VITAL SIGNS: COSTLY SIGNALNG AND PERSONAL ADORNMENT IN THE NEAR EASTERN EARLY NEOLITHIC

By

COLIN PATRICK QUINN

A thesis submitted in partial fulfillment of
the requirements for the degree of

MASTER OF ARTS IN ANTHROPOLOGY

WASHINGTON STATE UNIVERSITY
Department of Anthropology

DECEMBER 2006

To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of COLIN PATRICK QUINN find it satisfactory and recommend that it be accepted.

____

Chair

____

____

ACKNOWLEDGEMENTS

This thesis would not have been possible without the assistance of my committee members. I would like to thank W. Andrefsky for his help in developing many of the concepts in this thesis, for his insightful comments and critiques, for the research opportunities he afforded me, and for his time and effort in enhancing my anthropological education. I would like to thank I. Kuijt for introducing me to the Neolithic in the Near East, for allowing me to work with materials from Dhra', for the many other work and research opportunites, and for instilling in me a passion for archaeology. I would like to thank A. Duff for providing me with many of the methodological tools employed in this thesis, for his insightful comments on the thesis, for helping me think critically about our archaeological understanding of people in the past.

In addition to my committee, I would like to thank the numerous other faculty members at Washington State University that developed my knowledge of methodological and theoretical techniques that I use in this thesis and will continue to use throughout my career. Specifically, I would like to thank W. Lipe, T. Kohler, K. Lupo, J. Bodley, R. Quinlan, and J. Jones for their help and guidance with numerous aspects of my education and development as a professional anthropologist. Their support have made me a much better anthropologist than I was before stepping foot in Pullman.

Without the support of my fellow graduate students, both in developing and discussing many of the ideas put forth in this thesis as well as being great friends for the past several years, this thesis would not be possible. Additionally, the help of many others have made this thesis possible. While not an completely inclusive list, I would like to thank N. Goodale, A. Wright, J. Ferris, A. Boyette, M. Glaude, S. MacFarlan, A.

Nauman, M. Chesson, B. Finlayson, M. Peterson, R. Held, S. Cole, G. Loffler, M. Hill, S. Smith, E. Powell, S. Bergin, J. Stahl, P. Husmann, B. Wolfe, and B. Kroener.

Finally, I would like to thank my parents, Mary Alene and Patrick, and sisters, Meghan and Alene, without whom I would not be the person I have become. I am lucky to have such a wonderful and loving family who understand that anthropology may be important.

VITAL SIGNS: COSTLY SIGNALNG AND PERSONAL ADORNMENT IN THE NEAR EASTERN EARLY NEOLITHIC

Abstract

by Colin Patrick Quinn, M.A.
Washington State University
December 2006

Chair: William Andrefsky, Jr.

Material culture is a vehicle for social information exchange. In the past, as in modern day, individuals used material culture items to negotiate complex social relationships. In this thesis, I aim to understand how people use signals to negotiate complex interpersonal relationships. In particular, I explore how people were using costly material culture signals to enhance their reproductive fitness. Drawing upon a case study of personal adornment item production and use during the Early Neolithic in the Southern Levant at the site of Dhra', Jordan, I utilize the theoretical framework of costly signaling theory to evaluate how people in the past used particular material culture items to enhance their reproductive fitness. Assessments of the signaling power of material culture items within a continuum of reproductive fitness necessitate investigations into personal adornment production techniques, structure and intensity of production, and archaeological patterning. The signaling power assessments provided by the costly signaling model combined with the archaeological patterning of bead production and use at Dhra', highlights the complexity of the relationship between social information exchange and individual decision-making processes in the past.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Material culture is a vehicle for social information exchange. In the past, as in modern day, individuals used material culture items to negotiate complex social relationships. The information associated with material culture can range from mundane to vital for reproductive fitness, is culturally specific, and is intertwined with the people in the past.

In this thesis, I aim to understand how people use signals to negotiate complex interpersonal relationships. In particular, I explore how people were using costly material culture signals to enhance their reproductive fitness. For archaeologists, understanding information associated with particular artifacts and how these objects were perceived and used by people in the past is the foundation of the discipline. However, the task of reconstructing information associated with particular artifacts in the past is exceedingly complex. To begin to explore this complexity, I look at a case study of personal adornment item production and use during the Early Neolithic in the Southern Levant.

In the Pre-Pottery Neolithic A (PPNA) (11,700-10,500 cal. B.P.), people began to shift from a highly mobile hunter-gatherer economy to sedentary early village life with a focus on cultivation of wild cereals. Much of the socio-economic foundation for fully agrarian complex societies found during the later Neolithic and beyond was laid during the PPNA. Investigating the role of non-utilitarian objects, such as personal adornment items, at the forager-farmer transition can provide a foundation for understanding how people were negotiating interpersonal relationships during this time of economic, social, technological, and ritual change.

Beads and other personal adornment items likely played roles in social, economic, and ritual organization during the PPNA. However, it is the potential use of these items as costly signals of reproductive fitness for use in mating and alliance formation contexts that may explain aspects of production, deposition, and the archaeological record. Personal adornment items are not physically needed for survival, and as such, can be classified as non-utilitarian. However, people in cultures all over the world and throughout thousands of years have spent time and resources producing and acquiring these items. Using personal adornment item data from the site of Dhra', Jordan, a PPNA site in the Jordan Valley, I examine patterning in the archaeological data to understand social information exchange. In order to address the relationship between personal adornment items and social information exchange during the PPNA, I explore the theoretical grounds of costly signaling, personal adornment item data collection and reporting strategies, the technological constraints on bead production, the structure and intensity of production, and test expectations of signaling power models theoretically as well as with archaeological data from Dhra'.

In this study, I utilize the theoretical framework of costly signaling theory to evaluate how people in the past used particular material culture items to enhance their reproductive fitness. Costly signaling theory is a perspective on human behavior that attempts to explain 'wasteful' or 'uneconomic' behaviors or items based on the belief that these behaviors or items enhance the reproductive fitness of the individual who exhibits the behavior or displays the item. This theoretical paradigm affords the opportunity for archaeologists to build models about the relationship between material culture and reproductive fitness that can be tested and evaluated using real archaeological data. In this thesis, I build a model which creates expectations of signaling power based on the cultural context. This model is used to evaluate the signaling power of personal adornment items at Southern Levantine PPNA sites, to compare expected artifact frequencies with the archaeological record, and ultimately to understand why people were making and using these expensive items.

Near Eastern archaeologists have sought to understand how material culture items, such as lithics, faunal remains, architecture, groundstone, and botanical remains, changed during the Early Neolithic. One set of material culture objects that have not received the same level of analysis as the other specimens in the archaeological record are personal adornment items. In an attempt to standardize and enhance PPNA personal adornment item research I provide a data collection strategy, including a typology of PPNA personal adornment items, and suggest common reporting techniques that will hopefully improve personal adornment item research. I approach this study not as the all encompassing tome on PPNA bead production and use, but rather as a focused research project that addresses several key aspects of personal adornment item production and use in order to stimulate future research, discussion, and consideration of the potential utility of personal adornment item analyses.

Because the technological organization of bead production affects many processes that affect social information exchange, it is necessary to address how people were making beads during the PPNA in the Southern Levant before assessments of signaling power can be made. Using experimental replication of prehistoric bead making technologies, I test various hypotheses and challenge preexisting untested conceptions of bead production in the PPNA. After reviewing the chaîne opératoire of bead production, two hypotheses of stone bead drilling are tested using experimental techniques. The first hypothesis suggests that PPNA stone beads were drilled using pointed tools from the vast lithic assemblages found at sites during this time. The second hypothesis posits that organic materials, in this case bone pointed tools combined with water and sand, could have perforated PPNA stone beads. The experimental results are used to test these hypotheses, and provide important insights into PPNA technological organization and set the groundwork for explorations of signaling and social information exchange.

The information embedded in particular material culture items is also dependent upon the structure and intensity of craft production. There are numerous social and economic systems within which individuals manufacture personal adornment items. With the aid of attribute analysis of personal adornment items, intrasite spatial patterning of bead production, and regional bead production evidence, I explore several potential socio-economic systems of craft specialization. My aim is to determine the expense and visibility of PPNA bead production in the Southern Levant. Individual specialization and community-level specialization are examined to help determine who was making beads at Dhra' and other PPNA communities. Understanding the structure and intensity of the system within which bead producers operated illuminates the larger social and economic organization of the region and subsequently how people used beads and other personal adornment items to negotiate interpersonal relationships and enhance their reproductive fitness.

Drawing upon data produced by analyses of the expenses associated with bead production as well as the visibility of personal adornment item use and visibility, I test the model of signaling power in the PPNA. While material culture attributes affect the signaling power in the past, the signaling power of artifacts in turn affects patterning of these objects in the archaeological record. In this thesis I combine general discussions of signaling power in the PPNA with investigations of the archaeological record to highlight the complex decision making processes of individuals in the past who were using material culture to negotiate social relationships.

In sum, I employ various methodological, theoretical, and analytical techniques to understand how personal adornment items were used in complex social information exchange contexts during the PPNA. I argue that people in the past employed these objects as costly signals of underlying reproductive fitness characteristics in the hopes of securing better mates or allies in order to enhance their own reproductive fitness. These benefits can be seen in model building contexts and tested using archaeological data. Material culture, the cornerstone of archaeological investigations, contains embedded social, economic, and ritual information that is visually conveyed to others. Costly signals, those signals associated with underlying reproductive fitness, are embedded with important fitness enhancing information and understanding the signaling power of artifacts, as well as the affect of signaling power on the archaeological record, provide the basis for our understanding of past socio-economic relationships and decision-making processes.

Organization of the Thesis

Chapter 1 has explored the research goals of this thesis and introduced the methodological and theoretical tools that will be used to address them. Chapter 2 lays the theoretical foundation of social information exchange and costly signaling theory while building models to assess signaling power in small scale early agricultural societies.

Chapter 3 provides background on the temporal and regional focus of this study, discusses previous work by archaeologists in the PPNA in the Southern Levant, explores the range of issues personal adornment items can address, and highlights problems with past research into personal adornment manufacture and use. Chapter 4 presents the Dhra' project history and personal adornment assemblage while introducing a typology and a technique of bead data collection and reporting that, if adopted by all researchers in the Southern Levant, will allow for region-wide comparisons of personal adornment assemblages. Chapter 5 is an experimental exploration of bead production technology that attempts to replicate the production techniques employed by PPNA peoples to shed light on costs and technologies associated with production as well as other signaling power variables. Chapter 6 examines the structure and intensity of craft specialization with special consideration to the costs and visibility of craft production in the PPNA, which affects the signaling power of personal adornment items. Chapter 7 assesses signaling power and the use of personal adornment items as costly signals of reproductive fitness by testing the model of fitness signaling power and comparing it to the frequency of artifacts in circulation at Dhra'. Chapter 8 summarizes the results of the exploration of social information exchange, particularly the use of beads as costly signals of reproductive fitness, as well as provides an outline for further personal adornment and signaling research of the Southern Levant during the PPNA that will increase our understanding of prehistoric lifeways.

CHAPTER 2

COSTLY SIGNALING THEORY AND MODELING FITNESS SIGNALING POWER

In order to understand the social context of personal adornment items, it is important to review the underlying theoretical foundation of signaling power. After a review of human behavioral ecology, signaling theory, and costly signaling theory, I apply concepts of this theoretical paradigm to the creation of a model of signaling power that is contextually specific and directly related to reproductive fitness. This model of signaling power lays the groundwork for analytical explorations of the signaling power of personal adornments during the PPNA.

Costly Signaling Theory

Human behavioral ecology, also known as evolutionary ecology (Bettinger 1991) and behavioral ecology (Kelly 1995), is a neo-Darwinian social theory that establishes that all human behavior can be thought of in terms of genetic fitness (Bettinger 1991). This paradigm develops a coherent theory of sociocultural behavior in terms of similar principals that affect biological evolution (Bettinger 1991). Human behavioral ecology has many anthropological applications, though in this work I am concerned primarily with one aspect of this approach; the use of material culture as signals affecting reproductive fitness. Reproductive fitness is defined as an individual's ability to have their genes represented in subsequent generations. This includes both direct fitness (e.g - survive, reproduce, and have their offspring reproduce as well) and indirect fitness (e.g. - genetic material shared with kin) (Bettinger 1991; Hamilton 1964). Reproductive fitness can vary from low to high based on the genetic and phenotypic success within a given context (Smith and Winterhalder 1992). It is assumed that selection favors traits and behaviors with the highest fitness, and that individuals attempt to maximize their own fitness within a given environment (Kelly 1995). Decision-making processes are guided by specific adaptations that have been shaped by natural selection to promote adaptability through rapid phenotypic plasticity in a given context (Kantner 2003). Proxy markers of reproductive fitness, those materials that are correlated with high reproductive fitness in specific contexts, are important to anthropologists modeling human behavior and attempting to explore reproductive fitness in antiquity.

Behaviors, and in the case of archaeology - material culture, need not be directly genetically linked to affect reproductive fitness. Instead, behaviors and material culture are often seen as part of the extended phenotype (the outward expression of the genotype) of an individual (Boone and Smith 1998; Dunnell 1980; Kantner 2003). There has been much debate about the concept of an extended phenotype and the role of natural selection operating on the phenotype (interactors) (Dunnell 1980; Lyman and O'Brien 1998, 2001) or on individuals (replicators) (Boone and Smith 1998; Kantner 2003; Smith and Winterhalder 1992). I work under the assumption that material culture can be thought of as the extended phenotype of an individual. The selective process occurs on the individual, as selection of particular material culture items that make up an extended phenotype is governed by individual decision making and cultural transmission (Boone and Smith 1998; Boyd and Richerson 1985; Durham 1991; Kantner 2003; Kelly 2000; Smith 2000; Smith and Winterhalder 1992). The reason for this assumption is the fact that socially embedded information within material culture is often associated with markers of reproductive fitness as well as the individual themselves. Just as there is genotypic plasticity that affects biological phenotypic expression (such as genes for height being affected by an individual's nutrition while young), I believe that phenotypic plasticity can be seen in material culture. Phenotypic variability is not generated randomly, even in biological contexts (Dawkins 1987; Rindos 1989; VanPool and VanPool 2003). For example, artifacts that represent reproductive fitness for an individual at one time in their life may not be reproductively fit at another time in their life. Fitness is, therefore, mutable and fluid. While not being genetically linked, material culture items associated with an individual often link to attributes such as age, gender, status, wealth, and access to resources, thereby becoming phenotypically expressed. Since phenotypes affect reproductive success, variability in behavior or material culture that causes an individual to have more, higher quality offspring than other individuals, will be subject to selection processes similar to those guiding natural selection.

The most common examination of signaling in human behavioral ecology is through costly signaling theory. Costly signaling theory combines concepts of costly behavior and public generosity (Mauss 1924; Fried 1967; Veblen 1994) as forms of social competition that provide a way to articulate the notion of intangible social benefits that can be gained through symbolic representations of self with more materialist notions of individuals as self-interested but socially embedded decision makers (Bleige Bird and Smith 2005; Quinn 2006). Others have defined costly signaling as something that increases the fitness of an individual by altering the behavior of recipients of the signal (Dawkins and Krebs 1978; Hasson 1994; Krebs and Dawkins 1984; Maynard Smith and Harper 1995). The signal must be beneficial for reproductive fitness in the given information exchange between individuals, yet costly in other contexts (Hasson 1994;

Maynard Smith and Harper 1995). Additionally, the signal must be an honest representation of an individual's underlying reproductive fitness predicated on the fact that the signal is so costly that it is impossible to possess without the characteristics or qualities being signaled.

Costly signaling theory has its roots in biology and the concept of the handicap principle. Zahavi (1975) originally explored costly signaling while attempting to understand why animals would engage in costly and extravagant displays. For example, the handicap principal explains the practical inefficiency of peacocks' tails. Peacocks require the necessary genetic ability to fight parasites and invest energy into the tail, which means that a large and healthy tail would signal to peahens that those individuals had good genes. Grafen (1990) reformulated the handicap principle into a series of models, including costly signaling, where individuals used visual displays at various costs to signal their quality as mates, and emphasized that signaling was an evolutionarily stable strategy. Anthropologists then took this concept and attempted to apply costly signaling theory to conspicuous consumption and 'uneconomical' displays in ethnographic contexts (Hawkes 1990, 1991, 1993; Kaplan and Hill 1985; Veblen 1994).

There are two conditions required for the evolutionary stability of costly signaling (Zahavi 1975; Grafen 1990). First, signals must convey reliable information about variation in the underlying quality being advertised, involving such aspects as resource control and competitive ability (Quinn 2006). Second, the signal must impose a cost upon the signaler that is directly linked to the quality being advertised. The payoff to the signaler comes from being chosen as a mate or ally or deferred to as a dominant in mating, cooperative, or competitive contexts (Smith and Bliege Bird 2000). The payoff to the recipient comes from the usefulness of the information being signaled to evaluate the signaler's quality as a competitor, mate, or ally.

Costly signaling theory has been used by anthropologists to explain uneconomical, altruistic, and potentially irrational and wasteful behaviors by people as adaptive and strategic behaviors based on people's cost benefit analyses and decision making processes (Bliege Bird and Smith 2005). Bliege Bird and Smith explain costly signaling in negotiating interpersonal relationships:

> Those seeking assurance that a given individual has sufficient personal resources or belongs to a kin group of sufficient resource holdings or productivity to qualify as either an equal or a social superior do not need to put their faith in words but can examine the evidence of deeds, such as displays of generosity or waste, that are too costly to be worth faking. More broadly, signal cost (actual or potential) can serve as a powerful means of guaranteeing honesty and thus allow observers to gauge the relevant hidden qualities of potential allies, mates, or competitors. Inequality is tolerated when signalers demonstrate their competitive superiority, and deference (or interest in the signal) provides greater benefits than resistance (or ignoring the signal) (Bliege Bird and Smith 2005:223).

Numerous researchers have used aspects of signaling theory in their research to explain non-utilitarian actions or actions that contain a high number of costs. Signaling has been tracked in hunting contexts (Smith and Bliege Bird 2000; Hawkes and Bleige Bird 2002; McGuire and Hildebrandt 2005; Smith 2004; Sosis 2002) and in simple exchange contexts (Hawkes 1992; Wiessner and Shiefenhovel 1996; Boone 1998) in simple and complex societies. Anthropologists focused on actions, such as big game hunting, as examples of show-off and costly behavior and found that it related to the reproductive success of those individuals who engaged in the actions. Due to the honesty required for costly signaling theory and the fact that certain human behavioral actions, such as hunting big game, are difficult to fake without the underlying genetic capacity to perform those tasks, researchers devoted much of their time and energy studying the signaling power of actions.

The data that are available to archaeologists are decidedly different than the data available to ethnographers. As a result, archaeologists use material culture to discuss signaling theory which poses problems of relating artifacts to behaviors and individuals in the past. For this reason, very little work has been done with signaling in the archaeological record.

Costly Signaling and Archaeological Data

There are two ways the archaeological record can be used by researchers to explore signaling in the past. The first way is by looking at material correlates of the actions ethnographers have noted are linked to costly signaling. McGuire and Hildebrandt (2005), among others, have attempted to explore faunal assemblages for evidence of big game hunting in the past. Their research in the Great Basin attributes the patterning in prey choice to the prestige, status, and reproductive benefits of hunting the increasingly rare game in the region. While these researchers use archaeological evidence, they are still looking at actions as signals.

The second way archaeologists can use the archaeological record to address issues of signaling is by examining the signaling power of the material cultural items themselves. Fewer researchers are using signaling theory in this way, but I believe it is an important resource of theoretical exploration into the past (Neiman 1997). The material culture items individuals possess and the way they are displayed convey lots of non-verbal information about a person's occupation, socio-political standing, group membership, and individual identity.

In costly signaling theory, honesty is not guaranteed. However, while cheating is a possibility, it is not a viable long term strategy as dishonest signals would be selected against in the long term. Game theoretical perspectives on costly signals reaffirm that they are evolutionarily stable strategies that promote honest signals of reproductive fitness (Bliege Bird and Smith 2005; Gintis et al. 2001; Grafen 1990; Johnstone 1997). If signals are no longer honestly correlated with underlying reproductive fitness, then other signals are needed to be developed to represent high reproductive fitness, which explains variability in production materials, form, and intensity of material culture items through time.

With material culture, it is possible to receive items through inheritance, by stealing them, or by other means. The honesty of the artifacts as signals, therefore, is not as reliable as the honesty associated with behaviors. As such, there is likely substantial turnover in effective material culture signals of reproductive fitness, especially in complex societies when compared with behavioral signals in humans or biological signals in other animals. In natural selection, the processes of inheritance are at the generational level, while material culture inheritance and innovation can take place at a much more punctuated rate. By understanding the contextual relationship between high reproductive fitness and the signaling power of material culture items that display those fitness characteristics, archaeologists can begin to predict and model the types of items that will be effective signals as well as the conditions that provide incentive for individuals to change mediums of costly signaling.

Signaling Theory

All material culture items contain embedded information that is exchanged to others when seen. Also, all material culture items, no matter their utility, cost, or abundance, affect reproductive fitness. Therefore, all material culture items can be place under the umbrella of 'signaling theory'. Signaling theory suggests that all objects an individual possesses convey information about the individual to others, such as status, wealth, age, culture, kin group, individual skill, and gender. Signaling theory is broader in scope than the more common human behavior ecological approach of costly signaling theory (i.e. – Bliege Bird and Smith 2005). As such, it encompasses not only costly signals that reinforce or establish social status (Boone 1998), or display hunting prowess (Bliege Bird et al. 2001; Henrich and Gil-White 2001; Wiessner 1996), but also low cost displays of gender, age, and individual personas.

Signaling theory fits into other neo-Darwinian evolutionary techniques by combining elements of costly signaling theory (i.e. – Grafen 1990; Zahavi 1975; McGuire and Hildebrandt 2005) and the showoff hypothesis (i.e. Hawkes 1991; Hawkes and Bleige Bird 2002) to relate signals to underlying reproductive fitness based on such proxy markers of reproductive fitness as wealth, status, skill, and access to resources. This theory proposes that behavioral or physical signals are designed to convey information benefiting both signalers and recipients of the signals (Smith and Bleige Bird 2000). Signaling theory "provides a way to articulate idealist notions of the intangible social benefits that might be gained through symbolic representations of self with more materialist notions of individuals as self-interested but socially embedded decision makers." (Bliege Bird and Smith 2005:222).

Signaling Theory, Cultural Contexts, and the Fitness Continuum

While signaling theory is the overarching theory of social information exchange through material culture, not all signals interact with reproductive fitness in the same way. Some signals are more directly related to reproductive fitness than others, while some signals may convey very little information about the reproductive fitness of an individual. The relationship between signals and reproductive fitness can be conceptualized as a continuum, on one end are signals that do not affect reproductive fitness and on the other are signals that play a significant role in not only broadcasting, but enhancing, reproductive fitness (Figure 2.1). These two divisions of material culture based on their relationship to signaling reproductive fitness and costliness are not static, but rather form a fluid continuum based on cultural context. This continuum is set under the overarching view of signaling theory, where all objects and behavior display information about that particular individual.

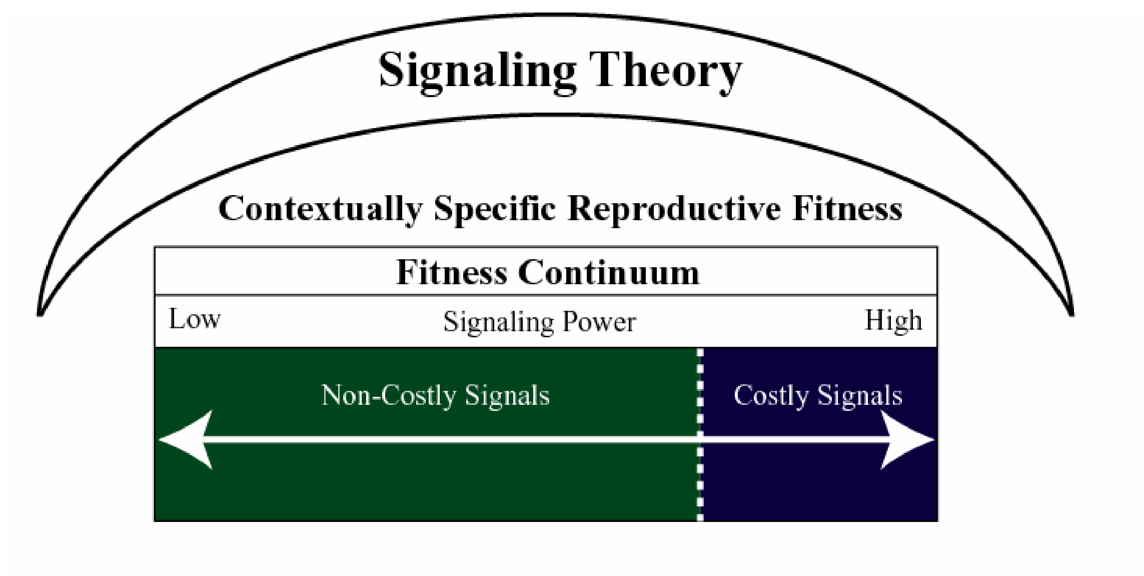

Figure 2.1 – The signaling fitness continuum. Under the umbrella of signaling theory, the relationship between signals and reproductive fitness in a given context is fluid and ranges from low signaling power (non-costly signals) to high signaling power (costly signals).

Reproductive fitness is contextually specific. Any given social, economic, political, or environmental setting will have differing individual attributes that enhance an individual's reproductive fitness. The characteristics that will be selected for by others in mating and alliance formation situations will be directly linked to the attributes that make an individual fit within that context. Hence, certain characteristics may be signaled in one context due to their desirability for mates or allies, while those characteristics may not be as important in the selection of mates or allies in a different cultural context. Additionally, a given artifact may be an accurate signal of reproductive fitness in certain contexts while not a fitness signal in others based on that artifact's link to honest representations of highly desired fitness characteristics. Therefore, proxy markers of reproductive fitness are not universal. The fitness of individuals will be based upon the cultural (including environmental) contexts and individuals who signal attributes that are the most directly linked to reproductive fitness in those contexts will likely be selected as mates or allies over individuals who do not signal fitness within that cultural context. As archaeologists, therefore, we cannot simply classify particular items or artifact classes as 'costly signals' or 'non-costly signals'. Instead, arguments for the past existence of costs and signaling power must be developed on a case by case basis to both predict expected signals in a given context as well as evaluate signaling power models.

There are numerous factors that determine what is fit in a given context. Some of the major factors are social scale, food production strategies, resource abundance and distribution, spatial relationship between people and resources, socio-political organization, and historical factors within a specific group. While each of these factors independently affects what types of characteristics, traits, and attributes are the most reproductively fit in a given context, the amalgamation of these factors provides a complex suite of reproductively fit strategies that will be selected for by individuals in mating and alliance formation situations. Table 2.1 explores the variability within many of these factors and provides expectations for qualities and characteristics that would be highly desired by other individuals in those contexts. While not an exhaustive exploration, this table shows that variability in contextual factors will affect what is reproductively fit and, ultimately how signaling of fitness characteristics varies by context.

Table 2.1 – The expected signals of reproductive fitness within several cultural contexts
.

Cultural Contexts	Fitness Characteristics	Expected Costly Signals
Small Scale Hunters and Gatherers (Unified)	Provisioning Ability	Big Game Hunting
	Hunting Prowess	Ornamentation from animals
	Kin groups	Heirlooms
Small Scale Agriculturalists (Unified)	Access to Resources	Exotic objects
	Wealth	Expensive goods
	Status	Ornamentation from animals
	Alliances	Heirlooms
	Hunting Prowess	
	Kin groups	
Large Scale Hunters and Gatherers (Subgroups)	Hunting Prowess	Big Game Hunting
	Access to Resources	Feasting
	Wealth	Exotic objects
	Status	Expensive Goods
	Alliances	Ornamentation from animals
	Kin groups	
Large Scale Agriculturalists (Subgroups)	Access to Resrouces	Exotic goods
	Wealth	Expensive goods
	Status	
	Alliances	

As reproductively fit characteristics based on context, the fitness continuum is dependant upon the characteristics that are desired by other individuals. Authors have labeled signals that are difficult to possess unless you have that underlying attribute being displayed as 'costly signals' (Bliege Bird and Smith 2005). Again, since the characteristics being signaled are contextually specific, the interplay between material culture objects affiliated with these characteristics and the fitness continuum will also be contextually specific.

Along the continuum there is a point, a threshold, which separates non-fitness related signals from costly signals of reproductive fitness. Signals that fall on the costly side of the threshold are often considered 'wasteful' or 'uneconomical', yet they contain a suite of information about the fitness of the signaler that benefits both the signaler and the recipient of the signal (Bliege Bird and Smith 2005). Items that fall below the costly threshold on the fitness continuum are often not used as signals of underlying reproductive fitness. This is not to say that these signals are devoid of meaning and information exchange. The information embedded in these objects reflect the identity of the individual or group membership yet are not directly related to characteristics that are selected by others as markers of reproductive fitness.

All of the discussions of costly signals and a fitness continuum are predicated on the linkages between material culture items to reproductive fitness. As explained before, material goods are potentially phenotypically affiliated with individuals based on the fact that socially embedded information within material culture is often associated with markers of reproductive fitness as well as the individual themselves. Additionally, certain material culture items are directly associated with underlying reproductive fitness. This link from the individual to reproductive fitness through their material culture makes it advantageous for individuals to enhance their reproductive fitness by signaling characteristics that are desired by others in a given context. Table 2.1 illustrates the potential interrelationships between enhanced reproductive success, reproductive fitness in a given context, characteristics associated with reproductive fitness, and proxy markers of characteristics associated with reproductive fitness. By determining how closely related particular items are to the characteristics desired by mates and allies, archaeologists can begin to understand, articulate, and explore the use of material culture items as costly signals.

Personal Adornment Items and the Fitness Continuum

Personal adornment items are a material culture medium that could have been utilized by people in the past to exchange social information about reproductive fitness. These items are visible, rare, and non-utilitarian, suggesting their manufacture and use is related not to survival, but can enhance reproductive fitness. Personal adornment items can be used to convey important socio-economic information about both the producers and consumers of these objects.

People producing personal adornment item were signaling 1) access to raw materials, 2) time to devote to manufacturing these goods, likely implying that they are so adept at food production and taking care of other necessities that they can participate in the manufacturing of non-utilitarian items; and 3) sufficient skills to be able to specially produce these items (Bliege Bird and Smith 2005). All of these embed a set of desirable traits upon the producer (Quinn 2006). Additionally, if the prestige item producers gave away their wares as gifts, it may have been a display of public generosity at a cost that would be repaid in status, alliances, and deterring competition with other individuals.

Individuals that possessed personal adornment items also would have been signaling particular information about their underlying reproductive fitness. Consumers able to acquire beads, through the exchange of resources or services, would have signaled

1) wealth and status, 2) access to resources, 3) alliances, 4) resources, and 5) other socially relevant information, such as age, gender, and group identity. Assuming the cost of the personal adornment items based on both their scarcity in the archaeological record and the time investment required for their manufacture, consumers would have required a surplus of wealth or other resources, or exclusive access to goods or knowledge that could have been given in exchange for personal adornment items. Therefore, individuals may sacrifice resources in exchange for a highly visible sign of their reproductive quality and provisioning ability.

Modeling Signaling Power on the Fitness Continuum in the PPNA

In order to compare artifacts along the fitness continuum, we need to first operationalize signaling power. One way of operationalizing signaling power is to build a model that takes into account the variables that affect the relationship between the proxy markers (artifacts) and the reproductive fitness characteristics being selected in a particular cultural context. Building a signaling power model requires several steps: 1) identify the cultural context; 2) determine what characteristics of individuals best represent reproductive fitness within that context; 3) establish the variables that affect how closely related signals are to the reproductive fitness characteristics and how they are related to each other; and 4) determine the threshold between costly and non-costly signals based on these variables. With this model, archaeologists conceptualize the fitness continuum and costly signaling threshold in an archaeological data framework. There are many potential applications of model building to evaluating costly signaling in archaeological contexts. In this study I focus primarily on one avenue of exploration:

understanding the relationship between signaling power and the archaeological collection in terms of frequency and abundance of specific artifact and raw material types.

Just as signals and reproductive fitness are contextually specific, individual models are also crafted with particular contexts in mind. Therefore, not all archaeological data can or should be fit into one model of signaling power. Instead, a series of models which take into account contextual and reproductive fitness variables should be built and applied to archaeological data for which they are held to be contextually suitable.

As I am interested in understanding how material culture items were used to negotiate social relations during the Pre-Pottery Neolithic A in the Southern Levant, I develop a model of signaling power that takes into account reproductive fitness within this particular temporal and spatial context. With this model, I explore the potential characteristics of reproductive fitness within the small scale early agricultural villages and articulate the variables that affect material culture signaling power along the fitness continuum. While this model does not quantitatively determine relationships between variables and signaling power (which is a potential line of inquiry for further research), it does qualitatively delve into the signaling power of material culture items in the PPNA.

As seen in Table 2.1, there are certain individual attributes that link to underlying reproductive fitness in small scale agricultural societies. During the PPNA, the Late Natufian highly mobile hunting and gathering economy that was replaced with sedentary village life predicated on cultivation of wild cereals in addition to hunting and gathering (Bar-Yosef and Belfer-Cohen 1992). It is likely that there was little social differentiation within these small scale societies (Kuijt 2000, 2001a). Communal action, as evidence by communal storage facilities (Finlayson et al. 2003) and community level craft production (see Chapter 5), was likely an important part of the social context. So, while there is little evidence for sociopolitical differentiation (Kuijt 1996), signals of skills, resources, and status were important for establishing leaders and enhancing reproductive success. Signals that honestly associate an individual with easy access to resources, large amounts of wealth, and high status potentially are the most desired signals during the PPNA. These traits would have been important for provisioning offspring and other kin due to the value placed on land, access to communal facilities and trade partners, and leadership.

Signals that most honestly represent access to resources, wealth, and status fall on the high end of the fitness continuum while signals that are not associated with access to resources, wealth, and status are on the opposite side of the fitness continuum. Honest proxy markers of access to resources, large amounts of wealth, and high status are dependant upon the costliness and expense of an item so that cheating is discouraged. By modeling the variables that affect honesty and the relationship between a signal and reproductive fitness, the signaling power of particular material culture items during the PPNA can be determined.

As outlined by Bliege Bird and Smith (2005), the best signals of an individual's access to resources, wealth, and status are expensive and highly visible items. The more an item costs, the less likely it is that an item can be acquired by an individual without access to resources, wealth, and high status. The cost of an item links it to signaling fitness on the fitness continuum, where the threshold is represented by diminishing returns for cheaters. Expensive and costly items to make or acquire that possess high visibility in information exchange situations are costly signals of reproductive fitness.

Signaling power is linked to two variables: 1) the expense of the item and 2) the visibility of the signal (Figure 2.2). We can envision that these two variables are continuums made up of several production, use, and contextual factors. The expense of an item is dependant upon the 1) production cost and 2) maintenance cost. The visibility of the signal is dependant upon the 1) audience size, 2) visibility of manufacturing, and 3) visibility of the object when being used. People in the past would have attempted to maximize the effects of their signals by selecting items that had the highest signaling power based on these variables. The use of material culture signals is the result of complex cost and benefit analyses by people in the past, who attempted to maximize the reproductive benefit of signals while minimizing the investment into that signal. Manipulation of these five variables of signaling power provides us with a methodological basis for comparing and contrasting signaling power of artifacts through time and space. It also allows us to develop models with which to test the archaeological record. This should facilitate refinement of the model employed, as well as more detailed understanding of the use of material objects in social information exchange.

As seen in Figure 2.1, the model of signaling power and the fitness continuum presented in this thesis emphasizes the effects of particular variables on the signaling power of an item. Using this model, artifacts and classes of artifacts can be placed along the fitness continuum according to their expenses and visibility in regards to the fitness characteristics desired in small scale early agricultural societies.

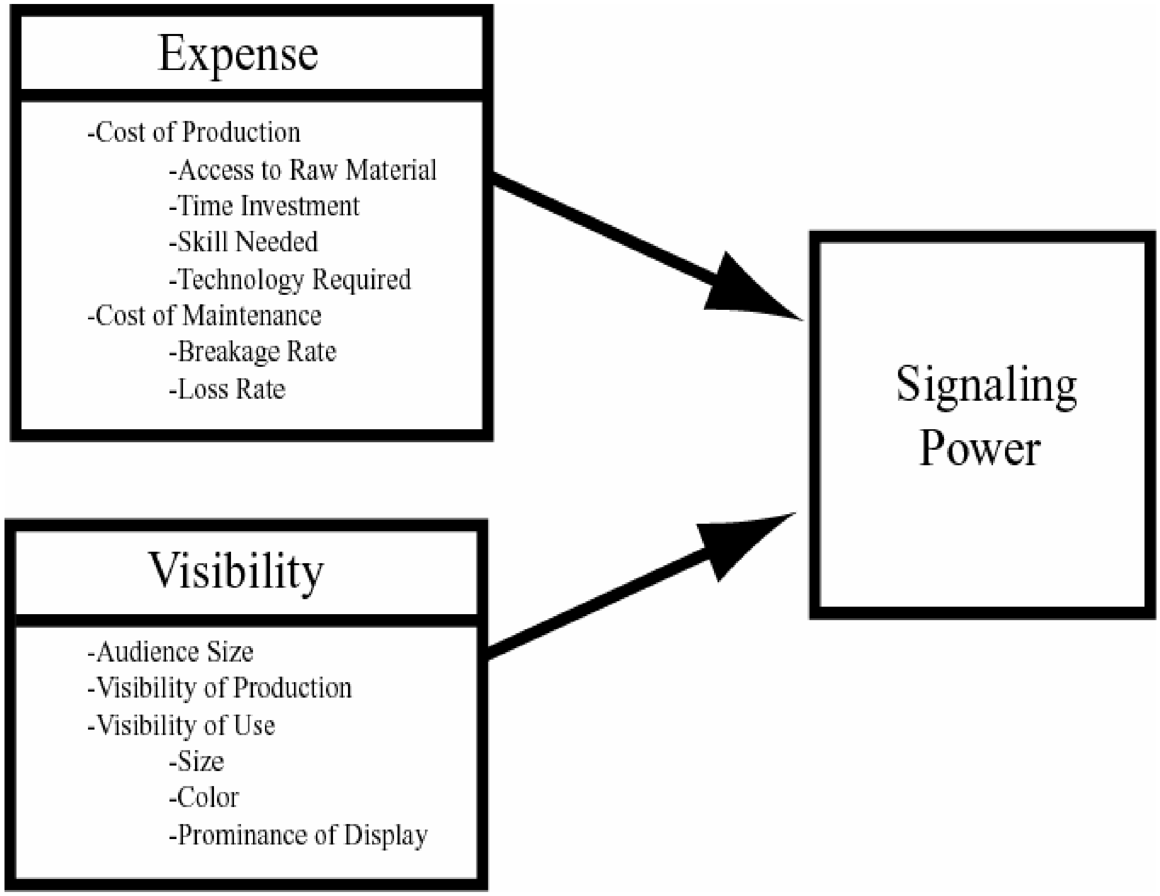

Figure 2.2 – The variables that affect signaling power in small scale early agricultural communities.

Expense: Production Cost

In general, the more costly the production of an item, the more likely it will be used as a signal of underlying reproductive fitness. Production costs are affected by several variables; 1) access to raw materials, 2) time investment in the manufacture of items, 3) technological requirements of manufacture, and 4) skill required to manufacture the items. Items with high signaling power are often made on rare raw materials, take a long time to produce, and are manufactured with tools and techniques that are rare or require high skill levels. Conversely, objects will have relatively low signaling power if the raw material for an item is easily acquired and if the items can be made quickly, easily, and with little technological investment.

Expense: Maintenance Cost

Just as the cost of production affects the signaling power of an item, the cost of maintenance will also affect its' signaling power. Maintenance costs can be described in two ways; 1) the durability of the object (breakage rate) and 2) the likelihood of losing that object (loss rate). Items that are easily broken require more care and attention in order to preserve them and use them as signals. Loss rates are affected by two intersecting variables: artifact size and search time (Schiffer 1987). The smaller an artifact is, the more likely it is to be lost. For example, it is much more likely for someone to misplace their keys than to misplace their car. The result is that keys have a higher loss rate than cars. When objects are roughly the same size the loss rate will then depend on the value of the items, which translates into search time. For example, a penny and a wedding ring may both be misplaced at a similar rate due to their size. The amount of time dedicated to finding each of these items, however, is highly variable with people likely to spend much more time searching for a misplaced wedding ring because of its monetary and sentimental value than searching for a penny. The loss rate of the wedding ring, therefore, is lower than the penny, because it is more likely that individuals will put more effort into retrieving that item. In summary, items that are fragile and have low loss rates will have high signaling power, while items that are durable and have low loss rates will have lower signaling power.

Visibility: Audience Size

The signaling power of an item, such as a stone bead, is linked to the number of potential people who see and understand the signal. Therefore, to assess the potential effectiveness of an item as a costly signal of reproductive fitness, we must first consider audience size. Audience size is the number of people who will see a signal and usually, but not exclusively, correlates with population size. The larger the community, the more people will see the item being used as a signal. Variation in social organization and residential mobility, even in situations where population size is similar, can affect the number of people who interact with a signal and the signaling power of an item. For example, individuals in highly mobile dispersed groups may interact with fewer people on a daily basis than individuals in sedentary aggregated groups. In this situation, signals in the sedentary context would be more powerful than similar signals in highly mobile contexts. Variability in audience size must be examined by archaeologists on a case-by-case basis in order to determine the power of a signal based on residential patterns, though signaling power is maximized when the number of people that can see an item is the greatest.

Visibility: Manufacturing

In this model, when the visibility of manufacturing of a particular item is high, then the signaling benefits for the individual extend beyond the mere signal of possession or ownership. Highly visible production increases the honesty of the acquisition of an item as individuals will be familiar with who has the skill, access to resources, and time to manufacture material culture items. This honesty provides benefits to the individual who manufactures items such that devoting time and efforts into costly production is rewarded not only with the item being produced, but also the recognition by others of an individual's skill, access to resources, and excess time. Low visibility of manufacture lowers the signaling power not only of the item itself, but also of the association of individuals to the desired characteristics that are represented by skilled manufacturers.

Visibility: Use of the Object

Objects that are highly visible are more effective signals than less visible objects. Signals should be easy to see and easy to understand, and if items are not visibly associated with an individual, then they will have low signaling power. For example, a bead that is worn on the outside of clothing is infinitely more powerful as a signal than a bead that is worn under the clothing. The point of having a signal is to exchange information with others and if people cannot easily receive that information, the signaling power is diminished. In addition to the location of display, the physical attributes of an item will make it more or less visible. Larger, more colorful items make more powerful signals, while small, dull colored objects are less likely to be noticed.

How to evaluate the model:

In order to use this model of signaling power to evaluate personal adornment item production and use during the PPNA in the Southern Levant, I want to first explore the variables of expense and visibility of production and use of these objects. To do this, I turn to experimental replication to evaluate aspects of the cost of production and maintenance of groundstone beads. By replicating the technologies individuals in the past used to make beads, I can gain insight into the technological, temporal, and skill requirements that would have affected the costliness of bead production in the PPNA. In addition to experimental replication of bead production technologies, understanding the structure and intensity of craft production in the PPNA can give insight into costs of production, visibility of production, as well as the ways in which beads were used by people in the past. These explorations provide data that can help archaeologists operationalize signaling power of personal adornment items in the PPNA and which I use to discuss costly signaling at the site of Dhra'. Before these analyses can be performed, however, thorough descriptions of PPNA personal adornment item data, temporal and regional contexts, and the site of Dhra' itself must be reviewed.

CHAPTER 3

NEAR EASTERN EARLY NEOLITHIC AND PERSONAL ADORNMENT BACKGROUND

Culture History

Location

The Levant is located in Southwest Asia and stretches from eastern Turkey in the north to the Sinai Peninsula to the south, with the eastern boundary marked by the Middle Euphrates Valley and the western boundary being the Mediterranean Sea (Bar-Yosef and Belfer-Cohen 1992) (Figure 3.1). The Southern Levant is primarily made up of the modern countries of Jordan and Israel (including the Gaza Strip and the West Bank). In the center of the Southern Levant running north to south is the Rift Valley, which is formed by the Jordan River and the Dead Sea.

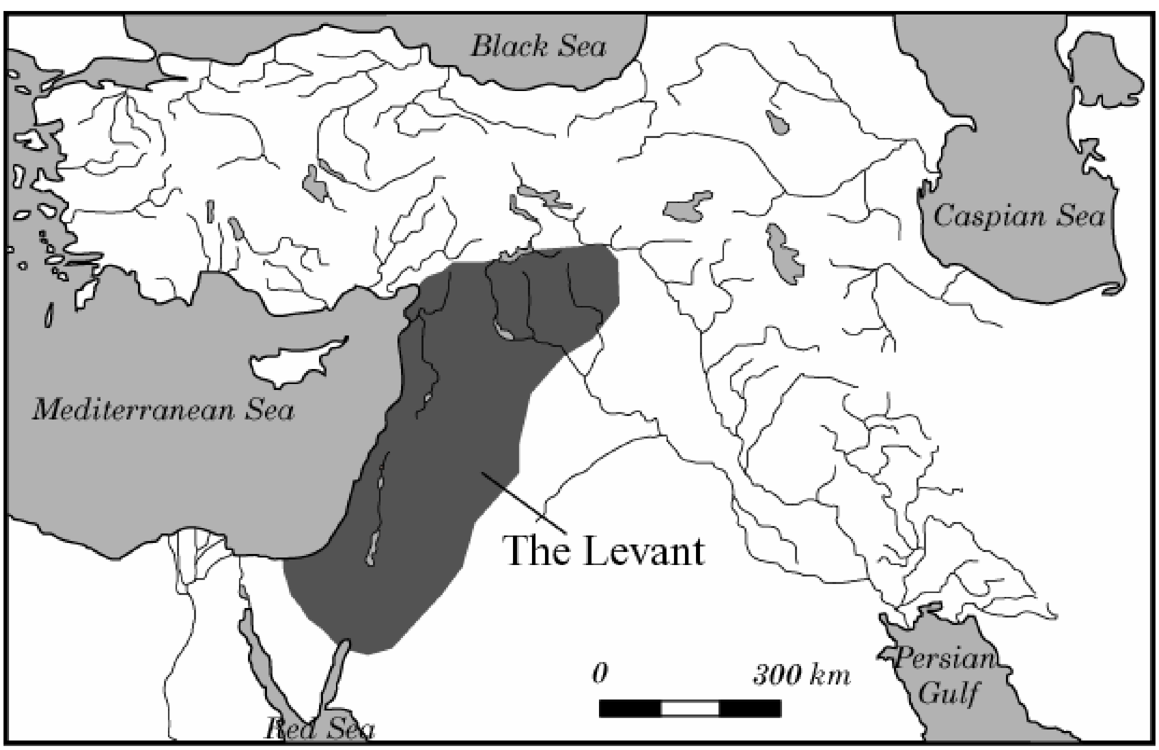

Figure 3.1 – Map of the Levant.

Regional Chronology

Hominid occupation of this region of the world has been consistent since the Lower Paleolithic (Bar-Yosef 1980), and it has been a focal point for major changes in human behavior. The start of the Pre-Pottery Neolithic A coincides with one of the major transitions in prehistory: the shift from a foraging subsistence strategy towards an agrarian economy (Figure 3.2). Immediately preceding the PPNA is the Epi-Paleolithic, also known as the Natufian time period. The Natufian can be broken up into two phases that likely reflect significant social variability (Bar-Yosef and Belfer-Cohen 1989, 1992). Early Natufian (15,700-13,700 cal. BP) peoples were hunter-gatherers who likely had continuous seasonal or sedentary residence patterns focused on hunting and harvesting wild cereals as evidenced by investment in architecture as well as the presence of underground storage pits (Bar-Yosef and Belfer-Cohen 1992). The Late Natufian (13,700-11,700 cal. BP), however, was marked by a brief environmental shift from a warm arid climate to a cooler, wetter climate known as the "Younger Dryas" (Bar-Yosef and Belfer-Cohen 1992; Munro 2004). During this time mobility increased, population size declined, and seasonality increased.

The Pre-Pottery Neolithic A (PPNA) (11,700-10,500 calibrated years B.P.) marked the start of the Neolithic revolution. This shift corresponds with the origins of agriculture and sedentary lifeways in the Southern Levant. Following the PPNA are the Middle Pre-Pottery Neolithic B (MPPNB) (10,500-9,500 cal. BP) and the Late Pre-Pottery Neolithic B (LPPNB) (9,500-8,700 cal. BP), both of which were periods of increasing socio-political complexity and full adoption of sedentary and agrarian lifeways. The Pre-Pottery Neolithic C (PPNC) (8,700-8,400 cal. BP) was a period of abandonment of large villages in favor of smaller communities.

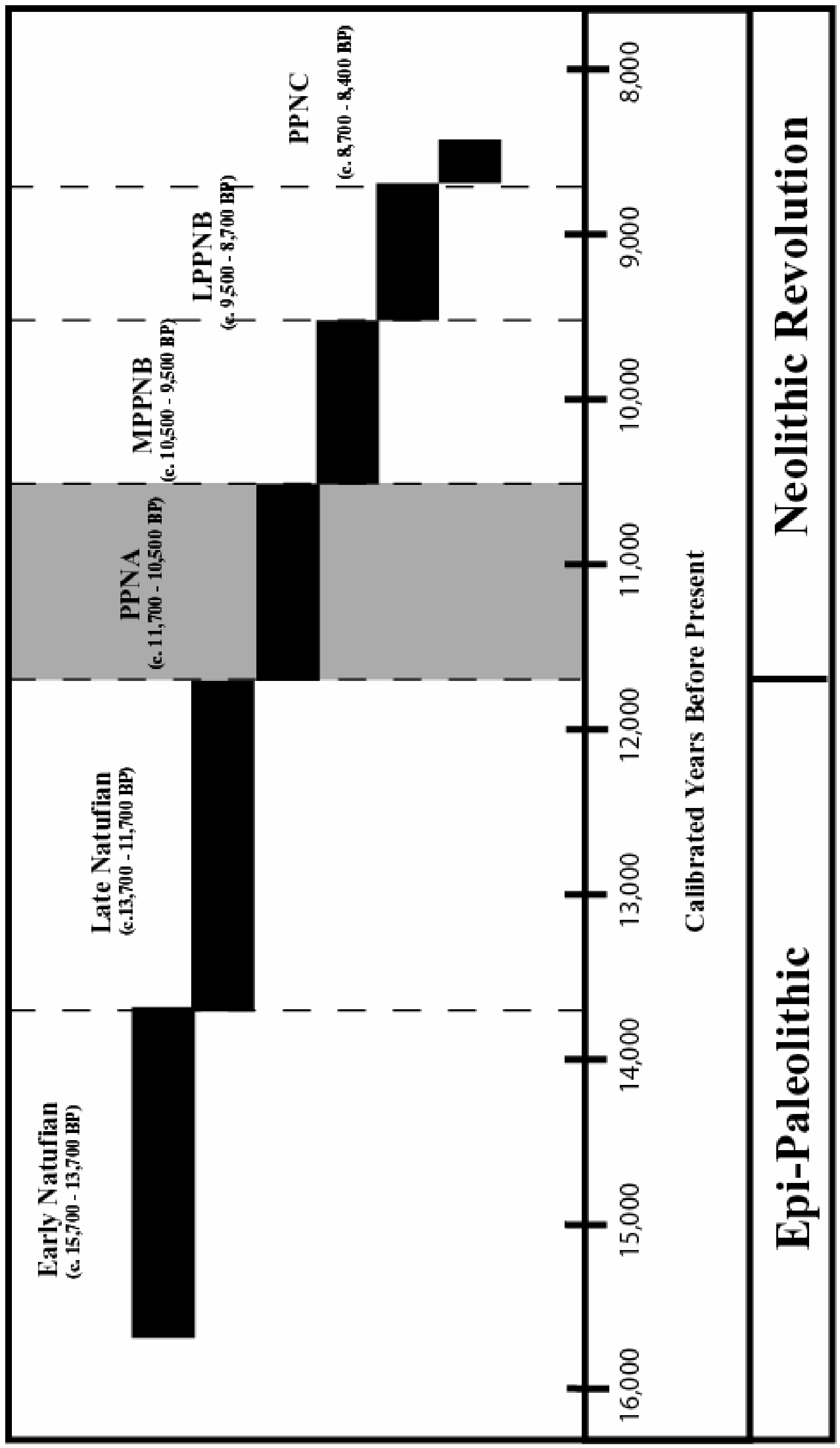

Figure 3.2 – Cultural Chronology of the Southern Levant at the Forager-Farmer Transition.

Pre-Pottery Neolithic A (PPNA) Material Culture

The PPNA emerged at the end of the Younger Dryas and was substantially different than the preceding Natufian lifeways (Bar-Yosef and Belfer-Cohen 1992). Residence sites were likely permanent, with semi-subterranean stone and mudbrick structures the most common architecture (Bar-Yosef and Belfer-Cohen 1992). The lithic industry at PPNA sites includes numerous pointed tools such as el-Khiam points, Salibiya points, Jordan Valley points, borers, and awls, sickle blades, Hagdud truncations, bladelets, microliths, and few scrapers (Crowfoot-Payne 1976, 1983; Sayej 2004; see also Bar-Yosef, 1981; Bar-Yosef and Belfer-Cohen 1989, 1992; Bar-Yosef and Kislev 1989; Nadel 1997). The groundstone assemblages are primarily limestone and basalt items such as figurines, celts, manos, metates, pestles, and mortars (Bar-Yosef and Belfer-Cohen 1992).

Of all of the material culture items, chipped stone artifacts have undoubtedly received the most attention (e.g. – Goodale and Smith 2001; Quinn et al. n.d.; Sayej 2004). The importance of lithics is not surprising due to the almost non-existent use of fired clay, that past excavation techniques employed poor screening techniques (most famously the site of Jericho), the poor preservation of organics due to the amount of time that has passed since deposition, and the fact that many sites have great quantities of lithics (for example, Dhra' has over one million recorded pieces of chipped stone from four seasons of excavation). While lithics have received a large amount of attention by Near Eastern archaeologists, objects of personal adornment have been poorly recorded, reported, and analyzed despite their potential to provide insight into social, economic, and technological organization. The major issues concerning Near Eastern bead research are discussed below.

PPNA Subsistence Strategy

The subsistence economy of PPNA peoples focused on both vegetal food-stuffs such as wild cereals, legumes, seeds and fruits as well as hunting mammals (primarily gazelle), reptiles, birds, and fish (Bar-Yosef and Belfer Cohen 1992; Clutton-Brock 1979; Davis 1983, 2005; Hillman and Davies 1990; Hillman et al. 1989; Hopf 1983; Kislev 1989; Noy et al. 1973; van Zeist and Bakker-Heeres 1985, 1986; Verhoeven 2004; Zohary and Hopf 2000). The Southern Levant is home to the earliest evidence of plant cultivation in the world (Zohary and Hopf 2000; Munro 2004), and this likely affected the social, economic, and ritual lifeways of PPNA peoples. Hunting and gathering was still of primary importance during the PPNA and cultivation of cereals had not yet developed into large scale domestication, which occurred during the Pre-Pottery Neolithic B. Still, consistent surpluses, as evidence by grain storage locations such as the mud structure (Feature 1, Structure 4) at Dhra' (Kuijt and Finlayson 2001), were collected and provided the opportunity for more permanent residence at home base sites.

PPNA Ritual Lifeways

Belief systems are poorly represented in the mortuary and artistic data (Bar-Yosef and Belfer-Cohen 1992; Belfer-Cohen 1991a, 1991b; Belfer-Cohen and Bar-Yosef 2000). Burials are often single interments of individuals in a flexed position and vary in orientation. During the Early Natufian, grave goods were common, with many burials containing beads made of shell and other objects of personal adornment. The PPNA burials, however, have a distinct lack of grave goods. At many sites, such as Jericho and

Netiv Hagdud yet notably not Dhra', post-burial modification occurs where the crania are removed from adult burials one or two years after death (Bar-Yosef and Belfer Cohen 1992). There are no grave goods associated with the burials that would hint at perceptions of an afterlife, though secondary burial modifications may have represented a form of ancestor worship or social memory exchange (Kuijt 2001a). Wright and Garrard (2003) note for the PPNB that a lack of grave goods may suggest a religious importance of the present world with less regard for the afterlife and this may also be the case during the PPNA. Other art objects such as figurines have been found along with numerous beads, pendants, and bracelets. All of these items may have played a role in ritual activities during the PPNA, though the context of many of these items makes it nearly impossible to determine what role they played in rituals.

PPNA Social Lifeways

The start of village life at sites around the Southern Levant during the PPNA had profound impacts on social, economic, and ritual lifeways. Social dynamics, as evidenced by mortuary data, shifted during the foraging-farming transition. Near Eastern archaeologists often assume that PPNA peoples were egalitarian based on the lack of grave goods and the lack of prestige item data. Because items that may be associated with wealth and status, such as beads, are not found with individuals in a mortuary context, it is extremely difficult to assess ownership and their role in social interactions. While material culture evidence in the PPNB illustrates that social inequality did exist after the PPNA, I believe that a certain level of social inequality is present in the PPNA, though it is nearly impossible to determine status of specific individuals in the archeological record. With the presence of communal storage locations and regional exchange systems, the access to resources could easily have been controlled by an individual or group of individuals during the PPNA. As Hayden (1990) has argued, this is of primary importance in the development of social inequality, and the PPNA has all of the ingredients for the creation of differential access to resources (Rosenberg and Redding 2000). As a result, items that can be used to negotiate social and political capital within PPNA societies can be very important for our understanding of social complexity. The non-utilitarian properties, restricted access to raw materials, and intensity of manufacture make beads and other objects of personal adornment critical in the understanding of social, economic, and ritual lifeways and can hopefully be looked at in the future to reassess the concept of social complexity in the PPNA.

PPNA Economic Lifeways

The decreased mobility associated with increased plant cultivation likely impacted regional social and economic systems. Previous research has shown that expansive trade networks were present during the PPNA. Bar-Yosef and Belfer-Cohen (1992) note the presence of Anatolian obsidian at the sites of Jericho, Netiv Hagdud, Nahel Oren, and Hatoula, indicating that long distance trade routes were present. Additionally, marine shells from the Red Sea and Mediterranean Sea are found at numerous sites (including Dhra'), which again suggest the presence of expansive trade systems. The decrease in mobility associated with the shift to an agrarian lifestyle would have made the direct procurement of these items much more difficult, instead increasing reliance on trade and exchange with other communities within the Southern Levant and beyond.

The impetus behind the development of exchange systems as well as the mechanisms for maintaining these partnerships have as yet been underrepresented in the Near Eastern literature. With this in mind, this study addresses the issue of trade and exchange by focusing on the movement of beads and other objects of personal adornment in the Southern Levant during the PPNA with the hope of exploring the theoretical costs and benefits of exchanging these items and creating region-wide trade networks.

PPNA Research

Situated during one of the most important transitions in human history, the shift from a foraging to farming subsistence strategy, the PPNA of the Southern Levant has had surprisingly few sites identified (Figure 3.3). Only 18 sites have been recorded (substantially fewer have actually been excavated), and variable preservation conditions, stratigraphic continuity, excavation techniques, and publishing records have further blurred our understanding of this important time period (Sayej 2004). In fact, as of the late 1970s very few PPNA sites had been identified, causing Henry (1986) to argue that there were no clearly identified PPNA sites in Jordan (Kuijt 1994a), though sites had been identified in Israel, such as Jericho.

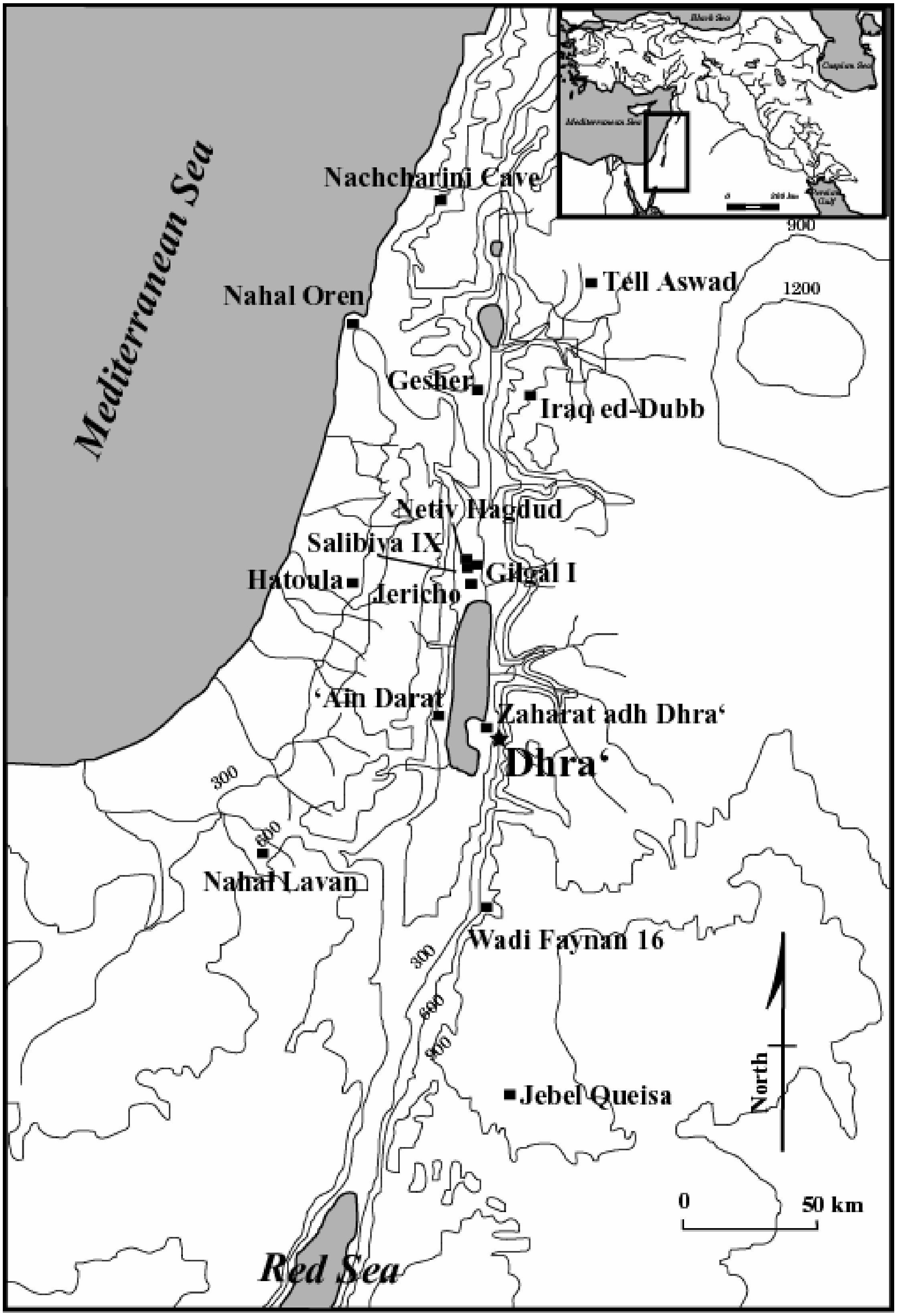

Figure 3.3 – Map of the Southern Levant with Several PPNA Sites.

Among the sites in the Southern Levant that have PPNA components are Gesher (Garfinkle and Nadel 1989), Gilgal I (Noy 1989), Salibiya IX (Enoch-Shiloh and Bar-Yosef 1997), Ein Suhun (Nadel et al. 2000), Ain Darat (Gopher 1995), Hatoula (Lechevallier and Ronen 1994), Iraq ed-Dubb (Kuijt 1994b; 2004), Nahal Oren (Stekelis and Yizraely 1963), Jebel Quiesa (Kuijt and Chesson 1994), Jilat 7 (Garrard et al. 1994), Abu Madi I (Bar-Yosef 1991), Nahal Lavan (Noy et al. 1981), Nachcharini Cave (Copeland 1991), Tell Aswad (Sayej 2004), and Zahrat adh-Dhra' (Edwards et al. 2002).

This study is concerned with signaling power of personal adornment items. Towards this end, this study focuses on the sites of Dhra' (e.g., Kuijt and Mahasneh 1998), Netiv Hagdud (e.g. Bar-Yosef and Gopher 1997), and Wadi Faynan 16 (e.g., Mithen and Finlayson 2000) as they provide the most complete bead data from PPNA sites. Probably the most well known PPNA site, Jericho (e.g., Kenyon 1957; Kenyon and Holland 1981), is not considered in this study for various reasons; primarily due to the lack of sieving while excavating (Sayej 2004). While Dhra', WF 16, and Netiv Hagdud were all excavated using 2mm screens to standardize the collection of objects of personal adornment and related items, excavation techniques at Jericho preclude a systematic and intensive comparison of their data because the bead production assemblage is no doubt incomplete. Wadi Faynan 16 and Netiv Hagdud have the most complete personal adornment assemblage reported for PPNA sites outside of Dhra'. While these two sites actually have personal adornment data, Netiv Hagdud's recording and discussion of personal adornment objects is neither systematic nor detailed. In the final site report volume (Bar-Yosef and Gopher 1997), the entire personal adornment assemblage is described in eleven sentences (Gopher 1997:167 and 171). Among these eleven sentences are gross morphological descriptions, raw material identifications that include the categories of 'greenstone', 'orange', and 'grey-colored', no data tables, and only one photograph of beads, assuming that all of the bead and bead related production items have been included in these eleven sentences and photograph. WF 16's assemblage has yet to be published, though future site volumes (Critchley n.d.; Finlayson and Mithen n.d.) will no doubt add a great deal to the understanding of PPNA personal adornment items, including descriptive data as well as production related information. It is within this framework that the importance of this study is accentuated. The void in PPNA bead research is vast and this study of how beads were produced, the structure of their socioeconomic system that limited who made the beads, as well as theoretical considerations of why people would make beads based on their use of personal adornment items in the ritual, social, and economic lifeways will begin to fill the gap in PPNA knowledge.

Bead Research

Research Potential of Beads

Objects of personal adornment are unique in their ability to provide information about social, economic, ritual, and technological organization in the past. Numerous archaeologists in various parts of the world have explored many of the issues that beads and other items can address. These issues fall into one of four major categories: 1) technological organization; 2) ritual behavior; 3) social information exchange; and 4) economic systems. Highlighting examples of previous personal adornment item research from various temporal and regional contexts in each of these four categories demonstrates the interpretive value of beads and other items. After demonstrating the benefits of bead research, I turn to PPNA bead research in the Southern Levant, or more accurately, the lack of PPNA bead research in the Southern Levant, note the problems with personal adornment research in the region, and pose solutions to these problems. The results of this exploration of the potential and realized research utility of personal adornment items provide a framework within which future bead research, including the rest of this study, can be developed and completed.

In order to understand signaling power and bead use within communities, it is necessary to consider technological organization. Archaeologists rightfully spend a great deal of time and energy reconstructing technologies in an attempt to fully understand the behavior of people in the past. Flintknapping, pot construction, and other experimental archaeological techniques have given archaeologists profound insights into the mechanics of material culture manufacture. As items that are non-utilitarian (this term is used generally, not to imply a lack of function, which personal adornment items certainly have), the technological investment by people in the past into making personal adornment items is unique in the archaeological record. The importance in discovering how people made these items is an issue that has been stressed in numerous places by numerous archaeologists. For example, Kenoyer et al. (1991) use experimental and ethnographic techniques to explore the transformation of agate from mining to a finished bead. In this detailed study of contemporary stone bead manufacturing in India, the authors describe techniques, technologies, and materials required in each step of the manufacturing process. Analogies are drawn from contemporary bead making techniques to bead production in the past. By fully understanding the skills, time, and resources needed to make beads, the authors discuss technological organization and its impact on social and economic lifeways, in this case through craft specialization as an adaptive strategy (Kenoyer et al. 1991). This level of knowledge of technological organization, primarily focused on manufacturing techniques, is required before the research potential of beads and other prestige items can be realized. For this reason, I provide a thorough exploration into the manufacture techniques of beads during the PPNA in the Southern Levant.

The second major suite of issues that bead research addresses is ritual behavior. Reconstructing ritual behavior, as well as attempting to rediscover the meaning of artifacts for people in the past, is one of the more complex ventures in archaeology. Proving what people in the past thought about life, the afterlife, deities, the weather, and other major issues is nearly impossible. However, we cannot ignore the fact that beads and other personal adornment items may have been used in ritual settings. Many archaeologists have attempted the daunting task of understanding ritual behavior based on items such as beads. Beads have been described by authors as “a crystallization of [the] raw life force” of people (Janowski 1998:241), associated with ancestral spirits (Carey 1998), connected to magic (Francis 1999), and associated with death and the afterlife. No matter what the specific interpretation of ritual behavior in the past the point is clear; beads are not mundane. One example that illustrates an exploration of the potential ritual nature of beads is the work of Wright and Garrard (2003) with PPNB assemblages in the Levant. It should be noted that Wright and Garrard’s work is closely aligned with the current study due to similar physiographic and temporal constraints. These authors suggest that aesthetic choices, as seen through color selection, may reflect certain meanings. For example, ‘greenstone’ is the most common bead color among assemblages in the Levant from the PPNA onward and may come from an underlying association of the color green to life and fertility, especially with increased reliance upon domestication. The authors are quick to point out, however, that such inferences of meanings associated with particular colors cannot be substantiated (Wright and Garrard 2003:278). This is just one example of the potential and limitations for archaeologists to gain insight into past ritual beliefs through the study of beads and is yet another reason why PPNA bead research is important.

Third, beads and other objects of personal adornment are highly visible items. Along with the visibility of these artifacts comes the benefit of information exchange among people in the past. Many archaeologists have recognized the role that beads may have played in complex social interactions and have studied the production and use of these rare items as part of a social information exchange system. Ethnographic work has shown that bead production and ownership is linked to visual displays of wealth and status, often associated with special occasions, rituals, and feasts (i.e. – Eicher 1998; Janowski 1998), gender and age roles (i.e. – Carey 1998; O'Hear 1998; Sciama 1998), kin and ethnic affiliation (i.e. – Meisch 1998), and mate acquisition (i.e. – Carey 1998). By wearing certain types and quantities of beads in particular patterns, individuals are able to convey information about political prowess, socioeconomic standing, gender, age, occupation, kin group, cultural group, wealth, status, and religious identity in a clear and simple manner that otherwise would be impossible to visually display (Dublin 1987, 1999; Hodder 1977, 1982; Strathern and Strathern 1971; Vanhaeren 2005; Vanhaeren and Errico 2006; Wright and Garrard 2003). Archaeologists have taken note of the role personal adornment items have as displays of social information and have made social information exchange a cornerstone of personal adornment research (i.e. – Hayden and Schulting 1997; Quinn 2006; Vanhaeren and Errico 2006). Ethnographic studies suggest beads have a prominent role in negotiating complex social interactions and it is likely that this was also the case during the PPNA in the Southern Levant, which further highlights the need for comprehensive analyses of bead and personal adornment assemblages.

The fourth general category of bead research is work that is concerned with economic systems. Studies of economic systems have been a staple of archaeological research for decades. Personal adornment items are often made of raw materials with limited availability, take large amounts of time and skill to produce, and are often markers of individual or community economic prowess. As such, beads and other adornment items played a vital role in economic transactions, alliance formation, and increasing cultural complexity. Research into the economic systems of the past through personal adornment items has covered many topics including craft specialization (i.e. – Costin 1991; Junker 1993; Kenoyer et al. 1991; Miller 1996), trade and exchange (i.e. – Allen et al. 1997; Currie 1995; Galm 1994; Kuhn and Stiner 1998; Quinn 2006; Sciama 1998; Stiner 1999; Vanhaeren et al. 2004), and wealth and resource acquisition (i.e. – Hayden and Schulting 1997; Janowski 1998). Craft production structure and intensity, along with trade and exchange networks, has important social and economic ramifications as people began to shift from a mobile hunter-gatherer lifeway to a more sedentary agricultural economy. Increased sedentism during the PPNA combined with personal adornment raw materials that have a patchy distribution (such as marine shells in the Mediterranean and Red Seas and malachite near copper sources) may have forced people in the PPNA to form and maintain trade and exchange networks. While several

Near Eastern archaeologists have considered this possibility (i.e. – Gopher 1997; Bar-Yosef and Belfer-Cohen 1992), the mechanics for starting and maintaining exchange systems has not yet been fully explored.

Problems with PPNA Bead Research

At Southern Levantine PPNA sites, the full research potential of personal adornment items has not been reached. Our poor understanding of PPNA beads stems from three main problems: 1) inconsistent recording techniques, 2) poor reporting in publications, and 3) failure to realize the interpretive benefit of personal adornment items. With acknowledgement of these shortcomings in the past and explorations of possible solutions to these problems, archaeologists in the Near East may begin to use these data sets to reconstruct past social, economic, ritual, and technological organization.

The first problem with personal adornment research is a lack of an agreed upon data recording strategy. Unlike chipped stone artifacts, no typology has been developed and adopted by researchers for personal adornment items. The vague and inconsistent terminology that arises from the lack of an agreed upon typology prevents archaeologists from comparing assemblages from different sites within the Southern Levant during the PPNA. As one example of the variability in recording of bead data, Netiv Hagdud beads are described as being either ‘flat beads,’ ‘thick cylindrical beads,’ or ‘other items,’ made of “different minerals, mainly greenstone but some orange and grey-colored beads also appear” (Gopher 1997:167). For comparison, the site of Basta has “small finds” that consist of “fairly flat beads”, “beads made from various minerals”, “tubular bones”, and “almost complete rings of bracelet size” (Nissen et al. 1987:109-110). At Zahrat Adh-Dhra’ 2, “fragments of green copper ore and fragments of a hard green mineral” were found (Edwards et al. 2002:6). These examples highlight the variability as well as the lack of precision and uniformity in recording of PPNA personal adornment items. Beyond simple classification data, as yet Near Eastern archaeologists have not recorded important information such as the condition of the finds, production stage information, detailed raw material identification, and specific metric attributes of individual items as well as other potentially useful information.

It is possible that analysts have recorded this information, but this brings us to the second issue; a lack of standardized and detailed reporting of personal adornment item assemblages. Many of the sites that have published bead data include photographs or illustrations of the artifacts undoubtedly because of their aesthetic qualities, while simple yet vital information, such as the total count of personal adornment items, the use of sampling in the illustrations or photographs, counts of different raw material types, production evidence, and preservation condition of items remain unreported. Much of this information could be encapsulated in tabular form, such as used to report lithic assemblage data, though this has not been adopted as a reporting strategy. Perhaps more alarming than vague and potentially biased reporting of personal adornment assemblages is the paucity of personal adornment publications in the Near Eastern PPNA archaeological literature. For example, the site report from Netiv Hagdud has roughly 70 *pages* dedicated to the chipped stone industry at the site (see Nadel 1997), yet only 11 *sentences* on beads and other decorative items (see Gopher 1997). While I do not believe that the personal adornment assemblages at PPNA sites require equal publication space as lithic assemblages (primarily due to the relatively low frequency of personal adornment items when compared with chipped stone artifacts), the limited reporting of personal adornment item data is a disservice to the archaeological record.

The third major problem with PPNA personal adornment research is intertwined with the previous two; the potential of personal adornment items to address questions about social, economic, and technological organization has not been realized. Near Eastern archaeologists have been concerned with trade and exchange networks and given the rarity of beads and their potentially discrete raw material sources, beads can potentially help our understanding of the economic and social pressures on trade networks. Sociopolitical complexity has also been a major source of debate considering the major shift in subsistence strategy from the Natufian to the PPNA that impacts residence patterns, food availability, and other factors that are important when trying to understand social systems during the PPNA. As items that likely carried large economic and social value, beads and other objects of personal adornment may provide insight into social organization during the PPNA. A more fundamental question, and one that has surprisingly been overlooked, is how were people making these artifacts? While perhaps mundane, this question can help us understand technological organization and factors associated with reproductive fitness signaling power in the Southern Levant using an as yet underused material culture resource. The lack of detailed recording, accurate reporting, and concern with major analytical issues leaves a vast source of knowledge of past peoples untapped and potentially lost forever. It is this factor, among others, that highlights the importance of this study for Near Eastern Neolithic research.

CHAPTER 4

MATERIALS AND METHODS

This study utilizes bead and stone tool data from the PPNA site of Dhra', Jordan (Figure 4.1). Dhra' was first discovered and tested in 1979 by Bennett (1980) and Raikes (1980) and was revisited by Kuijt and Mahasneh (1998) in 1994 (Sayej 2004). Under the direction of Dr. Ian Kuijt (University of Notre Dame) and Dr. Bill Finlayson (Council for British Research in the Levant), the site of Dhra' was excavated for a total of 30 weeks during four field seasons from 2001-2005 (no excavation took place in 2003). The project was funded by the National Science Foundation, the Council for British Research in the Levant, the British Academy, the University of Notre Dame, and the Social Sciences and Humanities Research Council of Canada. The site of Dhra' consists of a Pottery Neolithic occupation, which is omitted from this study, and a PPNA occupation (Finlayson et al. 2003; Goodale et al. 2002; Goodale and Smith 2001; Kuijt 1994, 2001b; Kuijt and Finlayson 2001, 2002; Kuijt and Mahasneh 1995, 1998).

Figure 4.1 – Photograph of the site of Dhra', Jordan.

Dhra' Project Background

The goal of the Dhra' archaeological project is to increase understanding of the transition from foraging to farming along the Dead Sea Basin and Kerak Plateau (Kuijt and Finlayson 2001). Towards this end, research that explores social, economic, and ritual lifeways during this period in the Southern Levant are of primary importance to the research agenda. Research into personal adornment items, which play a major role in all three of these aspects of prehistoric life, can assist in better understanding change during the forager-farmer transition.

Dhra' is situated five kilometers east of the modern town of Mazra, Jordan in the Jordan Valley. Located 35 meters below sea level, the site is bounded by high cliffs to the east, the significant drainage of Ain Waida, which provides a year-round local freshwater supply, to the north and erosional cuts to the west and south. Nine 5 meter by 5 meter excavation units have been opened; excavated to depths ranging from .5 to 2.5 meters below the surface as well as several smaller units utilized to test the extent of the PPNA occupation.

The site itself is a relatively large residential community covering an area of at least 6500 square meters in size with oval and circular structures made of stone and mud (Finlayson et al. 2003). Multiple radiocarbon dates have placed the site within the PPNA, spanning from 11,500 to 11,200 calibrated years B.P. The structures have been interpreted to be variable in use, with such functions as residences and a communal grain storage locations being identified. Many of the structures represent multiple occupations based on fill and flooring episodes as well as construction phases.

The artifacts at Dhra' are consistent with those from previously excavated PPNA sites, though although the number of chipped lithic artifacts is much greater (Finlayson et al. 2003; Goodale and Smith 2002; Raikes 1980). Over one million lithic artifacts have been analyzed from the 2001-2005 excavation seasons. Among the collection are large numbers of pointed tools, such as el-Khiam points, Salibiya points, Jordan Valley points, awls, and borers, sickle blades, Gilgal and Hagdud truncations, burins, unifacial tools such as denticulates and scrapers, bifacial tools such as picks, chisels, and axes, single platform cores, and many types of debitage produced by the predominantly blade-core technology (Finlayson et al. 2003). In addition to the chipped stone industry at Dhra', there are also numerous groundstone items, such as mortars, pestles, grinding slabs, and beads. The faunal assemblage includes numerous pieces of modified bone, including bone points. Eight human burials without grave goods were also excavated.

Data Collection Strategy for PPNA Personal Adornment Items

The objects of personal adornment were analyzed from the 2001, 2002, 2004, and 2005 excavation seasons of at Dhra'. Beads, pendants, bracelet fragments, and raw materials likely used in the manufacturing of these are classified as objects of personal adornment. Whenever possible, personal adornment items were recovered in situ, preserving contextual and provenience information. While some materials were not found in situ, all sediment excavated on site was screened using 2mm mesh and all cultural material remaining in the screens, including the personal adornment items, were collected. While still in the field, each bead was given a special finds number whether it was found in situ or in the screen. Associated with this number are the one by one meter square in which the item was found, the depth range in terms of absolute elevation below sea-level (the Jordan Valley near the Dead Sea is below sea-level), the spit number (also known as level number), and if found in situ, the exact three point provenience. Raw materials were rarely given special finds numbers. Such raw materials were collected into one individual bag per 5cm spit in each one-by-one unit. Once excavated and recorded in the field, they were brought back to the lab for more detailed analyses. Prior to analysis, a comprehensive database had to be constructed to collect as much data as possible as well as provide data on issues of production and spatial distribution. One major task was constructing a PPNA bead typology, as there has yet to be a classification system put forward in the archaeological literature. Additionally, an entire data collection strategy was developed and is included in this work as a template for future PPNA personal adornment research. Provenience information, observations, classifications, and numerous types of measurements were made on the objects of personal adornment and recorded using a Microsoft Access database (APPENDICES A, B, and C).

ID Number

Each item was given a unique ID number generated in sequential order starting with 1. These numbers are not all in direct order as deleted/modified entries that did not represent actual finds had their ID numbers removed from the sequence.

Special Finds Number

The unique special find number was recorded for each specimen. When possible, the number was recorded in the field obtaining numbers from the special finds log which also included items other than personal adornment items, hence the gaps in numeration. On the other instances, the specimen was given a unique and arbitrary special finds number which is noted in the database by a lower case 'x' at the start of the special finds number.

Season

The season of excavation was recorded primarily for cataloguing, back checking, and accuracy purposes.

Area

Site Area was also recorded. Main excavations during 2002, 2004, and 2005 focused on Area 1, but adornment objects from other excavation areas around the site were also included.

Context

When found in proper stratigraphic context, which excludes surface finds, the Context number was recorded. Surface finds were given the Context designation of 'Surface'.

Easting, Northing and Quadrant

The site was excavated in one by one meter units and each unit was designated by the Easting and Northing of the Southwest corner of the unit. For each personal adornment item, the unit designation (Easting and Northing) was recorded. Additionally, excavations in 2001 used a Quadrant designation on some of their finds, and that designation was also recorded.

Spit

Excavations in each one by one meter unit were performed in five centimeter levels within the natural stratigraphy. Each five centimeter or less level was given a unique number within the particular stratigraphic context, called the spit number. Within a unit, spit numbers started at one and increase by one until a new stratigraphic context was designated with a new context number. The new context was excavated starting with spit number one and the spit number increased with each subsequent 5 centimeter level.

Bag Number

As special finds, each object of personal adornment was normally given a unique bag number. In the case of raw material, particularly malachite pieces and debitage, all items within a spit were collected and placed in the same bag.

Point Plot Easting, Point Plot Northing, Depth

The three point provenience, the exact Easting, Northing, and depth of finds, was recorded when artifacts were found in situ. When not found in situ, the point plot Easting and Northing were not applicable and the depth was recorded as the depth range of the southwest corner of the one by one meter unit.

Class (Cross-Section View) - Typology

The objects of personal adornment were classified by their type (each explained in detail below), based on a typology that was developed for PPNA personal adornment assemblages: flat disc beads (Type 1); beveled disc beads (Type 2); flat oval beads (Type 3); cylindrical beads (Type 4); barrel-elliptical beads (Type 5); indeterminate type (Type 6); pendants (Type 7); bracelets (Type 8); raw material pieces and debitage (Type 9); and other types that do not fit other typological classifications (Type 10) (Figure 4.2).

As yet, there has been no published personal adornment typology for Southern Levantine PPNA assemblages. With this in mind, a typology was developed in hopes of standardizing discussions of personal adornment items as well as urging more detailed and thorough recording and reporting of personal adornment assemblages at PPNA sites.

This new typology combines attributes of previous personal adornment work in the region by Critchley (n.d.) with the typological approach utilized by Wright and Garrard (2003) in their analysis of PPNB assemblages in the Levant.

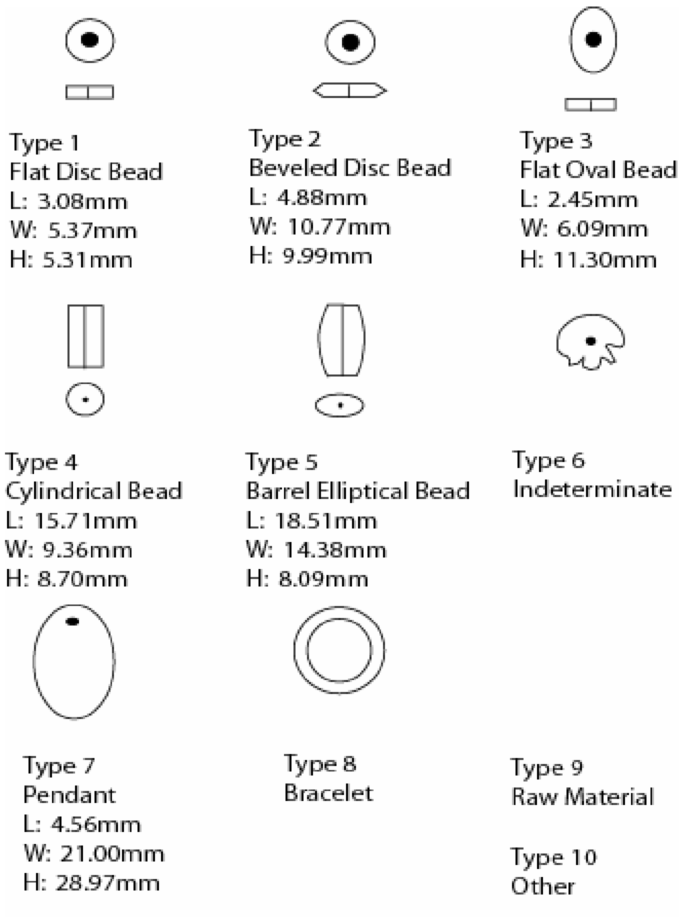

Figure 4.2 - Morphological Typology of PPNA Adornment Items. Not drawn to scale. All measurements are averages of finished complete items. L=length, W=width, H=Height. Adapted from Wright and Garrard (2003)

In this typology it is important to note that while these classes represent gross morphological differences in the personal adornment assemblages of the PPNA, there is still quite a bit of morphological variability within each type. For example, there is no standardization in morphological attributes of barrel-elliptical beads (See Chapter 5 for detailed discussion). However, the low quantity of personal adornment items combined with the structure and intensity of craft production creates ranges of acceptable morphological variability that does not challenge the typological classification of the objects. Unfinished items, such as partially drilled beads and bead blanks, are included in the typology under the type that they were likely to become had they been finished. As with any typology, the goal is to provide archaeologists with a way of discussing and comparing morphological variability and similarity without having to describe each piece independently of others. In this case, manufacturing techniques, size, and shape guide the development the typology. Hopefully, the typological classes mirror variation and conceptualization of the items by individuals in the past. While the goal of this typology is to provide a template for further research, future analysis and more data may require modification of this typology. This typology, detailed below, was developed using the personal adornment assemblage at Dhra', and variability seen at the site may or may not reflect the variability at other PPNA sites.

Flat Disc Beads (Type 1) (Figure 4.3)

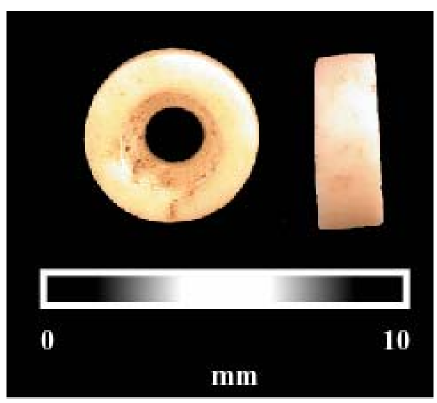

Figure 4.3 – Adornment Type 1

Beads in this class are circular in cross section view (looking through the perforation). The plan-view for these beads is linear, with the axis parallel to the perforation (length) being less than the axis perpendicular to the perforation (width). The rim of the beads in the flat disc beads is the same thickness throughout, which is the diagnostic difference between flat disc beads and beveled disc beads (Type 2). Often, these beads are very small when compared with beveled disc beads, which tend to be larger.

Beveled Disc Beads (Type 2) (Figure 4.4)

Figure 4.4 – Adornment Type 2

Beads in this class are circular in cross section view (looking through the perforation). The plan-view for these beads is linear, with the axis parallel to the perforation (length) being less than the axis perpendicular to the perforation (width). The rim of the beads in the beveled disc beads is thicker in the center than at the margins, which is the diagnostic difference between beveled disc beads and flat disc beads (Type 1). Often, these beads are larger than flat disc beads.

Flat Oval Beads (Type 3 (Figure 4.5)

Beads in this class are ovular in cross section view (looking through the perforation), which is the main diagnostic difference between flat oval beads and flat disc beads (Type 1). The plan-view for these beads is linear, with the axis parallel to the perforation (length) being less than the axis perpendicular to the perforation (width). The rim can either be flat or beveled, though among the small number of flat oval beads in the Dhra' assemblage, all had flat rims.

Cylindrical Beads (Type 4) (Figure 4.6)

Figure 4.6 – Adornment Type 4

Beads in this class are circular in cross section view (looking through the perforation), which is a diagnostic difference between cylindrical beads and barrel-elliptical beads (Type 5). The plan-view for these beads is cylindrical, with the axis parallel to the perforation (length) being larger than the axis perpendicular to the perforation (width). Additionally, the width of the rim is even across the entire axis of the bead. The plan-view shape is diagnostic of cylindrical beads when compared with flat disc beads (Type 1), beveled disc beads (Type 2), and barrel-elliptical beads (Type 5).

Barrel-Elliptical Beads (Type 5) (Figure 4.7)

Figure 4.7 – Adornment Type 5

Beads in this class are ovular in cross section view (looking through the perforation), which is a diagnostic difference between barrel-elliptical beads and cylindrical beads (Type 4). The plan-view for these beads is ovular as well, though the ends of the bead are often truncated. This forms a plan-view along the axis that is parallel to the perforation (length) that is wider in the midpoint of the bead than on the two ends that are perforated.

Indeterminant (Type 6) (Figure 4.8)

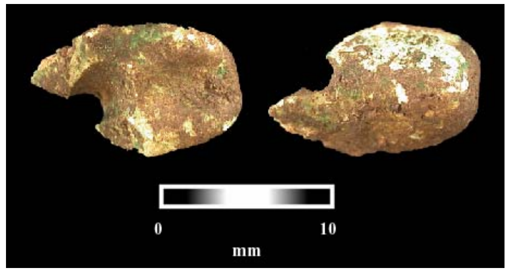

Figure 4.8 – Adornment Type 6

Objects of personal adornment that are classified in this category are often broken or damaged in some way that precludes their inclusion into any of the other categories. This differs from objects classified as 'other' (Type 10) in that their morphological characteristics upon which the typological classification system is built are unknown and unable to be estimated based on preserved characteristics.

Pendant (Type 7) (Figure 4.9)

Figure 4.9 – Adornment Type 7

Objects in this class are characterized by the location of their perforation. Pendants are perforated towards one edge of the item rather than in the center. Pendants are often linear in plan-view with the axis parallel to the perforation (length) being less than the axes perpendicular to the perforation (in this case, both width and height).

Bracelet (Type 8) (Figure 4.10)

Figure 4.10 – Adornment Type 8

Objects in this class are characterized by a narrow rim and large perforation or space on the interior. These objects are considerably larger than many of the other objects of adornment as they are not perforated to be held on a line, but rather, have such a large gap that it is likely that these items were placed directly on the body, in locations such as wrists and ankles.

Raw Material (Type 9) (Figure 4.11)

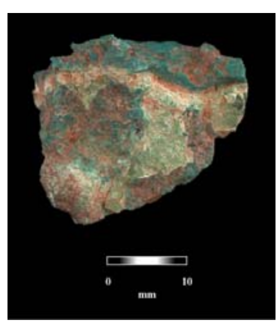

Figure 4.11 – Adornment Type 9

Objects in this class are as yet unmodified pieces of raw material that could be used for manufacturing other objects of personal adornment. Large pieces that may be made into items and smaller pieces that are likely production debris are not discriminated between in the classification, though larger pieces are noted when analyzed.

Other (Type 10) (Figure 4.12)

Figure 4.12 – Adornment Type 10

Objects in this class do not fit into any of the other nine types based on morphological characteristics. Most items that fall into this category are unique from all other items in the assemblage at Dhra', and a larger sample that includes personal adornment from more PPNA sites may show that objects classified in this type are not unique and may be classified accordingly.

Plan-View Shape

As the classification of personal adornment items is based primarily on the cross section shape, the plan-view shape of the items (the axis parallel to the perforation) was recorded separately as one of the following shapes (Figure 4.13): oval; circular; linear; cylindrical; or another shape that does not fit within the other plan-view classifications.

Oval objects in plan-view have a relatively oval shape defined as longer along the axis parallel with the perforation than the axis perpendicular to the perforation. They can, however, be truncated on either end which leaves the object with a wider mid-region when compared with narrower ends. Circular items have an axis parallel to the perforation that is equal to the axis perpendicular to the perforation and forms a circular shape. Linear items in plan-view have a ratio of the axis parallel to the perforation to the axis perpendicular to the perforation that is less than 1:1. Cylindrical items are those that have a ratio of the axis parallel to the perforation to the axis perpendicular to the perforation that is greater than 1:1. This differs from oval objects in that the width of the object along the axis perpendicular to the perforation is the same for the entirety of the axis parallel to the perforation. Objects that do not have plan-views that fit these standardized types are classified as having 'other' plan-views.

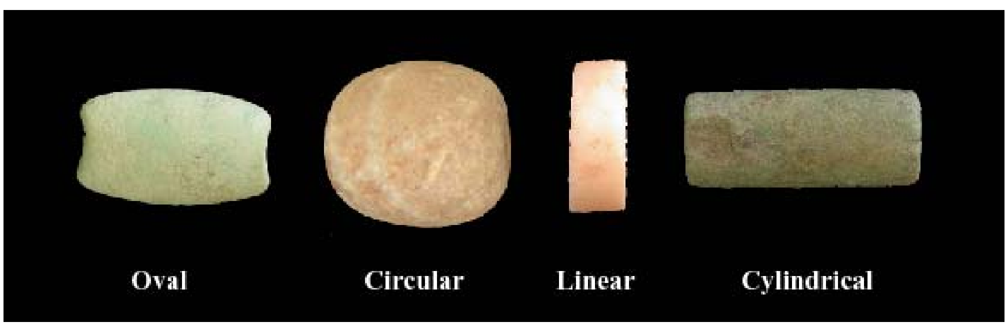

Figure 4.13 – Plan-View Shape.

Preservation

The preservation condition was recorded for each personal adornment item. The items were classified as complete, where the entirety of the item has been recovered, incomplete, where only a portion of the object has been recovered, and broken, where items are either found broken or are broken during the excavation process and can be refit with the other broken pieces (Figure 4.14). Broken pieces were not given separate special finds numbers for each portion of the item and were bagged and recorded as one item.

Figure 4.14 – Preservation Condition.

Raw Material

The raw material for each personal adornment item was recorded whenever a determination of raw material could be made. Among the raw materials recorded for the prestige item assemblage at Dhra' are quartz, malachite, limestone, jasper, jade, soapstone, shell, bone, indeterminant raw material, and other uncommon raw materials.

Color

The color of each personal adornment specimen was recorded in a nominal manner that notes variability among the adornment items. The color of items highlights the variability present among raw material types; a factor that would be missed if researchers focused solely on raw material classification. Color was recorded in a fairly subjective manner, which captures variability in raw material type but is up to interpretation based on individual researchers. Potentially, a hue and chroma scheme, such as the Munsell color chart for soils, may be agreed upon and universally applied by bead researchers. However, standardized color descriptions were not employed in this analysis.

Production Stage

The production stage of each personal adornment item was recorded for the assemblage at Dhra'. The production stages are finished, partially drilled, blanks, and raw materials (Figure 4.15). Objects classified as finished have been completely perforated, as this was likely one of the last steps in production. Partially drilled items are incompletely perforated. Blanks have been roughed out or even polished but have yet to be perforated. Raw materials are items that have not been directly modified by humans. Debitage produced by manufacture is also included in the raw material category, as the debitage has not been directly modified by humans.

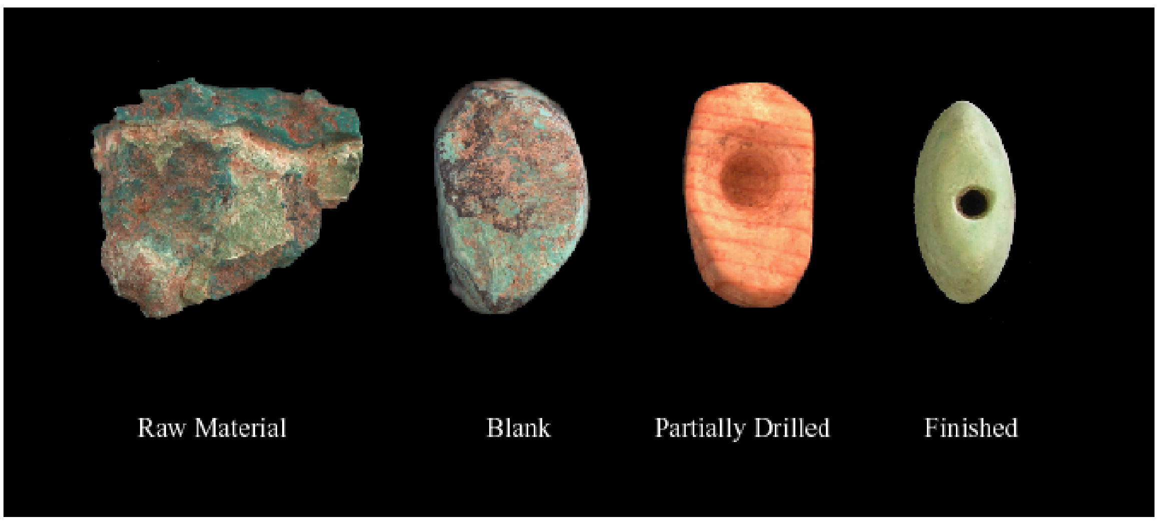

Figure 4.15 – Production Stages.

Production Technique

The production technique, mainly perforation technique of beads, was also recorded. Biconically drilled items are those items that have two cone shaped perforations, each initiated on opposite sides, which meet in the center of the object to create a perforation. Uniconical items are drilled from only one side in order to create the perforation. When the perforation type was indeterminant it was noted as such, and items that were not perforated were classified as having an 'other' production technique.

Surface Treatments

Surface treatments, such as polishing, incisions, and other human modifications to the surface of the specimen were noted and recorded.

Bead Metrics – Length, Width, Height

Metric dimensions of each bead were recorded using digital calipers in millimeters accurate to 1/100000 of a meter (Figure 4.16). The dimension of length was measured as the axis parallel to the perforation when the perforation is present. The location of the axis was estimated when items were in blank or partially drilled form. The length was recorded as the longest axis when in raw material or irregular form. The dimension of width was measured as the axis perpendicular to the perforation when the perforation is present. The location of the width axis was estimated when in blank or partially drilled form. The width axis was recorded as the longest axis perpendicular to the length axis when in raw material or irregular form. The dimension of height was measured as the axis perpendicular to the perforation and also perpendicular to the axis measured as the width. The location of this axis was estimated when in blank or partially drilled form. The height axis was recorded as the longest axis perpendicular to the length axis in one dimension and perpendicular to the width axis in the second dimension. When adornment items are incomplete their orientation is estimated, though the metric measurements only measure the preserved material.

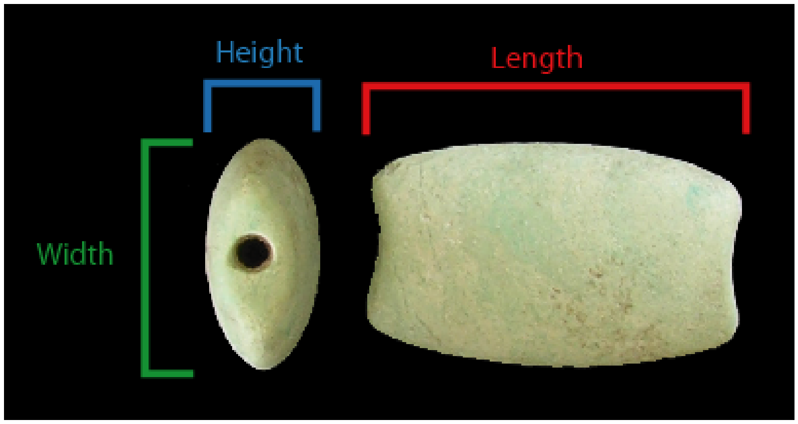

Figure 4.16 – Bead Personal Adornment Item Metric Dimensions.

Perforation and Rim Metrics

Metric measurements (in millimeters) of the perforations and rims were also taken on all perforated objects of personal adornment (Figure 4.17). Maximum perforation diameter is the longest linear diameter for the perforations on an item. Minimum perforation diameter is the shortest linear diameter for perforations on an item. Maximum and minimum perforation metrics could be taken on the same perforation or on opposing sides as long as that dimension is the widest or narrowest (respectively) portion of the perforation. Maximum and minimum rim size is governed by the same rules. The thickest portion of the rim, taken along a ray from the center to the outside, was recorded as the maximum rim size. The thinnest portion of the rim, taken along a ray from the center to the outside, was recorded as the minimum rim size.

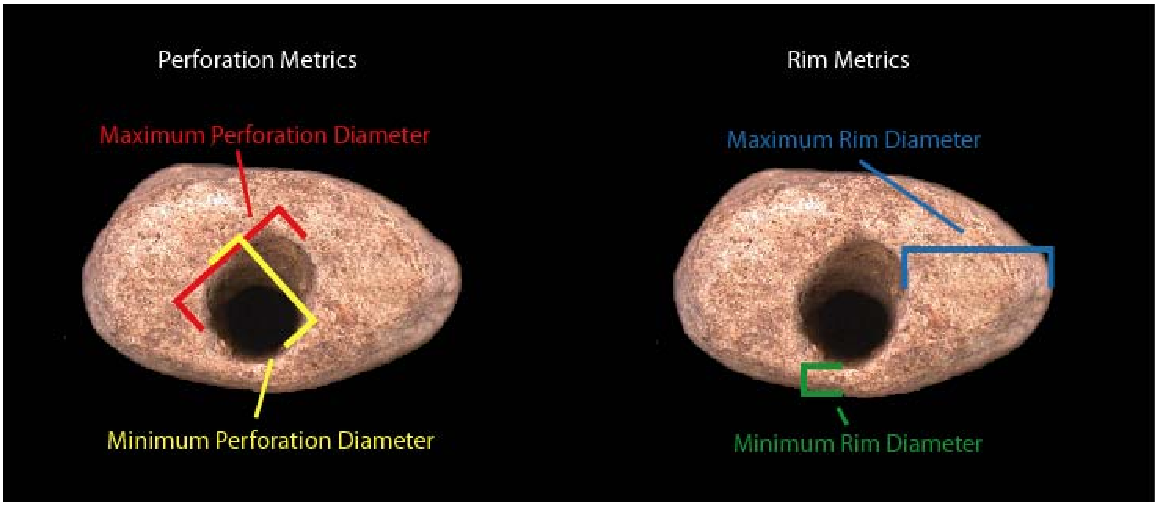

Figure 4.17 – Personal Adornment Item Perforation and Rim Metrics.

Notes

In addition to these data points, a brief description of the item was recorded when warranted. These notes were used to record information that the database was not set up to record, such as the abundance of raw materials within a single bag, describing an unknown raw material, or describing an item that did not fit into the newly developed morphological typology.

Dhra' Bead Assemblage

In order to understand PPNA signaling power and personal adornment item production, three of these categories - types, raw materials, and production stages - are of primary importance. The most common class of personal adornment item in the Dhra' assemblage are raw materials (Type 9), followed by barrel-elliptical beads (Type 5), flat disc beads (Type 1), and beveled disc beads (Type 2) (Figure 4.18). The most common raw material for the entire assemblage is malachite; with limestone and quartz in a distant second and third respectively (Figure 4.19). The Dhra' personal adornment assemblage is dominated by raw materials, followed in order by finished beads, bead blanks, and partially drilled beads (Figure 4.20).

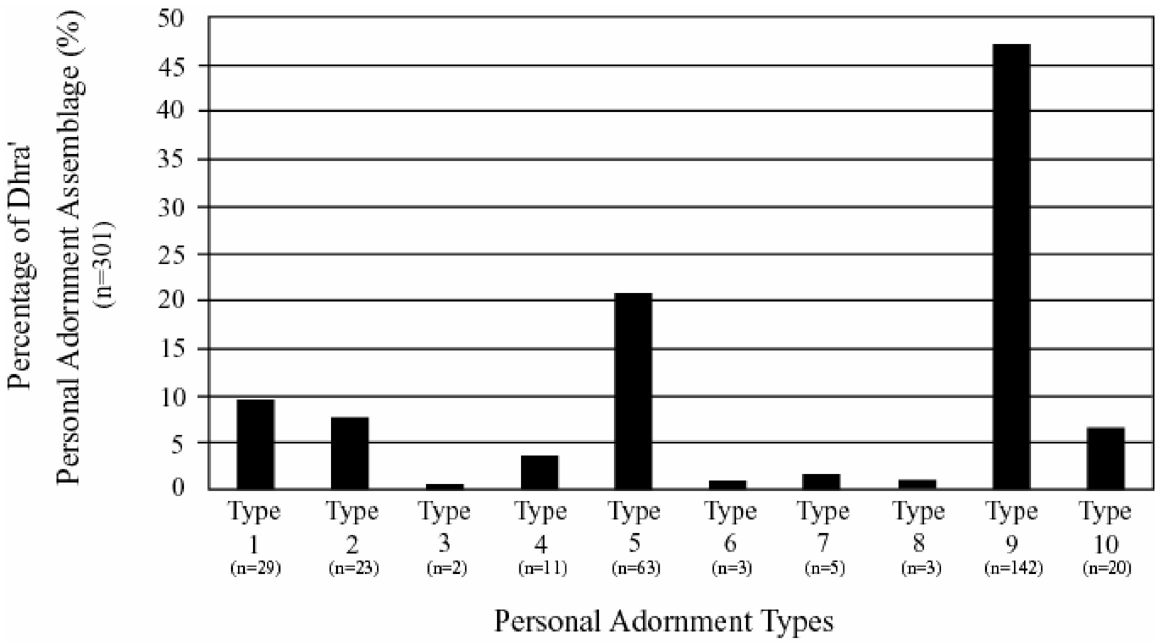

Figure 4.18 - All Dhra' Personal Adornment Specimens by Type

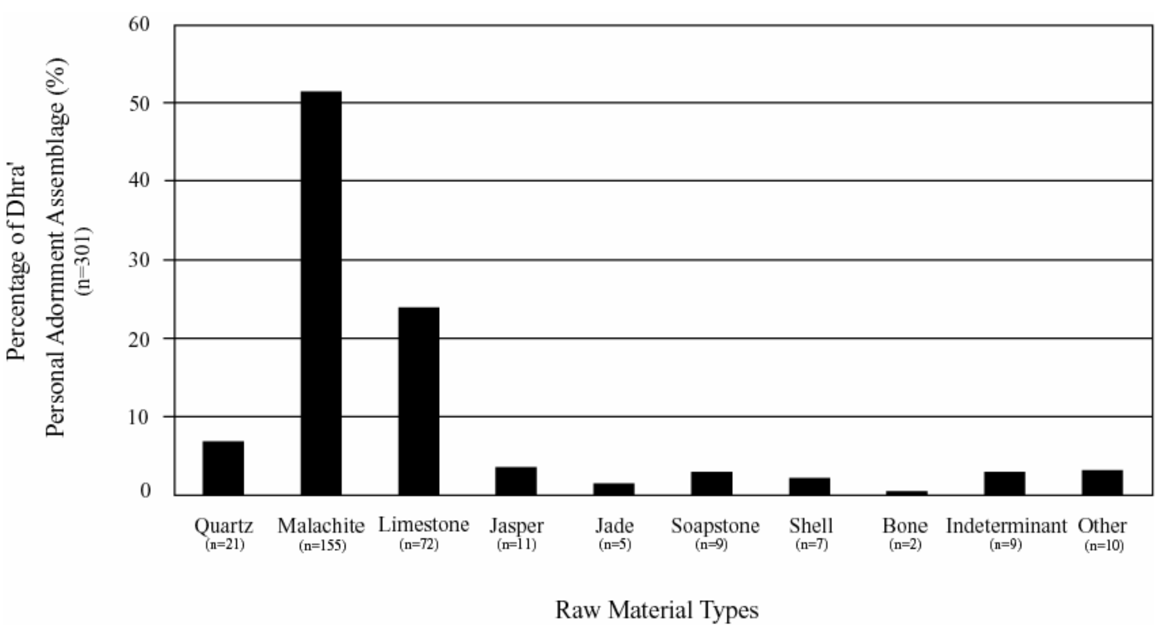

Figure 4.19 - All Dhra' Personal Adornment Specimens by Raw Material Type

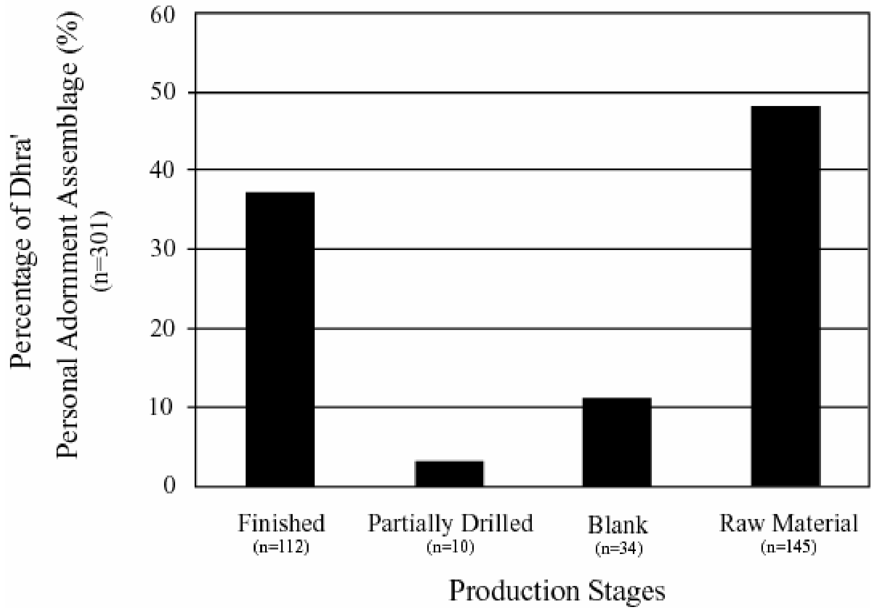

Figure 4.20 - All Dhra' Personal Adornment Specimens by Production Stage.

The raw material stage, however, is problematic and may be slightly skewing the data. Not all potential raw materials for personal adornment items were collected. For example, there are a large number of limestone beads, but because limestone is abundant in the area and was also used for other items, 100% of the limestone was not collected and inventoried. Conversely, the foreign nature of malachite, with the closest source being near Wadi Faynan over 50 kilometers to the south, combined with its bright color made it more likely to be recovered, inventoried, and analyzed. As a result, the data are also organized by omitting the raw material (Type 9) items.

Looking at only finished beads, the most abundant type of item are barrel-elliptical beads (Type 5) with flat disc beads (Type 1) and beveled disc beads (Type 2) a distant second and third, respectively, though there it a higher percentage of items that do not fit the typology (Type 10) than these last two categories (Figure 4.21). In terms of raw material abundance, the omission of raw material has made limestone the most abundant raw material for finished beads with over 50% of the finished beads made of the chalky white material, while no other single raw material type makes up even 10% of the assemblage (Figure 4.22). When finished beads are combined with partially drilled beads and bead blanks, we see a similar distribution of personal adornment classification (Figure 4.23) and raw material (Figure 4.24) as the data with only finished beads.

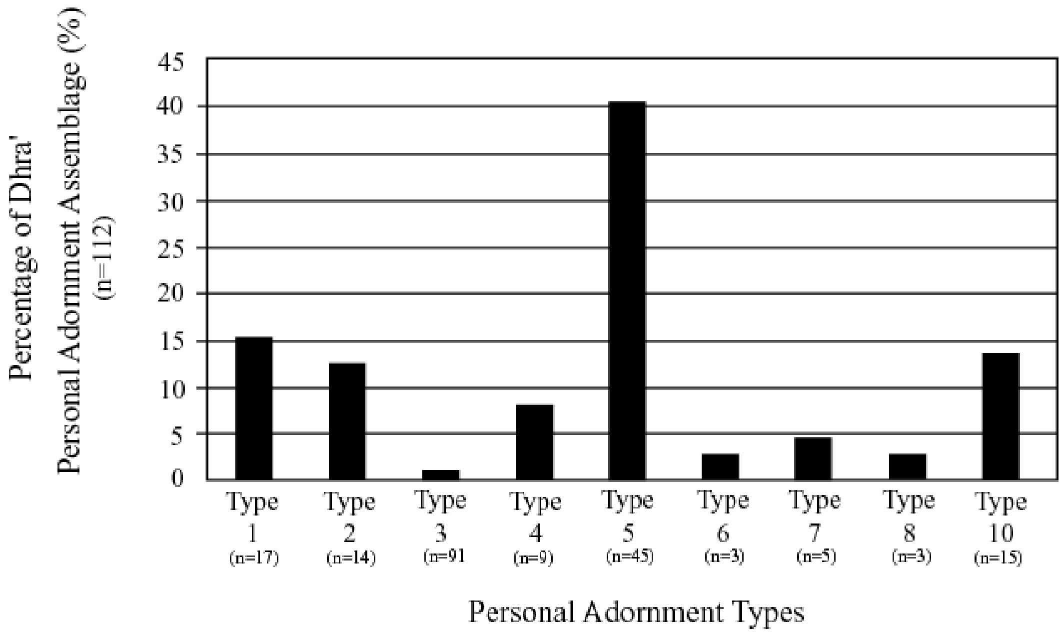

Figure 4.21 – Finished Dhra' Personal Adornment Specimens by Type.

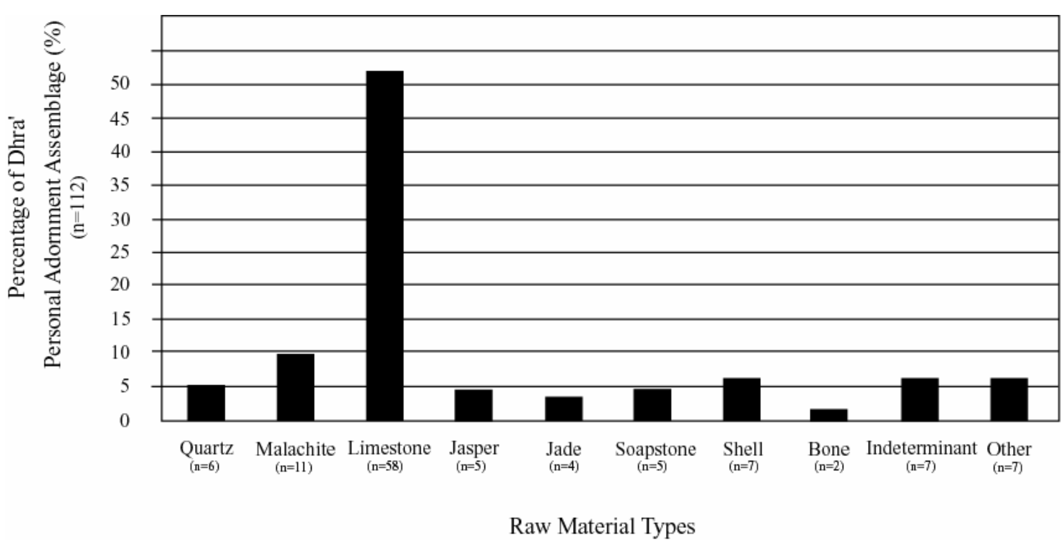

Figure 4.22 - Finished Dhra' Personal Adornment Specimens by Raw Material.

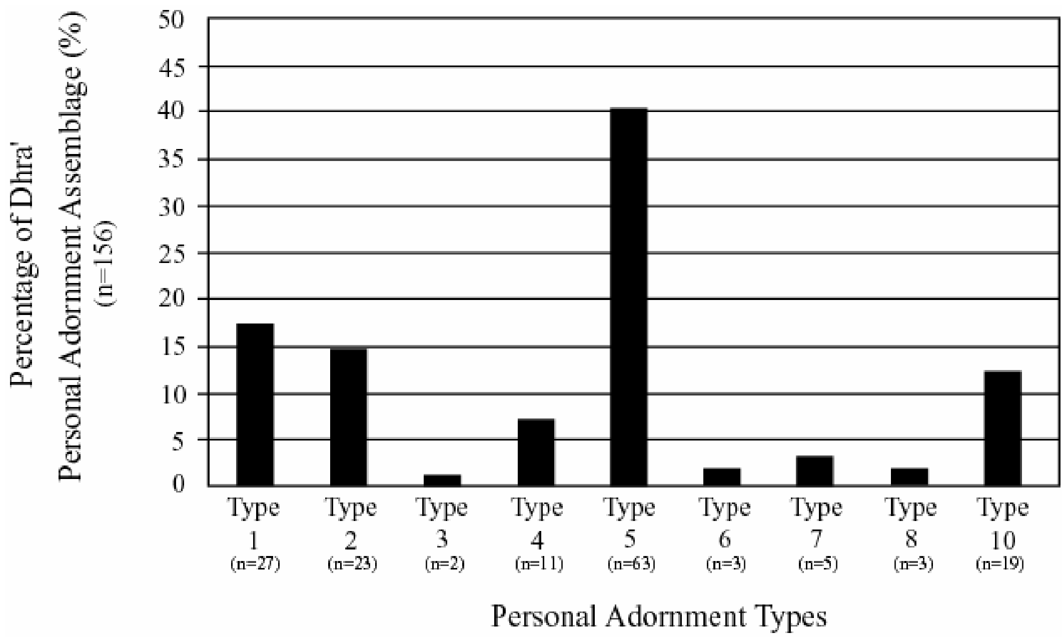

Figure 4.23 - Dhra' Personal Adornment Specimens Not Including Raw Materials by Type.

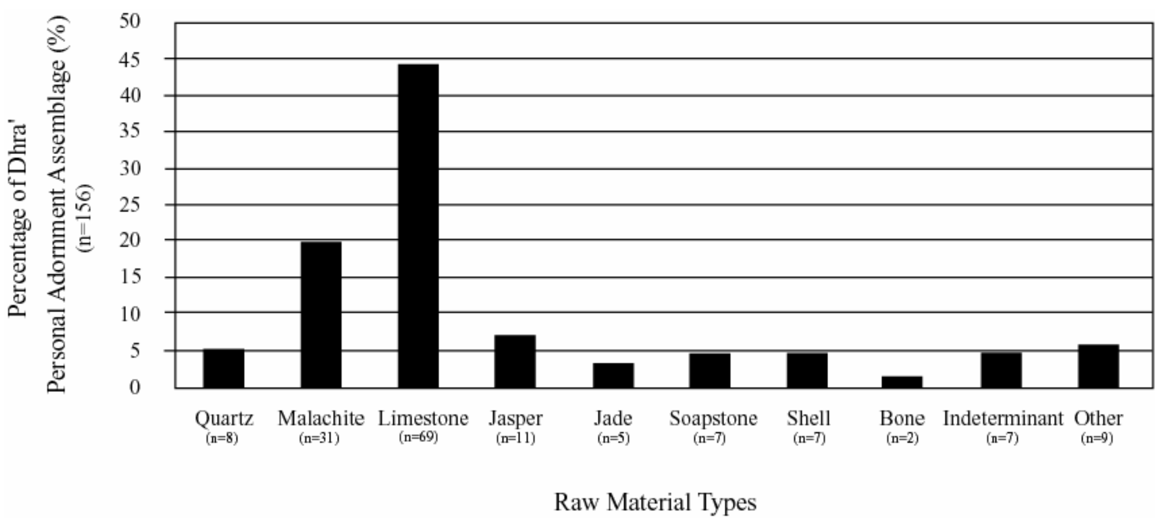

Figure 4.24 - Dhra' Personal Adornment Specimens Not Including Raw Materials by Raw Material.

The recording problems in the PPNA can be remedied by the adoption of this data collection strategy and personal adornment typology. The publication problems, however, are not solved by the recording improvements. Of course, the more thorough a publication or report can be in its data presentation the better it is for presenting data. Space constraints, however, often limit the amount of detail archaeologists can devote towards raw data presentation. Given these limitations, there are still standards that must be established and adopted in order to guarantee that archaeological data are made available to other researchers. Therefore, I propose a simple summary data table format (similar to lithic data tables already present in PPNA Near Eastern archaeological literature) that easily conveys data of personal adornment items at a site (Table 4.1). This table provides the minimum amount of information about a site's personal adornment assemblage for intersite and regional comparisons of adornment assemblages.

Table 4.1 – Summary Data Table of Dhra' Personal Adornment Items.

		Counts	Percentage
PPNA Bead Typology	Type 1	29	9.6
	Type 2	23	7.6
	Type 3	2	0.7
	Type 4	11	3.7
	Type 5	63	20.9
	Type 6	3	1.0
	Type 7	5	1.7
	Type 8	3	1.0
	Type 9	142	47.2
	Type 10	20	6.6
		301	100.0
Raw Material Types	Quartz	21	7.0
	Malachite	155	51.5
	Limestone	72	23.9
	Jaspar	11	3.7
	Jade	5	1.7
	Soapstone	9	3.0
	Shell	7	2.3
	Bone	2	0.7
	Indeterminant	9	3.0
	Other	10	3.3
		301	100.0
Production Stages	Finished	112	37.2
	Partially Drilled	10	3.3
	Blank	34	11.3
	Raw Material	145	48.2
		301	100.0

CHAPTER 5

EXPERIMENTAL REPLICATION OF BEAD PRODUCTION

Assessing signaling power of personal adornment items in the PPNA requires that we understand the costs of production of these items. This research is aimed at experimentally verifying aspects of the *chaîne opératoire* of bead production, in particular drilling technologies, to provide data to evaluate production costs such as amount of time, skill level, and tools required to manufacture these items. These data will prove useful when evaluations of signaling power of personal adornment items during the PPNA in the Southern Levant are conducted.

Experimental Archaeology

In order to address issues of bead production technology, specifically drilling technology, I employ experimental laboratory research to recreate past technologies. Experimental archaeology is a method of testing our ideas about technologies in the past through experiments (Shimada 2005). Experiments can be used by archaeologists to "transform a belief about the past into an inference" (Ascher 1961:795). Experimental archaeology is a technique that has been employed by archaeologists for over a century in an attempt to elucidate the function, usage, and manufacture of ancient tools (Coles 1979; Trigger 1989; Shimada 2005). As the emphasis of archaeological research shifted away from culture histories and towards scientific methods that highlight objectivity in the early 1960s, experimental archaeology changed from a supplemental data exploration technique into a method that could produce useful and detailed data for study by archaeologists (i.e. – Ascher 1961; Saraydar and Shimada 1973). Since the 1960s, experimental methods have become mainstream in several areas of archaeology, and are seen along with ethnoarchaeological research as a major source of data and interpretation for researchers (Reid et al. 1975; Schiffer 1976; Schiffer et al. 1994).

In order for experiments to have proper interpretive benefit to archaeologists, Ascher (1961) suggests three guidelines to govern how experiments are constructed and utilized in a study. First, the materials being used in the experiments must be known to have been available, or could have been available, during the time period in question. Secondly, the technique employed must have been available to people in the past. Finally, the experiment must take into account the potential and limitations of the physical characteristics of the materials being employed (Aschner 1961; Shimada 2005). Experiments that attempt to replicate past technologies must control as many variables as possible to focus on the variable(s) of primary interest for the researchers. By eliminating outside sources of variability, an accurate interpretation of technological replication can take place. To this end, hypotheses must be developed prior to designing an experiment to allow the researcher to test the appropriate variables. With a properly developed experimental design, data that evaluates the hypotheses can be produced.

Experimental archaeology attempts to test, evaluate, and explicate method, technique, assumptions, hypotheses, and theories (Ingersoll and MacDonald 1977). It must be pointed out, however, that "replicative experiments do not 'demonstrate the reality' of anything; experiments demonstrate only that a given technique could have been used in the past – that it was *not impossible*" (Thomas 1999:181). While this is the case, combined with a thorough understanding of the archaeological record and proper theoretical considerations, archaeologists can begin to test and refute at least some of the competing plausible hypotheses or models on an issue (Shimada 2005). It is with an understanding of the limitations as well as the immense potential to test and evaluate hypotheses that this experimental study was conducted.

Chaîne Opératoire of Bead Production

Beads go through a series of production stages before they are finally put to use as decorative items. By examining the *chaîne opératoire* of bead production, archaeologists may be able to discover important production patterning within the archaeological record (Figure 5.1). We can conceptualize this as a sequence. First, raw materials are procured by mining local materials or trading for non-local materials. The raw material is usually prepared into a long bead blank through knapping and grinding. Segmentation using a flint or limestone blade or abrasive twine creates an incision on the blank which can then be snapped in two. The beads are then drilled, usually biconically, to create a perforation that allows the bead to be held on a string or other similar object. The final stage of production includes polishing the bead, which makes it ready for use, though polishing can occur at any stage in the production sequence. Beads that do not require segmentation are ground into a blank, and then drilled.

This study is concerned with the technology and materials associated with drilling the beads. Drilling is poorly understood and holds the potential to provide insight into PPNA technology and production intensity, which has ramifications for ritual, economic, and social lifeways. Determining production costs of drilling, figuring out what types of materials were used to perforate the beads, and establishing what types of techniques were employed for drilling are important unexplored technological topics.

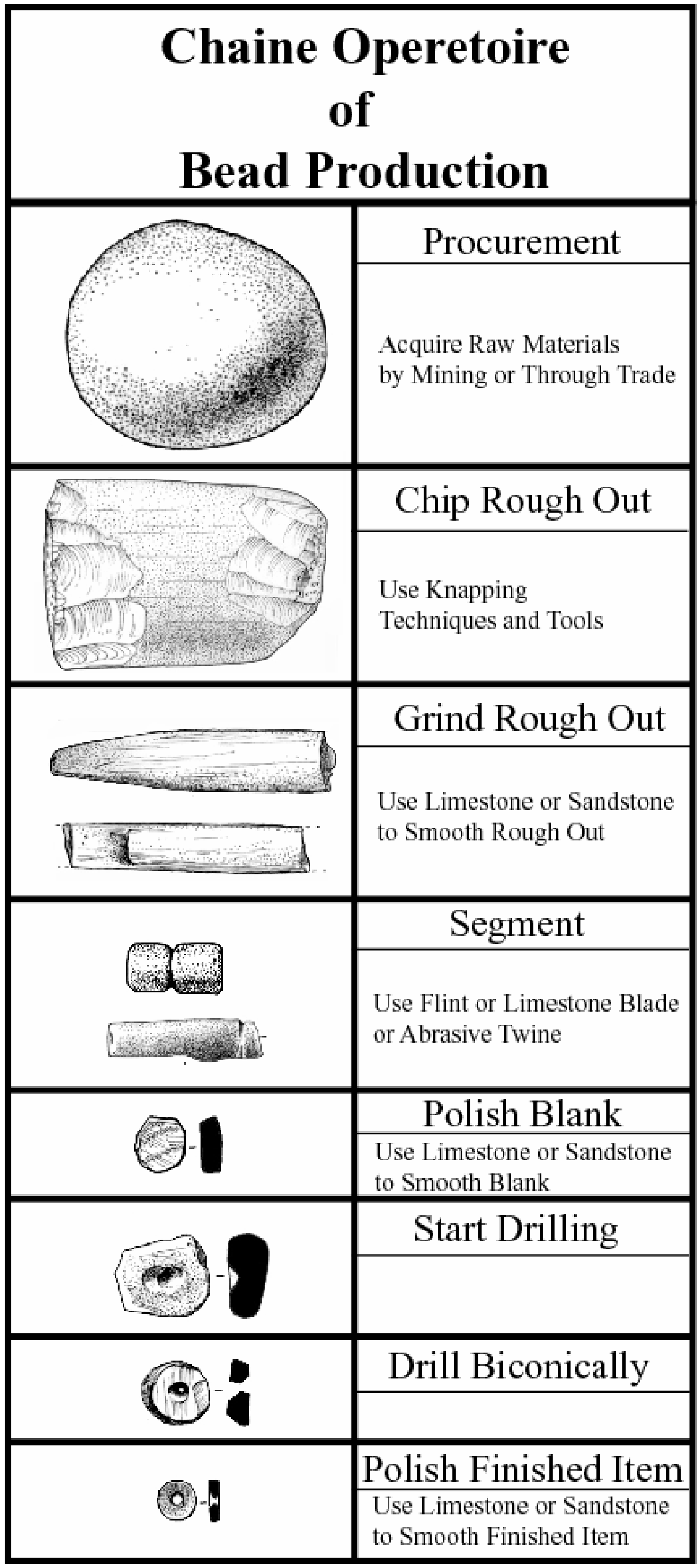

Figure 5.1 – Chaîne Opératoire of PPNA Stone Bead Production

Stone Tool Hypothesis

For many years, Near Eastern archaeologists assumed explicit functional attributes of stone tools based on their morphological characteristics. Due to their morphology, for example, el-Khiam points have been traditionally classified as projectile points (e.g. - Bar-Yosef and Gopher 1997). While some el-Khiam points were undoubtedly used as projectile technology, the abundance of these points in the residential context of Dhra', Jordan, suggests that these points had an additional function. Recently, Smith (2005) has employed microwear studies to demonstrate that these points were also used as perforators. Based on microwear patterns it has been argued that these points were being used to drill beads (Goodale and Smith 2001; Smith 2005). Building on this research, I conducted a series of controlled experiments to test whether they were could have been used to drill beads.

There are numerous types of pointed tools found at PPNA sites such as awls and borers, but paradoxically it is the hafted points that previous microwear studies have suggested were possibly associated with bead production (Goodale and Smith 2001; Smith 2005). In PPNA assemblages, there are three main types of projectile point technology, el-Khiam points, Salibiya points, and Jordan Valley points (Figure 5.2). Microwear evidence has suggested that el-Khiam points were used as drills, which makes this type the most important in determining how the beads at Dhra' were manufactured.

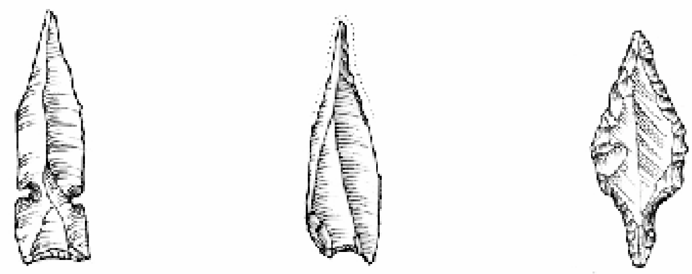

Figure 5.2 – Point Styles Found at PPNA Sites.

The el-Khiam point is the most abundant point type found at PPNA sites in the Southern Levant (Nadel 1997), and this is also the case at Dhra'. In fact, the projectile point and awl/borer assemblage at Dhra' is one of the largest that has been recovered from any PPNA site (Finlayson et al. 2003). El-Khiam points are defined as unifacial points made on blades or bladelets that have side notches that may be bifacially worked, and basal retouch (termed couze retouch) may be present. The point is formed by pressure-flaking the blade edge creating steep retouch rather than invasive flakes, and can be found on 1) the ventral side of the flake on both margins, 2) the dorsal side of the flake on both margins, or 3) on the ventral side on one margin and on the dorsal side on the other margin. Bifacial retouch on the tip and blade is exceedingly rare and the retouch on the tip does not necessarily extend down the entire margin, as there are usually areas without retouch along the margins. The notching and basal retouch suggests that the points were hafted. At Dhra', over 800 el-Khiam points have been identified and recorded. In this study, all of the complete and a non-random sample of the broken el-Khiam points from the 2004 field season were analyzed. These points come from numerous locations and contexts within the site and likely represent much of the variability in manufacture, use, and discard within the site.

I will examine five lines of evidence to evaluate the hypothesis that stone tools, namely point technology, were used to drill groundstone beads at Dhra': 1) a qualitative estimate of effectiveness in the task, 2) morphological characteristics of perforations, 3) location of retouch on the stone tool, 4) breakage patterns of points, and 5) an index of point sharpness. The results of these experiments will either support or refute the possibility that el-Khiam points were the bead drilling implement of choice for PPNA peoples.

For this experiment I employed an experimentally produced el-Khiam point assemblage. First, blades were removed from a flint nodule using a soft hammer indentor made of antler. This nodule was taken from the same flint source, located 30 meters off site, used by the prehistoric occupants of Dhra'. The blades that had a single dorsal arris, that were twice as long as they are wide, and that had margins roughly parallel to each other were selected for making el-Khiam points. An antler tine and a wooden anvil were then used to shape the blades into thirteen notched points. Finally, the el-Khiam points were hafted to shafts of willow and oceanspray wood using a mastic and binding. These items replicated past technologies and binding materials available to PPNA peoples while creating a strong haft element. Twelve of the specimens were used in a drilling motion, with three points drilling each of the following materials; limestone, malachite, willow, and alder. The points were used to bore holes into the materials using both a hand drill and a bow drill. The use-life of the points ended when either the point broke or the point became useless for the task of drilling. The points were subsequently photographed and data was recorded for several macroscopic use-wear attributes. The data were analyzed using several statistical techniques as well as developing a new index for measuring point sharpness.

The first assessment of point function and contact material was a qualitative measure of drilling effectiveness. It was hypothesized that if these points were being used to drill beads, they would be effective at drilling through limestone and malachite. If the points did not effectively drill holes in stone, then this would make it unlikely that PPNA peoples used el-Khiam points to drill beads. Estimating the effectiveness of el-Khiam points in performing perforating tasks, while important, is somewhat of a qualitative venture. Therefore, additional quantitative measures were taken into account to compare the assemblage of experimentally produced points to a non-random sample of points from the archaeological assemblage at Dhra'.

The second assessment measure compares the morphological characteristics of the perforations created by the el-Khiam points to the perforations in the beads at Dhra'. It is hypothesized that morphological similarity between the two samples reflects similar production technologies. Morphological variability, however, would indicate that the two assemblages were not produced by the same manufacturing tools and techniques. The ratio of perforation depth to perforation width is a simple yet potentially telling characteristic of the perforations and therefore was utilized in this study.

The next assessment measure examines the location of retouch. Four areas on the tips were examined (dorsal dexter, dorsal sinister, ventral dexter, ventral sinister) for evidence of flake removals (Figure 5.3-a). Manufacturing retouch on the el-Khiam points is almost universally isolated to one surface (either dorsal or ventral) per margin. When there are flake scars on one or both of the two remaining tip locations, I assume that these flake removals were created by use rather than production. In an attempt to quantify use related wear, I recorded the presence or absence of use related flake removals for the experimental and archaeological collections.

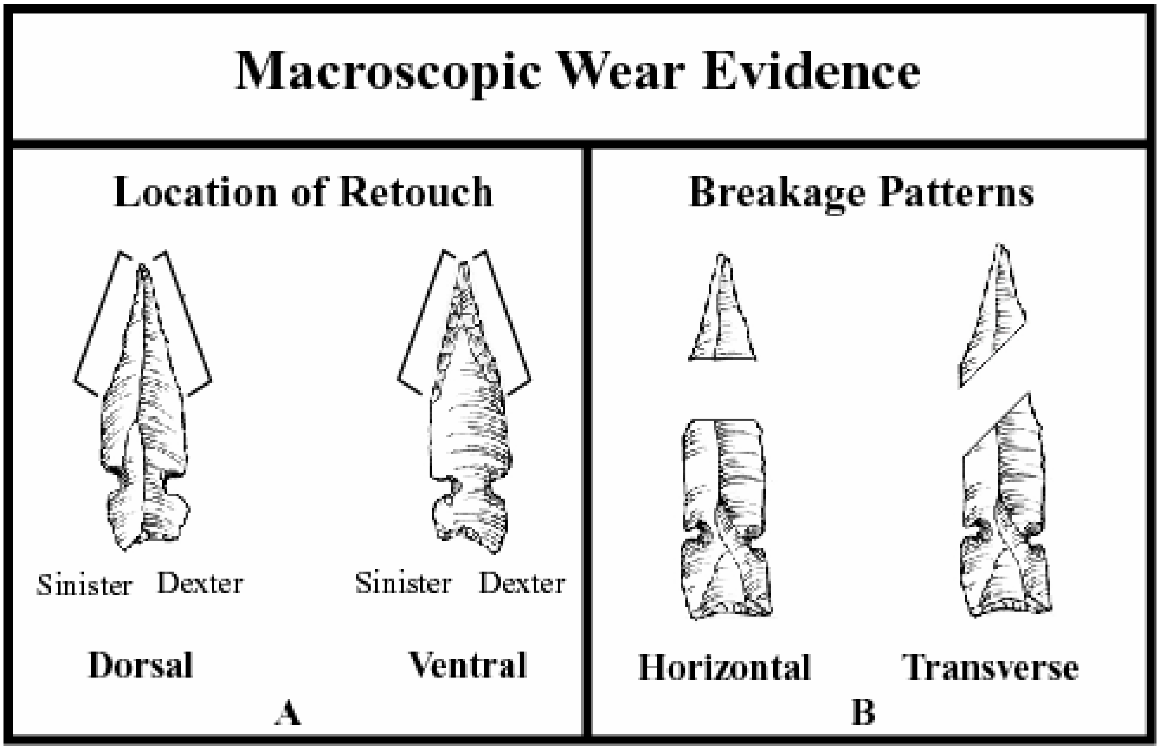

Figure 5.3 – Macroscopic Use-Wear Evidence on el-Khiam Points.

Breakage patterns are also important for determining function of the points. Variation in perforating actions, properties of the contact material, and the application of force can cause the points to break in different ways. In this study, I look at two types of breakage patterns, horizontal and transverse (Figure 5.3-b), in both the experimental and archaeological collections, to see if the breakage patterns with experimental el-Khiam points used to drill stone replicate those from the archaeological collection.

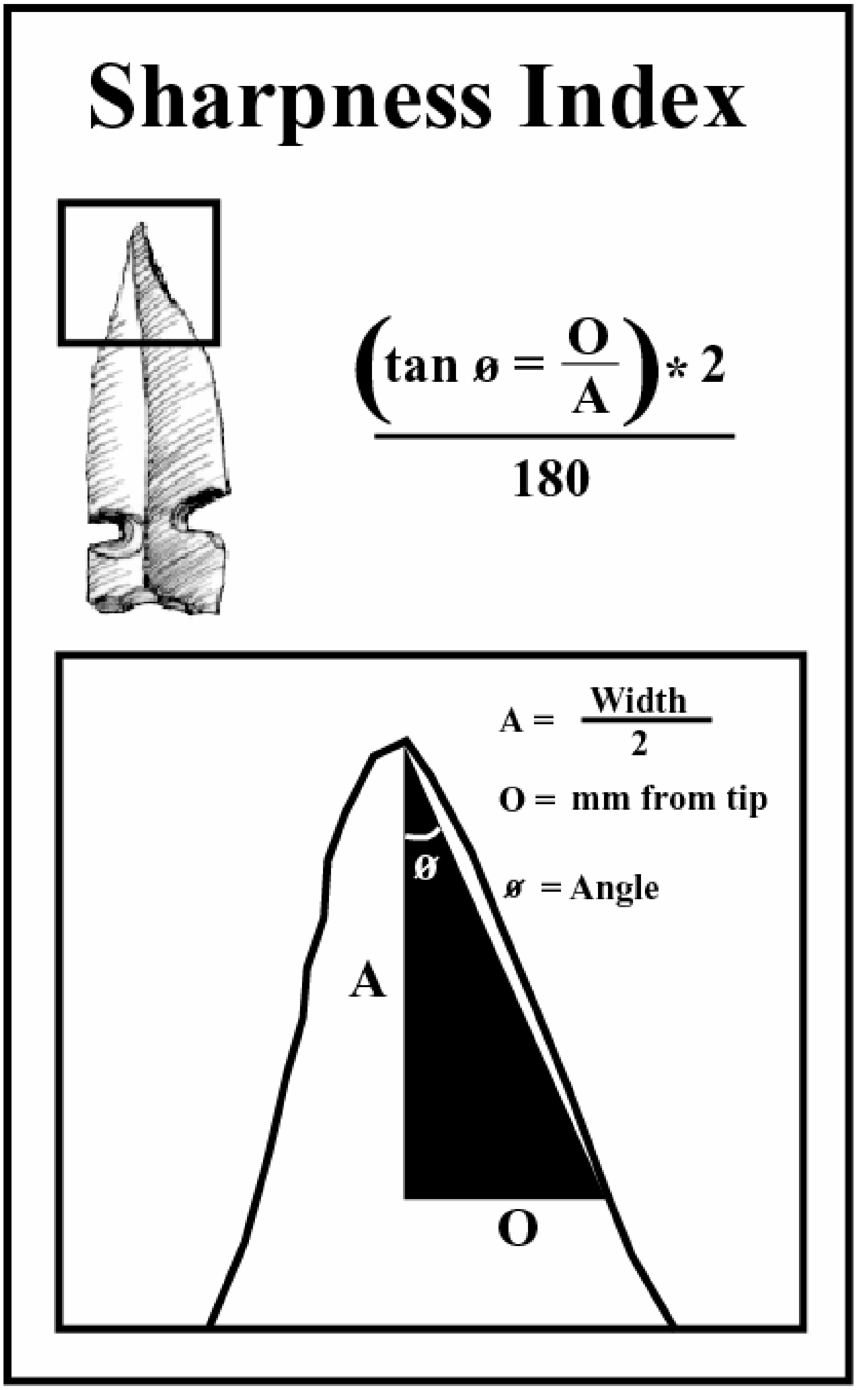

Figure 5.4 – The Sharpness Index.

The "sharpness index" (Figure 5.4), addresses concerns raised by archaeologists about the accuracy of exterior edge angle measurements (c.f. - Andrefsky 2005) and was the final assessment measure. In order to avoid the possible pitfalls of measuring the exterior edge angle, this measure calculates the interior edge angle to determine the sharpness of a point. The interior edge angle is calculated at various locations on the points. First, intervals of 1mm are taken from the tip of the point to 5mm from the tip. At each millimeter, the width of the specimen is taken using a pair of digital calipers. This process is repeated at 1mm, 2mm, 3mm, 4mm, and 5mm. In order to calculate the interior edge angle, the width at any given distance from the tip is divided in half. The given distance from the tip and one half of the width make up two sides of a right triangle, and using the Pythagorean Theorem, one half of the interior angle can be calculated using this equation:

tan θ = Opposite side (one half of the width) / Adjacent side (distance from the tip)

This angle measure is doubled in order to determine the entire interior point angle (see Andrefsky 1986 for a similar calculation for flake curvature). In order to standardize the index from a range of 0 to 1, the interior angle is divided by 180 (the maximum potential angle of the tip). Points that score high on the sharpness index will have the most acute interior angles, while the points that score the lowest on the sharpness index will have interior angles that are high, with the maximum value of 180 degrees. The expectation is that the sharper the point, the more acute the interior angle, and conversely, the duller the point, the more obtuse the interior angle. The sharpness index, combined with efficiency, retouch location, and breakage patterns provide the basis for evaluating the contact material of perforating el-Khiam points. These five lines of evidence will provide the basis for evaluating the bead drilling hypothesis for PPNA beads at Dhra'.

Bone Tool Hypothesis

Bone tools have been used by societies in archaeological (e.g. – Ganges in Northern India during the Neolithic) (Sinha 1994) and ethnographic (e.g. – Coastal Yuki in Northwest North America) (Gifford 1887) contexts to drill beads. While discussing the drilling of beads and pendants at the site of Chirand in Northern India, Sinha suggested bone tools were used to drill the stone beads made of semiprecious stones in lieu of stone drills:

> Most likely at Chirand, bone drill was used for the purpose instead of stone. One cannot say with certainty, whether the drilling work was carried out by the wrist movement or by some type of rotary-drill. The bone drill was used in Sind during the 3rd millenium B.C. apart from the stone drills. It is very likely that the Neolithic craftsmen also used the bone drill for the purpose. Probably, the bead to be perforated, was affixed in the hallow cervices on the wooden frame, and after preparing drilling surfaces, the bead was perforated. At the time of drilling, sand powder was used as an abrasive to cut away the stone and water was used as the lubricant. The drill was turned to and fro. After drilling the bead mid-way, the bead was reversed. (Sinha 1994:110).

It is possible that the beads at Dhra' and other PPNA sites were drilled in a similar manner.

Bone tools alone are likely not strong enough, or possess enough friction to drill through stone. It is the use of sand and water that makes these tools effective drills. Quartz, the most common constituent of sand, is one of the hardest materials on earth. The quartz crystals are trapped between the bone tool and the stone bead and chew away at the stone, forming the perforation. Prior to the invention of metal drill bits, bone and sand was likely used along with lithic tools to drill objects of personal adornment. Ethnographic and archeological evidence that bone drills can be used to drill personal adornment items makes it a viable hypothesis to test with the Dhra' assemblage.

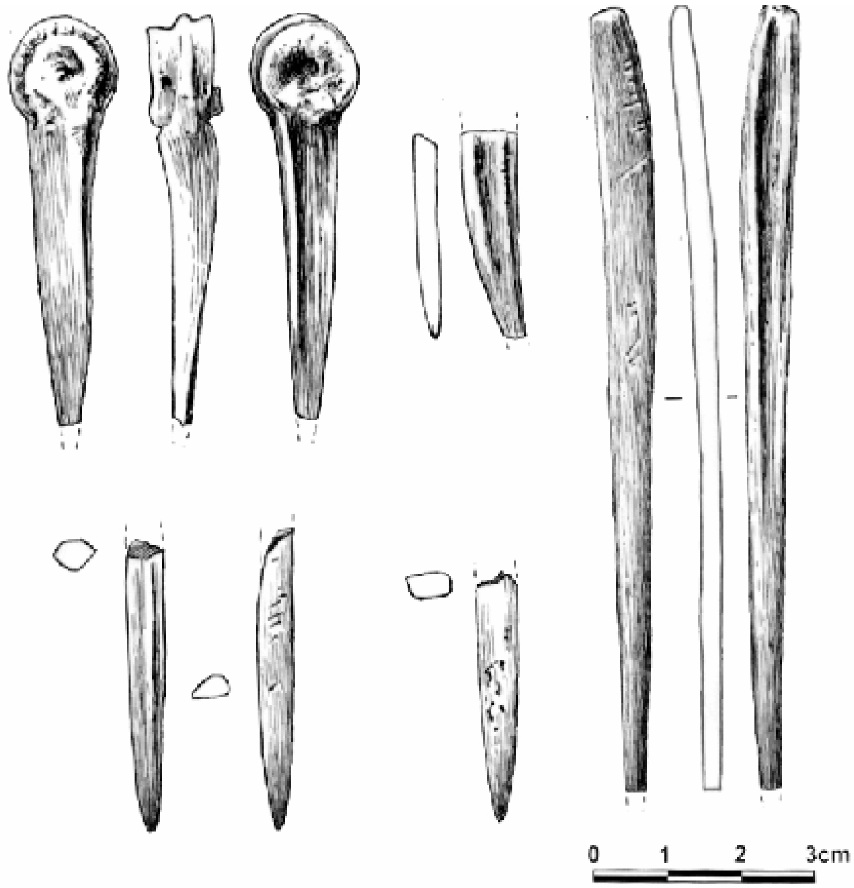

Figure 5.5 - Examples of Worked Bone Points Found at Dhra'.

The Dhra' worked bone assemblage contains numerous pointed tools that could have been used as drill bits (Figure 5.5). While we do know that these tools exist, several limitations of the Dhra' faunal assemblage currently make more specific analyses of the points and assessments of quantities of points in the assemblage very difficult. The faunal assemblage from Dhra' has not yet been completely or systematically analyzed. As a result, the quantity of bone points is unknown. Additionally, the bone points were inaccessible for this study, so specific use-wear patterns of the specimens at either the macroscopic or microscopic level were unattainable for comparison with experimentally replicated tools. Finally, the preservation of bone tools at a 10,000 year old open air site is not ideal, and many of the tools may have not survived the taphonomic processes since the PPNA. These factors hinder the level of confidence that can be placed in experimental replicative technologies, though future intensive study of the faunal assemblage at Dhra' will provide more evidence to either confirm or disconfirm the hypothesis that bone points were used to drill stone beads at Dhra'.

Acknowledging the limitations of data for the bone tool hypothesis, experimental replication can still support or contradict the suggestion that the beads at Dhra' were drilled with bone drills, sand, and water. As with the stone tool hypothesis, a sample of bone drills had to be manufactured. Many of the bone points found at Dhra' were made with gazelle long bones, metacarpals, and metatarsals. In lieu of gazelle bones, a series of bone points were made from the cortical bone of bovid long bones. Using a lithic chopper tool, the long bone was cracked and the marrow and other organic material removed from the bone. The bone was further splintered using the same chopper to make several bone points roughly 10 cm in length and less than 1 cm in diameter. Using a flint knife, the tip of the bone splinter was shaved down to a point. The bone points were then hafted to handles of willow and oceanspray in a manner similar to the hafting of the stone points.

Once a number of bone points had been fashioned, they were used to drill limestone using a slurry of water and sand. The drilling took place using a bow drill and a hand drill, with the hand drill being utilized more often as it was easier to manipulate the sand while using the hand drill action. During drilling events the time and amount of drilling was recorded as well as noting several other aspects of drilling such as efficiency, the strength of the tool, and attributes of the perforations.

In order to evaluate the potential validity of this hypothesis, several lines of evidence are used. It is expected that if bone points with sand and water were used to drill beads at Dhra', then the experimental bone points should be able to perforate stone. This qualitative assessment of effectiveness is also combined with other qualitative measurements. An important factor of production intensity is the consideration of how long it would take to perforate the beads at Dhra' using this technology. Additionally, attributes of the perforations created experimentally should mirror the perforation attributes found in the Dhra' assemblage. As previously explained, the limitations of the data on the archaeological bone points inhibit a comparison of the experimental bits with the archaeological bits. Unfortunately, several issues in this hypothesis are unable to be addressed at this time, but the experimental evaluation that takes place here will help PPNA researchers begin to consider the possible technologies employed by people in the past to make personal adornment items.

Stone Tool Results

From the experiments, the most obvious qualitative assessment was the efficiency of the points. The el-Khiam points were able to bore holes in the willow, alder, and limestone with relative ease, while the malachite proved to be a more formidable material, it was still possible to bore a hole. To create a perforation that ranges from 5 to 15 mm in depth takes approximately 60 seconds for willow and alder, less than 5 minutes for limestone, and likely more than one hour to create a perforation that deep in malachite. These results mirror results by Smith (2005) that suggested that el-Khiam points were effective drilling implements.

The perforations on the archaeological specimens are too deep and narrow for the flint points to have been used to drill them (Figure 5.6). The most telling evidence is the ratio of perforation depth to perforation width. To explore this further we compared these results to the width and depth of perforations in beads from Dhra'. In the archaeological sample from Dhra', barrel-elliptical beads had a depth to width ratio of 9.32:3.79 (mm), while the experimental perforations in hard material had a reversed depth to width ratio of 6.80:8.28 (mm).

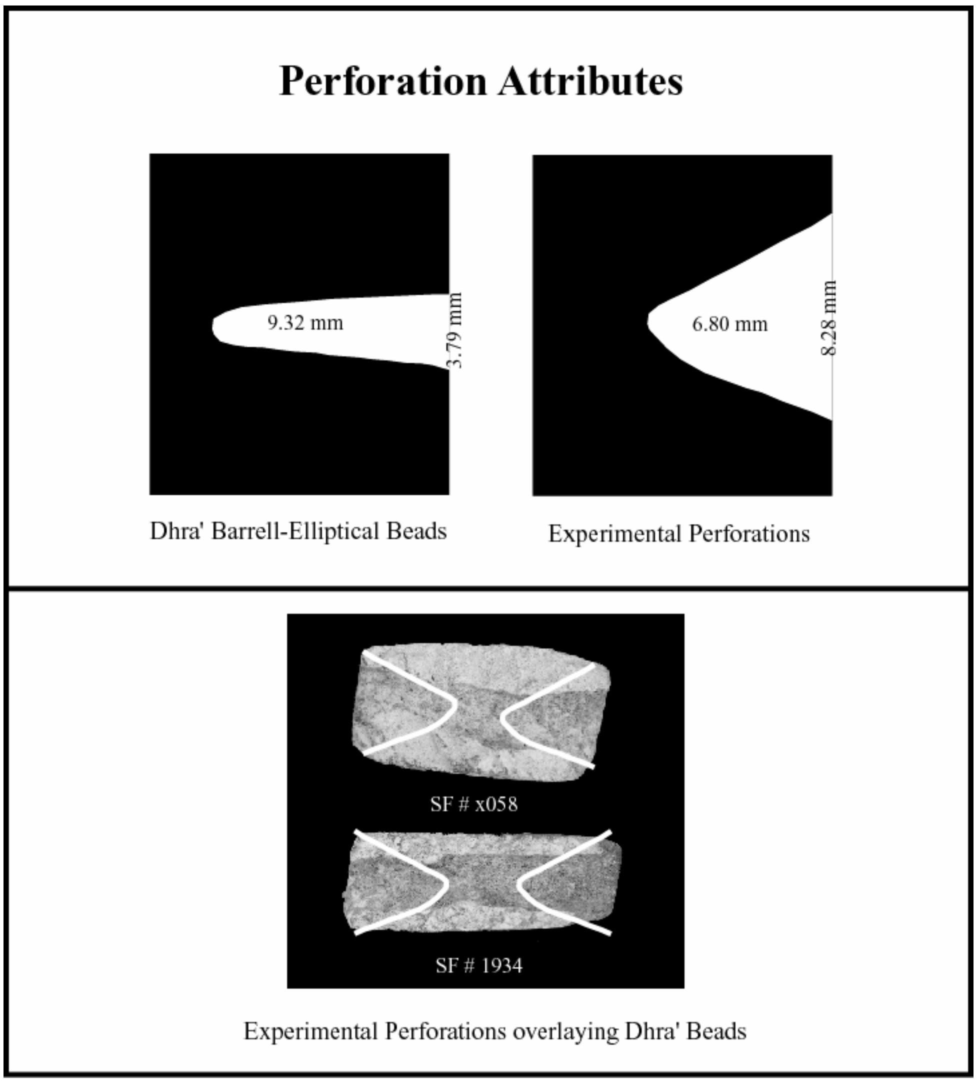

Figure 5.6 – Comparison of Experimental and Archaeological Perforations. The perforations created by stone drills are significantly different than the perforations found on beads at Dhra'.

The damage patterns on the el-Khiam points used to drill hard materials are clearly different than those found in the archaeological collection from Dhra' (Table 5.1). Experimental work shows that the Dhra' sample is different from the retouch patterns produced from drilling stone and wood. The points at Dhra' rarely have use-related flake removals while the hard material perforators have a high rate of use-related flake removals (Fisher's Exact $p<0.0001$). Such data patterning suggests that the Dhra' points were not being used to drill hard materials. The groundstone beads made primarily of malachite and limestone would have left much more severe use-wear on more surfaces near the tip than is found on the stone tools at Dhra'.

Table 5.1 – Comparison of Macroscopic Wear on the Experimental Stone Drills and the Dhra' Points.

	Use-Related Retouch		Breakage Pattern	
	Present	*Absent*	*Transverse*	*Horizontal*
Stone Drills	11	1	4	0
Dhra' Sample	3	39	5	50

Similarly, the experimentally produced breakage patterns indicate that the experimental points used to drill stone and wood fracture differently than the points found at Dhra' (Table 5.1). All four of the points that broke during drilling hard contact material had transverse fractures. This is significantly different than the Dhra' assemblage, where the breakage patterns of a random sample of 55 broken points were predominantly horizontal (Fisher's Exact $p=.0003$). Again, this evidence undermines the hypothesis that the archaeological points from Dhra' were used to drill stone beads.

Finally, the sharpness of the used tip is important for determining whether or not it was possible that the stone points at Dhra' were used to drill the beads. The wood and stone drilling points all had significantly lower sharpness index values at each 1mm

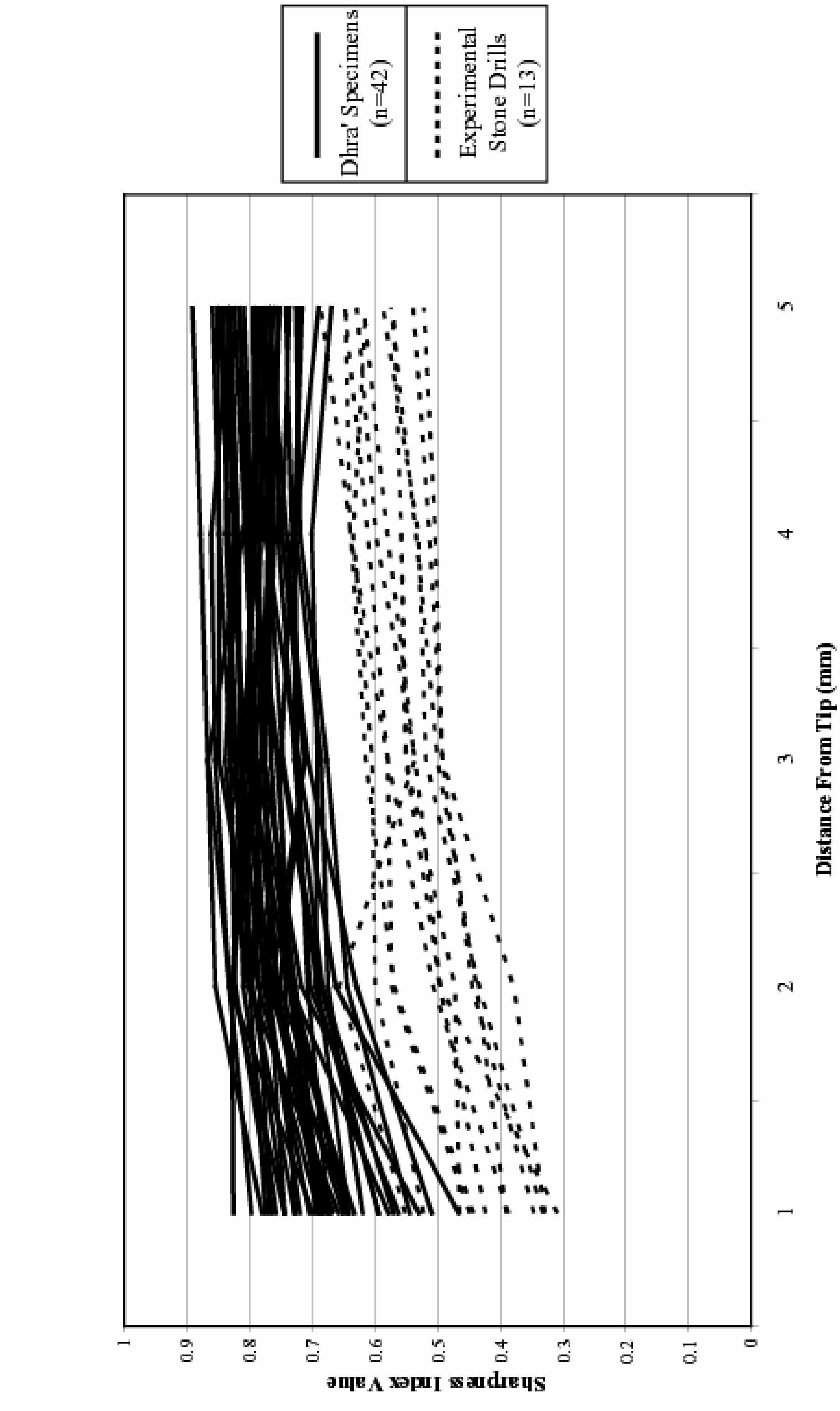

Figure 5.7 - Sharpness Index Results - Stone Drills vs. Dhra' Points. The stone drills cluster lower on the sharpness index than the Dhra' points, suggesting differences in use.

interval from the tip than the archaeological specimens (Figure 5.7). As a whole, the points used to drill hard materials are distinct in their distribution from the points at Dhra'. The measure of sharpness using the interior angle did show that the archaeological samples were much sharper when they were discarded than the points used as drills. This is important, as people were probably not inclined to resharpen their points immediately prior to discarding them. The damage sustained by drilling the two types of stone and two types of wood were visibly, and quantifiably, more severe than the use damage seen on the archaeological specimens.

Bone Tool Results

Experimental research demonstrated that the bone points were effective implements for drilling stone. The combination of sand and water provided enough abrasive material around the tip of the bone point for it to drill into limestone. Drilling the stone with the bone was not incredibly difficult to perform, but it did require a large amount of time. For each millimeter drilled into limestone by the bone point, almost one hour of drilling was required. It should be noted that as the perforations became deeper, the drilling time was decreased as more sand could fit into the perforation. This increase in speed, however, was not very substantial and drilling of the stone beads still required a significant investment of time. The slow pace of perforation, however, made it easier to maintain a more accurate and symmetrical perforation. These results suggest that bead manufacturing with bone points is an incredible investment of time and energy. Kenoyer et al. (1991) note that making stone beads in ethnographic contexts can take many weeks, and the long amount of time needed to drill stone in these experiments suggest that a similar time investment was likely for PPNA peoples.

The perforations made by the bone tools were more similar to the stone beads at Dhra' than the perforations created by the stone drills. The ratio of depth to width of the experimentally produced perforations (2:1) closely reflects the ratio of depth to width of perforations found on the Type 5 beads at Dhra' (2.5:1).

Discussion of Bead Production Technologies

The results of the experimental replication do not support the hypothesis that stone points were used to drill the beads at Dhra' but the results did show that the beads could have been drilled with bone points. The el-Khiam points that were alleged to have drilled stone beads likely had an alternate function and other experimental work has shown that they may have been used to perforate soft materials such as leather (Quinn et al. nd). While the bone tool hypothesis is plausible, the current limitations of the archaeological faunal data preclude me from stating that the bone points were definitely used to drill the beads at Dhra'. Further research into the faunal assemblage including a detailed study of the bone points both macroscopically and microscopically, more experimental replication of drilling technology, and microscopic comparisons of the interior of perforations in the archaeological sample to perforations produced through replication will provide more insight into the topic of bead production.

These results allow us to revisit the *chaîne opératoire* of bead production and address the gap in understanding of drilling technology. We now know that stone points were not used to drill the beads. It is also evident that bone points may have been used and the fact that these have been used in other societies both past and present suggests that this is a likely technique employed by PPNA peoples.

It is important to note the cost of production when stone beads are perforated using bone tools, sand, and water. The significant amount of time required to drill beads would have barred many people from drilling beads without making conscious decisions to allocate time towards the production of beads. The costly nature of bead production plays an important role in addressing the signaling power and economic value of these items as well as craft specialization in the Southern Levant during the PPNA. These issues, among others, are ripe with information about past social, economic, and ritual lifeways and are important avenues of exploration of the past for not only researchers interested in personal adornment items, but for Near Eastern archaeologists as a whole.

CHAPTER 6

STRUCTURE AND INTENSITY OF PPNA BEAD PRODUCTION

The cost of production and visibility of manufacture of artifacts are affected by the structure and intensity of craft production. Systems of craft specialization often dictate who can participate in manufacturing certain items. As a result, explorations into signaling power of items can gain many insights into the variables associated with reproductive fitness by looking at the structure and intensity of craft production. Specialization occurs in nearly any society where divisions of labor (based on age, sex, individuals, kin groups, lineages, etc.) determine which people can engage in certain activities. As such, it is not a question of *if* specialization occurred in the production of personal adornment items at PPNA sites, but rather *what* characteristics of personal adornment manufacture determined the type of specialization that governed this technology. In this section, I explore the structure (individual specialization vs. community specialization) and intensity (high vs. low) of the production of personal adornment items at Dhra' to not only address a common issue in personal adornment research (specialization), but also to explore the costs and visibility of production of beads during the PPNA in the Southern Levant.

Defining Craft Specialization

Prior to the early 1990s, craft specialization was often seen as a unilineal evolutionary development, from small-scale household production to larger-scale factory manufacture (e.g., Childe 1946, Santley et al. 1989). These perspectives often omitted, or underplayed the role of, craft specialization in cultures with little status differentiation, with some notable exceptions including the work of Clark and Parry (1990) and Brumfiel and Earle (1987). Starting with Cathy Costin's (1991) multidimensional framework for craft specialization, however, many more archaeologists began examining the nuances of differential production of goods in varying contexts.

Any discussion about craft specialization requires us to define the term. Costin defines specialization as "a differentiated, regularized, permanent, and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least in part for their livelihood, and consumers depend on them for acquisition of goods they do not produce themselves" (Costin 1991:4). While in agreement with Costin about the role of specialization in socioeconomic relationships between producers and consumers, this definition does not address alternate forms of reciprocation beyond goods that support their "livelihood", such as status building, alliance formation, and exchange of ritual knowledge. Therefore, a more general definition of craft specialization is required. Miriam Stark and James Heidke (1998), from Costin's definition, provide an alternative definition which is more inclusive and therefore more apt for this study, referring to craft specialization as "systems in which households and communities," (I would also add individuals), "devote some portion of their productive efforts toward manufacture for exchange" (Stark and Heidke 1998:497). These production units work independently and are outside of the umbrella of elite control. An understanding of craft specialization based on these observed principles has proved useful in examining small-scale, nonmarket economies (Clark and Parry 1990; Kramer 1985; Stark 1991; Stark and Heidke 1998), and such a definition will work for bead production in the Early Neolithic Near East.

Craft Specialization: Structure and Intensity

It is important to note that this study is not aimed at addressing whether craft specialization is present during the PPNA. Craft specialization is a "continuous adaptive process" (Kenoyer et al. 1991:46), present in all societies as differential production based on available time, skill of the individual, and available resources (see Kenoyer et al. 1991 for a more detailed discussion). Therefore, the question is not whether there are craft specialists during the PPNA in the Southern Levant, but rather, what is the role of craft specialization in the social and economic organization of the past (Kenoyer et al. 1991).

In order to analyze the role of craft specialization during the PPNA, we must understand its structure. Towards this end, I divide craft specialization into two classes: individual and community specialization. Individual specialization is found in production systems where autonomous individuals or households are producing for unrestricted local consumption. Community specialization, on the other hand, is found in production systems where an aggregation of autonomous individuals or households produces for unrestricted regional consumption (Costin 1991; Stark 1974, 1991; Hodder 1981). Neither of these types of specialist production requires complex social systems or elite governance, and therefore fit within the social framework of the PPNA. By determining which of these structural frameworks of specialization the PPNA data fit, we can better understand social and economic complexity during the forager-farmer transition.

Another aspect of craft specialization that dictates the characteristics of specialist production is the intensity of production (Costin 1991). This measure of intensity considers efficiency of production, risk reduction, and time available for production. As evidenced by the experimental replication of bead production technologies in this study, bead manufacturing required a large amount of work and time investment. Other authors have suggested that manufacturing individual stone beads could take days to weeks and my experiments echo these observations (Kenoyer et al. 1991; Wright and Garrard 2003). Risk reduction is an area where bead manufacturing may have had an important function. Several authors have considered risk reduction as an important factor in sharing and exchange systems, primarily due to unpredictable food sources (e.g. Bliege Bird et al. 2002; Hegmon 1989). Others have looked beyond mere food exchange to reciprocation in other currencies such as labor, social support, ritual and health exchange, finding that the risk reduction that comes with the trade of specially produced or procured items has many payoffs (Hill and Kaplan 1993; Kaplan and Hill 1985; Wiessner 2002). This type of exchange is often referred to by neo-Darwinian anthropologists as reciprocal altruism (Alexander 1979, 1987; Bliege Bird et al. 2002; Cosmides and Tooby 1992; Trivers 1971). Exchange in such systems where reciprocity is delayed can create socioeconomic relationships where the return good or service is negotiatable, allowing for insurance against unpredictable losses or situations (Cashdan 1985; Sahlins 1972; Smith and Boyd 1990; Wiessner 1982, 2002; Winterhalder 1986, 1990). As a non-utilitarian item, finished beads may have been traded throughout the Southern Levant to establish social networks and alliances. Alliance formation may have reduced the risk of bad crop yields during the transition from foraging to farming, produced access to ritual knowledge perhaps in the form of a shaman, and gained partners to turn to in other times of stress. Also factoring into the intensity of craft specialization, besides efficiency of production and risk reduction, is scheduling, or the time available for craft production. Obviously, if engaging in food procurement leaves no time for craft production, the intensity of craft production will be low. However, if food procurement and other necessities are taken care of, then individuals will have the opportunity to differentially produce other goods. During the PPNA, there appears to be only low intensity craft production. There is no strong evidence for intensive individual craft production. When combined, efficiency, risk reduction, and scheduling determine the intensity of craft production, and looking at the bead assemblages may provide an estimate of the level of craft specialization present in the PPNA in the Southern Levant.

Evidence of Production Structure and Intensity

Several lines of evidence can be examined by archaeologists to identify the structure and intensity of specialist production. Two of these lines of evidence, indirect evidence of standardization and direct evidence of production loci and debris, are of primary concern in this study. Standardization, both in terms of bead types and raw materials being used to make those beads, can be measured in the archaeological record as evidence of craft specialization (Roux 2003). In addition to standardization in bead technology, discrete locations of differential bead production may be tied to specific individuals manufacturing beads. To this end, spatial patterning of bead production materials may illuminate activity areas associated with bead manufacture. If these expectations of individual craft specialization are not supported using the archaeological record, intersite assemblage comparisons may show community based craft production. By looking at the structure of craft specialization (individual vs. community) and the intensity of craft specialization (high vs. low) during the PPNA in the Southern Levant using the bead production assemblage at Dhra', we can gain important insight into the social and economic complexity of early farming villages.

For this analysis, a sample of the bead production data was utilized: the assemblages from the 2002 and 2004 excavation seasons. The excavations from 2002 and 2004 produced 170 personal adornment materials, including 58 finished beads, 7 partially drilled beads, 18 bead blanks, and 87 pieces and bags of raw material and debitage. These production data were grouped into three categories: finished beads; beads currently in production (a combination of blanks and partially drilled beads); and raw materials. In addition to production stage data, this analysis utilizes metric, provenience, and contextual data for each item. Using correspondence analysis (CA), a multivariate approach that reduces dimensionality within an assemblage to allow for patterning within the data to be visually represented in two-dimensional space (Baxter 1994; Bolviken et al. 1982; Duff 1996; Greenacre 1994; Shennan 2001), and canonical discriminant function analysis (CDA), a multivariate technique that simultaneously attempts to maximize the difference in two-dimensional space between groups and test the result of clustering into larger groups by examining each case's membership in the group in order to evaluate intuitive clusters (Bettinger 1979; Klecka 1975; Shennan 2001), I statistically evaluate the presence of production, use, and cache locales at Dhra'. The results of these analyses, when combined with assessments of production standardization, and regional production data, allow researchers to evaluate the structure and intensity of craft production at Near Eastern PPNA sites.

Assessment of the Structure and Intensity of PPNA Bead Production

Standardization Results

Evidence of standardization in bead production was not found in the Dhra' bead assemblage. First, an examination of the bead typology shows no internal consistency in bead metrics of finished beads for any bead types, as seen in the examples of Type 1 beads (length – t=9.657, d.f.=7, p<.001; width – t=17.622, d.f.=7, p<.001; height – t=26.367, d.f.=7, p<.001) and Type 5 beads (length – t=12.338, d.f.=16, p<.001; width – t=13.822, d.f.=15, p<.001; height – t=15.863; d.f.=15; p<.001). The lack of standardized bead types is interpreted as multiple individuals making beads instead of a single individual or small group of individuals monopolizing production. In addition to morphological attributes, the raw materials used to create different bead types are also highly variable. There is no statistically significant difference between Type 1 beads and Type 2 beads, the two most common bead types at Dhra', and the raw materials being selected to make into these beads, with any observable differences being weak (x^2=.338, d.f.=2, .90>p>.75, V=.108). For the purpose of analyzing the raw materials and bead types, it should be noted that the raw materials were aggregated to the categories of whitestone, greenstone, redstone, blackstone and other. While this aggregation lacks specificity of raw material types, such course grained analyses have been used extensively in the Near Eastern literature (e.g. – Gopher 1997; Wright and Garrard 2003). This form of data manipulation also removes null values and increases sample size, enhancing the validity of statistical approaches such as chi-squares. For an evaluation of activity patterns at Dhra', multivariate exploratory data analyses were conducted.

Correspondence Analysis Results

Correspondence analysis suggest that there are three different activity areas at Dhra' as represented by the bead assemblages in various contexts (Figure 6.1). Assemblages with large amounts of raw materials for bead production and low levels of other artifacts are interpreted as raw material cache locales. A second type of activity area is represented by large quantities of bead blanks and partially drilled beads. Assemblages with numerous beads still in the production stage may be areas where beads were being roughed out and drilled. General use and discard of beads occurs in the third activity contexts at the site as evidence by the high quantities of finished beads and dearth of items in production and raw materials.

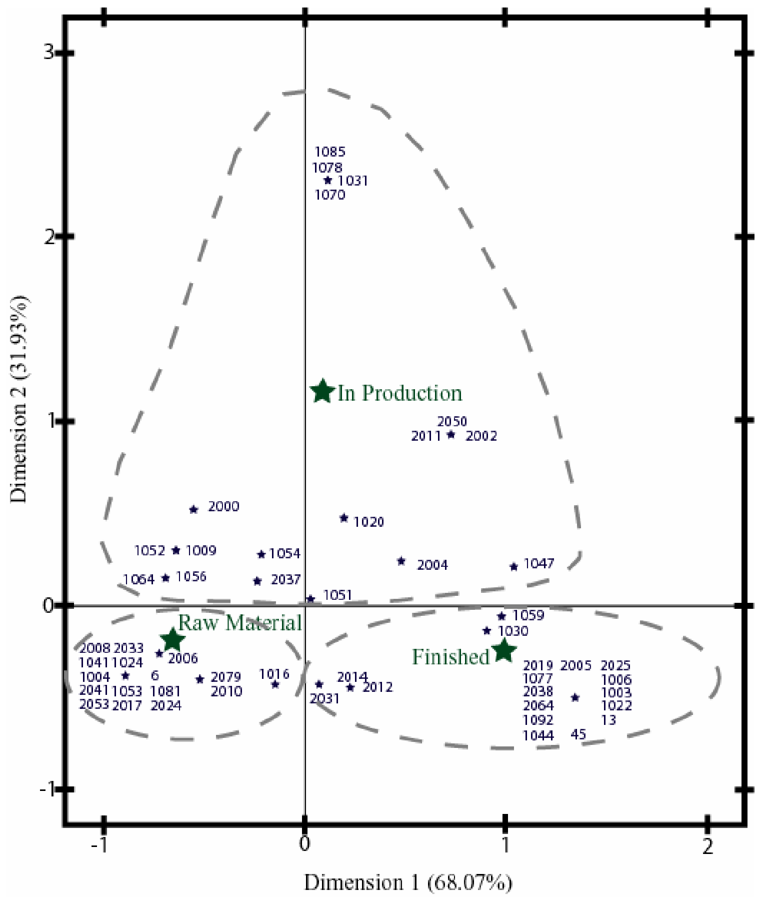

Figure 6.1 – Correspondence Analysis Results. Three general activity area clusters are identified (raw material caches, production areas, general use and discard areas).

As CA is a way of displaying patterning within the data, CDA was performed to determine whether the classifications derived from the CA plot are significant and accurate. CDA presupposes case membership to a group; therefore, each locus was grouped intuitively, based on the results of CA, into one of the following three classifications: bead raw material cache areas, bead production areas, and daily use activity areas. Of the original division of contexts into three clusters based on the CA representation of their assemblages, 92.3% of the cases were reassigned to their original cluster using CDA (Table 6.1). This high reclassification success rate lends statistical credence to the division of the Dhra' assemblage into three activity related clusters; raw material caches, blank rough out and drilling areas, and loci where finished beads were used and discarded or lost.

Table 6.1 – Canonical Discriminant Function Analysis Results.

			Predicted Group Membership			Total
			General Activity Areas	Production Areas	Raw Material Caches	
Original Classification	Counts	General Activity Areas	16	2	0	18
		Production Areas	0	17	1	18
		Raw Material Caches	0	1	15	16
	%	General Activity Areas	88.9	11.1	0	100
		Production Areas	0	94.4	5.6	100
		Raw Material Caches	0	6.3	93.8	100

Note: 92.3% of cases grouped by original classification were reclassified correctly

Interpreting CA and CDA Results

The results of the CA were then plotted on a site plan to show spatial relationships among loci with assemblages that represent different behavioral activities at Dhra'

(Figure 6.2). From these distribution maps, it is clear that the raw material caches, production areas, and use areas are not spatially delineated. Non-delineated activity areas suggest that bead production at Dhra' was not being performed by many people, not exclusively by one individual. It is not likely that all of the individuals living at Dhra' were manufacturing beads, as the time investment and skill required would place some limitations on people participating in bead production. However, the evidence from the distribution of bead production items does not correspond with the structure of individual specialization. The presence of community level specialization, where many individuals at Dhra' were manufacturing beads for both local consumption and regional exchange, is supported by the bead production data.

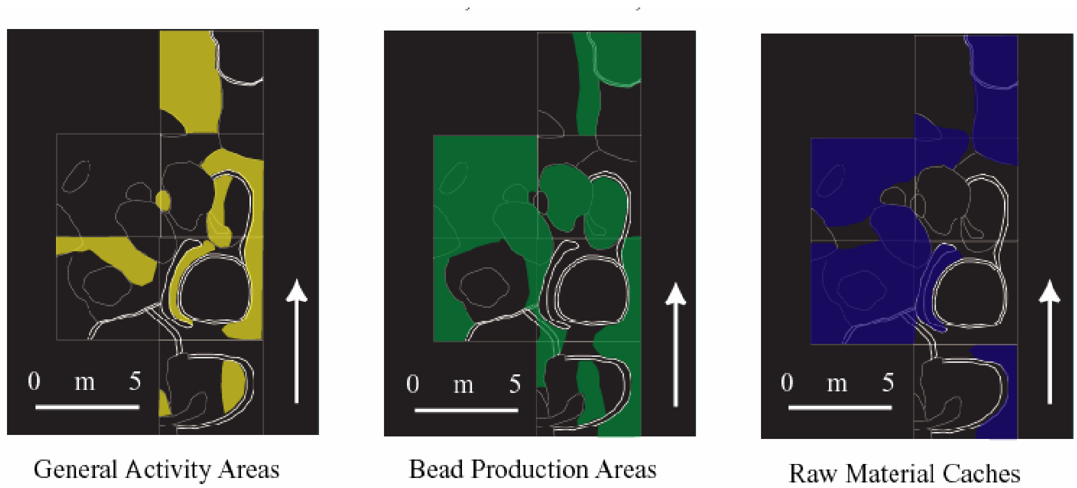

Figure 6.2 – Identification of Bead Activity Areas Based on the CA Results. Note the distribution of bead use, production, and cache locals. The high visibility of bead production is evident by the lack of spatially delineated production areas.

Regional Comparison Results

Consideration of the lack of standardized bead morphology and the spatial distribution of various activity areas at Dhra', makes it apparent that community level specialization was present at Dhra'. This structure of production can also be evaluated by comparing and contrasting the bead assemblages from other PPNA sites in the Jordan

Valley, in this case Netiv Hagdud and Wadi Faynan 16, with that of Dhra'. By comparing and contrasting the bead assemblages from Dhra' with these two sites, an archaeological fingerprint of community specialization may be seen.

The bead production assemblages vary at each site (Figure 6.3). The assemblage at Dhra' has large proportions of raw materials, while Wadi Faynan is dominated by finished beads but also contains beads in all stages of manufacture. Possibly due to sampling and reporting, the published objects from Netiv Hagdud are only finished beads. The lack of early production stage beads at Netiv Hagdud may reflect the importation of finished beads from outside of the site, or alternatively, may be linked to field and laboratory methods. Wadi Faynan and Dhra', on the other hand, appear to have on-site production.

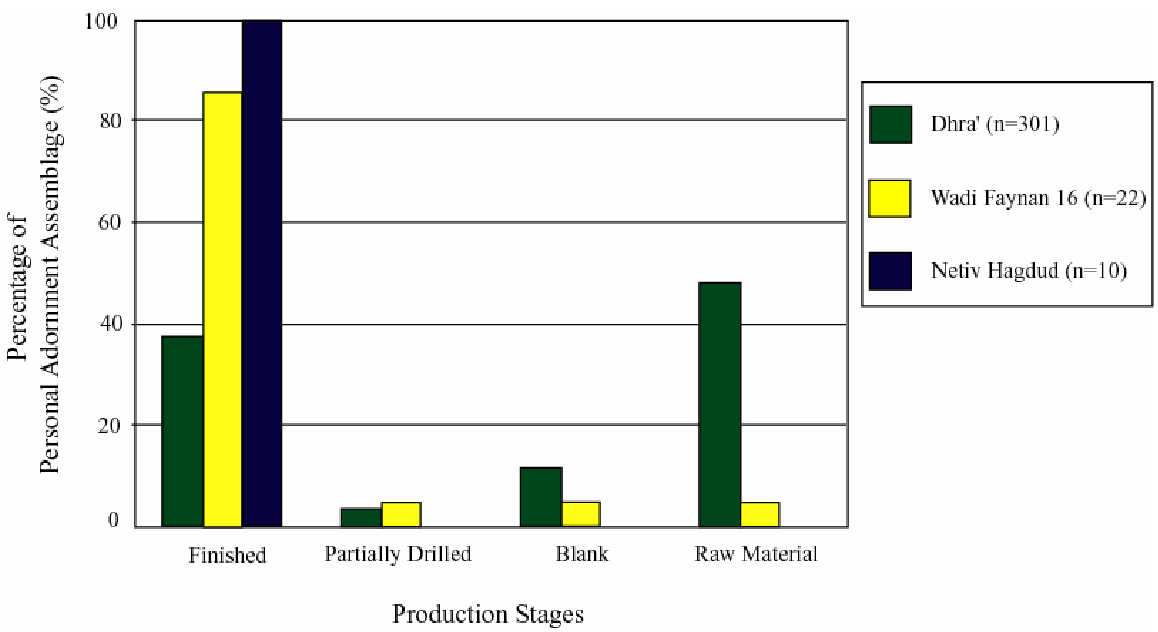

Figure 6.3 – Regional Comparison of Bead Production Stages.

In Chapter 3, I outlined the problems with published bead production data from PPNA sites. As these issues may be inaccurately representing bead production at the sites of Wadi Faynan 16 and Netiv Hagdud, comparing the distributions of bead production materials at each site may not be the best indicator of bead production. Within the Dhra' assemblage, however, there seems to be definitive evidence for the production and exchange of certain bead raw material types that would be consistent with community level specialization.

The distribution of production stage data at Dhra', however, clearly shows that people at Dhra' were trading for raw material and then trading valuable finished beads with other PPNA peoples. During the life history of beads, they move from raw materials, to bead blanks, to partially drilled beads, to finished beads. There is an expectation that the number of beads in production at any one time is likely relatively stable across time and that the number of finished beads will increase quickly. The archaeological signature that results is a relatively low number of beads in production with a high quantity of finished beads. At Dhra', limestone, jade, soapstone, and quartz assemblages fit this pattern (Figure 6.4). The malachite and jasper assemblages, however, vary with regards to the expected distribution of production data. These assemblages have more beads in production than finished beads. This raises the question – where are the other finished malachite and jasper beads?

I argue that the other expected finished beads were potentially traded off site. First of all, malachite and jasper are two of the rarest types of material in the region around Dhra', which means they likely had a high trade value. Conversely, the abundance of limestone, combined with its potentially easier production and less vibrant colors, likely lowered the potential trade value for limestone beads. By trading malachite and jasper beads, individuals at Dhra' were maximizing their return through trade and exchange networks. Additionally, the quantity of malachite beads in production dwarfs

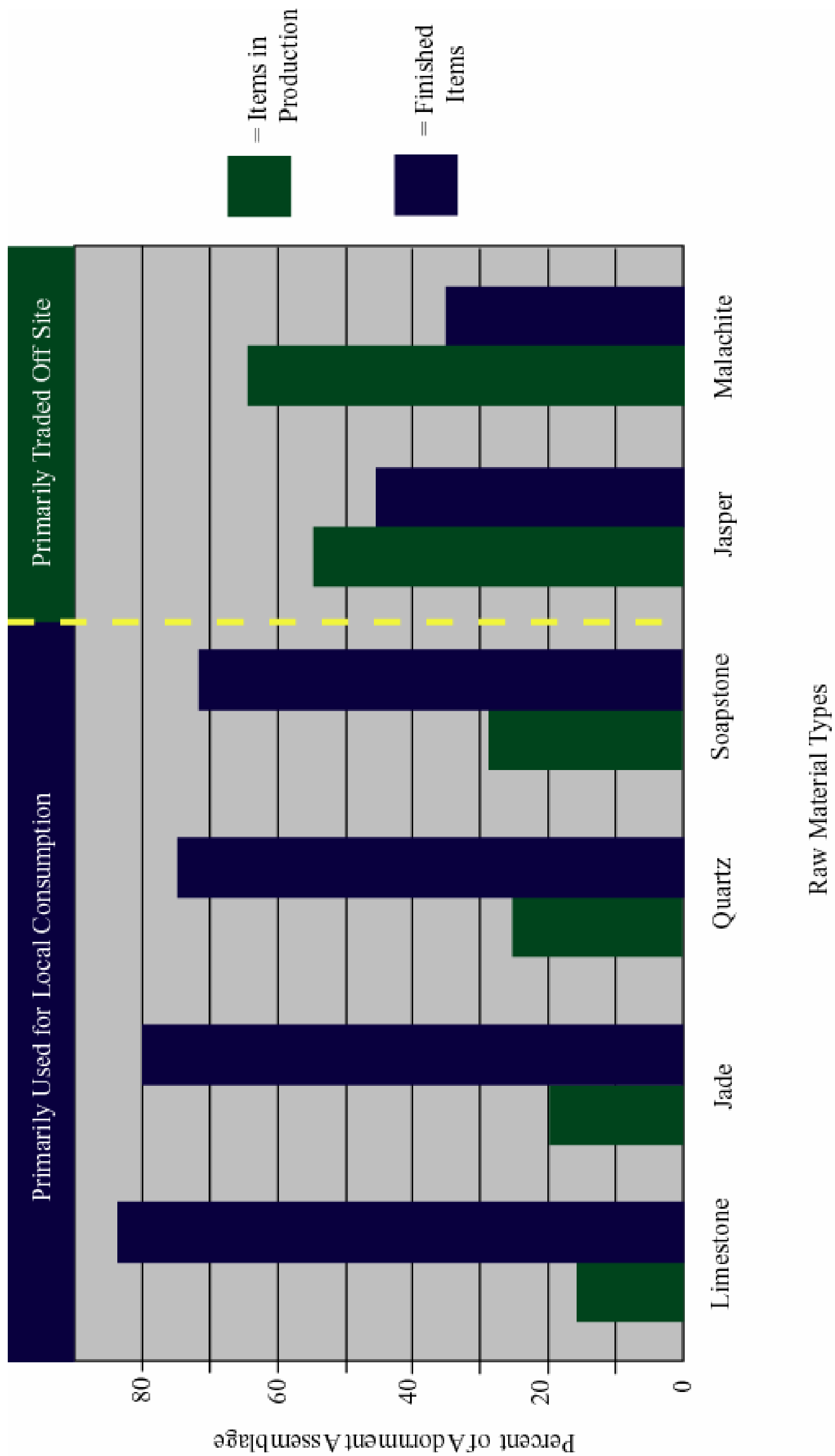

Figure 6.4 – Production Data for Various Raw Materials Used in Local and Trade Contexts. Note the low percentage of finished malachite and jade items, which suggest that these items were being manufactured at Dhra' and then traded off site.

the number of other raw material types (20 of 44 items in production are made from malachite – next most abundant raw material is limestone with 11 items). This hints at an emphasis on producing malachite beads, within the community level craft specialization system, that could then be contributed to regional exchange systems.

Discussion of the Structure and Intensity of PPNA Craft Production

The first task in identifying the role of craft specialization at Dhra' is to identify its structure; individual specialization or community specialization. Beads are not standardized in their manufacture or raw material, which suggests more than one individual or learning tradition was producing beads at Dhra'. CA and CDA illustrate that production areas are not spatially discrete and suggest both a visible nature of bead production and that many different people engaged in this activity. Regional distribution data indicate that people at Dhra' produced and exported finished beads. These lines of evidence combine to suggest that craft production at Dhra' is structured as community level production.

The other task in determining the role of craft specialization at Dhra' is to evaluate the intensity of bead production on site. The variability in bead types, raw materials, and metrics suggest low levels of intensity, as more intense production would lead to more standardization in bead morphology. The low abundance of bead materials at all PPNA sites also suggests that mass production and intensive specialization was not taking place. The lack of spatially discrete production areas again suggests that there was a low level intensity of bead production at Dhra'.

While there is only limited evidence for individual level craft specialization at Dhra', the presence of community level specialization is not rare in the ethnographic record among non-state level societies (Stark 1991). While increases in specialization have been linked to increasing social complexity (e.g., Brumfiel and Earle 1987; Earl 1987), this unilineal developmental trajectory is not supported ethnographically. Archaeological evidence of specialization at this level should not be interpreted as direct evidence of political and social control, and more often than not is indicative of community level specialization in non-state level societies (Stark 1991). At Dhra', the abundance of bead production materials suggests community level production with an emphasis on trade. It is important to note that the closest source of malachite, an important raw material for bead manufacture at Dhra', is near Wadi Faynan 16, 50 kilometers to the south. This means that the raw materials found at Dhra' may have been obtained through trade with the people at Wadi Faynan 16. Understanding the exchange of raw materials as opposed to finished beads is important for finding the contribution of the people at Dhra' to the regional exchange network.

Traditionally, the term 'craft specialization' has been reserved for state level societies (e.g., Childe 1951, 1954, 1958). This study, however, supplements more recent work by several archaeologists (e.g., Shafer 1985; Gilman et al. 1994) and anthropologists (e.g., Clark and Parry 1990) designed to identify the type and intensity of production occurring in non-state level, non-hierarchical, societies. At Dhra', beads were being produced by many individuals within the community, resulting in little standardization in the end product, and non-delineated production locales. Bead production was likely a part-time craft, but probably occurred often enough for individuals to keep up their skills (Gilman et al. 1994). Comparing Dhra' with other PPNA sites in the Southern Levant shows that bead production may not have been present at all sites. This evidence supports arguments for differential contributions to the regional exchange networks based on differential production of certain goods. Community level specialization, where shared learning networks and economic unity promote the production of certain goods at the site level for both internal use and trade, does appear to be occurring at Dhra'.

From this analysis, it is possible to draw conclusions about the visibility of production as well as the expenses of production as they pertain to costly signaling theory and the fitness continuum. The lack of spatially delineated activity areas associated with community level specialization suggests that bead production was a highly visible industry. Most production debris is associated with extramural contexts in which many people could have seen people manufacturing beads. The high visibility of bead production at Dhra' increases the honesty of personal adornment items as signals of wealth, status, and access to resources because people would know which individuals were skilled bead producers and likely sources of the beads in circulation.

Additionally, community level specialization affects variables that determine the expense of material culture items within the fitness continuum. Raw materials were brought in from outside areas and manufactured on site. Therefore, access to sources of raw material, either by trade (which imposes a cost) or by traveling to the source (which also imposes a cost), would have been a good signal of alliances, wealth, and access to resources, and by extension, reproductive fitness. Also, individuals who possessed expensive beads would have had a valuable resource that signaled reproductive fitness, such as malachite, to use in exchange, mating, and alliance formation contexts.

Signaling power in the PPNA was affected by the expense and visibility of the material culture item. Explorations of production technologies and now specialization have illuminated many of the variables that affect signaling power. The next step is to take the data produced through these analyses and fit them into the signaling fitness model provided in Chapter 2. By tying the archaeological evidence to the fitness continuum and gaining a more complete understanding of signaling power of personal adornment items in general, as well as of specific morphological and raw material types, researchers can evaluate the specific roles costly signals played in negotiating socio-economic information exchanges during the PPNA in the Southern Levant.

CHAPTER 7

PERSONAL ADORNMENT ITEMS AND PPNA COSTLY SINGALING

As noted in Chapter 2, experimental evaluations of production costs and assessments of production visibility provide a foundation for evaluating PPNA personal adornment items within the model of signaling power. In this chapter I discuss the signaling power of personal adornment items in general, as well as investigate the variability in signaling power among different types of personal adornment items. Using the personal adornment item data at Dhra', I explore the possible linkage between anthropological modeling of signaling power, its material manifestation, and expected artifact characteristics in order to evaluate costly signaling in the past, and the utility of this model.

Personal Adornment Item Signaling Power in the PPNA

In Chapter 2, I developed a model for assessing signaling power of material culture items related to the fitness characteristics (access to resources, wealth, and status) that were important for individual's reproductive fitness in the PPNA. To briefly recap, the power of expensive signals is affected by two variables: 1) the expense of the item and 2) the visibility of the signal. These two variables are continuums that are made up of several production, use, and contextual factors. The expense of an item is dependant upon the 1) production cost and 2) maintenance cost. The visibility of the signal is dependant upon the 1) audience size, 2) visibility of manufacturing, and 3) visibility of the object when being used. The model suggests that the most expensive and most visible material culture items have the highest potential signaling power. In order to evaluate the signaling power of personal adornment items as a whole at Dhra', I explore the context of production costs, and assess signaling power and its relationship to the fitness continuum.

Expense: Production Cost

Bead manufacturing at Dhra' included many costly variables that increased the signaling power of finished items. First, transportation and raw material availability affect signaling power. One of the main raw materials for bead production, malachite, had to be obtained and the closest malachite source is near Wadi Faynan 16, some 50 kilometers away. In order to acquire these materials, individuals at Dhra' would either have had to trade items or services to people in other areas of the Southern Levant who had access to them, or they would have had to spend time traveling to source locations and time mining the resources (assuming they were not under control of local individual or groups). Other raw materials such as marine shell, soapstone, jasper, and jade had to be acquired from non-local sources. As a result, simply acquiring the resources to make beads was a costly task.

Second, the production of beads required skill. There are numerous broken beads found at Dhra', and several of them were broken during production. The skill level needed to produce a bead would have signaled to others that individuals who manufactured beads possessed key attributes, such as dexterity and hand-eye coordination. Additionally, the skill level needed to produce a bead limited the quantity of beads that could be produced, as evidenced by only 109 recovered finished beads at Dhra'. The rarity of these items undoubtedly increased the signaling power of these items as they would stand out more than if beads were common at Dhra'.

Finally, manufacturing beads required a lot of time. Most of the personal adornment items at Dhra' were made of groundstone, which take a long time to shape and drill. Work by other researchers has suggested that stone beads can take weeks to make (Kenoyer et al. 1991; Wright and Garrard 2003). Experimental replication of bead production technology has shown the large time commitment required to drill beads (see Chapter 5 for discussion). It is likely that the beads at Dhra' took weeks to months to change from raw materials to finished beads. The number of work hours that would have been needed to make the beads is so high that proper time management, including the ability to finish all subsistence and other need base tasks, was necessary. Just as was the case with the skill level, the time required to make a bead likely contributed to the limited number of finished beads found at Dhra'. The signaling power of these items was accentuated by the paucity of these items in the archaeological record. The production costs, including access to raw materials, skill, and time needed to make the beads all contribute to the high signaling power of the personal adornment items at Dhra'.

Expense: Maintenance Cost

Most of the personal adornment objects from Dhra' are made of stone. While stone makes the production costs high, it is durable enough to limit the breakage rates among personal adornment items in circulation. However, stone beads still break, as evidence by 38 broken and incomplete beads at Dhra'.

The maintenance cost of beads is also determined by the likelihood an item would be lost. Loss rates are affected by two intersecting variables: artifact size and search time (Schiffer 1987). At Dhra', the number of beads found is likely attributed more to loss rates than to intentional discard. The small size of beads would make their potential misplacement high, especially when they become unfastened from the string or clothing to which they are attached. Their low loss rates, however, may be due to the value of these items as signals of reproductive fitness, continued recirculation, and the likely high search times that would follow misplacement. While the predicted loss rate of items at Dhra' is relatively low, 109 finished beads were still recovered by excavation, which means that not all beads that were misplaced were found. If we correlate one bead to a relatively conservative estimate of 50 work hours (based on experimental work by Kenoyer et al. 1991 and supported by experimental replication in Chapter 5), then the Dhra' personal adornment assemblage represents over 5,000 lost work hours. This high cost of the lost beads would mean that the maintenance cost of these items is also high, which results in increased signaling power for the items still in circulation. The maintenance costs suggest that while personal adornment items incurred a fair amount of maintenance costs, that their signaling power potential was not met through this variable due to the durability of stone and the middle range loss rate of beads.

Visibility: Audience Size

Based on increasing site sizes, researchers argue that the population increased from the Late Natufian to the PPNA (Bar-Yosef and Belfer-Cohen 1992:38). The increase in site size, however, may not directly correlate to an increase in population size. The larger sites during the PPNA may result from increased sedentism that did not necessarily require more people in the region. The first farming villages in the Southern Levant did not have a significant increase in population from the previous hunter-gatherer communities. The first farming villages' site size ranged from large to small: Jericho (5.0-2.5 hectares), Netiv Hagdud (1.5-1.0 hectares), Gilgal (1.0-0.5 hectares), and Nahal

Oren (0.5-0.2 hectares) (Bar Yosef and Belfer Cohen 1992:34; Kuijt and Goring-Morris 2002). Kuijt (2001b:109) considers Dhra' to be "a relatively large residential community, covering approximately 80m by 50m area," though evidence of human activity during the PPNA covers much of the 'Ain Waida fluvial fan. The site of Dhra' has also produced an astounding quantity of lithics when compared with other PPNA sites, suggesting that Dhra' was a major population center during the PPNA. Such relatively large communities likely contained a sizable potential audience for personal adornment item signaling in the Southern Levant. Additionally, the shift from mobile hunter-gatherer lifeways to more sedentary cultivation, and the potential population aggregation as a result, would mean that even if there were no more people in the region during the PPNA than previous time periods, the signaling power of personal adornments would still be high with a larger number of people being encountered on a daily basis.

Visibility: Manufacture

Bead manufacturing occurred in many contexts at Dhra', several of which were in non-delineated extramural areas (see Chapter 6 for spatial analysis). With multiple production areas in the community, it is likely that the production of personal adornment items was highly visible. This is important for two reasons. First, the act of producing a bead is a signal in and of itself. Manufacturing a stone bead requires time, skill, and access to the resources. All of these requirements may reflect underlying reproductive fitness because the person is showing that s/he is either personally adept at food production, or part of a powerful household with sufficient resources, that they have extra time to dedicate towards non-utilitarian item manufacturing. Additionally, the individual is signaling dexterity and other skills that may come in handy for hunting, manufacturing utilitarian items, and other tasks. This also reflects that they have access to resources through alliances, trade networks, or traveling and mining, which may be important for attracting and keeping a mate. Highly visible bead production and signaling power are linked since increased visibility in manufacturing spawns more honesty in the system. When bead manufacturing is public, people will know who the best bead producers are and who acquired finished beads. The honesty of bead production at Dhra' combined with the signaling power of production translate the highly visible production of personal adornment items into a very high level of signaling power.

Visibility: Use of the Object

Ethnographic studies of personal adornment item use show that they are meant to be displayed, not hidden (i.e. – Sciama and Eicher 1998). It is likely that PPNA peoples in the Southern Levant also wore personal adornment items in prominent locations. There are several ways beads can be worn to increase their visibility. Beads can be used as part of headdresses or have been fastened to exterior of clothing through the use of piercings. Beads can also be strung together for use as necklaces, bracelets, arm bands, waist bands, and anklets. Additionally, beads can be woven into clothing for decoration or as functional clasps. At Dhra', contextual and preservation issues make it difficult to determine exactly how beads were oriented on peoples' bodies. Nevertheless, it is reasonable to assume that these items were placed in prominent positions on the body or on garments. The high visibility of these items results in high signaling power, because signals must be seen in order for the information being conveyed to be received by others.

When these variables combined, it is evident that personal adornment items as a class of artifacts are costly signals of wealth, status, and access to resources. Beads are very expensive (often are made with costly exotic raw materials, require skill and time to manufacture) and highly visible (both in production and use), and are placed towards the costly end of the fitness continuum. On the whole, personal adornment items were likely above the costly signaling threshold and acted as honest signals of reproductive fitness in social information exchanges in the PPNA.

Signaling Power of Specific Types of PPNA Personal Adornment Items

While personal adornment items, as a group, appear to be either at or above the costly signaling threshold on the fitness continuum, not all personal adornment items have the same expenses associated with production or the same amount of visibility. Raw material types, morphological classifications, color, and size affect the signaling power of specific types of beads. In order to understand the variability within the general class of personal adornment items, I use the signaling fitness continuum model to examine the signaling power of specific items. By operationalizing signaling power it is possible to make arguments for which personal adornment items had the highest and lowest potential signaling power in the PPNA.

As the visibility of production and audience size during the PPNA was the same for all personal adornment items, comparisons of specific adornment types do not need to take these variables into account. For this analysis I focus on raw material availability (determined by the proximity of raw material sources to Dhra'), production costs (determined by the time and skill required to make the item), and visibility of the artifact (determined by the size and color of the object). Each of these variables is assessed on an ordinal scale (1=low, 2=medium, 3=high) in order to quantify signaling power of each class of personal adornment items. This analysis provides a way of assessing signaling power of specific adornment items in relationship to each other. After assessing the signaling power of each item, the objects were placed into rank order depending on the total of the variables of signaling power. This rank order shows the most effective signals of reproductive fitness during the PPNA (high rank - e.g. malachite barrel-elliptical beads) as well as the less effective signals of reproductive fitness (low rank – e.g. limestone flat-disc beads). The results of this analysis can be found in Table 7.1.

Table 7.1 – Signaling power rank assessment for various personal adornment types at Dhra'.

Type	Raw Material	Raw Mat Avail (1-3)	Prod Time (1-3)	Visibility (1-3)	Total	Signaling Power Rank
1 - Flat Disc	Bone	1	1	1	3	1
1 - Flat Disc	Limestone	1	1	1	3	1
2 - Beveled Disc	Bone	1	1	1	3	1
2 - Beveled Disc	Limestone	1	1	1	3	1
1 - Flat Disc	Shell	2	1	1	4	2
7 - Pendant	Bone	1	1	2	4	2
7 - Pendant	Limestone	1	1	2	4	2
2 - Beveled Disc	Shell	2	1	2	5	3
4 - Cylindrical	Limestone	1	2	2	5	3
5 - Barrel Elliptical	Limestone	1	2	2	5	3
7 - Pendant	Shell	2	1	2	5	3
1 - Flat Disc	Jade	3	2	1	6	4
1 - Flat Disc	Jasper	3	2	1	6	4
1 - Flat Disc	Malachite	3	2	1	6	4
1 - Flat Disc	Quartz	3	2	1	6	4
1 - Flat Disc	Soapstone	3	2	1	6	4
2 - Beveled Disc	Jade	3	2	2	7	5
2 - Beveled Disc	Jasper	3	2	2	7	5
2 - Beveled Disc	Malachite	3	2	2	7	5
2 - Beveled Disc	Quartz	3	2	2	7	5
2 - Beveled Disc	Soapstone	3	2	2	7	5
7 - Pendant	Jade	3	2	3	8	6
7 - Pendant	Jasper	3	2	3	8	6
7 - Pendant	Malachite	3	2	3	8	6
7 - Pendant	Quartz	3	2	3	8	6
7 - Pendant	Soapstone	3	2	3	8	6
4 - Cylindrical	Jade	3	3	3	9	7
4 - Cylindrical	Jasper	3	3	3	9	7
4 - Cylindrical	Malachite	3	3	3	9	7
4 - Cylindrical	Quartz	3	3	3	9	7
4 - Cylindrical	Soapstone	3	3	3	9	7
5 - Barrel Elliptical	Jade	3	3	3	9	7
5 - Barrel Elliptical	Jasper	3	3	3	9	7
5 - Barrel Elliptical	Malachite	3	3	3	9	7
5 - Barrel Elliptical	Quartz	3	3	3	9	7
5 - Barrel Elliptical	Soapstone	3	3	3	9	7

The Impact of Signaling Power on the Archaeological Record

Up to this point, I have focused on how characteristics and attributes of personal adornment items and bead production affect the signaling power of these items. However, the relationship between signaling power and the artifacts is more complex. In addition to being affected by the material culture items, signaling power affects the usage of material culture items in the past. Signaling power can affect archaeological patterning of the expected frequency of items and the contextual associations of the artifacts. To develop a more complete understanding of the relationship between signaling power and the archaeological record, we must consider the affects signaling power has on frequency and the context of deposition of material culture items in the past.

The theoretical construction of models and evaluation of signaling power must be reconciled with patterning within the archaeological record. Towards this end, I suggest that comparing the frequencies of beads found at archaeological sites to the expectations of the signaling power models illustrates how beads were used in signaling contexts. Archaeologists can develop predictive models of frequencies of artifacts based on the costliness of those items. In the case of personal adornment items at Dhra', I expect that the objects with the highest signaling power will be the rarest items, as the costs associated with production and ownership will limit the quantity of items in circulation. Additionally, costly items are less likely to enter the archaeological record because they usually have lower loss rates because of their visibility and costliness to obtain and individuals will likely dedicate time to finding misplaced items. Therefore, when all things are equal, the higher the signaling power of an item, the less frequently it will be represented in the archaeological record. This changes, however, when the signaling power of an item drops past the costly signaling threshold. Items that do not honestly represent reproductive fitness have diminishing returns in terms of enhanced reproductive fitness as compared to the time and resources invested in manufacturing the items. Consequently, signals below the costly signaling continuum will diminish in frequency in the archaeological record as their signaling power decreases. The result is a distribution of artifacts such as seen in Figure 7.1.

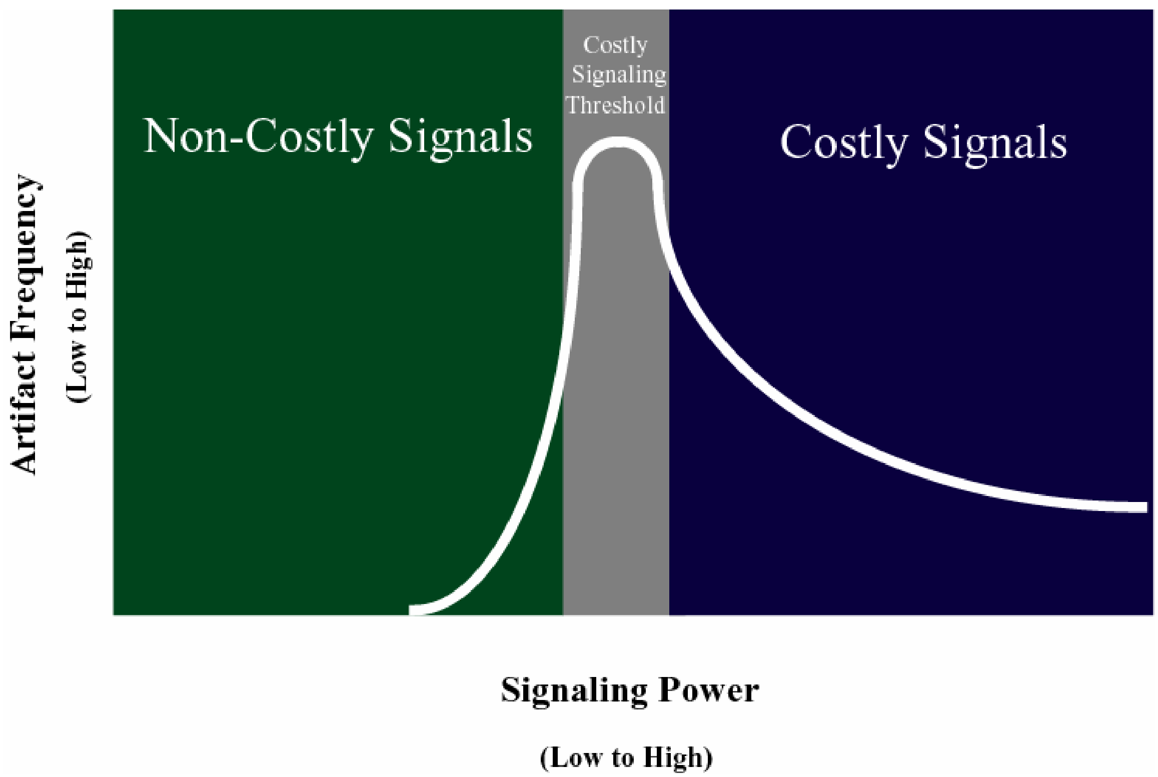

Figure 7.1 – Expected Frequency of Artifacts Based on Their Signaling Power.

By comparing expected distribution to the personal adornment assemblage at Dhra', it is possible to evaluate when signals are more or less frequent than expected. Deviations from the expected distribution of artifacts aids us in assessing signaling power and interpreting what items were selected for use as costly signals. Individual decision making processes in the past may have affected the production and distributions of material culture items and by comparing the archaeological record with predictive models, archaeologists can better understand past decision making processes.

Personal Adornment Item Production and Use as Costly Signals in the PPNA

Given that the archaeological record is equally affected by depositional history of a site and patterns of human behavior, I must examine the archaeological record while taking into account the site formation processes. In the case of personal adornment items, the circulation of an artifact throughout its life history (likelihood of transport off-site vs. likelihood of exclusively local use) and loss rates (likelihood a misplaced item is not recovered vs. likelihood a misplaced item is recovered) affect the frequency of artifacts in the archaeological record. At Dhra', personal adornment items are predominantly deposited in the archaeological record through loss. Personal adornment items are not intentionally deposited in cache or burial contexts.

To take into account these deposition variables, I employ estimates for the amount of beads in circulation during the occupation of the site (Table 7.2). These estimations of the number of beads in circulation at Dhra' can be used to develop a rank order of frequency from low (1) to high (11). This provides one means of evaluating the expected distribution of artifacts by signaling power (shown in Figure 7.1) using the archaeological frequency of particular bead types at Dhra'.

At Dhra', the expected frequency of the most costly signals (malachite barrel-elliptical beads, soapstone barrel-elliptical beads, cylindrical jasper beads, and cylindrical malachite beads) is higher than expected (Figure 7.2). The predominance of these costly items may be evidence of individual decision-making processes in the past. Individuals at Dhra' were actively choosing to produce these items at a higher rate than their costs would suggest. In sum, these items are likely overrepresented because of their utility in signaling reproductive fitness.

Table 7.2 – Estimating Artifact Frequency Based on Circulation/Loss Attributes and the Archaeological Record

Circulation Attributes	Estimated Rate of Deposition (per 100 items)	Bead Types	Bead Raw Material	Archaeological Frequency	Estimated Number of Items in Circulation (per 100 items)	Signaling Power Rank	Frequency Rank
High circulation / low loss	25	7 - Pendant	Shell	4	16	3	9
		7 - Pendant	Jade	0	0	6	1
		7 - Pendant	Jasper	0	0	6	1
		7 - Pendant	Malachite	0	0	6	1
		7 - Pendant	Quartz	0	0	6	1
		7 - Pendant	Soapstone	0	0	6	1
		4 - Cylindrical	Jade	0	0	7	1
		4 - Cylindrical	Jasper	2	8	7	6
		4 - Cylindrical	Malachite	1	4	7	4
		4 - Cylindrical	Quartz	1	4	7	4
		4 - Cylindrical	Soapstone	0	0	7	1
		5 - Barrel Elliptical	Jade	2	8	7	6
		5 - Barrel Elliptical	Jasper	0	0	7	1
		5 - Barrel Elliptical	Malachite	6	24	7	10
		5 - Barrel Elliptical	Quartz	0	0	7	1
		5 - Barrel Elliptical	Soapstone	3	12	7	8
Low circulation / low loss	50	7 - Pendant	Limestone	1	2	2	3
		4 - Cylindrical	Limestone	2	4	3	4
		5 - Barrel Elliptical	Limestone	34	68	3	11
High circulation / high loss	50	1 - Flat Disc	Shell	0	0	2	1
		2 - Beveled Disc	Shell	0	0	3	1
		1 - Flat Disc	Jade	0	0	4	1
		1 - Flat Disc	Jasper	3	6	4	5
		1 - Flat Disc	Malachite	0	0	4	1
		1 - Flat Disc	Quartz	3	6	4	5
		1 - Flat Disc	Soapstone	0	0	4	1
		2 - Beveled Disc	Jade	1	2	5	3
		2 - Beveled Disc	Jasper	0	0	5	1
		2 - Beveled Disc	Malachite	0	0	5	1
		2 - Beveled Disc	Quartz	2	4	5	4
		2 - Beveled Disc	Soapstone	1	2	5	3
Low circulation / high loss	75	1 - Flat Disc	Bone	0	0	1	1
		1 - Flat Disc	Limestone	6	8	1	6
		2 - Beveled Disc	Bone	1	1	1	2
		2 - Beveled Disc	Limestone	7	9	1	7
		7 - Pendant	Bone	0	0	2	1

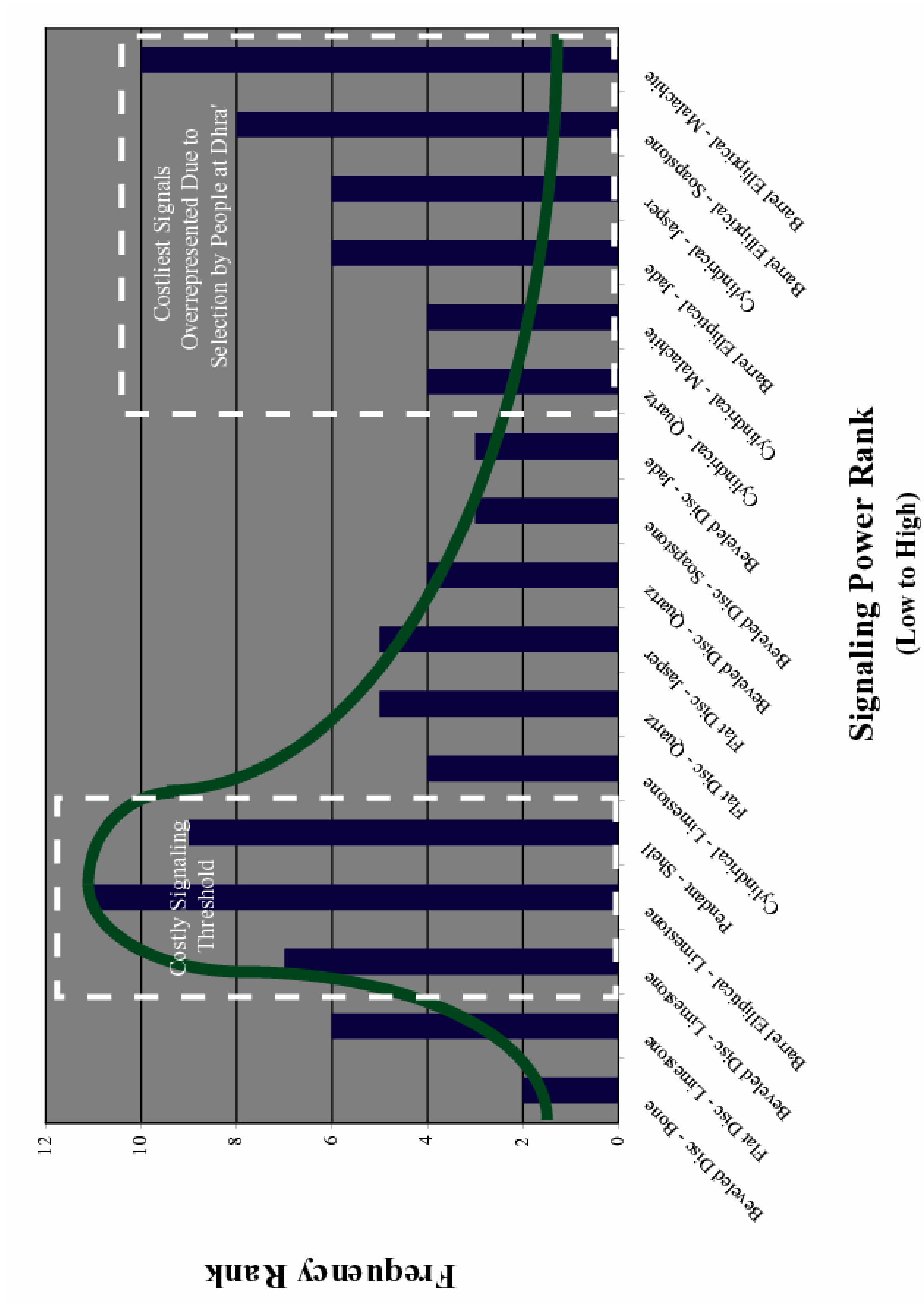

Figure 7.2 – Comparing the frequency of bead types at Dhra' with their signaling power. The expected distribution of artifacts (green line) is not seen among the most costly items at Dhra'. This overabundance is linked to individuals actively attempting to acquire or manufacture these costly signals based on their benefits in enhancing reproductive fitness.

The archaeological frequency of artifacts and their relative signaling power provide us with a more detailed understanding of the interplay between signaling power and specific types of beads at Dhra'. The relationship between specific adornment items and the costly signaling threshold is particularly interesting. In light of the relatively sparse data, it is best to envision this as a zone of signaling power, rather than a sharp line, that represents the distinction between costly and non-costly signals. Instead, I argue there is a gray zone along the signaling continuum where the shift from costly to non-costly signaling occurs. The placement of the gray zone of the costly signaling threshold is at the peak of the frequency of production and mimics the expectations of the signaling power and frequency relationship. Above this threshold zone, costly products are effective signals of reproductive fitness, though the expected frequency of items drops as the costliness of the signal increases. Below the threshold zone, the signals are less effective vehicles of social information exchange about reproductive fitness, and as such, the expected frequency of items drops due to diminishing returns in signaling contexts.

Of the items in the so-called gray zone, it is likely that limestone barrel-elliptical beads were still costly enough to produce that they were effective signals of reproductive fitness. The frequency of items below this zone, such as limestone disc beads and bone beads, suggests that these items were less effective signals of reproductive fitness. These items were not actively produced by people at Dhra', even though they are among the easiest personal adornment items to make or acquire.

The frequency of the costliest items at Dhra', the barrel-elliptical beads made of malachite, soapstone, and jade as well as the cylindrical beads made of jasper and malachite, was discordant with the expected frequency of these items. These artifacts were overrepresented in circulation at Dhra' when compared to their costs of production and acquisition. While the data patterning can be interpreted multiple ways, I argue that the overrepresentation of the costliest items suggests that these items were being actively, and consciously, produced and acquired by the people at Dhra'. These data support the notion that individuals at Dhra' were using personal adornment items to negotiate complex social interactions. As honest signals of reproductive fitness, personal adornment items, and particularly the four overrepresented and costliest bead types, were used by people in the past to enhance their reproductive fitness.

CHAPTER 8

CONCLUSION

Potential Future Research

In this thesis, I have considered the expense and visibility of bead production and use during the PPNA in the Southern Levant and linked these variables to costly signaling theory and the archaeological record. Nevertheless, there are still numerous issues that this study has not addressed as well as several potential lines of archaeological research that have arisen as a result of this study. While not an exhaustive list, I believe several of these issues can, and should, be addressed by Near Eastern archaeologists.

This study used controlled experimental replication to rule out the use of el-Khiam points as stone bead drilling implements. Additionally, results suggested that bone points may have been used by PPNA peoples to drill beads. More experiments are required to verify this assertion. Microscopic and macroscopic comparisons between experimental bone points and archaeological specimens from PPNA sites are potential further avenues of exploration into variables associated with the cost of bead production. The perforations on the archaeological beads also require more detailed microscopic analyses and comparisons with experimentally replicated perforations.

The problems with personal adornment item recording, reporting, and research that I have highlighted in this thesis have precluded more detailed regional comparisons of bead production assemblages. The future use of bead recording and reporting techniques used in this thesis will enhance the quantity and quality of our understanding of personal adornment items. Beyond increasing the data available to Near Eastern researchers, the assemblages from numerous sites can then be accurately and confidently compared and contrasted to address issues of differential production and use. Such comparisons are necessary to further support discussions of specialization in craft production and trade and exchange networks during the PPNA. Furthermore, sourcing raw materials that were used to make beads can potentially illuminate the movement of personal adornment items throughout the Southern Levant.

Personal adornment items can play a role not only in social information exchange, but also in ritual and economic contexts. Trade and exchange systems are initiated and maintained by the movement of non-utilitarian items as well as subsistence related goods. Additionally, beads are often used in ritual contexts as well as in the formation of social memory. These added contextual associations intensify the complexity of archaeological interpretations of material culture items. Future research into PPNA personal adornment production and use may prove beneficial in assessing what role beads played in ritual behavior and the formation of exchange networks.

Within social information exchange, beads are not only signals of reproductive fitness, but also are imbedded with other socially significant information. Among other characteristics, the beads at Dhra', both in a general sense and by typological variability, may have been markers of gender (males and/or females could have worn them), age (young and/or old people could have worn them), group identity (different kin groups could have had different beads). Future explorations into contextual associations and personal adornment item variability may shed light on these issues.

While the contextual associations of certain adornment items are important, there is no limited contextual differentiation in the deposition of beads at Dhra'. As a result, the model provided in this thesis has not considered the variability of contextual association such as loss, ritual caching, and grave goods and its impact on signaling power. Other models of signaling power for sites that have adornment items in various depositional contexts must include the potential for higher or lower signaling power depending on how they are deposited.

At Dhra', the beads are not found in burials but, rather, are found in midden and other general activity contexts and were likely introduced into the archaeological record by loss and not intentional deposition. The lack of grave goods during the PPNA is a significant departure from the use of personal adornment items in the Natufian as well as during the PPNB. Future research into signaling power, belief systems, and personal adornment items may address the question of why there are no beads in burials.

In addition to changing mortuary practices from the Natufian to the Early Neolithic, research aimed at understanding temporal and spatial variation in signaling power and the nature of signaling in various times and places is a potentially fruitful avenue for archaeologists. Comparisons of adornment items and contexts in the Natufian to the PPNA to the PPNB may highlight active decision-making processes to change costly signaling during the shift from foraging to farming. Additionally, comparing signaling power and archaeological patterning at Dhra' to other sites in the PPNA may highlight variability or uniformity in signaling techniques in the Southern Levant. These issues, among others, will yield information about bead production and use, costly signals that enhance reproductive fitness, and material culture's role in negotiating complex social-economic relationships in the Southern Levantine PPNA.

In this thesis, I have linked personal adornment items to issues of agency and individual decision-making processes. This treatment highlights the complexity of social information exchanges as well as the use of material culture to display and enhance reproductive fitness. Near Eastern archaeologists must consider these complex relationships between people and material culture in ways that have not been previously conceptualized. The assessment of costly signaling in this thesis begins to address this complexity.

Personal Adornment Items as Costly Signals in the PPNA

At Dhra', individuals were actively and consciously participating in costly signaling information exchanges by acquiring and producing items associated with high reproductive fitness. Experimental and statistical analyses have shed light on the expense and visibility of bead production and use; the primary variables affecting the signaling power of material culture items during the PPNA. These data have tested the theoretical framework of signaling theory and the model of signaling power provided in this thesis. While individuals at Dhra' displayed socially embedded information with every material culture item they possessed, the production and use of personal adornment items as costly signals of underlying reproductive fitness enhanced the reproductive fitness of individuals who manufactured or possessed these items. The signaling power assessments provided by the costly signaling model combined with the archaeological patterning of bead production and use at Dhra', highlights the complexity of the relationship between social information exchange and individual decision-making processes in the past.

BIBLIOGRAPHY

Alexander, R.D.

1979 *Darwinism and Human Affairs*. Seattle: University of Washington Press.

1987 *The Evolution of Moral Systems*. Hawthorne, NY: Akline de Gruyter.

Allen, Jim, Simon Holdaway, and Richard Fullagar

1997 Identifying Specialisation, Production and Exchange in the Archaeological Record: The Case of Shell Bead Manufacture on Motupore Island, Papua. *Archaeol. Oceania* 32:13-38.

Andrefsky, W., Jr.

1986 A Consideration of Blade and Flake Curvature. *Lithic Technology* 15(2):48-54.

2005 *Lithics: Macroscopic Approaches to Analysis Second Edition*. Cambridge: Cambridge University Press.

Ascher, Robert A.

1961 Experimental Archaeology. *American Anthropologist* 63:793-816.

Bar-Yosef, Ofer

1980 Prehistory of the Levant. *Annual Review of Anthropology* 9:101-133.

1981 The "Pre-Pottery Neolithic" Period in the Southern Levant. In *Prehistoire du Levant*, edited by J. Cauvin and P. Sanlaville, pp. 555-569. Paris: Editions SNRS.

1991 The Early Neolithic of the Levant: Recent Advances. *The Review of Archaeology* 12(2):1-18.

Bar-Yosef, Ofer, and Anna Belfer-Cohen

1989 The Origins of Sedentism and Farming Communities in the Levant. *Journal of World Prehistory* 3:447-498.

1992 From Foraging to Farming in the Mediterranean Levant. In *Transitions to Agriculture in Prehistory*, edited by A.B. Gebauer and T.D. Price, pp. 21-48. Madison, Wisconsin: Prehistory Press.

Bar-Yosef, Ofer, and Avi Gopher (eds.)

1997 *An Early Neolithic Village in the Jordan Valley. Part 1: The Archaeology of Netiv Hagdud*. Cambridge: American School of Prehistoric Research, Peabody Museum, Harvard University.

Bar-Yosef, Ofer, and Mordechai Kislev

1989 Early Farming Communities in the Jordan Valley. In *Foraging and Farming: The Evolution of Plant Exploitation*, edited by D.R. Harris and G.C. Hillman, pp. 632-642. London: Unwin Hyman.

Baxter, M.J.
1994 Correspondence Analysis – The Main Ideas. In *Exploratory Multivariate Analysis in Archaeology*, by M.J. Baxter, pp. 100-109. Edinburgh: Edinburgh University Press.

Belfer-Cohen, Anna
1991a The Natufian in the Levant. *Annual Review of Anthropology* 20:167-186.
1991b Art Items from Layer B, Hayonim Cave: A Case Study of Art in a Natufian Context. In *The Natufian Culture in the Levant*, edited by O. Bar-Yosef and F. Valla, pp. 569-588. Ann Arbor: International Monographs in Prehistory.

Belfer-Cohen, Anna and Ofer Bar-Yosef
2000 Early Sedentism in the Near East: A Bumpy Road to Village Life. In *Life in Neolithic Farming Communities: Social Organization, Identity and Differentiation*, edited by I.Kuijt, pp. 19-37. New York: Plenum Publishers.

Bennett, C.M.
1980 Soundings at Dhra', Jordan. *Levant* 12:30-39.

Bettinger, Robert L.
1979 Multivariate Statistical Analysis of a Regional Subsistence-Settlement Model for Owens Valley. *American Antiquity* 44(3):455-470.
1991 *Hunter-Gatherers: Archaeological and Evolutionary Theory*. New York: Plenum Press.

Bliege Bird, Rebecca, and Eric Alden Smith
2005 Signaling Theory, Strategic Interaction and Symbolic Capital. *Current Anthropology* 46(2): 221-248.

Bliege Bird, Rebecca, Eric Alden Smith, and Douglas W. Bird
2001 The Hunting Handicap: Costly Signaling in Male Foraging Strategies. *Behavioral Ecology and Sociobiology* 50:9-19.

Bliege Bird, Rebecca, Douglas W. Bird, Eric Alden Smith, and Geoffrey C. Kushnick
2002 Risk and Reciprocity in Meriam Food Sharing. *Evolution and Human Behavior* 23:297-321.

Bolviken, Erik, Ericka Helskog, Knut Helskog, Inger Marie Holm-Olsen, Leiv Solheim, and Reidar Bertelsen
1982 Correspondence Analysis: An Alternative to Principal Components. *World Archaeology* 14(1):39-60.

Boone, James L.
1998 The Evolution of Magnanimity: When is it Better to Give Than to Receive? *Human Nature* 9(1):1-21.

Boone, James L., and Eric Alden Smith
1998 Is it Evolution Yet? A Critique of Evolutionary Anthropology. *Current Anthropology* 39:S141-S173.

Boyd, R., and P.J. Richerson
1985 *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

Brumfield, Elizabeth and Timothy Earle
1987 Specialization, Exchange and Complex Societies: An Introduction. In *Specialization, Exchange and Complex Societies*, edited by E. Brumfiel and T. Earle, pp. 1-9. Cambridge: Cambridge University Press.

Carey, Margret
1998 Gender in African Beadwork: An Overview. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 83-94. Oxford: Berg.

Cashdan, E.
1985 Coping With Risk: Reciprocity Among the Basarwa of Northern Botswana. *Man* 20:454-476.

Childe, V. Gordon
1946 *What Happened in History*. New York: Penguin Books.
1951 *Social Evolution*. New York: Henry Shuman.
1954 Early Forms of Society. In *A History of Technology; Vol. 1*, edited by C. Singer, E.J. Holymyard, and A.R. Hall, pp. 38-57. London: Oxford University Press.
1958 *The Prehistory of European Society*. London: Penguin Books.

Clark, John and William J. Parry
1990 Craft Specialization and Cultural Complexity. *Research in Economic Anthropology* 12:289-346.

Clutton-Brock, J.
1979 The Mammalian Remains from Jericho Tell. *Proceedings of the Prehistoric Society* 45:135-157.

Coles, John M.
1979 *Experimental Archaeology*. London: Academic Press.

Copeland, L.
1991 Natufian sites in Lebanon. In *The Natufian Culture in the Levant*, edited by O. Bar-Yosef and F. Valla, pp. 27-42. Ann Arbor: International Monographs in Prehistory, Archaeological Series 1.

Cosmides, L. and J. Tooby
1992 Cognitive Adaptations for Social Exchange. In *The Adapted Mind*, edited by J. Barkow, L. Cosmides, and J. Tooby, pp. 163-228. Oxford: Oxford University Press.

Costin, Cathy Lynne
1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. In *Archaeological Method and Theory*, edited by M. Schiffer, pp. 1-56. Tuscon, University of Arizona Press.

Critchley, Pat
n.d. The Stone Beads. In *The Early Prehistory of Wadi Faynan, Southern Jordan: Excavations at the Pre-Pottery Neolithic A Site of WF 16 and Archaeological Survey of Wadis Faynan, Ghuwayr and Al Bustan*, edited by B. Finlayson and S. Mithen. Manuscript in Press.

Crowfoot-Payne, Joan
1976 The Terminology of the Aceramic Neolithic Period in the Levant. In *Terminology of Prehistory of the Near East*, Pre-Print IX UISPP Congress, Nice, France.
1983 The Flint Industries of Jericho. In *Excavations at Jericho* edited by K.M. Kenyon and T.A. Holland, Volume V, pp. 622-759. London: The British School of Archaeology in Jerusalem.

Currie, Elizabeth J.
1995 Archaeology, Ethnohistory and Exchange Along the Coast of Ecuador. *Antiquity* 69:511-526.

Davis, Simon J.M.
1983 The Age Profile of Gazelles Predated by Ancient Man in Israel: Possible Evidence for a Shift from Seasonality to Sedentism in the Natufian. *Paleorient* 9:55-62.
2005 Why Domesticate Food Animals? Some Zoo-Archaeological Evidence from the Levant. *Journal of Archaeological Science* 32:1408-1416.

Dawkins, Richard
1987 *The Blind Watchmaker*. New York: W.W. Norton and Company.

Dawkins, R. and J.R. Krebs
1978 Animal Signals: Information or Manipulation. In *Behavioural Ecology: An Evolutionary Approach 1st Edition*, edited by J.R. Krebs and N.B. Davies, pp. 282-309. Oxford: Blackwell Scientific Publications.

Dublin, L.S.
1987 *The History of Beads, From 30,000 B.C. to the Present*. London: Thames and Hudson.
1999 *North American Indian Jewelry and Adornment, From Prehistory to the Present*. New York: Harry N. Abrams Inc.

Duff, Andrew I.
1996 Ceramic Micro-seriation: Types or Attributes? *American Antiquity* 61(1):89-101.

Dunnell, Robert C.
1980 Evolutionary Theory and Archaeology. *Advances in Archaeological Method and Theory, vol. 3,* edited by M.B. Schiffer, pp. 35-99. New York: Academic Press.

Durham, William H.
1991 *Coevolution: Genes, Culture, and Human Diversity*. Stanford: Stanford University Press.

Earle, Timothy K.
1987 Specialization and the Production of Wealth: Hawaiian Chiefdoms and the Inka Empire. In *Specialization, Exchange and Complex Societies* edited by E.M. Brumfiel and T.K. Earle, pp. 64-75. Cambridge: Cambridge University Press.

Edwards, Phillip C., John Meadows, Mary C. Metzger, and Ghattas Sayej
2002 Zahrat Adh-Dhra' 2: A New Pre-Pottery Neolithic A Site on the Dead Sea Plain in Jordan. *Bulletin of the American Schools of Oriental Research* 327:1-15.

Eicher, Joanne B.
1998 Beaded and Bedecked Kalabari of Nigeria. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 95-116. Oxford: Berg.

Enoch-Shiloh, Dahlia and Ofer Bar-Yosef
1997 Salibiya IX. In *An Early Neolithic Village in the Jordan Valley Part I: The Archaeology of Netiv Hagdud* edited by O. Bar-Yosef and A. Gopher, pp. 13-40. Cambridge, MA: American School of Prehistoric Research Bulletin 46.

Finlayson, Bill, Ian Kuijt, Trina Arpin, Meredith Chesson, Samantha Dennis, Nathan Goodale, Seji Kadawaki, L. Maher, Sam Smith, Mark Schurr, and Jode McKay
2003 Dhra' Excavation Project, 2002 Interim Report. *Levant* 35:1-38.

Finlayson, Bill and Steven Mithen
n.d. *The Early Prehistory of Wadi Faynan, Southern Jordan: Excavations at the Pre-Pottery Neolithic A Site of WF 16 and Archaeological Survey of Wadis Faynan, Ghuwayr and Al Bustan*. Manuscript in Press.

Francis, Peter, Jr.
1999 *Beads of the World: Second Edition*. Atglen, PA: Schiffer Publishing Ltd.

Fried, Morton H.
1967 *The Evolution of Political Society*. New York: Random House.

Galm, Jerry
1994 Prehistoric Trade and Exchange in the Interior Plateau of Northwestern North America. In *Prehistoric Exchange Systems in North America*, edited by Timothy G. Baugh and Jonathon E. Ericson, pp. 275-305. New York: Plenum Publishing.

Garfinkel, Y., and D. Nadel
1989 The Sultanian Flint Assemblage From Gesher and its Implications for Recognizing Early Neolithic entities in the Levant. *Paleorient* 15:139-152.

Garrard, Andrew, D. Baird and B. Byrd
1994 The Chronological Basis and Significance of the Late Paleolithic and Neolithic Sequence in the Azraq Basin, Jordan. In *Late Quarternary Chronology and Palaeoclimates of the Eastern Mediterranean*, edited by O. Bar-Yosef and R. Kra, pp. 177-200. Tuscon: Radiocarbon.

Gifford, Edward W.
1887 *The Coast Yuki*. HRAF NS30.

Gilman, Patricia A., Beletta Canouts, and Ronald L. Bishop
1994 The Production and Distribution of Classic Mimbres Black-on-White Pottery. *American Antiquity* 59(4):695-709.

Gintis, Herbert, Eric Alden Smith, and Samuel L. Bowles
2001 Cooperation and Costly Signaling. *Journal of Theoretical Biology* 213:103-119.

Goodale, Nathan and Sam J. Smith
2001 Pre-Pottery Neolithic A Projectile Points at Dhra', Jordan: Preliminary Thoughts on Form, Function, and Site Interpretation. *Neo-Lithics* 2/01:1-5.

Goodale, Nathan, Ian Kuijt, and Bill Finlayson
2002 Results from the 2001 Excavations at Dhra', Jordan: Chipped Stone Technology, Typology, and Intra-Assemblage Variability. *Paleorient* 28(1):115-130.

Gopher, Avi
1995 Ain Darat: A PPNA Site in the Judean Desert. *Neo-Lithics* 1:7-8.
1997 Groundstone Tools and Other Stone Objects from Netiv Hagdud. In *An Early Neolithic Village in the Jordan Valley Part I: The Archaeology of Netiv Hagdud* edited by O. Bar-Yosef and A. Gopher, pp. 151-180. Cambridge, MA: American School of Prehistoric Research Bulletin 46.

Grafen, Alan
1990 Biological Signals as Handicaps. *Journal of Theoretical Biology* 144(4):517-546.

Greenacre, Michael
1994 Correspondence Analysis and its Interpretation. In *Correspondence Analysis in the Social Sciences: Recent Developments and Applications*, edited by M. Greenacre and J. Blasius, pp. 3-22. London: Academic Press.

Hamilton, W.D.
1964 The Genetical Evolution of Social Behaviour I and II. *Journal of Theoretical Biology* 7:1-16, 17-52.

Hasson, O.
1994 Cheating Signals. *Journal of Theoretical Biology* 167:223-238.

Hawkes, Kristen
1990 Why Do Men Hunt? Some Benefits for Risky Strategies. In *Risk and Uncertainty in Tribal and Peasant Economies* edited by E. Cashdan, pp. 145-166. Boulder: Westview Press.
1991 Showing Off: Tests of an Hypothesis about Men's Foraging Goals. *Ethology and Sociobiology* 12:29-54.
1992 Sharing and Collective Action. In *Evolutionary Ecology and Human Behavior*, edited by Eric Alden Smith, & Bruce Winterhalder, pp. 269–300. Hawthorne, NY: Aldine de Gruyter.
1993 Why Hunter-Gatherers Work: An Ancient Version of the Problem of Public Goods. *Current Anthropology* 34:341-361.

Hawkes, Kristen and Rebecca Bliege Bird
2002 Showing Off, Handicap Signaling, and the Evolution of Men's Work. *Evolutionary Anthropology* 11(2):58-67.

Hayden, Brian
1990 Nimrods, Piscators, Pluckers, and Planters: The Emergence of Food Production. *Journal of Anthropological Archaeology* 9:31-69.

Hayden, Brian and Rick Schulting
1997 The Plateau Interaction Sphere and Late Prehistoric Cultural Complexity. *American Antiquity* 62(1):51-85.

Hegmon, Michelle
1989 Risk Reduction and Variation in Agricultural Economies: A Computer Simulation of Hopi Agriculture. *Research in Economic Anthropology* 11:89-121.

Henrich, Joseph, and Francisco J. Gil-White
2001 The Evolution of Prestige: Freely Conferred Deference as a Mechanism for Enhancing the Benefits of Cultural Transmission. *Evolution and Human Behavior* 22:165-96.

Henry, Donald O.
1986 The Prehistory and Palaeoenvironments of Jordan: An Overview. *Paleorient* 12:5-26.

Hill, Kim, and H. Kaplan
1993 On Why Male Foragers Hunt and Share Food. *Current Anthropology* 26:223-245.

Hillman, G.C., and M.E. Davies
1990 Domestication Rates in Wild-type Wheats and Barley Under Primitive Cultivation. *Biological Journal of Linnaean Society* 39:39-78.

Hillman, G.C., S. Colledge, and D.R. Harris
1989 Plant Food Economy During the Epi-Paleolithic Period at Tell Abu Hureya, Syria: Dietary Diversity, Seasonality and Modes of Exploitation. In *Foraging and Farming: The Evolution of Plant Exploitation*, edited by G.C. Hillman and D.R. Harris, pp. 240-266. London: Hyman Unwin.

Hodder, Ian
1977 The Distribution of Material Culture Items in the Baringo District, West Kenya. *Man* 12:239-269.

1981 Society, Economy, and Culture: An Ethnographic Case Study Amongst the Lozi. In *Pattern of the Past: Studies in Honor of David Clark*, edited by I. Hodder, G. Isaac, and N. Hammond, pp. 67-95. Cambridge: Cambridge University Press.

1982 *Symbols in Action: Ethnoarchaeological Studies of Material Culture*. Cambridge: Cambridge University Press.

Hopf, M.

1983 *Excavations at Jericho*. London: The British School of Archaeology in Jerusalem.

Ingersoll, David and William MacDonald

1977 Introduction. In *Experimental Archaeology*, edited by D. Ingersoll, J.E. Yellen, and W. MacDonald, pp. ii-xviii. New York: Columbia University Press.

Janowski, Monica

1998 Beads, Prestige and Life Among the Kelabit of Sarawak, East Malaysia. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 213-246. Oxford: Berg.

Johnstone, Rufus A.

1997 The Evolution of Animal Signals. In *Behavioural Ecology: An Evolutionary Approach*, edited by R.M. Berndt and P. Lawrence, pp. 35-73. Oxford: Blackwell.

Junker, Laura Lee

1993 Craft Goods Specialization and Prestige Goods Exchange in Philippine Chiefdoms of the Fifteenth and Sixteenth Centuries. *Asian Perspectives* 32(1):1-35.

Kantner, John

2003 Biological Evolutionary Theory and Individual Decision-Making. In *Essential Tensions in Archaeological Method and Theory*, edited by T.L. VanPool and C.S. VanPool, pp. 67-88. Salt Lake City: University of Utah Press.

Kaplan, Hillard, and Kim Hill

1985 Food Sharing Among Ache Foragers: Tests of Explanatory Hypotheses. *Current Anthropology* 26(2):223-245.

Kelly, Robert L.

1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Washington: Smithsonian Institution Press.

2000 Elements of a Behavioral Ecological Paradigm for the Study of Prehistoric Hunter-gatherers. In *Social Theory in Archaeology*, edited by M.B. Schiffer, pp. 63-78. Salt Lake City: University of Utah Press.

Kenoyer, J. M. Vidale and K. Bhan
1991 Contemporary Stone Bead Making in Khambat, India. *World Archaeology* 23(1):44-63.

Kenyon, K.M.
1957 *Digging Up Jericho*. London: Ernest Benn Ltd.

Kenyon, K.M. and T.A. Holland (eds.)
1981 *Excavations at Jericho*. London: The British School of Archaeology in Jerusalem.

Kislev M.E.
1989 Pre-Domesticated Cereals in the Pre-Pottery Neolithic A Period. In *People and Culture Change*, edited by I. Hershkovitz, pp. 147-152. BAR International Series 508. Oxford: BAR.

Klecka, W.R.
1975 Discriminant Analysis. In *Statistical Package for the Social Sciences*, edited by H. Nie et al., pp. 468-514.

Kramer, C.
1985 Ceramic Ethnoarchaeology. *Annual Reviews in Anthropology* 14:77-102.

Krebs, J.R., and R. Dawkins
1984 Animal Signals: Mind-Reading and Manipulation. In *Behavioural Ecology: An Evolutionary Approach 2nd Edition*, edited by J.R. Krebs and N.B. Davies, pp. 380-402. Oxford: Blackwell Scientific Publications.

Kuhn, S. and M. Stiner
1998 The Earliest Aurignacian of Ripario Mochi (Liguria, Italy). *Current Anthropology* 39:S175-S189.

Kuijt, Ian
1994a Pre-Pottery Neolithic A Settlement Variability: Evidence for Sociopolitical Developments in the Southern Levant. *Journal of Mediterranean Archaeology* 7(2):165-192.
1994b A Brief Note on the Chipped Stone Assemblage from ‘Iraq ed-Dubb, Jordan. *Neo-Lithics* 2:2-3.
1996 Negotiating Equality Through Ritual: A Consideration of Late Natufian and Pre-Pottery Neolithic A Period Mortuary Practices. *Journal of Anthropological Archaeology* 15(4):313-336.

2001a Place, Death, And the Transmission of Social Memory in Early Agricultural Communities of the Near Eastern Pre-Pottery Neolithic. In *Social Memory, Identity, and Death: Intradisciplinary Perspectives on Mortuary Rituals*, edited by M.S. Chesson, American Anthropological Association, Archaeology Division, Vol. 10, pp. 80-99. Washington D.C.: American Anthropological Association.

2001b Lithic Inter-assemblage Variability and Cultural-Historical Sequences: A Consideration of the Pre-Pottery Neolithic A Period Occupation of Dhra', Jordan. *Paleorient* 27(1):107-126.

2004 Pre-Pottery Neolithic A and Late Natufian at 'Iraq ed-Dubb, Jordan. *Journal of Field Archaeology* 29(3/4):291-308.

Kuijt, Ian (ed.)

2000 *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation*. New York: Plenum Press.

Kuijt, Ian, and Meredith Chesson

1994 Investigations at Jebel Queisa, Jordan (1993): A Reconsideration of Chronology and Occupational History. *The Annual of the Department of Antiquities of Jordan* 38:33-39.

Kuijt, Ian, and Bill Finlayson

2001 The 2001 Excavation Season at the Pre-Pottery Neolithic A Period Settlement of Dhra' Jordan: Preliminary Results. *Neo-Lithics* 2/01:12-15.

2002 The 2002 Excavation Season at Dhra' Jordan: Preliminary results from the Jericho IX and Pre-Pottery Neolithic A Period Components. *Neo-Lithics*.

Kuijt, Ian, and Nigel Goring-Morris

2002 Foraging, Farming, and Social Complexity in the Pre-Pottery Neolithic of the Southern Levant: A Review and Synthesis. *Journal of World Prehistory* 16(4):361-440.

Kuijt, Ian, and H. Mahasneh

1995 Preliminary Excavation Results from Dhra' and 'Ain Waida. *American Journal of Archaeology* 99:508-511.

1998 Dhra': An Early Neolithic Site in the Jordan Valley. *Journal of Field Archaeology* 25:153-161.

Lechevallier, M. and A. Ronen

1994 *Le Gisement de Hatoula, en Judee Occidentale, Israel, Rapport des Fouilles 1980-1988. Memoires et Travaux du Centre de Recherche Francais de Jerusalem* 8. Jerusalem: Centre de Recherches Francais de Jerusalem.

Lyman, R. Lee, and Michael O'Brien
1998 Goals of Evolutionary Archaeology: History and Explanation. *Current Anthropology* 39:615-652.
2001 On Misconceptions of Evolutionary Archaeology: Confusing Macroevolution and Microevolution. *Current Anthropology* 42:408-409.

Mauss, Marcel
1924 *The Gift: Forms and Functions of Exchange in Archaic Societies*. London: Cohen and West.

Maynard Smith, J., and D.G.C. Harper
1995 Animal Signals: Models and Terminology. *Journal of Theoretical Biology* 177:305-311.

McGuire, Kelly R. and William R. Hildebrandt
2005 Re-Thinking Great Basin Foragers: Prestige Hunting and Costly Signaling during the Middle Archaic Period. *American Antiquity* 70(4):695-712.

Meisch, Lynn A.
1998 Why Do They Like Red? Beads, Ethnicity and Gender in Ecuador. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 147-176. Oxford: Berg.

Miller, Michele A.
1996 The Manufacture of Cockle Shell Beads at Early Neolithic Franchthi Cave, Greece: A Case of Craft Specialization? *Journal of Mediterranean Archaeology* 9(1):7-37.

Mithen, S., and B. Finlayson
2000 WF 16, A New PPNA Site in Southern Jordan. *Antiquity* 74(283):11-12.

Munro, Natalie D.
2004 Zooarchaeological Measures of Hunting Pressure and Occupation Intensity in the Natufian: Implications for Agricultural Origins. *Current Anthropology* 45(supplement):S5-S33.

Nadel, Dani
1997 The Chipped Stone Industry of Netiv Hagdud. In *An Early Neolithic Village in the Jordan Valley Part I: The Archaeology of Netiv Hagdud* edited by O. Bar-Yosef and A. Gopher, pp, 71-149. Cambridge, MA: American School of Prehistoric Research Bulletin 46.

Nadel, Dani, Alexander Tsatskin, Adam Zertal, and Tal Simmons
2000 Ein Suhun – A PPNA/B Settlement in the Eastern Samarian Hills. *Journal of The Israel Prehistoric Society* 30:73-87.

Neiman, Fraser
1997 Conspicuous consumption as wasteful social advertising: A Darwinian perspective on spatial patterns in Classic Maya terminal monument dates. In *Rediscovering Darwin: Evolutionary Theory in Archaeological Explanation*, edited by G. Clarke and M. Barton, pp. 267-290. Archaeological Papers of the American Anthropological Association, 7.

Nissen, Hans J., Mujahed Muheisen and Hans Georg Gebel
1987 Report on the First Two Seasons of Excavations at Basta (1986-1987). *Annual of the Department of Antiquities of Jordan* 31:79-119.

Noy, T.
1989 Gilgal I, A Pre-Pottery Neolithic A Site, Israel: The 1985-1987 Seasons. *Paleorient* 15:11-18.

Noy, T., E. Friedmann and F Burian
1981 Nahal Lavan 108: A Pre-Pottery Neolithic A Site in the Western Negev, Israel. *Palestine Exploration Quarterly*: 81-88.

Noy, T., A.J. Legge, and E.S. Higgs
1973 Recent Excavations at Nahel Oren, Israel. *Proceedings of the Prehistoric Society* 39:75-99.

O'Hear, Ann
1998 Lantana Beads: Gender Issues in their Production and Use. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 117-128. Oxford: Berg.

Quinn, Colin P.
2006 Exotics, Exchange, and Elites: Exploring Mechanisms of Movement of Prestige Goods in the Interior Northwest. *Journal of Northwest Anthropology* 41:207-224.

Quinn, Colin P., William Andrefsky, Jr., Ian Kuijt, Bill Finlayson
n.d. Stone Tool Perforating and Retouch Intensity: A Neolithic Case Study. In *Artifact Life-Cycle and the Organization of Lithic Technologies* edited by W. Andrefsky. Cambridge: Cambridge Press. In Press.

Raikes, T.D.
1980 Notes on Some Neolithic and Later Sites in the Wadi Araba and the Dead Sea Valley. *Levant* 12:40-60.

Reid, J.J., M.B. Schiffer, and W.L. Rathje
1975 Behavioral Archaeology: Four Strategies. *American Anthropologist* 77:864-869.

Rindos, D.
1989 Symbiosis, Instability, and the Origins and Spread of Agriculture: A New Model. *Current Anthropology* 21:751-772.

Rosenberg, M., and R.W. Redding
2000 Hallan Cemi and Early Village Organization in Eastern Anatolia. In *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation*, edited by I. Kuijt, pp. 39-61. New York: Plenum Press.

Roux, Valentine
2003 Ceramic standardization and Intensity of Production: Quantifying Degrees of Specialization. *American Antiquity* 68(4):768-782.

Sahlins, Marshall
1972 *Stone Age Economics*. Chicago: Aldine.

Santley, Robert, Phillip Arnold III, and Christopher Pool
1989 The Ceramic Production System at Matacapan, Veracruz, Mexico. *Journal of Field Archaeology* 16(1):107-132.

Saraydar, Stephen and Izumi Shimada
1973 Experimental Archaeology: A New Outlook. *American Antiquity* 38:344-350.

Sayej, Ghattas J.
2004 The Lithic Industries of Zahrat Adh-Dhra' 2 and the Pre-Pottery Neolithic Period of the Southern Levant. *British Archaeological Reports* S1329.

Schiffer, Michael Brian
1976 *Behavioral Archaeology*. New York: Academic Press.
1987 *Formation Processes of the Archaeological Record*. Albuquerque: University of New Mexico Press.

Schiffer, Michael Brian, James M. Skibo, Tamara C. Boelke, Mark A. Neupert, and Meredith Aronson
1994 New Perspectives on Experimental Archaeology: Surface Treatments and Thermal Response of the Clay Cooking Pot. *American Antiquity* 59(2):197-217.

Sciama, Lidia D.
1998 Gender in the Making, Trading and Uses of Beads: An Introductory Essay. In *Beads and Bead Makers: Gender, Material Culture and Meaning*, edited by L.D. Sciama and J.B. Eicher, pp. 1-46. Oxford: Berg.

Sciama, Lidia D., and Joanne B. Eicher (eds.)
1998 *Beads and Bead Makers: Gender, Material Culture and Meaning*. Oxford: Berg.

Shafer, H.J.
1985 A Mimbres Potter's Grave: An Example of Mimbres Craft-Specialization? *Bulletin of the Texas Archaeological Society* 56:185-200.

Shennan, Stephen
2001 *Quantifying Archaeology*. Edinburgh: Edinburgh University Press.

Shimada, Izumi
2005 Experimental Archaeology. In *Handbook of Archaeological Methods Volume I*, edited by H.D.G. Maschner and C. Chippindale, pp. 603-642. Lanham: Altamira Press.

Sinha, Harendra Prasad
1994 *Archaeological and Cultural History of North Bihar: With Special Reference to Neolithic-Chirand*. New Delhi: Ramanand Vidya Bhawan.

Smith, Eric Alden
2000 Three Styles in the Evolutionary Analysis of Human Behavior. In *Adaptation and Human Behavior*, edited by L. Cronk, N. Chagnon, and W. Irons, pp. 27-46. New York: Aldine de Gruyter.
2004 Why Do Good Hunters Have Higher Reproductive Success? *Human Nature* 15(4):343-364.

Smith, Eric Alden, and Rebecca L. Bliege Bird
2000 Turtle hunting and Tombstone Opening: Public Generosity as Costly Signaling. *Evolution and Human Behavior* 21:245-261.

Smith, Eric Alden, and Robert Boyd
1990 Risk and Reciprocity: Hunter–Gatherer Socioecology and the Problem of Collective Action. In *Risk and Uncertainty in Tribal and Peasant Economies,* edited by E. Cashdan, pp. 167–191. Boulder, CO: Westview Press.

Smith, Eric Alden, and Bruce Winterhalder
1992 Natural Selection and Decision Making: Some Fundamental Principles. In *Evolutionary Ecology and Human Behavior*, edited by E.A. Smith and B. Winterhalder, pp. 25-60. Hawthorne, N.Y.: Aldine de Gruyter.

Smith, Sam
2005 *A comparative analysis of the form and function of chipped stone artefacts from Wadi Faynan 16 and Dhra`: Implications for the description and interpretation of early Neolithic chipped stone variability*. Ph.D. Thesis. University of Reading.

Sosis, Richard
2002 Patch Choice Decisions among Ifaluk Fishers. *American Anthropologist* 104(2):583-598.

Stark, Miriam T.
1974 Geography and Economic Specialization in the Lower Papaloapan, Veracruz, Mexico. *Ethnohistory* 21(3):199-221.
1991 Ceramic Production and Community Specialization: A Ceramic Ethnoarchaeological Study. *World Archaeology* 23(1):64-78.

Stark, Miriam T., and James M. Heidke
1998 Ceramic Manufacture, Productive Specialization, and the Early Classic Period in Arizona's Tonto Basin. *Journal of Anthropological Research* 54:497-517.

Stekelis, M., and T. Yizraeli
1963 Excavations at Nahal Oren: Preliminary Report. *Israel Exploration Journal* 13:1-12.

Stiner, M.
1999 Trends in Paleolithic Mollusc Exploitation at Riparo Mochi (Balzi Rossi, Italy): Food and Ornaments from the Aurignacian Through Epigravettian. *Antiquity* 73:735-754.

Strathern, A. and M. Strathern
1971 S*elf-Decoration in Mount Hagen*. London: G. Duckworth.

Thomas, David H.
1999 *Archaeology: Down to Earth*. New York: Harcourt Brace College Publishers.

Trigger, Bruce G.
1989 *A History of Archaeological Thought*. Cambridge: Cambridge University Press.

Trivers, Robert L.
1971 The Evolution of Reciprocal Altruism. *Quarterly Review of Biology* 46:35-57.

van Zeist, W., and J.A.H. Bakker-Heeres
1985 Archaeobotanical Studies in the Levant: Neolithic Sites in the Damascus Basin, Aswad, Ghoraife, Ramad. *Palaeohistoria* 24:165-256.
1986 Archaeobotanical Studies in the Levant III: Late Paleolithic Mureybet. *Palaeohistoria* 26:171-199.

Vanhaeren, Marian
2005 Speaking with Beads: The Evolutionary Significance of Bead Making and Use. In *From Tools to Symbols, From Early Hominids to Modern Humans*, edited by F. d'Errico and L. Backwell. Johannesburg: Wits University Press.

Vanhaeren, Marian, and Francesco d'Errico
2006 Aurignacian Ethno-linguistic Geography of Europe Revealed by Personal Ornaments. *Journal of Archaeological Science* 33:1105-1128.

Vanhaeren, Marian, Francesco d'Errico, Isabelle Billy, Francis Grousset
2004 Tracing the Source of Upper Palaeolithic Shell Beads by Strontium Isotope Dating. *Journal of Archaeological Science* 31:1481-1488.

VanPool, Todd L., and Christine S. VanPool
2003 Agency and Evolution: The Role of Intended and Unintended Consequences of Action. In *Essential Tensions in Archaeological Method and Theory*, edited by T.L. VanPool and C.S. VanPool, pp. 89-114. Salt Lake City: University of Utah Press.

Veblen, Thorstein
1994 [1899] *The Theory of the Leisure Class*. New York: Dover.

Verhoeven, Marc
2004 Beyond Boundaries: Nature, Culture and a Holistic Approach to Domestication in the Levant. *Journal of World Prehistory* 18(3):179-282.

Wiessner, Polly
1996 Leveling the Hunter: Constraints on the Status Quest in Foraging Societies. In *Food and the Status Quest: An Interdisciplinary Perspective*, edited by P. Wiessner and W. Schiefenhovel, pp. 171-191. Oxford: Berghahn Books.
2002 Hunting, Healing, and *Hxaro* Exchange: A Long-Term Perspective on !Kung (Ju/'hoansi) Large-Game Hunting. *Evolution and Human Behavior* 23:407-436.

Wiessner, Pauline, and Wulf Schiefenhovel (eds.)
1996 *Food and the Status Quest: An Interdisciplinary Perspective*. Oxford: Berghahn Books.

Winterhalder, Bruce
1986 Diet Choice, Risk, and Food Sharing in a Stochastic Environment. *Journal of Anthropological Archaeology* 5:369-392.
1990 Open Field, Common Pot: The Behavioral Ecology of Nonmarket, Intergroup Exchange. In *Risk and Uncertainty in Tribal and Peasant Economies*, edited by E. Cashdan, pp. 67–87. Boulder, CO: Westview Press.

Wright, Katherine and Andrew Garrard
2003 Social Identities and the Expansion of Stone Bead-Making in Neolithic Western Asia: New Evidence From Jordan. *Antiquity* 77(296):267-284

Zahavi, Amotz
1975 Mate Selection: A Selection for Handicap. *Journal of Theoretical Biology* 53(1):205-214.

Zohary, D. and M. Hopf
2000 *Domestication of Plants in the Old World: The Origin and Spread of Cultivated Plants in West Asia, Europe, and the Nile Valley*. Oxford: Oxford University Press.

APPENDIX A

DHRA' BEAD PROVENIENCE INFORMATION

ID	Special Find Number	Season	Area	Context	Easting	Northing	Quad	Spit	Bag Number	Point Plot East	Point Plot North	Depth
1	1591	2004	1	1047	84.5	89		3	525	NA	NA	-36.30
2	1588	2004	1	2011	89	91		3	3413	89.35	91.30	-36.18
3	1589	2004	1	2011	89	91		3	3414	89.30	91.30	-36.17
4	1610	2004	1	1056	88	95		2	3356	NA	NA	
5	1369	2004	1	013	86	94			3001	86.80	94.20	-36.00
7	1595	2004	1	1044	88	100		4	12017	NA	NA	
8	1373	2004	1	1059	85	96		3	12064	85.82	96.62	
9	1482	2004	1	2025	84	97		F 39	9099	84.90	97.20	-36.27
10	1504	2004	1	Surface	87	83		1	303	87.90	83.51	-35.91
11	1408	2004	1	1054	89	102		3	15051	89.75	102.68	-36.20
12	1458	2004	1	1059	87	96		5	12214	NA	NA	-36.26
13	1583	2004	1	1030	85	105		5	15187	NA	NA	-36.65 - .70
14	1642	2004	1	1051	81.5	100		3	9203	NA	NA	-36.64 - .71
15	1431	2004	1	045	85	88		6	168	85.83	88.24	-36.36
16	1379	2004	1	2002	102	117		1	18008	102.22	117.47	-35.57
17	1404	2004	1	1054	89	104		3	15044	NA	NA	-35.64
18	1410	2004	1	1016	84.5	90		6	6167	NA	NA	-36.33 - .27
19	1425	2004	1	1052	84	97		F5	9068	84.20	97.20	-36.26
20	1426	2004	1	1030	86	105		1	15075	NA	NA	-36.51 - .55
21	1409	2004	1	1054	89	104		3	15052	89.86	104.11	-36.27
22	1586	2004	1	2010	81	90		5	6451	81.74	90.56	-36.75
23	1537	2004	1	2037	80	91		1	6352	80.20	91.70	-36.72
24	1552	2004	1	1030	87	106		4	15159	87.05	106.08	NA
25	1419	2004	1	1030	87	106		1	15069	NA	NA	-36.44 - .49
26	1396	2004	1	1054	89	105		2	15024	NA	NA	NA
27	1459	2004	1	2004	98	112		2	18096	98.80	112.60	-35.73
28	1139	2002	1	1016	83.5	91		4	NA	NA	NA	NA
29	1255	2002	1	1059	88	98		2		88.27	98.22	NA
30	1246	2002	1	1077	85	93		1		85.33	93.78	NA
31	1270	2002	1	1054	88	106		1		NA	NA	NA
32	1143	2002	1	1020	85	98		8		NA	NA	NA
33	1218	2002	1	1064	80	96		1		80.22	96.00	NA
34	1254a	2002	1	1031	88	106		NA	NA	NA	NA	NA
35	1279	2002	1	1054	89	106		1		89.00	106.22	NA
37	1261	2002	1	1059	88	99		2		NA	NA	NA
38	1164	2002	1	1030	87	102	E 1/2	2		NA	NA	NA
39	1254b	2002	1	1047	85	92	C	6		NA	NA	NA
40	1167	2002	1	1052	84	96			1	84.42	96.94	NA
41	1258	2002	1	1059	88	98		2		NA	NA	NA
42	1266	2002	1	1054	88	106		1	1	NA	NA	NA
43	1265	2002	1	1059	87	96		3	NA	87.09	96.61	NA
45	1291	2002	1	1059	87	99		2		87.62	99.40	NA
46	1286	2002	1	1047	85	90		7		NA	NA	NA
47	1256	2002	1	1059	88	96		2		88.72	96.13	NA
48	1025	2002	1	1006	82.5	92		1	1	NA	NA	NA
49	1099	2002	1	1024	81	98		1		81.20	98.14	NA
50	1042	2002	1	1003	87	103		1	1	NA	NA	NA

51	1009	2002	1	1006	79.5	94		1	1	NA	NA	NA
52	1086	2002	1	1030	86	104		1		86.65	104.98	NA
54	1205	2002	1	1047	85	90		4	NA	NA	NA	NA
55	1062	2002	1	1009	88	106		1	1	NA	NA	NA
56	1085	2002	1	1020	85	97		3	NA	NA	NA	NA
57	1070	2002	1	1070	88	99		2	NA	NA	NA	NA
58	1064	2002	1	1022	87	100		1	NA	87.75	100.29	NA
59	1302	2002	1	1059	88	97		3	NA	NA	NA	NA
60	1325	2002	1	1059	88	96		3		88.31	96.23	NA
61	1321	2002	1	1059	89	98		3	NA	NA	NA	NA
62	1211	2002	1	1064	80	96			NA	80.42	96.40	NA
63	1245	2002	1	1052	82	96				82.55	96.58	
64	1326	2002	1	1076	85	94	A					
65	1111	2002	1	1009	89	105		3		89.84	105.33	
66	1208	2002	1	1064	79.5	96		1				
67	1212	2002	1	1064	79.5	96						
68	1209	2002	1	1064	1	96				81.31	96.13	
69	1191	2002	1	1051	80.5	99		1				
70	1184	2002	1	1009	88	106		4				
71	1173	2002	1	1052	83.5	95						
72	1290	2002	1	1081	84.5	96		2	1	84.57	95.58	
73	1244	2002	1	1052	82.5	96				82.53	96.73	
74	1180	2002	1	1053	88	104		1	1	88.23	104.89	
75	1364	2002	1	1004	83.5	98		2	1			
76	1422	2004	1	1052	83.5	97		F5	9064			
77	1530	2004	1	2024	87	89		3	372	87.5	89.76	-36.20
78	1465	2004	1	1081	83.5	97		3				-36.30
79	1539	2004	1	2014	89	91		1		89.15	91.2	-36.12
80	1469	2004	6	2004	99	114		4	18111	99.3	114.3	-35.63
81	1391	2004	1	1054	88	102		2	15009	88.75	102.46	
82	1370	2004	1	1041	81.5	90		2	6014			
84	1639	2004	1	2006	88	105		4	15229			-36.42-.47
85	1675	2004	1	2005	88	87		3	143			
86	1649	2004	1	1085	84	91		3	3455	84.82	91.24	-36.45
87	1654	2004	1	2006	89	105		6	15278			-36.48
88	1637	2004	1	2053	86	106		3	15233	86.79	106.51	-36.80
89	1526	2004	1	2038	88	85		4	355	88.26	85.33	-36.47
91	1650	2004	1	2006	89	106		6	15274	89.66	106.87	-36.47
92	1643	2004	1	1051	81.5	100		3	9202			-36.64-.71
93	1617	2004	1	1041	82.5	94		4	6499			-36.47-.50
94	1630	2004	1	2037	79.5	91		4	6537			-36.93-.96
95	x001	2004	1	2037	80.5	90		4	6525			-36.86-.91
96	x002	2004	1	1054	88	103		4				-36.30-.35
97	x003	2004	1	2012	88	105			15302			-36.47
98	x004	2004	1	2079	89	106		1	15299			-36.51-.53
99	x005	2004	1	2006	89	106		5	15242			-36.46-.49
100	x006	2004	1	2010	84.5	90		1	6538			-36.41-.47
101	x007	2004	1	2006	88	106		4	15239			-36.44-.48
102	x008	2004	1	2006	88	105		5	15263			-36.47-.49
103	x009	2004	1	2006	88	105		4	15232			-36.41-.47
104	x010	2004	1	2006	89	106		4	15225			-36.37-.46
105	x011	2004	1	1056	87	96			FL-2004-26			-36.18-.24
106	x012	2004	1	2033	81.5	91			FL-2004-35			-36.83.89
107	x013	2004	1	2006	89	106		3	15219			-36.36-.43
108	x014	2004	1	2006	89	106		6	15277			-36.49-.53

109	1638	2004	1	2006	88	106		4	15235			-36.45
110	x015	2004	1	2006	89	105		6	15279			-36.48-.50
111	x016	2004	1	2006	89	104		5	15257			-36.36-.41
112	x017	2004	1	2006	89	105		5	15246			-36.43-.48
113	x018	2004	1	1051	79.5	96		3	9185			-36.75-.80
114	x019	2004	1	2008	86.5	94.5			FL-2004-21			-36.25-.31
115	x020	2004	1	2006	88	106		5	15255			-36.48-.52
117	x021	2004	1	006	85	93		6	3435			-36.16-.22
119	1685	2004	1	2005	88	87		6		88.62	87.30	-36.84
120	1671	2004	1	2050	87	87		4	707	87.94	87.66	-37.00
121	1710	2004	1	2079	89.22	105.01		3	15376	89.22	105.01	-36.60
122	1659	2004	1	2050	88	86		1	700	88.10	86.15	-37.02
123	x022	2004	1	2010	81.5	90		6	6455			-36.83.86
124	x023	2004	1	2079	88	106		3	15377			-36.58-.64
125	x024	2004	1	1054	89	104		5	15319			-36.39-.42
126	x025	2004	1	2079	89	106		2				-36.53-.58
127	x026	2004	1	2079	89	106		3	15387			-36.58-.64
128	1712	2004	1	2037	80.5	90		1	6543			-36.71-.76
129	1713	2004	1	2017	83.5	90		1				-36.32-.39
130	1538	2004	1	1056	87	97		6	12350	87.22	97.42	-36.35
131	1657	2004	1	1051	82.5	97		9	9228			-36.60
132	1492	2004	1	2000	88	85		1	292			-36.14-.26
133	1726	2004	6	2004	95	111		3	18171			
134	1725	2004	1	1016	84.5-83.5	91-90			FL-2004-23			-36.29-.39
135	1596	2004	1	1030	86	101		4	15192	86.65	101.28	-36.60
136	1724	2004	1	1030	87	104		2	15109			-36.42-.48
137	1367	2004	1	1059	85	97			12006	85.66	97.45	
138	1722	2004	6	2004	99	115		2	18168			
139	1720	2004	1	1051	83.5	98		4	9241			-36.54-.56
140	1493	2004	1	2000	88	85		1	291	88.75	85.40	-36.16
141	1727	2004	1	2064	86	96			12612	86.44	96.00	-36.44
142	1467	2004	1	2019	82.5	90		1	6209			
143	1721	2004	1	2031	89	95		2	FL-2004-37	89.3	95.41	-36.19-.24
144	1342	2002	1	1092	95	112		1	1			
145	x027	2004	1	2041	87	86		2	432			-36.51-.60
146	x028	2004	1	2006	89	105		3	15072			
147	1402	2004	1	1054	88	105		2	15037			
148	1465	2004	1	1081	83.5	97		3	9083			-36.30
149	x029	2004	1	1016	84.5	90		4	6144			-36.14
150	x030	2004	1	2006	89	106		4	15100			-36.37-.46
151	x033	2004	1	2037	80.5	91		3	6457			-36.81
152	x031	2004	1	2006	89	106		3				-36.30-.35
153	x032	2004	1	1059	89	97		3	12074			
154	1393	2004	1	1054	89	106		2	15020	89.12	106.82	
155	1394	2004	1	1054	89	106		2	15023	89.09	106.28	
156	x034	2004	1	1016	84.5	90		6	6166			-36.22-.27
157	x035	2004	1	1056	88	96		1	12131			
158	x036	2004	1	1056	87	96		4	12151			-36.13-.16
159	x037	2004	1	2006	88	106		3	15081			-36.46-.51
160	x038	2004	1	1052	84	97		F5	9108	84.20	97.15	
161	x043	2004	1	1016	83.5	90		6	6084			
162	x042	2004	1	2031	89	95		1	3243			-36.14
163	x041	2004	1	1016	84.5	90		5	6152			-36.17
164	x040	2004	1	2006	89	105		3	15059			

165	x039	2004	1	2008	86	94		2	3059			-36.18-.23
166	1398	2004	1	1054	88	106		2	15031			
167	1723	2004	1	2000	86	86		1	183			-36.49-.51
168	1551	2004	1	2014	88	95		4	3260	88.90	95.70	-36.21
169	1197	2004	1	1009	88	102		4	1	88.60	102.74	
170	1190	2002	1	1020	85	98		8	1			
171	x044	2004	1	1054	88	104		4	15247			-36.35-.38
172	1711	2004	1	2079	88	106		3	15379	88.11	106.96	-36.63
173	1728	2004	6	2002	101	117	3	1	18006			
174	1673	2004	1	2012	88	104		1	15325			-36.37-.42
176	1729	2004		Backdirt								
177	1730	2004		Backdirt								
178	1695	2004	1	1054	89	103		6	15350	89.25	103.80	-36.40
179	1691	2004	1	cleaning	85	92		2	3512			-36.26-.33
180	1749	2005	1	2037	80	96		3	9381	80.7	96.8	-36.81
181	1732	2005	1	2081	85	84		1	1732	na	na	-36.24-.29
182	1755	2005	1	2011	88	90		1	3650	88.07	90.00	-35.92
183	1763	2005	1	001	87	95		5	3679			-36.09-.14
184	1736	2005	1	2062	84	100		4	9271	84.50	100.20	-36.51
185	1765	2005	1	2042	84.5	93		2	3690			-36.51-.52
186	1764	2005	1	001	87	95		5	3686			-36.14
187	1772	2005	1	2100	87	95		2	3745			-36.27-.24
188	1778	2005	1	2011	89	90		3	3769			-36.17-.23
189	1769	2005	1	2100	87	95		1	3716			-36.14-.27
190	1742	2005	1	2081	87	83		2	785			-36.22-.27
191	1771	2005	1	2100	87	95		2	3742			-36.27-.24
192	1786	2005	1	2112	91	104		1	15479	91.05	104.60	-36.22
193	1787	2005	1	2006	90	106		2	15480			-36.36-.39
194	1782	2005	1	2011	89	90		4	3781			-36.13-.17
195	1796	2005	1	Surface plus 40cm	91	85		3	18084	91.33	85.70	-35.68
196	1770	2005	1	2103	88	89		8	3738	88.31	89.89	-36.19
197	1774	2005	1	2044	83.5	98		1	9519			-36.59-.60
198	1758	2005	1	001	87	95		4	3654			-36.04-.09
199	1789	2005	1	2116	87	95		1	3827			-36.40-.43
200	1765	2005	1	2042	84.5	93		2	3690			-36.51-.52
201	1820	2005	1	2192	85	92		1	4003			-36.42-.45
202	1793	2005	1	2116	87.80	95.51		2	3843			-36.30
203	x045	2002	1	1020	83.5	95		3	1			
204	x046	2002	1	1016	82.5	90		5	1			
205	x047	2002	1	1009	88	106		4	1			
206	x048	2002	1	1020	85	97		3	1			
207	x049	2002	1	1009	88	106		2	1			
208	x050	2002	1	1031	88	106		1	1			
209	x051	2002	1	1081	84.5	96		1	1			
210	x052	2002	1	1073	100	111		2	1			
211	x053	2002	1	1054	89	106		1	1			
212	x054	2002	1	1081	83.5	96		3	1			
213	x055	2002	1	1066	85	93		1	1			
214	1799	2005	1	2038	87	84		3	980			-36.42-.47
215	x056	2001	1	022			7A		475			
216	x057	2004	1	2010	84.5	90		F44	FL2004-47			-36.46-.54
217	1878	2005	1	2135	91	105		2	15648			-36.54-.61
218	1877	2005	1	2067	87	96		5	12675	87.11	96.92	-36.56

219	1869	2005	1	2050	86	88		5	1208	86.61	88.42	-36.99
220	1802	2005	1	1051	84.5	97		7	9670	84.95	97.42	-36.58
221	1870	2005	1	2135	91	105		1	15629			-36.52
222	1879	2005	1	2079	90	103		2	15639			
223	1875	2005	1	2056	81.5	93		3	6835			-36.67-.72
224	1815	2005	1	2112	91	103		3	15510			-36.30-.35
225	1853	2005	1	2112	91	104		4	15568	91	104	-36.33-.36
226	1858	2005	1	2111	90	105		2	15598			-36.30-.35
227	1833	2005	1	2006	91	105		4	15547			-36.40-.45
228	1852	2005	1	2102	86	85		1	1154			-36.79
229	1888	2005	1	2008	88	94		3	4344			-36.18-.24
230	1894	2005	1	2021	85	88		10	1256			-36.75
231	1831	2005	1	2006	91	106		4	15539			-36.39-.45
232	1847	2005	1	2126	87	92		1	4110			-36.47-.53
233	1857	2005	1	2111	90	105		2	15597			-36.30-.35
234	1841	2005	1	2112	90	104		4	15562	90.83	104.25	-36.35
235	1840	2005	1	2112	90	104		4	15561	90.16	104.13	-36.35
236	1855	2005	1	2050	86	88		3	1162	86.31	88.32	-36.91
237	1913	2005	1	2056	81.5	92		3	6981			-36.72-.77
238	1908	2005	1	2058	86	95		5	4476	86.74	95.30	-36.46
239	1912	2005	1	2056	81.5	90		1	6973			-36.88-.91
240	1897	2005	1	2138	87	86		1	1260	87.92	86.83	-37.16
241	1906	2005	1	2079	90	102		4	15716			-36.48-.53
242	1843	2005	1	2112	90	104		4	15564	90.65	104.34	-36.37
243	1835	2005	1	2030	88	95		1	4095	88.81	95.14	-36.19
245	1842	2005	1	2112	90	104		4	15563	90.70	104.16	-36.34
246	1910	2005	1	2056	91.5	94		4	6967			-36.76-.81
248	1767	2005	1	2099	90	104		2	15439			-36.10-.15
249	1827	2005	1	013	87	94		4	4041			-36.23-.25
250	1792	2005	1	1051	80.5	97		5	9611			-36.87
251	1747	2005	1	1051	82.5	97		10	9357			-36.60-.66
252	1866	2005	1	2056	85	94		1	4202			36.48
253	1933	2005	1	2076	85	99		4	12789	85.23	99.52	-36.84
254	1947	2005	1	2068	88	93		2	4650	88.41	93.44	-36.35
255	1920	2005	1	2132	87	86		2	1352	87.92	86.45	-37.25
256	1952	2005	1	2147	82.5	90		2	7113	8.12	90.81	-36.98
257	1938	2005	1	2089	86	96		2	12799			36.62-36.67
258	1916	2005	1	2058	88	93		1	4522			36.37-36.39
259	1929	2005	1	2056	82.5	94		7	7036	82.90	94.70	-36.83
260	1934	2005	1	2076	85	99		5	12792	85.50	99.23	-36.88
261	1943	2005	1	2147	83.5	90		2	7074			36.94-36.99
262	1941	2005	1	2076	84.5	99		4	9789			36.87-36.92
263	1939	2005	1	2089	88	95		7	4606	88.40	95.72	-36.56
264	1956	2005	1	2106	88	92		2	4785			36.58-36.68
265	1931	2005	1	1085	88	93		1	4575	88.61	93.14	-36.26
266	1945	2005	1	2155	87	92		1	4639	87.17	92.09	-36.63
267	1944	2005	1	2076	84.5	100		7	9793			36.93-37.01
268	1903	2005	1	2135	91	106		4	15709			-36.67
269	1901	2005	1	2135	90	106		3	15703			36.61-36.68
270	1892	2005	1	2136	85	91		1	4399			36.60-36.65
271	1748	2005	1	1051	82.5	99		5	9360			36.62-36.69
272	1972	2005	1	2056	81.5	90		3	7163			36.94-36.98
273	1848	2005	1	1051	82.5	99		5	9722			36.62-36.69
274	1900	2005	1	2115	87	94		1	4436	87.85	94.22	-36.30
275	x058	2005	1	2044	85	98		3	12723			36.45-36.50

276	1898	2005	1	2044	85	98		3	12723			36.45-36.50
277	1830	2005	1	2067	88	96		2	12630	88.09	96.19	-36.39
278	x060	2005	1	2111	90	105		2	FL-2005-63			36.31-36.36
279	x059	2005	1	2095	83.5	97		1	FL-2005-05			36.58-36.68
280	1809	2005	1	2054	83.5	91		1	6611			36.62-36.67
281	x061	2005	1	2106	88	90		6	4769			36.72-36.81
282	x063	2005	1	2135	91	106		3	FL-2005-151			36.55-36.61
283	x064	2005	1	2115	87	95		1	3802			36.28-36.33
284	x065	2005	1	2006	91	106		3	FL-2005-82			36.34-36.40
285	1867	2005	1	2135	90	106		1	15622			-36.48
286	x068	2005	1	2127	87	92-93		3	3999			36.32-36.37
287	x067	2005	1	2135	90	106		2	15664			-36.59
288	x066	2005	1	2112	90	105		4	15556			-36.34
289	x070	2005	1	2135	90	106		1				-36.48
290	x069	2005	1	2135	90	106		1				-36.48
291	1795	2005	1	surface	91	87		3	18081	91.10	87.40	35.51
292	1819	2005	1	suface	90	85		4	18101			
293	x062	2005	1	2063	90	97		3	FL-2005-38			35.83-35.84
294	1845	2005	1	2112	90	105		4	15556			36.34-36.44
295	1744	2005	1	1051	83.5	99		5	9342	83.57	99.26	-36.65
296	x071	2005	1	2050	86	87		3	FL-2005-133			36.92-26.97
298	x075	2005	1	2105	87	94		1	3976			36.09-36.16
299	x074	2005	1	2125	88	90		5	4447			36.45-36.49
300	x073	2005	1	2056	81.5	90		3	7155			36.94
301	0119	2001	2	014			Unit 1					158 BS
302	x072	2001	1	000					1134			
303	x073	2001	1	061	84	96						
304	x074	2001	1	148	83	95			1082			
305	x075	2001	1	001			Unit 4		408			
306	0098	2001	1	102	87	86						97.31
307	x076	2001		000					655			
308	0099	2001	1	106	84	94						97.42
309	x077	2004	1	Surface								
310	x078	2005	1	Surface								
311	x079	2005	1	2076	85	101		5	FL-2005-82			-36.69-.73
312	1844	2005	1	2050	86	86		1	1116	86.20	86.38	-36.76
313	1918	2005	1	2051	84.5	99		4	9778			-36.61-.64

APPENDIX B

DHRA' BEAD CLASSIFICATION INFORMATION

ID	Special Find Number	Class (Cross Section View)	Planview Shape	Preser-vation	Raw Material	Color	Prod-uction Stage	Surface Treatment	Notes
1	1591	Type 2	Linear	Incomplete	Bone	Tan / Light Brown	Finished	Polished	One side polished - other side inside of long bone
2	1588	Type 5	Oval	Complete	Limestone	White / Grey	Finished	Unpolished w/ Drill Scars	Typical white oval bead
3	1589	Type 2	Linear	Incomplete	Malachite	Sea Green	Partially Drilled	Unpolished	Poss. Broken before perforation was complete
4	1610	Type 1	Cylindrical	Complete	Limestone	White	Blank	None	Not degraded like other limestone… may not be l.s.
5	1369	Type 5	Oval	Complete	Soapstone	Dark Grey w/ white inclusions	Finished	Polished	
7	1595	Type 1	Linear	Complete	Jasper	Tan / Peach	Finished	Polished	
8	1373	Type 4	Cylindrical	Complete	Jasper	Tan / Peach	Finished	Polished	Milky material
9	1482	Type 5	Oval	Complete	Limestone	White / Grey	Finished	Unpolished	Irregular perforation
10	1504	Type 5	Oval	Complete	Limestone	White w/ hint of green	Finished	Unpolished w/ Drill Scars	Smoother than limestone beads of similar shape
11	1408	Type 5	Oval	Complete	Soapstone	Green / Teal	Partially Drilled	Polished with drill scars	Dabba Marble - Similar to 1369 soapstone yet green
12	1458	Type 2	Linear	Incomplete	Jade	Green	Finished	Polished	broken, just over half left
13	1583	Type 4	Cylindrical	Complete	Bone	Dark Grey and Tan	Finished	None	Might just be burnt faunal bone
14	1642	Type 10	Other	Complete	Soapstone	Dark Grey / Black	Finished	Polished, one large incision, no perforations	figure 8 shape, no holes, tied on by incision
15	1431	Type 1	Linear	Complete	Indeterminant	Light Brown / Tan	Finished	Polished	Very regular
16	1379	Type 10	Circular	Complete	Other	Teal / Light Blue	Finished	Polished	Very small, very blue, detailed drilling
17	1404	Type 2	Linear	Complete	Jasper	Light Brown / Peach	Blank	Polished	Part. Ground into preform, sqr. depression one end
18	1410	Type 2	Linear	Broken	Limestone	White	Finished	Unpolished, small incisions across section surface	Small incisions poss. prod, or use marks

19	1425	Type 10	Other	Complete	Jasper	Peach / tan - milky	Blank	Polished w/ surface incisions, no perforations	Sect. - rect., plan - trapezoid, one flat side
20	1426	Type 5	Oval	Complete	Limestone	White	Finished	Unpolished	Poorly preserved, plan shape more trap. than oval
21	1409	Type 2	Linear	Complete	Indeterminant	Dark Grey	Finished	Unpolished	Irregular sect. view
22	1586	Type 1	Linear	Complete	Indeterminant	Light Grey	Finished	Unpolished	thicker than other flat beads
23	1537	Type 5	Oval	Complete	Limestone	Very light green	Finished	Drill scars	smooth, typical oval bead
24	1552	Type 9	Oval	Incomplete	Quartz	Peach - pinkish white	Raw Material	None	Quartz Pebble - one half
25	1419	Type 5	Oval	Broken	Limestone	White - hint of green	Finished	unpolished	degraded limestone broken in half length-wise
26	1396	Type 9	Other	Complete	Malachite	Green	Raw Material	Raw Material	One piece
27	1459	Type 10	Other	Broken	Malachite	light green inside, tan outside	Raw Material	one smoothed side	One ground side, for pigmentation
28	1139	Type 2	Linear	Incomplete	Limestone	White	Finished	Unpolished, drill scars, numerous incisions	Chalky white-incisions on sect surface-half missin
29	1255	Type 3	Linear	Complete	Malachite	Light green	Finished	2 perforations	double perforation, very regular
30	1246	Type 10	Linear	Complete	Limestone	White w/ green and brown flecks	Finished	one polished edge- 4 perforations one less regular	4 holes, one not as reg as the others
31	1270	Type 5	Oval	Complete	Malachite	Dark/light green	Partially Drilled	one end partially drilled, just started	basic preform w/ start of one hole on one end
32	1143	Type 5	Oval	Complete	Malachite	Light Green	Blank	unpolished	regularly shaped perform
33	1218	Type 5	Oval	Complete	Malachite	Dark/light blue	Blank	Unpolished	like above ex., but more blueish than green
34	1254a	Type 5	Linear	Complete	Malachite	blue green	Blank	Polished	
35	1279	Type 1	Linear	Complete	Quartz	Cream	Finished	Polished	one side has much wider drill hole
37	1261	Type 1	Linear	Complete	Indeterminant	grey / brown	Finished	Unpolished	Very regular
38	1164	Type 5	Oval	Incomplete	Limestone	white w/ hint of green	Finished	Unpolished, drill scars	slightly chipped - standard oval bead
39	1254b	Type 2	Oval	Complete	Malachite	dark/light green	Blank	Unpolished	longer/narrower (ratio) than other mal blanks

40	1167	Type 2	Linear	Complete	Malachite	Light green/blue	Blank	unpolished	poss. flat bead blank
41	1258	Type 6	Oval	Incomplete	Malachite	Light green / brown	Finished	drilled twice, once ladit. And once longitud	oval bead broken/half-new drilling on other side
42	1266	Type 3	Linear	Complete	Malachite	Blue/green	Blank	Smoothed	flat oval shaped bead perform
43	1265	Type 6	Linear	Incomplete	Limestone	white/tan	Finished	slight incisions and depression on one side	Square-shaped, broken in half on diag. axis
45	1291	Type 5	Oval	Incomplete	Malachite	Light/sea green	Partially Drilled		broken during production-still smoothed from use
46	1286	Type 4	Cylindrical	Complete	Other	brown / grey	Finished	Unpolished	dark, long basalt cylindrical groundstone
47	1256	Type 5	Oval	Broken	Limestone	White/ tan	Finished	Unpolished	Reg oval bead-shattered but completish
48	1025	Type 7	Other	Complete	Shell	Tan	Finished		Ground down on one side - red or mediteranian
49	1099	Type 9	Other	Complete	Indeterminant	Dark brown	Raw Material	none	Chunk of raw material, unworked
50	1042	Type 7	Linear	Complete	Shell	Shiny/pearly peach	Finished	polished/smoothed - may be due to raw material	rectangular sect-very shiny, perf at top of bead
51	1009	Type 2	Linear	Complete	Quartz	White/tan	Finished	drill scars	more solid than limestone, not very regular
52	1086	Type 2	Linear	Complete	Quartz	White	Finished	Unpolished	not very regular, more solid than limestone
54	1205	Type 5	Oval	Incomplete	Limestone	White/grey	Finished	Unpolished	2 Pieces - standard oval bead
55	1062	Type 1	Other	Complete	Quartz	white	Blank	None	sect & plan are rectangle, quartzy material
56	1085	Type 2	Oval	Complete	Limestone	White w/ hint of green	Finished	Unpolished, drill scars	standard oval bead
57	1070	Type 1	Linear	Complete	Jasper	Peach / rosy	Blank	None	preform for larger flat bead
58	1064	Type 5	Cylindrical	Complete	Soapstone	Black w/ light white inclusions	Finished	deep incision-no perforations-one oval depression	rectangular plan view, deep incision
59	1302	Type 1	Linear	Complete	Quartz	White	Finished	Polished	very regular flat bead, the hard white material
60	1325	Type 1	Linear	Complete	Indeterminant	brown/tan/grey	Finished	Unpolished	very regular flat bead

61	1321	Type 6	Other	Incomplete	Jade	Grey, green, blue	Finished	Unpolished	broken in 1/2-rect Plan-perf in the center not end
62	1211	Type 9		Complete	Malachite	Light blue/green	Raw Material		2 pieces
63	1245	Type 9			Malachite	Light green	Raw Material		1 piece
64	1326	Type 9			Malachite	teal and light green	Raw Material		1 piece
65	1111	Type 9			Malachite	light blue/green	Raw Material		1 piece
66	1208	Type 9			Malachite	light blue/green	Raw Material		1 piece
67	1212	Type 9			Malachite	light blue/dark green	Raw Material		2 pieces
68	1209	Type 9			Malachite	light blue green	Raw Material		1 piece
69	1191	Type 9			Malachite	light blue/green	Raw Material		1 piece
70	1184	Type 9			Malachite	light green	Raw Material		1 piece
71	1173	Type 9			Malachite	light blue/green	Raw Material		1 piece
72	1290	Type 9			Malachite	teal/ blue green	Raw Material		1 piece
73	1244	Type 9			Malachite	light blue green	Raw Material		1 piece
74	1180	Type 9			Malachite	light blue	Raw Material		3 pieces w/ some debitage
75	1364	Type 9			Limestone	grey / brown	Raw Material		1 rounded pebble, poss. Limestone
76	1422	Type 9			Malachite	blue / green	Raw Material		1 piece
77	1530	Type 9			Limestone	Tan	Raw Material		1 oval pebble, poss bead blank
78	1465	Type 9			Malachite	light blue green	Raw Material		3 pieces w/ some debitage
79	1539	Type 5	Oval	Incomplete	Malachite	light green	Finished	Unpolished	half of small oval bead
80	1469	Type 10	Linear	Incomplete	Other	peach/tan	Finished	either biconical or preformed… most likely drilled	1/2 Ceramic disc, poss. Made from pot sherd
81	1391	Type 9			Quartz	Tan / light brown	Raw Material		Quartz pebble
82	1370	Type 1			Soapstone	Black	Raw Material	Polished	poss bead prod piece-blank snapped off??
84	1639	Type 2	Cylindrical	Complete	Quartz	White	Blank		may have piece snap off-1end 1/2 smooth 1/2 rough

85	1675	Type 10	Linear	Complete	Indeterminant	Dark grey/black	Finished		tear-drop shape flat bead
86	1649	Type 5	Oval	Complete	Malachite	Light blue/green	Partially Drilled		thick oval bead perf started on one end
87	1654	Type 10	Linear	Complete	Limestone	White / chalky	Finished	drilled into section of 1/2 broken circular bead	new perf in broken circular bead frag-reused bead
88	1637	Type 9			Quartz	Rosy peach	Raw Material		Quartz pebble
89	1526	Type 5	Oval	Complete	Limestone	White	Finished		regular white oval bead, uneven ends
91	1650	Type 9			Malachite	Light blue/green	Raw Material		large malachite chunk w/ bands of color
92	1643	Type 9			Malachite	Light blue/green	Raw Material		1 piece
93	1617	Type 9			Malachite	Light blue/green	Raw Material		1 piece
94	1630	Type 9			Quartz	White	Raw Material		1 piece of quartz/calcite
95	x001	Type 9			Malachite	light blue	Raw Material		1 piece
96	x002	Type 9			Malachite	Light blue/green	Raw Material		2 pieces
97	x003	Type 9			Malachite	Light blue/green	Raw Material		1 piece of debitage
98	x004	Type 9			Malachite	Light blue/green	Raw Material		c. 9 pieces w/ debitage
99	x005	Type 9			Malachite	Light blue/green	Raw Material		c. 6 pieces w/ debitage
100	x006	Type 9			Malachite	Light blue/green	Raw Material		1 piece
101	x007	Type 9			Malachite	Light blue/green	Raw Material		3 pieces w/ debitage
102	x008	Type 9			Malachite	Light blue/green	Raw Material		1 piece
103	x009	Type 9			Malachite	Light blue/green	Raw Material		1 piece of debitage
104	x010	Type 9			Malachite	Light blue/green	Raw Material		4 pieces
105	x011	Type 9			Malachite	Light blue/green	Raw Material		1 piece of debitage
106	x012	Type 9			Malachite	Light blue/green	Raw Material		5 pieces w/ debitage
107	x013	Type 9			Malachite	Light blue/green	Raw Material		3 pieces w/ debitage
108	x014	Type 9			Malachite	Light blue/green	Raw Material		1 piece w/ debitage

109	1638	Type 9			Malachite	Light blue/green	Raw Material		c.8 pieces w/ debitage
110	x015	Type 9			Malachite	Light blue/green	Raw Material		1 piece w/ debitage
111	x016	Type 9			Malachite	Light blue/green	Raw Material		2 pieces of debitage
112	x017	Type 9			Malachite	Light blue/green	Raw Material		1 piece
113	x018	Type 9			Malachite	Light blue/green	Raw Material		8 pieces w/ debitage
114	x019	Type 9			Malachite	Light blue/green	Raw Material		1 piece of debitage
115	x020	Type 9			Malachite	Light blue/green	Raw Material		2 pieces
117	x021	Type 9			Malachite	Light blue/green	Raw Material		1 piece
119	1685	Type 9			Malachite	Light blue/green	Raw Material		1 piece
120	1671	Type 5	Oval	Complete	Jade	light green	Finished	drill scars, polished, very smooth	very regularly shaped, poss light colored jade
121	1710	Type 9			Quartz	White	Raw Material		White quartz pebble
122	1659	Type 5	Oval	Complete	Jasper	alternating tan/rosy stripes	Partially Drilled	drill scars	odd color pattern-fine grained chert
123	x022	Type 9			Malachite	Light blue/green	Raw Material		1 piece
124	x023	Type 9			Malachite	Light blue/green	Raw Material		1 piece
125	x024	Type 9			Malachite	Light blue/green	Raw Material		1 piece of debitage
126	x025	Type 9			Malachite	Light blue/green	Raw Material		5 pieces
127	x026	Type 9			Malachite	Light blue/green	Raw Material		2 pieces w/ debitage
128	1712	Type 2	Linear	Complete	Malachite	Light blue/green	Blank		type 1a perform
129	1713	Type 1	Linear	Complete	Indeterminant	Dark grey	Raw Material		poss part of blank raw material-broken&round ends
130	1538	Type 9			Quartz	red-brown and tan	Raw Material		2 quartz pebbles

131	1657	Type 4	Cylindrical	Complete	Jade	Dark green	Partially Drilled	broken edge, incision from break off -2 rough ends	slight perf-fresh break, no polished ends
132	1492	Type 9			Malachite	Light blue/green	Raw Material		1 piece
133	1726	Type 1	Cylindrical	Complete	Soapstone	Dark grey	Blank	incised freshly broken end	cylinder that had round blanks removed
134	1725	Type 1	Linear	Incomplete	Limestone	White	Finished		half of a white beveled bead
135	1596	Type 4	Cylindrical	Complete	Jasper	Tan/peach	Finished	degrading surface, drill scars	lower quality jaspar bead w/ irregular ends
136	1724	Type 5	Oval	Complete	Malachite	Light blue/green	Blank		Malachite bead blank, but small end prevent drill
137	1367	Type 5	Oval	Complete	Malachite	Light blue/green	Blank		small malachite bead perform
138	1722	Type 5	Oval	Complete	Limestone	Grey/black	Finished	degrading, drill scars	burnt limestone bead
139	1720	Type 5	Oval	Incomplete	Limestone	White w/ hint of green	Finished		half longwise, able to see inside of perforation
140	1493	Type 5	Oval	Incomplete	Limestone	White / tan	Blank	smoothed with possible incisions	possible limestone blank but fracturing = no drill
141	1727	Type 7	Linear	Complete	Shell	Tan	Finished	2 perf, ground around edges	shell w/ 2 perf, ground into oval
142	1467	Type 7	Linear	Incomplete	Limestone	White / tan	Finished	cutmarks/incisions on one side	part of bead production or pendant or stone disc
143	1721	Type 8	Linear	Incomplete	Limestone	Tan	Finished	ground	Broken ground stone bracelet found in burial c2048
144	1342	Type 8	Linear	Incomplete	Other	Grey / tan	Finished	ground bracelet	basalt or limestone groundstone bracelet fragment
145	x027	Type 9			Malachite	Light blue/green	Raw Material		1 piece
146	x028	Type 9			Malachite	Light blue/green	Raw Material		3 pieces w/ debitage
147	1402	Type 9			Malachite	Light blue/green	Raw Material		4 pieces w/ debitage
148	1465	Type 9			Malachite	Light blue/green	Raw Material		4 pieces w/ debitage
149	x029	Type 9			Malachite	Light blue/green	Raw Material		1 piece
150	x030	Type 9			Malachite	Light blue/green	Raw Material		Debitage

151	x033	Type 9			Malachite	Light blue/green	Raw Material		1 piece w/ debitage
152	x031	Type 9			Malachite	Light blue/green	Raw Material		1 piece w/ debitage
153	x032	Type 9			Malachite	Light blue/green	Raw Material		Debitage
154	1393	Type 9			Malachite	Light blue/green	Raw Material		3 pieces w/ debitage
155	1394	Type 9			Malachite	Light blue/green	Raw Material		6 pieces w/ debitage
156	x034	Type 9			Malachite	Light blue/green	Raw Material		1 piece
157	x035	Type 9			Malachite	Light blue/green	Raw Material		1 piece
158	x036	Type 9			Malachite	Light blue/green	Raw Material		1 piece
159	x037	Type 9			Malachite	Light blue/green	Raw Material		7 pieces w/ debitage
160	x038	Type 9			Malachite	Light blue/green	Raw Material		Debitage
161	x043	Type 9			Malachite	Light blue/green	Raw Material		1 piece
162	x042	Type 9			Malachite	Light blue/green	Raw Material		1 piece w/ debitage
163	x041	Type 9			Malachite	Light blue/green	Raw Material		1 piece
164	x040	Type 9			Malachite	Light blue/green	Raw Material		1 piece
165	x039	Type 9			Malachite	Light blue/green	Raw Material		Debitage
166	1398	Type 9			Malachite	Light blue/green	Raw Material		7 pieces w/ debitage
167	1723	Type 9			Limestone	grey/brown/tan	Raw Material		1 pebble
168	1551	Type 9			Quartz	White	Raw Material		translucent white quartz chunk
169	1197	Type 9			Soapstone	dark grey/black	Raw Material	incisions, poss from forming it into stick	poss preform of barrel
170	1190	Type 9			Quartz	White	Raw Material		quartz chunk w/ cortex
171	x044	Type 9			Malachite	Light blue/green	Raw Material		2 pieces w/ debitage
172	1711	Type 10	Other	Complete	Malachite	Light blue/green	Finished		rect ^3 bead w/ 2 perforations
173	1728	Type 10	Other	Complete	Malachite	Light blue/green	Blank		smaller version of 1246 w/ no perf

174	1673	Type 10	Linear	Complete	Limestone	White / tan	Finished		squarish bead
176	1729	Type 10	Linear	Complete	Other	Tan	Finished	striations on the section surface, drill scars	ceramic disc made from broken potsherd
177	1730	Type 2	Linear	Complete	Soapstone	Dark grey / black	Finished		flat soapstone beveled bead, found during backfill
178	1695	Type 5	Oval	Complete	Limestone	White/grey	Finished	Unpolished	regular limestone barrel bead - not photographed
179	1691	Type 10	Cylindrical	Complete	Limestone	brown	Finished		semicircular section view - no photo
180	1749	Type 8	Circular	Broken	Limestone	Cream, white	Finished	Scoring on surface	Broken bracelet fragment
181	1732	Type 2	Oval	Complete	Limestone	white/tan	Blank		
182	1755	Type 9		Complete	Quartz	white/tan	Raw Material		
183	1763	Type 9		Complete	Malachite	blue/green	Raw Material		
184	1736	Type 9		Complete	Quartz	rosy peach	Raw Material		
185	1765	Type 9		Complete	Malachite	green	Raw Material		
186	1764	Type 1	Linear	Complete	Limestone	grey/black	Blank	slight incisions on both sides	smoothed drilling surfaces, rough margins
187	1772	Type 1	Linear	Complete	Jasper	peach with red lines	Blank		smoothed drilling surfaces, rough margins
188	1778	Type 4	Cylindrical	Complete	Malachite	green	Blank	polished on all sides	maybe presegmented for types 1a, or 2
189	1769	Type 5	Oval	Complete	Malachite	green/blue	Blank		
190	1742	Type 10	Linear	Complete	Limestone	white - chalky	Partially Drilled	linear incisions plus circular drill scarring	square thick bead with small perf on one side
191	1771	Type 2	Linear	Complete	Indeterminant	peach	Finished	slight incisions, polished drilling sides	small pebble, ground, perforated, pos not finished
192	1786	Type 10	Circular	Complete	Other	peach with white linear inclusions	Finished	ground/polished	Giant bead - made of big pebble of dabba marble
193	1787	Type 1	Linear	Complete	Quartz	light tan/white	Finished		possible segmented root casing
194	1782	Type 5	Oval	Complete	Limestone	white - chalk	Finished		made of chalk from limestone deposits

195	1796	Type 7	Linear	Complete	Shell	white with rosy patch	Finished	drill scars	broken part of a shell then drilled
196	1770	Type 5	Oval	Broken	Limestone	grey/brown	Finished		broken, but still usable, not white chalk
197	1774	Type 5	Oval	Complete	Limestone	white/greenish hue - chalky	Finished	striations	made of chalk
198	1758	Type 1	Linear	Complete	Jasper	rosy and white/tan	Finished	polished	poss same material as giant bead - sf 1786
199	1789	Type 9			Malachite	green/blue	Raw Material		
200	1765	Type 9			Malachite	blue-green	Raw Material		
201	1820	Type 9			Malachite	light green	Raw Material		
202	1793	Type 9			Malachite	light green	Raw Material		1 piece
203	x045	Type 9			Malachite	light blue	Raw Material		1 piece of debitage
204	x046	Type 9			Malachite	light blue	Raw Material		1 piece of debitage
205	x047	Type 9			Malachite	blue/green	Raw Material		7 pieces and debitage
206	x048	Type 9			Malachite	blue/green	Raw Material		1 piece
207	x049	Type 9			Malachite	blue/green	Raw Material		4 pieces
208	x050	Type 9			Malachite	blue/green	Raw Material		>7 pieces and tons of debitage
209	x051	Type 9			Malachite	blue/green	Raw Material		1 piece
210	x052	Type 9			Malachite	blue/green	Raw Material		1 piece
211	x053	Type 9			Malachite	blue/green	Raw Material		1 piece and debitage
212	x054	Type 9			Malachite	blue/green	Raw Material		1 piece of debitage
213	x055	Type 9			Malachite	light blue/green	Raw Material		1 piece
214	1799	Type 9			Malachite	blue/green	Raw Material		1 piece
215	x056	Type 5	Oval	Broken	Limestone	white with greenish hue	Finished		broken bead from 2001 in a fauna bag
216	x057	Type 9			Malachite	light blue	Raw Material		2 pieces of debitage from heavy residue of float
217	1878	Type 9			Malachite	light blue/green	Raw Material		2 pieces
218	1877	Type 5	Oval	Complete	Soapstone	dark brown	Finished	third perforation started on length section	dimple perforation/third perf
219	1869	Type 4	Cylindrical	Complete	Malachite	light green	Finished	polished	might be dabba marble
220	1802	Type 1	Cylindrical	Complete	Other	brown/black	Blank		root casing with started segmentation

221	1870	Type 5	Other	Complete	Jade	light blue green	Finished		barrel elip bead, then one half ground down-dabba
222	1879	Type 9			Malachite	blue/green	Raw Material		1 piece and 2 pieces of debitage
223	1875	Type 4	Cylindrical	Complete	Limestone	grey	Finished		kind of a mix between cylind and bar-elip
224	1815	Type 2	Linear	Complete	Limestone	white/tan	Finished		
225	1853	Type 9			Malachite	blue/green	Raw Material		1 large piece
226	1858	Type 9			Quartz	white/tan	Raw Material		1 pebble
227	1833	Type 1	Linear	Complete	Limestone	light brown/grey	Finished		poss root casing bead
228	1852	Type 5	Oval	Complete	Limestone	grey	Finished		
229	1888	Type 5	Oval	Complete	Limestone	light and dark grey	Finished		
230	1894	Type 5	Oval	Broken	Malachite	light green	Partially Drilled		
231	1831	Type 9			Malachite	light blue/green	Raw Material		1 piece, maybe cut but no evidence of polish/drill
232	1847	Type 9			Malachite	light blue/green	Raw Material		2 pieces of debitage
233	1857	Type 9			Malachite	blue/green	Raw Material		1 piece with debitage
234	1841	Type 9			Malachite	blue/green	Raw Material		1 piece
235	1840	Type 9			Malachite	blue/green	Raw Material		
236	1855	Type 5	Oval	Incomplete	Limestone	grey/brown	Finished		
237	1913	Type 5	Oval	Incomplete	Limestone	white/green chalk	Finished	6 perforations, polished	6 perforations - 4 secondary along the width dimen
238	1908	Type 5	Oval	Complete	Malachite	blue/green	Finished	polished	
239	1912	Type 9			Malachite	blue/green	Raw Material		1 piece
240	1897	Type 5	Oval	Complete	Limestone	white	Blank		incised/shaped - not drilled
241	1906	Type 1	Linear	Complete	Limestone	white/brown	Finished		poss root casing bead
242	1843	Type 5	Oval	Complete	Malachite	light blue/green	Blank		poss similar to double drilled malachite bead
243	1835	Type 5	Oval	Incomplete	Malachite	blue/green	Finished		broken length-wise
245	1842	Type 10	Cylindrical	Incomplete	Limestone	green/brown	Finished	polished	
246	1910	Type 1	Cylindrical	Complete	Limestone	tan	Blank		slightly curved
248	1767	Type 1	Linear	Complete	Limestone	brown	Finished		possible root casing bead
249	1827	Type 10	Other	Complete	Shell	tan	Finished	sliced shell	shell cut in half and then cut to have a perf
250	1792	Type 1	Linear	Complete	Jasper	green	Finished		possible dabba marble bead

251	1747	Type 5	Oval	Incomplete	Limestone	green	Finished		dabba marble
252	1866	Type 9			Malachite	light green	Raw Material		1 piece
253	1933	Type 5	Oval	Complete	Limestone	white/green tint	Finished	polished	Chalk
254	1947	Type 9			Malachite	blue/green	Raw Material		1 piece – big
255	1920	Type 2	Oval	Complete	Limestone	white	Blank	burning, cut marks	Evidence of segmentation on one end
256	1952	Type 9			Quartz	tan/white	Raw Material		1 piece – big
257	1938	Type 2	Linear	Complete	Limestone	gray	Finished		
258	1916	Type 2	Linear	Complete	Limestone	dark gray	Finished	incisions/scrap marks	
259	1929	Type 4	Cylindrical	Incomplete	Quartz	tan/white	Finished	polish - possibly biconical	one rough end broken width-wise/possibly cut
260	1934	Type 5	Oval	Broken	Limestone	white/chalky	Finished		Chalk
261	1943	Type 5	Oval	Complete	Limestone	white/chalky	Finished		Chalk
262	1941	Type 5	Oval	Complete	Limestone	white/chalky	Finished		Chalk
263	1939	Type 5	Oval	Complete	Limestone	light tan	Blank		one end rounded
264	1956	Type 9			Other	light red/brown	Raw Material		one piece
265	1931	Type 10	Other	Complete	Shell	pinkish white	Finished	cut in half	possible bead
266	1945	Type 1	Linear	Complete	Limestone	brown/beige	Finished		possible root-casing bead
267	1944	Type 5	Oval	Complete	Limestone	white with green hue	Finished		Chalk
268	1903	Type 9			Malachite	blue-green	Raw Material		9 pieces
269	1901	Type 9			Malachite	green-blue	Raw Material		1 piece
270	1892	Type 9			Quartz	tan-brown	Raw Material	polish	1 piece
271	1748	Type 1	Cylindrical	Complete	Other	tan	Finished		root casing; cut on 1 end
272	1972	Type 10	Linear	Complete	Malachite	light green	Finished	4 perforations	4 holes
273	1848	Type 1	Cylindrical	Complete	Other	brown	Blank	partially segmented	scored root casing
274	1900	Type 9			Malachite	light blue	Raw Material		1 piece with debitage
275	x058	Type 5	Cylindrical	Broken	Limestone	white w/ green hue	Finished		broken lengthwise; chalk bead
276	1898	Type 5	Cylindrical	Complete	Limestone	white w/ green hue	Finished		chalk bead
277	1830	Type 4	Cylindrical	Incomplete	Shell	tan	Finished	ground/polished	
278	x060	Type 9			Malachite	light green	Raw Material		1 piece
279	x059	Type 9			Malachite	light green	Raw Material		2 pieces

280	1809	Type 5	Oval	Complete	Limestone	white w/ green hue	Finished	polish	Chalk
281	x061	Type 5	Oval	Complete	Limestone	gray/white	Finished		
282	x063	Type 9			Malachite	green	Raw Material		9 pieces
283	x064	Type 9			Malachite	light green	Raw Material		1 piece; pulled from MO-2005-08
284	x065	Type 9			Malachite	green-blue	Raw Material		3 pieces
285	1867	Type 9			Malachite	green	Raw Material		1 piece
286	x068	Type 9			Malachite	green	Raw Material		1 piece; pulled from FL-2005-75
287	x067	Type 9			Malachite	green-blue	Raw Material		6 pieces
288	x066	Type 9			Malachite	light green	Raw Material		3 pieces
289	x070	Type 5	Oval	Broken	Malachite	light green	Finished		3 pieces; same spit as raw mat and part. Drill
290	x069	Type 5	Oval	Complete	Malachite	light green	Partially Drilled		Same spit as broken bead and raw material
291	1795	Type 5		Incomplete	Malachite	light green	Finished	heightwise perforation started	
292	1819	Type 1	Cylindrical	Complete	Limestone	dark brown	Blank	ground	
293	x062	Type 2	Linear	Complete	Jasper	rose/peach	Blank		possible red dabba
294	1845	Type 10	Other	Complete	Malachite	blue/green	Blank		like 4 perforation rectangular bead
295	1744	Type 5	Other	Complete	Limestone	dark & light brown	Blank	striations	segmenting piece
296	x071	Type 5	Oval	Complete	Limestone	dark green/red lines	Finished		broken and reused/polished – dabba
298	x075	Type 5	Oval	Complete	Limestone	gray/green	Finished	polished	dabba marble
299	x074	Type 2	Linear	Complete	Limestone	dark gray/brown	Finished		
300	x073	Type 9			Malachite	blue-green	Raw Material		1 piece
301	0119	Type 9			Malachite	blue/green	Raw Material		2 pieces of debitage
302	x072	Type 9			Malachite	light light blue	Raw Material		1 piece
303	x073	Type 9			Malachite	blue/green	Raw Material		1 piece of debitage
304	x074	Type 9			Malachite	light blue/green	Raw Material		3 pieces
305	x075	Type 9			Malachite	light blue	Raw Material		1 broken piece
306	0098	Type 9			Malachite	blue/green	Raw Material		1 piece of debitage
307	x076	Type 9			Malachite	light blue	Raw Material		1 piece

308	0099	Type 9			Malachite	light blue/green	Raw Material		1 broken piece
309	x077	Type 5	Oval	Complete	Malachite	light green/white	Finished	polished	found in backdirt - very small perforation/long
310	x078	Type 4	Cylindrical	Complete	Limestone	green/white	Finished	polished	dabba marble - wide perf
311	x079	Type 1	Linear	Complete	Limestone	grey/brown	Finished		
312	1844	Type 9			Malachite	blue/green	Raw Material		1 piece
313	1918	Type 5	Oval	Complete	Limestone	white w/ green hue	Finished	poss painting - along w/ other chalk beads	chalk bead

APPENDIX C

DHRA’ BEAD METRIC INFORMATION

ID	Special Find Number	Length	Width	Height	Maximum Perforation Diameter	Minimum Perforation Diameter	Maximum Rim Size	Minimum Rim Size
1	1591	3.03	18.05	8.95	4.00	NA	7.46	5.61
2	1588	31.65	22.50	9.82	6.27	6.13	7.75	0
3	1589	4.63	NA	NA	NA	NA	NA	NA
4	1610	13.28	9.41	8.16	NA	NA	NA	NA
5	1369	23.05	13.18	9.65	4.79	3.85	4.17	1.37
7	1595	1.35	5.38	5.32	2.19	2.19	1.87	1.53
8	1373	8.56	9.62	9.37	5.01	3.60	2.98	2.12
9	1482	17.05	13.88	8.87	4.71	3.59	4.21	0.96
10	1504	18.33	14.29	8.44	4.02	3.88	5.17	1.20
11	1408	23.68	13.07	7.39	5.65	4.96	3.54	0
12	1458	2.99	11.19	NA	3.10	2.97	4.46	4.23
13	1583	19.69	6.40	6.37	4.26	3.94	0.97	0.87
14	1642	5.57	10.24	5.68	None	None	None	None
15	1431	1.91	6.19	6.16	2.37	2.22	2.30	2.22
16	1379	2.38	3.39	3.04	1.01	0.83	1.02	0.71
17	1404	8.54	14.41	13.73	NA	NA	NA	NA
18	1410	6.61	20.95	20.26	5.04	4.65	10.21	6.30
19	1425	22.70	19.57	11.84	NA	NA	NA	NA
20	1426	20.68	15.46	11.37	4.66	3.92	6.43	2.83
21	1409	2.29	8.24	7.11	2.43	2.00	3.91	2.22
22	1586	2.43	4.96	4.94	2.41	2.01	1.68	0.97
23	1537	25.98	15.36	6.36	3.75	4.45	3.25	0.67
24	1552	32.24	43.32	23.51	NA	NA	NA	NA
25	1419	19.05	16.65	9.95	5.23	4.16	6.37	1.99
26	1396	15.00	14.50	7.07	NA	NA	NA	NA
27	1459	21.45	12.31	13.21	NA	NA	NA	NA
28	1139	11.94	34.15	17.44	NA	NA	13.60	NA
29	1255	2.45	6.09	11.30	2.48	2.09	2.90	1.69
30	1246	10.36	35.82	9.98	4.44	3.73	4.72	0.89
31	1270	12.10	10.39	8.17	2.16	1.92	3.14	1.61
32	1143	13.17	11.51	7.72	NA	NA	NA	NA
33	1218	14.33	12.63	8.20	NA	NA	NA	NA
34	1254a	4.38	12.01	11.23	NA	NA	NA	NA
35	1279	1.75	4.85	4.87	2.88	1.67	1.90	1.11
37	1261	1.38	5.38	5.41	2.10	1.82	1.77	1.76
38	1164	16.28	13.58	7.93	4.96	3.99	4.79	1.33
39	1254b	14.89	8.49	5.19	NA	NA	NA	NA
40	1167	2.28	6.90	6.21	NA	NA	NA	NA
41	1258	12.62	6.54	7.85	NA	NA	4.50	NA
42	1266	4.77	12.10	9.28	NA	NA	NA	NA
43	1265	1.94	12.53	7.72	2.70	NA	5.88	4.46
45	1291	19.05	6.84	6.21	NA	NA	NA	NA
46	1286	15.65	6.34	5.73	2.58	2.38	2.43	1.61
47	1256	24.31	14.69	7.17	NA	NA	NA	NA
48	1025	11.26	38.55	26.96	7.27	5.66	27.33	2.73
49	1099	23.81	15.42	13.24	NA	NA	NA	NA
50	1042	1.36	12.57	22.05	3.12	2.69	17.69	1.88

51	1009	5.63	12.70	12.59	3.53	3.15	6.02	3.36
52	1086	6.55	12.27	12.24	4.19	3.82	4.91	3.14
54	1205	15.88	14.97	7.81	4.38	NA	4.63	1.32
55	1062	23.10	11.61	10.11	NA	NA	NA	NA
56	1085	16.07	13.69	8.99	5.25	4.26	5.36	1.63
57	1070	3.10	12.60	11.89	NA	NA	NA	NA
58	1064	12.13	21.05	9.63	NA	NA	NA	NA
59	1302	1.60	4.49	4.45	1.93	1.92	1.29	1.27
60	1325	1.34	5.12	5.11	1.76	1.59	1.70	1.61
61	1321	4.82	11.88	17.76	NA	NA	10.07	NA
62	1211							
63	1245							
64	1326							
65	1111							
66	1208							
67	1212							
68	1209							
69	1191							
70	1184							
71	1173							
72	1290							
73	1244							
74	1180							
75	1364							
76	1422							
77	1530							
78	1465							
79	1539	6.83	4.54	3.08				
80	1469	11.56	32.15	20.24			14.95	
81	1391	47.98	36.14	23.82				
82	1370	29.11	11.61	9.17				
84	1639	29.70	13.82	12.39				
85	1675	3.33	12.28	13.53	4.41	4.07	5.74	4.20
86	1649	18.70	14.22	11.71	1.46		5.55	3.61
87	1654	7.10	26.63	13.92	4.61	3.83	15.14	2.11
88	1637	48.46	43.01	22.87				
89	1526	17.01	15.73	8.94	3.74	3.54	6.98	2.37
91	1650	24.67	22.91	11.92				
92	1643							
93	1617							
94	1630							
95	x001							
96	x002							
97	x003							
98	x004							
99	x005							
100	x006							
101	x007							
102	x008							
103	x009							
104	x010							
105	x011							
106	x012							
107	x013							
108	x014							

109	1638							
110	x015							
111	x016							
112	x017							
113	x018							
114	x019							
115	x020							
117	x021							
119	1685							
120	1671	15.99	8.80	6.08	3.60	3.20	3.33	0.91
121	1710							
122	1659	15.71	11.00	6.16	5.73	3.69	4.66	0.76
123	x022							
124	x023							
125	x024							
126	x025							
127	x026							
128	1712	3.00	8.78	9.38				
129	1713	19.68	8.92	7.89				
130	1538							
131	1657							
132	1492							
133	1726							
134	1725	2.77	7.23	4.53	2.16		3.32	
135	1596	12.54	9.52	9.60	4.49	3.32	4.57	1.84
136	1724	13.52	10.53	6.67				
137	1367	8.61	5.95	4.17				
138	1722	12.34	11.89	6.40	4.75	3.36	4.50	1.43
139	1720	11.01					4.18	
140	1493	25.72	14.88	10.03				
141	1727	2.09	17.23	20.88	2.36	2.21	9.09	3.34
142	1467	15.82	52.94	51.07	13.72	9.24	26.20	22.63
143	1721	8.26					13.43	
144	1342	11.23					14.85	
145	x027							
146	x028							
147	1402							
148	1465							
149	x029							
150	x030							
151	x033							
152	x031							
153	x032							
154	1393							
155	1394							
156	x034							
157	x035							
158	x036							
159	x037							
160	x038							
161	x043							
162	x042							
163	x041							
164	x040							
165	x039							

166	1398							
167	1723							
168	1551							
169	1197							
170	1190							
171	x044							
172	1711	4.56	5.78	14.14	2.25	1.98	3.90	1.40
173	1728	5.92	8.85	20.75				
174	1673	2.78	8.00	9.90	3.02	2.81	6.95	2.98
176	1729	10.15	46.86	47.45	11.77	9.36	19.15	14.63
177	1730	2.35	12.14	11.09	4.43	2.97	3.95	3.20
178	1695	22.01	18.36	10.53	5.31	5.01	6.53	1.90
179	1691	13.79	8.25	6.31	2.93	2.31	3.92	1.79
180	1749	36.00	11.00	9.91	NA	NA	NA	NA
181	1732	14.01	25.33	25.00				
182	1755							
183	1763							
184	1736							
185	1765							
186	1764	4.35	13.17	12.03				
187	1772	3.97	11.51	11.50				
188	1778	17.68	7.53	6.12				
189	1769	11.71	8.05	6.24				
190	1742	10.14	19.40	15.88	5.16	5.02		
191	1771	4.66	12.54	13.59	4.30	3.53	7.13	3.74
192	1786	26.88	25.91	23.73	6.54	6.34	5.11	3.94
193	1787	1.64	4.35	4.32	2.59	2.03	1.24	0.77
194	1782	18.82	15.17	9.48	5.10	4.62	5.65	1.15
195	1796	3.52	15.66	45.97	4.49	3.07	36.58	3.31
196	1770	16.88	15.11	8.08	4.52	3.13	4.74	0.48
197	1774	13.59	11.79	7.61	4.37	3.78	4.21	1.59
198	1758	2.44	8.23	8.07	3.07	2.73	3.10	3.03
199	1789	7.63	3.64					
200	1765	12.14	6.25					
201	1820							
202	1793							
203	x045							
204	x046							
205	x047							
206	x048							
207	x049							
208	x050							
209	x051							
210	x052							
211	x053							
212	x054							
213	x055							
214	1799							
215	x056	19.96	7.23					
216	x057							
217	1878							
218	1877	12.37	11.75	7.31	5.10	4.85	4.18	0.81
219	1869	27.54	11.59	9.78	4.80	4.56	3.89	1.50
220	1802	33.27	7.71	7.12				
221	1870	14.45	13.76	6.02	3.38	3.18	6.42	0.96

222	1879							
223	1875	7.05	8.13	7.13	4.32	3.36	2.92	1.60
224	1815	3.10	4.73	4.51	3.02	2.75	1.45	1.05
225	1853							
226	1858							
227	1833	1.28	4.48	4.37	2.32	1.69	1.37	1.34
228	1852	19.56	19.77	9.14	5.73	4.24	7.33	0.91
229	1888	17.57	11.27	6.18	4.28	3.09	3.81	0.73
230	1894	12.16					3.18	
231	1831							
232	1847							
233	1857							
234	1841							
235	1840							
236	1855	19.59		9.63				
237	1913	19.47	14.85	8.81	4.43	3.31	3.62	1.66
238	1908	16.00	12.70	6.34	3.39	2.85	4.87	0.84
239	1912							
240	1897	32.58	12.90	8.28				
241	1906	1.54	4.60	4.55	2.34	2.10	1.37	1.34
242	1843	11.32	19.68	8.13				
243	1835	11.81	3.61	3.95				
245	1842	12.25	7.05	14.78				
246	1910	20.80	6.77	6.30				
248	1767	2.10	4.42	4.35	2.30	2.09	1.43	0.82
249	1827	11.03	4.81	15.80				
250	1792	2.42	6.34	6.21	2.92	2.12	2.20	1.30
251	1747	25.33	8.55	9.83				
252	1866							
253	1933	24.42	14.62	7.85	4.17	4.12	4.50	2.00
254	1947							
255	1920	21.07	8.27	6.02				
256	1952							
257	1938	2.59	11.04	9.85	2.90	1.97	4.46	3.42
258	1916	2.16	9.07	8.83	2.98	2.53	4.45	2.62
259	1929	18.17	10.60	9.90	5.58	3.45	4.20	2.44
260	1934	19.91	14.42	7.13	5.11	4.21	5.25	1.33
261	1943	25.18	13.83	8.68	3.97	3.66	4.85	2.77
262	1941	14.76	14.89	8.17	4.13	3.81	6.10	2.04
263	1939	34.11	15.12	10.41				
264	1956							
265	1931	16.16	11.79	5.60				
266	1945	1.43	4.47	4.43	2.36	2.00	1.41	0.92
267	1944	14.39	11.20	6.74	4.76	4.06	3.80	1.10
268	1903							
269	1901							
270	1892							
271	1748	22.56	7.68	7.63	3.21	2.69	4.04	2.05
272	1972	8.81	15.38	5.40	3.20	2.21	3.83	1.06
273	1848	30.88	7.77	7.72				
274	1900							
275	x058	18.44	10.30	9.65				
276	1898	25.79	13.39	9.44	5.03	4.38	5.79	2.05
277	1830	14.59	9.97	9.01	5.15	3.03	2.36	1.17
278	x060							

279	x059							
280	1809	18.86	17.45	10.09	5.61	4.39	6.65	1.87
281	x061	18.12	14.98	9.08	5.86	3.84	6.08	1.96
282	x063							
283	x064							
284	x065							
285	1867							
286	x068							
287	x067							
288	x066							
289	x070	17.67	12.55	6.80	3.57	3.37	4.83	1.49
290	x069	13.04	11.13	7.85	4.08		4.05	2.85
291	1795	7.15		5.98			2.18	
292	1819	28.71	10.19	9.61				
293	x062	3.19	9.61	9.31				
294	1845	8.53	16.45	6.50				
295	1744	57.85	12.98	7.13				
296	x071	9.22	9.98	4.68	3.15	1.81	4.34	1.04
298	x075	16.51	11.09	5.45	3.36	2.90	4.20	1.10
299	x074	3.38	11.26	11.09	4.42	3.94	4.65	3.02
300	x073							
301	0119							
302	x072							
303	x073							
304	x074							
305	x075							
306	0098							
307	x076							
308	0099							
309	x077	26.38	15.96	7.66	2.59	2.31	4.21	1.32
310	x078	18.91	13.89	12.94	7.35	5.58	4.02	1.20
311	x079	2.12	4.93	4.82	2.78	2.65	1.19	1.05
312	1844							
313	1918	14.60	12.88	8.53	4.75	3.94	3.89	1.15