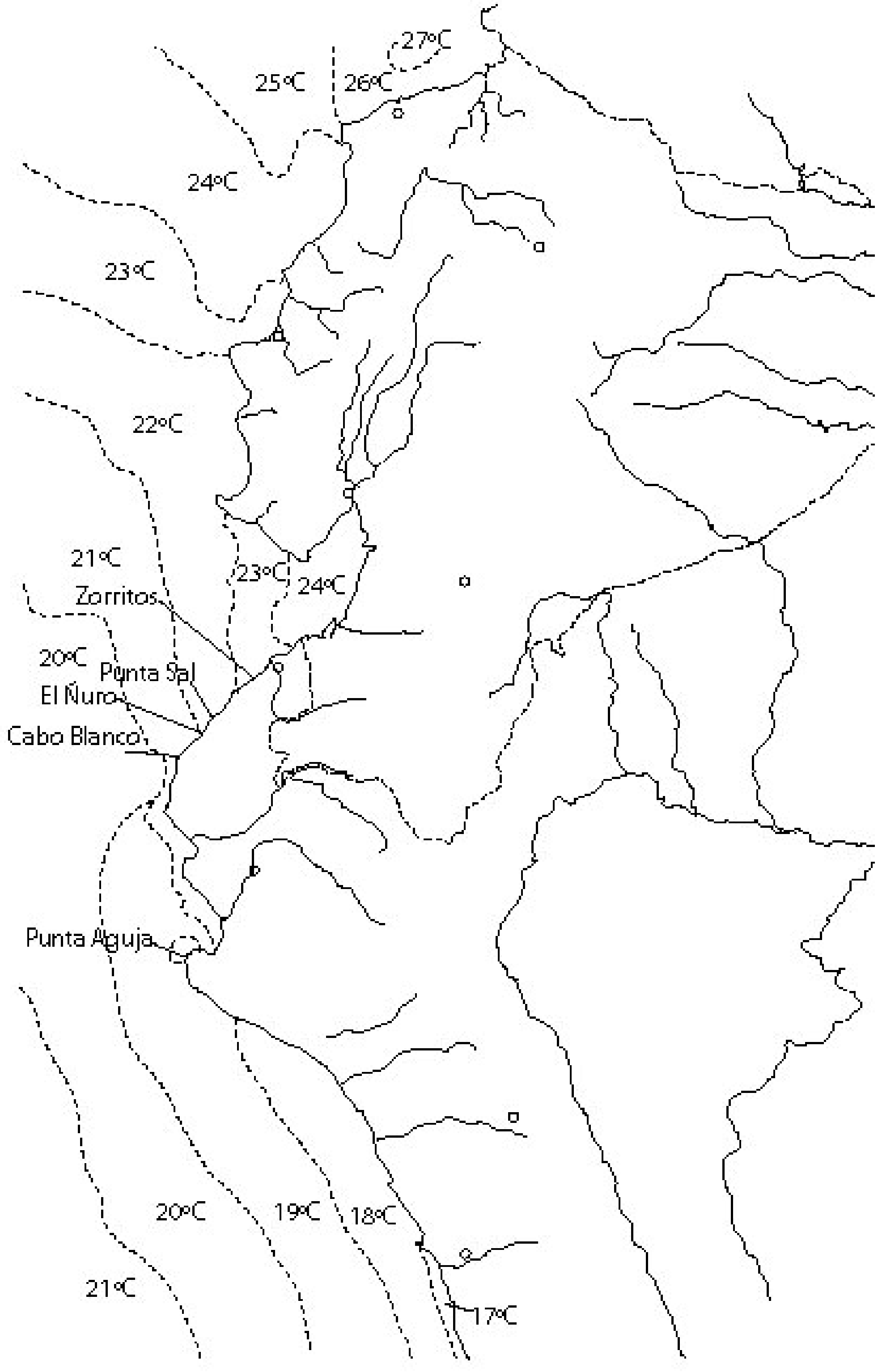


Figure 5-5. Map of Ecuador and Northern Peru, showing average sea surface temperature from 2000-2003. Redrawn from Teran et al. 2004: Figura 2.3.

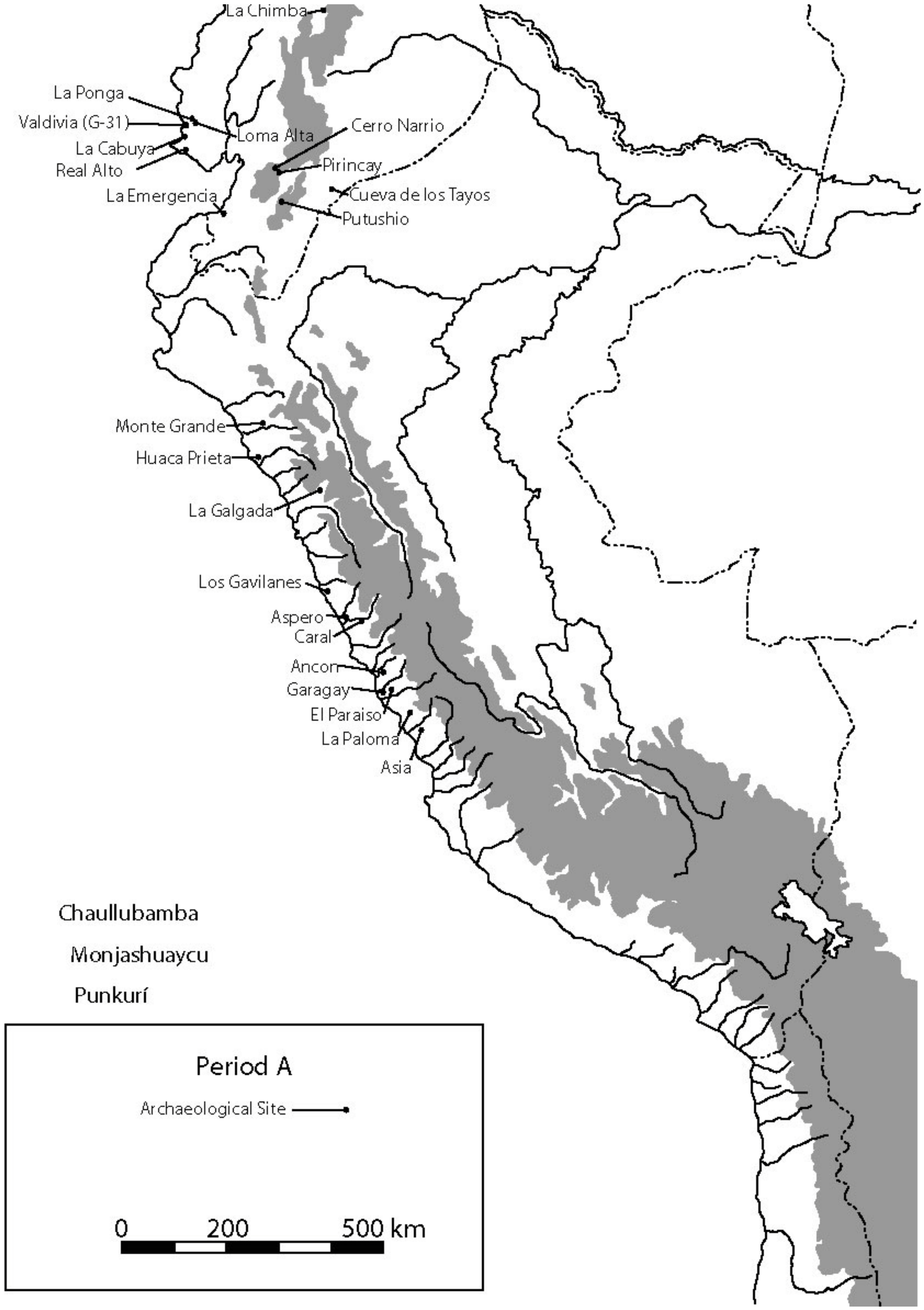


Figure 5-6. Map of Ecuador and Peru, showing sites mentioned during the discussion of Period A (before 1100 B.C.) Map based upon Moseley 1996: Figure 42

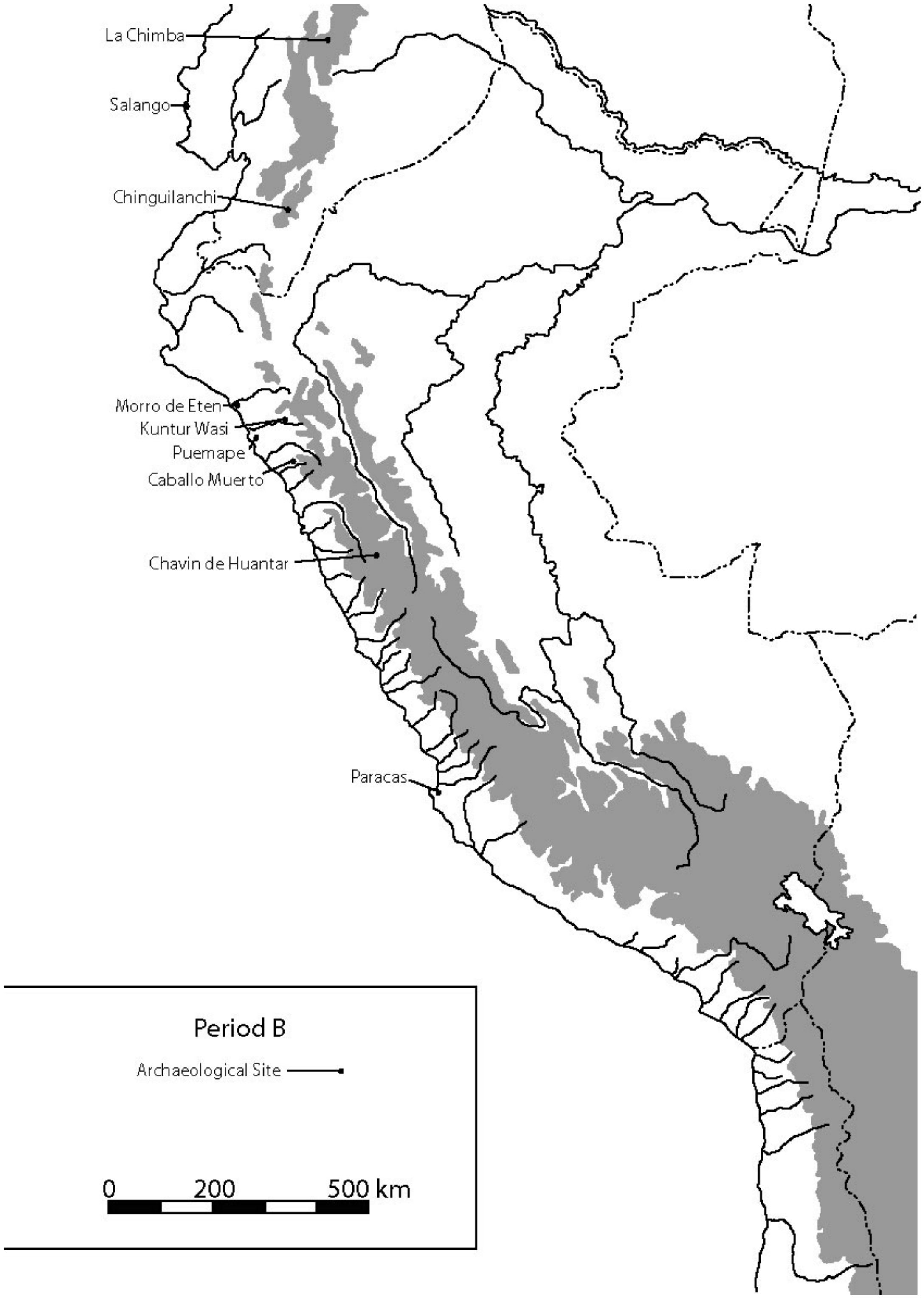


Figure 5-7. Map of Ecuador and Peru, showing sites mentioned during the discussion of Period B (1100 to 100 B.C.). Map based upon Moseley 1996: Figure 42

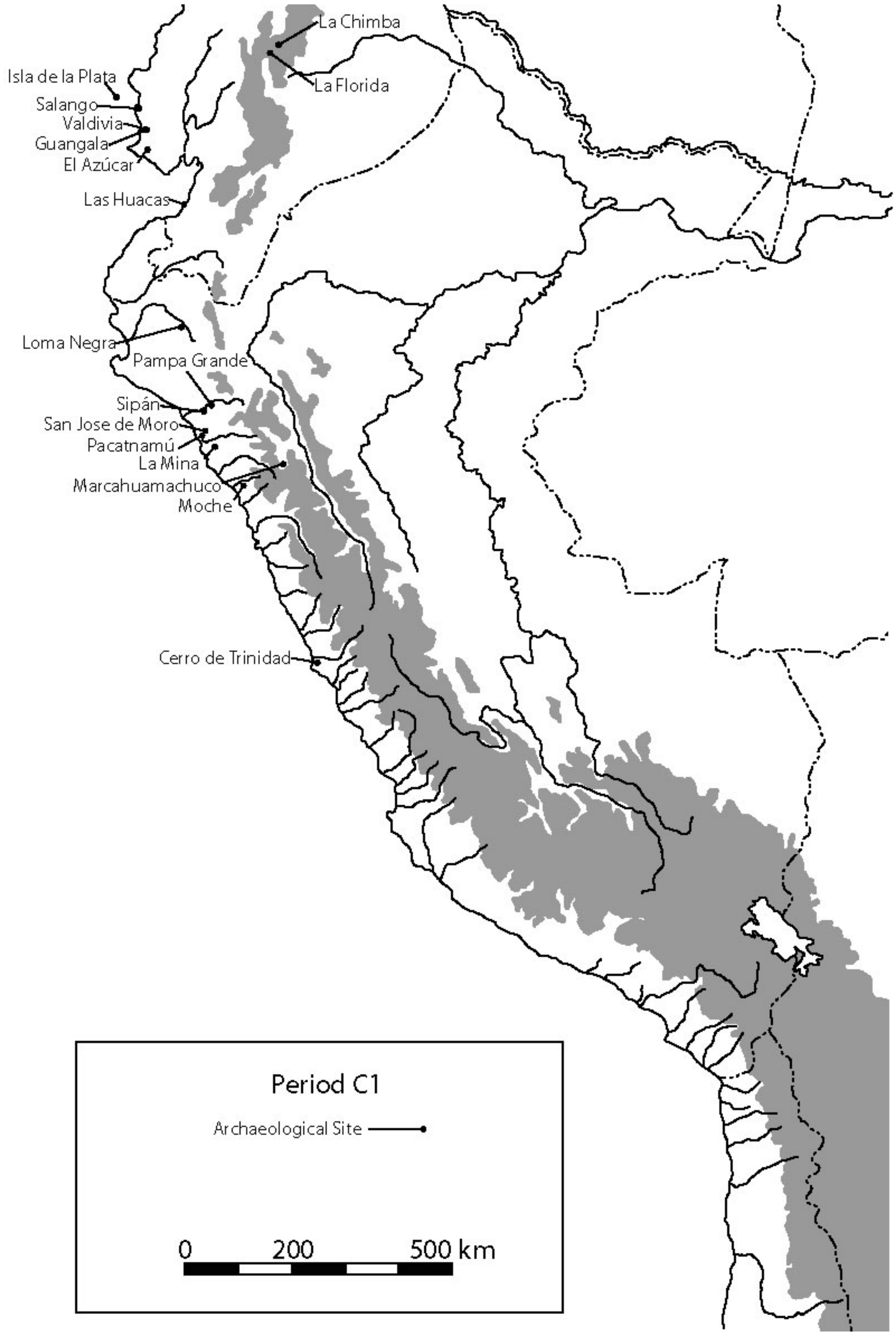


Figure 5-8. Map of Ecuador and Peru, showing sites mentioned during the discussion of Period C1 (100 B.C.- 700 A.D.). Map based upon Moseley 1996: Figure 42

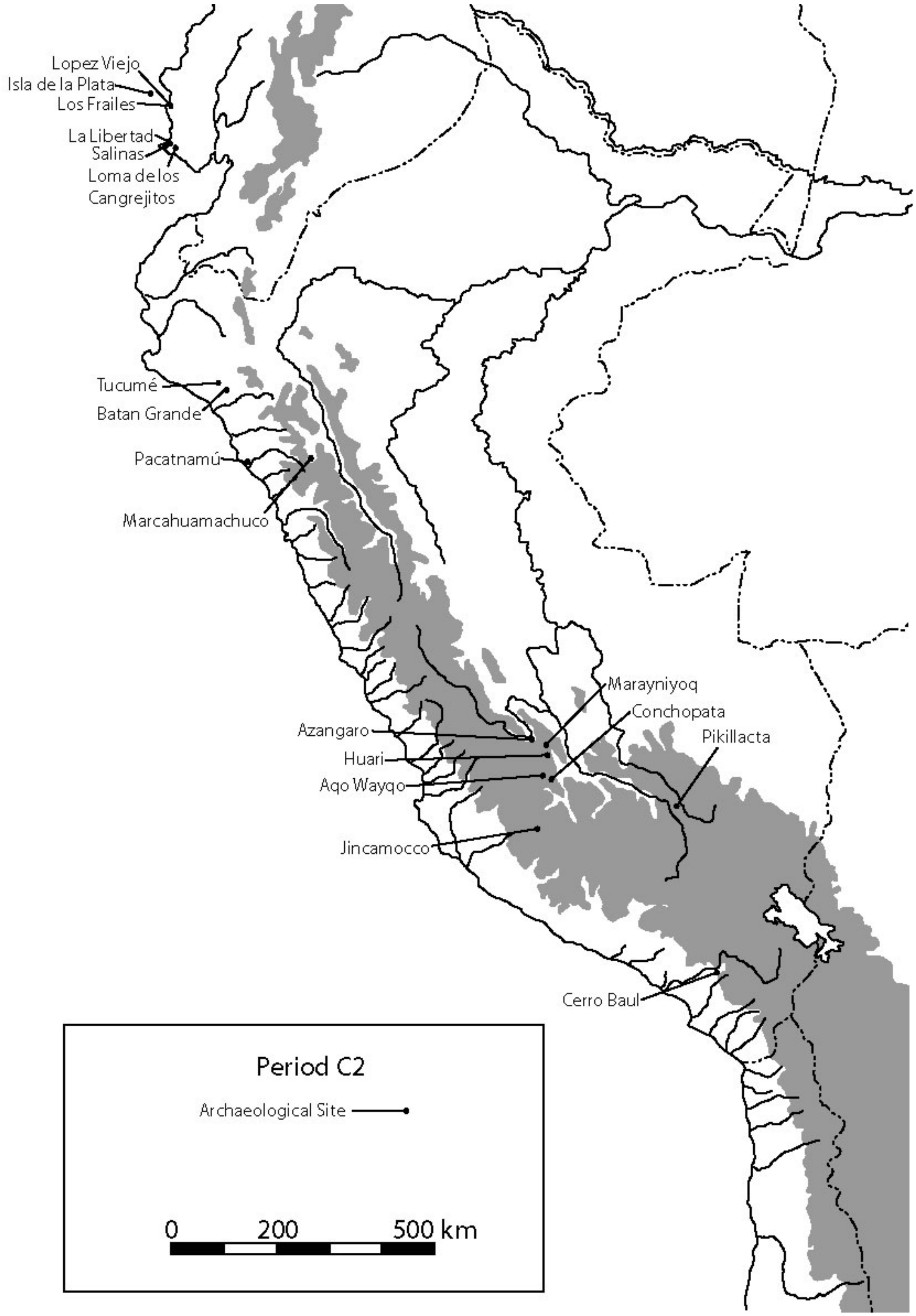


Figure 5-9. Map of Ecuador and Peru, showing sites mentioned during the discussion of Period C2 (700 to 1100 A.D.). Map based upon Moseley 1996: Figure 42

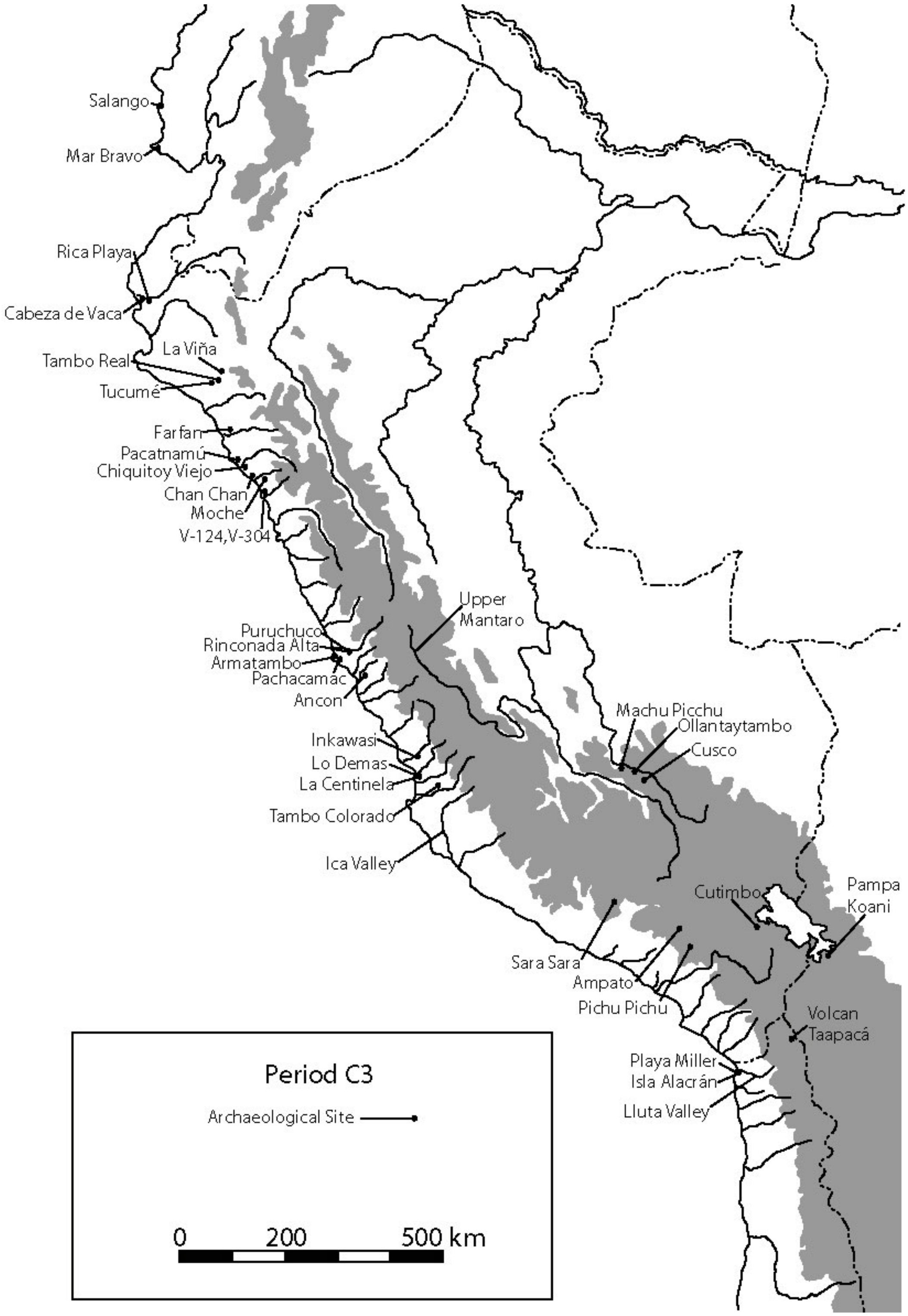


Figure 5-10. Map of Ecuador and Peru, showing sites mentioned during the discussion of Period C3 (1100 to 1532 A.D.). Map based upon Moseley 1996: Figure 4.

Chapter 6. Theoretical Background- Society and Technology

This section addresses one of the central issues in archaeology, the relationship between artifacts and the people who made them and why they made them a certain way. This topic has been discussed since the beginnings of scientific archaeology. Therefore, this section is a discussion of only a portion of the vast archaeological and anthropological literature regarding the relationship between people and their things. Initially, my approach is framed in terms of the 'style' of artifacts. Specifically, the difficulty of identifying 'style' and its partner, 'function,' is brought to light through an discussion of a scholarly dialectic between James Sackett and Polly Wiessner, advocates of distinct definitions of these concepts. I suggest that we are asking the wrong question. While we do need to identify which aspects of material culture are 'functional' at a general level, the more useful approach is to analyze the relationship between artifactual variation and social factors. It has become increasingly clear over recent decades that artifact production, though certainly an economic activity, it is highly influenced by non-economic social pressures. I argue that in most non-industrialized cultures, including Precolumbian societies, economic activity is social activity. Further discussion, therefore is framed in terms of the social interplay between individual and structure and its affect artifact production.

Social action is no longer seen as a process of simply 'obeying' structure nor as the product of free-willed actors, but a process in which individual actions can affect the very same structure that limits and enables them. Advances in social theory in the last thirty years are relevant in that they show how individual people relate to this larger thing we call 'society' or 'structure.' These theories, especially Pierre Bourdieu's theory of practice (especially Bourdieu 1977, 1990, 2000) and Anthony Giddens' theory of structuration (especially Giddens 1979, 1984), place the emphasis of social analysis not in the individual nor the structure, but in the interaction between the two; in the production and reproduction of the structure by individuals and the ability of the structure to both constrain and enable human action.

Although both structuration and practice theories provide a starting point, they lack detailed discussion of how dynamic social interaction can lead to change and stability. Both approaches seem to stress the stability of social systems, but archaeology, which is particularly interested in the long term, needs a better understanding of how such well-founded social theories can account for patterned change and stability. Therefore, I develop my own model for how social interaction can be understood and, since artifact production is essentially social, how change and stability in artifactual variation is produced. Central to this attempt is that all social interaction is conditioned by a set of internal and external factors that influence action. I identify these as biological predispositions, individual dispositions, social dispositions (i.e., structure) and social contexts. These factors cannot be thought of as determining action, but as indicating more or less appropriate actions to the agent. In this sense, these factors are probabilistic. Because of the variability of each individual's development of their own dispositions (as in Bourdieu's *habitus*), the probability of options may vary between actors. Stability and change in artifactual variation is promoted by the options available to the artisans; the more options available to an artisan, the more easily artifactual change can be produced by an shift in social factors and, inversely, the less options available to an artisan, the more difficult artifactual change will be because to these artisans options do not exist and must be innovated or adopted. Artifactual change can happen in both cases, but I argue is much more likely to happen if that change ‘fits’ well within the society. Even if an artifact type includes a great deal of variation, its mean and measure of dispersion will remain relatively constant if they ‘fit’ well with social factors. By ‘fit’ I mean that artifact production matches well with social factors, of which economic factors are clearly important. For example, in this study I recognize significant change in shell bead production. I argue that one of the main factors in a shift from tiny, very regular beads to larger, more irregular beads is the apparent drop in consumption of tiny beads among cultures of the Peruvian Coast. I do not see such a change as supply mechanistically responding to demand, but as an external factor affecting Manteño society and individual artisans affecting that change. While they certainly were directly affected by the change in consumption, they point is that how they reacted to this change is socially constructed. If the story were as simple as supply and demand, then there would have been no reason to continue to produce any shell beads, as the cultures of the Peruvian Coast were the main consumers. However, Manteño artisans chose to continue to produce shell beads, but ones that were much more expedient. This should not be seen as the artisans mechanistically responding to local demand, which did exist, but of making a technological choice that accorded well both with external factors (i.e., the disappearance of external demand from the Peruvian Coast) as well as internal factors. There were multiple possibilities for responding to these conditions and yet, one particular choice was made. I argue that this is not because it was the most rational choice, but because it was one of the possibilities that fit well with other social factors and may have been chosen by Manteño artisans as a whole for historically contingent factors that may be only peripherally associated with strictly economic factors.

This chapter provides the theoretical basis for the analysis of shell artifact production in the following chapters. Shell artifacts are present throughout much of the prehistoric world, but are often relegated to archaeological appendices or brief mention in final reports. They are much more valuable to us than this, however. The key to shell beads, especially discoid shell beads, is that the number of observable variables is limited and they are fairly ubiquitous in prehistory. The quantification of shell artifacts can enlighten the discussion about the recursive relationship among artifact, artisan and society. It is through these shell beads that this approach is demonstrated.

6.1. Archaeological Style.

The style of an artifact has long been seen as important in the reconstruction of prehistory, especially culture history. Indeed, the basis for Christian Thomsen's early Three Age System is the recognition that style changes through time and these changes can be used to relate people to different relative time periods (e.g., Kroeber 1957; Trigger 1989:73-79; Watson 1995). Style in this sense is a key tool that all archaeologists use; it records a concrete foundation of social processes in archaeological remains and we are unlikely to dispose of it (DeBoer 1990:102). A strict culture history, however, tells us little about the people who made and used the artifacts (see discussion in Johnson 2004). Style can give us so much more than relative dating.

Until around twenty years ago, style and function were commonly seen as two distinct properties of an artifact. Certain attributes of an artifact were determined by its function and the rest was style and could vary according to the wishes of the 'culture', 'society', or individual. It is now recognized that this dichotomy is unrealistic and even traits that are mainly functional can vary stylistically and that style, more often than not, has a function, even if it is non-economic (e.g., religious or social). To clarify the relationship between 'style' and 'function', we must first understand what is meant by these terms.

6.1.1. Defining Style and Function

Varying definitions of style and function have been offered (Boast 1997; Conkey and Hastorf 1990; Dunnell 1978; Hegmon 1992; Plog 1983; Sackett 1977, 1982; Wobst 1977). Most treat function and style as two separate but, often highly, interrelated aspects of the material record. In order to deal with the concept of style, it is informative to discuss the scholarly interaction between James Sackett (Sackett 1977, 1982, 1985, 1990) and Polly Weissner (Wiessner 1983, 1984, 1985, 1990). Their interchange, done in a positive scientific and dialectical way, improved the theoretical concepts employed by both scholars, but did not produce a unitary definition of either style or function. Their discussion highlights the difficulty in identifying which aspects of an object are functional, or even whether ideological or social functions are 'function' or 'style.'

6.1.1.1. James Sackett's isochrestic and iconological style

James Sackett identifies two types of style, isochrestic and iconological, but it is the former upon which he focuses. He defines isochrestic style as "a highly specific and characteristic way of doing something, which, by its very nature is peculiar to a specific time and place" (Sackett 1982:63). Isochrestic style is based mainly upon unintended choices. He explains that all artifact variability can be attributed to either function or style. Function, according to Sackett, includes "functioning in all realms of cultural life…

not simply in the material realm of technology and economics, but simultaneously as well in the societal and ideational realms" (Sackett 1977:370). Including societal and ideational realms under the aegis of 'function' would appear to exclude most of what archaeologists consider style such as painted designs on a pottery vessel, which may have religious or social connotations and therefore a function. This makes the term style difficult to use because we would be unable to create material culture histories based upon stylistic variation, because Sackett's broad definition of function eliminates style from all variation except where it plays no role in society. However, his discussion of style as a "banner advertising the arena in which… roles are being performed" (Sackett 1977:370), suggests that, even in his limited definition, *style is functioning* to identify the group using the artifacts. Sackett's discussion makes in unclear whether an attribute that is stylistic can also be functional.

Sackett's solution to this problem lies in identifying style as how an artifact is made, not necessarily in its overt characteristics. He argues that there are many ways of making an artifact that are functionally equivalent (see also Lemonnier 1992). The choice of which particular technique to employ is the locus of isochrestic style. The decision of which functionally equivalent style to use, however, is not made by the individual, but by society; "chance alone dictates that the precise choice made by one society is extremely unlikely to be made in another, unrelated society" (Sackett 1977:370-371). Artisans make things the way they do because it is 'the way things are done.' Sackett makes a largely structuralist argument, giving much more weight to society or structure than to the individuals who populate it. The individual is but a vessel through which 'society' or 'culture' make objects. His isochrestic style allows little room for people to populate the past leaving them as vessels through which society makes things. Such a definition allows little space for stylistic change. If a society has chosen a certain technique, how and why would it change? These technological changes are the heart and soul of archaeological analyses of 'style,' but Sackett does not provide us with a way in which society decides to change. It must be through people.

Based upon Sackett's discussion, style is present only in the random choices made by 'society' in the material realization of its craft. Sackett has removed what many archaeologists consider a key aspect of style: intentionality. Polly Wiessner provides a view distinct from Sackett's.

6.1.1.2.Polly Weissner's active and passive styles

Polly Wiessner's discussion of style and her reaction to Sackett's work are particularly informative (Wiessner 1983, 1984, 1985, 1990) in light of the above. Wiessner sees style as primarily communicative; "style is a means of communicating based on doing something in a certain way" (Wiessner 1990:106; see also Wobst 1977). Further, she indicates that the primary goal (is this an artifact's function?) of style is to express relative identity. In this way, the style of an artifact can be used to signify inclusion in or exclusion from a group or, more dynamically, to challenge or reaffirm the possessor's status relative to one or many groups. Interestingly, Wobst (1977) suggests that style is an inefficient way to communicate and, therefore, style is only communicative when it is the most efficient option. However, it is fairly clear that style need not be efficient. Indeed when competitive consumption is considered, often style is distinctly inefficient (e.g., Earle 1990).

Wiessner admits that not all style is used for overt identification, what she calls 'active' style, but also may be 'passive' in that it does not communicate anything in particular. Not all actions have a conscious and intended consequence (Wiessner 1990:107). Passive style may express group identity because people who are raised in a similar environment learn to 'do' in similar ways, which is clearly similar to Sackett's isochrestic style. Passive style is often not recognized emically until a particular way of doing comes into question: for example, when compared with similar objects from outside the group. People don't recognize the way they do things as a particular variant, but as the only way to do something, until they are confronted with an alternative. For Weissner, however, even if passive style does have a function (as Sackett argues), as does active style, it is also 'style.' She does not separate function from style like Sackett.

It is Weissner's 'passive' style that Sackett argues is isochrestic style and by doing so, he relegates the use of artifacts as tools of identification to a function (Sackett 1990:36). Sackett argues that 'active' (what he calls iconological) style forms the minority of style and 'passive' (i.e., isochrestic) the majority. In this way, he makes much of the choices made by society and minimizes the role of the individual.

6.1.1.3. What is stylistic? and what is functional?

The main question that arises out of the discussion between Sackett and Wiessner is still, "What is stylistic and what is functional?" There is no simple answer: functional attributes, because an artisan must choose one of many options to create the artifact, are also stylistic and stylistic attributes may have a function, even if it is not recognized as such by the producer. Stylistic attributes may be the consequence of highly intentional efforts by the artisan to communicate (Wiessner's active style, Wobst's communicative style and Sackett's iconological style), or to more passive, unintentional actions representing group identity because it is simply the way things are done (Wiessner's passive or Sackett's isochrestic style).

If the stylistic attributes of an object cannot *a priori* be separated from the functional aspects of the same object (Boast 1997; DeBoer 1990; Gosselain 1998, 2000), does this mean that we can no longer analyze style? On the contrary, this simply indicates that style may be present in all artifactual variation, even that which is functional. Style may only be absent when there is only one way of doing something, a distinct rarity. Stylistic studies, in the culture historical sense, rarely utilize all of the style present but focus upon certain attributes that have been identified as important to the analyst. However, that does not mean that style is not present in the ignored attributes.

Style seems best described as a 'way of doing' (Hodder 1990:45) represented in practically all attributes of artifacts. What determines this way of doing? Why do people make artifacts in certain ways? How much control do they have or understand over the choices that they make? The main theme behind the discussion between Wiessner and Sackett is the relationship between individual artisans and the wider community in which they act/produce (see Boast 1997). This is the starting point for a discussion of the three important aspects of production: the role of the individual, the role of society, and the role of doing. These issues are at the heart of Anthony Giddens' structuration theory and Pierre Bourdieu's practice theory.

Style represents 'ways of doing' that are both inherently social as well as individual (Childs 1998; Conkey and Hastorf 1990; Dobres and Robb 2000; Dougherty and Keller 1982; Gardner 2004; Gosselain 1999; Hegmon 1992; Hodder 1990, 2000;

Ingold 1990; Killick 2004; Lechtman 1977, 1993; Lemonnier 1986, 1990, 1992, 1993; Schlanger 1990, 1996, 1998; Schlanger and Sinclair 1990; Stark 1998 and works therein; see also articles in Journal of Anthropological Research, 2001, vol 57[4]). It is clear that technological production is not simply a matter of one person making an artifact out of raw materials, but an artisan producing within a web of social connections, which affect the way that the artisan works.

6.1.2. Agents (re)producing structure (re)building agents

In the late 1970s and early 1980s, Pierre Bourdieu and Anthony Giddens made important contributions to the study of the relationship between the individual and society. Both Bourdieu's theory of practice and Giddens' theory of structuration were reactions to overly-objectivist and determinist structuralism as well as overly-subjective phenomenology. Their most important contribution lies in the recognition that social life does not involve two separate things, structure and agent, but is a process of reproduction and production of the social structure through the actions of social individuals who are, in turn, shaped by social structure. In this way, Bourdieu and Giddens attempt to overcome the question of which is more significant, the individual or society, by placing emphasis upon the relationship between the two. Society cannot exist without individuals and individuals do not exist outside of society. Bourdieu tends to lean more heavily on the structure, leaving the individual with less agency than Giddens (Ortner 1984; Sewell 1992).

6.1.2.1. Pierre Bourdieu and *habitus*

Pierre Bourdieu, in his *Outline of a Theory of Practice* (1977[1972]) and *The Logic of Practice* (1990[1980]), introduced the theory of practice and, in *Pascalian*

Meditations (2000[1997]), continues to develop his theory of practice. One of the main concepts he employs is *habitus*, which is a set of unique, durable, and internalized dispositions (Bourdieu 1977, 1990). An individual's *habitus* is built through social interaction with other people. The uniqueness of an individual's *habitus* is derived from the fact that each person has a distinctive social experience that yields a different *habitus* within each social actor. A person's *habitus* is determined by their social experience and social experience is produced by the conjunction of the unique *habitus* of individuals. *Habitus* may be conscious or unconscious; we may or may not be aware that we are acting upon these dispositions and we may or may not be able to actively engage these dispositions. *Habitus* are reproduced through the actions of individuals who strive, not for wealth and power by themselves, but for social recognition.

By stressing the interplay between individuals and social structure, practice theory denies the centrality and strict rationality of individuals stressed by theorists such as Jean-Paul Sartre and Edmund Husserl as well as rational action theorists (Bourdieu 2000:138). In an attempt to be non-deterministic, Bourdieu (2000:149) states "dispositions do not lead, in a determinant way to a determinant action; they are revealed and fulfilled only in appropriate circumstances and in relation to the situation". The way a person acts within any social situation is produced by the conjunction of a person's unique *habitus* and the social conditions (what Bourdieu calls 'field') in which the action takes place or is about to take place (Wacquant in press). The recognition of the importance of the context of social interaction is significant, but he still seems to indicate that actions are determined, not by structure or habitus, but by the conjunction of these with the social context. If an individual's *habitus* and the social context is known, then behavior could be mechanistically predicted. Since social context can be identified (though perhaps not completely), the behavior of different actors varies due to the uniqueness of *habitus*. This recognizes that human behavior is contingent upon previous experience, but leaves little free will (Dornan 2002:305-7; Throop and Murphy 2002).

Bourdieu suggests that individual choice is mainly limited to new experiences. When something occurs that has never been previously experienced, then the individual is unable to formulate a 'right' response (Bourdieu 2000:148-149). The response that the individual does develop is based upon his or her unique *habitus*, but, since there is no prescribed action, it may be very different from the response of another individual. Such a situation allows for a degree of variability among individuals of normally like-mind. It seems that, for Bourdieu, the social situations where a person's *habitus* does not indicate a particular action (a disjuncture) are the loci of free will because people must create their own novel response. Bourdieu, however, limits his discussion of 'free will,' focusing instead upon the durability of *habitus* and the process of practice.

In Bourdieu's perspective, social change is not likely in normal day-to-day life, and is related to disjunction between *habitus*, i.e., how things should be to that particular person, and the actual social situation. Precisely how social change happened was not discussed in great detail as Bourdieu's focus was to address the duality of society and individual in a theory that combined the two. It does appear that, to Bourdieu, variation in social action is largely due to the uniqueness of individual *habitus* and the occasional disjuncture between their habitus and field, which can yield change. Bourdieu does identify another possibility for social change via the recognition of our own dispositions and actively changing them. This privileges modern sociology and limits social change outside of modern social activism. Such a perspective means that one must recognize that there is another way of doing things that is somehow 'ideally,' a condition that is probably limited to situations where many cultures come into contact. This may limit such a perspective to post-Columbian globalization or to elaborate states with multiethnic populations (e.g., Teotihuacan?). Such a perspective does little to help us understand how society changed throughout much of human existence (Bourdieu 2002; Dornan 2002:305-306; Free 1996; Jenkins 1992; Throop and Murphy 2002:186-188; Wacquant in press).

The concept of *habitus* suggests that there would be relatively little change, but clearly, especially through the long term of special concern in archaeology, social change is an integral part of human history (Joyce and Lopiparo 2005:368). The question then, is how do societies and the durable dispositions upon which they are defined change? Bourdieu has done little to address this issue for pre-industrialized and non-Western societies.

6.1.2.2.Anthony Giddens' structuration theory

Anthony Giddens' theory of structuration is more flexible than Bourdieu's *habitus*, but it also stresses the process of producing and reproducing social structure via the actions of individuals. Compared to Bourdieu, he stresses agency, where "agency concerns events of which an individual is the perpetrator, in the sense that the individual could, at any phase in a given sequence of conduct, have acted differently" (Giddens 1984:9). Bourdieu does not discuss such individual freedom or choice.

Unlike Bourdieu, Giddens presents three different types of knowledge: unconscious, practical and discursive knowledge. Unconscious knowledge is a "basic security system" (Giddens 1984:41). Agency lies only in the use of the practical and discursive knowledge, particularly in the latter. Giddens' practical knowledge is, in many ways, similar to Bourdieu's *habitus* in that it is the nondiscursive and relatively automatic. Most knowledge exercised in social interaction is practical, which "is inherent in the capability to 'go on' within the routines of social life" (Giddens 1984:4). Discursive knowledge is those things that people consciously understand and can actively analyze and discuss. Discursive knowledge is where contradiction and contestation occurs within a society. There is no absolute dividing line between practical and discursive knowledge, however, as there is between these and unconscious knowledge; "the line between discursive and practical consciousness is fluctuating and permeable, both in the experience of the individual agent and as regards comparisons between actors in different contexts of social activity" (Giddens 1984:4). Even ingrained practical consciousness can be modified by the agent, though on a day-to-day basis there is relatively little discursive thought related to practical knowledge. It is mainly through the 'routinization' of practical knowledge that social structure is reproduced via the agent and it is the discursive knowledge that tests the limits of the same social structure as people engage actively with other agents. Giddens' version of structure, however, is different from that employed by Bourdieu in the sense that structures are resources that can be used in social interaction rather than the social generalization of individual *habitus*. In this sense, structure plays a more active role in the lived life of people, but, as a resource, it remains relatively unchanged and in the end the structure is reproduced.

Though Giddens gives more agency to individuals, he, like Bourdieu, stresses the importance of long-term durable social structures and discusses social change relatively little. In *The Constitution of Society,* Giddens dedicates a chapter to “Change, Evolution and Power,” but discusses frustratingly little about how change happens on the level of the individual, concentrating mainly upon critiquing evolutionary schemes of social change. The discussion that he does provide focuses upon the origins of states and the use of allocative (i.e., economic) and authoritative (or social) resources as strategic resources used by individuals. In many ways, his discussion is so general as to provide little instruction on how social structures change which, contradictorily, is one of his main critiques of other theories. It appears that, for Giddens, the key to change is the unintended consequences of the ‘normal’ use of practical and discursive knowledge. Change, therefore can be produced by an agent, operating inside structures, by pushing the boundaries of those structures and/or producing unintended consequences which may create new social situations that demand new social strategies and that may result in a modified structural system.

Giddens suggests that agents have more power in modern versus premodern settings. Most importantly, he provides hunters and gatherers with few avenues for social change, which he bases mainly upon their limited resources and their ability to ‘live with nature’ (Giddens 1984:227-280; Sassaman 2000). In other words, social change is the prerogative of recent history. He gives no strict reason to give ‘us’ more power over our own lives than ‘they’ had, however. What we do need to recognize is that in different places and at different times, that there has been variation in the amount of power an individual possessed. I would suggest that an individual’s ability to use structures as a resource is roughly dependent upon their consciousness of those structures; a consciousness that likely increases as they are exposed to more ‘ways of doing.’ It is perhaps in this way that 'modern' individuals have greater knowledge of their own structures because we are much more exposed to those of other cultures than groups of hunters and gatherers would have been 10,000 years ago.

Finally, Giddens also appears to assume the rationality of actors; that they will use discursive knowledge to act in their own benefit, but even Max Weber has pointed out that not all behavior is 'rational' (Dornan 2002; Weber 1978 [1914]).

6.1.2.3.Style by Bourdieu and Giddens.

The debate between Polly Weissner and James Sackett can be seen in the theories of practice and structuration. Sackett stressed the importance of the unconscious isochrestic style, which can be thought of as the physical manifestation of Bourdieu's *habitus* and Gidden's practical knowledge, while Polly Weissner stresses the intentionality (i.e., the agency) of the actor in a the manner of Giddens' discursive knowledge. However, the important contribution of Giddens and Bourdieu is not their stress on structure or agent, but their stress on the dialectic relationship between the two. Style cannot be thought of as originating uniquely in free will or in the social structure (though see Hegmon and Kulow 2005). It is present in the objectification of the conjunction, or disjunction, between *habitus* and field (social context). Therefore, artifactual style resides at the intersection of an individual's unique *habitus* and their physical and social environment. Artifacts, therefore can be seen as the objectification of the dialectic between structure and agent. They are a key element of social interaction: they both materially reflect, however imperfectly, and help produce, in a physically durable and visual sense, social structures. Artifacts, therefore, and can be used to examine the dialectic between structure and agent.

6.1.3. Agency theory or structuration/practice in archaeology.

Structuration and practice theories can be categorized within what has become known as agency theory in archaeology. Increasingly, agency theories are being used from various archaeological perspectives (Ashmore et al. 1996; Brumfiel 1992; Dobres 1995, 1999; Dobres and Hoffman 1994; Dornan 2002; Gardner 2004; Hodder 1982, 1990; Joyce and Lopiparo 2005; Killick 2004; see also articles in Journal of Archaeological Method and Theory, volume 12 [2005], issues 3 and 4). As some have noted, however, there is no such thing as 'agency theory' (Clark 2000:97; Joyce and Lopiparo 2005:365). Indeed, what the term agency refers to has not been agreed upon (Dobres and Robb 2000; Dornan 2002). Dobres and Robb (2000:8) state that "agency is a notoriously labile concept (Sewell 1992), but most agency theorists, whatever their stripe, would subscribe to at least four general principles…: the material conditions of social life[;] the simultaneously constraining and enabling influence of social, symbolic and material structures and institutions, habituations and beliefs; the importance of the motivations and actions of agents; and the dialectic of structure and agency." They later simplify this to indicate that agency "encompasses at least two fundamental and inseparable phenomena: (1) materiality and (2) social reproduction" (Dobres and Robb 2005:162). The latter is too broad to be useful; it's like saying archaeology involves things and people. While true, it tells us little. Some archaeologists believe that agency also includes choice; "Agency is an inter-subjective social phenomenon mostly concerned with the conditions and possibilities of choice and action" (Clark 2000:97; see also the 'social constructivist' approach of Killick 2004). However, Gardner puts it best: " It [agency] concerns the nature of individual freedom in the face of social constraints, the role of socialization in the process of forming 'persons', and the place of particular ways of doing things in the reproduction of cultures." (Gardner 2004:1). While some lean more or less heavily on the agent or the structure it seems that, following Bourdieu or Giddens, we must avoid this dualism and lean on the structuration (or practice) process (Joyce and Lopiparo 2005).

What has become known as agency theory is based upon the theories of structuration and practice, though they are not the same thing. Within agency theories people are seen as active participants in the production and reproduction of broader social rules, especially through *objects* (Miller 2005). The main difference between structuration and practice theories, on one hand, and agency theories in archaeology, on the other, is the latter's stress on materiality (see section 6.2.5.2 for a discussion on the effects of material objects on social interaction). It is not surprising that archaeologists, who are primarily concerned with material objects, are most concerned with the concept of materiality.

Agency theories can be thought of as stressing the importance of the individual at the expense of the larger group, the society, the culture, etc…, i.e., the structure (see discussion in Gardner 2004; Gero 2000). Often a stress on the side of the individual in the agent/structure continuum results in a loss of some of the structure within which the individual lived. Free will is stressed over social influences, perhaps due to the stress on the individual within our own society (e.g., Patterson 2005).

It is especially clear to archaeologists that there are limits to the agency of the individual. If the main variable in artifact production were individual will, it would be very difficult to identify long term patterns in the archaeological record. It is the agent-based structures (Gidden's practical and discursive knowledge or Bourdieu's *habitus*) that produce the material patterns that allow us to define archaeological cultures. As archaeologists, we must understand that people are constrained and enabled by social structure internalized in each of us as durable dispositions. The real question is, how do we make sense of the rather simple concepts of structuration, practice and agency with archaeological data? How can we see both the individual and the structure in archaeological data? What aspects of material objects are due to social influences and which are due to individual propensities? For me it is inadequate to state that the most prevalent or standardized attributes are due to structure and variation from the structure is due to agency (c.f., Hegmon and Kulow 2005).

In order to address my own uncertainty about how the structuration process works, I have developed the following model. It is broadly based upon Bourdieu and Giddens, but I believe brings their ideas into sharper focus, which means they are more useful in understanding both what it means to be human but also operationalizing these terms for use in material studies in archaeology. My goal here is to stress how social change and stability occur, which directly informs how production, as a social activity, also produces change and stability. I believe that the key to understanding these processes is that how we act is patterned; we do not blindly follow strict 'rules' or 'norms' but we are also not free to do just anything. In general, we do follow our dispositions, which are not exactly the same as any other individuals, but not in the slavish manner of an automaton. To me the best way to think about these concepts is through statistics, which allow a 'norm' to be conceptualized, but also allow variation to be conceptualized equally.

6.2. The Fuzzy People Model- On thinking about structuration statistically.

People are not easily categorized; they rarely fit into neat little boxes. Instead, they are fuzzy; difficult to fit into any single category and often overlapping into others. It is these edges, this fuzzy variation that has so often been ignored or simply noted and, yet, it is this fuzziness, this imprecision in human action that needs to be theorized. The key to understanding how people behave lies in theorizing patterning in both regularities, which are well-discussed, as well as variability, which has rarely been discussed. Theorizing variability allows one to recognize how 'free-willed' actors operating through their own internalized version of social structure can produce change and stasis in a non-deterministic and non-evolutionary way. This can be done through the use of standard statistical devices, which help to both analyze as well as theorize variability in human behavior, including producing artifacts. I argue that in order to understand artifact variation, which is one type of social behavior, one must first theorize the factors of social interaction. It is these factors, considered probabilistically, that help us understand

An emphasis on statistics should not be seen as reductionist, indeed this is exactly what I hope to avoid. I want to emphatically state that I don't believe that an individual, society, environment, etc… can be reduced to such statistical measures, only that it is theoretically and analytically useful to think of pieces of them in a statistical manner. The factors discussed below play a highly significant role in social change and stasis, but do not determine it; they simply make certain actions more likely. Rather than saying that people are different and therefore their actions cannot be determined, here I hope to outline that people are different to degrees and this difference can help us create statistical statements that better describe the choices that people have.

In archaeology, dichotomies are often created with the caveat that most people fall in between (e.g., specialized or non-specialized craft production, 'attached' or 'independent' specialization). Instead of poles, these dichotomies are best thought of as the tails of a distribution between which most people fall. In this way variation in structure and agency can be accounted for in an analytical, and eventually methodological, framework.

6.2.1. Assumptions of the Fuzzy People Model

It is essential to recognize that the Fuzzy People Model has some assumptions. These are based mainly upon the discussion of structuration and practice theories above. They include:

1. People are knowledgeable, active agents who have control over their own lives. They are not all-knowing in the sense promoted by Rational Action Theory (e.g., Elster 1989), but they are 'sensible' (Cowgill 2000:52). People do not act randomly, but have a good, though imperfect, knowledge of their own existence.
2. People act largely based upon dispositions, especially in the 'normal' routinized actions of life (Giddens' unconscious and practical knowledge and Bourdieu's *habitus*).
3. Dispositions are beliefs about how the world works and life should be lived.
4. Dispositions may be conscious or unconscious and their status as one or the other may change (as with Giddens' practical and discursive knowledge). Some dispositions are more likely to remain unconscious (in the sense of

Giddens' [1984] "basic security system") while others are more likely to stay conscious (Giddens' [1984] discursive knowledge).

5. Dispositions are discursive to different degrees; many are non-discursive. The latter are often difficult for an informant to describe and, when questioned, may only result in claims that indicate these dispositions are 'natural' or 'normal'. More highly discursive dispositions are locations of contestation and are often used in social stratagem.
6. Dispositions are not necessarily durable in the sense of Bourdieu's *habitus* (sensu Bourdieu 1977), but can vary. For example, in general, children have less durable dispositions than adults, because they are early in the learning (or socialization or enculturation) process.
7. Dispositions are many and they may contradict one another. Most dispositions should agree, however, for otherwise the world would not 'make sense' to people. People may actively use contradictory dispositions in social and political contestation.
8. Dispositions are produced and reproduced through social interaction, or 'situated learning' (Lave 1996) by biological entities. They are developed mainly during childhood, but their modification and production occurs throughout life.
9. People tend to group themselves into 'communities of practice', i.e., groups of people who do things similarly (Childs 1998; Lave and Wenger 1991; Sassaman and Rudolphi 2001). One can belong to numerous communities of practice and membership may be strict and permanent or fluid and variable.

These can be any grouping that people create and are based upon such things as kinship, material production, ‘occupation,’ gender, sociopolitical differences, etc. The number of communities of practice within a single community or ‘society’ tends to be more limited for less complex societies (e.g., hunters and gatherers) than for more complex societies (e.g., state-level societies based upon intensive agriculture).

10. Communities of practice are the most immediate influence upon an individual’s dispositions, especially those that are socially ‘close.’ The degree of influence of any single community of practice is correlated with the individual’s degree of participation and role within the community of practice.
11. A social structure is a set of beliefs and rules by which people live. They are shared only in the sense that individuals in a community of practice hold similar, but not equal, dispositions.
12. Within and around the margins of social structures people have choices (Dobres and Robb 2000; Gardner 2004:5; Killick 2004:571). They often understand these choices (see assumption 1)
13. People are biological entities. We are different from most other biological creatures in that we share ‘culture’, especially language. Although some animals have a semblance of one or both of these things, their versions are qualitatively and/or quantitatively different than those held by humans.
14. Many, if not all, of the variables discussed below can be conceptualized as a measure of central tendency (MCT) and a measure of dispersion (MD). This, however, must be justified on a case-by-case basis (see below). The particular

MCT (e.g., mean, median, geometric mean, etc.) and MD (e.g., standard deviation, geometric standard deviation, etc.) used is predicated upon the theoretical or actual shape of the distribution. For the sake of convenience, all of the schematic diagrams (see Figure 6-1) are drawn as normal curves, but this does not mean that all factors can be represented as a normal curve.

These assumptions seem to me to be basic to any understanding of human agents acting in a society. What I hope to address below is how social interaction can be modeled statistically, thus yielding a much better understanding of how social change occurs. In order to do this, it is useful to break apart the components of social interaction and discuss them separately (again, this is an analytical separation only: it is difficult to operationalize in real life). Only after the components of social interaction have been discussed can they be reassembled and discussed. These factors include; the biological individual (or predispositions), individual dispositions, social structure and the social contexts of interaction. A preemptive warning is necessary here. Social interaction is a recursive dialectical process. Though I am looking first at the factors that affect social interaction, it must be acknowledge that they do not precede social interaction, but are, in turn, affected by social interaction. Each of these factors, therefore, can be changed through their social expression.

6.2.2. The Biological individual or neurocognitive predispositions.

No theory of the human condition can deny that people are biological entities who are both alike and different (e.g., Eerkens and Bettinger 2001). In light of the fact that we are made up of billions of atoms, our similarity is awesome. It is our biological variability, and that of our hominid family, however, that is the basis for the field of physical anthropology. Physical anthropologists focus upon biological characteristics in order to identify biological relationships among individuals and groups. From their research, it is clear that there is much biological variability in modern *Homo sapiens sapiens*. It is this biological variability that helps us understand variation in neurological predispositions.

Neurological predispostions are similar to Giddens' unconscious knowledge, which he describes as a 'safety system.' Instinct, as in-born predispositions for certain behaviors in certain situations (e.g., fight or flight), would fall into this category. Neurological predispositions are both a biological state present at birth (recognizing the effect of environment on prenatal development) and the neurocognitive changes that occur through the biological maturation and socialization of the individual. I agree with George Cowgill, who is "sure that many inbuilt capacities and propensities will be found; old models of the inexperienced human mind as a blank slate that passively absorbs inputs (e.g., Locke) are hopelessly inadequate" (Cowgill 2000:55).

Our minds are not blank slates, nor is each the same, when we are born. Genetics, random variation, the process of expression, environmental conditions in the womb, and the vagaries of sexual reproduction can yield distinctly different biological siblings. Even 'identical' twins, who share like DNA, are not identical in the neurocognitive and neuromuscular sense. Though we have physical similarities to our parents, we are very clearly not clones nor a pure mixture (Mendellian or otherwise) of both genetic codes. This difference, however, should not be seen as random but as statistically patterned, because, even though we are not clones of our parents, we do tend to look like them (we have the 'same' nose or eyes). Statistically speaking, this means that for any single (measurable) trait, we are more likely to be similar to our parents (e.g., similar length and shape nose) than an unrelated individual. In other words, we are not strictly determined by genetics. Our ancestry only indicates what we will probably be like.

If a neurocognitive variable could be extracted from the individual and measured, like physical traits can be, we could graph a sample of individuals and see a distribution. If the individuals came from a community that was genetically related (as many small scale and pre-modern societies are or were), then such traits would probably be normally distributed because any two parents will yield an offspring whose traits must be more or less related to those of the parents who are from the same 'gene pool.' Any measure of the trait of the offspring would be related to those of the parents, but the actual result would most likely be the mean of a theoretical probability distribution based upon the traits of the two parents. In other words, the measure could be practically anything, but will more likely be similar to the parents.

A probability distribution (such as a normal curve) can be used to model the distribution of any single trait (see Figure 6-1). For a single large genetic population, the MCT (e.g., mean or median) of any neurocognitive trait would be different than for other populations, but fall within the distribution of that trait for all humans. Such traits would vary similar to skeletal traits. Neurocognitive traits, as biological traits, will be patterned in the same way[4]. The distribution of such traits between genetic populations would overlap greatly, even if the MCT and MD are different.

Neurocognitive predispositions change through social interaction in the process of learning. Predispositions are both born into a child and effect the biological changes

[4] Since such traits are predispositions and prior to social interaction, they could never be used to indicate the 'intelligence' of one group versus another.

children go through as their body and brains mature (Dornan 2002:314; Jensen 2000; Joyce 2000:72; Kamp 2001; Minar 2001). In other words, there is an important corporeal component to the learning process. This is what I believe Bourdieu means when he says, “We learn bodily” (Bourdieu 2000:141). Biological predispositions are difficult to identify because during the maturation process there is a very tight feedback loop between in-born predispositions, neurocognitive development and the social learning of dispositions. For example, it is clear that certain types of interaction help develop neural connections in a child’s brain. Lack of such interaction delays this development. Such a delay affects the internalization of social interaction, and therefore of the development of dispositions. The interaction of biological and social factors makes it hard to identify exactly what effect biological predispositions have, but this fact should not be used to deny that they exist.

The bodily component of neurocognition is especially important in the manufacture of artifacts (Eerkens and Bettinger 2001). Bodily actions, especially repetitive ones, change neuromuscular predispositions through biological modifications of neural pathways and muscles. As novices, people can do certain things, such as make a simple pinch pot, but they cannot do others, such as a complex sculpture (Crown 2001:456). Such abilities must be learned (DeBoer 1990; Kamp 2001; Minar 2001; Wallaert-Pêtre 2001).

An individual’s success for bodily works is largely based upon experience (Crown 2001:456). For example, a child is more likely to be able to ride a bicycle if he has developed ‘coordination’ through other activities, but may also have in-born predispositions that affect the acquisition of this particular skill. Successfulness generated through learned experience is best labeled skill (Costin 2001:281-282; Olausson 1995). Because people are physically similar, nearly all people, through sufficient practice, can become proficient at most bodily actions carried out in the process of making things. However, we also differ and some will excel more than others. Their success is based both upon bodily-developed skill, which is partially dependent upon biological predispositions, and socially developed dispositions regarding what is skillful (see Section 6.2.3).

In summary, we are not all biologically identical; even in the moral sense we are not identical, but equal. We have different physical and neurocognitive features. These differences are not random. Variation is distributed around a measure of central tendency. In this way, we can conceptualize the overall similarity of people on a global level while still taking into account the biological differences among individuals.

6.2.3. Dispositions

Durable dispositions (or *habitus* in Bourdieu's terms) are an individual's unique version of internalized social structure, which when enacted both reinforce and modify shared social structures. In recognition of the fact that dispositions may not be 'durable' especially when they are being developed in children, however, I employ the concept without the 'durable.' Durable dispositions (i.e., *habitus*) probably form the non-discursive core of a society's structure (such as kinship rules) and are often simply seen as 'natural.' In this sense, these dispositions are less likely to be employed in contradiction and contestation within a single society.

6.2.3.1.Learning dispositions

A disposition and its durability are largely due to the socialization of the individual, especially as a child. The neurocognitive individual exists prior to dispositions, and acts as a filter in the process of their acquisition. The precise processes involved in disposition acquisition are difficult to assess because they are so deeply buried within us. It seems that social influences have a much greater affect on our dispositions in general, while neurocognitive variation, along with the uniqueness of the individual process of disposition acquisition (as in *habitus*; Bourdieu 1977, 1990), contributes to the individual variability of those dispositions.

Dispositions are developed through social interaction and, while some dispositions may be conscious, the process of development would rarely be understood by the individual. While each 'event' of social interaction normally affects a variety of dispositions, I will limit my discussion here to a single disposition, recognizing that more than one disposition is normally in play at any one time. Each social event promotes the development of dispositions in a cumulative, but not strictly additive, process. This interaction can be conceptualized by understanding dispositions as statistical statements.

Consider a young child with little or no developed disposition. Each event of social interaction, which is affected by all of the factors of social interaction (predisposition of the child, the dispositions towards their social partner(s), the dispositions of the social partner(s) and social contexts), produces a slight disposition in the child. Each interaction can be represented by a small distribution (see Figure 6-2). These distributions do not represent the disposition of the social partner(s) in the interaction, but the child's understanding of that disposition; the three small distributions shown in Figure 6-2 may have been interactions from the same individual, but the developing and learning child interpreted them differently. As the child matures biologically and socially, they become more proficient at interpreting others behavior and interaction with the same person would probably produce overlapping distributions. Initially, the ‘event’ distributions may represent contradictory dispositions as members of the society (or even the same individual) seem to represent different views to the child (as in Figure 6-2). Although the child has been exposed to social interaction relevant to this disposition, there is no pattern yet. The overall curve (the dotted line in Figure 6-2) represents the child’s understanding of that disposition. This line is low, representing limited durability (i.e., it is easily changed in light of contradictory information), the MCT (representing the ‘ideal’) is unclear and the MD is large representing little conviction about the ‘ideal.’ At this point, the disposition is not well developed and the child would have a very difficult time ‘knowing’ how to act.

As the child experiences more and more social interaction and is repeatedly exposed to the distributions of their closest social partners (i.e., those in their communities of practice, which, especially at an early age, are most likely their kin) dispositions are developed. Figure 6-3 represents a child who has been exposed to more social interaction with individuals who have similar dispositions (or dispositions that the child has, correctly or not, interpreted as similar). Because these social interactions have been with people with similar dispositions, the disposition developing in the child (represented by the dotted line) has become more durable (taller), the MCT is more obvious and the MD has decreased significantly. Now, the child has a better idea of how to act in a culturally ‘correct’ way.

As we continue to age and participate in more social interactions, as long as the dispositions to which we are exposed are relatively consistent, then dispositions will tend to become more durable and clearer to the individual (e.g., Figure 6-4). However, as we get older, we also tend to participate in an increasing number of communities of practice and the constituent individuals may have different dispositions than those we experience at an early age. In small-scale societies, communities of practice will tend to have similar dispositions as the wider society (with exceptions), but in large-scale societies, different communities of practice may have highly distinct dispositions (see Figure 6-5). In situations where an individual is exposed to dispositions based upon community of practice, dispositions may be contextual. That is, an individual may have a certain disposition when interacting with one community of practice, but another when interacting with a different community of practice (A and C in Figure 6-5). In large scale communities, this may not be problematic as communities of practice may be temporally or spatially separated. In small-scale societies, however, communities of practice are often subsets of the broader community that overlap significantly in membership and location in time and space. In this situation, the dispositions of members of different communities of practice are likely to be similar. If dispositions between two communities of practice within a small scale society are not similar (as in Figure 6-5), the individual may 'average' the two dispositions; they may take the 'middle road' (B in Figure 6-5).

6.2.3.2. Learned dispositions

If an anthropologist could design an appropriate survey or interview, single dispositions could be measured relative to other members of the same society. Such an undertaking is not easy to conceptualize much less realize, but more often than not this is what anthropologists are trying to do. However, often what is studied is the ‘rule’ or structure for the particular disposition, and variability, though often extensively discussed (e.g., Geertzian ‘thick description’), is not statistically analyzed. Actually measuring any single *habitus* for all but the simplest ones (most durably held and clearly stated by informants?) is very complex indeed-- not the least because such measurements must be taken in a social context between interviewer and interviewee (e.g.; Moore 2000), and not in the vacuum in which I have placed them. Even with these caveats dispositions can be thought of statistically.

If a single disposition could be measured for an individual and graphed, the MCT can be thought of as an individual’s ‘ideal’ (see Figure 6-1). In Figure 6-7, the three curves represent the dispositions of three individuals. Disposition A and C indicate the same basic ideal, while disposition B indicates a different ideal (i.e., in $MCT_A \approx MCT_C$, but $MCT_A \neq MCT_B$ and $MCT_A \neq MCT_C$). The MD can be thought of as the variation beyond this ‘ideal’ that is acceptable to the individual. Note that there is no cut-off point, only a decrease in acceptability as distance increases from the ideal. A large MD (i.e., a short wide distribution; Figure 6-6) would allow the individual to see actions (by themselves or others) quite different than what they expect (the MCT) as acceptable. A small MD (i.e., a tall thin distribution; Figure 6-6) would allow agents to see only actions close to the disposition as ‘correct’ and actions that diverge more than a small amount from the disposition would be seen as ‘incorrect,’ ‘improper,’ or ‘inappropriate.’ In Figure 6-6, both A and B are strongly held dispositions, while C would be a weakly held disposition (i.e., $MD_A < MD_C$, $MD_B < MD_C$ and $MD_B \approx MD_A$). Individual C is likely to see the actions of A and B as acceptable, while individual B is unlikely to see the behavior of

C or A as acceptable. The durability of these dispositions is represented by their height. Bourdieu's *habitus*, as durable dispositions, would probably be closer to the disposition with a fairly limited dispersion (A and B), while C would fall, comparatively speaking, only under the broader aegis of disposition. The disposition of an older individual would tend to have a smaller MD, even if the MCT is the same.

6.2.3.3.Technological dispositions

Technological success is culturally constructed because general dispositions effect both what is seen as a 'correct' artifact as well as how much variation from the ideal is acceptable to be 'correct.' For example, potters among the Fali of Cameroon are encouraged to produce new and unusual variants of pottery, while potters from the neighboring Dii, Duupa, and Doayo are encouraged to reproduce vessels exactly as their teachers demonstrated (Wallaert-Pêtre 2001:482-485). A distribution that represents generalized variation in pottery manufacture would be fairly broad among the Fali, but much narrower among the Dii, Duupa, and Doayo. Crown (2001) has identified a similar situation in the American Southwest; Mimbres potters appear to have accepted more variation (i.e., 'error') than Hohokam potters. Beyond general dispositions, people have very specific dispositions about how different objects should look or be. Often they cannot verbalize why they do not like 'badly' made objects, simply saying that they are not 'right.'

If an artisan were to make a set of the same artifact, the measurements of the artifacts would represent what the artisan's ideal for that artifact. Their dimensions would vary along a distribution. Even artisans who believe that they are making identical artifacts and perceive them, when finished, as identical do not in fact produce identical items, partially due to the limits of human perception (Eerkens 2000). Dimensions of artifacts made by experienced artisans would tend to have a fairly narrow distribution where the MCT represented the desired object and the MD represents the acceptable variation from that ideal. In other words they would make artifacts that are essentially what they want them to be. Dimensions of artifacts made by inexperienced artisans would vary more (Crown 2001; Longacre 1999) and have a larger MD, but the MCT would tend to be close to the desired size. The MD would be partially dependent upon the method of teaching as skilled teaching is more likely to produce a 'better' (i.e., one similar to the ideal of the teacher) product than are less directed observe-and-learn methods (Crown 2001:464).

A narrow MD in archaeology is what is often identified as 'standardization' (Arnold 2000; Arnold and Nieves 1992; Blackman et al. 1993; Costin 1991; Costin and Hagstrum 1995; Eerkens and Bettinger 2001; Longacre 1999; Rice 1991; Roux 2003). While standardization is often talked about in terms of economizing behavior or craft specialization (Brumfiel and Earle 1987; Clark 1995; Clark and Parry 1990; Costin 1991, 2001; Costin et al. 1998), the link is not straight forward (Blackman et al. 1993; Eerkens and Bettinger 2001; Kvamme et al. 1996; Roux 2003). Standardization here is seen as a measure of an artisan's skill and their dispositions towards variation. Skill is the result of experience and ability; the first is measured not in years but number of artifacts created (Roux 2003) or perhaps the number of times particular gestures or techniques have been carried out and the second is the degree to which the biological individual is predisposed to such actions. An artisan may be able to produce highly 'standardized' artifacts (i.e., they are highly skilled), but if they do not consider such standardization important they are more likely to allow their product to vary. This variation, however, would still be within the range of what is acceptable and therefore 'correct.' In contexts of workshops dedicated to the production of a single type of artifact, standardization is probably associated with specialization (Kvamme et al. 1996), but in non-workshop contexts, standardization is still found (e.g., Longacre 1999; Roux 2003), though perhaps to a lesser degree. Context, particularly the intended consumer or the organization of production, may dramatically affect how acceptable variation may be (e.g., Roux 2003). An extremely experienced artisan may allow attributes to vary for a variety of reasons, but will tend to simply make them the way they know how.

One of the primary ways in which we learn bodily is through observing and copying those 'experts' amongst us either informally or in apprenticeships of varying formality (Crown 2001; DeBoer 1990; Gosselain 1998:94-95; Kamp 2001; Killick 2004; Lave 1996; Longacre 1999; Wallaert-Pêtre 2001).

As with other dispositions, technological dispositions are learned through social interaction, which always has a visual, corporeal and, perhaps, verbal component. The corporeal component results in physical changes in the human body and its understanding of the physical world (Minar 2001; Minar and Crown 2001). The training of the physical body, or 'motor skills,' is the reason that Cameroonian potters can judge the appropriate weight of clay for a certain vessel, while others cannot. In the same society, women, who cook, can judge the right amount of millet for a certain amount of couscous, but men, who don't cook, cannot (Wallaert-Pêtre 2001). Ethnographic informants find it difficult to describe what they do, often simply giving "some variant of the statement that 'this is the way we do it'" (Killick 2004:573) precisely because they have not been taught the words to express the ideas. Apprentices who are taught verbally are more likely to be able to verbally describe their productive activities (Wallaert-Pêtre 2001:481). However, the hands, arms, legs, etc. of artisans who are less able to verbalize their craft know just as well as those who can how to create the desired product.

6.2.3.3.1. Chaîne opératoire

Methodologically speaking, the chaîne opératoire (or operational chain) is ideally suited to the identification of different ways of doing, (i.e., of style writ large). Not only may the final product vary stylistically, but the way in which an object is made is also a locus for style (Lemonnier 1986, 1990, 1992, 1993; Leroi-Gourhan 1943, 1945; Mauss 2006 [1935]; Pfaffenberger 2001; Schlanger 1990, 1998; Schlanger and Sinclair 1990; Sellet 1993). A chaîne opératoire was originally defined as “a series of operations, which brings a primary material from its natural state to a fabricated state” (Cresswell 1976:6). The basic idea is that each one of the operations is not determined, but that at each stage, an artisan faces a variety of choices and the route chosen is just as much the locus of style as choice as are painted decorations on pottery. As a methodology, evidence on artifacts of production techniques is used to record the production-, and sometimes use-, history of the object. This way, the production history as well as the appearance of the artifact can be studied. Although some see major schisms between the European use of chaînes opératoires and the American use of ‘technical choice’ (Schiffer et al. 2001; Schiffer and Skibo 1997; Skibo and Schiffer 2001; see discussion in Loney 2000), I do not see such a vast gulf between the two. The basic idea is the same; the way an artifact is made is not a mechanistic process determined by economics, but a fluid one determined by a variety of social factors. Studies using a similar theoretical standpoint, but that don’t use the term, chaîne opératoire, have also shown that production is social (e.g., Hosler 1996; Lechtman 1977, 1993; Shimada et al. 2000).

The chaîne opératoire approach has been used mainly in studies of lithic artifacts (Cresswell 1990; Edmonds 1990; Graves 1990; Pelegrin 1990; Ricou and Esnard 2000; Schlanger 1996; Sellet 1993), but progress has been made in studies of ceramics (Gosselain 1998, 1999, 2000; MacEachern 1998) and bone tools (Dobres 1995, 1999, 2000). The chaîne opératoire approach has not been used to study shell artifacts, although techniques of production of shell artifacts have been recorded (Kenoyer 1984, 1989; Suarez 1981). To date, however, no one has studied the way in which shell beads are made and, certainly, no one has studied them to the degree presented here.

Measurements of artifacts from archaeological sites can be understood as representations of people's dispositions regarding ideals. For example, most pottery vessels would be made by people with experience; even if people only made the pottery they needed themselves, over time most people learn how to make pots. Measurements of such vessels would be distributed around what was considered ideal. The distribution of the measurements would reflect two aspects of production: acceptable variation and experience. Some artifacts are going to vary rather widely simply because people did not have a strong disposition about the size of particular dimensions. There will always be some variation due simply to error that people do not recognize, which is likely less than 5% of the variation (Eerkens 2000; Roux 2003). A maximum of 57.7% error has also been proposed (Eerkens and Bettinger 2001), but this awaits proof of its practical application in archaeology.

6.2.4. Social structure.

On a social or intra-subjective level, the dispositions talked about in the previous section can be compared to the dispositions of other social actors. The cumulative effect of individual dispositions can be seen as social structure. If we graph the frequency of the MCT for a single disposition for each actor within a society, we will see a distribution. It will tend to be normal because people within a single society will hold similar but not equivalent dispositions. Even if the distribution is not normal, the distribution will group around a MCT with a MD. The MCT indicates the point around which the majority of dispositions of people in the society are located. Immediately at and around the MCT is what the majority believe to be the 'way it should be,' which can be thought of as the structural 'rule'. While few may have a disposition exactly the same as the MCT it represents the midpoint of what individuals believe: what one might say the 'society', as if it were a sentient being, believed. Most people are not going to have a disposition that represents the 'rule' exactly as it should be, but one that varies from this theoretical ideal. Their dispositions are not random, however, rather they lie within the distribution and are grouped around the 'rule'.

Dispositions that deviate from the 'rule' are due in part to the difference in the learning context (similar to the uniqueness of Bourdieu's *habitus*), including; the social contexts, individual biological predispositions and preexisting and partially learned dispositions that effect the social production of dispositions. The fact that such deviation varies around a central point is theoretically justifiable because as dispositions are developed, especially in children, they are exposed to different versions and they are likely to develop a disposition that takes all of them into account. Such a process does not ‘average’ all of the dispositions to which an agent is exposed because the who, what, when, where, and how of the exposure of a child to another’s disposition matter. In this sense it is more like a weighted average, with more weight placed on those dispositions acquired from people who are liked/respected more or in situations that promote the acceptance of certain dispositions.

Such social structure can have a direct result on material production. For example, Fali potters are open to attempting new and/or difficult types of pottery while neighboring Dii, Duupa, and Doayo refused to attempt such things (Wallaert-Pêtre 2001:483). Among the Fali, novel types of pottery were encouraged and even failure was seen as a source of knowledge, while among the other three groups, potters feared the negative social consequences, including judgment by their peers, mockery, and belittlement, stemming from their failure to produce pottery with fairly restricted attributes. The social structure regarding innovation among the Fali encouraged potters to make new and unique artifacts, while the structure discouraging innovation among the other three groups, encouraged the production of a consistent, standardized product.

Statistics allow both for succinct summary of complex data in a MCT and a measure of dispersion. In this way, we can take into account both the general trend and the trend in dispersion. A small number of extremes are within the pattern in statistics. An ‘outlier’ still represents a valid part of the distribution and only becomes problematic if there is a large quantity of them. The Fuzzy People Theory can represent both the ‘structure’ and the inherent variability of people within a theory that allows both to be patterned.

6.2.5. Social contexts

On top of predispositions, individual dispositions and social structure, the final factor of social interaction is the context of social interaction. The context within which social action occurs can affect the actions taken and whether or not dispositions are reinforced or slightly modified by any single interaction. Since social interaction is a day-to-day occurrence, little or no change in an individual's dispositions are the most likely outcomes. Large changes are possible, but are probably limited to times of social upheaval when broad aspects of the society are changing. Social context can be broken into personal, material, spatial, temporal and environmental context.

6.2.5.1. Personal contexts

The most obvious variable in the context of social interaction are the individuals involved. All individuals within the physical or effective range of any social interaction are part of the personal context. This includes anyone directly participating (e.g. two people talking; a group of individuals hoeing a field or hunting a giraffe) as well as others observing the interaction. Primacy is often accorded to the people most directly involved in the interaction, such as two people talking, but those that are observing the discussion may be less, equally or more significant than the primary actors. In some situations, individuals who are not part of the physical interaction may also be significant because they are indirectly involved (e.g., they are the ones being discussed) or may become involved in the interaction. There are certain variables that we can distill that are more or less important in the personal contexts of social interaction.

Social categories have long been recognized as significant cultural factors by anthropologists and they remain important to this discussion. Of great interest are age or age group, gender, kinship relations, 'occupation' (considered in the very broadest sense), social status and personality of the individuals involved (Gero 2000; Johnson 2004). With the exception of personality, these categories can be generalized as 'communities of practice,' which are groups of people who do things in a similar way or who identify themselves as part of such a group (Childs 1998; Costin et al. 1998; Lave and Wenger 1991; Sassaman and Rudolphi 2001). This is what we mean when we talk about potters, elite or shamans. One may participate centrally, marginally, or not at all in any single community of practice within a society. A person may be an experienced potter, an apprentice, a daughter of a potter or completely uninvolved in ceramic manufacture. One's participation in any community of practice may change through time (e.g., from daughter to apprentice potter and then to potter). An individual may participate in a variety of communities of practice (e.g. shell bead makers, women, and members of a particular family and/or clan).

In artifact production, the identity of a person, who may participate in a variety of communities of practice, as an artisan is one of the main factors relevant to his participation in social interaction (Costin et al. 1998). It is not only his or her own identity, but his or her identity relative to those involved in the act of production that is important: for example, those that are physically present during the act of production, potential consumers (present or not), as well as others who have an economic, political, or other stake in the production of artifacts all influence the social context of production.

The issue most often discussed in craft production literature is whether or not craft production is 'specialized.' A 'specialist' has been defined as someone who spends part of their time making artifacts that some of the rest of the community want/need and who is partially freed from the pursuit of subsistence. These ‘specialists’ cannot or do not provide for themselves all of the goods/services that they need. However, for the products of their craft they are remunerated by their consumers allowing them to acquire the goods/services they need and perhaps more (Arnold and Munns 1994; Clark 1995; Costin 1991, 2001; Cross 1993; Hegmon et al. 1995; Tosi 1984). Furthermore, a core idea is that “fewer people make a class of objects than use it” (Costin 2001:276). This is primarily a question of identity, however, not of economic relationships. It seems important to know how many people identify themselves as shell bead producers, distinguishing themselves and their community of practice. At the archaeological sites in question, I have not been able to identify a distinct group of people involved in shell bead manufacture. Evidence for manufacture of shell beads is approximately equally distributed across the sites. I cannot say that fewer people made the beads than consumed them. Indeed, evidence suggests that production was generalized and consumption, at least in northern Peru, was restricted to the very highest ranking elite.

Whether or not fewer people make a class of objects than use them can be a question of scale, however. At Loma de los Cangrejitos, for example, it appears that shell bead artisans were widely distributed throughout the site (though they still may have constituted a non-location specific community of practice), and that consumption was similarly generalized. However, considering the demand for shell beads to their south and the lack of evidence for production in that region it is logical to argue that the Manteño were trading these beads to the south. Within a regional trading system, therefore, the shell bead artisans were specialized, but perhaps not within a single site or within the archaeological culture known as Manteño.

Personal context can also be understood in terms of the social organization of production; i.e., who the producers are and for whom they are producing. This touches on the oft-discussed issue of attached or independent specialization, where attached specialists produce for elite in a prestige good economy or independent specialists produce for a generalized (semi-capitalistic) market (Arnold and Munns 1994; Clark and Parry 1990; Costin 1991; Earle 1981). This dichotomy is problematic and other variations have been identified (Ames 1995; Inomata 2001; Janusek 1999). At all of the sites examined for this study, there is no evidence for socioeconomic differentiation in shell bead production. It appears to have been widely distributed though out some sites (though Currie [1995b], does suggest that shell bead production was spatially limited at López Viejo) and evidence for distinctly elite areas is lacking (except perhaps at López Viejo). There is spatial segregation at Loma de los Cangrejitos, Los Frailes and López Viejo, but how this is associated with socioeconomic differentiation is unclear. Since a fairly large quantity of shell beads were exported from some of the sites, specifically Loma de los Cangrejitos and López Viejo, it is possible that the individuals or groups who owned or sailed balsa rafts had some degree of control over the artisans. Navigators would be necessary to transport the shell beads to the consumers, especially on the north coast of Peru.

The identity of social actors affects both how they behave and how dispositions are developed. In artifact production, the identities that most interest us are those of the producers, the people around them, and their consumers. These identities are often phrased in terms of specialization, but at the sites in question we have not been able to identify obvious socioeconomic or sociopolitical differences and production appears to have been distributed across the sites. For me, the most salient feature of shell bead production at the six coastal Ecuadorian sites appears to be the identity of their consumers.

6.2.5.2.Material contexts.

Contexts are material in the sense that social interaction is affected by material objects (Appadurai 1986; Bourdieu 1977; Marx 1967; Meskell 2005; Miller 2005; Preda 1999). In Wobst's terms, they are "material interferences [in that they are] linked to peoples' intentions to change something from what it was to what they thought it should be… or to prevent change that would take place in the absence of those artifacts" (Wobst 2000:42). Some claim that materiality (Miller 2005) is a main concept in 'agency' theory; "the material world is not just 'central' to social reproduction, but … material culture actually constitutes social relations and meaning making" (Dobres and Robb 2005:162). Material objects that affect social interaction may range from a cross worn around the neck, to a spiritual mask, to a statue of a mighty god, to a beaded necklace, and so on. All objects have an effect on social interaction; the question is to what degree. There are two ways to view the effects of material contexts upon social interaction.

The first view of material context recognizes that objects can give an overall sentiment to a space. The overall 'feeling' that material objects give to a space is not necessarily conscious. I agree with Miller that, "the less we are aware of them [objects], the more powerfully they can determine our expectations by setting the scene and ensuring normative behavior, without being open to challenge" (Miller 2005:5). This general, objectified sentiment that people are surrounded by is largely non-recursive. This fact is assisted by the repetitive nature of certain attributes across artifact classes (Boas

1955; DeBoer 1990). As such, an object is very much a representation, though imperfect and open to interpretation, of the social structure.

The second view of the material context of social interaction recognizes that material objects can have their own agency (Boast 1997; Chapman 2000; Miller 2005). The idea is that objects are not simply representations of ideas, be they cosmological, political, or other, but are social entities that interact with people. In this sense, statues of Egyptian gods are not representations of the gods, but gives the god form (Meskell 2005:54). In terms of social interaction, this means that disposition about the gods, not just those about representations of the gods (if they can even be separated out), are in effect when one of the social actors is a statue of a god. The god, materialized in the statue, is also a participant in social interaction.

Material contexts in the first sense can be thought of statistically. A material context murkily reflects the dispositions of the individual or individuals involved in the production/use/display of the objects. Rather than depict specific dispositions objects are likely to display certain sentiments. Such a reflection of dispositions can be thought of in terms of a MCT and MD in the sense that they are interpreted via the dispositions of the observer.

Material contexts in the second sense resist being thought of statistically because objects are either present or not: certain attributes (e.g. religious symbols) on those objects are present or not. Because these objects are social agents, however, then they can be thought of as part of the personal context discussed above.

In the material context of shell bead production, shell beads were used by the local populations from the Late Guangala/Early Manteño to post-Contact. The clearest example of the effect of the material context is from Loma de los Cangrejitos. We know that some individuals were buried wearing tiny shell beads. More importantly, however, some individuals were buried with whole complete beads along with in-process beads and tools for making beads, suggesting that the bead-making process was perhaps more important than the finished beads. These tiny shell beads, therefore, may have been present all around the artisans (we don't know if they were worn in life as in death), on their body and those of others in their community, and were thought of as more than just goods to export. The presence of these fairly durable objects long past their initial production most likely encouraged a continuation of such technology long after it was no longer economically necessary. At approximately AD 1100 (i.e., the end of the Middle Sicán) the demand for tiny shell beads from cultures of the Peruvian Coast declined drastically. Vagaries of radiocarbon dating do not allow us to identify how long after the drop in demand, the Manteño adjusted their production technology, but it is clear that they shifted from tiny, regular beads made using a consistent set of techniques to large, irregular beads made using simple expedient techniques.

A fairly expedient technology replaced what was a more labor intensive and technologically complicated chaîne opératoire, indicating a reduction in the disposition towards the process of making the beads. Burials at Loma de los Cangrejitos after this time period no longer contained shell beads, although shell beads continued to be made and used at later archaeological sites (Mar Bravo and Salango 140).

6.2.5.3.Physical properties of materials

The physical properties of materials (and the materials of the tools used in conjunction with them) clearly affect what types of artifacts can be created (Andrefsky

1998; Claassen 1998; Rice 1987). We have long understood that the physical properties of materials 'limit' what can be done with them. These physical limits, however, are not as clear as one might like. What can be made from certain materials is highly dependent upon the knowledge and skills possessed by the artisan, as well as available technology. The possible uses for different materials should be thought of in terms of probability. Instead of saying it is impossible to make a cooking pot from cryptocrystalline stone it is preferable to say that it is highly unlikely. It is also unlikely that elaborate sculptures could be made from obsidian, but that is precisely what Mayan artisans created. Their 'function' was probably associated with rituals and may not have been used to cut anything. Such 'exotics,' however, are extremely rare; that is the probability of their existence is still low. The key to discussing material 'limits,' therefore, is to discover what the possibilities are for different types of materials and investigating why certain materials were used for certain purposes. This is often going to yield fairly simple correlations, such as cryptocrystalline stone being used for chipped stone tools and certain types of clay (e.g. kaolin or montmorillite) being used for ceramics. It is just as interesting when materials not well-suited to a particular use are in fact used by people, especially if there are ostensibly better alternatives.

6.2.5.4. Spatial contexts

Contexts are spatial in the sense that it matters where social interaction occurs (e.g., Barrett 2000:61-62; Costin 2001:293-301). Interaction between married people may be very different if it occurs within the home or outside in full view of other social actors. Interaction between two young hunters may be very different when they are alone hunting or when they are describing their exploits to potential mates. Spatial contexts, like material contexts are difficult to conceptualize in terms of an MCT and MD, except in the sense of overall sentiment or perhaps in terms of proximity to particular places. The effect any ‘place’ has upon social interaction probably increases with proximity, reaching its maximum effect when the actors are at, within, or next to the ‘place.’ Spatial context is perhaps best seen as a moderating or exaggerating force. Although spatial context has an effect on social interaction it is probably the actors and their dispositions (and each actor’s imperfect knowledge of the dispositions of the other actors) towards such places that have a much more distinct effect on social interaction.

The spatial organization of production is often associated with the socio-political organization of craft production. Where production is ‘specialized’ and located in ‘elite’ areas, it is considered ‘attached specialization’ and when it is located in non-elite areas it is considered ‘independent specialization’. This dichotomy was recognized early as lacking (Arnold and Munns 1994; Costin 1991; Earle 1981; Clark and Parry 1990) and there have been many examples of specialization (or simply craft production) that fits neither of these categories (e.g., Ames 1995; Inomata 2001). It has been difficult to recognize any spatial differentiation in the contexts of shell bead production at any of the six sites considered in this study. Therefore, the best ‘categorization’ of craft production at these sites is village-level or community specialization (Costin 1991:8-9), similar to shell bead production in the preceding Guangala phase (Masucci 1996). At all of the sites, shell beads and/or evidence of shell bead production is distributed throughout, suggesting that production was not spatially limited.

Another particularly important factor in the spatial arrangement of craft production is the spatial relationship between the artisans and their consumers. At the sites in question, there were both proximate and distant consumers. At both Loma de los Cangrejitos and López Viejo, large quantities of shell beads were produced and, though it is unclear if production levels exceeded local need, similar beads were consumed in large quantities in contemporary archaeological sites in Peru, especially on the north coast. Evidence for their production has not been recovered elsewhere. It is quite likely, therefore, that the artisans at the two Ecuadorian sites were producing for local and long-distance consumers. There are two main effects of this situation. First, the beads had to travel from the place of manufacture to the consumers, a distance of many hundreds of miles. It is quite likely that the beads were transported in large balsa sailing vessels. This situation means that the individual or individuals controlling the watercraft would also have been major social partners for the shell bead producers. Second, a change in demand by the consumers would have an effect on the production of artifacts. However, the change in demand by these external consumers does not lead to immediate or determinate change in local production as in classical supply-demand economics (Smith 1776). The change is filtered or interpreted through the dispositions of the producing community of practice and their broader 'society.' It is more interesting to analyze and understand how these regional changes affect local social interaction and strategy.

6.2.5.5.Temporal contexts

Time also has an effect on social interaction (e.g., Barrett 2000:61-62). Its effect can be as simple as time of the day, time of the week (in societies that recognize such measures of time, such as mine), time in terms of the agricultural season or hunting strategy, or in terms of the ritual and/or religious year. For example, what is acceptable or not changes during the Catholic Holy Week or Islamic Ramadan.

Social interaction should be seen as an historical web of past interactions. It does not exist in a temporal vacuum, but neither is it necessarily linear. It is best seen as a web of interactions leading to the one in question, with strands leading off into the past, in the present and into the future. These strands change based upon any single interaction, but because interaction is patterned by the variables discussed above, that interaction is also patterned.

In terms of shell bead production on the coast of Ecuador, it is very clear that production changed through time.

6.2.5.6.Environmental contexts

Environmental contexts are often thought of as limiting factors, but this should not be seen in an absolute sense. Environmental attributes, such as amount of rainfall, temperature, season, latitude and longitude, biome, available water, microenvironments, etc. can all be seen as an MCT and MD. For example, for any given unit of time (e.g. month), there is a temperature that one expects. For July in Pennsylvania the average is 73ºF. However, the temperature of July in any given year and the temperature each day is distributed around 73ºF. In the same sense, the environment does not provide limiting factors that can be definitively identified. If a certain crop grows best in temperatures less than 73ºF, some years it may grow well in July and in others, much worse. Overall, farmers would recognize that July may not be such a good month for this crop. Social factors, however, may make it worthwhile to grow it during July. Perhaps the food is used during a festival at the end of July or it is desirable to harvest it with another crop. Environmental factors should not be thought of a limiting factor in the sense of absolute lines, but in the sense that certain environmental variables are more likely to encourage the development of some dispositions and discourage others. For example, much of the American Southwest was too dry for agriculture, except around certain watersheds at certain times of the year. More intensive agriculture could have been done, but the environment discouraged it. Today, we have developed methods of irrigation that encourage agriculture in areas once considered to dry. In other words, the aridity of the Southwestern climate should not be thought of as limiting, but as encouraging certain methods.

6.2.6. Social interaction

The different variables have been outlined, but how do these factors all come together to provide individuals with coherent options for social action? People are constantly 'acting', they are cooking, building, flintknapping, talking, making love, wearing clothes, nursing children, looking at one another and so forth; any and all human acts are social. Even acts produced when we are alone (as I am right now, writing this document) are social because by doing these things we are acting upon our own dispositions developed through social interaction.

Social interaction is the dialectical manner in which people act upon the factors discussed above; predispositions, dispositions, social structure and social context. As discussed above, these factors can be thought of in terms of probability. Each one can be associated with a certain set of actions that are more appropriate and, therefore, more probable than others. For example, dispositions may be general or very specific. Some factors have very 'tight' distributions (small MD), that is, there is a relatively small set of actions that are most 'appropriate' or 'acceptable', while others have a fairly large set (large MD) that are appropriate. Imagine each of these factors with a distribution that describes the likelihood of a set of behaviors. The MCT of each distribution describes the most likely behavior, but the ones immediately around it are nearly as likely. The MD describes how many different variables are 'acceptable'; some factors will allow for a wide range of actions that are acceptable (a large MD) and others will provide only a small range of factors that are acceptable. The size of the distribution is its overall relevance to any particular social activity: for example, environmental factors (such as rainfall) will be represented by a larger distribution in matters directly related to subsistence than for non-subsistence related actions.

One of the key aspects of understanding how people interact with each other is that in any particular social interaction, each actor has choices. Although in many situations there may appear to be only one choice for action, there are always others. They just may be less 'appropriate' for the particular situation. It is no different when people create artifacts because artifacts can be made in a variety of different ways and still serve their 'function' (e.g. Sackett 1982). The choices regarding an object that do not contribute directly to its function can be thought of as stylistic, as discussed above. Like all other social choices, however, these are largely based upon, but not determined by, individual disposition and shared social structures (Dietler and Herbich 1998; Dobres 1999; Killick 2004; Lechtman 1977, 1993). Choice is based largely in dispositions (similar to Sackett's isochrestic style) within the possibilities of the physical material. In a particular production event the possible choices that artisans can make is based upon what is acceptable and, since production is social, upon the other factors. Importantly, the human body also places certain limitations on what can be done.

6.2.7. Social stability and change

Two things are clear about society from an archaeological perspective. First, societies often go through fairly long periods of stability (i.e., of limited, nondirectional change) interspersed with periods of more dramatic change. One of the most significant questions in archaeology, therefore, is why stasis is more common? Secondly, if stability is the norm what causes change. These questions are not fully address by Giddens' structuration theory and Bourdieu's practice theory (particularly the concept of *habitus*), but it is clear that social stability and change are produced by social interaction. I argue that stability is produced when internal and external factors of social interaction are in accord and change is encouraged, but not determined, by in a disjuncture among the factors of social interaction. The larger the disjuncture, the more likely change.

6.2.7.1. Social stability.

In any instance of social interaction, the actors bring certain predispositions and dispositions that they employ, more or less 'sensibly' (Cowgill 2000:55; see also Joyce 2000), within social contexts. All of these factors come together to provide actors with possibilities for action (or inaction). Since action is not determined by predispositions, dispositions, structure, or the contexts of interaction but these factors provide options, which results in predictable, yet non-determined action (or inaction). One can think of this as a whole series of probabilistic statements coming together and is best visualized as a whole set of overlapping normal distributions. Such a situation encourages the stability of dispositions. Figure 6-8 shows the junction of the factors of social interaction that would encourage reproduction of dispositions and, therefore, promote stability. Such a situation does not determine action as a number of options are available from which the actor can choose. It is not always clear which is the ‘best’, only that there are some that are better than others. In Figure 6-8, all of the factors ‘fit’ well, but not perfectly. The small degree of contradiction would mainly be used by individuals in social and political maneuvering within social structure but rarely challenging it. It would be unlikely to produce large scale change. In other words, people jockey for certain roles within societies and occupants of roles may change, but this neither changes the roles nor the dispositions about those roles. The use of these factors in social and political maneuvering can actually rigidify such dispositions precisely because they are being used as tools in social contests.

This process should not be seen as promoting stasis or lack of change, but as a process of people acting in ways that they see as ‘appropriate’ (or at least at the edge of appropriateness) while others are seeing and judging their actions. Negative or positive responses to those actions will tend to influence the future actions of all individuals involved. In this way, other actors (including observers or even individuals who hear about the interaction) tend to bring the initial actor back ‘into line’ with social norms. This is where leveling mechanisms such as rumor, passive aggression and outright violence may be employed. These leveling mechanisms tend to bring people who have acted unacceptably back into the range of ‘acceptable’ behaviors.

Stability therefore will tend to be the norm. Some slow and steady change may result through non-directional drift or through a slight pull on the system from a factor that is not quite aligned with the others.

6.2.7.2.Social change.

Most social change occurs when the factors of social interaction are out of alignment; i.e., there is a disjuncture between them. In other words, the factors of social interaction no longer ‘fit’. For example, a reduction in rainfall means that dispositions regarding how agricultural irrigation should be organized no longer ‘fit’ with the amount of irrigation water available. Disjuncture in the overlap of these distributions provokes an increase in the probability of social change, but does not determine it. A disjuncture may be due to factors external (e.g., initiation of warfare with other societies or environmental change) or internal (e.g., death of an heirless king or a change in production technology) to the society in question. Figure 6-9 shows how such a disjuncture can be visualized. Compared to Figure 6-8, distribution A in Figure 6-9 no longer ‘fits’ with the other distributions representing various factors of social interaction.

When disjuncture occurs, it is the people near the tails of the distributions where they still overlap who are more likely (slightly or considerably) to affect change. The disposition(s) of these individuals are in better alignment with the factor that no longer ‘fits’ well with the other factors of social interaction. Because of positive feedback among these individuals, whose disposition had been previously considered on the edge of acceptable, and because their disposition actually ‘fits’ better with the other factors of social interaction their behavior, based upon their disposition, can be seen more positively. Of course, this clearly depends upon other contexts of social interaction as social actors may or may not see the actions of these individuals positively depending upon many other factors, for example, their membership in communities of practice or social status. If their actions are seen positively, then social change will occur as people adjust their dispositions (or allow them to be adjusted since many are unconscious) to better fit the situation. It is precisely in these sorts of situations, where people's dispositions do not reconcile with social reality that people become more aware of their own dispositions and this makes them easier to change. They no longer necessarily see them as 'natural' or 'the way it is,' but as variable and contested.

If people do not see the actions of an individual in a positive light, then they may not change their dispositions, keeping the factors of social interaction in discord. More than one individual, however, lie within the overlap and these others may behave differently and, because they may have different social relations with other actors, their actions may or may not be seen in a positive light. If actions are seen as positive, social actors are likely to adjust their dispositions. If there are no actors within this overlap whose actions are seen positively, the factors of social interaction may remain in disjuncture. If a disjuncture is not dealt with by people in a society, however, then the consequences may be minor or major, possibly resulting in widespread death. A society may even be wiped out (or 'fall') for failing to adjust their social dispositions to meet major challenges.

The innovative individuals in question need not be at the fringes of society. Indeed, the actions of social outcasts are unlikely to be seen positively by the majority. Fringe dispositions may be present in highly-respected individuals as well, however. They may hold different dispositions because of different social backgrounds and predispositions (perhaps they were raised in a different village). Situations in which socially acceptable individuals with some variant dispositions are ideal for ‘aggrandizers.’ The success of their actions, even those of powerful individuals, however, is highly dependent upon how they are seen by the society in general.

There has been much discussion of ‘aggrandizers,’ or individuals who are able to seize power and affect social change, usually for their own benefit (Clark and Blake 1994; Flannery 1999; Hayden 1998; Maschner and Patton 1996; Spencer 1993), but the idea is problematic. It privileges leaders who were able to force their own will upon others, ignoring that other social actors, who support or contest such leaders, play an equally important role (Barrett 2000:62; Clark 2000; Pauketat 2000:117). Similarly, aggrandizers are products of their own social situations and, as such, will rarely act outside their own dispositions, which is a subset of social structure. Doing so would rarely achieve their goals, because they must convince the rest of society of the ‘rightness’ of their way in order to ensure their continued success. Aggrandizers with no social support may be able to seize power, but they will not last long. Hitler would not have lasted long without the support of much of the German public, many of whom saw him as restoring pride in ‘Germanness’ (e.g., Arnold 2006). Aggrandizer theories seem to stress individual rationality outside of social structure, which seems more of a reflection of our own society where such behavior is encouraged than a theory applicable to other societies (Barrett 2000:62). It is also likely that there were many individuals in prehistory who significantly affected the societies in which they lived (e.g., Flannery 1999).

The problem is that aggrandizers are under-theorized. How did such individuals come to be? Are they genetic mutants? Why did they only appear at certain periods in time and not others? Were there no ‘aggrandizers’ in hunter-gatherer societies (except when it was ‘time’ to become hierarchical)? Did they only come about when they were ‘needed’ (e.g., to make the transition to agriculture)?

If one sees people as both neurocognitively and socially variable, then aggrandizers can be seen as reasonable. An aggrandizer is an example of an individual who has some dispositions that lie at the edge of the social structure; i.e., some of their dispositions are significantly different than their social partners. We all have some of these dispositions: aggrandizers are no different than the rest of us, but represent a variant (perhaps an extreme one) present in the social spectrum. Potential aggrandizers probably existed throughout the past, but that they were only successful when situations permitted. They may tend, however, to have dispositions that are more individualistic, which would allow them to act outside of the norm (i.e., distinct from the MCT of the particular structure). It is during times of disjuncture in the factors of social interaction when these people, often because of a mixture of their social position and their ‘unusual’ dispositions, are able to become ‘aggrandizers.’

In hierarchical societies, potential aggrandizers tend to be those in socially higher positions, because people have dispositions that ‘naturalize’ greater leadership qualities within these people: why else would they already be considered better than others? An ‘aggrandizer’ may consciously use the structures of their own society, and variation within that structure, as a part of their political stratagem. They cannot act outside of the structure of their society because that brings their actions into direct conflict with the dispositions of other society members. The creation of such conflict will rarely benefit the ‘aggrandizer’. Indeed, I would argue that many ‘aggrandizers’ have failed precisely because they ‘went too far.’ Similarly, ‘aggrandizers’ may always be present, but their successfulness increases dramatically when societies face disjuncture in social interaction.

Change will occur more rapidly in situations where there is a larger degree of acceptable variation from the ‘rule’. In other words, a structure with a larger MD is more likely to allow change, because there is already a degree of acceptance for the variation. In Figure 6-9, factor A is out of ‘alignment’ with the other factors of social interaction (compare to Figure 6-8). If E and F are dispositions, F is the more likely disposition to change because there is already a degree of overlap between it and the changed A. Disposition E, however, is unlikely to change to come more in alignment with A because there is very little overlap between the two. This does not mean that it will not change; only that it is not probable. The acceptable variation of disposition E needs to change first; i.e., the MD needs to be larger. Therefore, F may change first and this change may result in an increase in the acceptable variation of E, bringing them into better accord. Over time, E may change enough so that it is now in alignment with A.

When disjunctions occur, the change that may or may not occur is a result of a dynamic process. The particular factor that is in disjuncture and its relationship to the other factors is highly significant. If there is a close relationship, then change will be closely linked, but if the relationship is weak, then the change will tend to be similarly weak or, potentially, absent. The particular actions and reactions of members of the community can affect the significance of the changes; it is very difficult to predict what will happen in these situations. If the primary disjunction is large (i.e., the distribution is greatly removed from the other distributions of factors of social interaction), then social change is more likely, but the route and the results of such a change are extremely difficult to predict. This is because this process of modifying positions is carried out by people through social interaction. In this sense, all the factors of social interaction are at play during every event. They allow certain options for action to be more favorable, but not determined, for actors. Following actions are based upon previous actions (and associated dispositions) and each action can modify the possibilities for the next action. Since people are 'sensible' their actions are not random (i.e., cumulative actions will tend to 'correct' the disjuncture) nor are they unrelated to environmental and other factors. Certain disjunctures are likely to affect certain dispositions (for example, an increase in aridity with affect agricultural options directly and other factors indirectly).

Change in dispositions is likely to take a relatively short amount of time, perhaps a matter of days or a few years. The amount of time is correlated with the severity of the disjuncture and the position of the exceptional individual within society or the social contexts of interaction. A more conservative society (i.e., one with structures that have small MDs) is more likely to resist change than a more liberal society (i.e., one with structures that have large MDs). In the later, there will usually be people whose dispositions overlap even with distributions that change greatly. In the former, there are very few people at the 'tails' of the distribution and even small changes can cause large problems as the society resists change, perhaps exacerbating the issue.

Examples of disjuncture in social interaction are provided by explorers and colonial settlers. The arrival of foreigners causes a disjuncture in the factors of social interaction. For example, the arrival of the *Discovery*, under Captain Clerke, put the Hawaiian chiefs in a situation where their dispositions were contradictory. Commoners were the first to meet the vessel and, in fact, traded with them for valuable iron and other artifacts for days before the arrival of the first chief. The arrival of Kaneoneo, "a chief of the highest tabus," (Sahlins 1981:34), put him in a situation where his own beliefs (i.e., dispositions) were in direct contradiction. As his larger vessel approached, he was obliged to ram and capsize four small canoes. This is a result of two major contradictions in dispositions. First, from the point of view of the commoners, they were required to do two things, 1) get out of the way and 2) prostrate themselves before this powerful chief. Clearly, they could not do both. Kaneoneo, or his paddling retainers, however, could not stop for the commoners; his vessel had a clear right of way. Such a situation would not have occurred in the normal course of Hawaiian life because, a chief rarely went out and when he did go in his vessel he was always at the lead. The commoners, however, had arrived at the English vessel first because of a disposition to 'seek' lords in order to curry favor (indeed the sexual advances of the women were for the same effect), while the chief, who normally had priority in such a situation, remained ambivalent about encountering the English as they were his direct competitors and, perhaps, deadly. He had to approach eventually, however, for in general chiefs were expected to take the primary role in such situations (Sahlins 1981:33-37). These contradictions in dispositions provoked the unraveling of much of Hawaiian society because the many 'taken-for-granted' dispositions were in disjuncture with the dispositions of the English, or simply with their presence. These conflicting dispositions affected both the Hawaiians and the English.

In terms of shell bead production, this theory of social change means that changes in raw materials, tools, producers, consumers, transportation, etc. will have an affect on production. Matching up the changes that occur and understanding how these changes may have happened is the key to this approach. Shell beads, complimented by analyses of the lithic microdrills used to make them and other associated artifacts, are an excellent material to demonstrate the usefulness of the Fuzzy People Model.

6.3. Shell beads- An application of the Fuzzy People Model

An application of this model to archaeological material is straight-forward. The key is remembering that all attributes could be the locus of 'style.' I will give seven reasons why shell beads are especially appropriate for this study.

First, the raw shell is relatively consistent (or perhaps I should say that an artisan can find within the raw material pieces that are fairly consistent). This is due to the fact that the shell is composed of a fairly consistent combination of calcium carbonate and proteins (though the later is absent in archaeological samples). Such consistency is difficult to find in other technologies of the Manteño. For example, the lithic material used by the Manteño is quite variable due to variation in the river cobbles used to make stone tools as well as the expedient technology use to make cutting tools. Because of the consistency of the source material, the variability of the bead can be related to the artisan and not the material.

Second, shell beads have limited attributes, all of which are taken into consideration by this study. In comparison, it would be nearly impossible to record all attributes for ceramic artifacts, even complete ones because they are much more variable. Such an undertaking would require hundreds, if not thousands of measurements per complete vessel. Fortunately, most variables can be measured for shell beads while the same approach for other types of artifacts, especially ceramics, would require many more measurements for each specimen.

Third, many shell beads are complete, which is certainly not true for ceramics from the study sites. This means that for a large number of beads all attributes can be recorded and most attributes can be recorded even for fragmented beads. Ceramics especially are broken more often than not making it very difficult to compare each sherd to others.

Fourth, the production sequence for shell beads is fairly simple. Compared to the production sequences for ceramics and lithic artifacts, which include a wide variety of chaînes opératoires for the artisan to choose from, the production of cylindrical shell beads provides more limited options. This means that we can observe the majority of variation without being forced limit this study to a few selected attributes to the detriment of others. This also means that we don't have to decide *a priori* which attributes are most appropriate for this study.

Fifth, shell (or bone or stone) beads, though rarely discussed in the archaeological literature, were produced and used throughout much of world prehistory. This means that the methods and theory proposed herein can be used by archaeologists throughout much of the world.

Sixth, shell beads are small. Because of their size, recording measurements is fairly simple, unlike larger artifacts, such as complete ceramic vessels or ground stone tools, which require specialized measuring devices. These beads were measure with a basic, inexpensive digital caliper directly attached to a laptop computer.

Finally, at the sites in question, shell beads were present in quantities comparable to (or in excess of) ceramic and lithic artifacts.

Methodologically speaking, an interest in the social enactment of artifact production necessitates a method that takes into account the process of production. The most often used method is a description of the chaîne opératoire.

6.4. Summary and proposal

In this section, I have attempted to model the relationships among the individual, structure and the process of structuration. This work stems from dissatisfaction with discussions about artifactual style. Style is not clearly associated with communication, nor is it a something 'society' makes through individuals. Because people produce artifacts through social interaction, 'style' is developed both through individual agency and structural control. It is neither the individual nor the society that has control over 'style.' It is created through the dialectical process between these two as individual dispositions are enacted in primarily social contexts. However, this leaves us wondering about how archaeological patterns, which can seem so clear, are produced over the long term and why we often see breaks in styles that quickly transition into others. Does this mean that when there are no changes structure predominates? And that change is due to individual agency? If one sees individual dispositions as statistical statements with an ideal and acceptable variation from that ideal, one can better theorize the role that the individual plays in both reproducing the structure of the society in which they live as well as being the primary instrument through which social change occurs. Of course, because social interaction involves a number of factors, and each of these factors can be associated with a distribution that describes an ideal as well as 'acceptable' variation, human action is not determined. Human social action instead is patterned because within societies certain actions are preferred and people will tend to act in accord. People can, however, by acting at the edges of the acceptable, cause change, especially when one of the factors of social interaction no longer ‘fits’ well with the other factors.

The seeds of change are present in the variation in individuals, dispositions, structure and social contexts of all societies in the sense that there are always options and different people will choose different options.

This model is particularly effective for understanding the patterning of both trends and variability in those trends. In the following chapters, I show how shell beads can be used successfully to demonstrate the utility of this model.

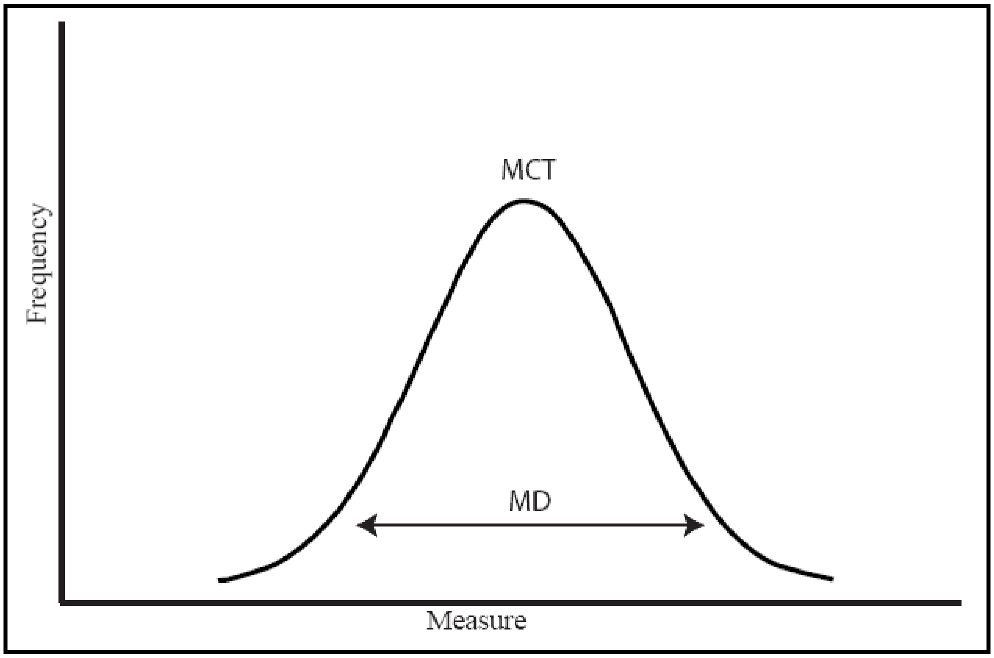


Figure 6-1. A normal curve indicating the measure of central tendency (MCT) and measure of dispersion (MD).

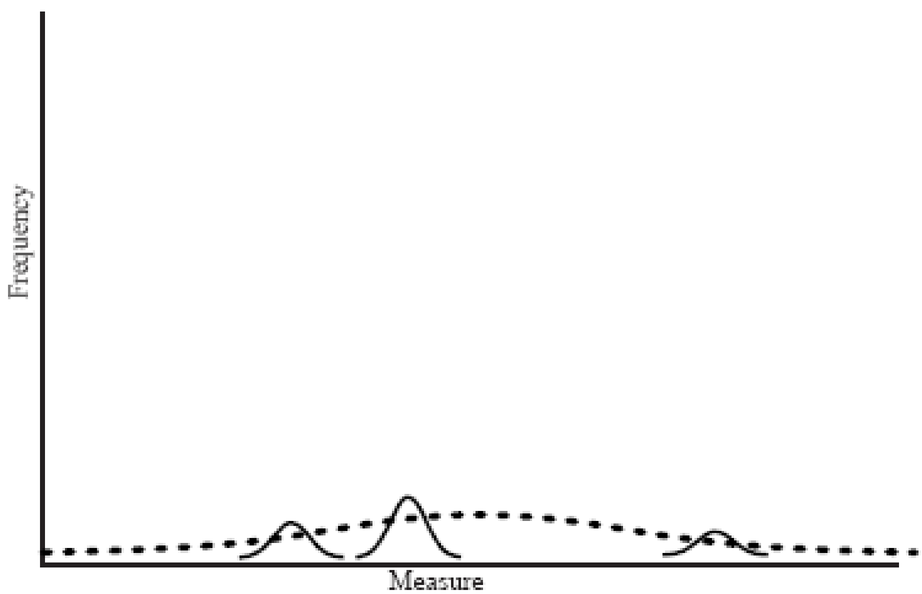


Figure 6-2. The development of dispositions. The three small distributions represent three separate social interactions. The dotted curve represents the cumulative effect of the social interactions. Note that the durability (height of the curve) of the disposition is low and the MD is large.

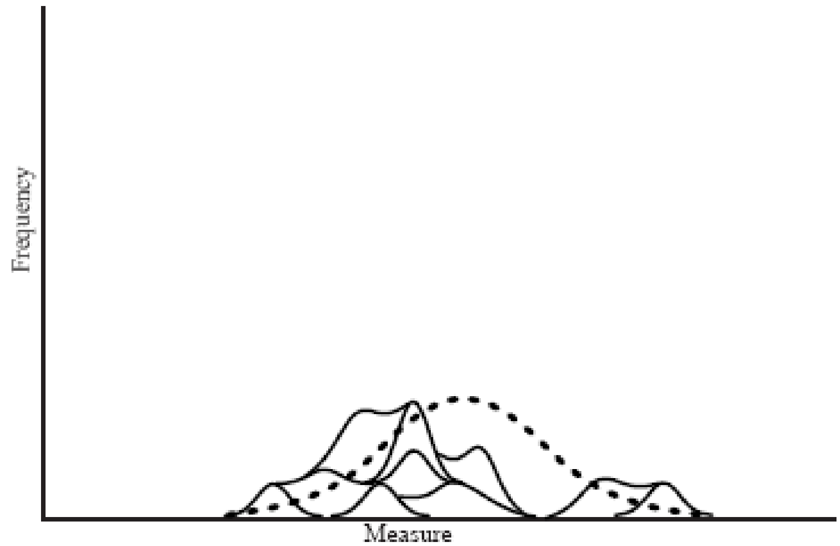


Figure 6-3. The development of dispositions. This represents a child who has developed begun to develop a disposition based upon ten social interactions. Note that the durability of the disposition has increased and the MD has decreased.

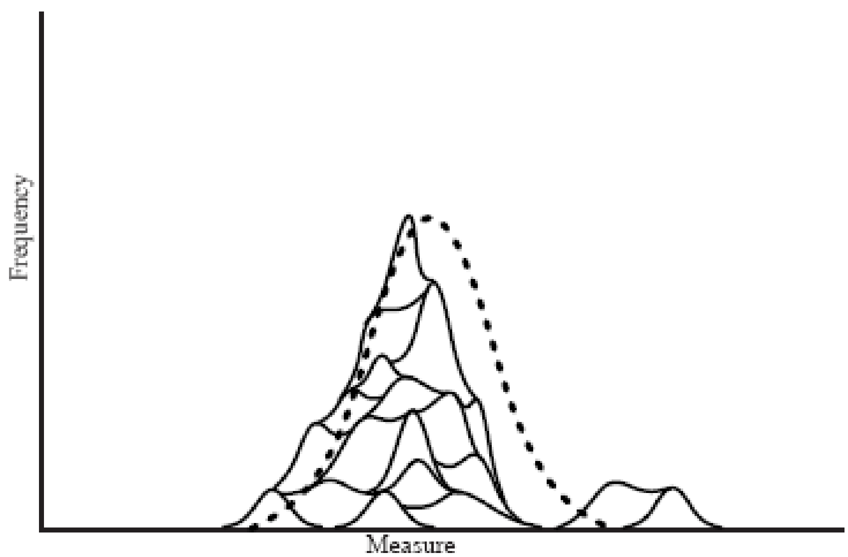


Figure 6-4. The development of dispositions. This represents an increase in the durability of the disposition through continued social interaction (19 events). The durability of the disposition has increased, the MD has decreased and the MCT has shifted to the left as dispositions similar to those on the right are rare encountered.

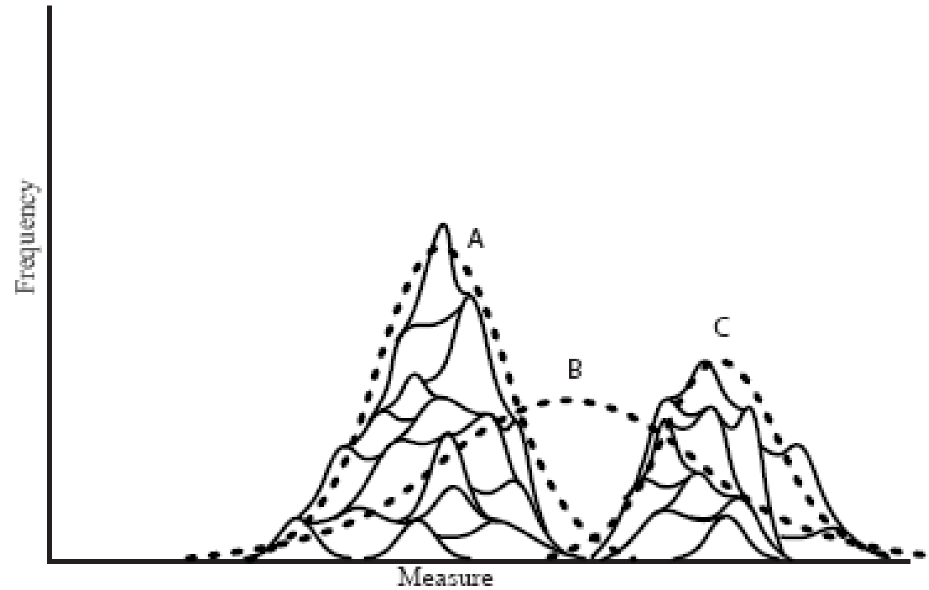


Figure 6-5. The development of a disposition when exposed to distinct dispositions associated with separate communities of practice.

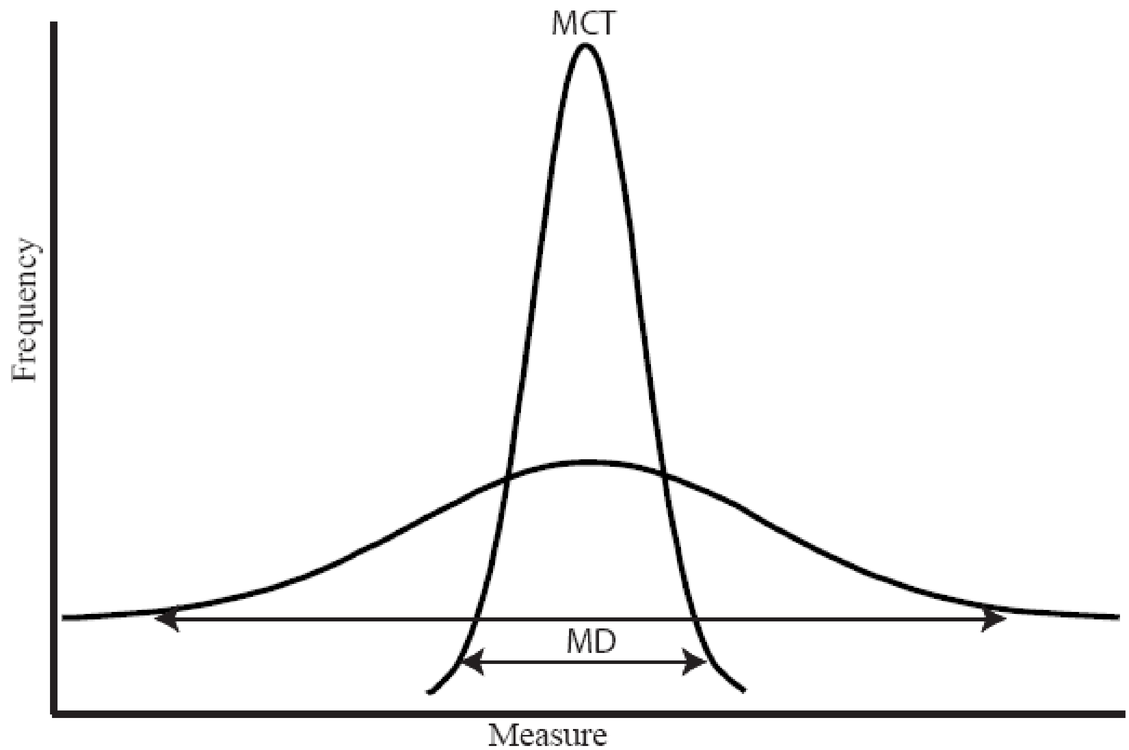


Figure 6-6. Theoretical diagram of individual dispositions represented by distributions. MD=Measure of Dispersion and MCT=Measure of Central Tendency.

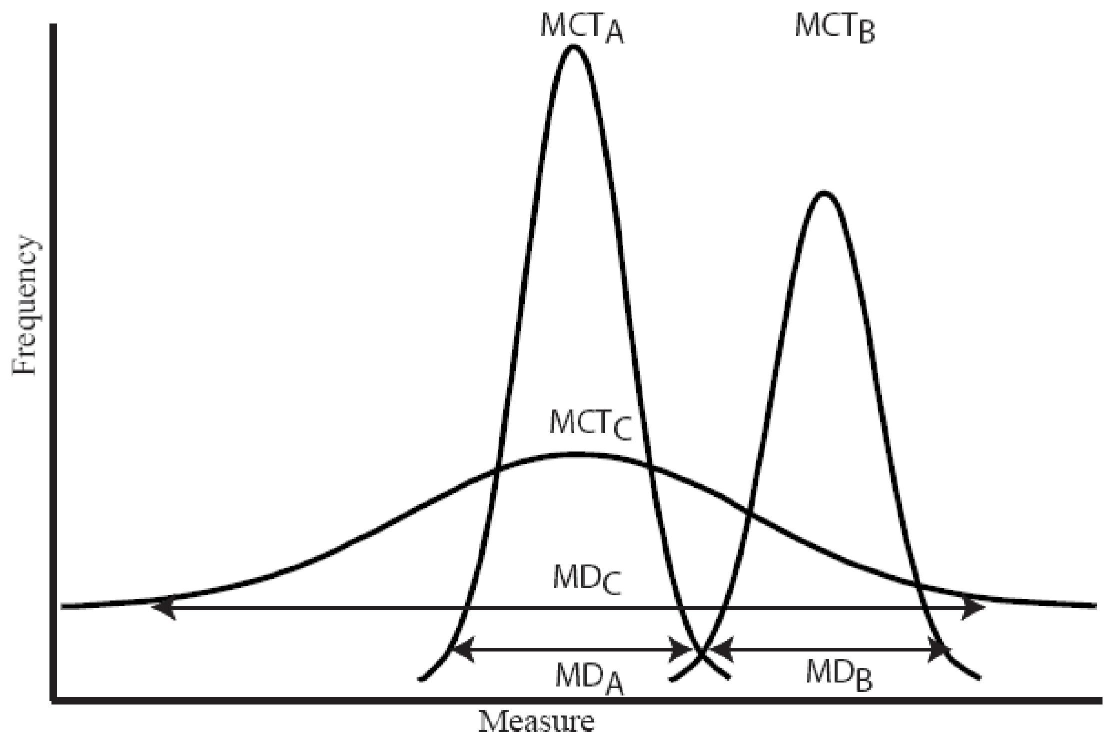


Figure 6-7. Theoretical diagram of group dispositions represented by distributions. A, B, and C represent the cumulative frequency distributions of all members in a society regarding a particular disposition. MD=Measure of Dispersion and MCT=Measure of Central Tendency.

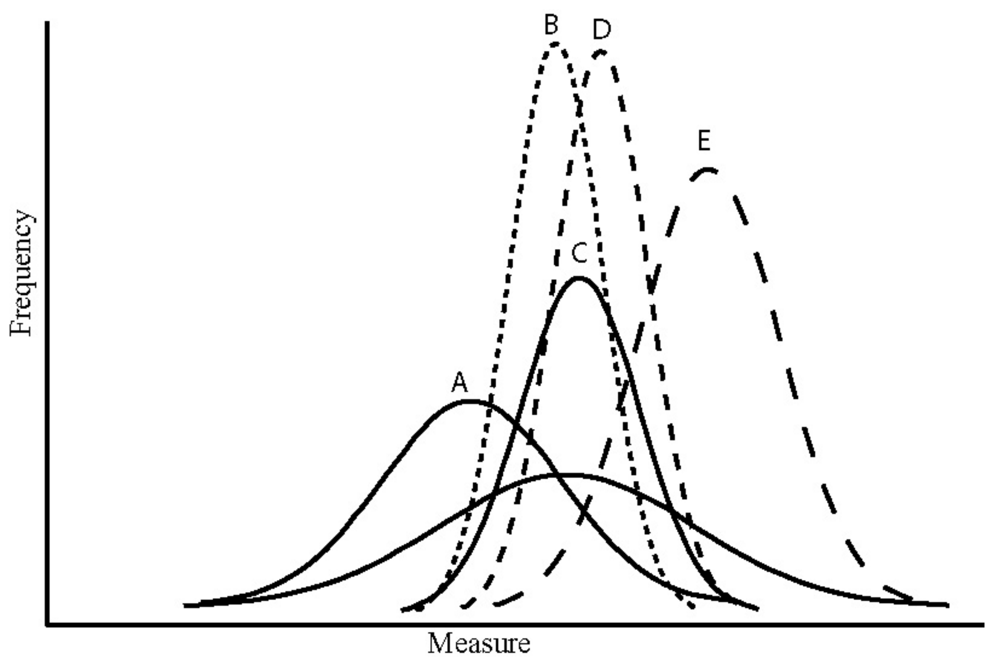


Figure 6-8. Theoretical diagram of how distributions 'fit' more or less to produce stability.

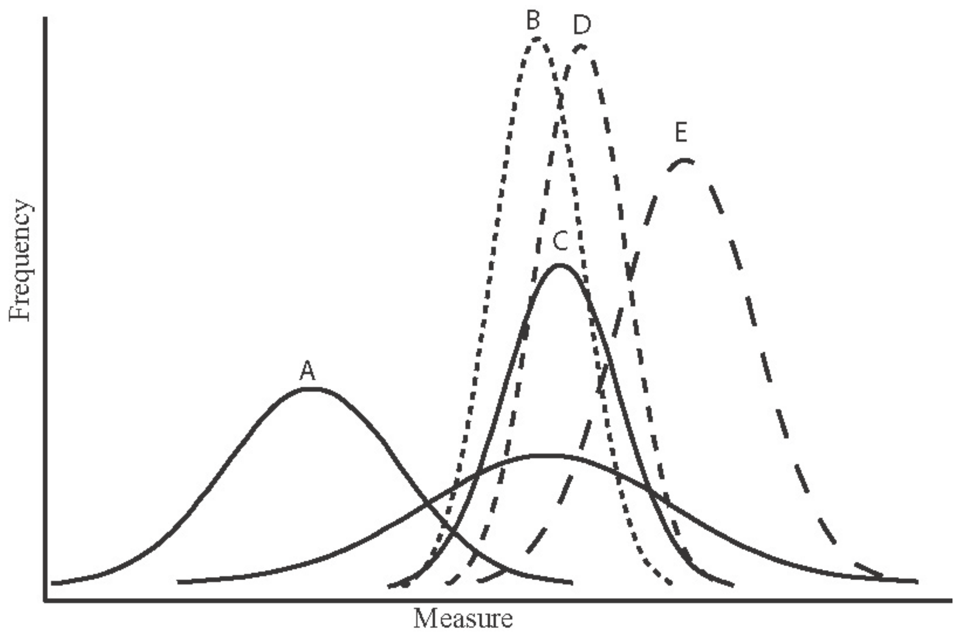


Figure 6-9. Theoretical diagram of a 'disjuncture' in the distributions of the factors of social interaction. Disjuncture often leads to change, but not necessarily.

Chapter 7. Data Collection

Although shell beads have long been discussed in archaeology, they have been the subject of only a hand full of studies (Allen et al. 1997; Arnold and Munns 1994; Francis 1982, 1989, 1991; Hammett and Sizemore 1989; Mester 1989; Moholy-Nagy 1989; Trubitt 2000; Yerkes 1983). Compared to other shell bead analyses, the present study includes a much higher degree of quantitative as well as qualitative analysis. My inclusion of the chaîne opératoire for describing shell bead production is unique.

7.1. Shell bead production throughout the world.

Before data collection can be described, a background in shell bead production throughout the world is in necessary. Shell beads may have been one of the first hallmarks of symbolic culture and were present as early as 75,000 years ago (Henshilwood et al. 2004; White 1993). They appear in archaeological assemblages throughout much of the world, including many parts of North America, Mesoamerica, South America, the South Pacific, Africa, Europe, the Middle East and Asia (Allen et al. 1997; Arnold and Munns 1994; Feinman and Nicholas 1993; Francis 1982, 1991, 1991; Hammett and Sizemore 1989; Haury 1931; Isaza Aizpurúa and McAnany 1999; Malinowski 1984; Miller 1996; Moholy-Nagy 1985, 1989; Trubitt 2000; Yerkes 1983). However, the technology of shell bead production has not yet been well studied. Most of the research into shell bead technology has focused upon the use of tiny lithic drills (called microdrills or microlithic drills; Allan 1989; Jones 2000; Mason and Perino 1961; Masucci 1995; Sierzschula 1980; Yerkes 1983; see also Gorelick and Gwinnett 1983; Gwinnett and Gorelick 1981; Kenoyer et al. 1991; Kenoyer and Vidale 1992; Kenoyer et al. 1991; see Figures 1-2 and 1-3) to perforate the shell. It has been clearly shown that many beads were perforated with these drills, though the drills may have been multifunctional. The lithic microdrills described and pictured in these works are essentially the same as those studied here. While shell beads have been studied from other parts of the world, they have either included small samples, general observations and/or were not measured. For example, Hammett and Sizemore (1989) studied 17,787 beads from the Wall and Fredricks sites, they did not measure each bead, but separated them using stacked sieves of with mesh sizes of 4.0, 2.8, 2.4, 2.0, 1.0 mm. While this does give a quick estimate of bead size it tells little directly about any single dimension, simply that one dimension was between two mesh sizes. Similarly, Allen et al. measured 303 shell beads from Motupore Island off the south coast of Papua New Guinea, but included only a single thickness and a single diameter measurement. The present study, therefore, both increases the number of beads present in any study of shell beads as well as drastically increases the number of both quantitative and qualitative variables observed.

One of the main techniques of shell bead production is known as the *heishi* technique (Allen et al. 1997; Foreman 1978; Francis 1982, 1989; Haury 1931). Foreman has identified four basic steps in the production of shell beads, including "(1) rough shaping of the bead material, (2) drilling holes and rough stringing, (3) grinding to size and (4) polishing and final stringing" (Foreman 1978:18; see also Francis 1989:31). The process identified herein is similar, though not the same. Some of the beads described (chaîne I) were also ground between Foreman's steps one and two to make a disc blank that is just slightly larger than the expected bead. I have also suggested that either an abrasive or a corrosive material (such as acid) may have been used to aid the drilling process, but the process would be difficult to identify archaeologically (Carter 1999).

Figure 1-1 shows the evidence for the modified heishi technique, what I call chaîne I, using archaeological artifacts recovered from Loma de los Cangrejitos. The blank on the left (1-1a) has only been roughly formed, probably using mainly percussion. The second bead (1-1b) has been ground on both the face and the edges. This creates a 'blank' with smooth parallel faces and faceted edges. The third bead (1-1c) shows a bead that was broken during perforation, while (1-1d) shows a bead that had been successfully perforated. In both of these beads, the facetted edges can still be seen. The second from the right (1-1e) shows a completed disc bead with very finely polished and smoothed edges with no evidence of facets. As described for the heishi technique, this bead was probably strung together with many other similarly sized beads. Tension would have been placed upon the beads, pulling them into a unit that moved together as they were rolled across a grinding stone. This would have rounded the facets and produced beads of very nearly the exact same size. The last bead (1-1f) shows a broken cylindrical bead in order to show the biconical shape of the perforation. The tools required are fairly simple, including a grinding stone, a microlithic drill and a piece of fibrous string. It has been suggested that some grinding stone with grooves were used for the final grinding and polishing of the beads (Francis 1989; Masucci 1995), but none of these were recovered in any of the excavations at the six sites included in this study.

Not all of the beads in this study were made using the heishi technique. I have proposed two, and possibly three, chaînes opératoires for making beads on the Ecuadorian coast. The first, described above, is known as chaîne I. The other chaîne opératoire, called chaîne II, is a much more expedient technology. Essentially a piece of beach worn shell is perforated. This may be used as is or the beads may be strung together and rotationally ground and, sometimes, even face ground (see also Feinman and Nicholas 1993). The identification of the stages of production is discussed below.

7.2. Data

A data collection program was organized to record the maximum amount of information about beads and lithic microdrills. Other artifacts were cataloged in less detail. Measurements of standardized dimensions were easily taken for both shell beads and lithic microdrills with great consistency. Six measurements and five categorical observations were attempted for the 7782 beads in the study, and six measurements and three categorical observations were attempted for the 996 lithic microdrills-- for a total of nearly 100,000 attempted observations. While not all observations were made (for example if there is no perforation in a bead it cannot be measured), this dataset is an order of magnitude more detailed than any other study of shell bead production.

Data for this project were collected over six years, from 2001 to 2006. This included an early pilot project in 2001, funded by a grant from Washington University, and the subsequent full-scale project from 2004-2006, which was funded by a NSF Dissertation Improvement Grant (#0417579). Artifacts were analyzed in 2001, 2004, 2005, and 2006.

7.3. Pilot project

The pilot project included data collection for all shell beads, lithic artifacts, greenstone objects, and obsidian fragments from excavations at Loma de los Cangrejitos (including MV-A3-4f, 4k, and 4n; see Carter 2001). With the permission of the

Ecuadorian government (unnumbered permission signed by María Elena Jácome, of the Instituto Nacional de Patrimonio Cultural, on June 15, 2000) these objects were brought to Washington University in St. Louis and returned the following year. Data collection for the pilot project proceeded in two stages, first a general inventory that included counting and weighing objects by provenience, and second, a detailed analysis of shell beads and lithic microdrills.

All objects from the three locations at Loma de los Cangrejitos were inventoried by provenience (i.e., site, unit, and level). Lithics were divided into a general category, microdrills, and preforms for the drills. Preforms were separated out in the hope of identifying drill production, but it became increasingly apparent that placing a lithic artifact in the 'preform' category was highly subjective. Therefore, the 'preform' category was eliminated and they were placed in the general category, leaving only the microdrills distinct from the general category, which was mostly made up of small flakes and a variety of debitage. Objects were weighed by provenience. A total of 6072 (6667 g) general lithic artifacts, 613 (172g) microdrills, 655 (35g) beads, 418 (90 g) obsidian fragments, and 50 (4.9g) greenstone objects were inventoried (Carter 2001). It should be noted that greenstone objects were included in some of the shell bead bags and were not originally a focus of this research. It is likely that there are more greenstone beads from these proveniences than noted here.

Data for general lithics and obsidian were not collected from the other five sites for logistical reasons, including difficulty in retrieving the artifacts or lack of availability. Therefore, the collection from Loma de los Cangrejitos can tell us more a little more about how shell beads and artifacts fit into overall artifact production and use than the collections from the other sites.

Detailed data was collected for beads and lithic drills from all but two of the units from MV-C2-4f. Units B3 and B4 were excluded because of possible mixing of contexts. A maximum of six measurements and four categorical observations (described below) were made for all 565 beads. Each bead was given a unique catalog number beginning with b; and numbered consecutively in the order in which they were measured. Each bead, with an acid-free tag on which the catalog number is recorded, was placed in an individual polyethylene resealable tube of the type used for DNA analysis.

A series of qualitative observations were also made. These were the same as those made for all the other sites and are discussed below.

Beads were measured using a microscope equipped with digital imaging equipment and a computer running a video capture program called Psion developed by NISD. A stage micrometer was used to calibrate the Psion program. Beads were placed in small container of sand so that they could be manipulated in order to measure the desired dimension of the three-dimensional objects in the two-dimensional view. This improvised stage was placed so that the bead was at the same level as the micrometer used to calibrate the measuring program. Measurements were transferred from the computer screen to a paper data sheet, which was then transferred first into an Excel spreadsheet and later, transferred to an Access database. This method was tedious and time-consuming. It is not recommended for large numbers of artifacts.

The results of this study were modest, mainly because I lacked a comparative dataset. The conclusions, therefore, were limited to identifying differences within the site.

I suggested that: 1) drills with more facets had been more heavily modified, which, therefore, represented greater use in shell bead production; 2) a relatively low quantity of ‘finished’ beads compared to ‘in-process’ beads indicated removal from the production area of the finished artifact; 3) smaller drills tend to be more heavily reworked, and, therefore also represent greater participation in the shell bead industry; and 4) cylindrical beads require more expertise than discoid beads.

7.4. NSF-funded research

Three other trips were made to Ecuador to collect data and samples to return to the United States. In Ecuador, I stayed with Dr. Karen Stothert in La Libertad and Valentina Martinez at the Salango Research Station in Salango. At these locations I received assistance from Dr. Stothert, Sra. Martinez, Dr. Richard Lunniss, Dr. Patrick Gay, and others. I also received vital assistance from Fredy Acuña, who participated in the original excavation of López Viejo and helped me organize the López Viejo material. Twice beads, microdrills, and carbon samples were taken from the country with the permission of the Subdireccion Regional del Litoral of the Intituto Nacional de Patrimonio Cultural (Authorizations SRL-INPC No. 011.2004 and SRL-INPC No. 007.2005). I also obtained the Los Frailes material by visiting Dr. Ann Mester at the University of Illinois Urbana/Champaign, who loaned me beads, drills, and other associated artifacts.

All artifacts were placed in new 4-millimeter thick resealable plastic bags. When necessary, a new tag was created, but often the originals were retained if they were in good condition so as to avoid errors in rewriting the information on the tag. In general, the system for organizing artifacts used by the excavators was retained in order to avoid confusion (e.g. original catalog numbers were retained). Objects from López Viejo were bagged and labeled individually when they were excavated; this system was retained but with the new, higher quality bags. Similar objects (for example, all of the beads from the same context) from Salango, Puerto de Chanduy, Los Frailes, and Mar Bravo were often in the same bag. This system was also retained, but with the new, higher quality bags. This preservation of the excavator's original system makes it less confusing when, or if, they, or another researcher, reexamine these materials.

The same measurements and qualitative observations used for the Loma de los Cangrejitos material were employed for taking data from the other five sites, but an inventory of general lithic artifacts and obsidian similar to that from Loma de los Cangrejitos was not completed. Measurements were taken using different techniques, because of the tediousness of the initial method. This included using a Mitutoyo Absolute Digimatic six-inch digital caliper (Model #- CD-6"C) attached directly to a laptop computer using a Mitutoyo Input Tool (IT-005D) and a three-foot Mitutoyo SPC cable. A push of the data button on the connection between the SPC cable and the caliper sent the measurement directly into the database. This sped up the data acquisition process and reduced the opportunity for error present when data are copied from screen to paper and then to database as was done for the pilot project.

7.5. Database

The Microsoft Access database is the key to analyzing this large database. There were five main advantages to using Access, including: 1) increasing the speed of data acquisition, 2) reducing error, 3) increasing the ease with which bead data can be compared, 4) increasing the ease with which variables can be converted into dummy variables for statistical analysis, and 5) increase in the ease with which summary statistics can be produced.

Information is easily entered into Access. Each measurement was entered into the database with the push of a button on the digital calipers. This database has three main spreadsheets: one for beads, one for lithic artifacts, and one for cataloged artifacts. It also has a number of smaller spreadsheets, which help link the larger ones together and elaborate upon the information included in the main spread sheets. By linking a larger spreadsheet, for example the beads, with a smaller one, for example location, I am minimized the amount of information I had to enter for each of the 9000+ artifacts. For example, I enter B1-2, which means Unit B1, Level 2 within excavation 4f at Loma de los Cangrejitos. This information is linked to a smaller database that contains the site #, site name, unit number, level number in separate columns. Therefore, by entering four characters in one column, I am able to get four columns of information and greatly increasing the efficiency of data acquisition.

By using linked spreadsheets in Access, I also reduced error. By using smaller linked spreadsheets, instead of entering four different columns of data, I only entered one, which then filled in the necessary columns. The amount of information entered is minimal and, if a problem is detected (i.e., the code entered in the larger spreadsheet does not match one in the appropriate smaller spreadsheet), it is easily remedied. If the code I entered for the context did not match on in the location spreadsheet, a warning would flash and I would know that I either needed to add the context to the smaller spread sheet or that I had made an error. This process increased error detection compared to entering each column separately, which both increased the chance for error and decrease the possibility of error detection. When there are often hundreds of beads in a single level this can equate to a significant amount of time saved.

By linking both larger databases to the location database, I am able to easily compare the two larger databases; i.e. drills and beads. For example, I can easily compare number of drills to the number of beads in a context, or the average length of a drill to the average thickness of a bead in a particular context. Such a task is a few clicks of the mouse in Microsoft Access, but very difficult to do using a spreadsheet program such as Microsoft Excel.

In order to statistically analyze categorical (quantitative) information it is often necessary to convert it into dummy variables (using ones and zeros indicating presence of absence of the category or trait). By using a smaller spreadsheet, I can easily convert the site category, which includes the names of the six sites into six dummy categories, with a separate column for each site. For example, if I enter B1-2 in the bead table, the linked table says that for this context, the "Loma de los Cangrejitos" column gets a 1, and the other 5 site columns get zeros.

In the Access program you can get summary statistics through a 'Query' or Pivot Table function, more easily and quickly than via Excel or other spreadsheet programs (where you would have to write equations and highlight data, etc.). There are some things, however, that Excel can do that Access cannot, but this is easily remedied with the "Analyze It with Microsoft Excel" button (under Tools- Microsoft Links) in Access: this allows one to manage in Access and to analyze in Excel. Excel's graphing function is particularly superior.

Using Access as a database manager increases efficiency, reduces error, easily connects information across artifact types and makes it simple to organize data to be analyzed in a statistical package (in this case, SPSS) that can do much more complicated statistical tests. Access greatly simplifies complex data manipulation.

7.6. Shell beads

Shell beads are the focus of this study and, therefore, they are the most numerous artifact studied and the one for which I recorded the most information. I attempted to record six quantitative and five qualitative observations were attempted for a total of 7782 beads from the six sites (Table 7-1).

7.6.1. Quantitative observations.

Six measurements were attempted for each bead; two bead diameter measurements, two bead thickness measurements and two diameter measurements of the bead perforation. These measurements were achieved for a varying number of shell beads (Table 7-2).

7.6.1.1.Diameter.

Diameter is the distance from one edge of a bead to the other bisecting the face of the bead (Figure 1-1). I attempted to make the first measurement the maximum, but many of the beads were close enough to circular that it was difficult to tell which dimension was larger. In these cases, two randomly selected, but perpendicular measurements were taken. Often the difference between these two measurements is in the hundredths of millimeters. When it was clear that the diameter was larger in a particular direction, that was recorded as the first measurement, and the second measurement was perpendicular to the first. Therefore, for irregular beads, the first measurement represents a maximum and the second represents a minimum. For very regular beads these are just two measurements of the diameter. When comparing the difference between these two measures, the absolute value is always used.

7.6.1.2.Thickness

Two thickness measurements were taken, which could also be called width measurements or, for cylindrical beads, length measurements. For my purposes, thickness is defined as the distance between the two faces of a shell bead. The first thickness measurement was taken where the bead was thickest and the second where it was thinnest. For irregular beads, the first thickness measurement was taken so that the entire bead was between the calipers; if it was arch shaped from one side to the other, the height of the arch was measured. The first measurement, at least for irregular beads, represents the maximum thickness of a bead. For the second measurement, thickness was measured where the bead appeared thinnest, yet also complete from the edge to the perforation (or the center if no perforation exists). For irregular beads, these measurements represent the maximum and minimum thickness dimensions; for regular beads, the two measurements are often within hundredths of a millimeter and therefore do not strictly represent maximums and minimums. In order to avoid confusion and recognize that these are not equivalent measurements, I refer to these as minimum and maximum thickness measurements. Maximum and minimum thickness measurements were taken in this way in order to get an understanding of the variation in each bead. When strung together, the beads would have been next to other beads and these measurements represent the maximum and minimum space that a bead would have occupied when strung together with other beads. If two irregular beads were placed side by side, either their convex sides would face each other (or concave) or concave would face convex. The first would take up the maximum amount of space on the string and the second the minimum. Therefore, the measurements closely represent the functional thickness of the beads.

7.6.1.3. Perforation

If a bead had been drilled, two perforation measurements were taken. Maximum perforation represents the diameter of the perforation at the surface of the face of the bead. Minimum perforation is the smallest diameter of the perforation. For biconically drilled beads, this is usually located approximately half-way through the bead, but closer to one face for conical perforations.

7.6.1.4. Quantitative observation conclusion

Table 7-2 shows the success rate of obtaining these measurements. The first diameter was taken for nearly all beads, even if they were <50% complete. This was done to get a relative idea of their size, but these measurements are not relevant for statistical comparisons with diameters that truly represent the size of the bead. This means that there are only 6982 beads (91.3% of all shell beads) for which the first diameter measurement indicates the true diameter of the bead (i.e., beads that are less than 50% complete were not complete enough to supply one complete diameter). The second diameter measurement, both thicknesses, and both perforation measurements were taken only if possible. When calculating statistics in the analysis, beads less than 50 percent complete were excluded for most analyses. It is safe, however, to say that we have accurate measurements for all dimensions for beads more than 50 percent complete.

7.6.2. Qualitative observations.

Along with the six measurements, a series of categorical observations were also made for each bead. These included a statement about material, fragmentation, type of bead, stage of manufacture and the color of the bead.

7.6.2.1.Stage of manufacture.

The stage of manufacture in which a bead is recovered is of vital importance. Chaîne I, as discussed above, is a series of 4 basic steps with relatively little variation; breaking, roughing out, perforation, and finishing (Table 7-3 and Table 7-4, Figure 1-1). Chaîne II was more variable and expedient (Figure 1-2). The only commonality among all chaîne II beads was that they were perforated: i.e., they could be identified as beads. Some were worked in a series roughly similar to chaîne I, while others were simply perforated *conchilla* (beach-worn shell fragments) of the right size. *Conchilla* is readily available at most beaches near these sites and is approximately the correct size for larger shell beads (i.e., chaîne II).

The coding for the different stages of production departs from the production steps discussed above in only one way . I do not use the term ‘stage’ to directly represent a step in the production process, but as a short-hand that represents a series of objective criteria (Table 7-3). For example, stage 3 and stage 4 beads are both part of the perforation of a bead and differ on in that stage 3 beads are not completely perforated as are stage 4 beads. This was done in order to ensure that different ‘stages’ were identified according to clear objective criteria.

Stage 1 represents a ‘roughed-out’ piece of shell that is approximately the right size and shape for a bead (Figure 1-1a). Stage 2 represents a bead blank that has been face and edge ground (Figure 1-1b). Stages 3 and 4 represent perforation. Stage 3 identifies beads that were not completely perforated (Figure 1-1c) and stage 4 beads are those that have been completely perforated (Figure 1-1d). If the perforation passed through the shell, no matter if the hole was big enough to be strung or not, it was considered a stage 4 bead.

The two different chaînes opératoires are fairly easy to distinguish from each other. Chaîne I is represented mainly by Stages 2, 3, 4 and 5, and chaîne II by Stages 4.1 and 4.2. There is some overlap between the two different production sequences, especially at stage 5. Stage 5 beads must have been ground on the face and rounded on the edge and, therefore, could be made using either chaîne opératoire. The chaîne of Stage 5 beads can be recognized because chaîne I yields small, regular beads and chaîne II, large irregular beads (compare Figure 1-1 and Figure 1-2). However, separating the two chaînes opératoires for stage 5 beads is difficult because they overlap significantly.

Stage 1 is underrepresented because of the difficulty of identifying a tiny, slightly modified piece of shell among large quantities of shell debitage. Stage 0 beads are those that could not be placed in any other category, often due to a high degree of fragmentation. Out of all shell beads, only 63 (0.8%) could not be identified as one of the seven stage codes, compared to 7587 (99.2%) that were coded. This is a high success rate, due mainly to the fact that a perforation and/or some modification of the face and edge are necessary to be a ‘bead’. Without these three things, it is difficult to recognize a fragment of shell as a bead during excavation and, therefore, those beads that very highly fragmented may not have been collected and, therefore have been removed a priori from the sample.

7.6.2.2. Material

This project was originally intended to study mainly shell beads, but ended up including a variety of other types of beads (Table 7-5) because they were included in shell bead bags by the original excavators. Since they were in the bags, I measured them and included them in the spreadsheet. Since non-shell beads were not the original purpose of this study, however, their frequency should be seen as a true representation of their frequency in the archaeological record. This category, is used mainly to remove any non-shell beads from analyses.

Most of the materials are easy to identify and include shell, greenstone, ceramic, stone, and a mystery material. The term ‘greenstone’ is an admittedly imprecise term and simply includes any stone material that has a green color and may include materials like serpentine, jade, jadeite, and many others. The mystery material was consistently fragile, often hollow, and had sand or other matrix stuck to the exterior. It appears to be heavily degraded bone or, possibly, sand dollar. It is so fragile that it is difficult to touch, much less obtain measurements, without crushing the bead.

Although ceramic beads were recorded for four of the sites, their absence from Los Frailes should be seen as a lack of data rather than a lack of ceramic beads and their absence from López Viejo in this database is because there were simply too many to record. López Viejo produced 718 ceramic beads, which were categorized according to the number of segments in each artifact, but were not measured (these are discussed further below).

7.6.2.3.Fragmentation.

Fragmentation (labeled *Whole?* in the database) was determined in a very general way. Three codes were used to identify the percent of a bead remaining (Table 7-6). The determination was made by looking directly at the face of the bead and determining how much of the circumference of the bead remained. Coding fragmentation at such a general level made it easy to make determinations and leaving few ‘unknowns’.

Beads that were split parallel to the face were difficult to code, because it was impossible to know how much was missing. Beads split parallel to the face are mentioned in the notes for each bead. Beads that were coded 3 (i.e., <50% complete) were often difficult to measure and, in general, are excluded from analyses of measurements. This, however, only amounts to 8.6% (657) of all shell beads. It is possible that some of the rougher beads were less than 100% complete, but were coded as a 3 (i.e., 100% complete) because of the failure to recognize that a broken edge was created after the bead was made rather than before. In general, however, the rougher beads tend to be much more complete, indicating that if the possibility of miscoding a 2 as a 3 does affect the data, it is probably a minor influence.

7.6.2.4. Type of bead

Types of beads identified include discoid, cylindrical, barrel-shaped, plaque, rectangular, rhomboidal, and unidentifiable (Table 7-7). The two main types of beads, discoid and cylindrical, have round faces with edges that are perpendicular to the faces and parallel to each other. The diameter of a discoid bead is greater than or equal to the thickness (or height) of the bead whereas the diameter of a cylindrical bead is less than the thickness of the bead. The other four types were in the distinct minority. Beads were usually unidentifiable because they had broken parallel to the face of the bead and could not be definitively placed in discoid or cylindrical categories.

7.6.2.5.Color

Color is a particularly difficult category to accurately qualify. The basic idea behind my color coding scheme was to attempt to include any color in the bead in the code, so that one bead was coded for as many as three colors. This resulted in 117 different color codes (such as w/t/b for white/tan/black and b/t/gr for black/tan/gray). These were reduced to absent/ present codes for eleven colors including; purple, red, orange, green, tan, gray, black, pink, burnt (different from dark or gray because it also appeared degraded by the heat), white, and other. I always erred on the side of generosity. In other words, if I couldn't decide if a bead was red or orange, then I coded as both. Notice that in Table 7-8, the sum of the percentages is 122%, because of the overlap between colors.

These color codes can be reduced to seven basic categories: 'Light', which includes clear, yellow, white, and tan; 'Dark' which includes black, gray, and brown (and burnt); 'R,O,P', which includes red, orange, purple, and pink; and 'Other', which includes green, unidentifiable, and all other colors. The ROP category is intended to represent Spondylus beads, but, as discussed above, no single bead can be identified as Spondylus, but as a whole most of the ROP beads probably are Spondylus. When categorized in these more general categories, the picture becomes clearer and the overlap is reduced; the sum of the percentages is only 104%. However, there is overlap, so overlapping categories, Light/ROP, Dark/ROP, and Dark/Light were created to take all overlap into account. Although these general categories seem overly inclusive, they yield some very distinctive and important patterns.

7.7. Lithic microdrills

Lithic artifacts were also examined for this study. In the pilot study (Carter 2001) I showed that much of Manteño lithic technology was 'expedient' (i.e., lacking in formalized tools). The major exception is the finely crafted lithic microdrills. These drills are produced from a variety of materials, most of which were readily available, though in varying degrees, to the artisans at the six archaeological sites. These tiny drills, some with a tip less than 1mm across, are extremely strong for their size. The cross-section of these drills, along both the shaft area and the tip, is nearly circular. This makes the drills resistant to rotary fracture and gives them the strength to perforate strong materials such as shell. It is clear by the association of these drills with shell beads that they were used to perforate the beads. How they vary and what they can tell us beyond that has remained an open question until now.

Three qualitative observations and six quantitative observations were attempted for each drill or fragment of drill. In total, 996 microdrills were analyzed.

7.7.1. Quantitative observations

Five quantitative observations were attempted for each microdrill or fragment of microdrill, including length, two perpendicular width measurements (one on the widest point and the other 90 degrees offset from the first measurement), the length of the tip, and the width of the tip. Nearly every fragment was measured for length, whether the complete drill was present or not. Because many of the drills were broken (61%), however, many of the length measurements represent a minimum estimate of the length of the drill, not the true measurement. The length of a complete drill, however, remains a good measure for comparison. Both of the tip measurements should also be seen as tentative. For length, it is not always obvious where the tip ends and the shoulder begins on microdrill other than those with very distinct bits. For the width, the tip is tiny and highly variable, so a small error in measurement can be a large percentage. For this reason, we must interpret all tip measurements carefully.

7.7.2. Qualitative observations

Qualitative observations of lithic microdrills included overall general shape, cross-section, number of sides worked, and fragmentation. I did not include raw material as a category, because all were a similar cryptocrystalline material (I presume chert) that varied mainly in color. Colors included mainly white to gray to black with some tan and could be translucent or opaque. Since I am not a lithics specialist, I did not feel I had the knowledge and skill to differentiate between these materials.

7.7.2.1.Shape

There were some obvious differences between the shapes of complete microdrills, such as that between the cigar shaped microdrill, which shows little or no shoulder between the shaft and the tip and the drill with an exaggerated shoulder. Initially, I began with codes 1, 2, 3, and 4, but soon developed intermediate categories, because many drills obviously fell between those categories (Table 7-12). Even with these categories over 16% were unidentifiable. This shows how variable the lithic microdrills are and how difficult it is to categorize them.

This coding system for the shape of microdrills was subjective. Whether or not the microdrill had a shoulder was objective, however, so microdrills were categorized as having a shoulder or not. The microdrills coded 1, 1.5, and 2 were considered to have shoulders and microdrills coded 3, 3.5, and 4 were considered to lack a shoulder. Microdrills coded 2.5 and 5 were intermediate and were not coded either way. A total of 509 (51.1%) of the microdrills had no shoulder (called cigar-shaped, eye-shaped or tear-drop-shaped) while 264 (26.5%) had distinct shoulders, leaving 223 (22.4%) of the microdrills uncategorized. Although much of the variation in lithic microdrills is clouded by a lack of clear categories, the attributes that we can identify give us useful insights into shell bead production.

7.7.2.2.Cross-section

The cross-section of the microdrill body was coded in order to help identify how much effort had been put into making, or remaking, these tiny drills (Table 7-13). Most often, drills start out with a fairly simple cross-section (either a triangular or a quadrilateral cross-section) that becomes more complicated (pentagonal, hexagonal, etc.) through reuse and modification. I judged the number of sides at the approximate middle of the shaft of the microdrill. Since this can change in a fairly short distance up and down the shaft, I tried to record what I thought was the most representative of the cross section near the midpoint. Initially, I also tried to code for the shape of the cross-section of the shaft (Table 7-12). This may be of use to others, but has limited use for the present study. For this only the number of sides is analyzed.

7.7.2.3.Fragmentation

All microdrills were categorized in terms of their fragmentation (called “broken?” in the database). The coding of fragmentation of lithic microdrills was different than for beads due to different breakage patterns between the two types of artifacts (Table 7-14).

Fragmentation of microlithic drill could be either from use or post-depositional processes. I believe that, especially for tips, most of the breakage is due to use. This is because many of the drills have a characteristic spiral fracture pattern that comes from breaking during a twisting motion, such as drilling. This means that breakage of 13.6 % (code 2) of the microdrills may have been due to post-depositional processes. Some of these drills, however, also had the characteristic spiral fracture. In the future the presence or absence of a spiral fracture pattern should be encoded.

7.8. Microscopic analyses of shell beads.

Shell beads were also analyzed microscopically in order to identify the traces of production and use. The actual beads were observed, but since it is especially difficult to see into the perforations of shell beads, impressions were also taken of the shell beads. The impressions are highly accurate and allow relatively easy observation of the details inside the perforation.

The initial analysis was performed at Drew University under the guidance of Dr. Maria Masucci. A Meiji ML9000 Series polarizing microscope with 40x, 100x, 200x magnification was used to identify traces of production or use for 100 artifacts. These artifacts were chosen from those assemblages that were available to me at the time, namely parts of the Mar Bravo and Salango collections and the López Viejo collection. I attempted to identify striations and polish on both the edges and the faces along with any striations or other marks within the perforations. In order to better observe the marks within the perforations, impressions were taken.

Because of the difficulty of observing the interior of the perforations a hydrophilic polyvinyl siloxane called Examix (Type 3 Low Viscosity Injection Type made by GC

America) was used to make negative impressions of the perforations. Polyvinly siloxane is often used by physical anthropologists to study ancient fossils because the impressions can be handled without concern for damaging the original fossil. Multiple positive casts can also be made from the negative impressions with great accuracy in the reproduction (Galbany et al. 2006).

The impressions were observed alongside the original beads. Observations were limited to polish and striations. No other evidence of production or use was uncovered. The beads tended to be highly variable in terms of polish and striae. Some had a large number of preserved striations while others had smooth shiny surfaces. Many of the beads had only minimal evidence of either of these, presumably because of either use or wear on the beads or through the post depositional exposure to chemicals that degrade at the microscopic level (such as acids in the soil). Information from electromicrographs (see below) suggests the former. The location of the marks did not seem to be patterned.

Therefore, it was determined that the marks helped identify the production process in general, but were of little use in determining variation between archaeological sites (see below). Indeed, the process was fairly labor intensive and the collection of data from the entire sample (or even a small representative subsample) would have been impractical and, based upon the studied sample, would not have produced significant results.

One of the major difficulties in assessing the markings on shell beads is limited focal range of the microscope. Only a small portion of the bead (especially where relief is high) could be in focus at any one time. This meant that observations had to be made while changing the focus. Since only a small slice of the bead could be viewed at any one time, the process was extremely time consuming. For a subset of the samples, digital images were recorded through a stereoscopic microscope using a digital camera attachment under the direction of Dr. David Miyamoto at Drew University. However, these images suffered from the same problem: in each image only part of the object was in focus.

While recording the images Dr. Miyamoto suggested using the scanning electron microscope (SEM) at Drew University. At first, I did not consider it because it is a fairly intensive process. But, as the microscopic images were essentially useless I decided I needed to record these images if only to support the overall process of bead production. Electromicrographs allow one to see much more of the artifact in focus at the same time. Therefore, a series of eleven samples were viewed under the SEM.

The preparation of samples for viewing under the SEM available at Drew University is destructive, primarily because the subject needs to be coated with a microscopic later of gold. Therefore, no shell beads were used, only the negative impressions made from the polyvinyl siloxane. This material is ideally suited for SEM analysis up to 1000x (Galbany et al. 2006). The process requires that the samples be conductive and neither shell beads nor the impressions are conductive. Therefore, a gold conductive coating (with an approximate thickness of 3 angstroms) was applied using sputter coating.

Samples were viewed at two magnifications: approximately 30x (this varied a little because the instrument would only allow greater magnification under certain conditions) and 1000x. The lower magnification was ideal for identifying traces of production but the upper magnification was not useful; it was hoped that the higher magnification would help identify different crystalline structures, but higher magnification, on the order of 10,000x to 20,000x is needed. Such magnification is beyond the impression material, however.

The evidence obtained from microscopic analyses is fairly minimal, but does support the overall understanding of the process of bead production. Specifically, striations from the drilling process can be seen in incompletely perforated beads (stage 3; see Figure 7-1), but not in finished beads (stage 5; see Figure 7-2). It is likely that the lack of striations in the later is due to either the polishing process, when beads are strung together on an abrasive cord and rolled across an abrasive surface such as sandstone, or to use, when beads were probably strung on a mildly abrasive cord that would have slowly erased evidence of drilling process. Similarly, compare the clear biconical shape of the perforation from a stage 4 bead in Figure 7-3 to Figure 7-2. Figure 7-3 shows a distinct ridge between the two cones, but 7-2 shows less evidence of this distinction and has more of an hourglass-shape. More often than not, the main observation possible from many of the impressions of perforations is that the play structure of the shell can be seen (Figure 7-3).

7.9. Catalog of other artifacts

A catalog of other objects was intended to include any artifacts that may have been associated with the shell bead industry: generally this included both other shell artifacts and ground stone tools. At least some of the ground stone tools were used in the production of shell beads and other shell artifacts. A total of 636 items were cataloged (Table 7-15).

Exceptions to the above include mother-of-pearl artifacts from Los Frailes and Olivella/Oliva artifacts and ceramic beads from López Viejo. Mother-of-pearl artifacts (300 out of a total of 462 artifacts cataloged by Mester) were not cataloged because a catalog and an analysis of these objects already exists (Mester 1992 [1985]). Redoing the catalog would produce minimal additional information and consume a great deal of time. Oliva/Olivella artifacts were so numerous at López Viejo (349 objects made from the shells of these two genuses) that cataloging each one would not have produced useful data. Most of the shells had the spire removed making a simple bead or pendant but with little other modification, so these were identified by genus and counted (145 Olivella and 183 Oliva beads). Oliva/ Olivella beads that had more significant modification (21 beads) were cataloged; many of these were 'fishhead' shape artifacts that were probably used as bangles or pendants (a.k.a., tinklers).

Objects were identified by material and divided into the following categories: shell, pearls, glass, ground stone, ceramic, copper, bone and unidentifiable. The shell category was further divided into the following groups: general, Spondylus, Oliva/Olivella, and mother-of-pearl (both nacreous species, *Pteria sterna* and *Pinctada mazatlantica* are included as a single group). The Spondylus group was much easier to identify for larger objects and was based upon both color and texture.

All cataloged artifacts were measured and described. A minimum of two measurements were attempted for each artifact; often three were obtained, but only rarely were four or five taken. All artifacts were described as accurately as possible, but because the objects are highly variable the descriptions are not standardized.

7.10. Data collection conclusion

The data that have been collected for this study are highly significant and different from the data recorded in any past study. Some of these data have been recorded for lithic microdrills (e.g., Yerkes 1983), but shell beads have rarely been to focus of any study (though see Allen et al. 1997; Masucci 1996) . Never has there been a database with such a large number of observations. The question remains, however, what can these beads tell us? The answer is a great deal.

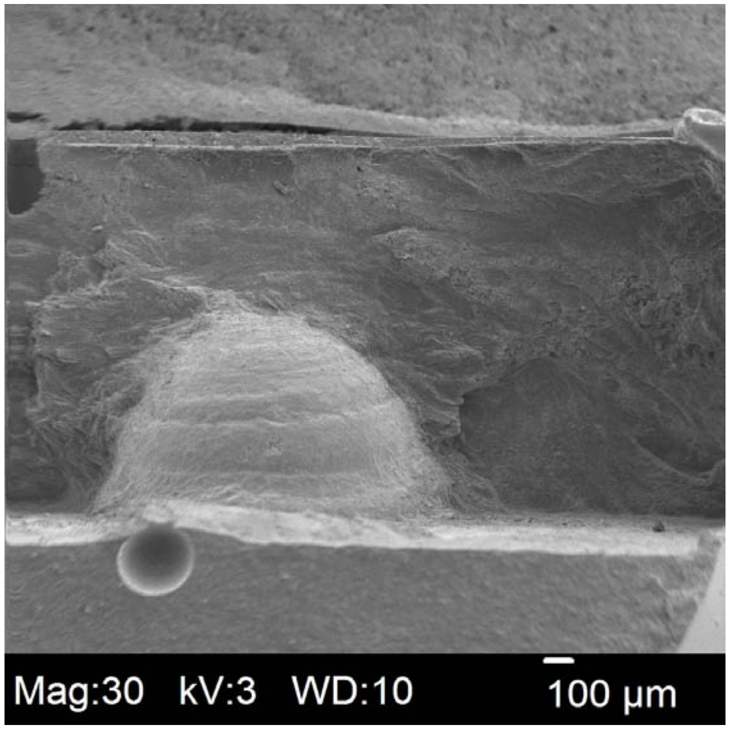


Figure 7-1. Electromicrograph of partially perforated Stage 3 bead showing clear striations resulting from the drilling process. Note the rough texture of the broken shell in the background.

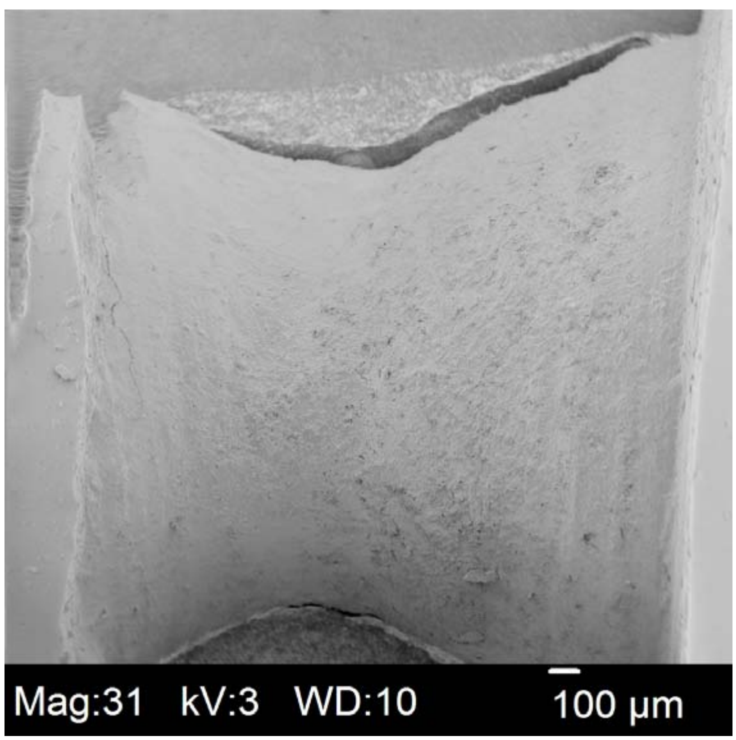


Figure 7-2. Electromicrograph of the impression of a stage 5 bead showing little evidence of striations. Note the hourglass shaped compared to the image in 7-3

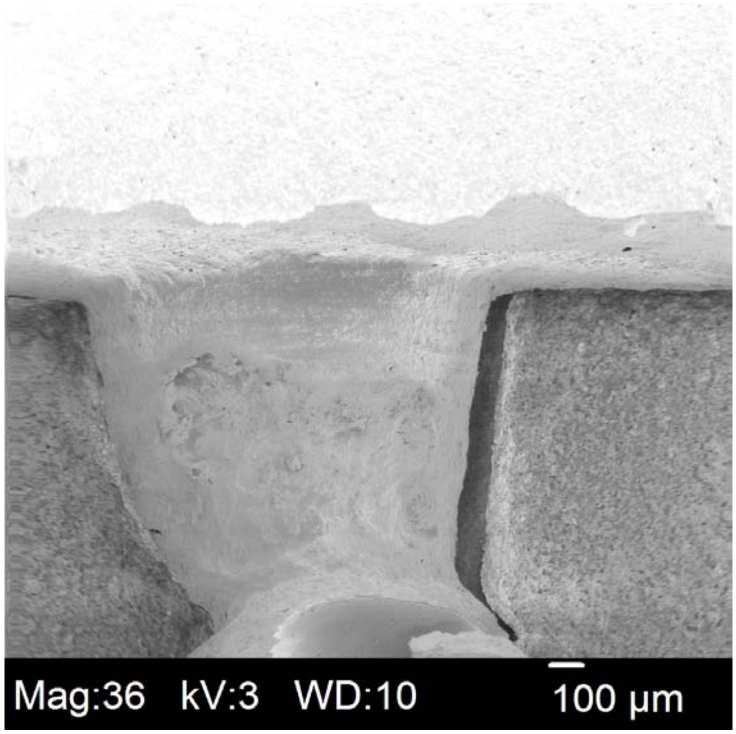


Figure 7-3. Electromicrograph of impression of perforation of stage 4 bead. Note the clearly biconical nature of the perforation, which is clearly different than the hourglass-shape of the perforation in Figure 7-2.

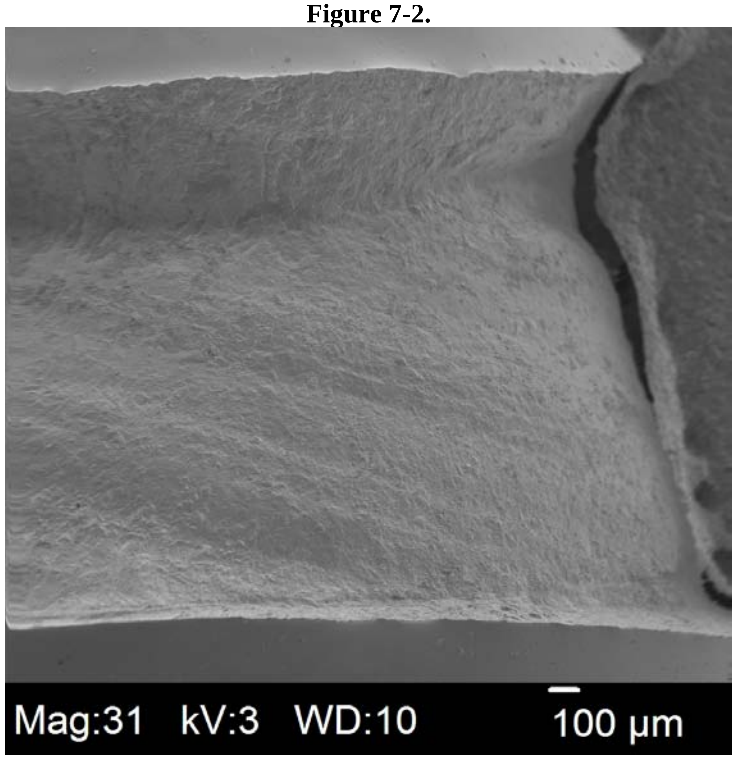


Figure 7-4. Electromicrograph of the impression of a perforation, showing the platy structure of the shell.

	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
All Beads (N)	573	2837	98	2121	829	1324	7782
All Beads (%)	7.4	36.5	1.3	27.3	10.7	17.0	100
Shell Beads (N)	571	2828	86	2083	792	1290	7650
Shell Beads (%)	7.5	37.0	1.1	27.2	10.4	16.9	100
Other Beads (N)	2	9	12	38	37	34	132
Other Beads (%)	1.5	6.8	9.1	28.8	28.0	25.8	100
Shell beads >50% complete (N)	495	2269	86	2069	789	1282	6990
Shell beads >50% complete (%)	7.1	32.5	12.3	29.6	11.3	18.3	100
Discoid Shell Beads > 50% complete (N)	423	2189	78	2049	776	1279	6794
Discoid Shell Beads > 50% complete (%)	6.2	32.2	1.1	30.2	11.4	18.8	100

Table 7-1. Frequency and percent of all beads, shell beads, other beads, shell beads more than fifty percent complete, and discoid shell beads more than fifty percent complete for which data was collected from each archaeological site.

		Maximum Diameter	Minimum Diameter	Maximum Thickness	Minimum Thickness	Maximum Perforation	Minimum Perforation	Total Beads
All Beads	N	7654	5945	7661	6213	5463	3028	7782
	%	98.4%	76.4%	98.4%	79.8%	70.2%	38.9%	100%
Shell Beads	N	7522	5835	7530	6112	5347	2965	7650
	%	98.3%	76.3%	98.4%	79.9%	69.9%	38.8%	100%
Shell beads		6980	5822	6913	6043	5320	2953	6990
>50% complete		99.9%	83.3%	98.9%	86.5%	76.1%	42.2%	

Table 7-2. Frequency and percent of successful measurement acquisition for six measurements.

Stage	Edge	Faces	Perforation	Chaîne
0	Unidentified	Unidentified	Unidentified	Unidentified
1	At least partially ground	Roughly correct shape	None	I, II(?)
2	Ground, but faceted	Ground	None	I
3	Ground	Ground	Partially perforated	I
4	Ground	Ground	Fully perforated	I
4.1	Not Ground	Ground	Fully perforated	II
4.2	Not Ground	Not Ground	Fully perforated	II
5	Rounded	Ground	Fully perforated	I and II

Table 7-3. Stage codes and description of modification of edges, faces, and perforation for all shell beads, including the chaîne used to make the bead.

	0	1	2	3	4	4.1	4.2	5	Total
All Sites n	63	32	808	524	722	1341	457	3703	7650
All Sites %	0.8%	0.4%	10.6%	6.9%	9.4%	17.5%	6.0%	48.4%	100%

Table 7-4. Frequency and percent of each stage for all shell beads.

Material	Frequency	Percent
Shell	7650	98.3%
Mystery Material	58	0.7%
Ceramic	45	0.6%
Greenstone	28	0.4%
Stone	1	0.01%
Total	7782	100%

Table 7-5. Frequency and percent of all beads for by material.

Fragmentation Code	Description	Total beads in category	Percent
1	Less than 50 % complete	657	8.6%
2	Between 50 and 100% complete	1291	16.9%
3	100% complete- no apparent breakage.	5698	74.5%
0	Unknown	4	0.1%

Table 7-6. Fragmentation codes, frequency and percent of all shell beads.

Code	Shape	Frequency	Percent of all shell beads
1	Discoid	7406	96.8%
2	Cylindrical	181	2.4%
3	Barrel-shaped	4	0.05%
4	Plaque	1	0.01%
5	Rectangular	3	0.04%
6	Rhomboidal	1	0.01%
0	Unidentifiable	54	0.7%
	Total	7650	100%

Table 7-7. Frequency and percent of each type of shell bead.

	Purple	Red	Orange	Green	Tan	Gray	Black	Pink	Burnt	White	Total
N	484	1381	1847	6	835	96	57	112	31	4475	7650
%	6.3	18.1	24.1	0.08	10.9	1.3	0.7	1.5	0.4	58.5	100

Table 7-8. Frequency and percent of colors identified for all shell beads. Note: percents total to 122% because some beads contained more than one color.

	Dark	Dark/ Light	Green	Light	Other	ROP	ROP/ Dark	ROP/ Light	UnID	Total
N	249	61	7	4710	77	2263	1	263	20	7650
%	3.3	.8	.1	61.6	1.0	29.6	.0	3.4	.3	100

Table 7-9. Frequency and percent of recoded colors for all shell beads.

Site	N	% of total microdrills
Loma de los Cangrejitos	444	44.6%
López Viejo	460	46.2%
Los Frailes	35	3.5%
Mar Bravo	24	2.4%
Puerto de Chanduy	9	.9%
Salango	24	2.4%
Total	996	100%

Table 7-10. Frequency and percent of total lithic microdrills by site.

	Length	Width 1	Width 2	Length of tip	Width of tip
N	992	993	991	96	114
%	99.6%	99.7%	99.5%	9.6%	11.4%

Table 7-11. Frequency and percentage of measurements taken for lithic microdrills.

Microdrill shape code	Point	Shoulder	Overall Shape	Microdrills in category N (%)
1	Edges of point are parallel	Very distinct		46 (4.6%)
2	Edges of point are widen toward the shoulder (V-shaped)	Distinct		203 (20.4%)
3	V-shaped	No distinct separation between shaft and point	Edges of shaft are parallel, looks cigar-shaped	333 (33.4%)
4	V-shaped	No distinct separation between shaft and point	Edges of shaft are not parallel, looks more like an eye	146 (14.7%)
1.5		Between 1 and 2		15 (1.5%)
2.5		Between 2 and 3		16 (1.6%)
3.5		Between 3 and 4		30 (3.0%)
5		Between 2 and 4		45 (4.5%)
6		Unidentifiable		162 (16.3%)

Table 7-12. Microdrill shape codes.

Code for cross-section	Description	Number of sides	Number of microdrills in category (%)
3.00	triangular	3	117 (11.7%)
	Total with three sides		117 (11.7%)
4.00	square	4	592 (59.4%)
4.20	rhombus	4	4 (0.4%)
4.30	slanted trapezoid	4	24 (2.4%)
4.40	trapezoid top and bottom parallel	4	12 (1.2%)
	Total with four sides		632 (63.5%)
5.00	pentagonal	5	103 (10.3%)
5.30	slanted pentagonal	5	6 (0.6%)
	Total with five sides		109 (10.9%)
6.00	round	6	75 (7.5%)
6.10	round with one side flat	6	44 (4.4%)
	Total with six sides		119 (11.9%)
7.00	other	?	19 (1.9%)

Table 7-13. Cross-section codes for lithic microdrills.

Fragmentation (broken?) code	description	Total microdrills in category
0	Unbroken, completely whole	391 (39.3%)
1	Tip broken and missing	364 (36.5%)
2/4	Breakage other than tip	175 (17.6%)
3	Tip only present	66 (6.6%)

Table 7-14. Fragmentation codes for lithic microdrills. Note: fragmentation codes for lithic artifacts are different than for shell beads.

Material	N	%	N (with non-cataloged artifacts)	% (with non-cataloged artifacts)
Shell- general	153	24.1%	153	7.3%
Shell- Spondylus	47	7.4%	47	2.2%
Shell- Mother-of-pearl	264	41.5%	564	26.7%
Shell- Oliva/Olivella	65	10.2%	393	18.6%
Total Shell	529	83.2%	1157	54.8%
Pearl	2	.3%	2	0.1%
Ground Stone	67	10.5%	67	3.2%
Ceramic	17	2.7%	735	34.8%
Glass	14	2.2%	14	0.7%
Bone	1	.2%	1	0.05%
Greenstone	1	.2%	1	0.05%
Copper	1	.2%	1	0.05%
Unidentifiable	4	.6%	4	.2%
Total	636	100%	2110	100%

Table 7-15. Cataloged items by material. Note items not cataloged, but included in second count include 718 ceramic beads and 328 Oliva/Olivella beads from López Viejo and 300 mother-of-pearl artifacts from Los Frailes. See text for discussion

Chapter 8. Data Analysis

In order to answer questions about the role of shell industries among the Manteño, we must turn to the hard data.

The first part of this analysis (section 8.2) deals with all shell beads as a single group. The first analysis (section 8.2.1) is used to determine whether or not the differences noticed between the two different chaînes are in fact statistically valid and how much they differ. That is, are chaîne I beads smaller and more regular than chaîne II beads? This analysis is supplemented by an analysis of the fragmentation of all beads in order to determine when, in their use life, beads break. Many of the tests employed are non-parametric because the distributions are clearly non-normal, therefore parametric tests cannot be used. These tests identify that the different stages of production are significantly different in many attributes and do in fact represent statistically separable categories.

The second part of the analysis is designed to analyze the differences (and commonalities) in beads between the different sites/time categories. It appears that most of the chaîne I beads were produced in the early part of the Manteño sequence while chaîne II beads were produced later. Many of the conclusions of the first analysis are supported when the beads are separated by site.

An analysis of lithic drills supports and expands the conclusions of the shell bead analysis. Specifically, the high number of drills from López Viejo and Loma de los Cangrejitos probably indicates a focus upon tiny shell bead production at the two sites. In contrast to beads, drills were limited at Puerto de Chanduy and Los Frailes, suggesting that use of shell beads, and not manufacture, was the primary concern at these two sites.

At the later sites of Mar Bravo and Salango 140, drills were also in short supply, though large, irregular beads were abundant. This suggests that bead production was much less formalized; beads may have been quickly made out of beach-worn shells with expedient drills that may have been organic (e.g., cactus spines) or may have been left elsewhere. They certainly were not kept at the site and used until they were almost worn-out as at Loma de los Cangrejitos and Lopez Viejo.

Finally, an analysis of cataloged artifacts is less quantitative, but appears to generally support the conclusions from the other analyses.

8.1. Statistical tools

Initially analyses involve a straightforward comparison of means, medians and frequency for the different stages of the chaînes opératoires. Ideally each chaîne would be analyzed separately, but I avoided determining the chaîne for each artifact opting to identify the stage which is based upon clear attribute differences.

The choice of statistical tests used is largely based upon whether the data are categorical, ordinal or interval. Categorical data involve non-numeric categories that have no natural order, such as color or shape. Ordinal data are not directly measured, but can be placed in some sort of order. The only ordinal data concern the amount of fragmentation, which is treated as categorical because then the same tests can be used. Treating ordinal data as categorical is more conservative. Interval data concern measurements, such as length and diameter.

The statistics used herein are intentionally relatively common and straight-forward. Most of the tests are based upon ANOVA and chi-squared analyses. Regression analysis was attempted, but because there are no independent and dependent variables, these were abandoned. The knowledge used here is based upon my own statistics education at Washington University. I used a few books as references, including the textbook from Washington University (Runyon et al. 2000), as well as reputable statistics help web sites, such as the Statistical Computing website of UCLA Academic Technology Services (Statistical Consulting Group, n.d.).

8.1.1. Significance levels

All statistical tests used yield a significance statistic, which if less than a predetermined significance level (α), are considered not to have been random. Because of potential problems with the data, the most conservative tests are used for all analyses. Therefore, for all statistical tests, the significance level was set at $\alpha=.001$, which means that a significant result is where $p<.001$. This minimizes the likelihood of Type I error, when the null hypothesis is erroneously rejected. For example, if one is using ANOVA to test for difference of means, the null hypothesis is that the two means are not different. If the test results in $p=.000$, then the null hypothesis is rejected. This means that there is less than 0.1% probability that the difference is due to random variation meaning that the difference in the means is most likely real. In other words, Type I error is unlikely. By using a .001 for a significance level, Type I error is reduced, but Type II error, not rejecting the null when it truly should be, is increased. For example, for an ANOVA test, if $p=.002$, the null is not rejected and the means are not seen as different, when perhaps they truly are. Most commonly, $\alpha=.01$ or $\alpha=.05$ are used. My use of $\alpha=.001$ is to be as statistically conservative as possible, thereby recognizing only statistical patterns that are almost certainly true. This does, however, mean that I have increased my chance of Type II error. For an ANOVA test, for example, I have increased the chance that I will not recognize some true differences in means. I have opted for this conservatism, because the data are messy enough (it is, after all, archaeological data) that I would prefer to only include relationships that are robust enough to past conservative tests than worry about the recognition of a pattern or difference that is, in fact, not real.

There is one test, however, in which this conservativism works in the opposite direction. For the Levene test for non-normality (see below), the null hypothesis is that the distribution is normal. Therefore, an alpha of .001 means that there is greater likelihood of Type II error, i.e., of identifying the distribution as normal when it may truly be non-normal. Such conservativism, in this case, may allow some distributions that are non-normal to be identified as normal. However, because of the nature of archaeological data, a nice normal distribution is highly unlikely. Instead of nice random samples we essentially get what we get. Although an excavation strategy can help ensure a random sample, none of the sites were excavated with random using a random sampling strategy. In order to support my inclusion of these distributions as normal, they were all visually examined with a normal curve based upon the calculated mean and standard deviation to ensure that they at least appear close to normal. For most Levene tests $p>.01$ (i.e., the test statistic is a factor of ten higher than needed) suggesting that using an alpha of .001 as the cutoff is not highly problematic. For the Levene test for non-normality I have opted for an inclusive strategy rather than an exclusive one mainly because ANOVA tests (see discussion below) is fairly robust even when the assumption of normality is violated. Therefore, if a distribution is close to normal it is best to treat it as normal because a slightly non-normal distribution can be used with ANOVA.

8.1.2. ANOVA and post-hoc Tukey HSD tests

For continuous numerical data divided into categorical groups (for example comparing measurements by stage), an analysis of variance (ANOVA) test is preferred. An ANOVA test compares the means and the variation between two or more normally distributed groups. For two groups, it identifies whether or not there are statistically significant differences among the means of the groups. For multiple groups it only identifies that there are significant differences between the means of the groups, but doesn't tell us which means are different. A post-hoc Tukey Honestly Significant Difference test (a.k.a., Tukey test) can tell us which means are statistically different. Since an ANOVA test is based upon certain assumptions, a priori tests were performed to ensure that an ANOVA was appropriate. ANOVA assumes that the data are normally distributed, variance between groups is homogenous, and that observations in each sample are independent of each other. Tests to ensure that these assumptions are not violated included a test of homogeneity of variance (also known as homoscedasticity), specifically Levene's test, and a test of normality, the Shapiro-Wilk test. Many of the groups of data were non-normal and variance was heterogeneous (a.k.a., heteroscedastic). Most of the samples are non-normal because there is a lower limit for bead size (about 2 mm) but no upper limit causing the distribution to have a long tail to the right and a truncated distribution to the left. This is known as a left-skewed distribution. Because of the skew, both mean and median are reported for groups of data (for an example, see Figure 8-7). A median that is lower than the mean indicates a left-skewed distribution.

8.1.3. Kruskal-Wallis, Tamhane and Mann-Whitney tests

Even though ANOVA is robust even when assumptions are violated, nonparametric tests are also performed to ensure that tests do accurately represent the data. Non-parametric tests have fewer assumptions about the shape of the distribution, but often have less power to identify true patterns; that is, small, but significant, differences are less likely to be recognized with non-parametric tests.

A Kruskal-Wallis test (often known as ANOVA of rank) was used as a supplement to ANOVA. This test, instead of comparing the mean and the distribution of the data, ranks the data and compares the sum of the ranks. If the shape of the distribution is similar, then the sum of the ranks should be similar. The Kruskal-Wallis and ANOVA tests often agree, highlighting the well-known robusticity of ANOVA tests when assumptions are violated.

When the assumptions of the ANOVA test are violated, the Tukey HSD test is problematic because it is built upon similar assumptions. Two supplemental tests were used. The Tamhane test is similar to the Tukey HSD, but does not assume homogeneity of variance. The Mann-Whitney test, uses a rank system like the Kruskal-Wallis test and, therefore, assumes nothing about the shape or the measure of central tendency for the distribution. Indeed, the Kruskal-Wallis is an extension of the Mann-Whitney test. The only difference is that the Kruskal-Wallis identifies differences between multiple groups while a Mann-Whitney test works for two groups. Like an ANOVA, the Kruskal-Wallis does not indicate which groups are different, merely that there is a difference. Since a Mann-Whitney is binary, if a difference is found, it is obvious where the difference is located. Therefore, if a Mann-Whitney is performed to support the Tukey and Tamhane tests, the Kruskal-Wallis is unnecessary. All three (Tukey, Tamhane, and Mann-Whitney) are used when the data appear to be non-normal. A difference of means is only considered significant if all three tests agree (which is more often than not).

Nonparametric tests are less powerful than parametric tests, but for large samples this is less important. However, once the data are broken up into many groups with relatively small sample sizes, nonparametric tests are less able to identify statistically significant data. Therefore, once the data are broken up by site and stage, parametric tests are both more highly desirable as well as more appropriate. Also, with an increased number of groups, performing ANOVA with Tukey and Tamhane tests along with Mann-Whitney tests would be a great deal of work. Since the non-parametric tests would yield few statistically significant results because of a reduction in sample size, this work would yield little information. The reasoning for relying more heavily upon parametric tests for data broken up by stage and site is discussed in detail below.

8.1.4. Chi-squared, Cramer's φ (phi), and adjusted residual tests

Nominal (color, site, and stage) and ordinal (fragmentation) data require different analyses. The main tests to identify differences in the categories between groups are the chi-squared (χ^2) test and its post-hoc tests. The cross tabulation function in SPSS was used to identify statistically significant differences between groups. Cross tabulation creates a matrix of the frequency where the two variables intersect; if 23 people in St. Louis drive Ford pickup trucks, then 23 goes in the cell where location is St. Louis and type of vehicle is Ford pick-up. A chi-squared test shows us whether or not the differences identified by the cross tabulation are statistically significant. A chi-square analysis tests the null hypothesis that the variation seen in a data set is simply random. If the null hypothesis is rejected (i.e., $p<.001$), then the difference between the two variables that is not random. It tells us neither the strength of the relationship nor what groups within the variable are related.

A Cramer's φ (phi) test is used to indicate the strength of the relationship. If phi is squared this gives us a measure of the association of the variables. For example, if we are testing the relationship between the type of car a person drives and their ethnicity and get phi=.54, then a person's ethnicity explains <u>approximately</u> 29% ($.54^2=.29$ or 29%) of the variation in the type of car a person owns. Phi tells us the strength of the relationship, but doesn't tell us where the relationship occurs. For example, do Latinos make up that 29% and drive a particular type of car while everyone else drives a random assortment of cars?

Like the Tukey test for ANOVA, the adjusted residual (ê) can be used as a post-hoc test to indicate where the relationship between the two variables is statistically significant. An adjusted residual with a magnitude greater than 3.4 indicates a cell where the two variables are not statistically independent. This yields a result similar to $\alpha=.001$. A positive adjusted residual indicates that the cell has a greater number than expected if variation was due only to randomness and a negative adjusted residual indicates that the number is higher than expected. One must be cautious, however. Chi-squared tests cannot have any cells that are predicted to be zeros. This is usually avoided by eliminating 'unknown' and 'other' categories.

A combination of ANOVA and chi-squared tests and related tests are the main statistical procedures used in this analysis.

8.2. Shell beads as a single group

Shell beads and how they are made are the focus of this study. They form the largest and most important data set in this study in terms of number of objects and number of observations per object. The analysis of shell beads will show significant differences between beads made using two different chaînes opératoires and it will explore how those chaînes were operationalized in different prehistoric societies. This highlights the complexity of the shell bead industry and its ability to help us better comprehend prehistoric processes along the southwestern Ecuadorian coast. It is widely thought that the Manteño participated in long distance exchange, but what is the archeological evidence for shell bead production and transportation?

8.2.1. Chaîne analysis

An analysis of the different chaînes opératoires used to produce shell beads among the ancient Manteño must be an analysis of the stages of production. When collecting data, I intentionally did not identify beads by their chaîne, but by their stage, which is based upon objective criteria (Table 7-3). Although the two chaînes opératoires are fairly distinct, there is overlap. Using objective criteria eliminates the need to place a bead into one or the other Chaîne when the distinction is unclear. This is especially important for stage 5 beads. It is very clear that stages 2, 3, and 4 are utilized mainly by artisans using Chaîne I, and they will be used as a proxy for Chaîne I. Stages 4.1 and 4.2 are utilized solely in Chaîne II and will be used as a proxy for it. Stage 5 beads can be produced using either Chaîne. In fact, I show below that stage 5 beads are the results of both chaînes. The validity of using different stages as proxies for chaînes is shown below.

8.2.1.1. Comparison of chaîne and measurements

Chaîne I shell beads are smaller and more regular than Chaîne II shell beads. Six different measurements were attempted for all shell beads. Only Stages 4, 4.1, 4.2, and 5 beads have perforation measurements, because beads in stages 1 and 2 are not perforated and stage 3 beads are, by definition, only partially perforated (I did record a few stage three measurements, but these should not be seen as representative). Diameter and thickness measurements were recorded for beads that were less than 50% complete, but these probably represent only a minimum estimate of the true measurements, and therefore only beads that are more than 50% complete are used in the following analyses. Table 8-1 shows the number of measurements taken for all discoid shell beads that are more than 50% complete. Nearly all beads <50% complete have the first measurements for diameter and thickness, while the second measurements and the maximum perforation measurement are less frequent and the minimum perforation measurement is the least likely to have been successfully obtained (2867 of the total 6784 beads >50% complete or 42%). The relatively low numbers of beads in stages 0 and 1 mean that conclusions based upon the statistics of these are unreliable. Indeed, they shouldn't be reliable. Stage 0 represents beads that could not be identified as another stage. There is no reason why beads that were unidentifiable to stage should show any pattern. Stage 1 beads are extremely difficult to distinguish from shell debitage and suffer from severe under representation. Therefore, Stages 0 and 1 are excluded from the analyses below.

Since there are multiple types of shell beads, the initial analysis of these measurements must consider only those that are discoid (Table 8-1), which make up the vast majority of beads measured (96.8% of all beads). This analysis is followed by a brief analysis of other types of beads.

8.2.1.1.1. Diameter.

Diameter is the measurement most useful for distinguishing differences between chaîne I beads and Chaîne II beads. Table 8-2 reports frequency, mean, standard deviation, median and significant similarities. Similarities were identified via an ANOVA test and the Tukey HSD test, the Tamhane test, and the Mann-Whitney test as discussed above. The Kruskal-Wallis is unnecessary because the Mann-Whitney test is performed. For all of these tests, a significant level of α=.001 meant that the null hypothesis, that the distributions of measurements were different, was rejected. While the correct interpretation of $p<.001$ is that we cannot accept that the groups are different (but says nothing about their similarity), the interpretation that the groups are similar is tenable, especially since all three tests often agree.

The means for diameter measurements of stages 2, 3, and 4 (i.e., chaîne I) beads are much statistically smaller than those for beads in stages 4.1 and 4.2 (3.97mm, 4.11mm, 4.30mm, 9.44mm, 9.48mm, respectively; see Table 8-2 and Figure 8-1). Stage 5 beads fall in between but are statistically different than beads of any other stage (mean= 5.16mm). Medians follow the same pattern (and are probably better measures of central tendency because the data are non-normal), but tend to slightly lower than the mean. Since stage 5 beads can be produced using either Chaîne I or Chaîne II, it is not surprising that the mean of the diameter of these beads is intermediate. Both maximum and minimum diameter follow similar patterns (compare Table 8-2 and Table 8-3).

Significance tests support this separation into three groups. All three post-hoc tests of differences (Tukey, Tamhane, and Mann-Whitney; see Table 8-2 and Table 8-3) indicate that the mean diameters of chaîne I beads (represented by stages 2, 3, and 4) cannot be shown to be statistically different from each other. The mean diameter of chaîne II beads (stages 4.1 and 4.2) also cannot be shown to be different from each other. Stage 5 beads are different from beads in other stages. Note that the similarity between the mean diameter of beads in stages 4 and 2 is questionable (i.e., significant by Tukey and Tamhane tests, but not by Mann-Whitney), but their similarity to stage 3 beads is not. Surprisingly, the mean diameter of stage 2 beads is less than that of stage 4 beads. One would expect beads to remain approximately the same size as the main difference between these beads is that stage 4 beads are perforated. It is possible that smaller beads are breaking during perforation, and therefore make up more of the sample for stages 2 than for stage 4.

The two diameter measurements are essentially measurements of the same dimension, except for stage 4.1 and 4.2 beads. When taking the measurements, I tried to make one a maximum and the other the minimum, but this was successful for only these two stages. Figure 2-1 and Table 8-4 show the difference between the two measurements. Note that there is much overlap for mean and medians for stages 2-4 and 5, but little for stages 4.1 and 4.2. This probably indicates that the distribution for diameter measurements is closer to a normal distribution for stage 2-4 and 5 beads than for stage 4.1 and 4.2 beads.

For those beads that have both diameter measurements, we can compare the difference between those two measurements by stage (Figure 8-1 and Table 8-4). If we take the absolute value of the difference between the two diameter measurements, stage 2, 3, and 4 beads are not statistically different from each other (mean difference of 0.17 mm, 0.21mm, and 0.21mm, respectively). That is, all three post-hoc tests fail to indicate statistically significant differences. Note, however, that these distributions are definitely non-normal and, therefore, the Mann-Whitney test is the most appropriate for these data.

Stage 4.1 and 4.2 beads, the chaîne II beads, are different from all other stages, including each other. The difference between the two diameter measurements for stage 4.2 beads is much larger than the others (mean difference= 1.01mm). This is most likely because stage 4.2 beads are the only beads that have not been edge ground, which would grind down any projections thus greatly reducing the maximum measurement. Stage 4.1 beads have the next highest difference between the two measurements (mean difference= 0.62mm).

Stage 5 beads are the least variable (mean difference= 0.15 mm). The edge of any bead categorized as a stage 5 bead has been heavily edge-ground, while stage 4.1 have been lightly ground and 4.2 beads have not been edge ground. Beads are edge ground using a rotary motion where the perforation is the center resulting a fairly consistent diameter. Therefore, it is not surprising that the difference between the two measures is so small. It is actually surprising that the difference between the two diameter measurements for stage 2, 3, and 4 beads is close to that for stage 5 beads. The former have not been rotationally ground and still have edge facets. The low variability of the diameter of stage 2-4 beads is an indication of the care each chaîne I bead was afforded, even in the early stages of production.

Diameter measurements show that chaîne I beads (stages 2, 3, and 4) are smaller and more uniform in diameter than the larger, more variable Chaîne II beads. Stage 5 beads are in between in terms of the diameter measurements, but are even less variable than all other beads. This is an indication of the uniformity produced by rotational grinding and the care taken, even in the early stages (stages 2, 3, and 4) of bead production, to keep the beads regular.

8.2.1.1.2. Thickness

Thickness can also be used to identify different chaînes opératoires. Beads in stages 2, 3, and 4 are thinner than beads in stages 4.1 and 4.2, and stage 5 beads are in between. Statistically, the story is more complex for thickness than diameter. Maximum thickness and minimum thickness do not agree.

An analysis of both the maximum thickness measurement (Table 8-5), and the mean (and median) of the two thickness measurements (Table 8-7) indicates that the mean (and median) of the maximum and average thickness of beads in stages 2-4 are statistically similar to each other (mean of first measurement= 1.70mm, 1.75mm and 1.71mm, respectively), but different from other stages. The mean maximum thickness and average thickness of beads in stages 4.1 and 4.2 (2.79mm and 2.67mm, respectively) indicate a similar story except the Mann-Whitney test suggests that average thickness measurements were different for stages 4.1 and 4.2 (i.e., was not able to say they are similar). Stage 4.1 beads appear to be slightly thicker than stage 4.2 beads.

Once again, stage 5 beads fall in between. The mean maximum thickness of stage 5 beads (2.13mm) places it squarely between the Chaîne I beads and the Chaîne II beads. The average of the two thickness measurements also may indicate that stage 5 beads are similar to stage 4.2 beads. Tukey and Tamhane tests indicate that they are similar, but the Mann-Whitney indicates that they are different. Since the data are non-normal, the Mann-Whitney test is the most appropriate.

The most interesting comparison is the minimum thickness measurement, because it indicates all sorts of unexpected similarities (Table 8-6). This is due to the manner in which these beads were measured. The first measurement represents a maximum. For irregular beads (mostly Chaîne II beads) the entire bead was placed between the calipers and the thickness measured, even if this meant measuring the height of the arch on a curved bead (see Data Collection for discussion). The second measurement represents the minimum thickness of the bead measured where it is still whole from the edge to the middle. In other words, Chaîne II beads have a greater maximum thickness because they are more irregular (see below), but their minimum thickness is nearly the same as the more regular Chaîne I beads. This similarity in the minimum thickness is likely a result of using shell that was thick enough to make a solid bead, but thin enough to be easily drilled. Lithic microdrills may also contribute to the technical limitations of the thickness of shell beads. Cylindrical beads (see below), which are thicker, were fabricated, but only in certain locations and in very limited quantities. This may mean that these beads were more difficult to make and only a certain segment of society fabricated them.

As with diameter, we can compare the absolute value of the difference between the two thickness measurements (Table 8-8). It is clear that the difference between the two thickness measurements is the lowest for beads in stages 2, 3, 4, and 5 (mean= 0.11 mm, 0.15 mm, 0.19 mm, and 0.24mm, respectively), while it is much greater for beads in stages 4.1 and 4.2 (mean = 0.86 mm and 0.85 mm, respectively). The data in this case are highly left skewed (to the point that they are Poisson distributions) and, therefore, the median is probably a better measure of central tendency. The median, however, shows the same exact pattern as the mean.

The Mann-Whitney test, which is the most appropriate for non-normally distributed data, finds that beads in stages 4.1 and 4.2 are statistically different, however. It should be noted that the differences between medians are much greater than the difference between the means. The thickness of stage 4.2 beads, therefore, is a little less variable than for stage 4.1 beads. I don't think we should put much weight on this difference, since the difference between the means is 0.01 mm and between medians is 0.08 mm. The difference between the two thickness measurements of stage 4.1 and stage 4.2 beads, however, is much greater than that for beads in the other stages.

In terms of the difference between the two thickness measurements, stage 5 beads are statistically different than all other beads. It is surprising that the variability in thickness is greater for stage 5 beads than for stage 2-4 beads since diameter was less variable. The diameter was less variable, however, because of rotational grinding. Although the faces of stage 5 beads were also ground, because the two faces are ground separately, we would not expect the consistency of rotational grinding. Stage 4.1 and 4.2 beads were not face ground at all. Stage 5 beads are a mixture of stage 4 beads that have been rotationally ground and stage 4.1 beads that have been face ground. Because stage 5 beads are a mixture of chaîne I and chaîne II, the variability of thickness also lies in between.

Thickness measurements reinforce the distinction between Chaîne I and II beads. Chaîne I beads (stages 2-4) are thinner and less variable than Chaîne II beads (stages 4.1 and 4.2). Both groups are internally and statistically similar. Stage 5 beads, since they are a mixture of the two chaînes, are intermediate in size. The minimum thickness of beads was similar across the two chaînes, perhaps reflecting a cultural preference or a physical limit.

8.2.1.1.3. Perforation measurements.

The dimensions of the perforations in the shell beads also indicate differences between beads made using chaîne I and II. Perforation measurements are only relevant for stages 4, 4.1, 4.2, and 5; beads in stages 1-3 have not been perforated or, in the case of stage 3 beads, were not completely perforated. Stage 4 beads have smaller maximum perforations than stage 4.1 and 4.2 beads. Stage 5 beads are in between stage 4 and stage 4.1 and 4.2 beads, because they can be produce using either Chaîne I or Chaîne II.

For both maximum and minimum perforation measurements, the only statistical similarity is between stage 4.1 and 4.2 beads (mean maximum perforation= 2.52mm and 2.49mm, respectively and mean minimum perforation= 1.85mm and 1.73mm; see Table 8-9 and Table 8-10). Stage 5 beads have smaller perforation dimensions (mean maximum= 1.80mm and mean minimum= 1.35mm) than these two stages, while stage 4 perforation dimensions are even smaller (mean maximum= 1.57mm and mean minimum= 1.08mm).

As with the diameter and thickness measurements, we can compare the two perforation measurements (Table 8-11). If the absolute value of the difference between the two perforation measurements is taken, the difference for Chaîne I beads (stage 4 beads) is statistically less than for Chaîne 2 beads (stage 4.1 and 4.2 beads). If the same type and size of drills were being used to perforate both types of beads, one would expect the same size perforation since their minimum thickness is not very different. This suggests that the Chaîne II beads may not have been perforated with the same type of drill as the Chaîne I beads. A relative lack of lithic drills from contexts with Chaîne II beads may suggest a perishable drill. An alternative explanation would be that many of the Chaîne II beads were drilled from one side. This would make the maximum perforation diameter larger because the drill would have to penetrate deeper into the shell. I observed many uniconically perforated beads, but did not record this trait for each bead because the direction of the perforation was difficult to identify for the majority of the beads. However, there were very few Chaîne I beads that were drilled from only one side.

The difference between maximum and minimum perforation measurements for stage 5 beads is statistically less than stage 4.1 and 4.2 beads and, surprisingly, less than stage 4 beads as well. Stage 5 beads do not fall in between the beads from the two different chaînes as one might expect. This is tentative evidence that the interior of the perforation of stage 4 beads had not been worn, but that it had in stage 5 beads. When a bead is drilled from both sides, the perforation is biconical in cross-section, meaning that there is a difference between the maximum measurement, taken at the 'base' of one of the cones, and minimum one, taken at the top of the cone, i.e. the middle of the bead. When the beads are strung on natural fibers, which, due to their silica content, are always a little abrasive, the first part of the perforation that is worn is the middle of the two cones. This effectively reduces the difference between the minimum and maximum diameters of the perforation.

8.2.1.1.4. Cylindrical beads

The only other type of bead that has a sample size large enough to analyze is cylindrical beads (Table 7-7). All but two of the cylindrical beads are in stages 2 (n=21), 3 (n=16), 4 (n=7), and 5 (n=100). Since none of the cylindrical beads were recovered in stages 4.1 or 4.2 they were most likely fashioned using the chaîne I technique. Cylindrical beads follow the same basic pattern as chaîne I discoid beads, except that they are thicker (Table 8-12). Although sample sizes are small, it is surprising that statistical differences are found for the thickness measurements between discoid and cylindrical beads. When comparing the thickness of complete discoid shell beads and complete cylindrical shell beads we can only compare stages 2, 3, and 4, because stage 5 beads may include chaîne II beads. This is why, for stage 5 beads, produced using chaîne I, the mean diameters (maximum and minimum) of cylindrical beads are statistically less than those for discoid beads (Table 8-12). The mean thickness of a cylindrical bead is 5.52 ± 1.92 mm (5.37 ± 1.95 mm, if stage 5 beads are included) while the mean thickness of chaîne I discoid beads (stages 2, 3, and 4) is 1.68 ± .62 mm. This difference is statistically significant at α=.001 if stage 5 beads are not included. It comes as no surprise that cylindrical beads are statistically thicker than discoid beads.

Cylindrical beads were produced using chaîne I. Evidence for this includes the extremely low frequency of cylindrical beads in stages 4.1 and 4.2 and a diameter statistically equal to stage 2-4 beads, but less than stage 5 beads, which include the larger chaîne II beads.

8.2.1.1.5. Comparison of chaîne and measurements conclusion

It is clear that stage 2, 3, and 4 beads, in other words beads made using chaîne I, are smaller and less variable than stage 4.1 and 4.2 beads, (i.e., chaîne II beads) while stage 5 beads often fall in between (see summary in Table 8-13 and Figure 8-2). Stage 5 beads, because they have been edge and face ground more than other beads, are overall less variable than stage 4.1 and 4.2 beads in thickness and diameter and less variable than stage 2-4 beads in diameter. Chaîne II beads are much larger, though thicker only in the maximum dimension, and more variable both as a sample (standard deviations are larger) and as individual beads (differences between measurements are larger). Stage 5 beads, which are a mixture of both chaîne I and chaîne II beads normally end up in between, often leaning towards stage 2, 3, and 4 beads because even when made using chaîne II, they are modified more similarly to stage 2, 3, and 4 beads than to stage 4.1 and 4.2 beads. Especially important for stage 5 beads is that, whether made using chaîne I or chaîne II, these beads have been rotationally edge ground and probably were worn resulting in an overall less variable bead. The dimensions and the difference between the perforation measurements indicate that the drilling process is different for chaîne II beads than for chaîne I beads. Cylindrical beads are thicker than discoid beads and were produced using chaîne I.

8.2.1.2.Comparison of chaîne and fragmentation

The above analysis of bead measurements and production stage only addresses beads that are more than 50% complete. This brings up the question of whether or not fragmentation may be patterned by production stage. A comparison of the stage of production and fragmentation of shell beads once again distinguishes the two production sequences from each other. Chaîne I beads are much more fragmented than Chaîne II beads. For the analysis of fragmentation by stage, all shell beads in stages 2-5 can be included because measurements are not used.

A cross tabulation and chi-square analysis indicates many significant differences when comparing stage of production and fragmentation (Table 8-14 and Figure 8-3). Since φ=.569, we can say that approximately 32.4% (0.569^2*100) of the variation in one variable is explained by the variation in the other. This indicates a fairly robust relationship between fragmentation and production stage.

The data for this analysis are summarized in a cross tabulation in Table 8-14. A cross-tabulation analysis shows the frequency for each cell, which is a combination of degree of fragmentation and stage of production, the expected frequency and the standardized residuals. Expected frequency for any cell is based upon the cumulative row and column ratios. For example, the expected frequency of stage 2 beads that are less than 50% complete is 69.4 which is equal to the proportion of the total in that row multiplied by the total of the column (i.e., (808/7651)*657). The residual is a measure of how far the actual is from the expected. A residual with a magnitude less than 3.4 indicates that the difference between the expected and the actual is random. Any residual whose magnitude is greater than 3.4 indicates a cell where the actual frequency is statistically different than the expected value (i.e., the difference is non-random). The sign indicates whether the actual is lower (negative) or higher (positive) than the expected.

The greatest amount of fragmentation is in stages 3 and 4 (Table 8-14); of the 1927 beads that are broken 986 (51.2%) are from these stages. Most of the stage 3 beads (463/524 or 88.4%) and stage 4 beads (523/722 or 72.4%) recovered are fragmented. The majority of the remaining beads were broken in stages 2 (148/1927 or 7.7%) or stage 5 (699/1927 or 36.3%). Although a large number of stage 5 beads were broken, only 18.9% (699/3704) of all stage 5 beads are broken. Since stages 3 and 4 represent the drilling process, drilling is clearly correlated with breakage. This makes sense as the drilling process is the most risky technique used to make shell beads.

On the other hand, it is amazing how few stage 4.1 and 4.2 beads, which have all been drilled, are broken (5.52% and 4.39%, respectively, of all beads in the stage). Since much of the breakage for chaîne I beads occurs during the perforation process, we may not have evidence for the perforation of chaîne II beads; they may have been perforated elsewhere. The chaîne II production sequence, however, is fairly expedient and does not require a great deal of effort or tools. The only part of the chaîne II sequence that is not quickly done is the drilling. It is possible that artisans used an organic drill, such as a cactus spine, and perhaps an abrasive to perforate the shell, though I was not able to identify such differences under the microscope. If this is the case, very few of the beads were broken in the drilling process. The relatively limited amount fragmentation may have been one of the more valuable aspects of chaîne II beads: both makers and users of the beads did not have to worry about breaking them.

Beads in stages 2 and 5 have similar degrees of fragmentation: both have approximately 81% complete and 19% fragmented (Figure 8-3). This suggests that beads in these stages are more likely to break than those in stages 4.1 and 4.2, but much less likely to break than those in stages 3 and 4. Stage 2 beads are less likely to break because they have not been perforated. There is some danger of breaking in the process of grinding (i.e., stage 1 to stage 2), but much less than during perforation. The final rotary grinding and polishing (i.e., going from stage 4 to 5) is not very dangerous, especially considering that, if stage 5 beads were worn, there should be a background of stage 5 beads that were broken through use. Chaîne I beads in stage 5 would have been smaller, with less shell between the perforation and the edge than chaîne II beads, making the former more likely to break during use. The breakage pattern for stage 5, therefore, may simply be one of breakage during usage. Since the breakage pattern of stage 5 beads matches the breakage pattern of stage 2 beads, this probably represents a background pattern; i.e., approximately 20% of all chaîne I beads will break. Chaîne II beads appear to be more resistant.

The perforation process is when most beads are broken. Chaîne II beads appear to be more durable than chaîne I beads. It seems that smaller stage 5 beads were probably broken more often than larger stage 5 beads, reflecting how little breakage there is for chaîne II beads.

8.2.1.3. Comparison of chaîne and color

The two chaînes opératoires were used to modify shell of different colors, indicating that they were used on different types of shellfish. Because of the difficulty of identifying the colors of beads (they often grade from one color to another), every color was identified on each bead and then placed into four categories; Dark, Dark/Light, Light, Red, Orange, and Purple (ROP), Light/ROP, Green, Other, and Unidentifiable. A single bead could fall under more than one category. For example, a bead might contain red and white and would be coded for both colors and counted in the combined category (i.e., Light/ROP). Beads were coded in this way because there was no objective way to code a bead as a single color because that would require subjective judgment about which color was more important. Were the artisans trying to make a white bead and it accidentally had some red? Or were they trying to make a red bead and got some white in it? I find it more aesthetically pleasing to have both colors in a single bead; but was this their goal? This way, all colors were recorded without making a judgment about which was more important. In order to reflect this overlap color groups were create: for example ROP/Light, includes beads that contained colors in both ROP and Light categories.

A cross tabs analysis of shell beads indicates that stage of production and color are not independent from each other (Table 8-15; see also Figure 8-4). This analysis was done two ways. First, all categories for both variables were included, but since many of the cells returned results of 0, the analysis was then run including only those categories that would not yield cells with zeroes. This analysis involved all stage categories except 0, the unknown, and 1, which has sample issues, and four color categories (Light, ROP, Dark, and ROP/Light). Interestingly, the results were nearly identical for the two analyses. The results of Cramer's φ test are .494 for the test that included everything and .472 for the more limited test. This indicates that stage and color are moderately dependent: between 22 and 24% of the variation in one is explained by the variation in the other.

Beads made using chaîne I (represented by beads in stages 2, 3, and 4) are much more likely to be red, orange, and/or purple than beads made using chaîne II (represented by beads in stages 4.1 and 4.2). Beads in stages 2, 3, and 4 had some red, orange, or purple on them (47.7%, 75.8%, and 60.8% of the total beads in each stage, respectively). Red, orange and/or purple occurred on only 8.2% and 13.6%, respectively, of stage 4.1 and 4.2 beads. Red, orange, and/or purple is present on 29.8% of the beads in stage 5, but this is not significantly different. This is probably due to its clearly intermediate position between chaîne I and chaîne II beads. Nearly half (43.7%) of all beads that contained some red were finished stage 5 beads.

While it is difficult to say that any one bead was made from Spondylus, the presence of so many red, orange, and purple beads, the main source of which is probably Spondylus, does indicate its use. Spondylus has a particular texture; the colored pieces (red, orange, purple, and some yellow) tend to be from the outer part of the shell called the prismatic layer (Claassen 1998) and it has more of a grain than the inner homogenous layer. This means that beads fabricated from the colored layer of Spondylus are more difficult to work with than white beads made from the homogenous layer of Spondylus and/or other shells. Though I have not developed an objective technique for identifying Spondylus v. other shells with similar colors, I believe, based upon my own experience, that many of the stage 4.1 and 4.2 beads that had some red were not Spondylus, while many of those from stage 2, 3, and 4 beads were Spondylus.

Although there are statistically significant differences for white beads across the sites, relatively little can be said about the Light beads because practically all shells have some white, meaning that a white bead can be made from nearly any species, including Spondylus.

Beads in stage 4.1, 4.2, and 5 were more often dark than those in other stages: 5.8% 9.0%, and 4.6% of the beads in each stage, respectively, although the difference is only statistically significant for Stage 4.2 beads. Nearly all of the Dark, Dark/Light and ROP/Dark beads are from these three stages (286/290 or 98.6%). This darkness appears to be a result of contact with heat or, perhaps simply with ashes. As such, it seems justifiable to interpret this as evidence that these beads were used and/or purposefully burnt. If they were worn while people went about their daily activities, there would have been greater chance for these beads to fall into the fire, or perhaps more likely fall onto the ground and be swept into the fire or midden, which was then burned.

Most of the shell beads recovered from the six archaeological sites are Light colored, which includes white, tan, and yellow (62%). Chaîne I beads were more often red, orange or purple, indicating that this was the preferred method to modify Spondylus shells. Beads in stages 4.1, 4.2, and 5 tend to be dark more often than Chaîne I beads, possibly due to their use.

8.2.1.4. Summary of chaîne analysis

It is clear that shell beads fashioned using the process of chaîne I are significantly different than those made using chaîne II in a number of ways. They are smaller in diameter and maximum thickness, but similar in minimum thickness. Chaîne I beads also tend to be less variable, both as a group and as individual beads, than the larger chaîne II beads. Chaîne I beads also tend to have some red, orange, or purple on them more often than chaîne II beads, which tend to have dark colors more often. The higher presence of red, orange and purple in chaîne I may indicate that more Spondylus was used for chaîne I beads. Chaîne I beads tend to fragment during the perforation process (i.e., stages 3 and 4).

Stage 5 beads tend to be somewhere in between these two groups, which makes sense because stage 5 beads could be produced using either chaîne I or II. The only exception to their middle position is that the thickness of stage 5 beads is less variable than all other stages. Stage 5 beads also tend to fragment only rarely and are often ROP beads. These ROP beads may represent chaîne I beads that are included in the stage 5 sample.

8.2.2. Fragmentation

Fragmentation can occur during manufacture, use or post-deposition processes. Once beads have been made, they are fairly durable, as indicated by the relatively low breakage rate for beads in stage 4.1, 4.2 and 5, especially the former two. But, do smaller beads break more often? Do different color beads break more often? Is there evidence for breakage due to taphonomic processes?

8.2.2.1.Comparison of fragmentation and measurements.

Smaller beads break more often. When the degree of fragmentation is compared to the various measurements, a complex picture resolves. First, when performing the comparison, we cannot compare all shell beads. Since it is clear, from above, that chaîne does make a difference in how fragmented a bead may be we will only include stage 5 beads because these beads probably were not broken in production. In order to compare measurements, we must again limit the analysis to only discoid beads. We must also ignore all beads that are <50%, because if they are less than 50% complete then the dimensions may not represent the true size of the bead. With all of these beads excluded, there are still 3348 beads (>50% complete, discoid, stage 5 shell beads) to analyze. If this database was much smaller, then comparisons where many beads must be excluded would be very difficult to be statistically valid. Tests were run using ANOVA (post-hoc tests not needed because there are only two groups, 100% and 50-99%) and the nonparametric Mann-Whitney test. Results from the two tests were nearly identical (Table 8-16).

Even when limited to stage 5 beads, this analysis indicates that broken beads tend to have smaller first diameter and thickness measurements. Small sample size for the second diameter measurement for 50-99% broken beads, and subsequently for the average of the two measures, is fairly low at 55 (though large enough to be statistically representative, i.e., >30). The maximum thickness measurement is also statistically smaller for broken beads than completely whole beads. Since most beads have a similar second (minimum) measurement, it is not surprising that there is no statistical difference in this measure between complete and 50-99% fragmented beads. Indeed, it is even surprising that p is so low (though not less than .001). The maximum perforation measurement shows no statistical difference between complete and 50-99% fragmented beads (though, again p is quite low). This is surprising considering that both thickness and diameter appear to be statistically different.

The minimum perforation is statistically smaller for 50-99% fragmented beads than complete beads. This may mean that beads that have been worn (enough to cause the perforation to be abraded by the fibers on which they are strung) and increased the size of the perforation. In other words, if a finished bead is going to break when worn, it will do so before it has been worn much. After a bead has been worn for an unknown period of time, the minimum perforation measurement will increase. The measurements are fairly close, however, and this may be a reflection of the difference in maximum perforation between fragmented and whole beads. It may also indicate that different materials were used for larger versus smaller beads; the material used for the latter was a little more unstable. Even though the difference in maximum perforation is not statistically significant it is greater than the difference between the two categories for minimum perforation. In other words, the difference in maximum perforation should probably also be considered statistically significant.

Broken beads tend to have smaller diameters, are less thick, and have smaller minimum perforation measurements than whole beads. Small beads, even finished ones, break more easily.

8.2.2.2. Comparison of fragmentation and color.

Beads of different colors may break more or less easily because they are usually from different mollusk species with different shell structures. A cross tabulation analysis (Table 8-17) indicates that the two variables are not independent and that significant differences occur for Dark, Light, and ROP beads. The analysis was run two ways; first it included all categories, except the unknown categories, and second it included only Light, ROP/Light, Dark, and ROP beads in order to eliminate cells with zeros (Table 8-17 and Figure 8-5). However, the results of the two tests were nearly identical, except that the first test also identified significant differences for Dark beads as well. Cramer's φ is .45 for both analyses, indicating a moderately robust dependence of variables; approximately 20% of the variation in one variable is explained by the other.

Dark beads are less fragmented than both Light and ROP beads. This may indicate the loss of beads during daily activities and the subsequent burning (or exposure to carbon rich soils) of the beads. It is surprising that beads that have been exposed to heat are not more easily broken.

Shell beads are more likely to break if they are ROP beads (1246 out of 2262 or 55%) than if they are Light (600 out of 4711 or 12.7%) or Dark (18 out of 249 or 7.2%). Why is this? If we look at all shell beads in stages 3 and 4 (Figure 8-5), when the beads are being perforated, the Red, Orange and Purple beads are more likely to break (677 out of 798 or 84.8% were broken) than Light colored beads (276 out of 392 or 70.5%). Most of the light beads made it past the drilling process, as indicated by the higher percent of beads in these two stages that are 100% complete and, more importantly, by the large majority of beads that are light colored in stage 5. This is more evidence that the drilling process is especially dangerous for Red, Orange, and Purple (read, Spondylus) shell beads than it is for light colored beads.

Overall, beads that are red, orange, and/or purple are more likely to be broken than other beads. This is especially true for stages 3 and 4, which represent the drilling of the beads. This is the riskiest point of the manufacturing process and the fact that ROP beads break more often during this process indicates that Spondylus shell is more likely to fragment when drilled than other types of shell. It is likely that the fragmentation is due to a variety of factors, including size, color and stage of production.

8.2.3. Color

The relationships between color and fragmentation and stage have already been analyzed. Beads that have some red, orange, and/or purple tend to be more fragmented and were recovered mostly from stages 2, 3, 4 and 5 suggesting that shells of this color (mainly Spondylus?) are used mainly for chaîne I beads. We do not yet have a good understanding, however, of the relationship between color and size. One would predict, however, that since chaîne I beads are smaller and also tend to be ROP more often, then ROP beads should also be smaller.

8.2.3.1. Comparison of color and measurements

Beads of different colors tend to be different sizes. ROP beads are smaller in all dimensions than all other beads.

ROP beads (ones that contain red, orange, and/or purple) are significantly smaller than all the other beads. They are smaller in terms of all diameter, thickness, and perforation measurements, as well as combinations thereof (Table 8-18 and Table 8-19). Table 8-19 shows that the means of measurements of ROP beads are statistically different (by Tukey, Tamhane, and Mann-Whitney tests) than all other beads, while Light, Dark and ROP/Light beads are similar in various dimensions. This is an indication that shells with red, orange, and/or purple were the preferred material for the smallest beads. These were probably made from Spondylus shells. The size of these beads may be related to the type of shell used. It is often difficult to find a piece of *S. calcifer* that is not pocked with epibionts. *S. princeps* does not suffer from this problem as most of the epibionts are non-invasive, but *S. princeps* shells tend to be smaller and thinner making it difficult to find many large piece of shell worth working. Of course, larger pieces were used to make larger objects (see below), but perhaps it was easier to make small beads rather than large beads from the red, orange, or purple layers.

The other three color groups of beads tend to be similar to each other. The ROP/Light beads tend to be larger than the rest, indicating that the red, orange, and/or purple in the bead may not be due to Spondylus use, but to the use of other shell fish which have only streaks of these colors. Dark beads tend to be in the middle and Light beads tend to be smaller than ROP/Light and Dark beads, but often are statistically similar to the later, but not the former. Dark beads may represent use through the presence of some sort of burning or exposure to highly carbonaceous materials. Therefore, it appears that larger beads (i.e., the ones made using chaîne II) were used by the Manteño population more than smaller ROP beads, but to a statistically similar degree to ROP/Light and Light beads. Light beads are probably statistically smaller than ROP/Light beads because they are a mixture of chaîne I and chaîne II beads.

8.2.4. Shell bead analysis as a single group summary

From this analysis, it is very clear that there some very distinct differences in the shell beads from the six Manteño archeological sites. The two distinct chaînes opératoires produce two different kinds of beads.

Chaîne I beads (stage 2, 3, and 4 beads) are smaller in diameter and in the size of the perforation than chaîne II beads (stages 4.1 and 4.2). Chaîne I beads have a smaller maximum thickness measurement than chaîne II beads, but statistically similar by the minimum thickness measurement. Chaîne I beads are also less variable, in terms of each bead and the collection in general. The means of measurements of stage 5 beads tend to fall between the means of chaîne I and chaîne II beads, because they can be made using either method. However, because they have been both edge and face ground, the difference between the two thickness measurements is less for stage 5 beads than all other stages.

Chaîne I beads are made in two distinct types, discoid and cylindrical. Cylindrical beads are similar to discoid beads except they are much thicker. Chaîne I beads tend to break during production, especially during stages 3 and 4, which involve the perforation of the bead. Relatively few of the stage 4.1, 4.2 and 5 beads are broken, probably indicating that these beads survived the production process and were lost, but remained mostly unbroken during use. Chaîne I beads also tend to have some red, orange, and/or purple on the beads than Chaîne II beads. I believe that Chaîne I employed Spondylus beads more often than Chaîne II. Color and fragmentation are also related: beads with red, orange, and/or purple tend to break more easily. There is also a strong relationship between the size of the beads and their propensity to break. Small beads, which also tend to be ROP beads, are likely to break more often than large beads.

8.3. Analysis of shell beads by site

The above essentially proves that chaîne I and chaîne II beads are in fact different. Once this has been established, however, it is more important to understand the variation present between sites. The shell bead assemblages from the six archaeological sites are very different. Artisans at López Viejo and Loma de los Cangrejitos produced mainly chaîne I beads and people at Puerto de Chanduy and Los Frailes seem to have been mainly consumers of chaîne I beads. Chaîne II beads were mainly produced, or possibly only consumed, at Mar Bravo and Salango.

8.3.1. Comparison of site and chaîne

The most obvious difference between the six sites is the presence of different beads in different stages of production at the various sites. Only stages 0 (i.e., unknown) and 1 (see above), which suffer from small sample size and questionable relevance, are excluded from this analysis. Table 8-20 and Figure 8-6 indicate that beads in stages 2, 3, and 4 (i.e., the chaîne I beads) are most prevalent at López Viejo and Loma de los Cangrejitos where there are no or very few stage 4.1 and 4.2 beads. The opposite is true for Salango and Mar Bravo, where most of the beads recovered were in stages 4.1 and 4.2 and relatively few beads in stages 2, 3, and 4 were recovered. The large majority of beads at both Los Frailes and Puerto de Chanduy are in stage 5, indicating that there was little or no production occurring at these sites. This is supported by the lithic drill data (see below). In terms of the presence of beads in different stages of production, the sites are very different. Many of the standardized residuals have a magnitude greater than 10 when, to be statistically significant, they need only be greater than 3.4. Indeed, φ is equal to .843, which means that approximately 71% ($.843^2$*100%) of the variation in one of the variables is due to variation in the other.

A subsequent cross tabulation and chi square analysis between sites that appear similar (i.e., between Loma de los Cangrejitos and López Viejo, Los Frailes and Puerto de Chanduy, and Mar Bravo and Salango; Table 8-21 to Table 8-23) indicates that they are all significantly different ($p<.001$) from each other. However, the phis are relatively low (φ= .143, .234, and .331, respectively). Even the largest phi indicates that the sites explain 11% of the variation in stage and only a few of the standardized residuals are greater than 3.4. This signifies greater similarity between the sites within these three groups than between the groups.

The differences between the sites do not appear to follow a distinct pattern. Of the recovered beads from Loma de los Cangrejitos, there are more stage 4 (ê= 7.1) and less stage 5 (ê= -5.9) beads than expected when compared to López Viejo. The number of beads in stages 2 and 3 from both sites were statistically similar (Table 8-21). Therefore, a greater proportion of the beads recovered from Loma de los Cangrejitos were discarded or lost in stage 4 than at López Viejo. Loma de los Cangrejitos had less stage 5 beads than López Viejo, which may indicate a slightly higher likelihood of retaining finished beads at López Viejo, perhaps because some of the contexts were burials. Were people buried with their shell bead necklaces? The contexts excavated at López Viejo were ones in which stage 5 beads would have been preferentially placed.

More of the recovered beads from Los Frailes were in stage 2 (ê= 6.2) than expected when compared to Puerto de Chanduy (Table 8-22). The numbers are very small (n=8), however, and this probably does not represent a true statistical difference and certainly, considering the nature of archaeological assemblages, we shouldn't make much of this.

A comparison between Mar Bravo and Salango reveals that fewer stage 4.1 (ê=-18.3) and more stage 5 (ê =16.8) beads were recovered from Mar Bravo than from Salango (Table 8-23). The adjusted residuals are quite large, so the difference is probably both statistically and truly significant. If we assume that beads in stages 4.1, 4.2 and 5 were all 'finished' artifacts and were worn in that stage, then this would indicate a preference at Mar Bravo for beads that had been not only rotationally edge ground, as had both stage 4.1 and 5 beads, but face ground as well. Alternatively, if stage 4.1 beads are 'in-process' beads that still need to be face ground before they are 'finished', then there are more unfinished beads from Salango. However, since there is relatively little evidence for the manufacture of shell beads at either of these sites (i.e., there are very few lithic microdrills; see below), the first alternative seems the most likely. It must be remembered, however, that the similarities between the two sites are much greater than the differences.

Stage 5 beads comprise a fairly large proportion of beads at all of the sites, ranging from 28% to 88%. At Puerto de Chanduy and Los Frailes, nearly all of the beads recovered are in stage 5 (88.5% and 81.4%). This is an indication of limited or nonexistent shell bead production. Of course, we should not see lack of evidence of production as lack of production, but it is clear that, from the contexts excavated, there is little evidence of production. Since the beads from Los Frailes and Puerto de Chanduy tend to be on the smaller side (see below), most of the beads from these sites were probably produced via chaîne I.

The shell bead assemblages from the six sites fall into three groups. At López Viejo and Loma de los Cangrejitos chaîne I beads were produced. At Puerto de Chanduy and Los Frailes, shell beads (mainly stage 5) were consumed, but it is not clear if they were they produced using chaîne I or II? Their size can indicate which chaîne was used. There also appears to be a lack of definitive evidence for any shell bead production at Mar Bravo, Salango, Puerto de Chanduy, and Los Frailes.

8.3.2. Comparison of site, chaîne, and measurements

It is fairly clear that chaîne I beads are smaller and less variable than chaîne II beads. It is also clear that chaîne I beads were produced at Loma de los Cangrejitos and López Viejo. Evidence for production of chaîne II beads is lacking, however, as we don't know whether stage 4.1 or 4.2 beads were 'in process' of becoming stage 5 beads, or if they were worn 'as is'. In order to better understand the relationship between sites and chaînes, we must look at the dimensions of the different stages by site. The good news is that when we do this, the distribution of the data are much closer to normal and parametric tests can be used. Parametric tests are much more powerful at detecting true differences. This is more important as the data are broken up into groups with smaller sample sizes. Smaller sample sizes make it more difficult to identify differences especially for nonparametric tests which are less powerful than parametric tests. The data up to this point have been used essentially as one large group, often broken into a couple of subgroups with large sample size. These larger groups are most often non-normal mainly because too much data are lumped together; e.g., beads from all sites probably should not be lumped together, except to prove that the beads produced using the two chaînes are different from each other. Once the data are broken up into groups by site and stage they are more often normally distributed. With a few justifiable modifications, almost all of the data in the site and stage groups are also normal.

We care if the distributions are normal for more than testing reasons, however. Considering the discussion in the theoretical section, a single ‘community of practice’ should make beads that are similar. The idea is that members of this community have the similar, but not the same, conceptions about how to make beads. This will result in a distribution for a large group of beads that may be normal (or log-normal; see below). The measure of central tendency (mean or geometric mean [or median] in this case) indicates the community ideal or structure, and the measure of dispersion (standard deviation or geometric standard deviation; see below) indicates how acceptable variation may be.

8.3.2.1.Is it normal?

Much of the analysis above is dependent upon the recognition that the data are not normally distributed and, because of this, mainly nonparametric analyses are used. However, if we examine the data when divided up into groups by site and stage, it is clear that, with a few justified adjustments, the data are normally distributed. Normally distributed data are important because even simple statistics, such as the mean, are based upon the assumption of a normal distribution. The mean is supposed to show one the point around which the data are distributed, but if the distribution is non-normal, then the mean is not a good measure of central tendency. Often, researchers simply produce the mean without examining the underlying distribution, but it is often not the best measure of central tendency. Standard deviations also make no sense for non-normal data. For example, with non-normal data, including some of that discussed above have standard deviations where one or two standard deviations below the mean is negative even though not a single data point is negative. Normality becomes even more important when we want to do a statistical test, for example ANOVA, which tests for statistical differences in means.

Once we have divided into groups by site and stage, then we can perform the Shapiro-Wilk normality test on each measurement of discoid shell beads that are greater than 50% complete, and as a result we see that many of the distributions produced are normal (Table 8-24 to Table 8-29 and summarized in Table 8-32). In statistical terms, a significant result for a Shapiro-Wilk test means that when $p<.001$ we can reject the null hypothesis that the curves are non-normal. This test does not say that the curve is normal, but it does suggest that the distributions are close enough for robust statistical analyses, such as ANOVA.

Many of the distributions can be considered normal. Table 8-24 to Table 8-29 present the results of the Shapiro-Wilk test for each measurement. All of the measurements from Loma de los Cangrejitos are normally distributed when they are divided up by stage, with the exception of both thickness measurements for stage 2 beads. Stage 4.2 beads are normally distributed for diameter and perforation measurements, but not for thickness measurements. For the perforation measurements, it is more common for the distributions by site and stage to be normal.

8.3.2.1.1. Is it log-normal?

Although many of the measurement distributions by site and stage are normal, some of them also are not. If we examine the histograms produced, many of them are skewed to the right. For example, Figure 8-7 shows the skewed distribution of maximum thickness measurements for stage 2 beads from Loma de los Cangrejitos. Left skew occurs when the peak of the distribution curve is near a lower limit to the measurement, but an upper limit is lacking. For example, in the distribution on the left-hand side of Figure 8-7, it appears that at a little less than one millimeter the frequency of bead thickness at López Viejo drops significantly. This lower limit may be due to the limits of the raw material, the tools used and/or the skills and goals of the artisans. We are, after all, talking about a single millimeter. Most of the data are distributed not far above this lower limit while a few thicker beads stretch the tail of the distribution to the right. These data are obviously non-normal when compared to the normal curve (this is drawn based upon the calculated mean and standard deviation). Note that the left tail probably goes negative, but a negative bead thickness is nonsensical. This distribution, therefore, is problematic for parametric analyses, such as ANOVA. The data can be transformed in order to be normal, however.

This type of distribution, skewed to the left with a long tail to the right, is what is known as a lognormal distribution, which is defined as a distribution that is normal if the log (usually the natural log, but the base does not matter) of each data point is taken. This type of distribution is extremely common. For example, this is how household income is often distributed, with many of us near the lower end and the Bill Gates and Warren Buffets way to the right. It is also extremely common in science; including chemistry, biology, environmental science, economics, and many other fields (e.g., Limpert et al. 2001). Lognormal data are very common, but in order to run standard tests, we must transform the data and then run tests. Such transformation is acceptable because it is simply seeing a pattern for what it is and modifying it in order to perform tests. The resultant statistics are highly informative. For data that is lognormally distributed, we can transform the data by taking the log of each point and running the desired parametric test, which is much more powerful than the nonparametric equivalent.

Summary statistics of log-transformed data can be highly informative. Transformation of data should be avoided when possible because data information is lost in the transformation. For example, I know what a diameter is, but find it is difficult to talk about the logarithm of diameter. Log-transformed data by itself has little use, but summary statistics of log-transformed data provide useful and interpretable information.

Log-transformation gives us a couple of important pieces of information (Table 8-30 to Table 8-31). For a lognormal distribution, the back-transformed mean of the transformed distribution (called the geometric mean) should be approximately the same as the median of the untransformed data (if the distribution is truly lognormal) and, therefore, is a better indication of central tendency than the mean for such a distribution. For the maximum thickness of stage 2 shell beads from López Viejo, the arithmetic mean is 1.68, and the arithmetic mean of the log-transformed data (Figure 8-7b) is 0.4619. If we back-transform this by exponentiating (i.e., $e^{0.4619}$) we get 1.59. The median of the untransformed data are 1.58. In the case of lognormally distributed data, because it matches the median closely (as the mean does in normally distributed data), the geometric mean is a better descriptor of central tendency. Since the data are heavily skewed in its untransformed state giving those high values more influence than any one lower value, transforming the data gives each point equal weight and a more accurate indication of the center of the data. If the geometric mean is a better indicator of central tendency, then the log-transformed data can then be used as the non-transformed data would normally.

The geometric standard deviation also provides more information for a lognormal distribution than does the standard deviation, which is often reported. The geometric standard deviation, like the geometric mean, is the back-transformed (i.e., exponentiated) standard deviation from the log-transformed distribution. The standard deviation for the log-transformed data in Figure 8-7 is 0.33398, therefore the geometric standard deviation is 1.40 ($e^{0.33398}$). The geometric standard deviation describes the percentage of data a certain distance from the geometric mean (or the median). However, because it is the geometric standard deviation, not the arithmetic standard deviation, this area is indicated by multiplying or dividing the geometric mean, not adding or subtracting as is normally done. Therefore, one geometric standard deviation for the untransformed data in Figure 8-7a would include from 1.14 (1.59/1.40) to 2.23 (1.59*1.40). Like the standard deviation for the normal curve, the geometric standard deviation for the lognormal curve describes where 68.3% of the data lie. The standard deviation and mean of the untransformed data suggests that 68.3% of the data lies between 1.09 (1.679-.589) and 2.27 (1.679+.589), however, there is obviously a lot more data to the right beyond one standard deviation than to the left. The geometric standard deviation is, therefore, a better indication of the distribution of the data. The geometric standard deviation indicates the shape of the lognormal curve. As such, distributions with similar geometric standard deviations have similar shapes.

The mean, standard deviation, median, geometric mean, and geometric standard deviation are given in Table 8-30 and Table 8-31 for each group of stage and site combinations for which there is a large enough sample of discoid shell beads that are more than 50% complete. These two tables also help us identify which of the site by stage groups of data are not log-normally distributed. For example, the mean, median and geometric mean of stage 5 beads from Salango are 7.13 mm, 7.56, and 6.63, respectively. If the data were log-normally distributed, then the geometric mean would be closer to (if not the same as) the median than the mean. Therefore, stage 5 beads from Salango are not log-normally distributed. Those sites where the distribution is not log-normally distributed are discussed below. Analysis of variance is performed below for the log-transformed data to identify which of the geometric means are statistically different.

Most of the data, when divided up by site and stage, are normally or lognormally distributed (Table 8-24 to Table 8-32). Some of the distributions are obviously in between because normality tests show both the raw data and the log-transformed data to be normal. Often, the p increases when transformed, even if $p>.001$ for the raw data. In other words, with transformation it becomes more difficult for the distribution to be seen as non-normal. For example, the distributions for maximum diameter for each stage of production at Loma de los Cangrejitos are most likely normal (Table 8-24; p=.001-.072), but the log-transformed data are less likely to be non-normal (p=.079-.514).

Finally, some of the data appeared highly normal, either before or after log-transformation but the Wilks-Shapiro test identified them as neither normal nor log-normal. Some of these distributions had obvious outliers. Therefore, all data points beyond 3 standard deviations were identified. These outliers were excluded if they had a significant effect on the normality of the distribution. Table 8-24 to Table 8-29 indicate when outliers were excluded. These data points were not excluded because they are considered 'bad' data, but because they were overly influential. For example, the maximum diameter measurements excluded for stage 5 beads from Los Frailes changed the probability of Type I error from $p<.001$ to $p=.917$. While some of the changes were not as dramatic, all outliers that were excluded produced a significant change. When outliers were excluded, they rarely made up more than 2% of all beads in the group. There is one exception, however.

The distributions of both diameter measurements of stage 4.1 beads from Puerto de Chanduy have very tall peaks at about 5 mm, with a very long tail to the right (Figure 8-8). If beads larger than 8 mm are excluded, then the distributions are normal and/or log-normal. This excludes 10 (7 for minimum diameter) beads, however, which is nearly 25% of the sample. It is probably more likely that this distribution is bimodal (like stage 5 beads from Mar Bravo and Salango, see below), but suffers from a sample size that is too small to identify the second, smaller, peak. When the outliers are excluded, the remaining sample size is 34 (for minimum and maximum diameter) is close to the cutoff (30) for samples that are too small to be tested. It is apparent, however, from the graphs that this is likely a bimodal graph that is difficult to identify due to low sample size, especially for the peak around 15 mm.

8.3.2.1.2. Non-normal and non-lognormal distributions

Some of the data are neither lognormal nor normal even when outliers are excluded (Table 8-32). These are the distributions that must be explained in greater detail. There are a total of 12 (13%) non-normal distributions out of 93 distributions with a sample size greater than 30. Most of the non-normal and non-log-normal distributions are from López Viejo and Puerto de Chanduy (each has 4). The remaining are from Mar Bravo (2) and Salango (2). Most of the non-normal distributions (10) are from measurements of beads in stage 5. Also, most of the non-normal distributions (10) are for diameter measurements. These distributions provide vital information that helps us better understand shell bead production and consumption at the six archaeological sites

At López Viejo the non-normal distributions are due to being 'too tall' near the middle when compared to a normal curve. This usually happens when a distribution that is truly normal has a number of outliers that have an overly powerful influence on the normal curve, making the normal distribution appear squatter than the distribution of data. Elimination of outliers often solves the problem but did not in this case. Therefore, I continue to use the data with the outliers included. If we look at the distribution for maximum diameter for stage 2 beads from López Viejo (Figure 8-9), it is clear that there are 'too many' beads between approximately 3 and 3.75 mm, thus causing the distribution to be non-normal. If we examine the data more closely, we see that there was an exceptionally large number (198) of stage 2 beads found in context LV-752 from López Viejo. If the cache from LV-752 is removed, the data are log-normal (p=.017, Figure 8-10). This appears to have been a cache of stage 2 beads. There is a similar cache of stage 2 beads from context B2-08 at Loma de los Cangrejitos. This cache is much smaller, only 12 beads, but that is over twice the number of stage 2 beads from any other context at Loma de los Cangrejitos. The cache from López Viejo is more limited in size than the overall distribution for the entire site. The LV-752 beads have a mean maximum diameter of 3.34 and standard deviation of .254 compared to 4.07 and .902 for all of stage 2 beads from López Viejo. B2-08 beads are not as restricted in size (mean=4.97 and std. dev.=1.12) compared to all stage 2 beads from the site (mean=4.41 and std. dev.=.784). This indicates something very important about the nature of bead production as it is related to the distribution of their measurements.

The stage 2 caches at both Loma de los Cangrejitos and López Viejo suggest that beads are not made as single entities that are truly separate from each other. The LV-752 cache and the standardization of the beads in it demonstrate that beads tend to be made in groups. The stage 2 beads from LV-752 are particularly important because artisans working with similar material and similar mental ideals would produce similar beads. Different artisans have similar, but not identical, ideas about what size beads should be, however. Therefore, while one artisan is making beads that are distributed around one mean, another is making beads with a different ideal size. However, most artisans in a community of practice will produce small distributions that would be distributed around the community ideal. Each of these little packets of beads would yield a small distribution that contributed to the larger distribution. Some would be a little larger and others a little smaller. The artisans, therefore, would produce beads that are normally distributed around what can be thought of as the ideal size, the rule or 'structure'.

Because we are discussing archaeological sites, however, we can say that all of those packets of similarly sized beads were broken up through cultural and taphonomic processes. This would yield something functionally close to a random sample. Caches such as the two mentioned, however, allow us more insight into the production process. Artisans, over perhaps hundreds of years, made many similarly sized packets of shell beads. Along come the archaeologists and collect a sample of these beads. Of course, the sample is not random. These caches represent an instance where the sample is notably not random and therefore, when combined with the other beads, does not produce a normal curve. One of those many packets that were produced in the past is nicely preserved (though perhaps, not completely). We can track the anomaly for stage 2 beads from López Viejo, but it is difficult to track anomalies due to cultural processes in the past.

Stage 5 beads are especially prone to being over represented by a few packets both because of the way they are finished and the way that they arrive in the archaeological assemblage (Figure 8-11). Think of a series of beads in stage 4 that have been strung together to be ground, which transforms them into ‘finished’ (i.e., stage 5) beads. These beads may have been made as a single packet or as multiple packets with the artisan or artisans aware of the approximate size of the other beads. Either way, the dimensions of the beads would be approximately normal, with the mean being the approximate desired size for the beads. In stage 5, however, the beads are strung together on a piece of fiber and run across an abrasive surface. This makes the diameter of the beads more similar. In other words, the ‘tails’ of the normal distribution are clipped off in the final stage of grinding and polishing. Therefore, each packet of stage 5 beads that was ‘finished’ together is to have a distribution for the diameters of the beads that is much taller than one would expect if the distribution were normal. These packets of beads that were strung together and may have remained that way as a necklace or bracelet or as decorations on fabric.

As mentioned above, ten of the twelve distributions that are neither normal nor lognormal are for stage 5 beads. Eight of these distributions are for maximum or minimum diameter measurements. Many of these distributions appear to have step-like distributions that one might expect for stage 5 beads due to the grinding process that lops off the tails of what probably would be normal distributions. One can see this effect in Figure 8-11, which shows the diameter distributions of stage 5 beads from López Viejo and Mar Bravo. The untransformed data from López Viejo appears bimodal, and seems even more so once log-transformed. If the data for stage 5 beads from López Viejo are examined closely, there are two contexts that standout. LV-702 and LV-785 contain a total of 287 beads (110 and 177, respectively) whose means (3.11 mm and 3.16 mm) are lower than the overall mean (3.56 mm). These two units contain nearly one quarter of all stage 5 beads from López Viejo. These two collections probably distort the statistics. If they are removed, then the distribution of stage 5 beads at López Viejo is log-normal ($p=.008$). The goal is not to remove data in order to create log-normal distributions, but to determine the possible causes behind the shapes of the non-normal and non-lognormal distributions. Therefore, the distorting data remains in the sample. We have learned however, the cause of the distortion.

Mar Bravo appears to have a step-like distribution (Figure 8-11). Note that the ‘step’ on the left of the Mar Bravo distribution is at approximately the same size as nearly the entire distribution for López Viejo and as the smaller distribution discussed below for Salango (Figure 8-11). Perhaps that ‘step’ on the Mar Bravo distribution is for beads that are more like beads from López Viejo (i.e., Chaîne I beads). An attempt to identify contexts with only small beads to see if the two modes could be separated, as was done above for López Viejo, failed. There were few contexts that had only small beads.

The two log-transformed distributions for stage 5 beads from Puerto de Chanduy (maximum diameter and thickness; minimum dimensions show similar patterns) seem to follow the overlain normal distribution, except at the top. This is likely are result of a sampling of a number of packets, with one (or more) that has the same mean, but a 'tighter' standard deviation than the overall.

While these distributions are not strictly normal, they do appear to be multimodal normal curves. In other words, the distribution is approximately normal with some 'packets' of beads that are themselves normally distributed, but whose means do not match the overall mean. Ideally, each one of these packets would be separated out and analyzed separately or sub-sampled and rejoined with the rest of the data. However, one has to decide which contexts to subsample in this way and it is a subjective determination which contexts should be dealt with unless it is an obvious case, such as contexts LV-702 and 785.

One of the easiest non-normal distributions to interpret is the diameter measurements from stage 5 beads at Salango (Figure 8-12). This is very obviously a bimodal distribution. There is even a nice dip between the two distributions separating them at approximately 5.5 mm. The smaller distribution to the left is very similar to the distributions for the small stage 5 beads from Loma de los Cangrejitos and López Viejo (see below). The majority of beads from both of these sites have a diameter smaller than 5.5 mm. This is quite distinct evidence that Chaîne I and Chaîne II beads are mixed in stage 5 beads from Salango. An attempt to separate contexts with beads with a diameter of less than 5.5 mm failed because the smaller beads are widely distributed at the site and are not limited to contexts that are free from the larger beads.

The ‘step’ on the distribution for maximum diameter for stage 5 beads from Mar Bravo is also at approximately the same place (<5.5 mm), indicating that small Chaîne I beads are also included in the stage 5 beads at Mar Bravo (Figure 8-11). Also, the other Chaîne II beads (stages 4.1 and 4.2) from both Mar Bravo and Salango have distribution for maximum diameter where 5.5 and 7.5 mm, respectively, are the approximate minimums. The larger diameter of Chaîne II beads from Salango compared to Mar Bravo allows there to be a distinct break between the modes of the distribution, while the smaller minimum for beads from Mar Bravo result in a mixed distribution for stage 5 beads (Figure 8-11). It would be fairly easy to separate out the Chaîne I beads from the Chaîne II beads at Salango based simply upon diameter, but to do so at Mar Bravo or other sites requires other methods.

8.3.2.1.3. Normality conclusion

The question remains, “Is it normal?” The process of shell bead production produces dimensions that are normally distributed. When tests have revealed that distributions are not normal or lognormal (after exclusion of potentially overly influential outliers; see Table 8-32), it is apparent that this is due to a mixture of more than one normal curve. This can be as simple as the over representation by a preferentially preserved ‘packet’ of beads, such as the obvious caches of stage 2 beads at both Loma de los Cangrejitos and López Viejo. If we had recovered a truly random sample in these situations, then the distribution would have been normal. However, due to the nature of these archaeological excavations, a truly random sample of the population is nearly impossible. Random sampling methods were not employed at any of the sites. Distributions for diameter measurements from stage 5 beads are especially prone to sampling problems, because when beads are finished, this tends to trim the distribution of each group of beads that were made together, resulting in a more step-like distribution. At Salango and Mar Bravo, it is very clear that both Chaîne I and Chaîne II beads are combined in the distribution for diameter measurements for stage 5 beads. While it would be straight-forward to separate them out for Salango, because of the obvious break in the distribution, this is less easily done at Mar Bravo.

These non-normal distributions, however, are not so non-normal that they cannot be addressed using regression in order to investigate their relationship. However, the results of tests involving distributions that are obviously bimodal, for example the distributions of diameter measurements for stage 5 beads from Mar Bravo and Salango, should be interpreted with great caution.

8.3.2.2. ANOVA.

Since most of these distributions now can be considered normal when the data are log-transformed and a minimal number of outliers are excluded, we can analyze the data with parametric tests. First, we can compare the means using analysis of variance (ANOVA) to investigate differences between stages and sites. The main problem with splitting the data up this way is that it gives us 36 groups (6 sites x 6 stage groups, if stages 0 and 1 are ignored). Presenting data from ANOVA on 36 groups would be very cumbersome, especially if all three post-hoc tests are performed (i.e., Tukey HSD, Tamhane, and Mann-Whitney). If groups without a large enough sample size (i.e., n<30) are ignored the number of groups is reduced to sixteen, which is more manageable. The sixteen groups include: stage 2, 3, and 4 beads from Loma de los Cangrejitos and López Viejo, stage 4.1 and 4.2 beads from Mar Bravo and Salango, and stage 5 beads from all six sites (see Figure 8-13 to Figure 8-24). Stage 4.1 beads from Puerto de Chanduy (Figure 8-8) are also excluded because, when outliers are excluded, the sample size is too small and if they are included, the distribution is problematic.

Analyses of variance were performed for all six measurements for these 16 groups. The data are log-transformed and some outliers have been excluded. All of the ANOVA tests indicated significant differences among the groups, so I performed a post-hoc Tukey HSD test to compare the means of each measurement for all 16 groups. This meant that a total of 1440 (16 groups x15 comparisons per group x 6 measurements) comparisons were made. Because of the large number of results, they are presented in two ways. First, a graph of the means of the measurement (divided up by site and stage) is presented (for example, Figure 8-13). This gives a good visual identification of the differences among the groups in paired comparisons. But, the question remains as to whether these differences are statistically significant or not.

The results of the post hoc Tukey HSD test are presented in a bubble-graph (for example, Figure 8-14). This allows us to see which groups are most alike. The maximum for this test is a 1, which indicates that there would be a 100% chance of Type I error (i.e., of rejecting the null hypothesis that the means are similar when it is in fact true). In other words, a 1 indicates that it is very likely that the two means are statistically similar. This is not the strictest interpretation of the Tukey test. Truly it can only tell whether one normal distribution is different than another, not how similar they are. However, the

Tukey test can be used as a proxy for showing similarity. Here interpretations of Tukey test results are based upon probabilities of type I error at or near the poles, p=0 and p=1, rather than to distinguish p=.05 from p=.001. In the bubble graph the larger the bubble (maximum of 1) the more likely it is that the means for the measurement for the two groups being compared are similar (or, the higher the probability of committing Type I error when rejecting the null hypothesis that the means are different). Note that test results for a group compared to itself, which would be one, are excluded. No bubbles indicate that there is little chance of type I error (i.e., the means are probably different).

The results of the Tukey HSD test were used to make groups of site and stage combinations on the graph of the means (for example, Figure 8-13). Groups with statistically similar means were circled to highlight their similarity. The highest mean and the lowest mean within each of the encircled group are often statistically different, but because there are other means in between with which they are both similar, they are placed into the same group. Often these groups make good theoretical sense also. For example, the stage 4.1 beads from Mar Bravo and Salango (the only stage 4.1 beads with large enough sample size) are similar. Beads within each stage should be similar as they were made using a similar Chaîne. Differences between beads in the same stage but from different sites indicate that slightly different chaînes were used at each site.

8.3.2.2.1. Diameter

Both diameter measurements gave similar patterns (compare Figure 8-13 to Figure 8-15 and Figure 8-14 to Figure 8-16). All of the means of log-transformed data for minimum and maximum diameter of beads from all stages at Loma de los Cangrejitos are statistically similar to stage 2, 3, and 4 beads from López Viejo and stage 5 beads from

Puerto de Chanduy. For maximum diameter, but not minimum diameter, stage 5 beads from López Viejo are statistically different from and smaller than all of the other beads. The next larger group is stage 5 beads from Los Frailes. All of these smaller beads are Chaîne I beads.

The stage 5 beads from Salango and Mar Bravo have the next largest mean diameters. Stage 5 beads from Salango are statistically larger than those from Mar Bravo. Recall that the distribution of diameter measurements for both of these groups is bimodal. Therefore, although the mean may be significantly different, the distributions may have some significant overlap (see Figure 8-25). Stage 5 beads from Mar Bravo and Salango are significantly smaller than stage 4.1 and 4.2 beads from those sites. This is due to two factors. First, there are some smaller, probably Chaîne I, beads included in the Mar Bravo and Salango samples. Second, stage 5 beads should have smaller diameters than stage 4.1 and 4.2 beads because they have been rotationally ground which reduces diameter, especially maximum diameter. If a stage 4.1 or 4.2 bead is strung and ground, then its diameter will be reduced. It is surprising, therefore that stage 4.1 beads, which have also been rotationally ground, are statistically similar to, not smaller than, stage 4.2. However, many of the stage 4.1 beads were only lightly ground, changing their diameter minimally. Note that there is a greater difference in the mean diameter for stage 4.1 and 4.2 beads between the two sites than between the two stages.

Stage 5 beads form 4 distinct groups (Figure 8-13 and Figure 8-25). López Viejo beads are the smallest and are even statistically smaller than stage 2, 3, and 4 beads from the same site for maximum diameter. For minimum diameter, they are only statistically similar to stage 3 beads from Loma de los Cangrejitos, probably because the latter’s sample size is small. The difference between the geometric means (back-transformed mean of the log-transformed data) of stage 5 and stage 2 beads from López Viejo is 0.34 mm. We should be cautious about over interpreting a relatively small difference even if it is statistically significant. Indeed, the distribution of stage 5 beads indicates that there is a 'packet' of smaller beads that pulls the mean down. If we remove this packet of smaller beads, then the stage 5 beads are statistically similar to stage 2 and stage 3 beads from López Viejo (untransformed). Of course, we also already know that there is a cache of stage 2 beads that pulls its mean downward also. Therefore, stage 5 beads from López Viejo are not statistically different than stage 2-4 beads and, therefore, do not represent a modified chaîne. Stage 5 beads from López Viejo are, however, statistically smaller than all other stage 5 beads.

The similarity of the stage 5 beads from Puerto de Chanduy with those from Loma de los Cangrejitos is striking (Figure 8-13 and Figure 8-25): the geometric means are within .02 mm (see Table 8-30 and Table 8-31). It is quite clear that a very similar technology was used to produce these beads. It is even possible that the beads from Chanduy were produced at Loma de los Cangrejitos. Recall that the former is only 4 km downriver from the latter. Puerto de Chanduy was occupied slightly later so the beads from that site may have been produced by the descendents of the bead producers from Loma de los Cangrejitos who were still using a fairly consistent chaîne.

Stage 5 beads from Mar Bravo and Salango are different from each other. Stage 5 beads from Salango have a distinct bimodal curve (Figure 8-25), indicating that there are two kinds of beads within the distribution. Therefore, even if one was to remove the smaller Chaîne I beads (see below), it appears that stage 5 beads from Salango would still be larger (mean approximately at 9 mm) than stage 5 beads from Mar Bravo (mean approximately at 7 mm).

8.3.2.2.2. Thickness

Thickness measurements show a similar, though less distinct, picture. The maximum thickness measurement indicates three groups (Figure 8-17). The first group contains all of the beads from Loma de los Cangrejitos, López Viejo and Puerto de Chanduy. Stage 5 beads from López Viejo are the smallest within this group and the least similar to the others. The stage 5 beads from Los Frailes form their own group in between the other two. The final group is all of the beads from Mar Bravo and Salango. The distributions for these groups are log-normal, except for stage 5 beads from Puerto de Chanduy (Table 8-32). However, the distribution for the log-transformed data, indicates that the distribution is simply ‘too’ tall (Figure 8-11). In other words, the Wilks-Shapiro test indicates that it is non-normal, but visual inspection of the distribution suggests that the distribution of the log-transformed data are very close to normal.

The minimum thickness measurement indicates some important patterns (Figure 8-19 and Figure 8-20). Most of the beads fall into the same group. The only exceptions are stage 5 beads from López Viejo, Mar Bravo and Salango. Stage 5 beads from López Viejo are thinner than all of the others and Mar Bravo and Salango stage 5 beads are thicker. The first pattern may be due to a few especially small and well-preserved packets of shell beads from López Viejo. The main difference between stage 5 beads and stage 4.1 and 4.2 beads at Salango and Mar Bravo is that the faces of stage 5 beads have been ground. This would make the thickness of stage 5 beads much less variable (i.e., their minimum and maximum thickness measurements should be nearly the same). If one ground the face down on a stage 4.1 or 4.2 bead, both the maximum and minimum thickness measurements would be approximately the same as the minimum measurements for stage 4.1 and 4.2 beads. The maximum and minimum thickness measurements from López Viejo are very close (see Table 8-30 and Table 8-31), but much larger than the minimum thickness for stage 4.1 and 4.2 beads. Therefore, stage 5 beads must have started out thicker than stage 4.1 or 4.2 beads, instead of starting out as stage 4.1 or 4.2 beads and then being ground down. However, the ground down stage 5 bead still has the same maximum thickness as stage 4.1 and 4.2 beads. When two beads are strung on both sides of a bead, the working distance between the two beads is essentially the maximum thickness of the bead in the middle, unless they fit into each other. In other words, an artisan would need to make the same number of stage 5 beads as stage 4.1 or 4.2 beads to make a certain size artifact (e.g., a necklace). Stage 5 beads, however, would take considerable more time to make, because they are both face and edge ground. The main result of using stage 5 beads rather than stage 4.1 or 4.2 beads would be to have a more consistent artifact.

8.3.2.2.3. Perforation measurements

The perforation measurements both reinforce and modify the conclusions from above (see Figure 8-21 to Figure 8-24). The maximum perforation measurement creates more groups than thickness and diameter measurements, mainly by separating out beads from López Viejo, Loma de los Cangrejitos and Puerto de Chanduy. The beads with the smallest maximum perforation means are stage 4 and 5 beads from López Viejo. The next smallest mean is for stage 5 beads from Puerto de Chanduy. The stage 4 and 5 beads from Loma de los Cangrejitos are statistically similar to stage 5 beads from Los Frailes.

In the other measurements Puerto de Chanduy beads were most similar to Loma de los Cangrejitos beads and Los Frailes beads were larger, but for maximum perforation, the Puerto de Chanduy beads are smaller than Loma de los Cangrejitos beads, while Los Frailes are similar to beads from Loma de los Cangrejitos.

The group with the next largest means includes stage 5 beads from Salango and Mar Bravo. The beads with the largest maximum perforation measurements are stage 4.1 and 4.2 beads from Mar Bravo and Salango.

Measurements of the minimum perforation lump the groups slightly differently. Stage 4 beads from Loma de los Cangrejitos have the smallest means. These are the only beads with perforation measurements that we can say, with a high degree of certainty, have not been used (i.e., strung and, perhaps, worn). These unused beads have a smaller minimum perforation because the interior of the perforation has not been worn by abrasive fibers that were used in either the finishing process or to string the beads for use.

As indicated for other measurements, the stage 5 beads from Loma de los Cangrejitos, López Viejo and Puerto de Chanduy are similar to each other. Once again, beads from Los Frailes take a middle position and all of the beads from Mar Bravo and Salango form the group with the largest means. Stage 5 beads from Mar Bravo and Salango did, however, have a statistically smaller maximum perforation, indicating that the maximum and minimum perforation diameters were closer to each other for stage 5 beads, but were more different for stage 4.1 and 4.2 beads. This probably is evidence of the effect of stringing the beads on any type of natural fiber, which is going to be somewhat abrasive especially if worn for long periods of time.

8.3.2.2.4. ANOVA summary

To summarize the results of the ANOVA and post-hoc Tukey HSD tests, there are two main groups of beads. Mar Bravo and Salango beads tend to be similar to each other, especially stages 4.1 and 4.2, and Loma de los Cangrejitos, López Viejo, and Puerto de Chanduy tend to have similar measurements. Los Frailes beads do not fit into either of these groups, but tend to form their own group, somewhere in between the other two.

Beads from Mar Bravo and Salango tend to be very similar to each other in all measurements, except for stage 5 beads, which tend to have a smaller diameter, similar maximum thickness, larger minimum thickness and a smaller maximum perforation, but similar minimum perforation. This is an indication that stage 5 beads from these two sites were made in basically the same way as the stage 4.1 and 4.2 beads, but must have been thicker before they were ground because their minimum thickness is much greater. We can say, therefore, that stage 4.1 and 4.2 beads are not 'in-process' of becoming stage 5 beads. Stage 5 beads from these two sites are smaller in diameter than beads from the other two stages. They also have a smaller maximum perforation measurement, but similar minimum perforation measurement indicating the use of abrasive fiber for the rotational grinding. Because stage 5 beads have a smaller maximum perforation measurement (but were thicker) than stage 4.1 and 4.2 beads, we can assume that finer drills were used. The artisan knew that the bead was going to be more finely finished and therefore took more care with these beads than with stage 4.1 and 4.2 beads. The stage 5 beads do, however, have a smaller diameter, as one would assume they would if they were stage 4.1 or 4.2 beads that had been ground down. Stage 5 beads from Mar Bravo and Salango probably did not start out as especially thick stage 4.1 or 4.2 beads, which were then ground down because then the maximum perforation measurement for stage 5 would be greater than that for stage 4.1 or 4.2 beads, which it is not. Due to the small difference between the perforation measurements, it is apparent that stage 5 beads were heavily rotationally ground or heavily used.

Stage 5 beads from López Viejo, Loma de los Cangrejitos and Puerto de Chanduy tend to be very similar. They tend to be the smallest in every dimension. Stage 5 beads from López Viejo tend to be on the lower end of the range, which is partially due to the two packets of beads from contexts LV-702 and LV-785, which are particularly small beads and are probably over represented in the sample. López Viejo beads tend to have a smaller maximum perforation measurement. This suggests that the drills used at López Viejo had smaller tips than those used at the other sites. Also, all stage 4 beads tend to have the smallest minimum perforation measurement because these perforations have not been worn down by abrasive fibers.

Los Frailes beads tend to be in the middle, but this is tough to interpret because the sample is relatively small and not ideal in other ways. The interpretation that their size is somewhere in between is, however, accurate.

8.3.3. Comparison of site, chaîne and color

It should come as no surprise that there are statistically significant differences in bead colors between the sites, since there are statistical differences between both sites and stages and since the latter have statistically different color distributions. An initial cross tabulation and chi-square test comparing the frequency of different colors between sites was run to identify site/ color combinations that fluctuate more than random variation would predict (Table 8-33). Recall that an adjusted residual (ê) greater than 3.4 indicates a statistically significant difference along the same order as $p<.001$. Negative values indicate that there are fewer differences than expected if there is only random variation between the sites, and positive values indicate that more differences than expected were identified.

The two sites where Chaîne I beads were produced, Loma de los Cangrejitos and López Viejo, contained more orange, red, and/or purple beads (ROP beads) than expected in the cross tabulation. These two sites contained fewer beads in the other two main color categories, Dark and Light. This is to be expected, considering that the beads from Loma de los Cangrejitos, López Viejo, Puerto de Chanduy and Los Frailes tend be the smaller Chaîne I beads, which are made from red shell more often than Chaîne II beads. The smaller Chaîne I beads from Puerto de Chanduy have fewer ROP beads than expected, suggesting that, since this is a site where there is no evidence of production, either white beads were preferentially imported or ROP beads were excluded. The reason for the lack of ROP beads at Puerto de Chanduy may have occurred at any point during the production, distribution, and use of the beads.

Beads from Los Frailes fall statistically in between the other sites in terms of color frequency. ROP beads were produced at Loma de los Cangrejitos, and López Viejo, but were neither produced or present in large proportions in the bead assemblage from any other site. Since ROP beads can be seen with some certainty as beads made from Spondylus, then we can infer that there was Spondylus bead production only at López Viejo and Loma de los Cangrejitos.

The patterns for beads from Mar Bravo and Salango were the opposite: ROP beads were underrepresented and Light and Dark bead frequencies were greater than expected. This also was not surprising, considering that these sites tend to have more

Chaîne II beads, which tend to have less ROP beads and more Dark beads. It is quite likely that, in general, Dark beads indicate exposure to fire or, perhaps, carbon-rich deposits, such as middens. This suggests that these beads were being used in domestic contexts and that some beads ended up in the fire or removed to the midden heap were they may have been burnt with the rest of the trash. Lack of Dark beads at Loma de los Cangrejitos and López Viejo may suggest that the beads were produced in a situation where none of the beads ended up where they would be burned.

8.3.3.1.Comparison of site, stage, color and measurement

Comparing the dimensions of different colored beads by site and stage results in some interesting patterns. We know, from above, that ROP beads tend to be smaller (Table 8-18 and Table 8-19) than beads of other colors. If we compare the means of the log-transformed data within each site and stage by color a distinct pattern emerges. Note that this must be done using only the discoid shell beads that are more than 50% complete, since only these measurements are directly comparable. Many of the cells (when divided up by stage, site, and color) did not have sample sizes over 30. Most of the cells where sample sizes were large enough for more than one color were stage 5 beads. Table 8-34 shows the total number of beads within each site by stage and by color category. These are maximum numbers, however, because some of these beads were not measured in all dimensions. For example, most of the sample sizes for stage by color groups from Loma de los Cangrejitos were too small to produce statistically reliable results (i.e., $n<30$).

Nearly all of the significant differences were identified in stage 5 beads (Table 8-35). Most significant differences were between ROP beads and Light beads. Sample sizes for other colors were often limited. Sample sizes were especially problematic at Loma de los Cangrejitos, Los Frailes, and Puerto de Chanduy (where there were 758 beads, but nearly all were Light meaning that sample sizes for the other colors were small). There were a few samples, such as stage 2 and 3 beads from López Viejo and stage 4.1 and 4.2 beads from Mar Bravo and Salango, that had large enough sample sizes but no statistically significant differences were found.

Stage 5 beads with red, orange, and/or purple on them are significantly smaller than stage 5 beads of other colors, especially Light beads. This is true for beads from López Viejo, Mar Bravo and Salango (these are the sites with large enough samples of stage 5 beads). ROP beads from Mar Bravo and Salango tend to have very similar dimensions, while ROP beads from López Viejo tend to be much smaller. The distributions for stage 5 beads from López Viejo, Mar Bravo and Salango were the least normal of all of the measurements, so this difference between ROP and Light beads must be more closely investigated.

Smoothed histograms of the distributions for Light beads and ROP beads in stage 5 (Figure 8-27) indicate that ROP beads are similarly sized, regardless of site, while Light beads tend to be highly variable. Between sites, stage 5 ROP beads are basically the same size with two exceptions. Stage 5 ROP beads from López Viejo are slightly smaller and stage 5 ROP beads from Los Frailes are slightly larger.

It is not surprising that stage 5 ROP beads from López Viejo are smaller than those from other sites because Chaîne I beads at López Viejo, in general, are smaller than all of the Chaîne I beads recovered from other sites and ROP beads are smaller than light beads (even for Chaîne I). The larger beads from Los Frailes are interesting, but the sample remains problematic.

The most interesting part of this analysis is that stage 5 ROP beads from Puerto de Chanduy, Loma de los Cangrejitos, Mar Bravo and Salango are all statistically alike, even though as a whole the stage 5 beads from Mar Bravo and Salango tend to be much larger. If we look at the distributions of stage 5 ROP beads from Salango and Mar Bravo, we can see that the ROP beads are much smaller than their Light counterparts (Figure 8-29). It is likely that these small ROP beads from Mar Bravo and Salango, where Chaîne II beads predominated, are more similar to beads produced using Chaîne I than those produced using Chaîne II. Only 32 stage 4.1 or 4.2 beads were categorized as ROP beads. Along with the smaller stage 5 ROP beads, this indicates that ROP beads, even at sites were Chaîne II beads predominate, were very rarely made using Chaîne II.

Light colored stage 5 beads, on the other hand, tend to separate out along expected lines (Figure 8-27 and Figure 8-28), with sites that have predominantly Chaîne I beads (López Viejo, Loma de los Cangrejitos, Los Frailes and Puerto de Chanduy) having smaller light colored stage 5 beads than sites with predominantly Chaîne II beads (Mar Bravo and Salango). The sites where larger Chaîne II beads predominated contained larger Light beads; in contrast, at sites where the smaller Chaîne I beads were more common, Light beads were smaller.

While Light colored beads were fashioned using either Chaîne I or Chaîne II, the smaller ROP beads were fashioned mainly using the techniques of Chaîne I. It is likely that Spondylus was used for only a minimal number of Chaîne II beads and was much more commonly used for Chaîne I beads. It is especially important to recognize that

Chaîne I beads were recovered from Mar Bravo and Salango. We don't know whether or not they were produced locally or imported.

8.3.4. Comparison of site, chaîne and fragmentation

We already know that Chaîne I beads are more highly fragmented than Chaîne II beads, especially those in stages 3 and 4 (see page 283). We also know that the people at Loma de los Cangrejitos and Lopez Viejo were primarily producers of Chaîne I beads, that the people at Puerto de Chanduy and Los Frailes were primarily consumers of Chaîne I beads, and that the people at Salango 140 and Mar Bravo were primarily consumers of Chaîne II beads. One would expect more evidence of breakage from Loma de los Cangrejitos and López Viejo than from the other sites because of higher frequency of the Chaîne I stages 3 and 4. This is, in fact, the case. Table 8-36 and Figure 8-30 show that most of the fragmented beads are from Loma de los Cangrejitos and López Viejo.

In order to further investigate the differences in fragmentation patterns at the sites, these were divided into pairs according to their similarities (López Viejo and Loma de los Cangrejitos; Los Frailes and Puerto de Chanduy; and Mar Bravo and Salango).

Beads from the first pair, Loma de los Cangrejitos and López Viejo, present an essentially similar pattern, as is expected (Table 8-37). When a cross tabulation and chi-square analysis is run on fragmentation for the two sites, it appears that less of the beads from Loma de los Cangrejitos were highly fragmented (i.e., <50% complete; ê= -3.8) than those from López Viejo (13.3% v. 19.7%). The pattern is reversed, however, for beads between 50% and 99% fragmented. Loma de los Cangrejitos yielded more (ê=7.1) moderately fragmented beads than López Viejo (45.0% v. 29.8%). If we look at the beads in terms of whether they were fragmented or not, there is no difference between the sites.

If the beads are broken up by stages, there is also no difference in the number of fragmented beads in each stage by site (Table 8-38).

There are no major differences in the fragmentation patterns between López Viejo and Loma de los Cangrejitos. In other words, the production sequence was very similar between the two sites. There are some slight differences, but these must be considered within the context of archaeological recovery. Considering that the contexts from these sites are different, we shouldn't make much of such minor differences.

When compared, the frequency of different beads divided up by site and fragmentation for Puerto de Chanduy and Los Frailes indicate that the pattern is the same between the two sites (for chi-square test, $p=.717$). When stage is included and the data are divided up into stage/fragmentation and site categories, there are no differences (for all chi-square tests by stage , $p>.450$). In essence, the beads from these two sites are rarely fragmented and most beads are in stage 5.

The beads from Salango and Mar Bravo are similar in terms of fragmentation when site and fragmentation are compared by stage (Table 8-39). The only statistically significant difference is that Salango has slightly more stage 4.1 beads that are whole (ê= 4.5) compared to Mar Bravo. At Salango 96.9% (724/747) of the stage 4.1 beads are whole while at Mar Bravo, only 91.1% (494/542) are whole.

Fragmentation, when divided up by site and stage, tells us that most fragmentation occurs at Loma de los Cangrejitos and López Viejo and relatively little fragmentation occurs at the other sites. Within the pairs of similar sites (i.e., Loma de los Cangrejitos and López Viejo, Los Frailes and Puerto López, and Mar Bravo and Salango) fragmentation patterns are basically consistent. The stage 4.1 beads from Mar Bravo are statistically more fragmented than those from Salango. The difference, however, is not great and we should be cautious about our interpretation. The major highlight here is the great difference in fragmentation between the three pairs of sites, but the basic similarity between the sites within the pairs.

8.3.4.1.Comparison of site, chaîne, fragmentation and measurements

All six dimensions of both complete and 50-99% complete beads were placed in site/stage groups. From above, one would expect that smaller beads would tend to break more than larger beads, but ANOVA analysis indicates that there are very few statistical differences between the means of 100% complete versus 50-99% complete beads when they are placed into groups by site and stage. This is partially due to small sample sizes, especially for Mar Bravo, Salango, Los Frailes and Puerto de Chanduy, where fragmentation is limited. Table 8-40 gives the frequency and geometric mean for measurements that are statistically different within the site and stage groups.

Initially, complete stage 2 beads from López Viejo appeared to have a smaller diameter than 50-99% complete stage 2 beads, but this difference disappeared when the cache of especially small complete beads from LV752 is excluded. Similarly, complete stage 5 beads from López Viejo appeared to have a smaller diameter, but were thicker than the 50-99% complete stage 5 beads from López Viejo. However, after excluding the caches of especially small stage 5 beads from contexts LV785 and LV702, only the diameter difference remains statistically significant. A single difference like this should not be seen as tremendously important. Indeed, for López Viejo and Loma de los Cangrejitos, the sources of most fragmented beads, it is surprising that the majority of means do not differ significantly.

Complete stage 4.1 beads from Mar Bravo are significantly larger in diameter than 50-99% complete stage 4.1 beads from the same site. Sample sizes for the 50-99% complete beads, however are low (though greater than 30). Even though this is a statistically significant difference, it is more interesting that beads from Salango and Mar Bravo are basically complete.

Complete stage 5 beads from Puerto de Chanduy also tend to be thicker (both maximum and minimum) than beads that are 50-99% complete (Table 8-40). This sample, however, definitely suffers from sample size problems: there are less than 30 beads that are fragmented for both maximum thickness and minimum thickness (21 and 10, respectively). Therefore, such differences should not be considered statistically significant.

Overall, it is fairly clear that most beads are broken in stages 2-4 of Chaîne I production. These beads tend to be smaller than Chaîne II beads and therefore, it appears that smaller beads fragment more. However, since within each stage we cannot say that size matters in terms of fragmentation, the best interpretation is that Chaîne II beads fragment less and happen to be larger, not that smaller beads tend to fragment more often. We see less fragmentation of Chaîne II beads because we have little or no evidence of the perforation of these beads. Were they perforated differently than Chaîne I beads so that the evidence is more difficult to recognize? Or were the beads simply produced at within an unexcavated section of the site or at a different site altogether?

8.3.5. Conclusion for analysis by site.

When the data are divided up into groups, first by site and then by site and stage, the conclusions from the previous section are both supported and modified.

Chaîne I beads are produced at only two sites, Loma de los Cangrejitos and López Viejo. Most of the stage 2-4 beads are from those two locations. Stage 2-4 beads are essentially the same size at Loma de los Cangrejitos and López Viejo, although stage 5 beads from López Viejo are smaller in diameter and maximum perforation. The stage 5 beads at López Viejo, therefore, represent a slightly different mental chaîne. Perhaps the beads were simply ground more during the final rotational grinding to make a slightly smaller bead. Whatever the reason, artisans at López Viejo saw the ideal bead as smaller than the artisans at Loma de los Cangrejitos

Fragmentation, as indicated above, is mainly limited to stage 3 and 4 beads. However, ANOVA tests on the mean of each measurement for 100% complete and 50-99% complete beads for each stage/site combination indicate that fragmented beads of the same stage at the same site are not statistically different in size. Above, it appeared that smaller beads tend to fragment more, but this is a case of data being lumped into inappropriate groups. When grouped appropriately (by site and stage), fragmented beads cannot be shown to be a different size than the complete beads. Therefore, smaller beads do not fragment more. It is much more likely that, since there is only good evidence for the production of Chaîne I beads, which are also smaller, fragmentation occurs mainly during the production process. Small beads tend to be more fragmented because we have good evidence for the perforation process. We have little evidence of Chaîne II perforation.

Beads from Mar Bravo and Salango present very similar patterns. Both sites contain mainly Chaîne II beads (i.e., those from stage 4.1 and 4.2). Stage 5 beads from Salango and Mar Bravo present highly non-normal distributions. This is because both distributions contain smaller Chaîne I and larger Chaîne II beads, making the distributions appear multimodal. At Salango, the smaller beads produce a distinct distribution, but at Mar Bravo, the Chaîne II beads are small enough that the two distributions overlap, making it impossible to separate beads made from the two different Chaînes. We have observed that both sites contained some Chaîne I ROP beads, and furthermore that ROP beads at all sites tend to be approximately the same size and distinctly smaller than larger Chaîne II beads. It is highly likely that the assemblages from Mar Bravo and Salango also contained Chaîne I beads of other colors. This can be seen in the distribution of Light Stage 5 beads from Salango (Figure 8-29).

It is very clear that stage 4 beads were not used, even though they were perforated. They tend to have a much smaller minimum perforation than stage 5 beads from the same site, which means that stage 4 beads had not been strung or used: had they been used, the movement and abrasion from the fiber would have increased the minimum perforation measurement of these beads. Therefore, all stage 4 beads represent production, not use. That means that, since there are some stage 4 beads from each site, there was some production, even though it was minimal at Los Frailes, Puerto de Chanduy, Salango 140, and Mar Bravo.

Only Chaîne I was used to make beads with red, orange, and/or purple, which means that only Chaîne I was used in the production of Spondylus beads. Stage 5 beads with red, orange, and/or purple from all sites tend to be small and similar in size. López Viejo stage 5 ROP beads are smaller than the others and Los Frailes stage 5 ROP beads are on average slightly larger. Considering the great differences in means for Light beads, it is surprising and significant that the stage 5 ROP beads from Mar Bravo, Loma de los Cangrejitos, Salango and Puerto de Chanduy are so similarly sized.

8.4. Shell bead impressions analysis.

Regrettably, little analysis of the shell bead impressions was possible. Because of the difficulty of focusing on an entire bead under magnification and the relative lack of any marks except those resulting from polishing and striations, no patterns were identified. The main result of this process has been to provide more evidence for the production sequence described above.

8.5. Lithic microdrill analysis.

It has often been assumed that lithic microdrills were used to perforate shell beads. This assumption is supported by the lithic artifacts from our six archaeological sites. Sites with no or few beads that we can identify as clearly in-process, similarly have few lithic microdrills. This section necessarily focuses upon López Viejo and Loma de los Cangrejitos, which are the only two sites with sample sizes large enough for analysis.

The main difference observed among the samples of lithic microdrills between the sites is that sites on the Santa Elena Península tend to have much shorter drills than those in Manabí. It is also fairly clear that, in terms of fragmentation and shape ,that the lithic microdrill assemblages from the different sites are essentially the same. There may be some difference in shape between Loma de los Cangrejitos and López Viejo: but this is probably due to the difference in mean length of the drills between the two sites and the corresponding effect this has upon the shape.

8.5.1. Frequency of microdrills by site

The sites where Chaîne I was used to produce shell beads, Loma de los Cangrejitos and López Viejo, contained the vast majority of all lithic microdrills. At sites where Chaîne I beads were consumed, Los Frailes and Puerto de Chanduy, and where mainly Chaîne II beads were used, they all have fewer lithic microdrills. Exactly 90.8% (904/996) of all artifacts identified as lithic microdrills were recovered from Loma de los Cangrejitos and López Viejo (see Table 8-41 and Table 7-10). The picture is slightly more complicated than this, however.

Table 8-41 gives frequency of lithic microdrills, all shell beads, and stage 3 and 4 shell beads, as well as the ratios for microdrills per 100 beads and microdrills per 100 stage 3 and 4 beads. These ratios are used to standardize the number of microdrills because sample sizes vary greatly between sites. Of course, this is imperfect at best for there are multiple factors that would affect the recovery of both beads and microdrills. Ideally, types of artifacts not directly connected to shell bead making should be used to standardize the number of lithic microdrills, but these data are unavailable for most of the sites. The gross comparisons given in Table 8-41 assume a great number of things, the foremost of which is that all shell beads were produced in a similar matter. These ratios nevertheless do provide useful insights.

Sites where beads were produced should contain a higher number of drills per 100 beads. Sites where beads were either not produced or produced in limited quantities should present many fewer microdrills per 100 beads. If there is no evidence for production at a site and if lithic microdrills were used mainly or exclusively for shell bead production then lithic drills should not be present in the same quantities as at sites were beads were produced. Ratios of lithic microdrills per 100 beads are the highest for Loma de los Cangrejitos (78), López Viejo (16), and Los Frailes (41) and an order lower for the other three sites; Mar Bravo (1.2), Puerto de Chanduy (1.1), and Salango (1.9). Therefore, evidence for production is limited to the three former sites.

If the frequencies of microdrills are compared to only stage 3 and 4 beads from each site (Table 8-41), the ratios, ranging from 51 to 589 lithic microdrills per stage 3 and 4 beads, are remarkably similar. Stage 3 and 4 beads are the best kinds of beads to compare to the number of lithic microdrills because they are the ones that were lost or discarded during or at the end of the drilling process. The ratio of microdrills per 100 stage 3 and 4 beads represents a direct link between the two variables. Similar ratios between sites indicate that those microdrills were used almost exclusively for perforating shell.

The highest and lowest ratios (excluding Los Frailes for a moment; see below) are from the two sites where there is the greatest evidence for Chaîne I production, Loma de los Cangrejitos (161 lithic microdrills per 100 stage 3 and 4 beads) and López Viejo (51 lithic microdrills per 100 stage 3 and 4 beads), respectively. One would expect these two sites to represent the 'true' number of expected drills per 100 stage 3 and 4 beads because of the extensive evidence for production (especially frequency of stage 2-4 beads). Nearly all of the other sites, even those sites with very minimal frequencies of stage 3 and 4 beads and/or microdrills, fall in between 51 and 161 lithic microdrills per 100 stage 3 and 4 beads. While the numbers of microdrills per 100 beads are widely divergent, ranging from 1.1 to 78, the numbers of stage 3 and 4 beads per microdrill are much closer to each other, 51 to 161 (excluding Los Frailes, see below). Therefore, the frequency of lithic microdrills seems to be directly related to the frequency of stage 3 and 4 beads offering proof that the lithic microdrills were used almost exclusively on shell beads and specifically on Chaîne I shell beads.

Los Frailes presents an enigma. The ratio of microdrills to 100 stage 3 and 4 beads to microdrills at the site (589) is much higher than expected since there is little evidence of Chaîne I production. There are either more drills than expected or fewer stage 3 and 4 beads when compared to the other five sites. If there is no evidence for Chaîne I production, then what were all of the drills for? Mester has presented ample evidence for the manufacture of mother-of-pearl artifacts, many of which were perforated. In comparison to the other five sites, Los Frailes contained more than half of all mother-of-pearl artifacts recovered from all sites (300/562 or 53.4%; see Table 7-15). It is highly likely, therefore, that the very high ratio of lithic microdrills to 100 stage 3 and 4 shell beads is due to a higher number of drills being needed, not for shell beads, but for mother-of-pearl artifacts.

Lithic microdrills were used to fashion Chaîne I beads, which was done mainly at Loma de los Cangrejitos and López Viejo, where most of the lithic microdrills were recovered. An apparent excess of lithic microdrills at Los Frailes is most likely due to the need for them during the production of mother-of-pearl perforated artifacts rather than for shell bead production. The ratio of lithic microdrills to 100 stage 3 and 4 beads at all sites, except Los Frailes, leads one to believe that they were used mainly for the production of Chaîne I beads, even beyond López Viejo and Loma de los Cangrejitos.

8.5.2. Microdrills as a whole and by site.

Due to small sample size all of the lithic microdrills are analyzed as one large group. Only Loma de los Cangrejitos and López Viejo have large enough samples to be compared separated out and compared statistically.

8.5.2.1. Measurements.

Of the five measurements, length and width are the most informative. However, since length was measured for nearly all lithic microdrills, whether they were fragmented or not, only the length of complete lithic microdrills is relevant. In the analysis of length below, therefore, only beads that were 100% complete (broken?=0, in the database) were used. Width is relevant for lithic microdrills that were complete or had the tip missing (broken?=0 and 1 in the database). Because width is measured well above the tip of the artifact, its absence is irrelevant. The other two measurements, tip width and tip length were only taken when I could be absolutely sure that the measurement was sound: only 141 and 96 measurements, respectively, were taken from drill tips. Measurements of lithic microdrills show us that those artifacts from López Viejo are longer than those from Loma de los Cangrejitos. The measurements also provide numerical support for the use of lithic microdrills for the perforation of shell beads, especially Chaîne I shell beads.

8.5.2.1.1. Length

Variation in the length of drills between sites may indicate access to lithic resources. The means of the length measurement for each site were compared using ANOVA. Table 8-42 presents the frequency, mean, standard deviation, median, geometric mean, and geometric standard deviation for all unbroken lithic microdrills by site. Table 8-43 is the same, except that outliers beyond 3 standard deviations were excluded. Excluding the outliers changed the distribution little. Unfortunately, the sample sizes for unbroken lithic microdrills at all sites but López Viejo and Loma de los Cangrejitos were too small to be statistically representative.

Although López Viejo and Loma de los Cangrejitos are both sites were Chaîne I beads were produced, the lithic microdrills recovered from the two sites are different. Both post-hoc tests, Tukey HSD and Tamhane, for untransformed and log-transformed data, with or without outliers excluded, indicate that the lithic microdrills from Loma de los Cangrejitos are smaller than those from López Viejo. The distributions of untransformed data also support this conclusion (Figure 8-31).

The distributions also indicate that, in general, there was a collection of lithic microdrills of varying sizes, some large enough that they should be called lithic drills, not microdrills. I have made no attempt, however, to place an arbitrary line between these two types of drills. The larger drills may have been used to make some of the larger perforations in shell beads, but they certainly were not common and it is likely that they were used for purposes beyond shell bead production. The difference between López Viejo and Loma de los Cangrejitos is apparent in these larger drills as well. At López Viejo, the main distribution is between 10 and 22 mm in length and largest drill is 79.55 mm in length. At Loma de los Cangrejitos, the distribution is much more limited, from approximately 9 mm to 19 mm with the largest drill being only 24.86 mm in length.

The overall difference in the size of drills can be seen as a broader regional pattern. The drills recovered from the Santa Elena Península tend to be smaller than those from Manabí (see Table 8-44). The means are not so different, but the upper end of the distribution is dominated by drills from Manabí. Table 8-44 presents the number and percent of lithic microdrills beyond 23.00 mm and the number of microdrills longer than 33.00 mm. The first number indicates where the main distribution stops (see Figure 8-31) and the second where there are no more drills from the Santa Elena Península. This shows that large drills were only recovered from those sites in Manabí.

Clearly, both the lithic microdrills, which were probably mainly used for shell bead production, and larger drills, which were either multipurpose or were used for other purposes, from Loma de los Cangrejitos were shorter than those from López Viejo.

I believe this is due to differential access to lithic resources. At López Viejo, and Manabí in general, good lithic sources are relatively close. Areas of the nearby site of Agua Blanca are covered with lithic tools and debitage. At Loma de los Cangrejitos, lithic resources are more distant and, therefore, more difficult to obtain. The artisans at Loma de los Cangrejitos, therefore, reused their drills to a greater degree. The drills from López Viejo are much more formal and symmetrical while most of the microdrills from Loma de los Cangrejitos are much smaller and rougher; they simply look like they have been worked down.

8.5.2.1.2. Width

Although clearly the mean length of lithic microdrills differs between López Viejo and Loma de los Cangrejitos, the data are less clear for mean maximum and minimum widths. As indicated in Chapter 5, two width measurements were recorded; the first was the maximum and the second the minimum. Although the sample size is the same (See Table 8-45 to Table 8-48), these two measurements tell us different things. ANOVA tests with sixteen different post-hoc Tukey's HSD and Tamhane tests were performed on the two measurements in their original state and log-transformed.

Frequency, mean, standard deviation, median, geometric mean, and geometric standard deviation for the two measurements, both with or without outliers excluded, are presented in Table 8-45 to Table 8-48. The sample sizes for all the sites except Loma de los Cangrejitos and López Viejo are low.

All of the results from the Tukey and Tamhane post-hoc tests did not agree, so it is important to decide whether or not the data should be transformed or not and whether or not the outliers should be excluded. Recall that if the median is close to the mean, then the curve is probably normal and the data should not be transformed. If the geometric mean is closer to the median, then it best represents the data and should be log-transformed. For the entire sample, the geometric mean is closer for the maximum width measurement (with and without outliers) and for the minimum width measurement (only without outliers; see Table 8-45 to Table 8-48). Figure 8-32 and Figure 8-33 show the distributions of both untransformed and log-transformed data with outliers excluded. It is fairly clear that the normal curve fits the log-transformed data better than the untransformed data.

Because a few of the drills are so large (like one from López Viejo, which is approximately 70 mm long and 30 mm wide) and could not have been used to perforate shell beads, excluding these is appropriate for this study. Indeed, probably more of the drills should be excluded, but since there is no obvious dividing point (although, see above), an arbitrary limit (beyond three standard deviations from the mean) is used. Therefore, it is quite likely that log-transformed width measurements with the outliers excluded produce the most representative measure of central tendency. The normality of the log-transformed data are a sign that the means of the log-transformed data should be compared in the ANOVA test.

Levene tests for normality were also performed for the transformed and untransformed distributions with and without outliers, and these tests indicate that none of these distributions can be shown to be normal. This contradicts Figure 8-32 and Figure 8-33 in which the log-transformed data appear to be highly normal. Therefore, along with the ANOVA and post-hoc Tukey and Tamhane test, a Mann-Whitney test was also performed. Recall that the Mann-Whitney is the closest thing to a non-parametric version of the Tukey and Tamhane tests that is available.

An ANOVA test indicates that there are significant differences in the means of the two width measurements in both their transformed and untransformed states ($p<.001$). Post-hoc Tukey and Tamhane tests indicate that the significant differences lie between the means of width measurements from Loma de los Cangrejitos, López Viejo and Los Frailes. All other samples are ignored because sample size is not large enough to be considered representative.

The Los Frailes microdrills are statistically wider than those from López Viejo and Loma de los Cangrejitos (Table 8-45 to Table 8-48). However, there are only 30 lithic microdrills from Los Frailes, so I will limit the inferences drawn from this difference in means. Perhaps wider drills were needed or useful for working with mother-of-pearl. Certainly there are mother-of-pearl artifacts that have fairly large perforations.

The mean of the maximum width measurement of lithic microdrills from Loma de los Cangrejitos is statistically greater than that of the lithic microdrills from López Viejo. Post-hoc Tukey and Tamhane test indicate that the means are statistically different (p<.001). The means of the minimum width measurements cannot be shown to be to be different between the two sites. The Mann-Whitney test indicates that the ranked means of both maximum and minimum width measurements differ between the two sites. The Mann-Whitney test is probably the most appropriate test since the Levene test could not show the raw or log-transformed data to be normal. Therefore, it seems likely that means of both the width measurements are greater at Loma de los Cangrejitos than at López Viejo, with a little more doubt about the minimum width measurement.

The distributions support this interpretation (see Figure 8-34 and Figure 8-35), although they do indicate that the differences are relatively small. The fact that not all of the statistical tests agree is an indication that the difference, if one exists, is quite small.

Distributions for both length and width measurements also indicate that a fairly wide range of lithic microdrills and drills were in general use. However, it is also clear that sites were very different. Table 8-49 and Table 8-50 indicate that larger drills occur mainly at the sites along the Manabí coast. Two dividing lines were chosen, the first represents where the main distribution stops (at 7.00 and 6.50 mm for maximum and minimum width, respectively) and the second where there are few or no larger drills from the Santa Elena Península (10.00 mm and 8.00 mm for maximum and minimum width, respectively). When we break the sites up according to their location (Manabí vs. Santa Elena Península), it is clear that all of the largest drills are from Manabí.

It is highly surprising that the lithic microdrills from Loma de los Cangrejitos are statistically wider than those from López Viejo because they tend to be much shorter. It may be that originally, lithic microdrills at Loma de los Cangrejitos were wider and perhaps longer or as long as those from López Viejo, but they had to be reused more than those from López Viejo. Normally, when a drill breaks, it is at the tip, which is the weakest point of drill. Making a new tip means that some of the body is reduced at one end of the remaining body, leaving a fine tip once again. This means that reworking a drill does not change its width measurements, but does change its length measurements. Overall, there is extensive evidence for the greater reuse of lithic microdrills at Loma de los Cangrejitos.

8.5.2.1.3. Tip measurements

Few measurements of either the length or the width of the tip of lithic microdrills were taken (96 and 141, respectively). This means that, when placed in subgroups, few of the statistics presented for these measurements have a sample size large enough to be considered representative (i.e., >30). The mean length and mean width of the tip of those drills that were measured are 3.35 +/- 1.50 mm and 1.29 +/- 0.31 mm.

When divided up by site, the mean width for the tips of microdrills from López Viejo and Loma de los Cangrejitos are the same, 1.28 mm, with slightly different standard deviations (0.29 and 0.33 mm, respectively). An ANOVA test for the means of both untransformed and transformed data indicates that they are not different ($p<.001$). Only one site, López Viejo, has a sample size greater than 30 for the length of the drill tip measurement. Therefore, any comparison between sites would not produce statistically representative results.

The mean width measurement confirms that the lithic microdrills were used to perforate the shell beads. The overall means for the maximum and minimum perforation measurements for all shell beads are 2.02 mm and 1.42 mm, respectively. The same means for each site are shown in Table 8-51. This indicates that at sites with a reasonable sample of lithic microdrills (N>30; i.e., Loma de los Cangrejitos, Lopes Viejo, and Los Frailes) that the means for maximum and minimum perforation measurements for shell beads nicely bracket the mean of the width of microdrills. One would expect this. The maximum perforation measurement should be a little larger than the width of the drill tip because the tip is irregular and often slightly tapered. The minimum perforation would be expected to be slightly less than the width of the microdrill tip because often only the very end of the tip actually perforates the shell. If we look at only beads that have been perforated, but probably not used, i.e., stage 4 beads, this pattern is even more evident (see Table 8-51).

The tips of microdrills that were measured indicate similarity between Loma de los Cangrejitos and Lopez Viejo. The width of the drill tips do indicate that these drills were used to perforate shell beads. However, we must be cautious about over interpreting this data because only a subset of all drills, ones with tips distinct enough to record a reliable measurement, were used. This biases these measurements towards these types of drills.

8.5.2.2. Fragmentation

The most amazing thing about the lithic microdrill fragmentation coding for these sites is that there are statistically no differences between the sites. Recall that the codes for fragmentation are as follows: 0= no breakage or complete; 1= body present, but tip broken;; 3= only tip present; and 2/4= Broken other than tip. Originally 2 and 4 were coded separately, but there was not absolute difference between the two and, therefore, they were combined.

Most of the lithic microdrills are from Loma de los Cangrejitos and López Viejo. Los Frailes yielded 35 microdrills, which means that the sample size is sufficient to be considered statistically representative. The adjusted residuals for both Loma de los Cangrejitos and López Viejo are between -0.7 and 0.9, which is very low when, to be statistically different, the adjusted residual needs to be greater than 3.4 or less than -3.4. The fragmentation patterns are extremely similar between the two sites, even though taphonomy and excavation strategies and practices were very different. It is probably safe to say that the lithic microdrill assemblages have been changed relatively little by taphonomic processes and are a result of production activities.

The ratio of unbroken microdrills to microdrills with missing tips is nearly one to one. At Loma de los Cangrejitos the ratio of unbroken microdrills to microdrills with missing tips is 1.09 and at López Viejo it is 1.07. This suggests that unbroken microdrills were lost and/or discarded at the same rate as drills with missing tips. This seems surprising because one would expect unbroken drills to be relatively rare because people would tend to conserve lithic microdrills which are one of the few formal tools that the Manteño made. The ratio should be much lower.

One might expect the ratio of drills with broken tips to tips without the rest of the drill to be one to one, since for each drill with a broken tip there must be a fragment of a tip. The ratio is much higher, however, at 5.5 for all sites (and about the same for each site) because the recovery ratio is much higher for the larger part of the broken drill. Some of the broken drill tips would have been less than one millimeter and looked just like sand in the matrix, making recovery nearly impossible.

8.5.2.3. Shape.

Two basic shape categories of lithic microdrills are considered to be relevant. Initially, I identified four different categories and an unidentifiable category. It quickly became clear that the lithic microdrills did not fit nicely into these categories, so intermediate categories were created. This actually made identification more complicated and more subjective. An indication of the subjectivity of this is the large number of drills that fit into intermediate categories.

A single trait can be used to separate the drills into three groups. If a lithic microdrill was coded as 1, 1.5, or 2, it had a very distinct or distinct shoulder which separated the tip from the rest of the microdrill. If a distinct shoulder could not be identified (codes 3, 3.5, and 4), then the drill had a cigar, teardrop, or eye shape. Codes 2.5 and 5 are intermediate between these two groups and were placed in an 'Other' group along with drills whose shape was coded as unidentifiable.

Table 8-53 gives the breakdown of the three groups by archaeological site. Only lithic microdrills that were unbroken were used in this analysis because I cannot be 100% sure that enough remains of broken lithic microdrills to positively identify their shape. The only statistical difference between the sites is that Loma de los Cangrejitos contained fewer drills with shoulders than expected, while López Viejo yielded more drills with shoulders than expected. Loma de los Cangrejitos does have more artifacts classified as Other, and López Viejo less than expected, but these microdrills are identified, not by any commonality, but by their lack of features that characterize the other two groups. Therefore, they are impossible to interpret.

Drills with shoulders will tend to have a tip that has edges that are parallel, while drills without shoulders tend to have more tapered tips. A microdrill with a tapered tip would be more resistant to breakage, but would be more inefficient because it would remove more shell than necessary. A microdrill with an untapered (or truly, a less tapered) tip would be more prone to breakage, but would remove less shell and, therefore, would be more 'efficient' than a more tapered drill.

Longer drills tend to lack shoulders. This is because the body needs to be a certain size for hafting, so a smaller drill needs to have a shoulder in order to have an appropriate tip. Tips need to be small enough to remove shell efficiently, but large enough to be withstand the pressures involved in perforation. Therefore, a longer drill can have a body that is appropriate for hafting and sufficient bulk to gradually taper to a fine point. A shorter drill must taper from the same sized body to an appropriate point much more quickly giving rise to a shoulder, which can be thought of as an accelerated taper. In order to examine this, an ANOVA was performed comparing the mean length of two different shapes by site. The only statistically significant difference was that at López Viejo the mean length of drills with shoulders was less than those with a cigar-shape (16.53 mm and 20.67 mm, respectively; $p>.001$). At Loma de los Cangrejitos, the mean length of shouldered drills are less (mean= 12.44 mm) than for cigar-shaped drills (13.40 mm), but the difference is not statistically significant.

When the different shape groups are compared between sites, it is clear that drills of all types are longer at López Viejo than at Loma de los Cangrejitos. Both the mean length of the shouldered and cigar-shaped drills from López Viejo (16.53 mm and 20.67

mm, respectively) are statistically longer than those from Loma de los Cangrejitos (12.44 mm and 13.40 mm respectively).

The shape of lithic microdrills is difficult to identify because one shape tends to grade into the next making definitive placement within a category practically impossible. However, a single characteristic, the presence or absence of a shoulder, can be used to identify differences. This analysis indicates that there are minimal differences in shape between sites. A cross tabulation shows that there are statistically more shouldered microdrills from López Viejo than from Loma de los Cangrejitos. Shouldered microdrills also tend to be shorter than those considered to have a cigar shape. The only striking difference appears to be in average length between the sites, not in the different shapes. This difference is due to differential access to lithic resources as discussed above.

8.5.2.4. Number of sides and worked sides.

The number of facets around the middle of each lithic microdrill was identified along with the number of those sides that appeared to have been worked. Early on, it was realized that some drills look like they had not been used a great deal because there were very few small flakes removed from the drill. Other drills looked as though many small flakes had been removed from the surface of the drill. Many of the drills that had been worked to a high degree were also shorter.

Once again, the lithic microdrill assemblages at the various sites are fairly similar to each other (see Table 8-54 and Figure 8-36). Sample sizes at all but Loma de los Cangrejitos (341), López Viejo (346), and Los Frailes (30) are too small to be statistically representative even though the pattern appears to hold generally at those sites. Los Frailes also tends to fit the overall pattern relatively well.

The main differences are between Loma de los Cangrejitos and López Viejo. Since the many zeros in the initial cross tabulation (Table 8-54) can negatively affect the cross tabulation and chi-squared analysis, the same analysis was run with only López Viejo, Loma de los Cangrejitos and Los Frailes. The pattern was the same as seen in Table 8-54, although the numbers were slightly different. The main difference is that Loma de los Cangrejitos has many more drills with six sides than López Viejo. Therefore, the artisans at Loma de los Cangrejitos used drills with more sides in cross-section.

López Viejo had statistically more drills with 4 sides than expected: the majority of drills recovered have 4 sides (484/755 or 64.1%). This indicates that most lithic microdrills have a quadrilateral cross-section, which may indicate how they were produced. It is possible that a quadrilateral cross-section is more able to resist the pressures of rotary motion during drill than a triangular cross-section. Similarly, a quadrilateral cross section may provide a better surface for hafting than a triangular cross-section.

The number of worked sides can tell us how much the drills were retouched during their creation or during use. The number of worked sides refers to the number of sides which had small microflakes removed from them. When larger flakes are removed, this changes the number of sides on a drill, but the removal of smaller flakes from those faces affects the number of worked sides. However, it is not the number of worked sides that we are truly interested in because this is directly correlated with how many total sides there are. The interesting statistic, therefore, is the number of unworked sides, which is the number of total sides minus the number worked. This number indicates how many facets of the lithic microdrill (at about half way up the body) were modified by the removal of microflakes. This could happen either during manufacture or during the repair process for broken drills. Repairs to lithic drills would have been concentrated at the tip, however. This is where they break most often and repairs would have been made to create a new tip and would not have necessarily affected the body of the drill, at least not until the tip was encroaching on the body. Therefore, the removal of tiny flakes most likely took place during the creation of the lithic microdrills.

Table 8-55 presents the cross tabulation of site versus number of unworked sides. Once again, only the assemblages from Loma de los Cangrejitos, López Viejo and Los Frailes are large enough to be statistically representative. Only microdrills that are either unbroken or missing only the tip are included since we cannot be positive that the identification of number of sides or number of worked sides for more incomplete microdrills is accurate.

The main difference in the number of unworked sides compared to archaeological site is that López Viejo yielded more microdrills with no unworked sides than Loma de los Cangrejitos (233/346 or 67.3% compared to 171/341 or 50.1%). Conversely, this means that Loma de los Cangrejitos microdrills have at least one unworked side more often than those from López Viejo (170/341 or 49.9% compared to 113/346 or 32.7%).

The working of sides does not seem to be related to the retouch of lithic microdrills due to repair or modification of used microdrills. If it were, then the drills with greater retouch would also tend to be smaller. An ANOVA test indicates that there is no statistical difference between the length of complete drills with no unworked sides or with one or more unworked sides at each site. An ANOVA comparing the length of microdrills with no unworked sides and those with at least one unworked side from Loma de los Cangrejitos and López Viejo indicates that both categories of lithic microdrills are smaller at Loma de los Cangrejitos.

8.5.3. Lithic microdrill conclusion.

It is very clear that lithic microdrills were utilized most highly at López Viejo and Loma de los Cangrejitos, where Chaîne I beads were made. The similarity of the ratio of lithic microdrills to stage 3 and 4 beads at all sites indicates that lithic microdrills were utilized almost exclusively in the production of Chaîne I beads.

The lithic microdrills from López Viejo tend to be longer than those from Loma de los Cangrejitos. Microdrills from the two sites have basically the same width; if there is a statistically significant difference, the drills from Loma de los Cangrejitos are slightly thinner than those from López Viejo. The microdrills from López Viejo tend to have fewer facets approximately one-half of the way up the body of the artifact than those from Loma de los Cangrejitos. All microdrills tend to have four facets on the body more often than any other single number. The microdrills from López Viejo also tend to have all sides worked more often than at Loma de los Cangrejitos. Many of the lithic microdrills from López Viejo appeared more regular, like long stretched out eyes (Figure 1-4). The microdrills from Loma de los Cangrejitos appear much more worn, much shorter and often with very distinct shoulders (Figure 1-3).

8.6. Analysis of cataloged artifacts.

The analysis of cataloged artifacts, though limited in scope, highlights differences among the archaeological sites. This analysis is qualitative because statistical tests are all but impossible due to the dissimilarities among the artifacts, the contexts from which they were recovered, the excavation techniques used to recover them, and the availability and completeness of the assemblages.. Even so, it is clear that there are both commonalities and differences between the assemblages from the six archaeological sites.

Overall 726 shell and non-shell artifacts were cataloged (Table 8-56). These can be categorized both by material and by type of artifact (Table 8-57 to Table 8-61).

There are some problems with this data set. Although these problems cannot be ignored, important commonalities and differences can be seen among sites. Only artifacts associated with shell artifact production were included in the catalog: mainly non-bead shell artifacts and grinding tools that may have been used to make shell artifacts along with any other bead-like artifacts or items that might be associated with shell artifact production. This means that artifacts not associated with shell production are not included. Recall that ground stone artifacts from López Viejo were not cataloged for technical reasons. This makes an overall picture of ground stone artifacts difficult to assess. Mother-of-pearl plaques from Los Frailes were cataloged by Mester (1992) and that catalog was interpreted for this analysis. What Mester (1992) meant in her short catalog descriptions is probably closely aligned with my catalog, but there are discrepancies. Lastly, because of their number, both ceramic beads (N=718) and Oliva/Olivella beads (N=328) from López Viejo are not included in the catalog, but are included in the analyses below (see Table 8-56). Also, there were a number of simple non-shell beads that were included in the shell bead analysis, but not the catalog. These include greenstone beads and ‘simple’ ceramic beads (Table 8-56).

8.6.1. Type of material.

The materials used for artifacts were basically similar in all six sites with a few important distinctions. In general, it is clear that people at the six archaeological sites lived in varying contexts and used different and similar resources, resulting in a pattern of commonality with a few distinct patterns separating the sites.

8.6.1.1. Shell artifacts.

The majority of all non-shell-bead artifacts studied are made from shell (1250/2143 or 58.3% see Table 8-56). This is partially due to the design of the catalog; not all artifacts were cataloged, only ones that could be associated with the shell artifact industry. However, this often included nearly all ‘special’ artifacts (i.e., what would normally be cataloged). Shell artifacts make up a significant portion of the assemblages from all six sites.

Shell artifacts can be divided into two basic groups. The first, called whole shell artifacts, are shells that are minimally modified, often leaving most of the mollusk intact and easier to identify. The second group of shell artifacts is made up of shells that have been modified to the point where is it impossible or difficult to identify the mollusk from which the artifact was made. Mother-of-pearl (*Pteria sterna* or *Pinctada mazatlantica*) and Spondylus can be identified within this second group because distinctive traits of their shells remain even in greatly modified artifacts.

8.6.1.1.1. Whole shell artifacts

The production of whole shell artifacts is often an expedient process. Most of the whole shell artifacts are gastropods that have either had their apex removed or a hole punched, drilled or abraded into the side of the shell (or both). These artifacts are often called beads because one of more perforations of the shell means that they could have been strung. However, the removal of the apex may also facilitate removal of the animal for consumption. Most of the whole shell artifacts from the six sites are whole shell beads (531/547 or 97.1%; see Table 8-59). Some of the shells may have been naturally perforated by carnivores (such as *Conus* sp.) that drill holes into mollusks in order to consume the animal inside. Specifically, I believe that some of the bivalves were naturally perforated; the perforations are placed on the umbo, where carnivores often make their holes.

Most of the whole shell artifacts are Oliva/Olivella whole shell beads (434/547 or 79.3% of all whole shell artifacts), most of which are from López Viejo (348/547 or 60.7% see Table 8-57 and Table 8-58). The Oliva/Olivella whole shell beads from López Viejo were not cataloged and, therefore, we do not know where the holes were placed. Any whole shell artifact that had more than one hole or had other interesting features were cataloged (20 artifacts; Table 8-59). Most of those that were not cataloged, therefore, would have fallen into the 'apex removed' or 'hole in body' categories (or both). Most Oliva/Olivella whole shell beads from the other sites were modified only by removing the apex (86/107 or 80.4% of the artifacts that were cataloged), which may suggest that these were consumed rather than used as beads. Of course, 86 Oliva/Olivella would barely make a soup for a medium-sized family.

Some Oliva/Olivella shells were modified into the 'fish head' form. This entails abrading the posterior half of the shell completely off, leaving much of the aperture intact. The siphonal canal at the anterior end looks like an open (fish?) mouth. The addition of a single perforation approximately where an eye would be for a fish completes the artifact. These may have been ‘tinkler’ bells, but their function is unclear. They were recovered only from López Viejo (N=6) and Los Frailes (N=5), suggesting that this type of artifact may be a marker for Manabí during the earlier to middle part of the Manteño period.

Some of the other species of whole gastropods that were modified were more likely used for personal ornamentation. Modifications included abrading the apex so that only a little more than half of the shell remains or abrading the dorsal shoulder until a hole was worn in the shell (see catalog #1266 or 1267 from Salango). Most of these artifacts come from Salango (40 with a hole [or holes] on the outer surface of the shell and 17 with the apex also removed; see Table 8-59).

The remaining artifacts fall into an ‘other’ category or are gastropods that are multiply perforated in such a way to form what are probably whistles (see catalog #11963, 14760, 11272, and 12421) and trumpets (see catalog # 1278, 1279, and 1280, see Table 8-59). The whistles have a variety of drilled holes. Often, one is drilled on the edge near the aperture of the gastropod to serve as the probable mouthpiece. There may be two, four, or five other perforations. All four whistles were from López Viejo. The use of these whistles remains a mystery.

Trumpets are important because they are often associated with seafaring. They were often used to communicate over long distances, especially over water. A trumpet is made by removing the apex of the shell. Also, a hole may be placed near the aperture of the gastropod. To use the trumpet, one blows into the hole in the apex; the hole near the aperture may provide some control over the note being played. Much has been made of the association between Spondylus and Strombus (Marcos 1995a; Paulsen 1974), probably because of the association of the two shells on stone carvings from Chavín de Huantar (Burger 1992; Rick 2005). It is clear that the Stombus at Chavín came from a great distance and that they were significant ritual artifacts. However, this is enough evidence to establish only a very general connection between Ecuador and Peru, because Strombus does not exist in Peruvian waters (e.g., Rick 2005; although Paredes et al. 1999 list it as present in Peru).

The two *Strombus* (and one *Cassius*) trumpets from Salango contribute little to the discussion about connections between Ecuador and Peru, except to acknowledge that these were in fact used in Ecuador during the Manteño period. The presence of these trumpets at only Salango does suggest that the residents of the site may have been more involved in sea faring than the people of the other six sites.

8.6.1.1.2. Non-whole shell artifacts

Non-whole shell artifacts are often parts of shells that have been highly modified and are often made into specific shapes or designs. Therefore, archaeologists claim that they represent a greater labor investment than the less elaborated whole shell artifacts. Non-whole shell artifacts also can be characterized by their parent material. However, since these are so heavily modified, it is often difficult to identify the original mollusk. Only two groups are possible: mother-of-pearl that can be recognized by its nacreous and iridescent shell, and Spondylus sp. that can be recognized by color (red, orange, and purple) and the foliated texture of the colored shell.

Mother-of-pearl. Mother-of-pearl artifacts are the most numerous of all non-whole shell artifacts. Most of these artifacts are from Los Frailes (298/578 or 51.6% see Table 8-60) or López Viejo (170/578 or 29.4%, see Table 8-60). This would seem to suggest that the manufacture of mother-of-pearl artifacts happened mainly in Manabí during the earlier part of the Manteño period. The sites in Manabí appear to have many more mother-of-pearl artifacts than the sites located on the Santa Elena Península, although it is worth noting that the later sites of Mar Bravo on the Santa Elena Península and Salango in Manabí had similar numbers of mother-of-pearl artifacts (47/578 or 8.1%, and 48/578 or 8.3%, respectively). Is this due to differential opportunities for harvesting *Pteria sterna* and *Pinctada mazatlantica*? Perhaps there were naturally more mother-of-pearl mollusks along the Manabí coast. Or, is this due to a preference along the Manabí coast for mother-of-pearl goods? Why would there be a decrease in mother-of-pearl use in Manabí and an apparent increase in the sites on the Santa Elena Península? These questions can be partially answered by examining the types of mother-of-pearl artifacts that were made at the different sites.

The most numerous type of mother-of-pearl artifacts is the rectangular plaque (209/578 or 36.2% of all mother-of-pearl artifacts, see Table 8-60), the majority of which are from Los Frailes (174/578 or 30.1% of all mother-of-pearl artifacts from all six sites or 174/209 or 83.3% of all rectangular plaques). Rectangular plaques are normally square to rectangular and range from 0.6 to 3.5 cm in length and 0.5 to 2.0 cm in width (Mester 1992 [1985]). They may be unperforated or have one or more perforations. The edges of these artifacts are ground while the faces may or may not be ground. These artifacts are most likely for decorating textiles (Mester 1989, 1990). Although López Viejo had the second largest quantity of mother-of-pearl artifacts only six rectangular plaques (or 2.9% or all rectangular plaques and 3.5% of all mother-of-pearl artifacts from López Viejo) were recovered from the site. Los Frailes was a site where artisans specialized in the production of mother-of-pearl rectangular plaques for the decoration of textiles.

It should also be noted that the mother-of-pearl rectangular plaques from Los Frailes are very different than those from the other five sites. Often, the rectangular plaques from Los Frailes are perforated at one or more corners of the artifact, presumably to aid in the attachment to clothing or other surface. Most of the rectangular plaques from the other sites are unperforated. Only two artifacts are perforated more than once: one from Mar Bravo and one from López Viejo. Some of these plaques may not have been for adornment at all. Some of the thin long rectangular plaques may have been used as lime spoons, paraphernalia associated with the consumption of coca. Some of the larger rectangular plaques from Salango have designs scratched into their surfaces. The designs are mainly grids of thinly incised lines. The meaning of these lines is a mystery. This does indicate how very different Los Frailes is from the other five sites.

The artisans at López Viejo concentrated on another kind of mother-of-pearl artifact. Most of the mother-of-pearl artifacts from López Viejo are disks, perforated disks or rings (124/170 or 72.9% of all mother-of-pearl artifacts at López Viejo), which also make up a large proportion of all mother-of-pearl artifacts (210/578 or 36.3% of all mother-of-pearl artifacts). The ‘ring’ category includes artifacts that have an external diameter of approximately 2 cm and could be worn as rings on fingers (for example catalog #15479, 10947, 12903, 14775, 11043, and 9298) and artifacts that are often called fish hooks (see for example, catalog #10949, 11092, and 12499). The latter are often fragmentary so their exterior diameter is extremely difficult to estimate, but is certainly in excess of 3 cm and perhaps as large as 5 cm. During the cataloging process there seemed to be no absolute way to separate these two groups so they were left together. These ‘rings’ are fashioned by first making a shell disk, perforating that disk and then grinding away evidence of the perforation to make a smooth ring. The perforation can be produced in two ways. First, a large reamer, such as was found at Los Frailes (catalog #993) could be used to fashion a fairly large hole in the middle of a rough disk (see for example, 12244, 16114, 9671, 16064, 10920, and 11267). This hole was then enlarged, perhaps with the same reamer, to make the final artifact. Second, multiple perforations were made near the edge of the artifact, circumscribing a perforated line only millimeters inside the disk (see for example, catalog # 12750, 12336, 12441, and 12765). The interior would them be gently broken away (the holes are fairly close together so this would have been relatively simple), and a grinding stone (reamer?) could be used to remove the projections remaining between the perforations to make the final object. For the purposes of this study, rings include those artifacts with the projections from the perforations. Disks include circular objects of that have not been perforation, and perforated disks have been drilled with a large perforator. Perforated disks also include small, thin, and regular disks that are perforated with a single small hole near the edge (see for example, 13558, 13342, 10220, 14597, and 10169). These are probably more appropriately called disk pendants. Approximately 31 (out of 56 or 55.4%) of the perforated disks from López Viejo are these disk pendants. The rest tend to be larger, rougher disks with larger perforations.

Nearly all of the mother-of-pearl ‘rings’, disks, and perforated disks are from López Viejo (124/210 or 59.0%) and Los Frailes (54/210 or 25.7%). Of the remaining sites, only Mar Bravo shows any sign of the production of mother-of-pearl ‘rings’. Shell ‘rings’, including both rings that were worn on fingers as well as ‘fish hooks,’ were made mainly at López Viejo and were a secondary product at the mother-of-pearl workshop at Los Frailes.

One would not expect atl-atl hooks to be made from mother-of-pearl since they experience great forces during use and mother-of-pearl is thought of as weak. They were used however. Three of the four mother-of-pearl atl-atl hooks are from Mar Bravo (see Table 8-60). Indeed, five of the seven total atl-atl hooks are from Mar Bravo. This is likely due to differences in local environment. I hypothesize that atl-atls may have been used for large waterfowl as would be present in the large *salinas* (saline estuaries and/or salt drying beds) immediately to the north of the Mar Bravo site. All of the other sites have some sort of estuary nearby, but not on the scale of that near Mar Bravo. Three of the atl-atl hooks from Mar Bravo seem to be in the shape of bird heads (catalog #1051, 1016, and 1015); the fourth may also be a bird head (catalog #1012) and the last is anthropomorphic (catalog #1048).

Another distinctive type of mother-of-pearl artifact is the 'silla de poder,' which are named after the stone seats from large (probably Late) Manteño sites such as Agua Blanca (McEwan 1992 [1982]) and Cerro Jaboncillo (Saville 1910). Apparently, the seats were used by powerful individuals within the community during group meetings or ceremonies. These artifacts are reminiscent of this shape, with two projections that could be the legs and a flat 'seat' on top. On a more natural note, many of them appear to me to be stylized octopi, mainly because there is often a perforation in the central part of the 'seat' or head of the octopus. Only four mother-of-pearl 'sillas de poder' were recovered, but if we include all materials, a total of twelve were recovered. Ten of these objects were from Salango, including two mother-of-pearl (catalog #1145, 1164), two Spondylus (catalog # 1140, 1141), five general shell (catalog # 1142, 1137, 1143, 1144 may be sand dollar or bone and 1139), and one ceramic (catalog #1138). The other two are from Loma de los Cangrejitos (catalog #1301) and López Viejo (catalog #10464), both of which are made from mother-of-pearl. The stone 'sillas de poder' are a relatively late development, which can explain why there are so many of these at the late site of Salango. Of course, the presence of the mother-of-pearl 'sillas de poder' at Loma de los Cangrejitos and López Viejo, prior to the advent of the life-size stone versions, would suggest that the mother-of-pearl artifacts represent something else. It is also possible, however, that the life-size 'sillas de poder' were made of wood or another perishable material during the earlier part of the Manteño period. They, therefore, could have been known to the residents of Loma de los Cangrejitos and López Viejo.

The X-shaped mother-of-pearl artifacts are similar to the 'sillas de poder' in the sense that a 'silla de poder' is an X with the space between the two top arms filled in. The X-shaped artifacts are not filled in and are perforated at the ends of each extremity of the X. They were most likely strung together or attached to a substrate (perhaps cloth like the rectangular plaques). Thirteen of the fifteen X-shaped artifacts come from a single context at Salango (catalog # 1157- Feature # 140). The other two X-shaped artifacts (catalog # 1162 and 1160) look more like an H and are also from Salango. Since most of these artifacts were recovered together and there is no evidence for their production at the site, it is quite likely that they were worn at the site, and, if made at the site, were not produced in any quantity. It is probable that the thirteen X-shaped artifacts were part of a single compound artifact.

Spondylus. The other major material used for non-whole shell artifacts is Spondylus. The frequency of Spondylus sp. artifacts is much lower than for mother-of-pearl (47 compared to 578, see Table 8-56). This does not mean that Spondylus was a less important source for artifacts. Indeed, Spondylus shell is much harder and difficult to work than mother-of-pearl. For the same amount of labor, one could expect more mother-of-pearl artifacts. This probably does not completely explain why there are twelve times more mother-of-pearl artifacts than Spondylus artifacts, however. The low count of Spondylus artifacts compared to mother-of-pearl and, indeed, other types of shell is surprising considering the importance that archaeologists place upon this shellfish. With such low frequency for Spondylus in general and no apparent preference for any one type of artifact (see Table 8-62), it is unlikely that non-bead artifacts were being made from Spondylus for export. It is possible that Spondylus beads were made for export. Indeed, one would expect the largest numbers of Spondylus non-bead artifacts to come from sites that also yield large numbers of beads that we can prove are Spondylus (i.e., the ROP beads). However, the sites with the largest number of ROP beads, Loma de los Cangrejitos and López Viejo, do not have the largest number of Spondylus non-bead artifacts. Even at López Viejo, the site with both the most ROP beads and the most non-bead Spondylus artifacts, most (11/15, e.g. 12557-12560) of the non-bead Spondylus artifacts are tiny red spines that have been perforated. These should probably be counted among beads, rather than with other artifacts that would have taken a great deal of time to make. That leaves López Viejo with only four Spondylus artifacts compared to 1557 ROP beads (Table 8-33).

A couple of types of artifacts made from Spondylus deserve note. Atl-atl hooks and rings have also been discussed, but it is noteworthy to add that the ‘rings’ made from Spondylus are of the size that could have been worn on the finger. Such an artifact would have been much more laborious to fabricate from the harder Spondylus than from the softer mother-of-pearl. These Spondylus rings also represent a great deal of skill as it is very difficult to make such rings without breaking them: I tried to replicate these and failed miserably.

Seven ‘plumb-bob’ artifacts made from Spondylus were recovered from Mar Bravo (catalog # 268, 407, and 743) and Salango (catalog # 1204-1207). These are large (mainly >5 cm in length) and heavy tear-drop shaped objects that are often perforated at the apex of the tear-drop. These are made from very large chunks of Spondylus shell, which is most likely from geriatric specimens of *Spondylus calcifer* (*Spondylus princeps* do not get large enough). Some appeared at first to be unmodified, but it is clear that they have been pecked into shape. One of the ‘plumb-bobs’ from Los Frailes was even ground to make a nearly perfectly tear-drop shaped artifact (catalog #407). Some appear to be in-process and have not been completely perforated (e.g., catalog #1205, #743). It must have taken a great deal of work to make these artifacts. It is unclear exactly how these artifacts were used, but they may have served as net weights-- even if submerging such a labor intensive artifact in the water where it could be lost seems a little unusual. These artifacts have been observed at the bottom of the Bay of Santa Elena, however (Karen Stothert, personal communication 2007). Stone objects of this type were not cataloged. It would be interesting to compare Spondylus ‘plumb-bobs’ to those made from stone.

Six other ‘plumb-bob’ artifacts made from the columnellas of large gastropods were also recovered from Salango (catalog # 1194-1199). These are much lighter than the tear-drop shaped objects made from Spondylus. Another similar object from Salango is highly eroded and may be incomplete (catalog #1192).

It is very interesting that all of the ‘plumb-bob’ artifacts come from Salango, Mar Bravo, and Los Frailes, places where *S. calcifer* is still widely available.

8.6.1.2. Ground stone artifacts.

Ground stone artifacts can greatly inform the shell artifact industry because they are used to modify shell through grinding, cutting or polishing. Any ground stone tool considered to be potentially related to the shell artifact industry was cataloged. The major exception to this is that none of the ground stone artifacts from López Viejo were cataloged (one stone bead was measured, however). Even without the ground stone artifacts from López Viejo, the sites in Manabí (Salango and Los Frailes), yielded many more ground stone artifacts than all three of the sites on the Santa Elena Península (51/67 or 76.1% compared to 16/67 or 23.9%; see Table 8-61). Many of these artifacts are made from sandstone that is available along much of the coast in tablazo outcrops. Therefore, it appears that this is a difference in activities at between the sites in the two regions.

Many of the ground stone tools were used for grinding. Most of these artifacts were made from fine grained sandstone. Grinding stones were divided into three sub groups, a large and a small size group along with a fragment category. Both of the primary groups, large and small, are catch-all groups, but there are a couple of types of artifacts within these groups that deserve mention. First, Mar Bravo and Salango yielded five small, very fine grained sandstone artifact that look like a honing stones (see artifacts

1054, 1058 and 1059 from Mar Bravo, and 1220 and 1274 from Salango). They tend to be thin (c. 1 cm) and rectangular with all sides and edges ground and taper towards the ends as if the largest surface was used to 'sharpen' some other type of artifact. Salango also yielded some fragments that may be from this type of artifact (e.g., 1272). The function(s) of these 'honing' stones is unknown. They cannot be associated with Chaîne I bead production, which is mainly associated with Loma de los Cangrejitos and López Viejo. They are from sites that concentrated mainly on Chaîne II beads, but the association does not necessarily mean that these artifacts were used for grinding Chaîne II beads. Indeed, Chaîne II beads are only minimally ground and are fairly expedient and opportunistic. The 'honing' artifacts probably required a great deal of work to make and therefore are unlikely to be used for an expedient technology like Chaîne II beads. It is unclear, therefore if these artifacts are associated with the shell industry.

The larger grinding stones are mainly concentrated at Salango (15/22 or 68.2%; see Table 8-61). These grinding stones were probably used for the shell industry. The only site that lacks these artifacts is Puerto de Chanduy where few or no shell artifacts were made. Recall that, although few shell beads were made at Los Frailes, large quantities of mother-of-pearl artifacts, which also require grinding stones, were made there.

Many of the larger grinding stones from Salango were fine grained and often somewhat rectangular. We know that Spondylus shells were being processed at Salango because of all the 'cores' (Allan 1989), but how the grinding stones were used is unclear. A couple of the grinding stones show signs of percussion suggesting that they may have been used secondarily as anvils in the processing of Spondylus shells (e.g., catalog

#1217). Supporting evidence includes a very large, solid chunk of Spondylus that also shows evidence of being used as an anvil (catalog # 1203). Although we know that grinding stones were used for producing shell beads, it is clear that these artifacts were used for other purposes as well. The best evidence for their use in the shell artifact industry is the lack of grinding stones from Puerto de Chanduy where shell artifacts were not produced. Absence of evidence, however, does not necessarily equal evidence of absence.

Sandstone saws (tabular slabs of sandstone with one edge tapered to a v-shape) can be associated with the production of mother-of-pearl artifacts. Most of the saws are from Los Frailes (4/7 or 57.1%) where the majority of all mother-of-pearl artifacts were made (298/578 or 51.6%). One would predict that López Viejo would also yield a significant number of sandstone saws because 170 mother-of-pearl shell artifacts were recovered. However, it is unclear whether or not all sand stone artifacts from López Viejo were analyzed for this study.

The other major category of ground stone artifacts is the ‘other’ category. There is a greater variety of ground stone artifact types at Los Frailes (16/27 or 59.3% of these residual artifacts). A few of these other ground stone artifacts deserve special mention. First, there is a sandstone perforator (or reamer- catalog #993) from Los Frailes that was most likely used for making larger perforations in mother-of-pearl artifacts. Los Frailes also yielded the only two ‘atl-atl straighteners’ (catalog # 120, 752). These are sandstone artifacts that have deep U-shaped grooves that are a little larger than Chaîne I beads. It is thought that these were used in the final rounding of beads (Masucci 1995). However, since Chaîne I beads were not made (in any significant quantity) at Los Frailes, it is probable that these artifacts are not associated with shell bead production.

8.6.1.3. Ceramic artifacts.

Ceramic artifacts that can be associated with the shell industry indicate important distinctions between the assemblages. Ceramic beads were of two different types. The first is a larger more complex bead that often features some incised decoration ranging from human figures to a few lines. Many of the ‘complex’ ceramic beads have a tear-drop shape reminiscent of a small spindle whorl. The second type of bead is much smaller in diameter and looks like multiple shell beads strung together. These beads are made from clay wrapped around a long stiff organic material (a stick or the stalk of a tall thin grass) to make a cylinder of clay less than 5mm in diameter. The cylinder of wet clay is marked off in two to three millimeter sections (about the same as the thickness of a shell bead) by incising lines around the tube. This is fired, vaporizing the organic core and leaving a cylinder marked off in small ‘beads’ and ‘perforated’ down the middle. This then broken up into sections of 1-8 of these imitation ‘beads’. A single bead, therefore, may appear to be composed of up to eight beads.

The vast majority of the larger, more complex beads are from Salango (14/17 or 82.4%) with two (11.8%) from Mar Bravo and one (5.9%) from Puerto de Chanduy. We can associate these beads, therefore, with sites that were occupied later in the Manteño period. Even the one ‘complex’ bead (catalog #1111) from Puerto de Chanduy is relatively close to the top of the excavation (Level 7). The smaller ‘imitation’ ceramic beads are mainly from López Viejo (721/763 or 94.5%). Puerto de Chanduy has a significant amount (30/763 or 3.9%) of these beads and there are a few from Mar Bravo

(5/763 or 0.7%) and Salango (0.9%). There are none from Los Frailes or Loma de los Cangrejitos. At López Viejo, all of these beads are from contexts 700 (the first level, just below surface) to 759 even though the excavation continued to 796. Since the later sites, Mar Bravo and Salango yielded only a few of these beads, it is reasonable to place these 'imitation' beads within the middle part of the Manteño period.

8.6.1.4. Other cataloged material types

As mentioned previously, glass beads, the majority of which are a blue-tinged green are from the later sites, Mar Bravo and Salango. This is irrefutable evidence that they were occupied after the arrival of Columbus in 1492. At both sites, the glass beads appear to be in the upper levels suggesting that both sites were occupied prior to the arrival of the green glass beads. This does not necessarily suggest a prehistoric component.

Most of the artifacts made from green stone are beads and were not cataloged, but were assessed with the shell beads. Each archaeological site contained at least one green stone artifact. Loma de los Cangrejitos (1), López Viejo (4), Puerto de Chanduy (1), and Salango (2) all yielded less than five green stone artifacts. The assemblage from Los Frailes, which contained the most (12), is difficult to interpret because Mester (1992) did not catalog non-shell artifacts and so, contextual information in lacking. Six of the seven greenstone beads from Mar Bravo are from the same context (L5-N5, level 3) indicating that they may have been part of the same compound artifact but telling us little about the distribution of green stone artifacts at the site. Green stone artifacts, mainly beads, are a part of the assemblages from each archaeological site studied, but their frequency (i.e., <13) indicates that they were not a major artifact type at any site.

The other types of materials that were recorded from each site included copper, bone and an unidentified category. The single copper artifact does not represent the assemblage of copper artifacts from these sites. It was included in this catalog only because it was accidentally included with the shell beads. The single bone artifact (a perforated sharks tooth) should also not be seen as representative of the corpus of bone artifacts, but is a non-molluscan variation of whole shell beads.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Maximum Diameter	51	27	722	358	499	1330	454	3343	6784
Minimum Diameter	30	25	645	90	232	1276	439	2968	5705
Maximum Thickness	51	26	720	354	486	1330	454	3318	6739
Minimum Thickness	30	22	658	147	294	1322	443	3006	5922
Maximum Perforation					307	1324	453	3116	5200
Minimum Perforation					279	501	107	1980	2867
Total Possible	51	27	722	358	499	1330	454	3343	6784

Table 8-1. Frequency of Successful Measurements for Discoid Shell Beads that are More than 50% Complete from all Sites. Note: This does not include non-shell beads, non-discoid beads, or beads less than 50% complete.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	51	27	722	358	499	1330	454	3343	6784
Mean	5.93	5.59	3.97	4.11	4.30	9.44	9.48	5.16	6.05
Std. Dev.	1.88	1.56	.97	.77	.95	1.99	2.02	2.12	2.79
Median	5.33	5.02	3.75	4.08	4.15	9.38	9.34	4.55	5.02
Stage 2	-------	-------	------	*§	*				
Stage 3	-------	-------	*§	------	*§‡				
Stage 4	-------	-------	*	*§‡	-------				
Stage 4.1	-------	-------				-------	*§‡		
Stage 4.2	-------	-------				*§‡	-------		
Stage 5	-------	-------						-------	

Table 8-2. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Maximum Diameter for Discoid Shell Beads >50% Complete by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	30	25	645	90	232	1276	439	2968	5705
Mean	5.56	4.98	3.85	3.88	4.18	8.92	8.65	5.20	6.08
Std. Dev.	1.77	1.54	.94	.82	1.07	1.95	1.92	2.11	2.67
Median	5.10	4.69	3.61	3.83	3.99	8.79	8.47	4.65	5.47
Stage 2	-------	-------	-------	*§‡	*§				
Stage 3	-------	-------	*§‡	-------	*§‡				
Stage 4	-------	-------	*§	*§‡	-------				
Stage 4.1	-------	-------				-------	*§‡		
Stage 4.2	-------	-------				*§‡	-------		
Stage 5	-------	-------						-------	

Table 8-3. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Minimum Diameter for Discoid Shell Beads >50% Complete by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	30	25	645	90	232	1276	439	2968	5705
Mean	.39	.76	.17	.21	.21	.62	1.01	.15	.33
Std. Dev.	.46	.46	.23	.25	.20	.63	.78	.24	.50
Median	.21	.78	.09	.13	.15	.47	.86	.07	.13
Stage 2	-------	-------	-------	*§‡	*§			*§	
Stage 3	-------	-------	*§‡	-------	*§‡			*§	
Stage 4	-------	-------	*§	*§‡	-------			*	
Stage 4.1	-------	-------				-------			
Stage 4.2	-------	-------					-------		
Stage 5	-------	-------	*§	*§	*			-------	

Table 8-4. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for the Difference between Maximum and Minimum Diameter for Discoid Shell Beads >50% Complete by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

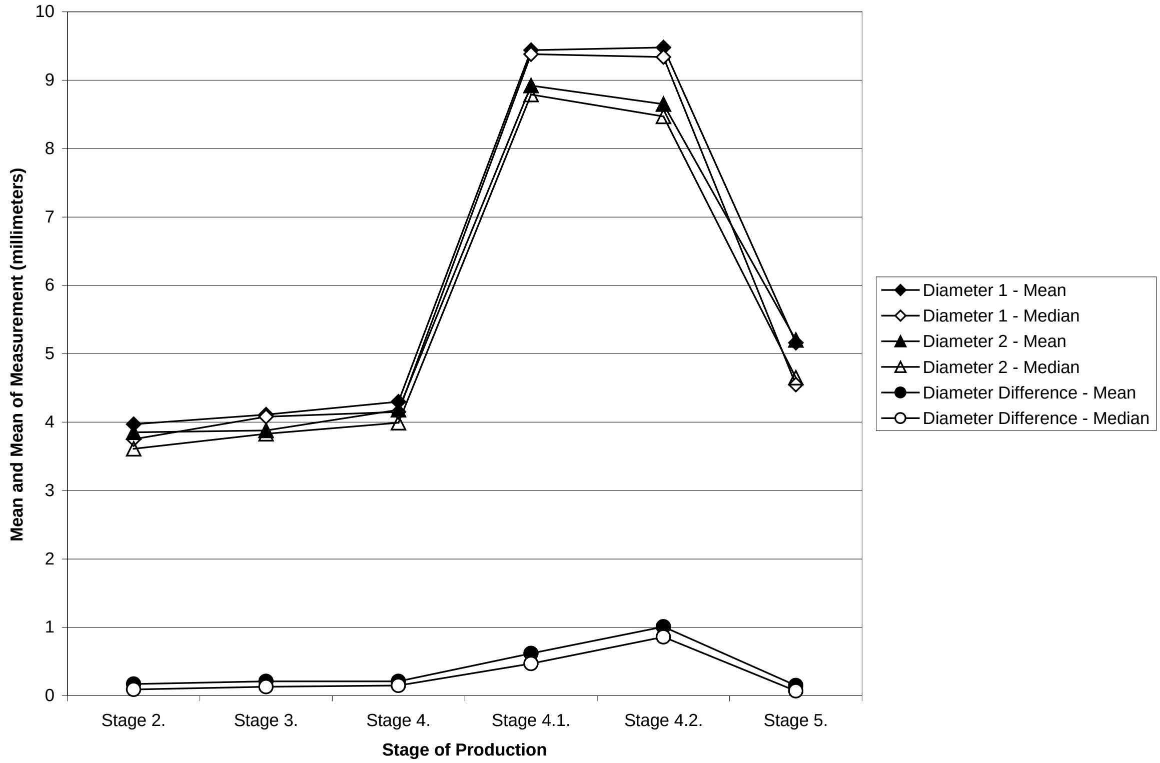


Figure 8-1. Mean and Median of both Diameter Measurements and the Difference between them.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	51	26	720	354	486	1330	454	3318	6739
Mean	3.13	1.99	1.70	1.75	1.71	2.79	2.67	2.20	2.24
Std. Dev.	2.65	.69	.63	.65	.64	.82	.95	1.05	1.02
Median	2.37	2.01	1.58	1.63	1.62	2.69	2.51	1.94	2.05
Stage 2	-------	-------	-------	*§‡	*§‡				
Stage 3	-------	-------	*§‡	-------	*§‡				
Stage 4	-------	-------	*§‡	*§‡	-------				
Stage 4.1	-------	-------				-------	*§		
Stage 4.2	-------	-------				*§	-------		
Stage 5	-------	-------						-------	

Table 8-5. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Maximum Thickness for Discoid Shell Beads >50% Complete by Stage.. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	30	22	658	147	294	1322	443	3006	5922
Mean	2.38	1.49	1.61	1.72	1.63	1.94	1.84	2.02	1.91
Std. Dev.	1.35	.67	.60	.55	.60	.58	.66	.95	.82
Median	2.17	1.41	1.49	1.62	1.56	1.87	1.74	1.80	1.75
Stage 2	-------	-------	-------	*§‡	*§‡				
Stage 3	-------	-------	*§‡	-------	*§‡	*	*§‡	‡	
Stage 4	-------	-------	*§‡	*§‡	-------		*		
Stage 4.1	-------	-------		*		-------	*§	*§‡	
Stage 4.2	-------	-------		*§‡	*	*§	-------	‡	
Stage 5	-------	-------		‡		*§‡	‡	-------	

Table 8-6. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Minimum Thickness for Discoid Shell Beads >50% Complete by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	30	22	658	147	294	1322	443	3003	5919
Mean	2.64	1.69	1.65	1.75	1.68	2.37	2.27	2.13	2.11
Std. Dev.	1.44	.66	.62	.54	.60	.65	.75	.99	.88
Median	2.25	1.44	1.53	1.68	1.57	2.30	2.17	1.91	1.97
Stage 2	-------	-------	-------	*§‡	*§‡				
Stage 3	-------	-------	*§‡	-------	*§‡				
Stage 4	-------	-------	*§‡	*§‡	-------				
Stage 4.1	-------	-------				-------	*§		
Stage 4.2	-------	-------				*§	-------	*§	
Stage 5	-------	-------					*§	-------	

Table 8-7. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for the Average of Maximum and Minimum Thickness for Discoid Shell Beads >50% Complete by Stage.. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	30	22	658	147	294	1322	443	3003	5919
Mean	.53	.41	.11	.15	.19	.86	.85	.24	.40
Std. Dev.	.59	.34	.15	.16	.21	.58	.65	.31	.50
Median	.30	.31	.06	.09	.13	.75	.67	.15	.22
Stage 2	-------	-------	-------	*§‡	*§				
Stage 3	-------	-------	*§‡	-------	*§‡			*	
Stage 4	-------	-------	*§	*§‡	-------			*§	
Stage 4.1	-------	-------				-------	*§		
Stage 4.2	-------	-------				*§	-------		
Stage 5	-------	-------		*	*§			-------	

Table 8-8. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for the Difference between Maximum and Minimum Thickness for Discoid Shell Beads >50% Complete by Stage.. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	307	1324	453	3116	5200
Mean	1.57	2.52	2.49	1.80	2.03
Std. Dev.	.42	.60	.59	.54	.65
Median	1.51	2.49	2.47	1.75	1.97
Stage 4	-------				
Stage 4.1		-------	*§‡		
Stage 4.2		*§‡	-------		
Stage 5				-------	

Table 8-9. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Maximum Perforation for Discoid Shell Beads >50% Complete by Stage.. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	279	501	107	1980	2867
Mean	1.08	1.85	1.73	1.35	1.42
Std. Dev.	.26	.36	.35	.36	.42
Median	1.08	1.83	1.76	1.28	1.35
Stage 4	-------				
Stage 4.1		-------	*§‡		
Stage 4.2		*§‡	-------		
Stage 5				-------	

Table 8-10. Frequency, Mean, Standard Deviation, Median and Statistical Comparisons for Minimum Perforation for Discoid Shell Beads >50% Complete by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Frequency	279	501	107	1980	2867
Mean	.49	.74	.79	.35	.45
Std. Dev.	.32	.47	.48	.26	.36
Median	.44	.69	.69	.30	.36
Stage 4	-------				
Stage 4.1		-------	*§‡		
Stage 4.2		*§‡	-------		
Stage 5				-------	

Table 8-11. Difference between the two perforation measurements for >50% complete discoid shell beads by Stage. Note: *= Not significantly different by Tukey HSD post hoc test. §= Not significantly different by post hoc Tamhane test. ‡= Not significantly different by Mann-Whitney test.

Stage	Type of Bead		Maximum Diameter	Minimum Diameter	Maximum Thickness	Minimum Thickness	Maximum Perforation	Minimum Perforation
2	Discoid	N	722	645	720	658		
		Mean	3.97	3.85	1.69	1.61		
		Std. Dev.	.97	.94	.63	.60		
	Cylindrical	N	21	18	21	19		
		Mean	4.00	3.89	5.60	5.49		
		Std. Dev.	.67	.68	2.08	2.18		
		Sig.			*†	*†		
3	Discoid	N	358	90	354	147		
		Mean	4.11	3.88	1.75	1.72		
		Std. Dev.	.77	.82	.65	.55		
	Cylindrical	N	16	5	16	7		
		Mean	3.62	3.50	4.34	4.53		
		Std. Dev.	.52	.61	1.01	.78		
		Sig.			*†	*†		
4	Discoid	N	499	232	486	294	303	276
		Mean	4.30	4.18	1.71	1.63	1.57	1.08
		Std. Dev.	.95	1.07	.64	.60	.42	.26
	Cylindrical	N	7	7	7	5	7	6
		Mean	4.06	3.98	5.00	5.15	2.00	1.21
		Std. Dev.	1.24	.97	2.11	2.44	.65	.25
		Sig.			*†	*		
5	Discoid	N	3343	2968	3318	3006	3083	1963
		Mean	5.16	5.20	2.20	2.02	1.79	1.34
		Std. Dev.	2.12	2.11	1.05	.95	.53	.35
	Cylindrical	N	100	62	100	68	83	74
		Mean	3.63	3.57	5.49	5.20	1.76	1.32
		Std. Dev.	.95	1.03	1.93	1.86	.43	.33
		Sig.	*†	*†	*†	*†		

Table 8-12. Comparison of the Means of all Measurements of Discoid and Cylindrical Shell Beads That are More Than 50% Complete by Stage. Note: * indicates that an ANOVA test indicates that the differences between the means of the two types of shell bead are significant. † indicates that a Mann-Whitney test indicates that the differences between the means of the two types of shell bead are significant.

	Stage 2, 3, and 4 beads	Stage 4.1 and 4.2 beads	Stage 5 beads
Diameter- size	smaller	larger	in between
Diameter- difference between two measurements	less	greater	Less than all others
Thickness- size	maximum- less minimum- equal average- less	maximum- greater minimum- equal average- greater	maximum- in between minimum- equal average- in between, but similar to 4.2
Thickness- difference between two measurements	less	greater	similar to stage 3 and 4 beads
Perforation- size	Maximum- less minimum- less	Maximum- greater Minimum- greater	Both- in between
Perforation- difference between two measurements	less	greater	less than both of the others (p<.005)

Table 8-13. Summary of statistically significant differences for discoid shell beads that are more than 50% complete by Stage.

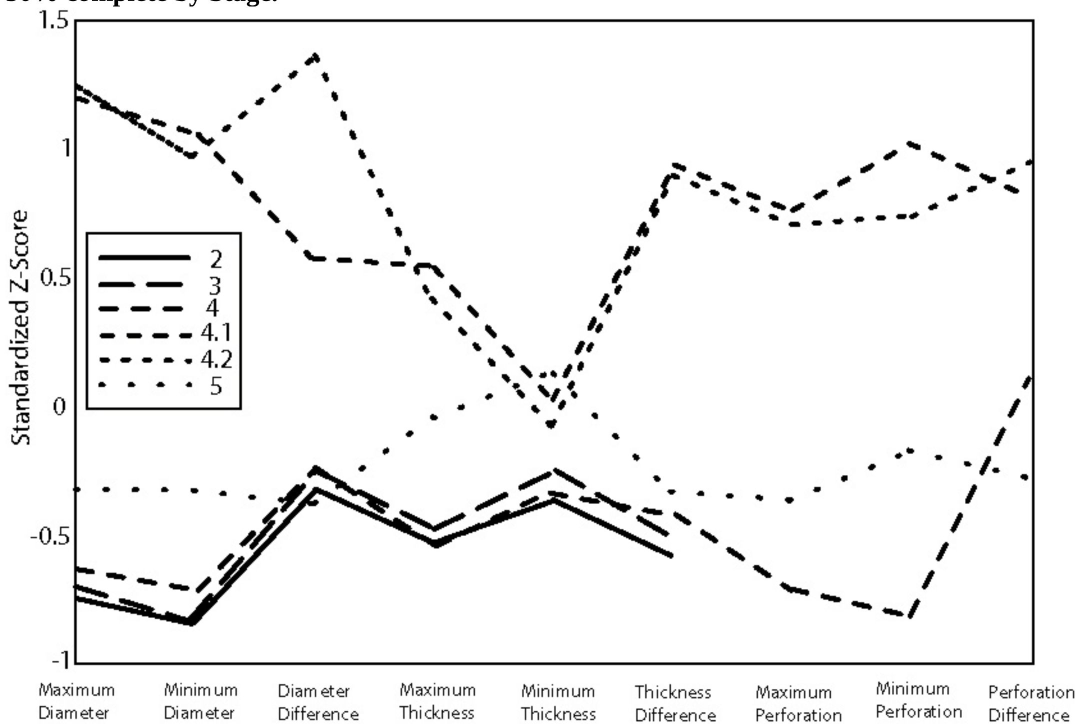


Figure 8-2. Graph of Standardized Measurements for Discoid Shell Beads by Stage. Note: Standardized as Z-scores based upon overall mean and standard deviation.

Stage		<50%	50-99%	100%	Total
2.0	N	50	98	**660**	808
	N_{exp}	69.4	136.3	**601.9**	808
	ê	-2.6	-3.8	**5.0**	
3.0	N	**147**	**316**	61	524
	N_{exp}	**45.0**	**88.4**	390.3	524
	ê	**16.5**	**27.5**	-34.2	
4.0	N	**200**	**323**	199	722
	N_{exp}	**62.0**	**121.8**	537.8	722
	ê	**19.3**	**21.0**	-30.4	
4.1	N	7	67	**1266**	1341
	N_{exp}	115.2	226.3	**998.9**	1341
	ê	-11.6	-12.8	**18.4**	
4.2	N	1	19	**436**	457
	N_{exp}	39.2	77.1	**340.4**	457
	ê	-6.6	-7.5	**10.6**	
5.0	N	240	459	**3005**	3704
	N_{exp}	318.1	625.0	**2759.0**	3704
	ê	-6.4	-10.1	**12.9**	
Total	N	657	1291	5699	7651
	N_{exp}	657	1291	5699	

Table 8-14. Counts, expected counts, and standardized residuals (ê) for all shell beads by Stage and Fragmentation. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

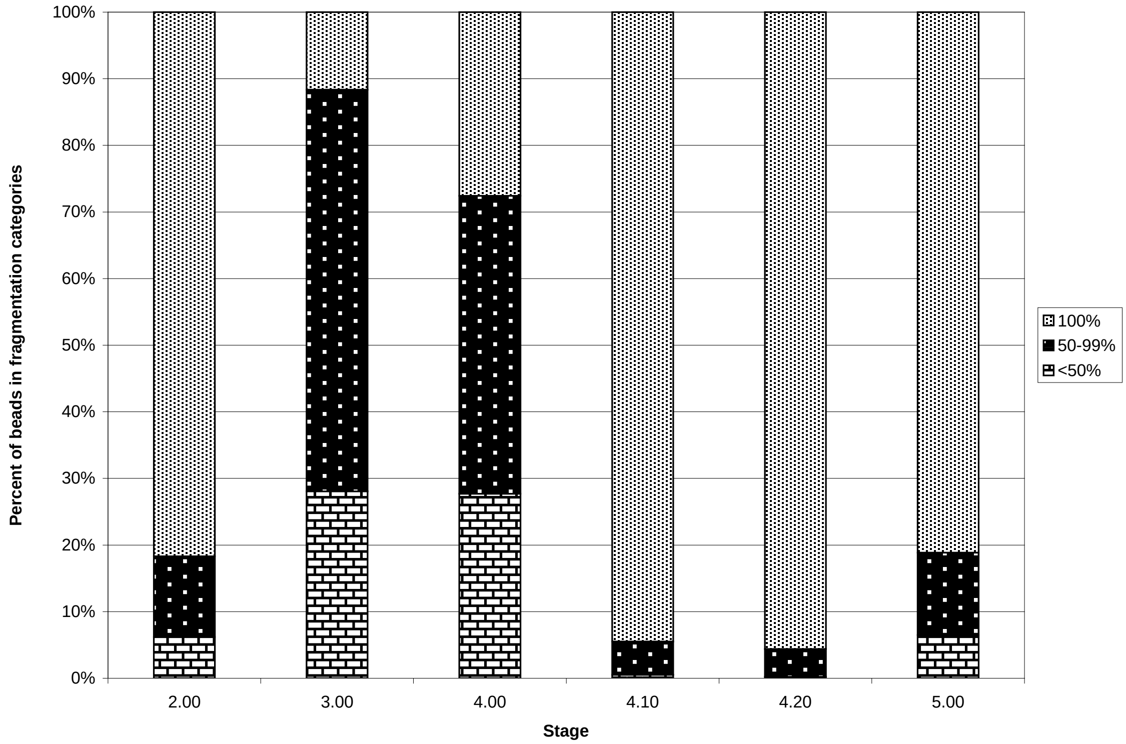


Figure 8-3. Percent of Bead in each Fragmentation Code by Stage.

		Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5	Total
Dark	N	<u>1</u>	<u>0</u>	<u>2</u>	58	**28**	144	249
	N_{exp}	<u>26.3</u>	<u>17.1</u>	<u>23.5</u>	43.6	**14.9**	120.5	249
	ê	<u>-5.3</u>	<u>-4.4</u>	<u>-4.7</u>	2.4	**3.6**	3.0	
Dark/Light	N	1	0	0	19	**13**	27	61
	N_{exp}	6.4	4.2	5.8	10.7	**3.6**	29.5	61
	ê	-2.3	-2.1	-2.5	2.8	**5.1**	-.7	
Green	N	0	0	0	2	0	5	7
	N_{exp}	.7	.5	.7	1.2	.4	3.4	7
	ê	-.9	-.7	-.9	.8	-.7	1.2	
Light	N	<u>402</u>	<u>125</u>	<u>267</u>	**1143**	**353**	**2376**	4711
	N_{exp}	<u>497.5</u>	<u>322.6</u>	<u>444.6</u>	**825.7**	**281.4**	**2280.7**	4711
	ê	<u>-7.3</u>	<u>-18.4</u>	<u>-14.3</u>	**19.6**	**7.1**	**4.5**	
Other	N	16	2	10	7	0	40	76
	N_{exp}	8.0	5.2	7.2	13.3	4.5	36.8	76
	ê	3.0	-1.5	1.1	-1.9	-2.2	.7	
ROP	N	**371**	**380**	**418**	<u>21</u>	<u>11</u>	1032	2263
	N_{exp}	**239.0**	**155.0**	**213.6**	<u>396.6</u>	<u>135.2</u>	1095.6	2263
	ê	**10.8**	**22.3**	**17.5**	<u>-24.7</u>	<u>-13.1</u>	-3.2	
ROP/Dark	N	0	0	0	1	0	0	1
	N_{exp}	.1	.1	.1	.2	.1	.5	1
	ê	-.3	-.3	-.3	2.2	-.3	-1.0	
ROP/Light	N	14	17	21	**88**	**51**	<u>72</u>	263
	N_{exp}	27.8	18.0	24.8	**46.1**	**15.7**	<u>127.3</u>	263
	ê	-2.8	-.3	-.8	**6.9**	**9.3**	<u>-6.9</u>	
Unidentifiable	N	3	0	4	2	1	8	20
	N_{exp}	2.1	1.4	1.9	3.5	1.2	9.7	20
	ê	.6	-1.2	1.6	-.9	-.2	-.8	
Total	N	808	524	722	1341	457	3704	7651
	N_{exp}	808	524	722	1341	457	3704	7651

Table 8-15. Counts, expected counts, and standardized residuals (ê) for all shell beads by color and stage. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

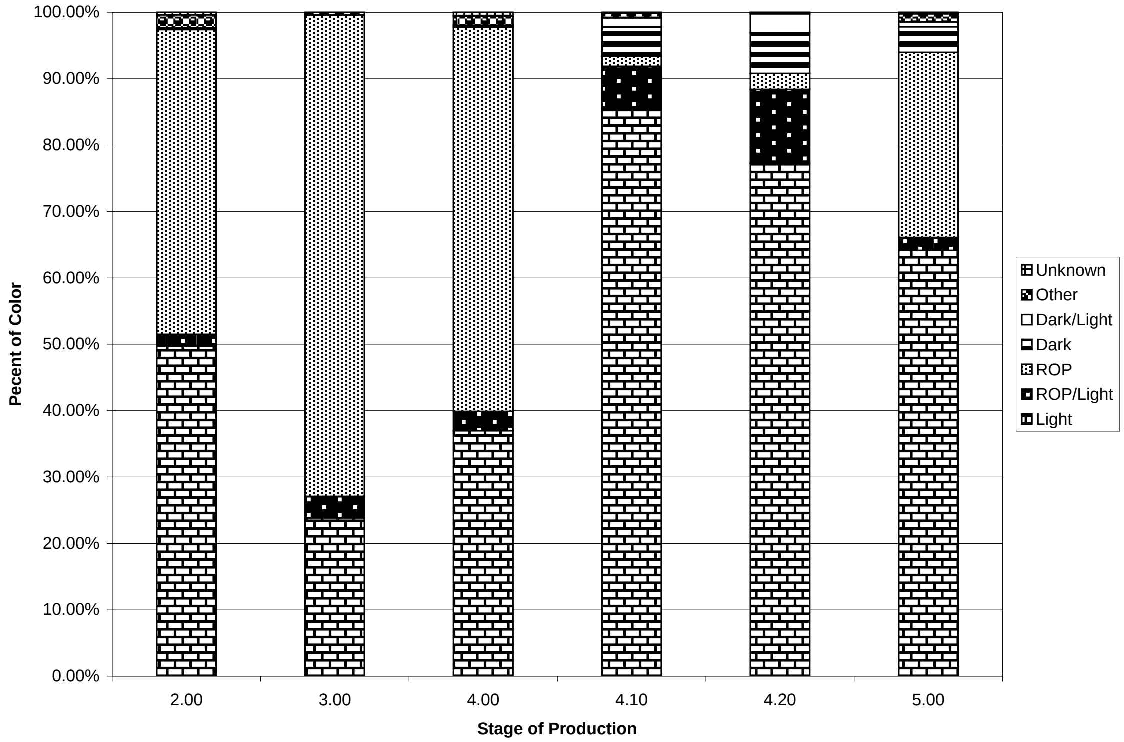


Figure 8-4. Percentage of Beads in Each Stage of Production by Color.

		Diameter	Diameter 2	Average Diameter	Thickness	Thickness 2	Average Thickness	Maximum Perforation	Minimum Perforation
100%	Mean ±std. dev (mm)	**5.27 ±2.17**	5.20 ±2.11	5.24 ±2.13	**2.25 ±1.07**	2.03 ±0.96	2.13 ±0.99	1.79 ±0.53	**1.35 ±0.35**
	N	**2932**	2913	2913	**2919**	2864	2863	2880	**1818**
50-99%	Mean ±std. dev (mm)	**4.37 ±1.49**	4.67 ±1.86	4.75 ±1.81	**1.84 ±0.87**	1.79 ±0.73	1.86 ±0.75	1.69 ±0.47	**1.22 ±0.32**
	N	**411**	55	55	**399**	142	140	203	**145**
	p (Mann-Whitney)	**.000**	.047	.111	**.000**	.031	.005	.007	**.000**
	p (ANOVA)	**.000**	.059	.091	**.000**	.003	.001	.004	**.000**

Table 8-16. 100 % complete bead compared to 50-99% complete beads by various measurements. Only discoid Stage 5 shell beads included; see text. *Note.* A statistically significant difference is where p<.001, shown in bold.

		Dark	Dark/ Light	Green	Light	Other	ROP	ROP/ Dark	ROP/ Light	Total
<50%	N	5	0	0	153	5	**479**	0	13	657
	N_{exp}	21.4	5.2	.6	404.8	6.4	**194.3**	.1	22.5	657.0
	ê	-3.8	-2.4	-.8	-21.1	-.6	**25.5**	-.3	-2.1	
50-99%	N	13	5	0	447	19	**767**	0	35	1291
	N_{exp}	42.0	10.3	1.2	795.3	12.7	**381.9**	.2	44.2	1291.0
	ê	-5.0	-1.8	-1.2	-21.9	2.0	**25.8**	-.5	-1.5	
100%	N	**231**	56	7	**4111**	51	1016	1	214	5699
	N_{exp}	**185.6**	45.5	5.2	**3510.9**	55.9	1685.8	.7	195.3	5699.0
	ê	**6.7**	3.1	1.5	**32.4**	-1.3	-38.5	.6	2.7	
Total	N	249	61	7	4711	75	2262	1	262	7647
	N_{exp}	249.0	61.0	7.0	4711.0	75.0	2262.0	1.0	262.0	7647.0

Table 8-17. Color of All Shell Beads by Fragmentation Code. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

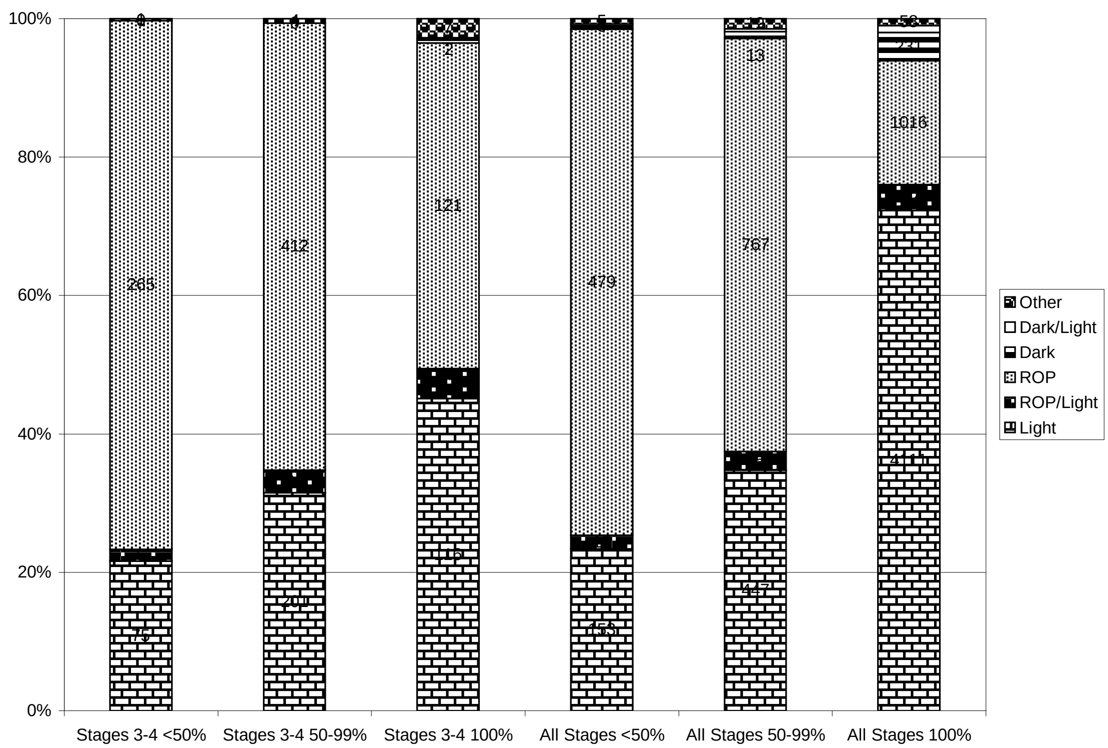


Figure 8-5. Percent of Beads in Each Fragmentation by Color for Beads in Stages 3 and 4 and in All Stages

Data	Dark	Light	ROP	ROP/Light
Diameter (n)	244	4617	2025	247
Mean ± std. dev.	7.05 ±2.66	6.55 ±2.79	4.02 ±1.33	7.73 ±2.98
Diameter 2 (n)	221	4134	1017	211
Mean ± std. dev	6.78 ±2.49	6.48 ±2.61	3.89 ±1.51	7.70 ±2.73
Diameter Diff. (n)	221	4134	1017	211
Mean ± std. dev	0.37 ±0.51	0.35 ±0.52	0.19 ±0.29	0.62 ±0.68
Average Diameter (n)	221	4134	1017	211
Mean ± std. dev	6.90 ±2.57	6.61 ±2.70	3.94 ±1.56	7.94 ±2.79
Thickness (n)	246	4635	2042	246
Mean ± std. dev	2.75 ±1.54	2.41 ±0.96	1.61 ±0.66	2.56 ±1.09
Thickness 2 (n)	225	4225	1150	242
Mean ± std. dev	2.22 ±1.03	2.00 ±0.81	1.51 ±0.61	1.95 ±0.72
Thickness Diff. (n)	225	4222	1149	242
Mean ± std. dev	0.45 ±0.45	0.45 ±0.52	0.16 ±0.22	0.68 ±0.67
Average Thickness (n)	225	4222	1149	242
Mean ± std. dev	2.43 ±1.06	2.22 ±0.85	1.57 ±0.63	2.26 ±0.85
Max Perforation (n)	234	3893	781	206
Mean ± std. dev	2.17 ±0.64	2.13 ±0.62	1.40 ±0.44	2.24 ±0.65
Min Perforation (n)	129	2025	617	54
Mean ± std. dev	1.52 ±0.42	1.52 ±0.40	1.10 ±0.27	1.35 ±0.38
Perforation Diff. (n)	129	2024	617	54
Mean ± std. dev	0.41 ±0.29	0.49 ±0.38	0.32 ±0.26	0.53 ±0.33

Table 8-18. All measurements (mm) by color for discoid shell beads. Note: Dark/Light excluded because the distribution is not normal. ROP/Dark, Green , Other, and Unknown groups excluded because of small sample size. See Table 8-19 for Statistically Similar Means.

	ROP (1)	ROP/Light (2)	Light (3)	Dark (5)
ROP (1)	-------------			PD (.001)
ROP/Light (2)		-------------	T1, T2, AT, +P, -P, PD	D1, T1, T2, AT, +P, -P, PD
Light (3)		T1, T2, AT, +P, -P, PD	-------------	D1, D2, DD, AD, TD, AT, +P, -P, PD
Dark (5)	PD (.001)	D1, T1, T2, AT, +P, -P, PD	D1, D2, DD, AD, TD, AT, +P, -P, PD	-------------

Table 8-19. Bead Dimensions that are not Statistically Different by Color. Code means that the two colors were not statistically different for all three tests, including Tukey's HSD, Tamhane T2 and Mann-Whitney. D1- diameter 1, D2- Diameter 2, DD- Diameter Difference, AD Ave. Diameter, T1- Thickness 1, T2- Thickness 2, DT- Thickness Difference, AT- Ave. Thickness, +P- Max. Perforation, -P – Min. Perforation, and PD= Perforation Difference.

Site Name		2	3	4	4.1	4.2	5	Total
Loma de los Cangrejitos	N	**116**	**101**	**175**	0	0	164	556
	N_{exp}	**59.5**	**38.6**	**53.1**	98.7	33.6	272.6	556
	ê	**8.1**	**10.8**	**18.3**	-11.4	-6.2	-9.6	
López Viejo	N	**674**	**403**	**510**	6	2	1204	2799
	N_{exp}	**299.3**	**194.1**	**267.5**	496.8	169.3	1372.1	2799
	ê	**28.9**	**19.6**	**19.7**	-30.6	-16.7	-8.0	
Los Frailes	N	6	2	4	2	2	**70**	86
	N_{exp}	9.2	6.0	8.2	15.3	5.2	**42.2**	86.0
	ê	-1.1	-1.7	-1.6	-3.8	-1.5	**6.0**	
Mar Bravo	N	9	4	12	**542**	**287**	**1198**	2052
	N_{exp}	219.4	142.3	196.1	**364.2**	**124.1**	**1005.9**	2052
	ê	-17.6	-14.1	-16.2	**12.0**	**17.7**	**9.9**	
Puerto de Chanduy	N	2	6	11	44	11	**701**	775
	N_{exp}	82.9	53.7	74.1	137.5	46.9	**379.9**	775
	ê	-9.9	-7.1	-8.1	-9.3	-5.7	**24.4**	
Salango	N	1	8	10	**747**	**155**	367	1288
	N_{exp}	137.7	89.3	123.1	**228.6**	**77.9**	631.4	1288
	ê	-13.5	-9.8	-11.8	**41.5**	**9.9**	-16.2	
Total	N	808	524	722	1341	457	3704	7556
	N_{exp}	808	524	722	1341	457	3704	7556

Table 8-20. Frequency and Expected Frequency for All Beads by Site and Stage. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4). The 95 beads in stages 0 and 1 are excluded from this analysis.

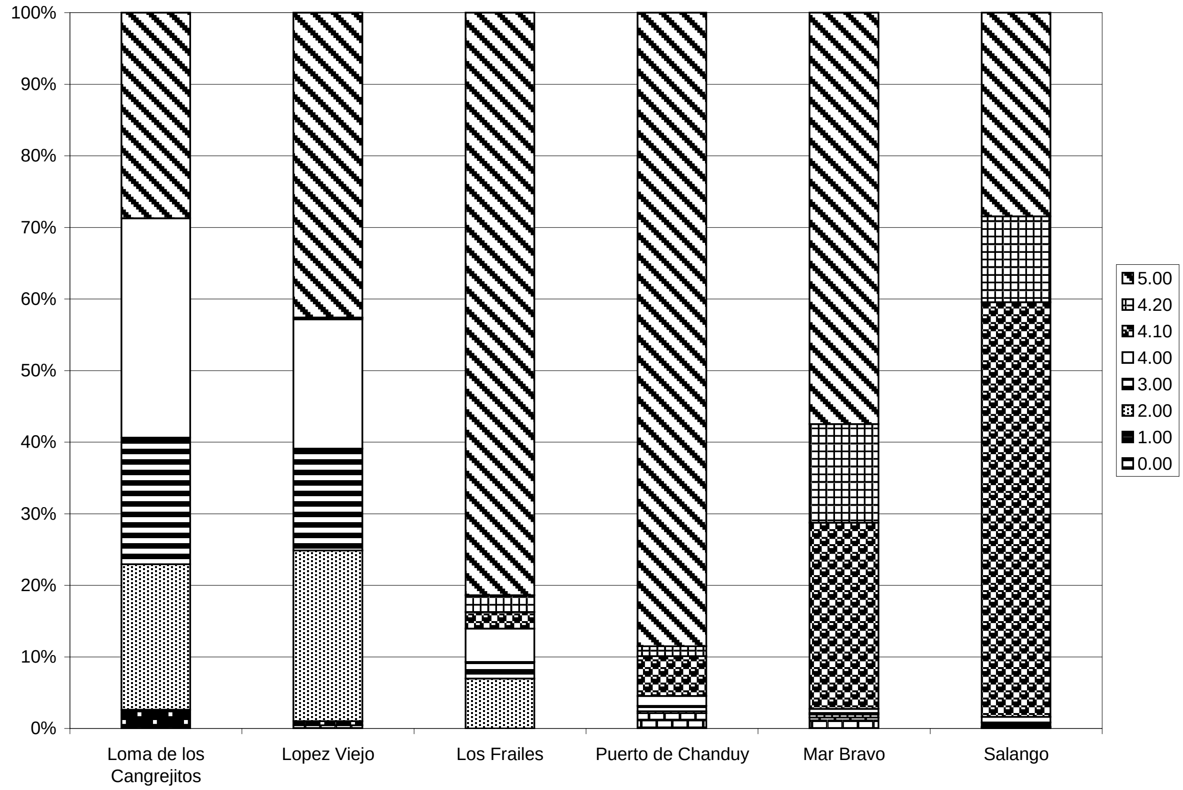


Figure 8-6. Percentage of All Beads at Each Archaeological Site by Stage.

		Stage 2.0	Stage 3.0	Stage 4.0	Stage 4.1	Stage 4.2	Stage 5.0	Total
Loma de los Cangrejitos	N	116	101	**175**	0	0	164	556
	N_{exp}	130.9	83.5	**113.5**	1.0	.3	226.7	556.0
	ê	-1.6	2.3	**7.1**	-1.1	-.6	-5.9	
López Viejo	N	674	403	510	6	2	**1204**	2799
	N_{exp}	659.1	420.5	571.5	5.0	1.7	**1141.3**	2799.0
	ê	1.6	-2.3	-7.1	1.1	.6	**5.9**	
Total	N	790	504	685	6	2	1368	3355
	N_{exp}	790.0	504.0	685.0	6.0	2.0	1368.0	3355.0

Table 8-21. All Shell Beads from Loma de los Cangrejitos and López Viejo by Stage. *Note*: Chi square test indicates significant differences (p<.001), φ= .143. Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

		Stage 2.0	Stage 3.0	Stage 4.0	Stage 4.1	Stage 4.2	Stage 5.0	Total
Los Frailes	N	**6**	2	4	2	2	70	86
	N_{exp}	**.8**	.8	1.5	4.6	1.3	77.0	86.0
	ê	**6.2**	1.4	2.2	-1.3	.7	-2.6	
Puerto de Chanduy	N	2	6	11	44	11	701	775
	N_{exp}	7.2	7.2	13.5	41.4	11.7	694.0	775.0
	ê	-6.2	-1.4	-2.2	1.3	-.7	2.6	
Total	N	8	8	15	46	13	771	861
	N_{exp}	8.0	8.0	15.0	46.0	13.0	771.0	861.0

Table 8-22. All Shell Beads from Los Frailes and Puerto de Chanduy by Stage. Note: Chi square test indicates significant differences (p<.001), φ= .234. Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

		Stage 2.0	Stage 3.0	Stage 4.0	Stage 4.1	Stage 4.2	Stage 5.0	Total
Mar Bravo	N	9	4	12	542	287	**1198**	2052
	N_{exp}	6.1	7.4	13.5	791.9	271.6	**961.5**	2052.0
	ê	1.9	-2.0	-.7	-18.3	1.6	**16.8**	
Salango	N	1	8	10	**747**	155	367	1288
	N_{exp}	3.9	4.6	8.5	**497.1**	170.4	603.5	1288.0
	ê	-1.9	2.0	.7	**18.3**	-1.6	-16.8	
Total	N	10	12	22	1289	442	1565	3340
	N_{exp}	10.0	12.0	22.0	1289.0	442.0	1565.0	3340.0

Table 8-23. All Shell Beads from Mar Bravo and Salango by Stage. Note: Chi square test indicates significant differences (p<.001), φ= .331. Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

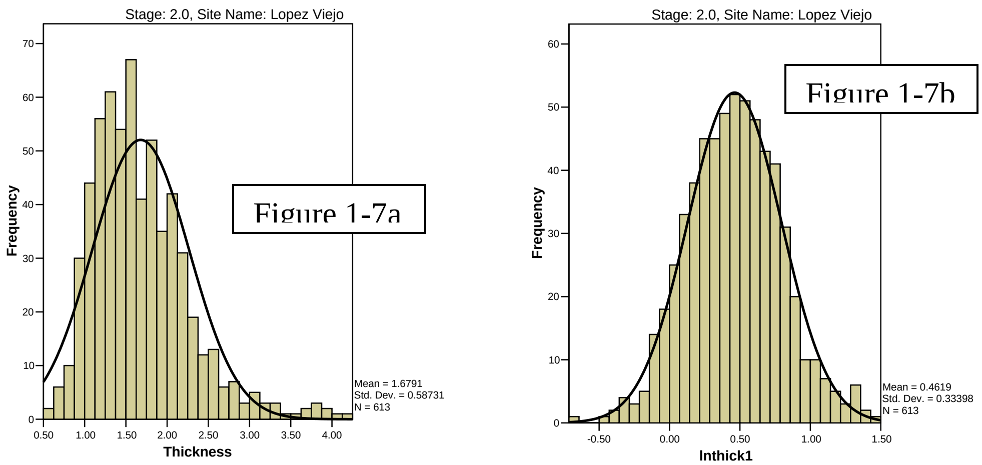


Figure 8-7. Histogram of maximum thickness measurement and the natural log of maximum thickness measurements. Note: The solid black line is the normal curved based upon mean and standard deviation. The histogram of the natural log of the data are normal, but the untransformed data are not.

Maximum Diameter		Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5
Loma de los Cangrejitos	N	92	79	129	0	0	109
	normal (p)	**.001**	**.002**	**.072**	--------	--------	**.043**
	lognormal (p)	**.419**	**.079**	**.416**	--------	--------	**.514**
	outliers	-------	--------	--------	--------	--------	2
López Viejo	N	615	258	334	6	2	948
	normal (p)	.000	**.050**	.000	--------	--------	.000
	lognormal (p)	.000	**.671**	**.005**	--------	--------	.000
	outliers	--------	2	--------	--------	--------	--------
Los Frailes	N	--------	2	4	2	2	61
	normal (p)	--------	--------	--------	--------	--------	**.917**
	lognormal (p)	--------	--------	--------	--------	--------	**.200**
	outliers	--------	--------	--------	--------	--------	2
Mar Bravo	N	7	4	11	534	283	1179
	normal (p)	--------	--------	--------	.000	**.044**	.000
	lognormal (p)	--------	--------	--------	**.513**	**.315**	.000
	outliers	--------	--------	--------	--------	2	--------
Puerto de Chanduy	N	2	6	11	34	11	682
	normal (p)	--------	--------	--------	**.376**	--------	.000
	lognormal (p)	--------	--------	--------	**.030**	--------	.000
	outliers	--------	--------	--------	10	--------	--------
Salango	N	1	7	10	744	154	360
	normal (p)	--------	--------	--------	.000	**.003**	.000
	lognormal (p)	--------	--------	--------	**.644**	**.459**	.000
	outliers	--------	--------	--------	--------	--------	--------

Table 8-24. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Maximum Diameter by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

Minimum Diameter		Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5
Loma de los Cangrejitos	N	75	17	54	--------	--------	59
	normal (p)	**.001**	--------	**.026**	--------	--------	**.286**
	lognormal (p)	**.037**	--------	**.324**	--------	--------	**.697**
	outliers	--------	--------	--------	--------	--------	1
López Viejo	N	555	60	144	6	2	689
	normal (p)	.000	**.001**	.000	--------	--------	.000
	lognormal (p)	.000	**.087**	.002	--------	--------	.000
	outliers	--------	--------	--------	--------	--------	--------
Los Frailes	N	5	2	3	2	2	60
	normal (p)	--------	--------	--------	--------	--------	**.898**
	lognormal (p)	--------	--------	--------	--------	--------	**.171**
	outliers	--------	--------	--------	--------	--------	2
Mar Bravo	N	7	2	10	499	270	1133
	normal (p)	--------	--------	--------	.000	**.003**	.000
	lognormal (p)	--------	--------	--------	.041	**.413**	.000
	outliers	--------	--------	--------	6	2	--------
Puerto de Chanduy	N	2	3	11	34	11	668
	normal (p)	--------	--------	--------	.000	--------	.000
	lognormal (p)	--------	--------	--------	.021	--------	.000
	outliers	--------	--------	--------	7	--------	--------
Salango	N	1	1	10	724	152	356
	normal (p)	--------	--------	--------	.000	**.135**	.000
	lognormal (p)	--------	--------	--------	**.232**	**.698**	.000
	outliers	--------	--------	--------	5	--------	--------

Table 8-25. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Minimum Diameter by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

Maximum Thickness		Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5
Loma de los Cangrejitos	N	92	75	120	--------	--------	103
	normal (p)	.000	**.085**	**.005**	--------	--------	**.008**
	lognormal (p)	**.619**	**.119**	**.098**	--------	--------	**.691**
	outliers	--------	--------	--------	--------	--------	1
López Viejo	N	613	253	330	6	2	932
	normal (p)	.000	.000	.000	--------	--------	.000
	lognormal (p)	**.477**	**.275**	**.018**	--------	--------	**.004**
	outliers	--------	7	--------	--------	--------	--------
Los Frailes	N	5	2	4	2	2	62
	normal (p)	--------	--------	--------	--------	--------	**.064**
	lognormal (p)	--------	--------	--------	--------	--------	**.836**
	outliers	--------	--------	--------	--------	--------	1
Mar Bravo	N	7	4	11	534	285	1177
	normal (p)	--------	--------	--------	.000	.000	.000
	lognormal (p)	--------	--------	--------	**.011**	**.207**	**.005**
	outliers	--------	--------	--------	--------	--------	--------
Puerto de Chanduy	N	2	6	11	44	11	682
	normal (p)	--------	--------	--------	.000	--------	.000
	lognormal (p)	--------	--------	--------	**.103**	--------	.000
	outliers	--------	--------	--------	--------	--------	--------
Salango	N	1	7	10	744	154	360
	normal (p)	--------	--------	--------	.000	.000	.000
	lognormal (p)	--------	--------	--------	**.096**	**.024**	**.002**
	outliers	--------	--------	--------	--------	--------	--------

Table 8-26. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Maximum Thickness by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

Minimum Thickness		I 2	I 3	I 4	I 4.1	I 4.2	I 5
Loma de los Cangrejitos	N	92	72	115	--------	--------	97
	normal (p)	.000	**.076**	**.063**	--------	--------	**.157**
	lognormal (p)	**.709**	**.456**	**.028**	--------	--------	**.021**
	outliers	--------	--------	--------	--------	--------	2
López Viejo	N	551	61	145	6	2	679
	normal (p)	.000	.000	.000	--------	--------	.000
	lognormal (p)	**.660**	**.009**	**.385**	--------	--------	**.489**
	outliers	--------	--------	--------	--------	--------	--------
Los Frailes	N	5	2	3	2	2	62
	normal (p)	--------	--------	--------	--------	--------	**.111**
	lognormal (p)	--------	--------	--------	--------	--------	**.172**
	outliers	--------	--------	--------	--------	--------	1
Mar Bravo	N	7	3	10	527	275	1138
	normal (p)	--------	--------	--------	.000	.000	.000
	lognormal (p)	--------	--------	--------	**.025**	**.010**	**.017**
	outliers	--------	--------	--------	--------	--------	--------
Puerto de Chanduy	N	2	4	11	44	11	669
	normal (p)	--------	--------	--------	**.063**		.000
	lognormal (p)	--------	--------	--------	**.650**		.000
	outliers	--------	--------	--------	--------	--------	--------
Salango	N	1	5	10	743	153	358
	normal (p)	--------	--------	--------	.000	.000	.000
	lognormal (p)	--------	--------	--------	**.001**	**.164**	**.022**
	outliers	--------	--------	--------	--------	--------	--------

Table 8-27. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Minimum Thickness by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

Maximum Perforation		Stage 4	Stage 4.1	Stage 4.2	Stage 5
Loma de los Cangrejitos	N	98	0	0	93
	normal (p)	**.286**	--------	--------	**.139**
	lognormal (p)	**.190**	--------	--------	**.834**
	outliers	--------	--------	--------	--------
López Viejo	N	167	6	2	722
	normal (p)	**.004**	--------	--------	.000
	lognormal (p)	**.480**	--------	--------	**.004**
	outliers	--------	--------	--------	--------
Los Frailes	N	2	2	2	62
	normal (p)	--------	--------	--------	**.314**
	lognormal (p)	--------	--------	--------	**.001**
	outliers	--------	--------	--------	1
Mar Bravo	N	11	528	284	1162
	normal (p)	--------	.000	**.296**	**.277**
	lognormal (p)	--------	**.296**	**.004**	.000
	outliers	--------	--------	--------	8
Puerto de Chanduy	N	11	44	11	676
	normal (p)	--------	**.003**	--------	.000
	lognormal (p)	--------	**.410**	--------	**.147**
	outliers	--------	--------	--------	--------
Salango	N	9	743	153	358
	normal (p)	--------	.000	**.153**	**.068**
	lognormal (p)	--------	**.017**	**.342**	.000
	outliers	--------	--------	--------	--------

Table 8-28. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Maximum Perforation by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

Minimum Perforation		Stage 4	Stage 4.1	Stage 4.2	Stage 5
Loma de los	N	88	0	0	88
Cangrejitos	normal (p)	**.010**	--------	--------	**.175**
	lognormal (p)	.000	--------	--------	.000
	outliers	--------	--------	--------	--------
López Viejo	N	166	6	2	653
	normal (p)	.000	--------	--------	.000
	lognormal (p)	**.618**	--------	--------	**.072**
	outliers	--------	--------	--------	5
Los Frailes	N	2	2	2	62
	normal (p)	--------	--------	--------	**.885**
	lognormal (p)	--------	--------	--------	**.491**
	outliers	--------	--------	--------	1
Mar Bravo	N	6	157	35	339
	normal (p)	--------	**.002**	**.285**	**.001**
	lognormal (p)	--------	**.779**	**.057**	.000
	outliers	--------	--------	--------	1
Puerto de	N	10	44	11	666
Chanduy	normal (p)	--------	**.002**	--------	.000
	lognormal (p)	--------	**.779**	--------	**.003**
	outliers	--------	--------	--------	3
Salango	N	4	292	57	143
	normal (p)	--------	.000	**.510**	**.036**
	lognormal (p)	--------	**.296**	**.827**	.000
	outliers	--------	--------	--------	--------

Table 8-29. Frequency, Results of Levene's Normality Tests and Excluded Outliers for Untransformed and Log-transformed Minimum Perforation by Site and Stage. Note: p indicates the probability of Type I error. A p greater than .001 indicates a normal distribution. See text.

		Loma de los Cangrejitos				López Viejo			
		Stage 2	Stage 3	Stage 4	Stage 5	Stage 2	Stage 3	Stage 4	Stage 5
Maximum diameter	Mean	4.47	4.55	4.46	4.58	3.84	3.98	4.16	3.52
	Std. Dev.	0.83	0.82	0.73	1.10	0.83	0.63	0.88	0.88
	Median	4.33	4.28	4.41	4.42	3.60	3.93	4.01	3.41
	Geometric Mean	4.40	4.49	4.40	4.46	3.76	3.93	4.07	3.42
	Geo. Std. Dev.	1.20	1.19	1.18	1.25	1.22	1.17	1.22	1.28
Minimum diameter	Mean	4.20	3.98	4.15	4.40	3.74	3.81	4.00	3.43
	Std. Dev.	0.82	0.68	0.70	1.17	0.78	0.59	0.93	0.91
	Median	4.18	3.97	4.07	4.08	3.53	3.78	3.94	3.30
	Geometric Mean	4.12	3.92	4.09	4.26	3.67	3.77	3.91	3.31
	Geo. Std. Dev.	1.21	1.20	1.18	1.28	1.21	1.16	1.24	1.30
Maximum thickness	Mean	1.68	1.70	1.62	1.75	1.68	1.76	1.72	1.58
	Std. Dev.	0.70	0.57	0.55	0.72	0.59	0.69	0.64	0.67
	Median	1.52	1.61	1.55	1.62	1.58	1.62	1.64	1.50
	Geometric Mean	1.55	1.60	1.53	1.64	1.59	1.66	1.62	1.46
	Geo. Std. Dev.	1.51	1.42	1.42	1.44	1.40	1.40	1.41	1.49
Minimum thickness	Mean	1.61	1.70	1.63	1.72	1.58	1.75	1.59	1.45
	Std. Dev.	0.64	0.57	0.53	0.70	0.56	0.57	0.59	0.59
	Median	1.45	1.63	1.60	1.61	1.49	1.60	1.52	1.35
	Geometric Mean	1.49	1.60	1.55	1.60	1.50	1.68	1.49	1.34
	Geo. Std. Dev.	1.47	1.41	1.41	1.45	1.40	1.33	1.43	1.49
Maximum perforation	Mean			1.76	1.84			1.47	1.43
	Std. Dev.			0.31	0.37			0.43	0.36
	Median							1.41	1.39
	Geometric Mean			1.73	1.80			1.39	1.38
	Geo. Std. Dev.			1.19	1.22			1.58	1.29
Minimum perforation	Mean	.		1.08	1.25			1.07	1.20
	Std. Dev.			0.23	0.26			0.27	0.28
	Median							1.05	1.18
	Geometric Mean			1.06	1.22			1.03	1.17
	Geo. Std. Dev.			1.29	1.26			1.28	1.26

Table 8-30. Mean, Standard deviation, Median, Geometric Mean, and Geometric Standard Deviation for Discoid Shell Beads that are More than 50% Complete from Loma de los Cangrejitos and López Viejo.

		Los Frailes	Puerto de Chanduy	Mar Bravo			Salango		
		Stage 5	Stage 5	Stage 4.1	Stage 4.2	Stage 5	Stage 4.1	Stage 4.2	Stage 5
Maximum diameter	Mean	5.73	4.48	9.24	9.32	6.29	9.79	10.00	7.13
	Std. Dev.	2.63	1.42	1.95	2.00	1.92	1.67	1.77	2.44
	Median	5.39	4.19	9.14	9.08	6.24	9.64	9.94	7.56
	Geometric Mean	5.42	4.33	9.04	9.11	6.01	9.65	9.85	6.63
	Geo. Std. Dev.	1.35	1.28	1.23	1.24	1.36	1.18	1.19	1.50
Minimum diameter	Mean	5.69	4.45	8.77	8.62	6.18	9.20	8.93	6.99
	Std. Dev.	2.57	1.35	1.94	1.90	1.90	1.67	1.77	2.35
	Median	5.33	4.18	8.65	8.41	6.11	9.06	8.79	7.33
	Geometric Mean	5.39	4.30	8.56	8.42	5.91	9.05	8.75	6.52
	Geo. Std. Dev.	1.35	1.29	1.26	1.24	1.36	1.20	1.22	1.48
Maximum thickness	Mean	2.20	1.85	2.81	2.67	2.71	2.83	2.76	2.91
	Std. Dev.	0.84	0.69	0.87	0.95	1.08	0.76	0.94	1.20
	Median	2.01	1.71	2.66	2.49	2.55	2.75	2.64	2.80
	Geometric Mean	2.07	1.74	2.69	2.52	2.51	2.74	2.63	2.67
	Geo. Std. Dev.	1.41	1.42	1.34	1.40	1.49	1.29	1.36	1.54
Minimum thickness	Mean	1.99	1.69	1.96	1.85	2.41	1.96	1.86	2.56
	Std. Dev.	0.73	0.63	0.58	0.71	1.01	0.58	0.60	1.05
	Median	1.87	1.56	1.88	1.74	2.24	1.88	1.76	2.43
	Geometric Mean	1.86	1.58	1.88	1.74	2.21	1.88	1.78	2.35
	Geo. Std. Dev.	1.44	1.43	1.32	1.40	1.52	1.32	1.35	1.53
Maximum perforation	Mean	1.85	1.54	2.51	2.46	2.07	2.59	2.60	2.09
	Std. Dev.	0.57	0.34	0.58	0.59	0.46	0.57	0.56	0.67
	Median	1.79	1.49	2.43	2.43	2.08	2.58	2.58	2.12
	Geometric Mean	1.79	1.50	2.45	2.39	2.02	2.53	2.54	1.97
	Geo. Std. Dev.	1.28	1.24	1.25	1.28	1.26	1.25	1.25	1.44
Minimum perforation	Mean	1.42	1.23	1.92	1.80	1.71	1.91	1.78	1.66
	Std. Dev.	0.35	0.24	0.33	0.35	0.29	0.31	0.31	0.47
	Median	1.39	1.20	1.88	1.85	1.74	1.86	1.76	1.75
	Geometric Mean	1.39	1.21	1.89	1.76	1.68	1.88	1.75	1.58
	Geo. Std. Dev.	1.23	1.20	1.18	1.23	1.20	1.17	1.19	1.39

Table 8-31. Mean, Standard deviation, Median, Geometric Mean, and Geometric Standard Deviation for Discoid Shell Beads that are More than 50% Complete from Los Frailes, Puerto de Chanduy, Mar Bravo and Salango.

		Stage 2	Stage 3	Stage 4	Stage 4.1	Stage 4.2	Stage 5
Maximum Diameter	Loma de los Cangrejitos	NL	NL	NL			NL
	López Viejo	**X**	NL	L			**X**
	Los Frailes						NL
	Mar Bravo				L	NL	**X**
	Puerto de Chanduy				NL		**X**
	Salango				L	NL	**X**
Minimum Diameter	Loma de los Cangrejitos	NL		NL			NL
	López Viejo	**X**	NL	L			**X**
	Los Frailes						NL
	Mar Bravo				N	NL	**X**
	Puerto de Chanduy				L		**X**
	Salango				L	NL	**X**
Maximum thickness	Loma de los Cangrejitos	L	NL	NL			NL
	López Viejo	L	L	L			L
	Los Frailes						NL
	Mar Bravo				L	L	L
	Puerto de Chanduy				L		**X**
	Salango				L	L	L
Minimum Thickness	Loma de los Cangrejitos	L	NL	NL			NL
	López Viejo	L	L	L			L
	Los Frailes						NL
	Mar Bravo				L	L	L
	Puerto de Chanduy				NL		**X**
	Salango				L	L	L
Maximum Perforation	Loma de los Cangrejitos			NL			NL
	López Viejo			NL			L
	Los Frailes						NL
	Mar Bravo				L	NL	N
	Puerto de Chanduy				NL		L
	Salango				L	NL	N
Minimum Perforation	Loma de los Cangrejitos			N			N
	López Viejo			L			L
	Los Frailes						NL
	Mar Bravo				NL	NL	N
	Puerto de Chanduy				NL		L
	Salango				L	NL	N

Table 8-32. Summary of Normality, Log-normality, or Non-normality for Distributions of Measurements for Discoid Shell Beads that are More than 50% Complete by Site and Stage. *Note*: N=not non-normal (p<.001), L= not non-log-normal (p<.001), and X= non-normal. See text.

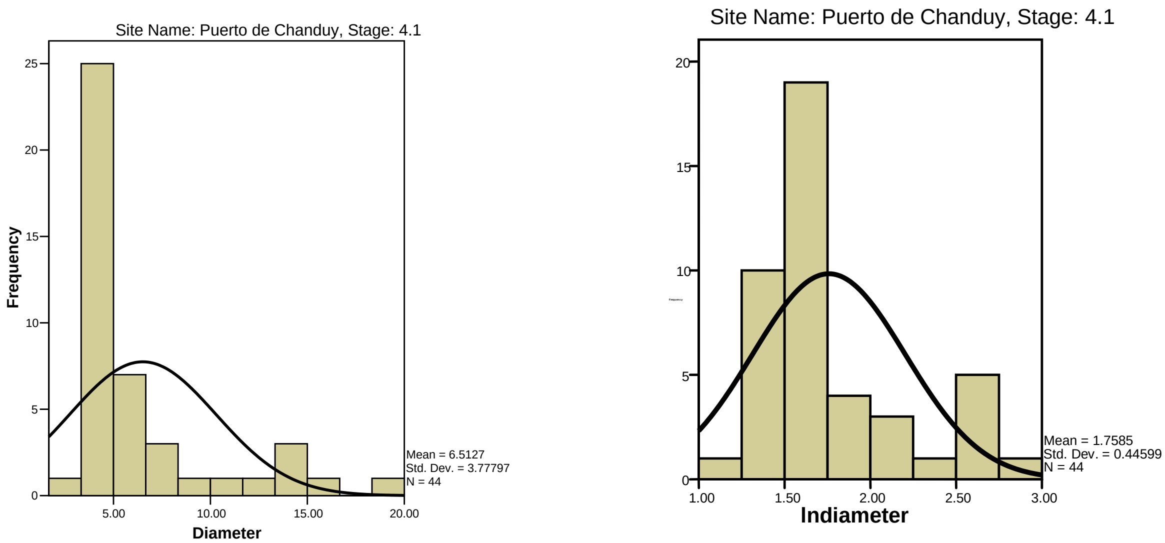


Figure 8-8. Un-transformed and Log-Transformed Distributions of Minimum Diameter for Discoid Shell Beads that are More than 50% Complete in stage 4.1 from Puerto de Chanduy. Note: the black curve represents the normal curve for the calculated mean and standard deviation.

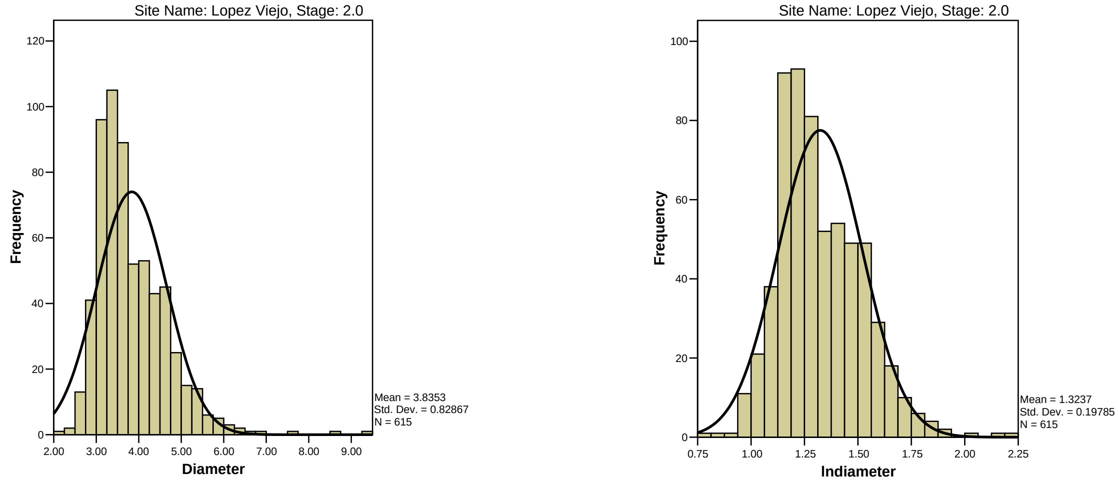


Figure 8-9. Un-transformed and Log-Transformed Distributions of Minimum Diameter for Discoid Shell Beads that are More than 50% Complete in Stage 2 from López Viejo. Note: the black curve represents the normal curve for the calculated mean and standard deviation.

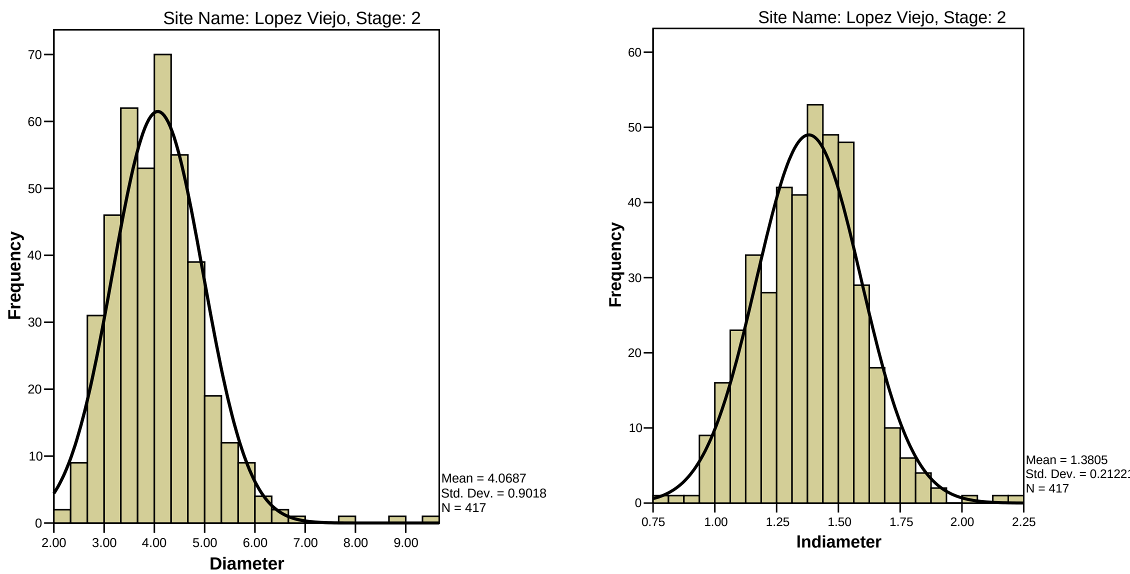


Figure 8-10. Same as Figure 8-9, except the 198 Stage 2 beads from context LV-752 have been removed. *Note*: The data are log-transformed data are normal (p=.017).

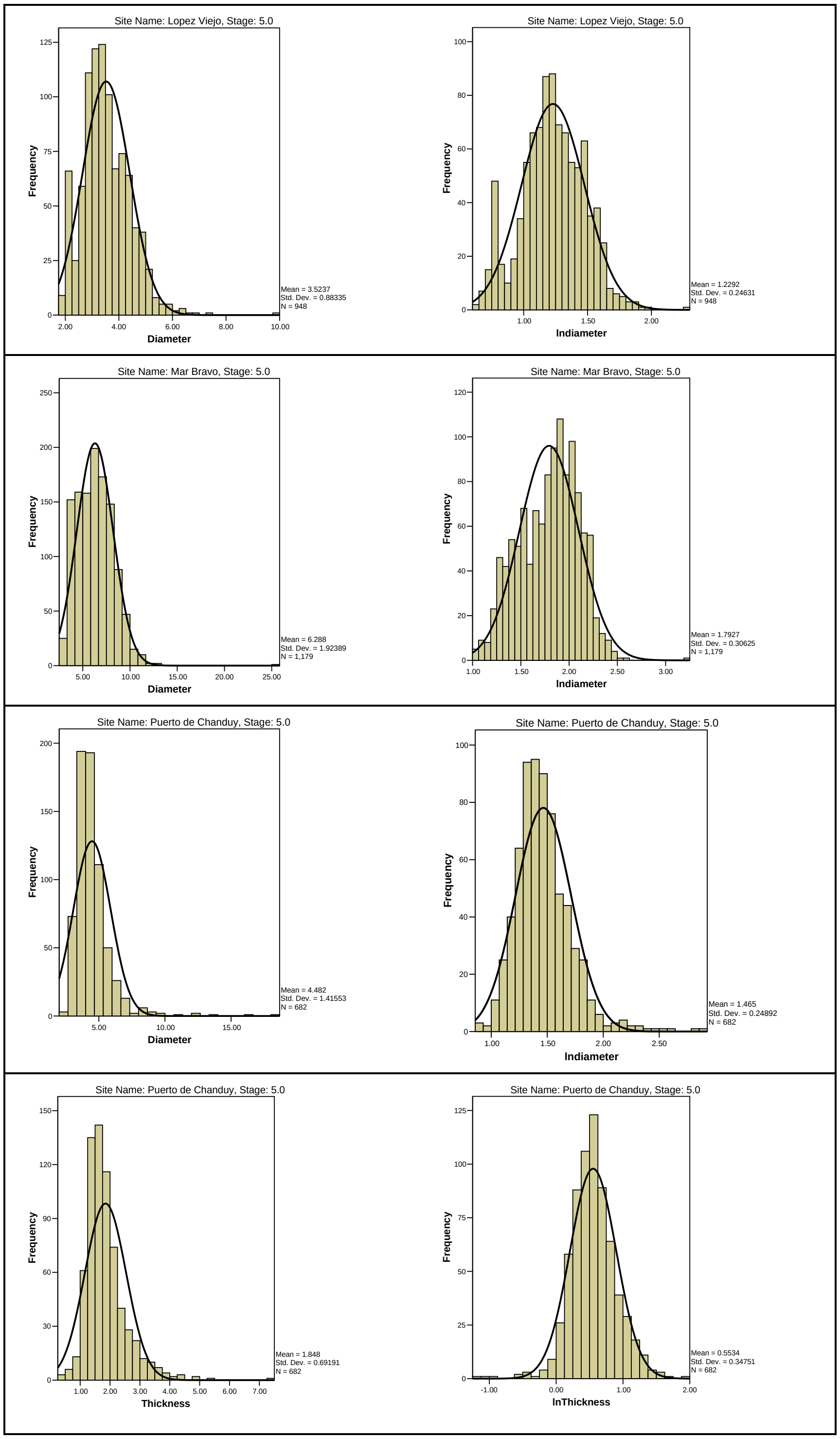


Figure 8-11. Four pairs of distributions for untransformed and log-transformed data for discoid shell beads from López Viejo, Puerto de Chanduy, and Mar Bravo. *Note*: All of these distributions are non-normal according to the Wilk-Shapiro test; see text for explanation.

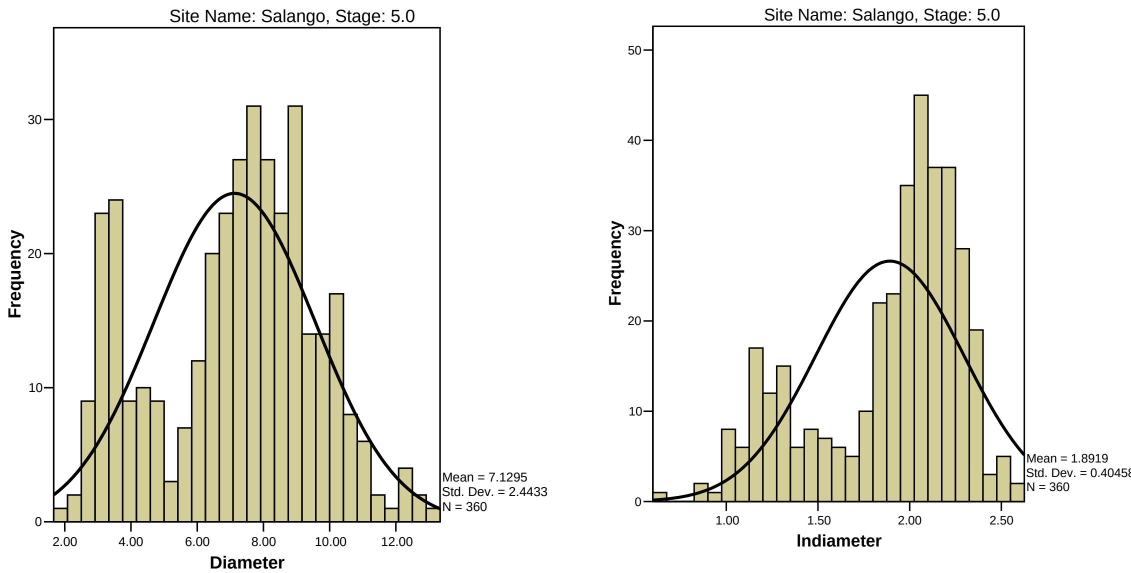


Figure 8-12. -transformed and Log-Transformed Distributions of Minimum Diameter for Discoid Shell Beads that are More than 50% Complete in Stage 2 from López Viejo. Note: the black curve represents the normal curve for the calculated mean and standard deviation. Notice the two distinct modes/

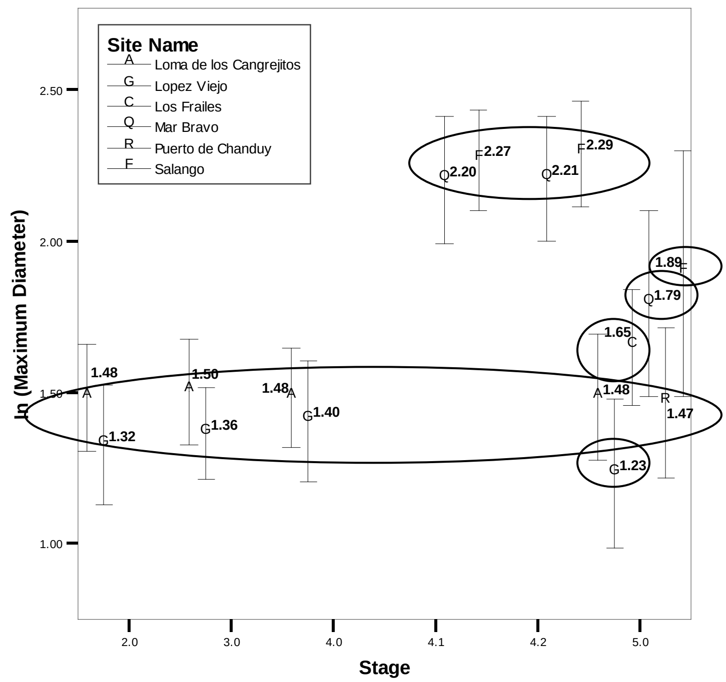


Figure 8-13. Means of Maximum Diameter for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

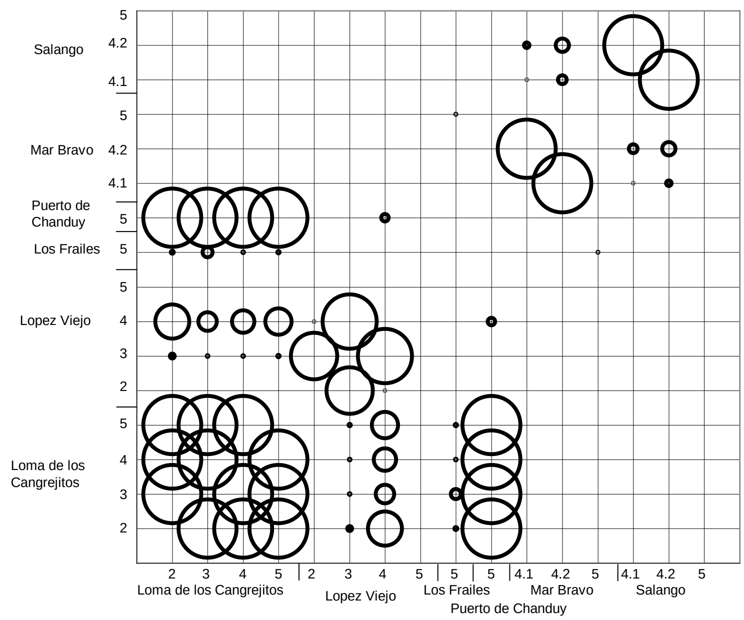


Figure 8-14. Diagrammatic Representation of Tukey HSD Results for Log-Transformed Maximum Diameter by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

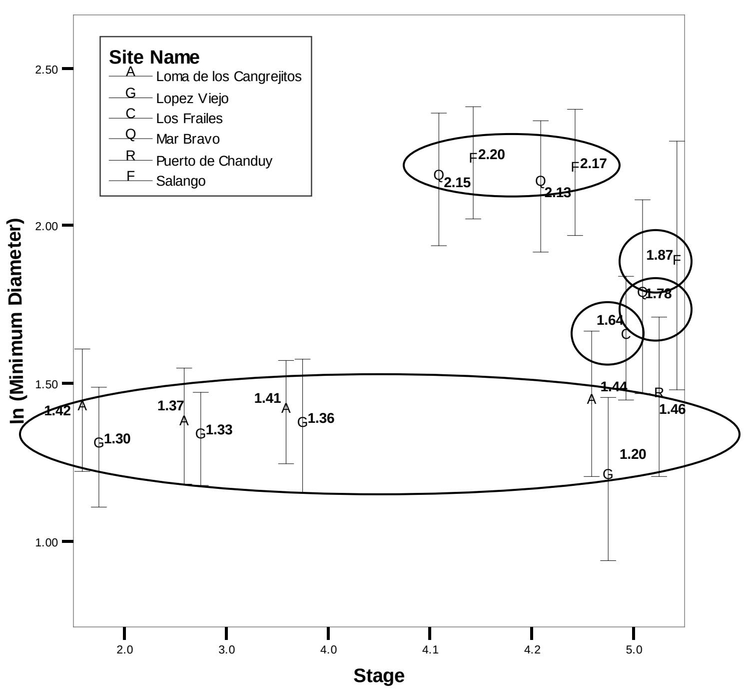


Figure 8-15. Means of Minimum Diameter for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

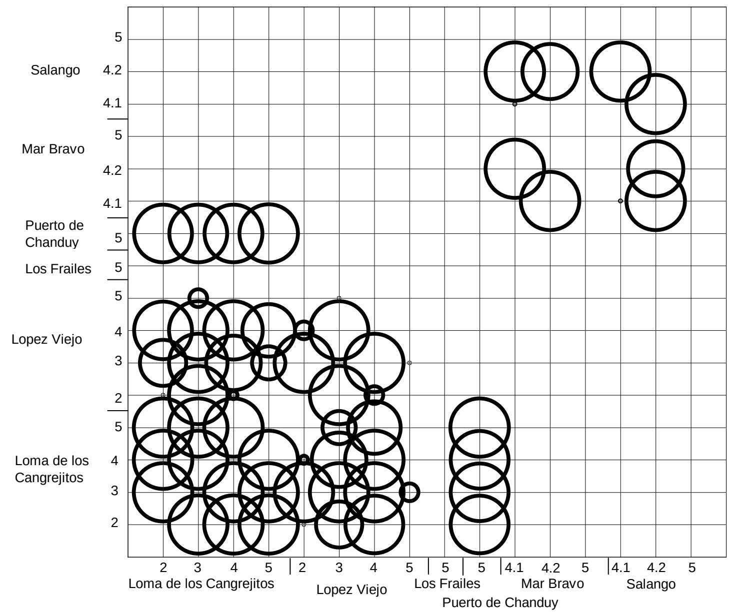


Figure 8-16. Diagrammatic Representation of Tukey HSD Results for Log-Transformed Minimum Diameter by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

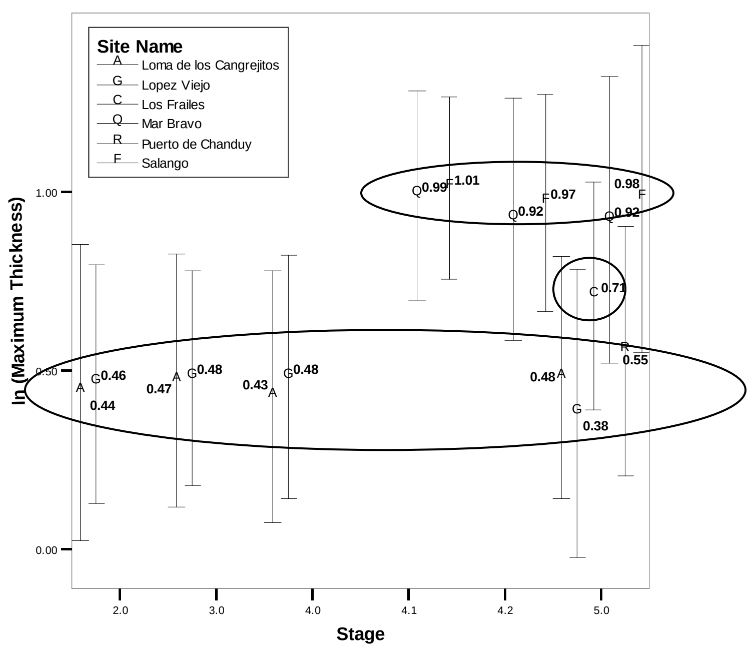


Figure 8-17. Means of Maximum Thickness for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

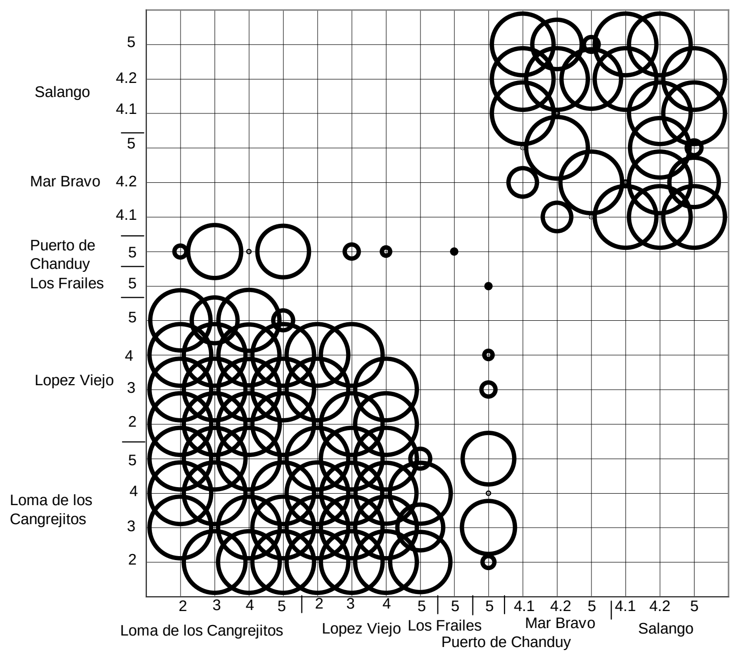


Figure 8-18 Diagrammatic Representation of Tukey HSD Results for Log-Transformed Maximum Thickness by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

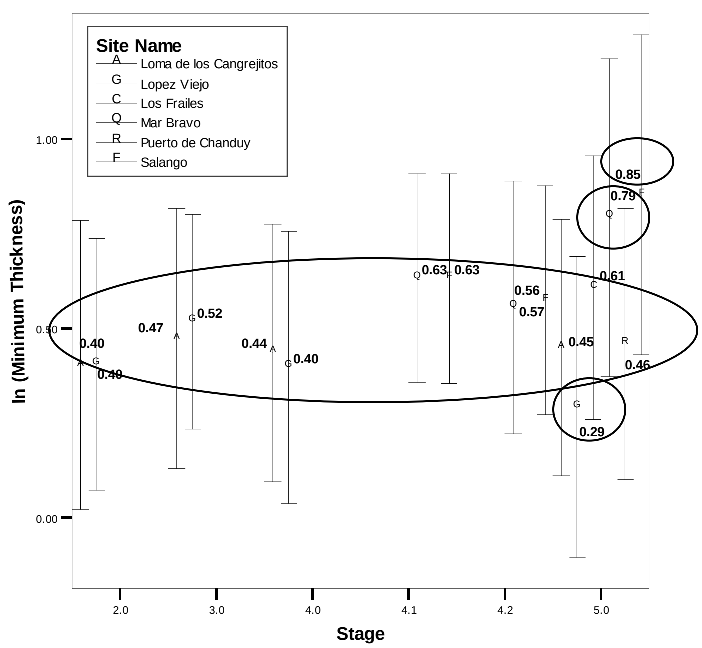


Figure 8-19. Means of Minimum Thickness for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

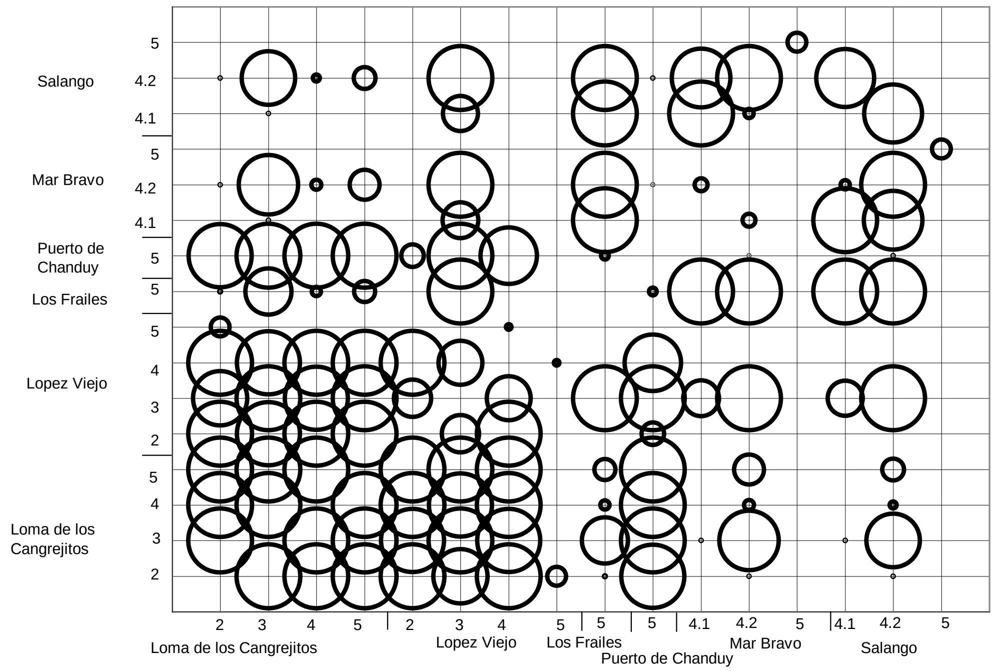


Figure 8-20. Diagrammatic Representation of Tukey HSD Results for Log-Transformed Minimum Thickness by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

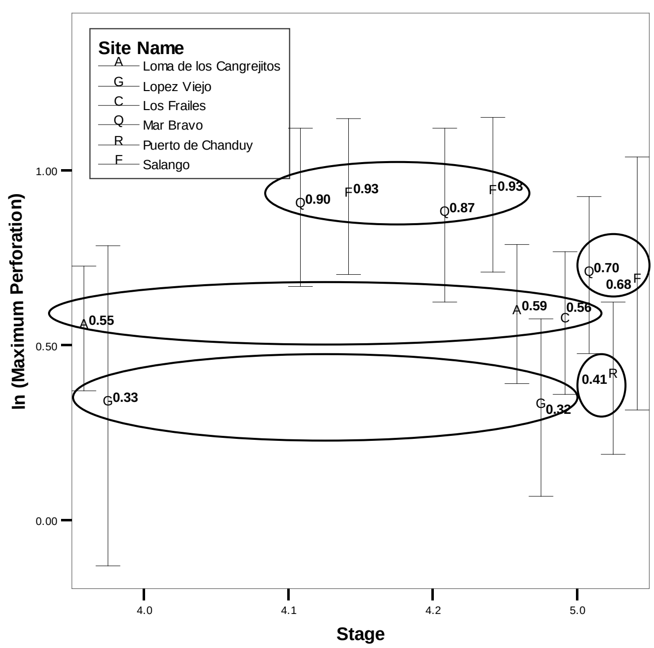


Figure 8-21. Means of Maximum Perforation for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

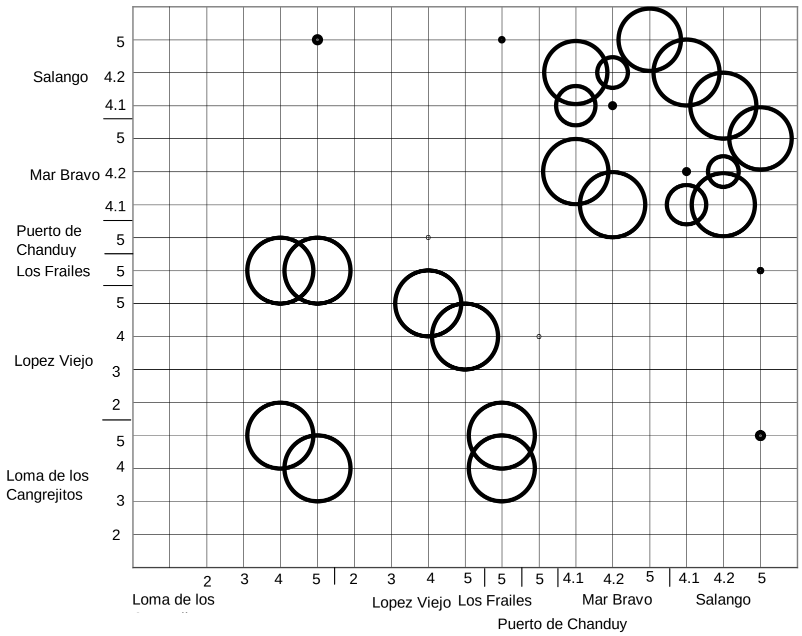


Figure 8-22. Diagrammatic Representation of Tukey HSD Results for Log-Transformed Maximum Perforation by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

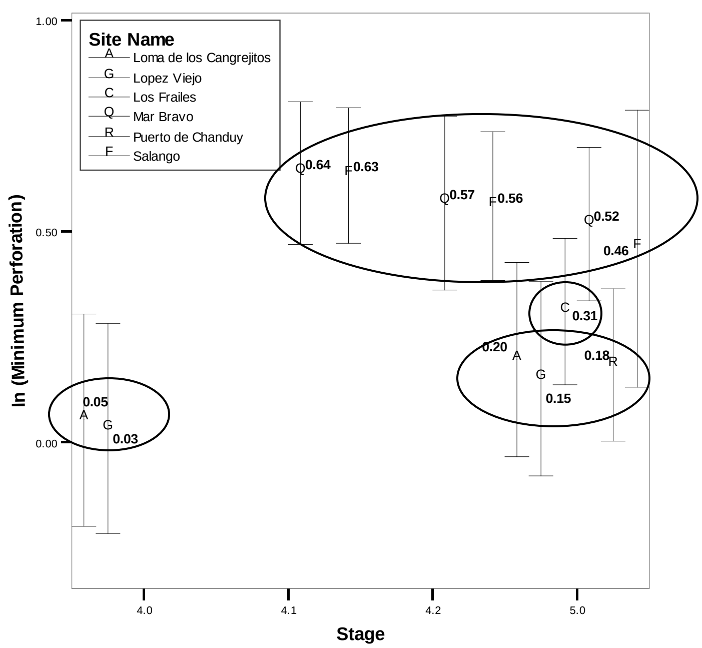


Figure 8-23. Means of Minimum Perforation for Log-Transformed Data by Site and Stage Showing One Standard Deviation. Note: Ovals indicate groups of statically similar site/stage combinations.

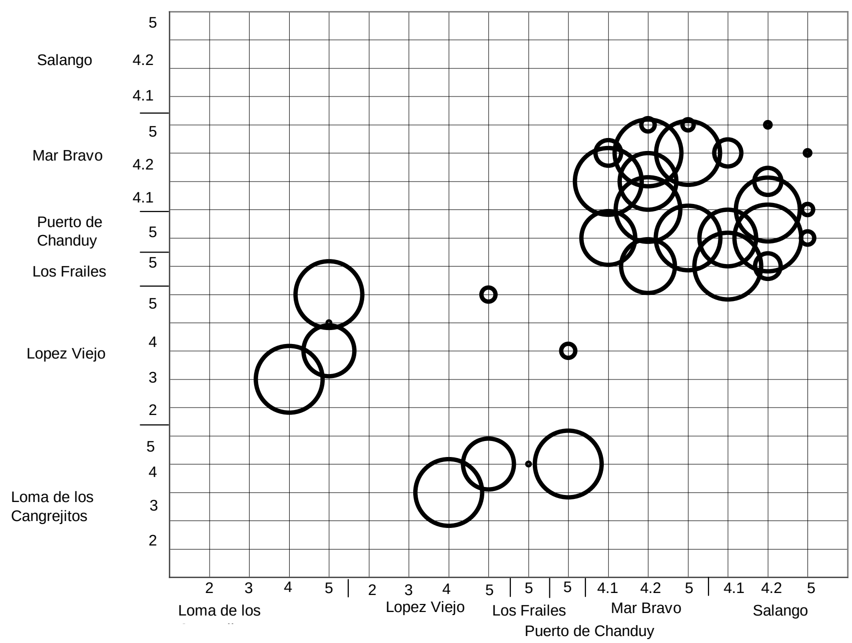


Figure 8-24. Diagrammatic Representation of Tukey HSD Results for Log-Transformed Minimum Perforation by Site/Stage Groups. Note: Larger circles indicate greater likelihood that the means of the two groups are similar.

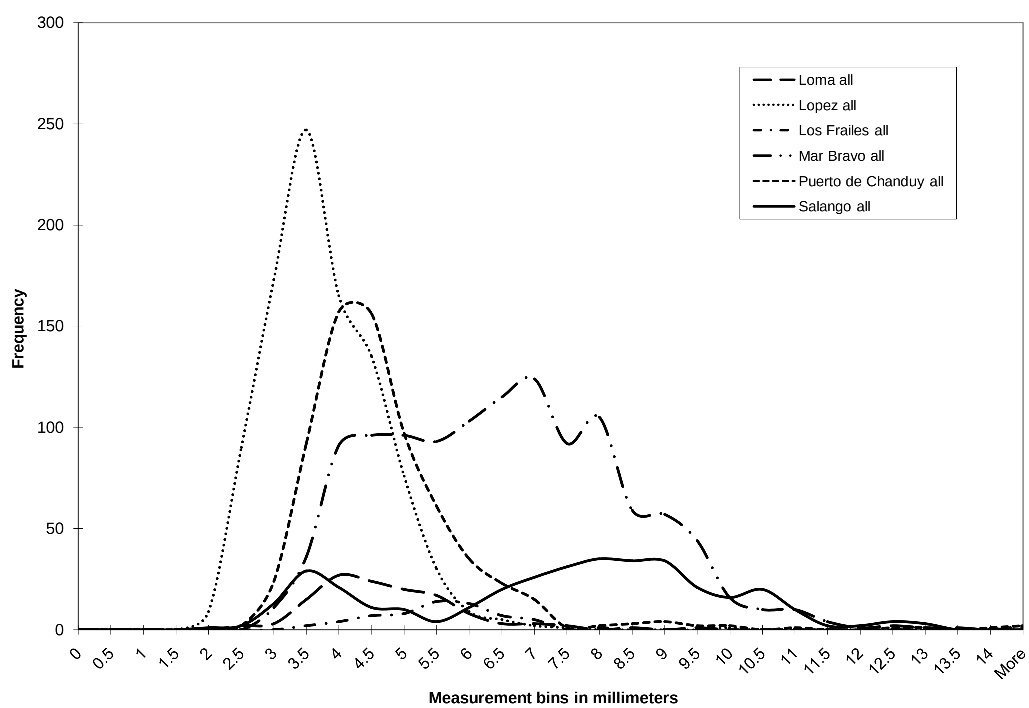


Figure 8-25. Smoothed Distributions for Maximum Diameter for All Stage 5 Discoid Shell Beads More than 50% Complete.

		Dark	Dark/ Light	Light	ROP	ROP/ Light	Total
Loma de los Cangrejitos	N	0	0	73	**390**	**68**	531
	N_{exp}	17.5	4.3	331.4	**159.2**	**18.5**	531.0
	ê	-4.4	-2.2	-24.0	**22.7**	**12.1**	
López Viejo	N	18	1	1219	**1557**	10	2805
	N_{exp}	92.6	22.7	1750.8	**841.2**	97.8	2805.0
	ê	-9.9	-5.8	-26.2	**37.2**	-11.4	
Los Frailes	N	5	0	41	37	3	86
	N_{exp}	2.8	.7	53.7	25.8	3.0	86.0
	ê	1.3	-.8	-2.8	2.7	.0	
Mar Bravo	N	**98**	**36**	**1762**	81	87	2064
	N_{exp}	**68.1**	**16.7**	**1288.3**	619.0	71.9	2064.0
	ê	**4.3**	**5.6**	**25.3**	-30.3	2.1	
Puerto de Chanduy	N	**64**	0	**591**	104	15	774
	N_{exp}	**25.5**	6.3	**483.1**	232.1	27.0	774.0
	ê	**8.2**	-2.7	**8.5**	-10.6	-2.5	
Salango	N	**64**	**24**	**1024**	94	**80**	1286
	N_{exp}	**42.4**	**10.4**	**802.7**	385.7	**44.8**	1286.0
	ê	**3.7**	**4.7**	**14.0**	-19.5	**5.9**	
Total	N	249	61	4710	2263	263	7546
	N_{exp}	249.0	61.0	4710.0	2263.0	263.0	7546.0

Table 8-33. Cross Tabulation of Shell Color and Site for discoid shell beads that are more than 50% complete. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

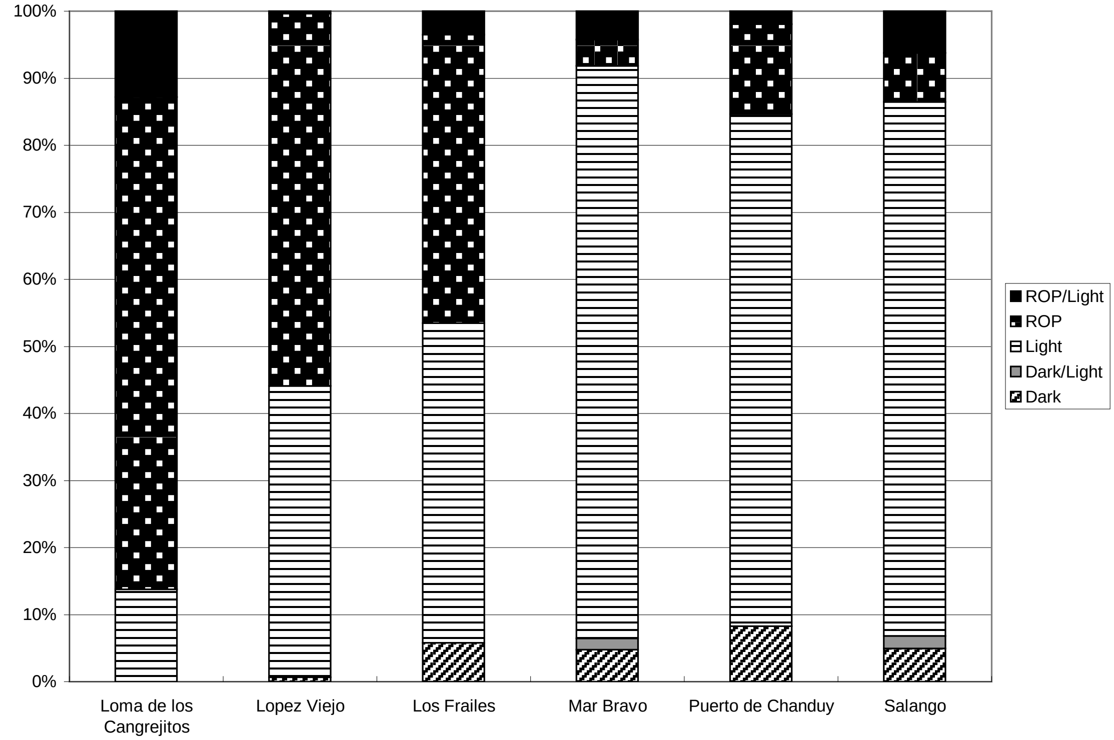


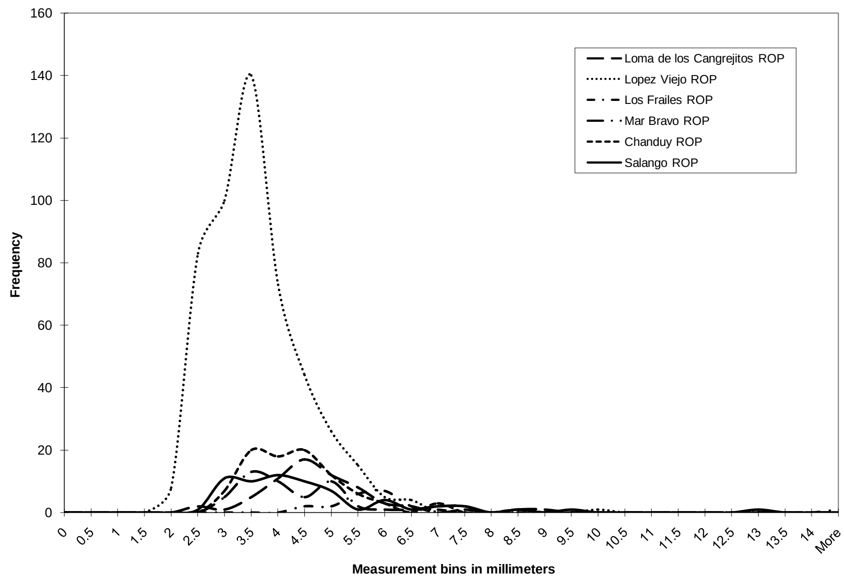
Figure 8-26. Bar Graph, showing the distribution of beads of different color. Data are from Table 8-33.

Site	Stage	Dark	Dark/ Light	Light	ROP	ROP/ Light	Total
Loma de los	2.0			10	**86**	11	107
Cangrejitos	3.0			5	**80**	15	100
	4.0			**31**	**113**	19	163
	5.0			25	**99**	23	147
López Viejo	2.0	1	1	**386**	**275**	2	665
	3.0			**113**	**289**	1	403
	4.0	2		**217**	**289**		508
	4.1	1		2	2	1	6
	4.2			1	1		2
	5.0	13		**489**	**685**	6	1193
Los Frailes	2.0				6		6
	3.0				2		2
	4.0				4		4
	4.1			2			2
	4.2			1		1	2
	5.0	5		**38**	25	2	70
Mar Bravo	2.0			4	3	1	8
	3.0			1	2		3
	4.0			5	5	2	12
	4.1	20	4	**480**	3	27	534
	4.2	15	10	**218**	9	**33**	285
	5.0	**51**	21	**1037**	**57**	24	1190
Puerto de Chanduy	2.0			2			2
	3.0			5	1		6
	4.0			9	2		11
	4.1	5		33	3	1	42
	4.2			11			11
	5.0	**57**		**517**	**98**	14	686
Salango	2.0				1		1
	3.0			1	6	1	8
	4.0			5	5		10
	4.1	**32**	15	**626**	13	**59**	745
	4.2	13	3	**121**	1	17	155
	5.0	18	6	**270**	**68**	3	365

Table 8-34. Frequency of Bead Color for All Shell Beads by Site and Stage. Note: Bold indicates sample sizes that are large enough for ANOVA test (see Table 8-35).

Site	Measurement	Stage	Dark	Dark/ Light	Light	ROP
López Viejo	Max. Thickness	3			1.89	1.49
López Viejo	Max. Thickness	4			1.81	1.42
López Viejo	Min. Thickness	4			1.63	1.26
López Viejo	Max. Perforation	4			1.54	1.14
López Viejo	Min. Perforation	4			1.10	0.93
López Viejo	Max. Diameter	5			3.67	3.22
López Viejo	Min. Diameter	5			3.63	2.97
López Viejo	Max. Thickness	5			1.66	1.31
López Viejo	Min. Thickness	5			1.49	1.16
López Viejo	Max. Perforation	5			1.55	1.21
López Viejo	Min. Perforation	5			1.27	1.04
Mar Bravo	Max. Diameter	5	6.36		6.05	4.19
Mar Bravo	Min. Diameter	5	6.23		5.93	4.10
Mar Bravo	Max. Thickness	5	2.59	3.56	2.54	1.67
Mar Bravo	Min. Thickness	5	2.23		2.23	1.52
Mar Bravo	Max. Perforation	5	2.13		2.04	1.40
Puerto de Chanduy	Max. Thickness	5	2.12		1.75	1.67
Puerto de Chanduy	Min. Thickness	5	1.97		1.59	1.51
Puerto de Chanduy	Max. Perforation	5	1.59		1.54	1.29
Puerto de Chanduy	Min. Perforation	5	1.27		1.23	1.05
Salango	Max. Diameter	5			7.39	4.10
Salango	Min. Diameter	5			7.17	4.10
Salango	Max. Thickness	5			2.92	1.65
Salango	Min. Thickness	5			2.54	1.50
Salango	Max. Perforation	5			2.19	1.22
Salango	Min. Perforation	5			1.75	1.12

Table 8-35. All Statistically Different Geometric Means (in mm) for Measurements of Different Colored beads Within Site and Stage Categories for all Discoid Shell Beads Greater than 50% Complete. *Note*: the underlined are statistically smaller than the others in the row.



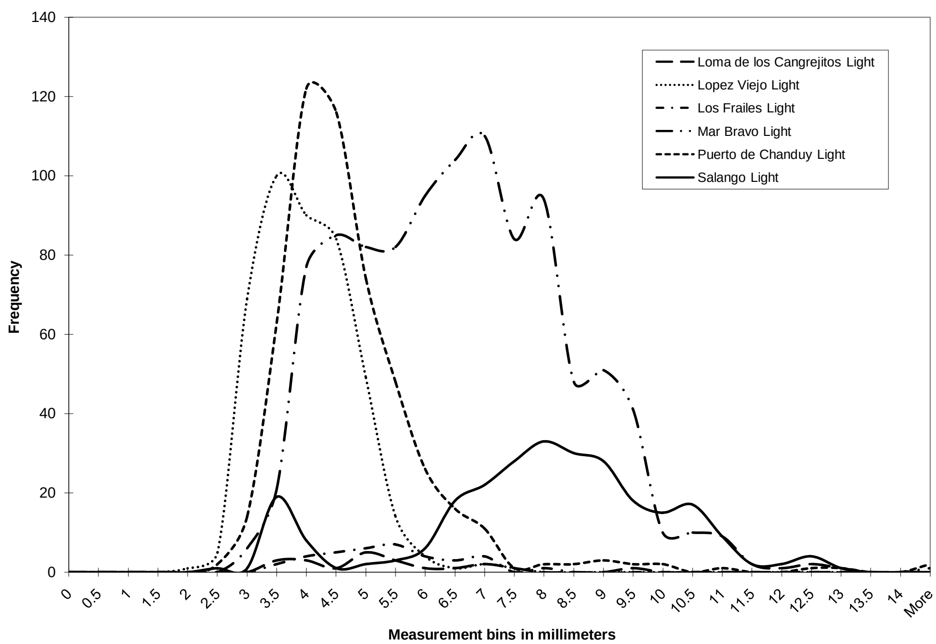
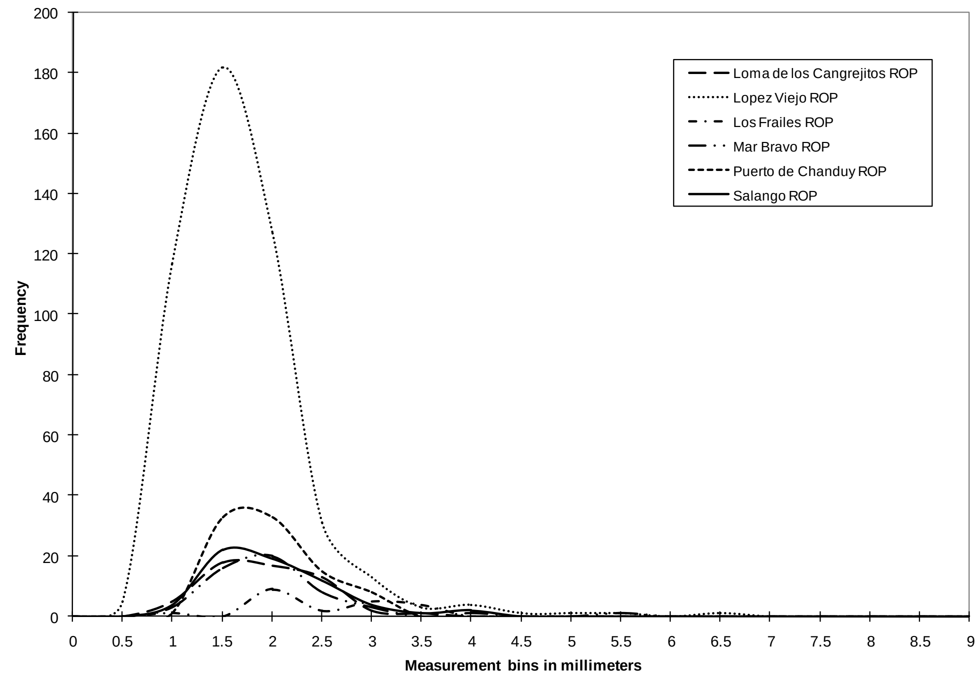


Figure 8-27. A Comparison of ROP and Light Bead Smoothed Distributions for Maximum Diameter Measurements for Stage 5 Beads. Note the similarity of ROP beads and the dramatic differences between Light beads, especially those from Salango and Mar Bravo.



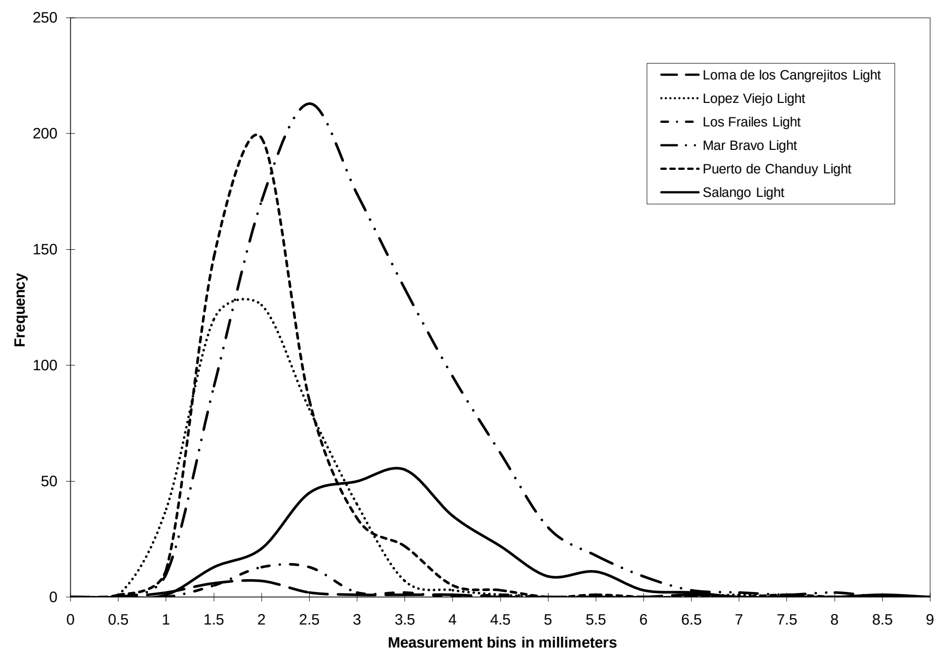
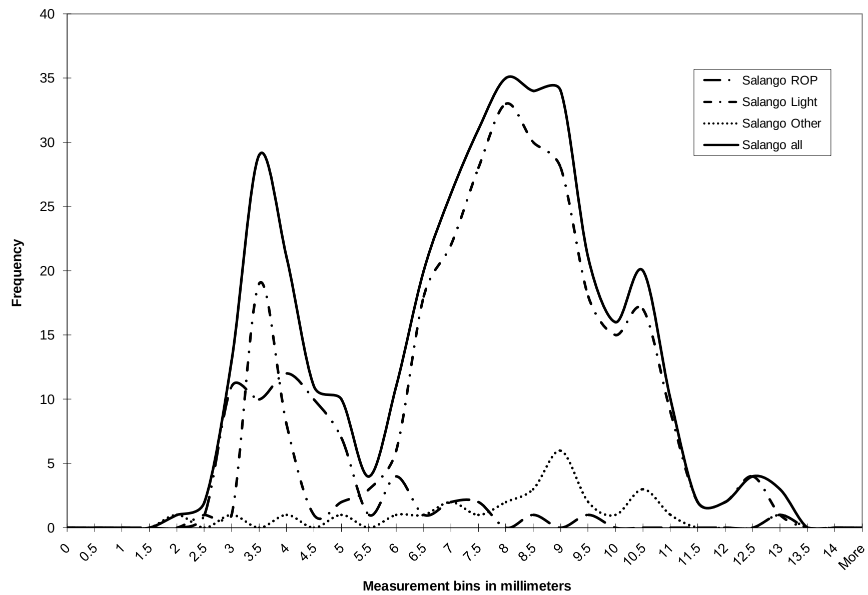


Figure 8-28. A Comparison of ROP and Light Bead Smoothed Distributions for Maximum Thickness Measurements for Stage 5 Beads. Note the similarity of ROP beads and the dramatic differences between Light beads, especially those from Salango and Mar Bravo.



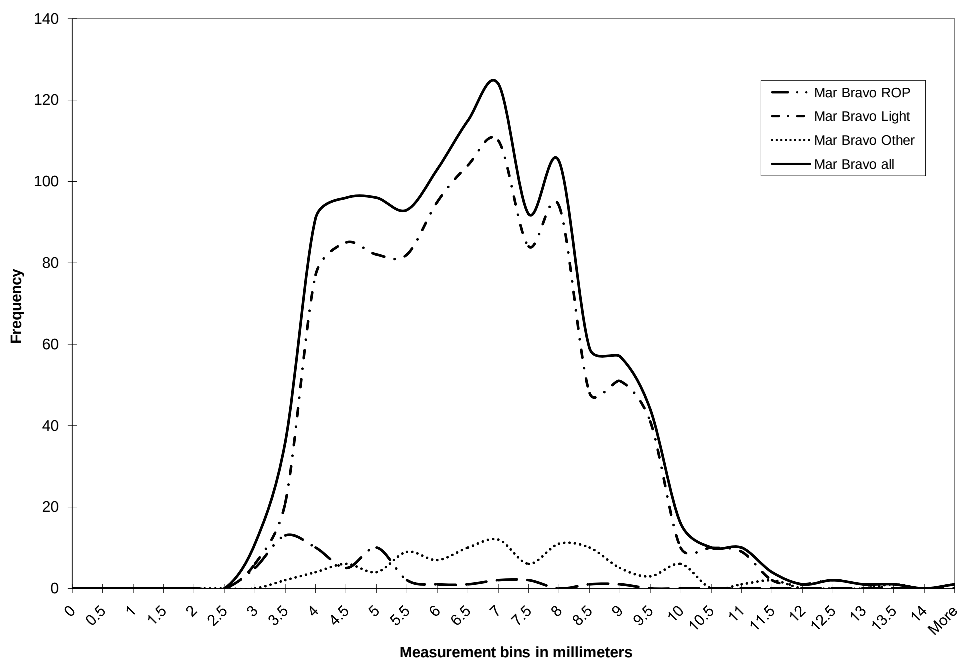


Figure 8-29. A Comparison of Smoothed Distributions for Maximum Diameter Measurements for Stage 5 Beads from Mar Bravo and Salango. Note how ROP beads are at the smaller end of the distributions.

		<50%	50-99%	100%	Total
Loma de los	N	**76**	**257**	238	571
Cangrejitos	N_{exp}	**49.0**	**96.3**	425.3	571.0
	ê	**4.2**	**18.7**	-18.7	
López Viejo	N	**558**	**842**	1427	2828
	N_{exp}	**242.8**	**477.2**	2106.5	2828.0
	ê	**26.6**	**23.1**	-36.9	
Los Frailes	N	0	5	**81**	86
	N_{exp}	7.4	14.5	**64.1**	86.0
	ê	-2.9	-2.8	**4.2**	
Mar Bravo	N	12	121	**1948**	2084
	N_{exp}	179.0	351.6	**1552.3**	2084.0
	ê	-15.3	-15.8	**23.3**	
Puerto de Chanduy	N	3	35	**754**	792
	N_{exp}	68.0	133.6	**589.9**	792.0
	ê	-8.7	-9.9	**14.1**	
Salango	N	8	31	**1251**	1290
	N_{exp}	110.8	217.7	**960.9**	1290.0
	ê	-11.2	-15.2	**20.3**	
Total	N	657	1291		5699
	N_{exp}	657.0	1291.0		5699.0

Table 8-36. Cross Tabulation of Fragmentation by Site for all shell beads. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

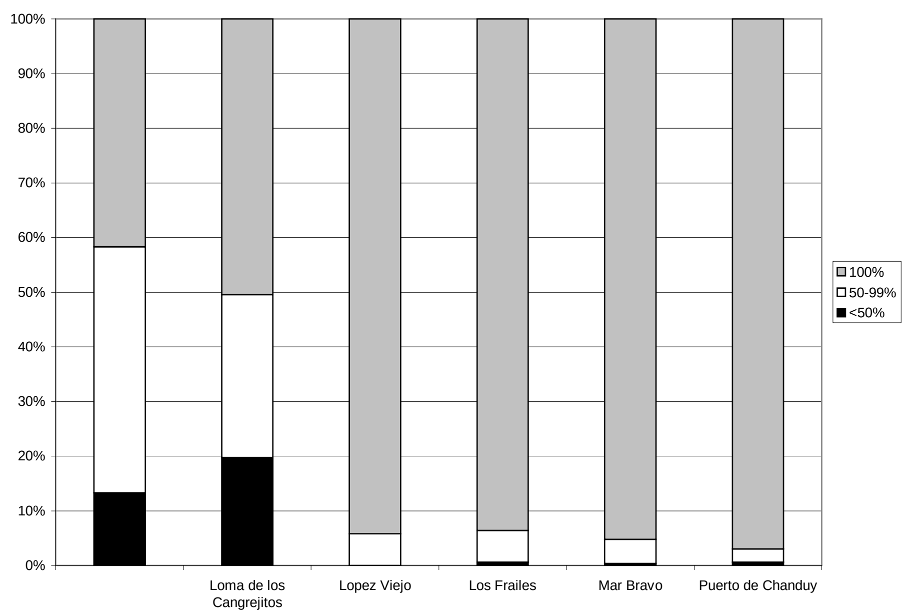


Figure 8-30. Percent of beads with each fragmentation code by site.

		<50%	50-99%	100%	Total
Loma de los Cangrejitos	N	76	257	238	571
	N_{exp}	106.5	184.6	279.7	571
	$\hat{e}$	-3.6	7.1	-3.8	
López Viejo	N	558	842	1427	2828
	N_{exp}	527.5	914.4	1385.3	2828
	$\hat{e}$	3.6	-7.1	3.8	
Total	N	634	1099	1665	3399
	N_{exp}	634	1099	1665	3399

Table 8-37. Cross tabulation of fragmentation by site for all shell beads from Loma de los Cangrejitos and López Viejo. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., $\hat{e}>3.4$) and below the expected are underlined (i.e., $\hat{e}<-3.4$).

Stage			<100%	100%	
2.0	Loma de los Cangrejitos	N	32	84	116
		N_{exp}	21.6	94.4	116.0
		ê	2.7	-2.7	
	López Viejo	N	115	559	674
		N_{exp}	125.4	548.6	674.0
		ê	-2.7	2.7	
	Total	N	147	643	790
3.0	Loma de los Cangrejitos	N	87	14	101
		N_{exp}	90.8	10.2	101.0
		ê	-1.4	1.4	
	López Viejo	N	366	37	403
		N_{exp}	362.2	40.8	403.0
		ê	1.4	-1.4	
	Total	N	453	51	504
4.0	Loma de los Cangrejitos	N	121	54	175
		N_{exp}	132.3	42.7	175.0
		ê	-2.3	2.3	
	López Viejo	N	397	113	510
		N_{exp}	385.7	124.3	510.0
		ê	2.3	-2.3	
	Total	N	518	167	685
5.0	Loma de los Cangrejitos	N	89	75	164
		N_{exp}	72.2	91.8	164.0
		ê	2.8	-2.8	
	López Viejo	N	513	691	1204
		N_{exp}	529.8	674.2	1204.0
		ê	-2.8	2.8	
	Total	N	602	766	1368

Table 8-38. Cross tabulation of fragmentation by site for all shell beads from Loma de los Cangrejitos and López Viejo by stage. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

Stage			<100%	100%	Total
4.1	Mar Bravo	N	48	494	542
		N_{exp}	29.9	512.1	542.0
		ê	**4.5**	-4.5	
	Salango	N	23	724	747
		N_{exp}	41.1	705.9	747.0
		ê	-4.5	**4.5**	
	Total	N	71	1218	1289
4.2	Mar Bravo	N	19	268	287
		N_{exp}	13.6	273.4	287.0
		ê	2.5	-2.5	
	Salango	N	2	153	155
		N_{exp}	7.4	147.6	155.0
		ê	-2.5	2.5	
	Total	N	21	421	442
5.0	Mar Bravo	N	57	1141	1198
		ê	1.7	-1.7	
	Salango	N	10	357	367
		N_{exp}	15.7	351.3	367.0
		ê	-1.7	1.7	
	Total	N	67	1498	1565

Table 8-39. Cross tabulation of fragmentation by site for all shell beads from Salango and Mar Bravo by stage. *Note*: Cells with actual counts significantly above the expected are in bold (i.e., ê>3.4) and below the expected are underlined (i.e., ê<-3.4).

			50-99%		100%	
Site	Stage	Measurement	N	Geo. Mean	N	Geo. Mean
López	2	Max. Diameter	68	4.26	547	3.71
Viejo	5	Max. Diameter	284	3.74	664	3.29
		Max. Thickness	279	1.57	653	1.42
Mar	4.1	Max. Thickness	41	2.10	493	2.75
Bravo		Min. Thickness	37	1.57	490	1.92
Puerto de	5	Max. Thickness	21	1.30	661	1.75
Chanduy		Min. Thickness	10	.94	659	1.60

Table 8-40. Frequency and geometric means (mm) for the given measurement between complete and 50-99% complete disc shell beads. Only geometric means that are significantly different are shown.

	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
All Shell Beads (N)	571	2828	86	2083	792	1290	7650
Stage 3 and 4 Shell Beads	276	913	6	16	17	18	1246
Lithic Microdrills (N)	444	460	35	24	9	24	996
Microdrills per 100 Shell Beads	78	16	41	1.2	1.1	1.9	1.3
Microdrills per 100 Stage 3 and 4 Shell Beads	161	51	589	149	53	133	80

Table 8-41. A comparison of the frequency of shell beads and lithic microdrills by site.

	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
N	177	179	17	7	3	8	391
Mean	13.17	19.47	28.02	13.60	20.84	31.68	17.15
Std. Dev.	2.69	9.42	11.42	2.88	10.15	23.03	8.88
Median	12.86	16.87	25.81	13.44	17.03	26.47	14.67
Geometric Mean	12.94	18.14	25.92	13.35	19.34	25.78	15.85
Geo. Std. Dev.	1.21	1.41	1.50	1.23	1.59	1.96	1.43

Table 8-42. Measures of central tendency and dispersion for the length measurement for all complete lithic microdrills.

	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
N	172	176	17	7	3	8	383
Mean	12.88	18.59	28.02	13.60	20.84	31.68	16.64
Std. Dev.	2.08	6.57	11.42	12.88	10.15	20.84	18.59
Median	12.77	16.83	25.81	13.44	17.03	26.47	14.67
Geometric Mean	12.72	17.73	25.92	13.35	19.34	25.78	15.58
Geo. Std. Dev.	1.34	1.17	1.50	1.23	1.59	1.96	1.40

Table 8-43. Same as previous, except outliers have been excluded.

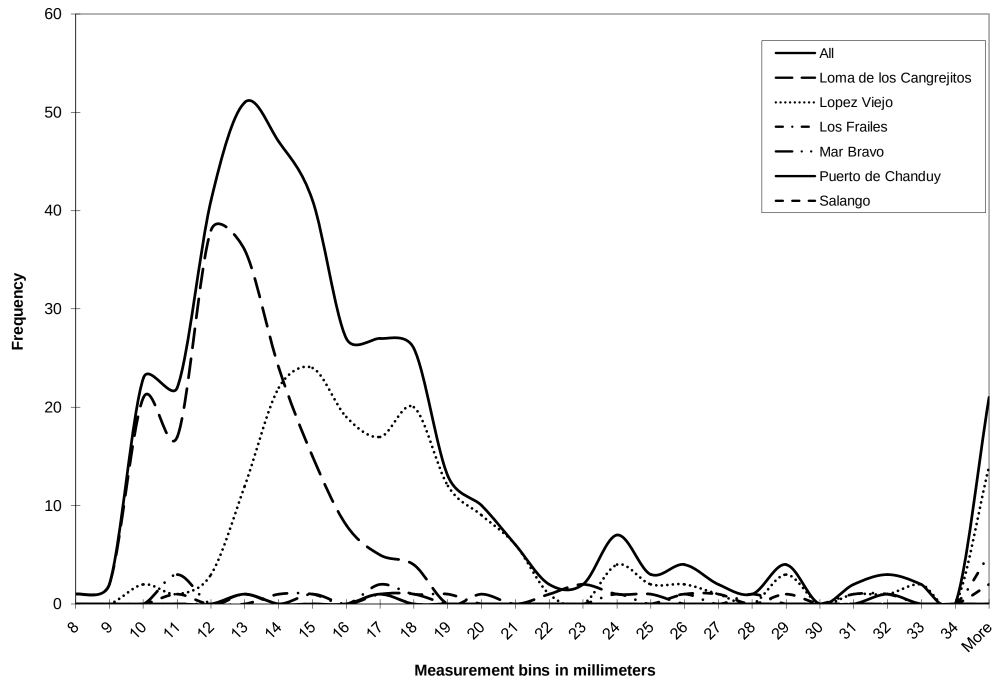


Figure 8-31. Smoothed Distributions of Microdrill Length Measurements by Site. Note: Bins are 1 mm.

Location		Total	N > 23.00 mm	% > 23.00 mm	N> 33.00 mm
Santa Elena Península	Loma de los Cangrejitos	177	4	2.3	0
	Mar Bravo	7	0	0	0
	Puerto de Chanduy	3	1	33.3	0
	Total	187	5	2.7	0
Manabí	López Viejo	178	30	16.9	16
	Los Frailes	16	10	62.5	5
	Salango	8	5	62.5	2
	Total	202	45	22.3	23

Table 8-44. Frequency and percent of lithic microdrills with a length greater than 23.00 mm and frequency of lithic microdrills with a maximum width greater than 33.00 mm.

	Puerto de Chanduy	Loma de los Cangrejitos	López Viejo	Los Frailes	Salango	Mar Bravo	Total
N	6	341	346	30	18	14	755
Mean	4.18	4.28	4.05	6.93	6.33	3.64	4.32
Std. Dev.	.65	1.02	2.23	2.39	3.26	.54	1.90
Median	3.91	4.12	3.62	6.44	5.28	3.74	3.91
Geometric Mean	4.14	4.17	3.81	6.60	5.70	3.60	4.09
Geo. Std. Dev.	1.16	1.25	1.35	1.36	1.57	1.17	1.34

Table 8-45. Measures of central tendency and dispersion for the maximum width measurement for lithic microdrills whose broken code is 1 or 0. See text for discussion.

	Puerto de Chanduy	Loma de los Cangrejitos	López Viejo	Los Frailes	Salango	Mar Bravo	Total
N	6	338	343	30	18	14	749
Mean	4.18	4.24	3.90	6.93	6.33	3.64	4.23
Std. Dev.	.65	.94	1.26	2.39	3.26	.54	1.43
Median	3.91	4.11	3.60	6.44	5.28	3.74	3.94
Geometric Mean	4.14	4.14	3.76	6.60	5.70	3.60	4.06
Geo. Std. Dev.	1.16	1.24	1.29	1.36	1.57	1.17	1.31

Table 8-46. Same as previous table, except outliers have been excluded.

	Puerto de Chanduy	Loma de los Cangrejitos	López Viejo	Los Frailes	Salango	Mar Bravo	Total
N	6	341	346	30	18	14	755
Mean	4.02	3.90	3.84	4.70	5.89	4.02	3.95
Std. Dev.	.71	.90	1.72	1.50	2.41	.60	1.44
Median	3.94	3.86	3.51	4.67	5.57	4.05	3.94
Geometric Mean	3.97	3.80	3.66	4.48	5.53	3.98	3.79
Geo. Std. Dev.	1.19	1.26	1.32	1.37	1.43	1.17	1.30

Table 8-47. Measures of central tendency and dispersion for the minimum width measurement for lithic microdrills whose broken code is 1 or 0. see text for discussion.

	Puerto de Chanduy	Loma de los Cangrejitos	López Viejo	Los Frailes	Salango	Mar Bravo	Total
N	6	338	343	30	18	14	749
Mean	4.02	3.87	3.72	4.70	5.89	4.02	3.89
Std. Dev.	.71	.87	1.01	1.50	2.41	.60	1.08
Median	3.91	4.11	3.60	6.44	5.28	3.74	3.74
Geometric Mean	3.97	3.78	3.61	4.48	5.53	3.98	3.76
Geo. Std. Dev.	1.19	1.25	1.26	1.37	1.43	1.17	1.28

Table 8-48. Same as previous, except outliers have been excluded.

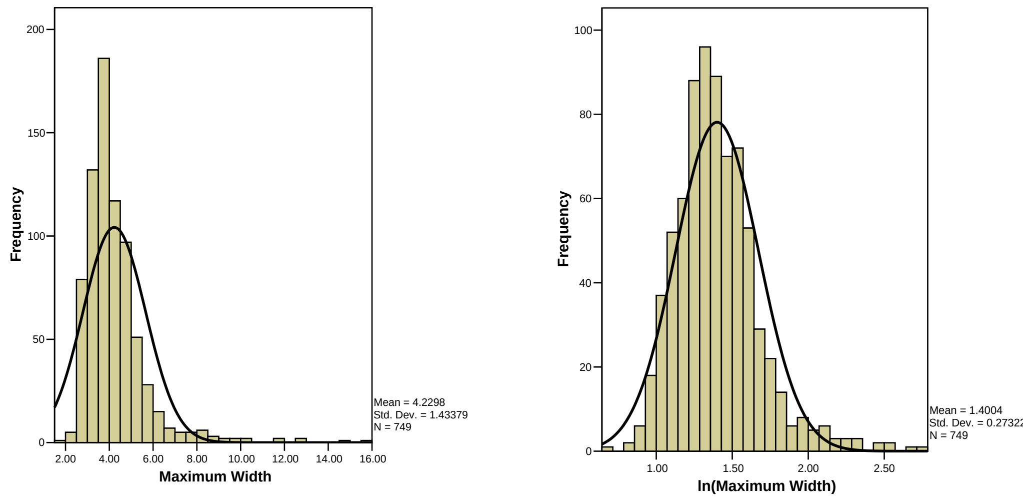


Figure 8-32. Comparison of distributions for untransformed and log-transformed maximum width measurements for lithic microdrills that are either whole or missing only the tip. Note: The normal curve fits the transformed data much better.

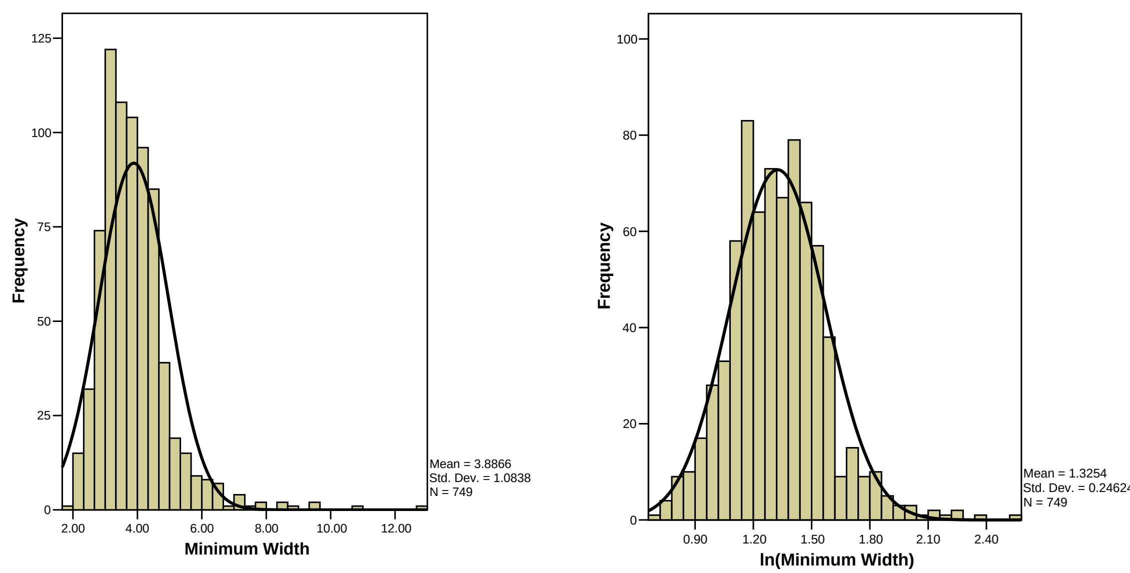


Figure 8-33. Comparison of distributions for untransformed and log-transformed maximum width measurements for lithic microdrills that are either whole or missing only the tip. Note: the normal curve fits the transformed data only slightly better.

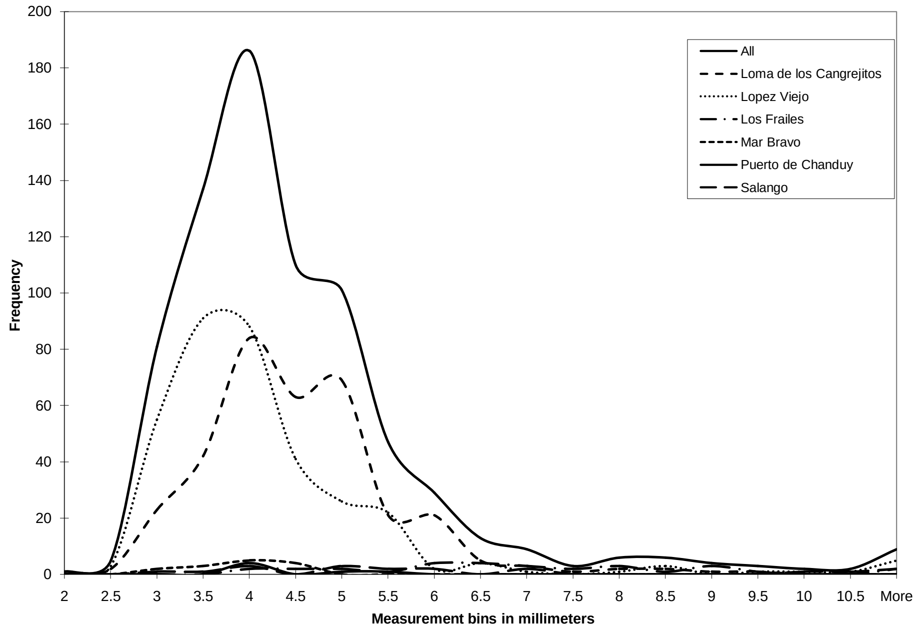


Figure 8-34. Smoothed distributions for maximum width measurement for all lithic microdrills with body intact

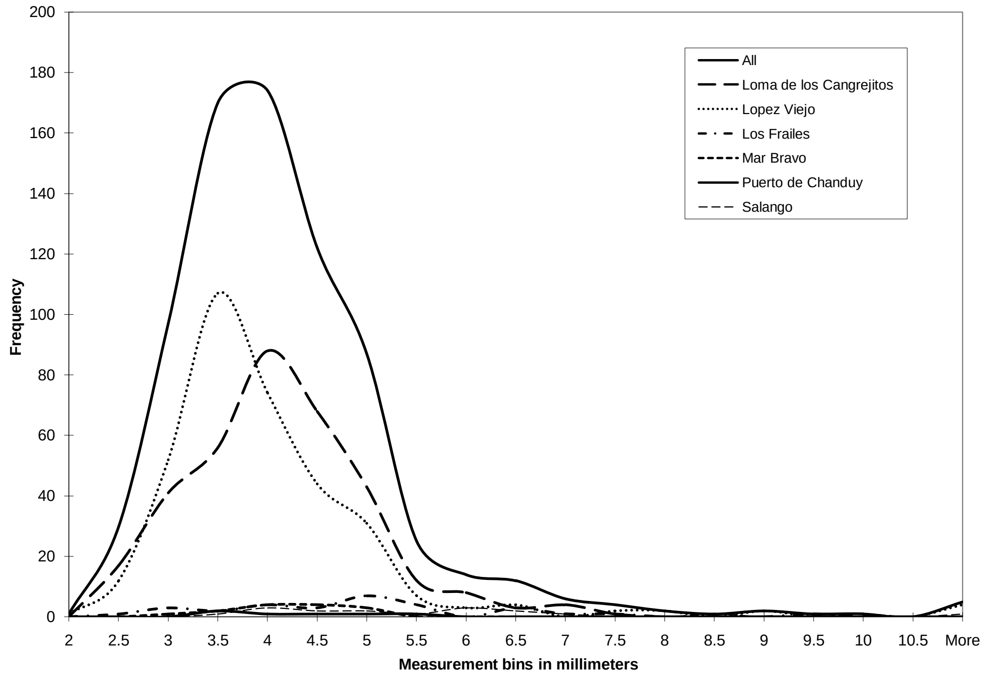


Figure 8-35. Smoothed distributions for minimum width measurement for all lithic microdrills with body intact

Location		Total	N > 7.00 mm	% > 7.00 mm	N > 10.00 mm
Santa Elena Península	Loma de los Cangrejitos	10	341	2.9	0
	Mar Bravo	0	14	0	0
	Puerto de Chanduy	0	6	0	0
	Total	10	361	2.8	0
Manabí	López Viejo	13	345	3.8	7
	Los Frailes	15	30	50	2
	Salango	6	18	20.9	2
	Three sites in Manabí	34	393	8.7	11

Table 8-49. Frequency and percent of lithic microdrills with a maximum width greater than 7.00 mm and frequency of lithic microdrills with a maximum width greater than 10.00 mm.

Location		Total	N > 6.50 mm	% > 6.50 mm	N > 8.00 mm
Santa Elena Península	Loma de los Cangrejitos	341	8	2.3	0
	Mar Bravo	14	0	0	0
	Puerto de Chanduy	6	0	0	0
	Total	361	8	2.2	0
Manabí	López Viejo	345	14	4.1	8
	Los Frailes	30	6	20	1
	Salango	18	6	33.3	3
	Total	393	26	6.6	12

Table 8-50. Frequency and percent of lithic microdrills with a minimum width greater than 7.00 mm and frequency of lithic microdrills with a minimum width greater than 10.00 mm.

	Width of Tip of Microdrill		Maximum Perforation		Minimum Perforation	
Site Name	Mean	N	Mean	N	N	Mean
Loma de los Cangrejitos	1.28	64	1.81 (1.78)	228 (108)	1.17 (1.10)	203 (96)
López Viejo	1.28	69	1.45 (1.47)	958 (180)	1.18 (1.06)	879 (171)
Los Frailes	1.51	8	1.87	76	1.44	76
Mar Bravo			2.24	2014	1.77	547
Puerto de Chanduy			1.55	756	1.23	747
Salango			2.44	1269	1.81	500
Grand Total	1.29	141	2.02	5301	1.42	2952

Table 8-51. Comparison of the width of the tip of lithic microdrills and the perforation measurements of shell beads by site. Note: the data in parentheses is for stage 4 beads only.

		Unbroken	Tip broken off	Tip only present	Broken other than tip	Total
Loma de los Cangrejitos	N	177	164	29	74	444
	N_{exp}	174.3	162.3	29.4	78.0	444.0
	ê	.4	.2	-.1	-.7	
López Viejo	N	179	167	34	80	460
	N_{exp}	180.6	168.1	30.5	80.8	460.0
	ê	-.2	-.1	.9	-.1	
Los Frailes	N	17	13	0	5	35
	N_{exp}	13.7	12.8	2.3	6.1	35.0
	ê	1.1	.1	-1.6	-.5	
Mar Bravo	N	7	7	1	9	24
	N_{exp}	9.4	8.8	1.6	4.2	24.0
	ê	-1.0	-.8	-.5	2.6	
Puerto de Chanduy	N	3	3	0	3	9
	N_{exp}	3.5	3.3	.6	1.6	9.0
	ê	-.4	-.2	-.8	1.2	
Salango	N	8	10	2	4	24
	N_{exp}	9.4	8.8	1.6	4.2	24.0
	ê	-.6	.5	.3	-.1	
Total	N	391	364	66	175	996
	N_{exp}	391.0	364.0	66.0	175.0	996.0

Table 8-52. Frequency, Expected Frequency, and Adjusted Residual for Fragmentation Codes for Lithic Microdrills by Site. Note: that none of the frequencies are statistically different than the expected frequency (i.e., ê <3.4).

		Shoulder	Cigar/ Teardrop-Shaped	Other	Total
Loma de los Cangrejitos	N	51	92	34	177
	N_{exp}	72.0	83.7	21.3	177.0
	ê	-4.3	1.7	4.0	
López Viejo	N	**91**	82	6	179
	N_{exp}	**72.8**	84.7	21.5	179.0
	ê	**3.8**	-.5	-4.8	
Los Frailes	N	10	3	4	17
	N_{exp}	6.9	8.0	2.0	17.0
	ê	1.6	-2.5	1.5	
Mar Bravo	N	3	2	2	7
	N_{exp}	2.8	3.3	.8	7.0
	ê	.1	-1.0	1.4	
Puerto de Chanduy	N	1	1	1	3
	N_{exp}	1.2	1.4	.4	3.0
	ê	-.3	-.5	1.1	
Salango	N	3	5	0	8
	N_{exp}	3.3	3.8	1.0	8.0
	ê	-.2	.9	-1.1	
Total	N	159	185	47	391
	N_{exp}	159.0	185.0	47.0	391.0

Table 8-53. Shape of unbroken lithic microdrills by archaeological site. Note: Bold indicates a frequency that is statistically greater than expected (ê>3.4) and Underline indicates a frequency that is less than expected (ê<-3.4).

Number of Sides		0	3	4	5	6	Total
Loma de los	N	2	22	205	31	**81**	341
Cangrejitos	N_{exp}	.9	31.6	218.6	43.8	**46.1**	341.0
	ê	1.6	-2.4	-2.1	-2.8	**7.5**	
López Viejo	N	0	36	**249**	45	<u>16</u>	346
	N_{exp}	.9	32.1	**221.8**	44.5	<u>46.7</u>	346.0
	ê	-1.3	1.0	**4.1**	.1	<u>-6.6</u>	
Los Frailes	N	0	7	11	9	3	30
	N_{exp}	.1	2.8	19.2	3.9	4.1	30.0
	ê	-.3	2.7	-3.2	2.9	-.6	
Mar Bravo	N	0	2	6	5	1	14
	N_{exp}	.0	1.3	9.0	1.8	1.9	14.0
	ê	-.2	.7	-1.7	2.6	-.7	
Puerto de	N	0	1	2	3	0	6
Chanduy	N_{exp}	.0	.6	3.8	.8	.8	6.0
	ê	-.1	.6	-1.6	2.7	-1.0	
Salango	N	0	2	11	4	1	18
	N_{exp}	.0	1.7	11.5	2.3	2.4	18.0
	ê	-.2	.3	-.3	1.2	-1.0	
Total	N	2	70	484	97	102	755
	N_{exp}	2.0	70.0	484.0	97.0	102.0	755.0

Table 8-54. Cross tabulation of number of sides for lithic microdrills by site. Note: Only microdrills coded 0 or 1 (i.e., unbroken or missing the tip) for fragmentation are included. Bold indicates a frequency that is statistically greater than expected (ê>3.4) and Underline indicates a frequency that is less than expected (ê<-3.4).

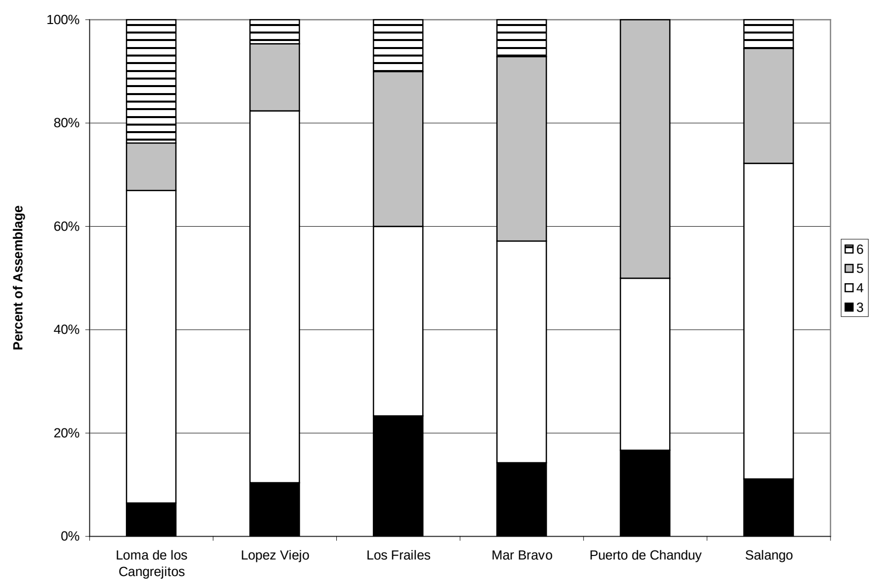


Figure 8-36. Bar Graph Showing Proportion of Microlithic Assemblage from Each Site with Different Number of Sides. Note: Only microdrills coded 0 or 1 (i.e., unbroken or missing the tip) for fragmentation are included.

Number of Unworked Sides		.00	1.00	2.00	3.00	4.00	Total
Loma de los Cangrejitos	N	171	102	60	5	3	341
	N_{exp}	196.9	90.8	47.4	4.1	1.8	341.0
	ê	-3.8	1.9	2.7	.6	1.2	
López Viejo	N	**233**	78	34	0	1	346
	N_{exp}	**199.8**	92.1	48.1	4.1	1.8	346.0
	ê	**4.9**	-2.3	-3.0	-2.8	-.8	
Los Frailes	N	6	12	9	**3**	0	30
	N_{exp}	17.3	8.0	4.2	**.4**	.2	30.0
	ê	-4.3	1.7	2.6	**4.5**	-.4	
Mar Bravo	N	11	3	0	0	0	14
	N_{exp}	8.1	3.7	1.9	.2	.1	14.0
	ê	1.6	-.4	-1.5	-.4	-.3	
Puerto de Chanduy	N	6	0	0	0	0	6
	N_{exp}	3.5	1.6	.8	.1	.0	6.0
	ê	2.1	-1.5	-1.0	-.3	-.2	
Salango	N	9	6	2	1	0	18
	N_{exp}	10.4	4.8	2.5	.2	.1	18.0
	ê	-.7	.7	-.3	1.7	-.3	
Total	N	436	201	105	9	4	755
	N_{exp}	436.0	201.0	105.0	9.0	4.0	755.0

Table 8-55. Cross Tabulation of Number of Unworked Sides by Site. Note: Only microdrills coded 0 or 1 (i.e., unbroken or missing the tip) for fragmentation are included. Bold indicates a frequency that is statistically greater than expected (ê>3.4) and Underline indicates a frequency that is less than expected (ê<-3.4).

Material	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
Shell- General	5	46	27	18	5	85	186
Shell- Mother-of-pearl	8	170	1 (+297‡)	47	7	48	281 (+297)
Shell- Oliva/Olivella		21 (+328†)	10	15	2	59	107 (+328)
Shell- Spondylus	2	15	12	6		12	47
Ground Stone	6	* (+1§)	25	7	3	26	67
Ceramic- Complex				2	1	14	17
Ceramic- Simple		(+718**, +3§)		(+5§)	(+30§)	(+7§)	(+763)
Glass				9		5	14
Pearl						2	2
Greenstone	(+2§)	(+4§)	(+12§)	(+7§)	(+1§)	1 (+1§)	1 (+27)
Copper						1	1
Bone				1			1
Unidentifiable/ Other			1			1	2
Grand Total	21 (+2)	252 (+1053)	76 (+309)	105 (+12)	18 (+31)	254 (+8)	726 (+1415)

Table 8-56. Cataloged artifacts by material type. Note- *Ground stone artifacts from López Viejo were not cataloged. **'Simple' ceramic beads from López Viejo that were counted, but not cataloged. § Artifacts that were measured with beads, but were not cataloged. †Oliva sp. and Olivella sp. whole shell beads from López Viejo that were counted, but not cataloged. ‡Mother-of-pearl artifacts cataloged by Ann Mester (1990), but not cataloged here.

	Pearl	General	Mother-of-pearl	Oliva/Olivella	Spondylus	Grand Total
Adze/Axe		3				3
'Antennae' beads		6				6
Atl-atl Hook			4		3	7
Ground Shell- Other		1	1			2
Lobed			5			5
Non-shell- Other	2					2
Other		17	70	1	9	97
Other Perforated			23			23
'Plumb-Bob'		1			8	9
'Plumb-Bob'- Columnella		6				6
Possible Non-artifact		14	12			26
'Rectangular Plaque'			209		4	213
Ring		15	67		5	87
Shell Disk		2	54		4	60
Shell Disk- Perforated			89			89
'Silla de Poder'		5	4		2	11
Small Pendant			20		12	32
Spoon/ Spatula		3				3
'Triangular Plaque'			6			6
Whole Shell- Apex and Hole		19		2		21
Whole Shell- Apex Removed		13		86		99
Whole Shell- Bivalve		17				17
Whole Shell- 'Fish Head'		1		10		11
Whole Shell- Hole in Body		50		5		55
Whole Shell- Other		6		3		9
Whole Shell- Whistle/Trumpet		7				7
X-shaped			15			15
Grand Total	2	186	579	107 (+328*)	47	921

Table 8-57. Shell Artifacts by Material and Type of Artifact. Note- *including the uncataloged Oliva/Olivella whole shell beads from López Viejo.

Material		Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
General	N	5	46	27	18	5	85	186
	%	33.3%	7.9%	7.7%	20.9%	35.7%	41.7%	14.5%
Mother-of-pearl	N	8	170	298	47	7	48	578
	%	53.3%	29.3%	86.0%	54.7%	50.0%	23.5%	46.4%
Oliva/Olivella	N		349	10	15	2	59	435
	%		60.2%	2.9%	17.4%	14.3%	28.9%	34.9%
Spondylus	N	2	15	12	6	0	12	47
	%	13.3%	2.6%	3.4%	7.0%	0%	5.9%	3.8%
Pearl	N	0	0	0	0	0	2	2
	%	0%	0%	0%	0%	0%	1.0%	.16%
Total	N	15	580	347	86	14	206	1250
	%	100%	100%	100%	100%	100%	100%	100%

Table 8-58. Comparison of cataloged shell artifacts by archaeological site. Note: The partially cataloged whole shell artifacts from López Viejo and the mother-of-pearl artifacts from Los Frailes are included in the above numbers (see text and Table 8-56).

Site Name	Shell Type	Apex and Hole	Apex Removed	Bivalve	'Fish Head'	Hole in Body	Other	Whistle/Trumpet	Total
Loma de los Cangrejitos	General		1						1
	Oliva/Olivella								
López Viejo	General		3	6		3		4	16
	Oliva/Olivella		13		6	1			20 (+328*)
Los Frailes	General		6	4	1	1	1		13
	Oliva/Olivella		6		4				10
Mar Bravo	General	2	2	5		6			15
	Oliva/Olivella		14			1			15
Puerto de Chanduy	General			2			3		5
	Oliva/Olivella					2			2
Salango	General	17	1			40	2	3	63
	Oliva/Olivella	2	53			1	3		59
Total		21	99	17	11	55	9	7	219 (+328*)

Table 8-59. Whole shell artifacts by shell type (general or Oliva/Olivella) and Site. Note- * uncataloged Oliva/Olivella artifacts from López Viejo.

Type of Artifact	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
'Rectangular Plaque'	3	6	174*	6	4	16	35 (209)
'Triangular Plaque'	1		3*	1		1	3 (6)
Ring	1	47	14*	4	1		53 (67)
Shell Disk		21	21*	9	1	2	33 (54)
Shell Disk- Perforated		56	19*	10		4	70 (89)
'Silla de Poder'	1	1				2	4
Small Pendant		9	1*	4	1	5	19 (20)
Atl-atl Hook		1		3			4
Lobed		5					5
X-shaped						15	15
Other	1	9	1(+49*)	9		1	20 (69)
Other Perforated		6	16*			1	7 (23)
Possible Non-artifact	1	9		1		1	12
Grand Total	8	170	1 (298)	47	7	48	281 (578)

Table 8-60. Mother-of-pearl artifacts from all archaeological sites by type of artifact. Note- *Mother-of-pearl Artifacts from Los Frailes not in current catalog because they were cataloged by Mester (1992). Numbers in parentheses are with these artifacts added.

Type of Artifact Alpha	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
Grinding Stone- Fragment	1			1			2
Grinding Stone- Large	3		3	1		15	22
Grinding Stone- Small	2		1	3		1	7
Ground Stone- Axe			1				1
Ground Stone- Other			16		3	8	27
Ground Stone- Saw			4	2		2	8
Grand Total	6	*	25	7	3	26	67

Table 8-61. Ground Stone Artifacts from All Six Sites. Note: *- Ground Stone Artifacts from López Viejo were not cataloged for technical reasons.

Type of Artifact Alpha	Loma de los Cangrejitos	López Viejo	Los Frailes	Mar Bravo	Puerto de Chanduy	Salango	Total
Atl-atl Hook	1			2			3
'Plumb-Bob'			3			4	7
'Rectangular Plaque'				2		2	4
Ring		4	1				5
Shell Disk	1		2			1	4
'Silla de Poder'						2	2
Small Pendant		11	4	2			17
Other			2			3	5
Grand Total	2	15	12	6	0	12	47

Table 8-62. Breakdown of Spondylus shell artifacts by artifact type and site.

Type of Shell Artifact N(%)	Loma de los Cangrejitos	Puerto de Chanduy	Mar Bravo	Los Frailes	López Viejo	Salango	Total
Adze/Axe				1		2	3
Atl-atl Hook	1		5		1		7
Lobed					5		5
'Plumb-Bob'			1	3		5	9
'Plumb-Bob'-Columnella						6	6
Ring	1	1	4	5 (+14)	62		73(+14)
Shell Disk	1	1	9	2 (+21)	23	3	39 (+21)
Shell Disk- Perf.			10	(+19)	56	4	70 (+19)
'Silla de Poder'	1				1	9	11
Small Pendant		1	5	(+1)	20	5	31 (+1)
X-shaped						15	15
Spoon/ Spatula	1		1			1	3
'Rectangular Plaque'	3	4	8	(+174)	6	18	39 (+174)
'Triangular Plaque'	1		1	(+3)		1	3 (+3)
Whole Shell- Apex and Hole			2			19	21
Whole Shell- Apex Removed	1		16	12	16	54	99
Whole Shell- Bivalve		2	5	4	6		17
Whole Shell- 'Fish Head'				5	6		11
Whole Shell- Hole in Body		2	7	1	4	41	55
Whole Shell- Other		3 (33.3)		1		5	9
Whole Shell- Whistle/Trumpet					4	3	7
'Antennae' beads	3			1		2	6
Other- Ground Shell			2				2
Other	1		9	13 (+50)	14	9	46 (+50)
Other Perforated				(+16)	6	1	7 (+16)
Possible Non-artifact	1				21	1	26
Total	15	14	86	50 (+298)	251	204	621 (+298)

Table 8-63. Frequency and percentage of various types of shell artifacts from all six sites.

Chapter 9. Summary and Interpretation

9.1. Introduction

This research contributes to archaeological theory and method and to the culture history of South America. I have compiled the most complete archaeological history of one of the most prized PreColumbian materials, Spondylus. The methods used herein demonstrate the usefulness of fairly simple technology for collecting and analyzing large datasets. More specifically, I develop methods of study for an often overlooked material, shell beads, showing that they can yield important information. I have developed an approach that better conceptualizes how technology changes and I demonstrate it with these data. Finally, this test case, which provides greater insight into shell bead production among the Manteño, will interest archaeologists concerned with culture change, archaeological methods, and the culture history of South America.

9.2. Culture History of Spondylus

Spondylus shells have been worked to produce valued artifacts in many parts of the world. The creation of an updated culture history of Spondylus directly affects a wide variety of archaeological interpretations throughout South America, the Americas in general, and beyond. Most archaeological interpretation about this region has retained hypotheses regarding Spondylus that were put forward in the 1970s (Marcos 1977/78; Paulsen 1974). While interpretation from the 1970s remain valuable, they were in dire need of an update. The culture history presented herein is different from this early work. Primarily, this updated culture history appears to both contradict and deepen the original hypotheses put forward by Marcos (1977/78; see also 1986, 1995a and Marcos and Norton 1981, 1984) and Paulsen (1974).

I have retained the backbone of Paulsen's culture history with slightly modified time periods. I have used extensive searches of published literature for this reconstruction, but have refrained from using museum materials because they normally lack contextual information and often carry the cultural designation of Chimú (on the coast) or Inka (in the highlands). It now appears that many of these objects may be incorrectly associated with these two cultures, however. Specifically, the similarity of Sicán and Chimú material culture, makes it difficult to identify museum pieces as one or the other.

I provide a more dynamic culture history of this highly valued material that diverges from Paulsen's in two major ways. First, Spondylus appears to arrive in the Peruvian Highlands (at La Galgada c. 2000 BC; or perhaps by 2900 BC at Caral) earlier than in the Ecuadorian highlands (at Cerro Narrío c. 1400 BC), which reverses Paulsen's claim. Secondly, I see a general trend of increase in the consumption of Spondylus through much of prehistory, peaking among the Moche and Sicán (Lambayeque; c. 100 B.C. and A.D. 1100), but which declines in late prehistory during the Chimú and Inka periods. Paulsen saw a consistent increase throughout prehistory. Her conclusion seems to be based largely upon the direct interpretation of *mullu* as Spondylus, however, David Blower (1995, 2001) has shown that during the post-Contact period, *mullu* was any of several highly significant, ritually charged materials and that Spondylus was only one of these materials. Since there are many types of *mullu*, the conflation of this term with

Spondylus is not only unwarranted, but erroneous. Based upon current archaeological evidence, Spondylus use appears to have peaked earlier.

I have shown that Spondylus use appears to peak on the north coast of Peru during the Moche and Sicán/Lambayeque phases. During this time, three main types of Spondylus artifacts were used, including tiny shell beads (*chaquira*), whole shells and inlay in gold and wooden artifacts. While I believe that Spondylus use declined during later periods, there is certainly no evidence for a continued increase. Yet, there was a highly significant switch from Spondylus shell beads to other types of artifacts, such as inlay for wooden idols among the Chimú and diminutive figurines (*idolillos*) among the Inka. Whole Spondylus shells were offered in tombs by the Chimú and coastal residents during the Inka period, showing continuity with their cultural predecessors, the Moche and Sicán. Fragments and a few whole Spondylus shells have been recovered from the highlands, but these quantities are minimal compared to those on the coast. It is important to note that some of the best evidence for Spondylus usage comes from Marcahuamachuco and Cerro Amaru (c. A.D. 350-800) in the northern highlands, perhaps because of the association between highland peoples and the Moche and Sicán on the north coast. This interpretation is based upon current published evidence and may be biased by the large scale excavations of Sicán and Moche tombs of the elite, and the relative lack of equivalent Chimú and Inka burials.

In addition to updating the culture history of Spondylus, I have also updated the arguments put forward by Jorge Marcos, whose economic hypothesis hinges upon the difficulty of obtaining Spondylus and the necessity of long distance trade to Mesoamerica in order to acquire this sacred material. There are three basic problems with his argument.

First, Marcos' discussion appears to conflate much of Ecuadorian prehistory, from Early Valdivia through the Contact period. As I have shown, Spondylus use does not appear to peak in Ecuador until sometime around the end of the Guangala period and the beginning of Manteño period. Evidence of earlier use of Spondylus seems to indicate the consumption of a local resource by local people. The occurrence of Spondylus at Peruvian sites away from the coast at fairly early times does not necessarily suggest contact with peoples who lived in what is modern-day Ecuador, but perhaps only with people from northwest Peru. It is possible, however, that the people of what is now extreme northwestern Peru were culturally similar to those of coastal Ecuador and may have maintained extensive contacts with them.

Secondly, it has not been proven that Spondylus (either *S. princeps* or *S. calcifer*) were ever difficult to acquire in the Manteño region. In particular, since both species were available at depths that would have been relatively easily accessible to divers there is no evidence that specialist divers were required. There does not appear to be any evidence for over-fishing so that divers would have to plunge deeper and deeper until only professional divers were needed. Evidence of overfishing is difficult to identify, however, so the ever increasing difficulty of acquiring Spondylus remains a possibility. Although southwestern Ecuador was clearly a significant source of Spondylus ecofacts and artifacts for much of prehistory, extreme northwestern Peru, where Spondylus appears to have been both available and worked, is a key region that needs to be further investigated.

There is no evidence that Manteño (or other peoples in southwestern Ecuador) needed to travel to Mesoamerica for Spondylus, nor is there definitive evidence that they did so. So far, archaeologists have overlooked the role that communities in Central America, such as at the Cerro Juan Diaz site (Cooke and Sanchez 1997; Mayo 2004), may have played in the possible transmission of cultural traits from Ecuador to Mexico. I believe that the oft-discussed connection between Ecuador and West Mexico (e.g., Anawalt 1992; Hosler 1988; Marcos 1977/78;) need to be reassessed.

Thirdly, it is often said, especially in southwestern Ecuador, that Manteño traders travelled not only north to Mexico but also thousands of miles south to the land known today as Chile. This is, at the very least, a stretch and, at worse, simply wrong. Spondylus artifacts have been recovered from relatively few contexts in Chile and all of these are late in prehistory and are often associated with the Inka, including offerings on high peaks. This suggests that the southern diffusion of Spondylus is associated with Inka transportation and statecraft and not with the long distance transportation of the artifacts aboard Manteño rafts. In fact, there is relatively little evidence of the Manteño traveling long distances to the south or to the north. It is fairly clear that they were a seafaring people who concerned themselves with maritime exchange, but it does not seem, however, that they travelled thousands of miles, but perhaps only hundreds.

While the original studies by Marcos and Paulsen exciting in the 1970s, these works have not been updated, although many archaeologists working in South America continue to cite these as the definitive works on Spondylus. My critique contributes to the archaeological study of South American cultures by providing researchers with a more detailed and accurate account of the archaeological occurrence of Spondylus, as well as, an updated description of our current knowledge of Spondylus biology and habitat. This will more accurate interpretations of South American prehistory.

9.3. Methods

The most significant findings from this study stem from the methods used to collect and analyze data. This study has contributed to the methods of scientific archaeology in four ways. First and foremost, I have shown that there is a great deal of information in the tiny shell beads that are so often relegated to appendices or brief mention in both published works and unpublished reports. Second, I have demonstrated the ease with which these data can be collected, a task that would have been extremely laborious only 10 years ago. Thirdly, the combination of a Microsoft Access database with the SPSS statistical package, enabled this analysis. The large number of simple analyses of hundreds of thousands of data points would have been difficult only a decade ago. Lastly, the use of the *chaîne opératoire* (or similar methodological tools) to describe shell bead production is uncommon. This approach allows me not only to analyze and understand finished products, but to address qualitative and quantitative variation during all stages of production.

9.4. Summary of Manteño shell bead production.

I have shown that shell beads from all six archaeological sites were produced using two different chaînes opératoires. The first *chaîne opératoire*, known as chaîne I, involves: shell procurement; reduction of the shell by percussion; edge and face grinding to produce a faceted disk (i.e., a bead 'blank'); perforation with tiny lithic microdrill; and, a final grinding upon an abrasive surface, probably sandstone, with multiple beads strung together on a fibrous cord. Chaîne I is similar to the ethnographically recorded *heishi* technique (Foreman 1978; Francis 1982, 1989; Malinowski 1984 [1922]). Chaîne II includes: shell procurement; some reduction by grinding; perforation with organic drills or with lithic microdrills that were not recovered; and, finally, some of the beads (stage 4.1 and 5 beads) were strung and rotationally edge ground as in chaîne I.

Procurement appears to be quite different for the two chaînes opératoires. Chaîne I beads are produced from whole shells or large chunks of shell, including, and possibly limited to, Spondylus. Chaîne II beads appear to be made mainly, though not exclusively, from *conchilla*, small water worn shell fragments found along the beach; very few of these show the characteristic colors of Spondylus.

Chaîne II could be labeled an expedient technology. There is very little effort invested in making these shell beads, with the possible exception of the drilling process, about which we know relatively little. It is possible that chaîne II beads were generated by two separate operational chains, one that produced stage 4.1 beads, which were not ground at all, but are simply perforated *conchilla*, and one that produced stage 4.2 and 5 beads, which are both rotationally ground. Stage 5 beads are also face-ground. It is possible that chaîne II beads were perforated using organic materials, such as cactus spines or thorns, or with arsenical copper needles or awls. The later may have been valuable enough that they were rarely lost and, therefore, rarely recovered in archaeological excavation. Some have been recovered in contexts with shell beads, but it is difficult to show that they were used to perforate shell beads. There don't seem to be any differences in the production/ wear patterns between chaîne I and chaîne II beads, but this may be because use wear has erased the evidence of production and not because they were produced using the same drilling method. Chaîne II beads do appear to have been drilled from one side more often than chaîne I beads, but so many of the perforations of the beads have parallel walls, it is difficult to identify the direction of drilling.

These two chaînes opératoires produce quantitatively and qualitatively distinct beads. Chaîne I beads are smaller in all dimensions except minimum diameter, probably because of the thinness of *conchilla* used for chaîne II beads (see Figure 8-2 and Table 8-13). Perforations for chaîne I beads also tend to be smaller than those for chaîne II beads, which is supported by the fact that smaller microdrills, with smaller tips, are associated with sites where the primary technique for making beads was chaîne I, while larger, and many fewer, drills are associated with sites where primarily chaîne II beads were used. Chaîne I beads are more regular (i.e., less variable) in all dimensions than the rough, expedient beads of chaîne II. The diameter of Stage 5 beads, made using either chaîne I or II, are less variable than all other beads because they have been rotationally ground.

Chaîne I beads tend to break much more often than chaîne II beads and are particularly vulnerable during the perforation process (stages 3 and 4; see Figure 8-3). Since it is unclear if the drilling process is represented in the assemblage of chaîne II beads, it is difficult to know the amount of fragmentation during perforation, but these beads are much less likely to be broken. Based upon the variety of raw material used (i.e., *conchilla* versus Spondylus, especially for ROP [red, orange, purple and pink] beads) and the larger size of the beads, I do not think that the perforation of chaîne II beads caused as many beads to break as the perforation of chaîne I beads. Colored Spondylus was one of the main materials used for producing chaîne I beads and the outer colored part of the Spondylus shell has a rough texture pockmarked by parasites that would probably increase the possibility of breakage. Chaîne II beads rarely were fashioned from this material. Similarly, since chaîne I beads are quite a bit smaller, one might hypothesize that they are also more likely to break simply because there is less shell between the perforation and the edge of the bead. This does not appear to be the case, however, since smaller chaîne I beads do not break more easily than large chaîne I beads. Instead, high fragmentation rates are associated with color and therefore with a particular type of material. Indeed, when only stage 3 and 4 beads (incompletely and completely perforated chaîne I beads) are included, the majority of the breakage occurs for ROP beads (see Table 8-17 and Figure 8-5). Chaîne I beads (as represented by stage 2, 3, and 4) tend to be red, orange, and purple (and some pink) much more often than chaîne II beads. It appears to me that the coloration of many of the chaîne II beads that were coded ROP or ROP/Light is distinctly different from the chaîne I beads. The chaîne II beads tend to have small streaks of color while the chaîne I beads tend to ROP over a larger portion of the bead. On a similar note, ROP beads are smaller than Light beads (see Table 8-18 and Table 8-19), partially because they tend to be made using chaîne I.

Cylindrical beads, which differ from discoid shell beads only in their greater 'thickness' or length, were produced using only chaîne I. I have argued elsewhere (Carter 2001), that a longer, thinner lithic drill was required to perforate cylindrical beads because, even though cylindrical beads are longer than discoid beads, their perforation measurements are similar. If the same drill (i.e., one with a conical point) were used for both, the maximum perforation diameter for cylindrical beads would be larger than for the thinner discoid beads because the cone must perforate farther into the shell yielding a larger diameter at its base which corresponds with maximum diameter of the perforation. However, this measurement is similar for cylindrical and discoid beads, suggesting that the tips of drills used for cylindrical beads were longer and thinner. Like chaîne I beads, cylindrical beads also tend to be ROP or ROP/Light beads, and many probably were made from Spondylus.

There are two major chaînes opératoires used to produce shell beads on the southwestern coast of Ecuador between AD 700-1532. Most of the chaîne I beads are from the early part of the Manteño sequence (prior to c. AD 1300), after which chaîne II beads became more prevalent. A small percentage of the beads recovered from the later contexts were chaîne I beads, but there is little evidence for their production. It may be that the chaîne I beads used during the later period were reused or curated beads, originally made during the earlier period. Even if some chaîne I beads were made during the later period, it is clear that there was a major transition in shell bead production at approximately AD 1300.

9.5. Shell Bead Production by Site

The shell beads appear more consistent between contemporaneous sites, but vary in production and consumption through time. Shell beads were produced using chaîne I at the sites of Loma de los Cangrejitos and López Viejo. Chaîne I beads were consumed at Los Frailes and Puerto de Chanduy, which date to approximately the same time as the aforementioned sites (on the early side and late side, respectively. Most importantly, Puerto de Chanduy shows evidence of a transition from chaîne I beads to chaîne II beads. The majority of the beads from Mar Bravo and Chanduy, which date to a later time period (after AD 1300), are produced using chaîne II beads.

Chaîne I beads were produced at Loma de los Cangrejitos, located on the Santa Elena Península, and at López Viejo, in southern Manabí. These two sites are not strictly contemporaneous; pit C (at López Viejo) appears to have been used around the same time as the abandonment of the excavated contexts at Loma de los Cangrejitos (i.e., c. A.D. 1200; note that there are later occupations at Loma de los Cangrejitos). This could be seen as a cooptation of the shell bead industry by the artisans of López Viejo at a time when shell bead production was diminishing Loma de los Cangrejitos. Considering that there are contexts at both sites that were not excavated and may overlap significantly as well as the imprecision of radiocarbon dating, I acknowledge that there are other possible interpretations, but I suggest that at around AD 1200, artisans at both locations were producing chaîne I beads.

The shell beads produced at these two sites are almost strictly chaîne I beads. These two sites yielded approximately the same proportion of stages 2-5 beads (see

Figure 8-6) and these beads seem to be approximately the same size. There are proportionately more stage 4 beads at Lopez Viejo than at Loma de los Cangrejitos, but I see no good explanation for this difference. Also, the stage 5 beads from López Viejo are slightly smaller than the beads from Loma de los Cangrejitos. It is quite likely that beads at the two sites were produced using nearly identical technology. Artisans at López Viejo may have rotationally ground their beads slightly more than the artisans at Loma de los Cangrejitos. One might think that this would increase the chance of breaking a stage 5 bead, but there is no statistically significant difference between the amounts of fragmentation present on stage 5 beads at the two sites (Table 8-38). It is possible, therefore that the artisans at Lopez Viejo had a disposition for slightly smaller beads than the artisans from Loma de los Cangrejitos. However, because the contexts studied from Lopez Viejo appear to represent fairly rapid deposition and those from Loma de los Cangrejitos appear to have been lain down over a longer period of time, I hypothesize that at AD 1200 the artisans at these two sites had similar dispositions, but this is disguised at Loma de los Cangrejitos by the inclusion of beads from an earlier time period when slightly larger beads were favored. There does not appear to be any statistically significant difference in the size of shell beads from distinct stratigraphic levels at Loma de los Cangrejitos, but this may be due to the relatively small sample size per level.

One major unexpected finding of this study was the recognition of two ‘packets’ of stage 2 beads (face ground and edge ground discs, but without perforations; also known as ‘blanks’); one from López Viejo (context LV-752; n=198) and one from Loma de los Cangrejitos (context B2-08; n=12). The identification of these 'packets' is highly significant to this study because they provide a demonstration of a disposition with an ideal (represented by the measure of central tendency) and associated variation (represented by the measure of dispersion). Both of these 'packets' were probably made by either a single artisan or perhaps a couple of members of the same shell-working community of practice. I cannot imagine a reason that unassociated artisans would place groups of stage 2 beads in these contexts. I imagine that the beads from Lopez Viejo either were placed in this context as some form of ritual deposit or perhaps a small skin or woven bag was lost with the beads inside. The former is more likely since the context appears to be more structured than strictly domestic middens: perhaps the refuse was deposited during a feast for the deceased recovered from adjacent pits.

These packets are important because they demonstrate nicely the how an artisan , who has an ideal, produces beads that are distributed around that ideal. The beads have a mean maximum diameter of 3.34 millimeters and a standard deviation of 0.254 millimeters. This is both smaller and less variable than the stage 2 beads at Lopez Viejo as a whole. Including all of the stage 2 beads from López Viejo, the mean maximum diameter is 4.07 millimeters with a standard deviation of 1.12 mm. Clearly a single artisan is making beads that are tightly distributed around their ideal, but other artisans had distinct ideals. What we see in the archaeological record is a representation of a generalized ideal. While the cache represents a single production episode, the rest of the beads represent a wider number of shell-bead producers at the site. Since the excavated contexts at López Viejo appear to have been deposited over a relatively short period of time, the analyzed assemblage from the site probably represents a larger social disposition during a relatively short interval.

Lithic microdrills are present in quantity at only two sites, Loma de los Cangrejitos and López Viejo. These two sites are the only sites with any quantity of stage 2-4 beads. Because of this, I infer that these are the only two sites where chaîne I shell beads were produced. The lithic drills at other sites tend to be larger and, therefore, probably were not associated with chaîne I bead production, and they may not be associated with bead production at all. There are significant differences between the drills found at Loma de los Cangejitos and Lopez Viejo, however.

The drills from López Viejo are longer, more narrow, tend to have an elongated diamond shape and lack shoulders between the body of the drill and the tip compared to those from Loma de los Cangrejitos. The microdrills from Loma de los Cangrejitos tend to be shorter and a little fatter, but they also appear to have been reworked repeatedly. The drills from Loma de los Cangrejitos may have been initially similar in length to those from López Viejo, but were broken, 'resharpend', and reused more frequently. Although the excavated contexts at the sites are slightly different, this does not appear to explain the difference in lithic microdrills. Perhaps greater proximity or access to lithic resources explains the length of microdrills at López Viejo. The distribution of lithic resources and the quality of those resources is not well known in either of these regions, but lithic resources at Loma de los Cangrejitos appear to be limited to river cobbles. It is probably difficult to get a fairly long drill from such material, ensuring that each drill, once made, was essentially used up. Perhaps good quality lithic materials were closer at López Viejo so each lithic microdrills was not used so intensively. It is also possible that artisans at López Viejo had developed a disposition for this type of drill without any direct economic implications.

The shell bead assemblages from Los Frailes and Puerto de Chanduy appear to represent the consumption of beads since most recovered beads are Stage 5 and very few lithic microdrills are present. Los Frailes has much more evidence of other activities at the site, such as the production of mother-of-pearl artifacts, while the excavated contexts from Puerto López represent mainly midden or, potentially, feasting.

The Los Frailes beads tend to be statistically larger in most dimensions compared to beads from López Viejo, Loma de los Cangrejitos and Puerto de Chanduy. They are statistically larger in practically all dimensions (see Figure 8-13 to Figure 8-24), but are also clearly chaîne I beads. Dates from Los Frailes (c. 800-1200) indicate that the site was occupied at approximately the same time as the 4f excavations at Loma de los Cangrejitos (c. 700-1100). The larger beads from Los Frailes appear to be a continuation of the shell bead technology practiced by the Guangala people of El Azúcar, which featured beads, similar to chaîne I, but in two distinct sizes, a smaller one (4-8 mm in diameter, 1-5 mm in thickness and perforation diameter of 1-2 mm) and a larger one (15-20 mm in diameter, 7-9 mm in thickness and perforation diameter of 4-5; Masucci 1995:75). The Los Frailes shell beads are similar to the smaller beads from El Azúcar, but are on the upper edge of bead sizes from Loma de los Cangrejitos, López Viejo and Puerto de Chanduy. The beads at López Viejo, c. AD 1200, are smaller than those from the earlier contexts at Loma de los Cangrejitos. This seems to suggest that, from the middle of the Guangala Phase (c. A.D. 100-600) through the middle of the Manteño Phase (c. 1300 A.D) bead size, on the average, tended to decrease. Such a decrease probably occurred over fairly long periods of time and varied between sites. For example, there is little evidence for any change through time in the size of beads at Loma de los Cangrejitos.

The beads from Puerto de Chanduy are similar to those from Loma de los Cangrejitos and López Viejo. Since the samples from López Viejo (c. A.D. 1200) and Puerto de Chanduy (c. A.D. 1000- 1350) date to approximately the same time this is not surprising. The shell beads from Puerto de Chanduy appear to represent a continuation of the technology based at nearby, though slightly preceding, Loma de los Cangrejitos. Beads were not produced at Puerto de Chanduy, however. This is not surprising since the site was probably mainly used for the processing and consumption of fish and shellfish. These beads may have been fashioned by the people represented in the very upper, undated levels at Loma de los Cangrejitos. They could also be coming from López Viejo, where beads were clearly being produced at the same time. The most interesting aspects of the beads from Puerto de Chanduy is that they increase in variability through time. Figure 9-1 plots the maximum diameter of each complete (i.e., unfragmented) discoid bead against the excavation level from which it was recovered. There is a very clear increase in the variability of size between levels 13 and 14. This is true for stage 4.1, 4.2, and 5 beads. Fortunately, level 13 yielded a carbon sample dating between A.D. 1161-1285 (calibrated with two sigma). Considering the dates from Loma de los Cangrejitos, which lacks any chaîne II beads, the transition probably occurred at approximately A.D.

1200/1250. Puerto de Chanduy also shows a lower percentage of ROP beads than Loma de los Cangrejitos and Puerto López, but a similar proportion to Mar Bravo and Salango (see Figure 8-26). The beads from Puerto de Chanduy can be thought of as pertaining to the period of transition when the production of the small regular beads of chaîne I gave way to the production of to the larger, irregular beads of chaîne II.

Mar Bravo and Salango represent bead technology from approximately AD 1300/1350 until after Spanish contact. The majority of these beads are made using chaîne II, but small chaîne I beads were used during this time period, as well. Because there are essentially no stage 2, 3, or 4 beads and very few lithic microdrills, it is unlikely that chaîne I beads were produced at Salango and Mar Bravo. It is possible that these chaîne I beads were reused or curated beads that were made prior to AD 1300. They may have also been produced at a yet undiscovered (or excavated) site. Indeed, they may have been made at Mar Bravo, because both drills and tiny beads had been noted at a now destroyed area of the site (personal observation 1998). Salango (AD 1300-1600) appears to have been occupied slightly later than Mar Bravo (c. AD 1300-1450). Green glass beads at both sites, suggest that they were minimally occupied until at least A.D. 1492.

Variation in chaîne I beads appears to have increased at Puerto de Chanduy at approximately AD 1200/50, at which time chaîne II beads also appear at the site (see Figure 9-1). Prior to this time period most beads were small (<5 mm in maximum diameter), while after this time, many more beads are larger than 5 mm, even up to 30 mm in maximum diameter. It is also at this time when there was a significant break in chronology between the earlier sites (Loma de los Cangrejitos, Los Frailes, López Viejo, and Puerto de Chanduy) and the later sites (Mar Bravo and Salango). It is at approximately the same time that the colored floors were created at Loma de los Cangrejitos. The artisans and consumers at the earlier sites mainly fabricated and used chaîne I beads, while at the later sites chaîne II beads were most popular.

9.6. Interpretation

Shell bead production is but a single component of Manteño society, but it has been at the core of interpretations regarding the role of this craft in regional and interregional interaction, particularly in terms of long-distance and Spondylus trade. However, the way in which these factors of social interaction affect each other has been poorly theorized. The Fuzzy People Model discussed herein provides a more nuanced account of how social, including technological, change occurs. Changes in some factors result, not in a direct change in others, but in a disjunction in the factors of social interaction. This disjunction can cause an increase in interest in dispositions previously considered marginal. As those marginal dispositions become more attractive to the majority, social change occurs, perhaps without anyone even noticing. This process, however, is in no way determined and, because of the variety of dispositions brought to bear in any social interaction, the vagaries of who, what, when, where, and how matter. Therefore, if the same external change occurs in different societies, at different times, or even between different people within a society the results are rarely inevitable: those external changes will be dealt with in a way that is appropriate to the unique social situation. This may seem to suggest that anything can happen. While this is true, certain outcomes are more probable than others. No single outcome can be predicted, but outcomes can be seen as more or less likely. Such outcomes, however, are often seem to have been predictable in retrospect. This is because, as dispositions change, certain actions become more likely and, more often than not, these actions are taken. They are not necessarily taken, however and therefore social change is never predictable, certain results are only more or less likely.

Clearly the use of chaîne I during the Late Guangala/Early Manteño period was a continuation of a technique developed early in Ecuadorian prehistory, and mainly used by their predecessors during the Middle Guangala period. From the Middle Guangala to Late Guangala/Early Manteño periods, shell bead size decreased and became increasingly focused upon ROP beads. Why would artisans decide to change the size and color of beads? The technology to produce small ROP beads was present even early on, but was not the preferred technology. In other words, these type of beads were at the edge of the distribution of the bead disposition; artisans could produce such beads, but had no disposition towards doing so. In order for such change to occur, other dispositions needed to be adjusted. This happened in this case through a combination of external and internal contributing factors.

The decrease in bead size is a reflection of the adjustment by a community of artisans to a changing social environment. It appears that the preference for smaller beads increased through time, perhaps driven by the artisans as they worked to develop their own capabilities and skill or through competition and a desire to secure a distinct position within society. It may have been driven by local social preferences, perhaps by leaders in the community who saw smaller beads as more attractive or more labor-intensive and, therefore, highly valuable. It may have been driven by factors external to Manteño society, particularly from societies with whom the Manteño traded. Indeed, the preference for tiny shell beads was most likely embedded within society on the southwestern coast of Ecuador well before the commencement of the Manteño period. Preference for smaller ROP beads by distant elites greatly increased before the Manteño period, particularly among the Moche (e.g. at Sipán; c. AD 1-300) of the north coast of Peru, and those of the Chaupicruz phase site of La Florida (c. AD 100-450) in the highlands of Ecuador (see Section 5.3.3). Based upon current archaeological evidence, demand for tiny shell beads peaked between 100 BC and AD 900, prior to and during the beginning of the Manteño period. Surprisingly, there is little evidence for the location at which these beads were made. It is possible that some of them were made at the Guangala site of El Azúcar (Masucci 1995), although most beads from El Azúcar were large and white whereas the beads from Sipán or La Florida tend to be much smaller and include numerous ROP beads. The beads from Loma de los Cangrejitos (c. AD 700-1200) are the correct size and color, but are their manufacture seems to post-date the period of time. The bead technology used at Loma de los Cangrejitos must have had a precedent at another location, perhaps within southwest Ecuador or extreme northwest Peru. The artisans at Loma de los Cangrejitos most likely inherited a Late Guangala (or other contemporaneous group) production tradition from this unknown source. A change of preference from the production of larger white chaîne I beads (as evidenced at El Azúcar) to smaller ROP chaîne I beads (as evidenced at Loma de los Cangrejitos and López Viejo) cannot be easily explained with current evidence.

The process of reduction in bead size and increase in the production of ROP beads should not be unilaterally attributed to the demand of the southern elites. It was likely a process in which bead makers provided a variety of bead sizes and colors and those that were preferred by the consumers were the types that the producers ultimately re-focused upon. This should not be seen as predetermined action driven by a supply, but where demand is locally viewed within a broad social context composed of multiple dispositions and acted upon within those dispositions. External forces did not cause the change so much as both parties acted within their own dispositions. This dialectical process may have been affected by direct or indirect communication between the producers and the consumers via the ocean-going sailing rafts used by the Manteño (and contemporary residents of extreme northwest Peru).

I have suggested three explanations for the fact that the beads from López Viejo are smaller than those from Loma de los Cangrejitos. First, as discussed above, the greater variation at Loma de los Cangrejitos may be due to a change in dispositions through time at the site. Second, because the beads from Loma de los Cangrejitos represent a fairly stable shell bead technology through time and space, they probably represent similarly stable dispositions towards attributes in shell beads for a community of practice that extended through time and space at the site. However, because the sample from López Viejo is restricted in time and the contexts may be ritual, the shell beads may be representative of only a subsection of the shell bead making community of practice. For example, perhaps only certain artisans (those able to make the tiniest beads?) contributed to the deposit. The socio-political environment may have been different at

Lopez Viejo compared to Loma de los Cangrejitos because the former site has impressive stone architecture that probably expressed greater hierarchy. This interpretation, however, is based upon the assumption that the constructions all across the site are contemporary with the excavated units, but it is possible (and I think likely) that the stone foundations of large communal structures were a later development. What the site looked like at A.D. 1200, when the beads were made is not well understood.

Alternatively, one could argue that the assemblages from López Viejo and Loma de los Cangrejitos are representative of the local community of practice. Under this interpretation, the shell bead artisans at López Viejo had a disposition for beads slightly smaller than those from Loma de los Cangrejitos. The shell beads from López Viejo vary less than those from Loma de los Cangrejitos, indicating that the artisans at the former site were less accepting of variation from what they considered ideal. It is possible that the artisans at López Viejo did produce based upon more rigid dispositions about shell bead size than at Loma de los Cangrejitos.

The frequencies of ROP shell beads are greater at both López Viejo and Loma de los Cangrejitos than at other sites included in this study. Considering the relative lack of ROP beads at Puerto de Chanduy, which is contemporaneous with both López Viejo and the final occupation of Loma de los Cangrejitos, it is probable that light colored beads were mainly used locally, while the ROP were preferentially exported. Considering the importance of colored beads among the contemporaneous people of Sicán and Chaupicruz phase La Florida, these two places were significant destinations for the ROP beads.

The evidence from the time period represented by Loma de los Cangrejitos, López Viejo and the earlier levels of Puerto de Chanduy is the best we have for understanding the apogee of tiny shell bead production and export. The importance of this hypothetical exchange is suggested by the ritual interment in burials of tools for making shell beads and in-process beads (Zevallos 1995).

At Puerto de Chanduy we can see the transition from small regular chaîne I beads to larger chaîne I and chaîne II beads dated to approximately AD 1200/50. Most of the tiny shell beads from northern Peru are from Middle Sicán (c. AD 900-1100) tombs, not from Late Sicán (c. AD 1100-1375) contexts, so the transition from tiny beads to much larger and irregular beads may post-date a decline in the demand in northwestern Peru for these beads. This transition from small chaîne I beads to larger chaîne II beads at Puerto de Chanduy lies well within the Late Sicán, which is a time of transition from the powerful Middle Sicán to greater domination by the Chimú. There is little evidence for the consumption of chaîne I beads on the north coast of Peru during the Late Sicán and the Chimú period. This suggests that chaîne I technology may have been conserved longer among the Manteño than external demand. Of course, all of these dates have a reasonable amount of error, so we must be careful of relying upon them too closely.

The conservation of chaîne I technology beyond the decline of external demand is due partially to the resistance of a highly repetitive technology to rapid change, but this does not account for the conservation of a technology for a hundred years or more. It is likely that artisans suffered from a drop in the demand for their work, so why would they continue to produce these beads? The conservation of the technology beyond tens of years may indicate that demand was found elsewhere. Local demand, Puerto de Chanduy for instance, might have supported the continuation of shell bead making technology. The limited evidence for ROP beads at Puerto de Chanduy (15% of the complete discoid stage 5 beads vs. 70% and 57% for Loma de los Cangrejitos and López Viejo, respectively) suggests that production continued, but with less of a focus upon ROP beads. At roughly AD 1200/50 a relaxation in quantitative and qualitative attributes of shell beads from Puerto de Chanduy can be seen; beads remained important after the loss of demand by the Sicán (c. AD 1100), but with less production of the more difficult ROP beads made from the outer layers of Spondylus shell. After c. AD 1200/50 variation in bead size increased, indicating changing dispositions towards acceptable bead sizes. Tiny shell beads were still consumed in very small quantities, but larger more irregular beads, including those made using chaîne II, became the dominant type.

Existing dispositions, buried deep within routinized bodily motion, changed slowly. Dispositions that allow for relatively little variation tend to change slowly because the associated distributions have very short tails. I argue that the fairly restricted size and raw materials of beads from both Loma de los Cangrejitos and Lopez Viejo suggest such a disposition. As more variation becomes acceptable, even if the ideal bead doesn't change, other varieties of beads can then be satisfactory (i.e., the curve representing the disposition, widens and the MD increases). Once this has happened, only then can a different type of bead become the ideal. Artisans may consciously resist such change because it would indicate a decrease in the importance of their trade and, thereby, a reduction in their own status. A reduction in the significance of shell bead production is clear at Loma de los Cangrejitos where burials from the later time period no longer include the tools or in-process beads and also lack the copper money-axes that are thought to have been used in exchange.

At the later (c. AD 1250 to post-Contact) sites of Salango and Mar Bravo, chaîne II was used almost exclusively to make shell beads. Chaîne I beads continue to be present, but they were either made during the earlier time period and curated or recovered from archaeological contexts, or they were made at an unknown location. Chaîne II beads are a ‘new’ technology and, therefore, must have been produced during this time period. Production of these beads is a fairly expedient technology requiring few tools-- especially if the beads were drilled with an organic drill (e.g. cactus spines, perhaps with abrasive or acid). The only tool that would have been preserved would be sandstone grindstones, which are present at both of the later sites.

Interestingly, most of the stage 5 ROP beads present at Mar Bravo and Salango appear to be very similar to those from the earlier sites (i.e., made using chaîne I). It is likely that these beads were curated and/or recovered from archaeological deposits, but it is also possible that they continued to be made at a currently unidentified site or a site where shell bead data have not been published (e.g. Agua Blanca). I believe the former is much more likely considering the extensive evidence for production at the earlier sites and almost complete lack at the later sites. There may have been evidence for chaîne I production at Mar Bravo, but that section of the site no longer exists (personal observation 1998). These beads would have been seen by these later residents as part of local history, perhaps of reminiscent of a more ‘successful’ time. Curation of such historical artifacts is common.

Clearly, shell beads were a significant category of objects to the inhabitants of southwestern Ecuador since at least the middle Guangala Period (c. AD 1) until after Spanish contact. The production of shell beads was focused upon certain types at different times. After the decline in the demand for shell beads c. AD 1100, shell beads remained important, but social dispositions regarding the size, regularity, and color of the beads were being relaxed. A bead’s value as an export good declined and artisans relaxed their dispositions about bead attributes, but shell beads remained an important aspect of society until after Spanish Contact.

While local demand for shell beads was high, external demand shifted from shell beads (especially ROP beads) to raw material, specifically whole Spondylus shells and fragments. The Chimú, unlike their Moche and Sicán predecessors, took little interest in shell beads, but they had a strong taste for Spondylus shells, which were employed in offerings and as inlay in compound artifacts (especially metal and wooden ones). This pattern was developed in the preceding time periods. The Sicán, especially, are well-known for the large piles of Spondylus interred with high ranking individuals as well as the whole shells offered within chambers on top of large structures; the Moche did this as well, but with smaller quantities of Spondylus shells. The Chimú continued this tradition using Spondylus as offerings in its raw (whole, ground, or powdered shell) form and as inlay in compound artifacts, especially wooden statues used in, and to portray, burial ceremonies. The Chimú, however, were not interested in small shell beads.

Later sites, especially Salango, appear to have an overabundance of Spondylus 'cores', the extremely hard and nearly unbreakable area of the shell around the hinge—a fact not explained by the production of shell beads or other artifacts (which is why they are present at earlier Loma de los Cangrejitos). While some have suggested that this indicates segmented production of shell beads (Harris et al. 2004; Norton 1986; Norton et al. 1983), it is more likely that the raw material, either as whole shells or just the colored lip (leaving the 'core' behind), were shipped to consumers, especially in Peru, where the Chimú and, subsequently, the Inka were the main consumers.

Current evidence for the Inka indicates that Spondylus was consumed in two very different ways: as raw material for small figurines (*idolillos*) or whole shells deposited in mummy bundles. Spondylus shell was acquired by the Inka who converted it into a variety of *idolillos*, representing principally humans and llamas, but including many other forms, that were used as offerings from the north coast of Peru to Chilean and Argentinean mountain peaks. The recovery of the burial of an Inka Spondylus worker at La Viña offers definitive evidence for the production of these *idolillos* and suggests that they were made on the north coast of Peru and subsequently shipped all over the Inka empire, perhaps via the famous road system. The Inka-period people around modern-day Lima also buried Spondylus valves with their dead in mortuary bundles. Although it is often suggested that the Manteño transported Spondylus all the way to Chile, the Inka period dates for these finds probably indicate that this long-distance trade was a result of the expansion of the Inka empire, not of Manteño trading. A more parsimonious explanation would involve traders from Peruvian coastal communities, such as Chincha

(Rostworowski de Díez Canseco 1970), within a linked network of traders: the Manteño may have traded only as far south as the extreme northwest coast of Peru where their goods were transported inland and to the south by road and boat. There is no good evidence that the Manteño traveled directly to Chile.

During this later period (after c. AD 1200), there may have been a distinct shift in the acquisition of Spondylus. The majority of Spondylus diving imagery that can be securely dated is associated with the Chimú, though some is likely of Sicán origin. This may indicate a greater concern not just with the raw material itself, but with the retrieval of Spondylus from the religiously-charged watery depths. This change in imagery may be just that, the physical memorialization of a disposition that was essentially in place as early as Moche V. The appearance of Spondylus diving imagery at this time does not suggest that the Chimú (or the Sicán) were the first cultures in Peru to take an interest in this activity. It is still unclear whether specialized Spondylus divers were even necessary and if they did exist the question of when and who will be difficult to address.

Late Manteño period communities, therefore, probably did not see a drop in demand for their services (e.g., long-distance voyaging) and goods (e.g., Spondylus and cotton fabric, salt, dried fish, etc.). The only sector that certainly suffered from a decline in demand for shell beads were the shell bead makers. Spondylus fishers may also have suffered as the Chimú (and perhaps as early as Moche; Cordy-Collins 1999, 2001) increasingly controlled the acquisition of these shell fish. The increase in diving imagery during the Chimú (or Sicán) period suggests that this means of acquisition figured among their dispositions. Clearly they were keenly interesting in the process of diving for

Spondylus, but this iconography fails to tell us how the industry was organized. The burial of an elite Inka person on Isla de la Plata near hundreds of *S. princeps* shells also suggests that the Inka were directly involved in the handling, if not the acquisition, of the shellfish along the coast of Ecuador (Dorsey 1901; Marcos and Norton 1981; Marcos and Norton 1984; McEwan and Silva I. 1989). Exactly what role the Inka official played is unclear, but, based upon current evidence, we can say that there was a further increase in the involvement of people from modern-day Peru in Spondylus exchange during the Inka period and possibly during Sicán and Chimú times.

After the Manteño came into contact with Spaniards, both shell bead production and Spondylus consumption were affected. The details, however, are unclear. Previous interpretations of colonial period Spondylus are based upon the translation of *mullu* as Spondylus. However, Blower has argued convincingly that Spondylus is *mullu*, but *mullu* includes a whole lot more than just Spondylus shell. A finer understanding of Spondylus during early Colonial times must await the investigation of archaeological sites from this time period.

Artifacts are created by sensible artisans acting within a social environment. Production, as a primarily social activity, is both affected by and affects the social milieu. In terms of shell bead production, the choice of what materials to use, what techniques to use and what attributes the finished product should have were affected by social actors around the artisan. The choices artisans make reinforce or modify the expectations of consumers and other social partners, i.e. they produce and reproduce individual dispositions. They also affected by the factors of social interaction outlined in the Fuzzy

People Model above, including: predispositions, dispositions, social structure, and context. This does not mean that shell bead production is affected by any small change in social variables. Indeed, shell bead production, as with much ‘daily’ technology, is fairly resistant to change because of the highly repetitive actions used to make the beads and the neuromuscular training that results. A resistance to change clearly does not indicate that the technology remains static, rather, the process occurs over fairly long periods of time.

Most social change happens when disjunctures occur, but not in a deterministic way. Disjunctures may be large or small and may be associated with both increases and decreases in the likelihood of certain actions or processes that can lead to broader change. In this case, the Manteño shell bead artisans were faced with a disjuncture in the social factors of shell bead production, namely the drop in external demand for tiny shell beads. This external change lead to a series of changes within Manteño shell bead production, not because artisans were forced by external changes, but because those external changes made certain actions more likely and others less likely. In this way, the change recorded herein was not inevitable, but resulted from the artisans’ modification of their own dispositions by recognizing that certain actions no longer fit with the other factors of social interaction. They continued to produce traditional beads, however, for four potential (and not mutually-exclusive) reasons: 1) because dispositions that are deeply embedded in the human neuromuscular system are more difficult to change than others, 2) dispositions with relatively little acceptable variation are also difficult to change, 3) artisans consciously used their own strategies to ensure that bead-making fit the new social realities and 4) some local demand remained for shell beads. The variation in dispositions that permitted this change, however, was already present in society and the artisans first simply broadened their shell bead making repertoire to include ‘expedient’ beads. This process resulted in a some desire for tiny shell beads among the Manteño that form a small percentage of the assemblages from Mar Bravo and Salango, but the supply seems to have come from curated or recovered beads, not from production. Although beads remained a significant material aspect of later Manteño society, shell-bead producers may have lost any differentiated position that they held as production became more expedient and, thus, more available to every member of the society.

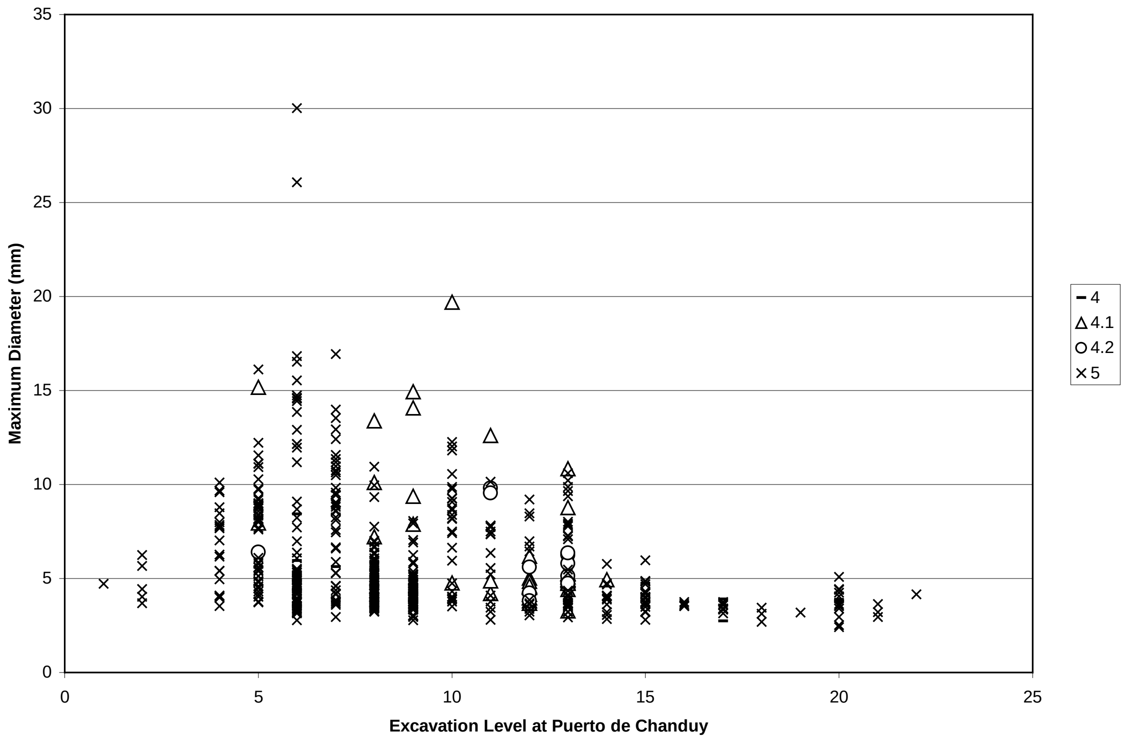


Figure 9-1. Distribution of beads by maximum diameter and excavation level at Puerto de Chanduy. Note that not all excavation levels are equal, but are generally sequential with upper levels on the left; see section 4.2.2 for description of excavation.

Chapter 10. Conclusion

In this dissertation, I contribute to the scientific study of archaeological remains and to the reconstruction of South American prehistory. I compiled and updated the culture history of the highly-desired shellfish, Spondylus. I model how individual people, through social interaction, can produce both change in social structure and material culture. I produced an innovative interpretation of changes in shell bead production technology during late prehistory on the coast of southwestern Ecuador. I demonstrate the utility of close examination of shell beads in archaeology emphasizing the importance of measuring as much variability as possible. I employed straight-forward and easy to interpret statistical analysis with a very conservative significance level, thus achieving a high level of confidence in the data and in their subsequent interpretation.

Spondylus ecofacts and artifacts have been important material objects since early in the prehistory of western South America. It is abundantly clear, however, that the uses of this shellfish varied greatly through time and space. Early in the late prehistoric period (c. A.D. 800), Spondylus was used mainly in the form of tiny shell beads, known as *chaquira*, and as whole shells. As time progressed, shell beads fell out of favor with consumers on the north coast of Peru. Shell bead producers in Ecuador, continued to produce beads, which tended to be larger and eventually these were produced more expediently, resulting in a bead type requiring little specialized knowledge.

Bead producers did not just stop when demand for their beads evaporated. Bead production had been important for generations of Guangala and Manteño people;

such a deep tradition resists extinction. Artisans had learned dispositions and trained their bodies to make beads. These dispositions were fairly rigid, as evidenced by strict control over bead size, which changed gradually. Shell beads were produced by the Manteño long after their important consumers had forgotten about them. This interpretation is based upon a well-founded argument that technology is a social process and it must be conceptualized as such: style is social or it is nothing.

Social processes are dynamic, involving social structure which both enables and constrains the actors who produce and reproduce it. The question becomes how does this process, which appears to give actors great power over their own social structure, produce both stability and change. This can be understood by using probabilistic statements for the multiplicity of factors involved in social interaction, including predispositions, dispositions, social structure and context. Stability occurs when all of these factors fit well together and are mutually reinforcing. Change occurs when, through internal or external disturbances, one or more of these factors is no longer in accord with the other factors, thus creating social anxiety that must be resolved. What happens next is not strictly predictable or predetermined, but some options can be seen as more probable than others. For example, the Manteño shell bead artisans had to deal with the loss of consumers by reducing their social investment in shell beads over time. They did not need to abandon their craft when external demand dried up, and clearly did not do so. They could have developed relationships with new consumers, but this did not happen. Toward the end of late prehistory the expedient production of large, irregular beads fit better with other social factors than did the production of labor intensive *chaquira*. It is noteworthy that the vessel encountered by Bartolomeo Ruiz did carry both Spondylus shell and red and white beads, but it is unclear if these were the tiny chaquira or larger beads. It would be interesting to know what other kinds of social change occurred during this time.

I would like to see studies similar to mine focus on other times and locations. The intensive collection of diverse measures of variation for large numbers of artifacts is key to this research. Without such measures, it is impossible to see the requisite distributions and very difficult to analyze change or stasis in artifact production. While such studies need not focus on shell beads, these tiny objects have been particularly useful for my research in Ecuador. Large numbers of shell beads from six different archaeological sites have provided evidence of periods of both stability and change. Shell beads should no longer be relegated to appendices and unpublished documents.

The very straightforward statistical analyses used in this study provided easily interpretable data. Although lognormal transformations were used because of the clear skewness of some data, analysis of transformed data provides better estimates of the measure of central tendency and the measure of dispersion. The use of ANOVA and chi-squared analyses on large data sets has allowed me to break them up in multiple categories and test for differences between these categories. Also, the examination of the distributions has lead to detailed interpretations that would otherwise be impossible with just descriptive statistics. This raises confidence in the interpretation of data.

This study has produced an interpretation of dynamic social processes related to shell bead production in western South America during late prehistory. Much of the theory and the simple methods used herein are applicable across the field of archaeology.

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Appendix A. Raw Data for Radiocarbon Dates

Lab Code	Site	Site Name	Unit	Date (BP)	Error	13C/12C (o/oo)	Date Type	Reference
Beta-194787	MV-A3-362a	Mar Bravo	H10-11, Level 3	520	60	-24.8	Conv.	Herein
Beta-194788	MV-A3-362a	Mar Bravo	H10-11, Level 4	720	50	-9	Conv.	Herein
Beta-194789	MV-A3-362a	Mar Bravo	H10-11, Level 5	510	60	-23.7	Conv.	Herein
AA-68846	MV-A3-362b	Mar Bravo	5B2-3	493	38	-24.5	AMS	Herein
Beta-194790	MV-A3-362c	Mar Bravo	A Cateo 1, Feature 41	590	60	-25.9	Conv.	Herein
AA-68843	MV-A3-362c	Mar Bravo	c15-16, Level 4	609	45	-24.1	AMS	Herein
AA-68845	MV-A3-362c	Mar Bravo	c15-16, Level 9	583	36	-23.8	AMS	Herein
Beta-194791	MV-A3-362d	Mar Bravo	2A (212-227 cm)	580	50	-20.5	Conv.	Herein
AA-68844	OMJPLP-140	Salango	Feature 125	374	24	-25	AMS	Herein
AA-68847	OMJPLP-140	Salango	Feature 150	468	32	-26.3	AMS	Herein
Beta-194792	OMJPLP-140	Salango	8-8.3 Level 3	570	60	-24.2	Conv.	Herein
Beta-194793	OMJPLP-140	Salango	0-2N/1-2W, Level 5	300	50	-24.4	Conv.	Herein
Beta-194793	OMJPLP-140	Salango	6-6.3W, Feature 6	630	60	-26.2	Conv.	Herein
AA-31704	MV-C2-3a	Puerto de Chanduy	A7-7	657	43	-22.493	AMS	Masucci 2000b
Beta-124405	MV-C2-3a	Puerto de Chanduy	A7-13	790	80	-25	Conv.	Masucci 2000b
Beta-124406	MV-C2-3a	Puerto de Chanduy	A7-15	870	50	-25	Conv.	Masucci 2000b
AA-31705	MV-C2-3a	Puerto de Chanduy	A7-22	1035	65	-24.759	AMS	Masucci 2000b
Beta-124411	MV-C2-4f	Loma de los Cangrejitos	B6-6	1280	70	-25	Conv.	Masucci 2000b
AA-31706	MV-C2-4f	Loma de los Cangrejitos	B1-7	1165	45	-23.969	AMS	Masucci 2000b
Beta-124408	MV-C2-4f	Loma de los Cangrejitos	B1-7	1020	50	-25	Conv.	Masucci 2000b
Beta-124409	MV-C2-4f	Loma de los Cangrejitos	B1-13	1130	50	-25	Conv.	Masucci 2000b
AA-31707	MV-C2-4f	Loma de los Cangrejitos	B1-16	1130	45	-25.794	AMS	Masucci 2000b
Beta-124410	MV-C2-4f	Loma de los Cangrejitos	B1-18	1190	70	-25	Conv.	Masucci 2000b
Beta-141683	MV-C2-4k	Loma de los Cangrejitos	TP2-5	1140	60	-25	Conv.	Masucci 2000b
Beta-141684	MV-C2-4k	Loma de los Cangrejitos	TP2-6	890	60	-25	Conv.	Masucci 2000b
AA-39566	MV-C2-4k	Loma de los Cangrejitos	TP2-7	1094	42	-23.5	AMS	Masucci 2000b

Table A-1. Raw data for radiocarbon dates. Continued in Table A-2.

	Site	Site Name	Unit	Date (BP)	Error	13C/12C (o/oo)	Date Type	Reference
Beta-141685	MV-C2-4n	Loma de los Cangrejitos	TP1-4	1020	50	-25	Conv.	Masucci 2000b
AA-39565	MV-C2-4n	Loma de los Cangrejitos	TP1-5	915	41	-25.9	AMS	Masucci 2000b
Beta-141686	MV-C2-4n	Loma de los Cangrejitos	TP1-6	960	60	-25	Conv.	Masucci 2000b
AA-39564	MV-C2-4n	Loma de los Cangrejitos	TP1-7	934	41	-23.1	AMS	Masucci 2000b
ISGS-1449	OM-JP-MH-108	Los Frailes	A4, contect 862	660	70		Conv.	Mester 1992
ISGS-1450	OM-JP-MH-108	Los Frailes	A3, context 684	920	140		Conv.	Mester 1992
ISGS-1483	OM-JP-MH-108	Los Frailes	A5, context 498	1150	100		Conv.	Mester 1992
ISGS-1479	OM-JP-MH-108	Los Frailes	A2, context 430	1120	100		Conv.	Mester 1992
ISGS-1446	OM-JP-MH-110	Los Frailes	E, context 23	1000	70		Conv.	Mester 1992
UB-4320	OM-JP-LP-15	López Viejo	Pit E?, context 653	834	51		Conv.	Currie n.d.; 2001
UB-4321	OM-JP-LP-15	López Viejo	Pit A?, context 96	806	32		Conv.	Currie n.d.; 2001
UB-4322	OM-JP-LP-15	López Viejo	Pit C, contect c. 203/204	816	31		Conv.	Currie n.d.; 2001

Table A-2. Raw data for radiocarbon dates. Continued from Table A.1. 13C/12C (o/oo) unavailable from Los Frailes and López Viejo, but samples from both sites were corrected for isotopic fractionation.

Appendix B. Calibrated Radiocarbon Dates

Lab Code	Sample Code	14C age	corrected error	1 or 2 sigma	lower cal range BC/AD	upper cal range BC/AD	relative area	median probability
Beta-194787	Mar Bravo- 362a H10-11 L 3	520	60	1	1323	1347	0.253042	1405
					1392	1443	0.746958	
				2	1297	1466	1	1405
Beta-194788	Mar Bravo- 362a H10-11 L4	720	50	1	1229	1231	0.00757	1279
					1243	1246	0.022801	
					1252	1301	0.835105	
					1367	1382	0.134524	
				2	1215	1320	0.825025	1279
					1350	1391	0.174975	
Beta-194789	Mar Bravo- 362a H10-11 L5	510	60	1	1324	1345	0.200369	1412
					1393	1447	0.799631	
				2	1297	1485	1	1412
AA-68846	Mar Bravo- 362b 5B2 L3	493	38	1	1413	1441	1	1426
				2	1325	1344	0.048439	1426
					1393	1456	0.951561	
Beta-194790	Mar Bravo 362c A Cateo 1 F41	590	60	1	1304	1365	0.711009	1353
					1384	1409	0.288991	
				2	1287	1428	1	1353
AA-68843	Mar Bravo 362c c15-16 L4	609	45	1	1301	1332	0.403465	1349
					1337	1368	0.391693	
					1382	1397	0.204841	
				2	1289	1411	1	1349
AA-68845	Mar Bravo 362c c15-16 L9	583	36	1	1314	1356	0.689091	1349
					1388	1407	0.310909	
				2	1298	1372	0.669875	1349
					1378	1419	0.330125	
Beta-194791	Mar Bravo 362d 2A 212-227 cm	580	50	1	1309	1360	0.672213	1353
					1386	1412	0.327787	
				2	1294	1426	1	1353

Table B-1. Calibrated radiocarbon dates for Mar Bravo. Continued in Table B-2. Output from Calib 5.1 beta. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

Lab Code	Sample Code	14C age	corrected error	1 or 2 sigma	lower cal range BC/AD	upper cal range BC/AD	relative area	median probability
AA-68844	Salango 140 F125	374	24	1	1455	1512	0.767318	1503
					1601	1616	0.232682	
				2	1448	1523	0.654686	1503
					1559	1563	0.008874	
					1571	1630	0.33644	
AA-68847	Salango 140 F150	468	32	1	1424	1446	1	1435
				2	1409	1464	1	1435
Beta-194792	Salango 140 8-8.3 L3	570	60	1	1309	1361	0.615036	1358
					1386	1418	0.384964	
				2	1293	1436	1	1358
Beta-194793	Salango 140 0-2N/1-2W L5	300	50	1	1513	1600	0.724969	1569
					1617	1650	0.275031	
				2	1462	1666	0.979642	1569
					1784	1795	0.020358	
Beta-194793	Salango 140 6-6.3W F6	630	60	1	1291	1325	0.409087	1347
					1344	1394	0.590913	
				2	1276	1415	1	1347
AA-31704	Puerto de Chanduy 3a A7-7	657	43	1	1283	1314	0.493552	1340
					1356	1388	0.506448	
				2	1275	1333	0.486842	1340
					1337	1398	0.513158	
Beta-124405	Puerto de Chanduy 3a A7-13	790	80	1	1161	1285	1	1222
				2	1038	1306	0.969564	1222
					1363	1385	0.030436	
Beta-124406	Puerto de Chanduy 3a A7-15	870	50	1	1049	1084	0.245418	1164
					1124	1137	0.080299	
					1151	1222	0.674283	
				2	1040	1112	0.284703	1164
					1115	1257	0.715297	
Beta-124411	Loma de los Cangrejitos 4f B6-6	1280	70	1	659	781	0.906933	748
					790	809	0.093067	
				2	639	895	0.992206	748
					925	936	0.007794	
AA-31705	Puerto de Chanduy 3a A7-22	1035	65	1	896	923	0.157318	1000
					940	1042	0.785355	
					1106	1117	0.053261	
					1144	1145	0.004065	
				2	832	836	0.001479	1000
					869	1164	0.998521	

Table B-2. Calibrated radiocarbon dates for Mar Bravo. Continued from Table B-1. Output from Calib 5.1 beta. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993).

Lab Code	Sample Code	14C age	corrected error	1 or 2 sigma	lower cal range BC/AD	upper cal range BC/AD	relative area	median probability
AA-31706	Loma de los Cangrejitos 4f B1-7	1165	45	1	780	792	0.094643	865
					803	897	0.746042	
					921	943	0.159315	
		1165	90	2	723	740	0.020398	865
					770	984	0.979602	
Beta-124408	Loma de los Cangrejitos 4f B1-7b	1020	50	1	904	912	0.041664	1014
					970	1044	0.826055	
					1099	1119	0.111694	
					1142	1147	0.020587	
				2	895	924	0.07802	1014
					938	1059	0.686442	
					1066	1072	0.008751	
					1075	1155	0.226788	
Beta-124409	Loma de los Cangrejitos 4f B1-13	1130	50	1	832	836	0.019661	913
					869	986	0.980339	
				2	778	997	0.986039	913
					1004	1012	0.013961	
AA-31707	Loma de los Cangrejitos 4f B1-16	1130	45	1	876	984	1	916
				2	778	994	0.998522	916
					1009	1010	0.001478	
Beta-124410	Loma de los Cangrejitos 4f B1-18	1190	70	1	719	742	0.096982	834
					769	898	0.794638	
					920	944	0.10838	
				2	682	982	1	834
Beta-141683	Loma de los Cangrejitos 4k TP2-5	1140	60	1	783	788	0.021879	894
					817	843	0.142669	
					859	980	0.835452	
				2	722	740	0.019926	894
					770	1018	0.980074	
Beta-141684	Loma de los Cangrejitos 4k TP2-6	890	60	1	1045	1094	0.352645	1136
					1120	1141	0.146541	
					1147	1214	0.500814	
				2	1027	1252	1	1136
AA-39566	Loma de los Cangrejitos 4k TP2-7	1094	42	1	895	925	0.353911	947
					936	990	0.646089	
				2	785	785	0.000715	947
					829	838	0.007696	
					867	1023	0.991589	

Table B-3. Calibrated radiocarbon dates for Loma de los Cangrejitos. Continued in Table B-4. Output from Calib 5.1 beta. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993)

Lab Code	Sample Code	14C age	corrected error	1 or 2 sigma	lower cal range BC/AD	upper cal range BC/AD	relative area	median probability
Beta-141685	Loma de los Cangrejitos 4n TP1-4	1020	50	1	904	912	0.041664	1014
					970	1044	0.826055	
					1099	1119	0.111694	
					1142	1147	0.020587	
				2	895	924	0.07802	1014
					938	1059	0.686442	
					1066	1072	0.008751	
					1075	1155	0.226788	
AA-39565	Loma de los Cangrejitos 4n TP1-5	915	41	1	1042	1106	0.596682	1111
					1117	1162	0.403318	
				2	1029	1208	1	1111
Beta-141686	Loma de los Cangrejitos 4n TP1-6	960	60	1	1021	1058	0.316372	1092
					1065	1065	0.006762	
					1072	1155	0.676866	
				2	985	1213	1	1092
AA-39564	Loma de los Cangrejitos 4n TP1-7	934	41	1	1036	1058	0.204257	1101
					1075	1154	0.795743	
				2	1021	1187	0.989258	1101
					1199	1206	0.010742	
ISGS-1449	Los Frailes 108 A4 #862	660	70	1	1277	1323	0.500059	1332
					1346	1393	0.499941	
				2	1228	1232	0.005041	1332
					1240	1247	0.01008	
					1251	1418	0.984879	
ISGS-1450	Los Frailes 108 A3 #684	920	140	1	999	1002	0.009252	1103
					1013	1254	0.990748	
				2	781	790	0.004557	1103
					807	1302	0.987715	
					1367	1382	0.007728	
ISGS-1483	Los Frailes 108 A5 #498	1150	100	1	775	987	1	873
				2	661	1041	0.995939	873
					1109	1116	0.004061	
ISGS-1479	Los Frailes 108 A2 #430	1120	100	1	782	790	0.032448	904
					809	1015	0.967552	
				2	674	1049	0.958714	904
					1084	1124	0.030902	
					1137	1151	0.010384	

Table B-4. Calibrated radiocarbon dates for Loma de los Cangrejitos and Los Frailes. Continued from Table B.3. Output from Calib 5.1 beta. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993)

ISGS-1446	Los Frailes 110 E #23	1000	70	1	978	1054	0.542414	1043
					1077	1154	0.457586	
				2	893	1187	0.993985	1043
					1199	1206	0.006015	
UB-4320	López Viejo 1	834	51	1	1165	1258	1	1200
				2	1045	1095	0.115648	1200
					1119	1141	0.041999	
					1147	1277	0.842353	
UB-4321	López Viejo 2	806	32	1	1216	1262	1	1234
				2	1176	1273	1	1234
UB-4322	López Viejo 3	816	31	1	1210	1261	1	1228
				2	1168	1268	1	1228

Table B-5. Calibrated radiocarbon dates for López Viejo (Currie n.d.). Output from Calib 5.1 beta. (Reimer et al. 2004; Reimer et al. 2005; Stuiver and Reimer 1993)

Appendix C. Catalog of Associated Artifacts.

Appendix C is located on the compact disk enclosed with this dissertation. It contains descriptions of all the artifacts cataloged and images of most of these artifacts; a few artifacts lack images. The text of the catalog is contained within the file named "Appendix C Artifact Catalog Text" and the images are in "Appendix C Artifact Catalog Images," both of which are Adobe Acrobat (.pdf) files and are viewable with Adobe's free Reader. Within the image file, the name of the JPEG image (cross-referenced to the text catalog) is given in parentheses and the catalog numbers for the items are given at the end of the captions.

Appendix D. Compact Disc of Data.

All of the original data accompanies this dissertation. It is in a Microsoft Access Database named "Appendix D database bpc". It is comprised of 18 tables that contain linked information (see Table D-1). These tables can be combined in queries, including All Bead Info, All Lithic Info and Catalog All. Other queries are available, but specific queries can also be designed.

Spreadsheet Name	Spreadsheet Contents
Bcolor	Links with 'Bead' color codes with descriptions, code
Bead	Main database for bead measurements, etc.
Bead stage	Links 'Bead' color codes with descriptions and coding
Broken?	Links 'Lithics' fragmentation code with descriptions and coding
Catalog Material	Links 'Catalog Table' material codes with descriptions and coding
Catalog Table	Main database for cataloged material
Inventory	Original inventory of all lithics, etc… from Loma de los
Lcrosssection	Links 'Lithics' cross-section codes with descriptions and coding
Lithics	Main database for lithic microdrills.
Location	Links Context codes in 'Bead', 'Catalog Table', 'Microscope
Lshape	Links 'Lithics' shape codes with descriptions and coding
Material	Links 'Beads' material codes to description and coding
Microscope Work	Links bead that were analyzed under the microscope to 'Location'
Sides	Links 'Lithics' to # of worked sides to description
Site Name	Links 'Location' site numbers to site names
Type	Links 'Beads' type codes to descriptions and coding
Type of Artifact	Links 'Catalog Table' artifact types to description and coding.
Whole?	Links 'Beads' fragmentation codes to description and coding.

Table D- 1. Table names and description of tables in Microsoft Access database.