THE RISE AND FALL OF AN EARLY FORMATIVE COMMUNITY: LA MULA-SARIGUA, CENTRAL PACIFIC PANAMA

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ABSTRACT

This manuscript is based on the results of a site survey and evaluation project undertaken in 1983-84 at the archaeological site of La Mula-Sarigua, Central Pacific Panama. The primary goal of this project was to document socioeconomic structures during the 1st millennium B.C. The ultimate goal was to explain change(s) in those structures by reference to regional socioeconomic patterns which preceded (2500-1000 B.C.), coincided with (1000-200 B.C.) and followed (200 B.C.-A.D. 500) the major occupational episode at La Mula-Sarigua (ca. 400-200 B.C.).

To identify and interpret socioeconomic structures at La Mula-Sarigua, field research focused on collecting baseline data (utilizing probabilistic and purposive sampling strategies) to determine (1) site size, (2) site chronology, (3) internal site layout, (4) resources utilized, (5) goods produced and (6) technology.

Both the time period and the site are critical to interpretations of the prehistory of Central Panama. For example, prior to 1000 B.C. human occupation in Central Panama is represented by small mobile egalitarian groups; by the 1st millennium B.C. some groups have begun to permanently settle at a few large sites, with the largest and most internally variable being the 58 ha site of La Mula-Sarigua.

Extensive analyses of material remains from La Mula-Sarigua indicate that many of the features which characterize the later

well-developed, hierarchically-ordered societies in Panama make their initial appearance during the 1st millennium B.C. at La Mula-Sarigua. These features include: (1) large site size, (2) agriculture as a major subsistence activity, (3) specialization in craft production, (4) distribution of goods (regional exchange), (5) differential treatment of the dead and (6) settlement centralization.

This paper describes the evidence for the above features at La Mula-Sarigua; discusses the relationship of these features to reconstructions of socioeconomic structures in Central Panama specifically and discusses the implications of the foregoing relationship for examining questions pertinent to societal transformations in general.

For

KEITH

"One of Three Roses"

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CHAPTER I

INTRODUCTION

How societies have changed from one form into another, or failed to do so, has been an issue of fundamental concern to anthropologists for decades. That change did occur is indisputable. Archaeological sequences in many parts of the world begin with small mobile, egalitarian groups of hunter-gatherers and end with large sedentary, internally differentiated groups of agriculturalists; the former are often referred to as non-hierarchically ordered (consensual based or small-scale) societies (e.g., Leacock and Lee 1982, Price and Brown 1985) and the latter as hierarchically-ordered (conflictual based or complex) societies (e.g., Drennan and Uribe 1987, Earle 1987, Fried 1967, Haas 1982, Johnson 1982, Johnson and Earle 1987, Patterson and Gailey 1987, Vargas 1987).[1]

Why this socioeconomic transformation occurred is another issue; and judging from the variety of schemes that have been put forth to organize, study and explain this phenomenon, there is not widespread agreement (e.g., Flannery 1972, Harris 1979, Hodder 1985, Kohl 1981, Price 1982, Renfrew and Cherry 1986, Spriggs 1984, Tilley 1982). In fact, when we consider the diversity of positions, there is neither agreement on the types of questions to be asked nor on the types of data required for identifying and analyzing the phenomenon.

The Research Problem

The primary goals of the present study were to identify socioeconomic patterns and to explain change(s) in those patterns in the seasonal tropics of Central Pacific Panama during the 1st millennium B.C. The field research focused on one archaeological site in Central Panama, La Mula-Sarigua. As will be shown below both the time period and the site are critical to interpretations of regional change.

Prior to 1000 B.C. the archaeological record of Panama is characterized by small settlements (maximally 3 ha) which were the product of mobile, egalitarian groups; by 200 B.C. the region is represented by large (over 40 ha) nucleated floodplain settlements of maize agriculturalists. By A.D. 500 a hierarchically-ordered society appears to be well ensconced. At the beginning of the present decade, however, there still remained a hiatus of approximately 800 years in the archaeological record between ca. 1000-200 B.C. The few looted tombs and sparse surface assemblages ascribed to this interval provided little information for examining questions of change in Central Panama. It was not until the initiation of the Proyecto Santa Maria (hereafter referred to as the PSM)[2] in 1982 that habitation sites dating to the 1st millennium B.C. were identified and evaluated. By far the largest of these was the La Mula-Sarigua site complex initially reported by Willey and McGimsey (1954). The PSM's evaluation led to its identification as the earliest, large sedentary agricultural community in Panama; and on the basis of size (minimally 65 ha), perhaps the first regional center as well. More than interesting is the fact that the size, age and nature of material remains at La Mula-Sarigua are almost identical to those described for the period termed Early Formative in Mesoamerica (cf. Flannery 1976, Flannery and Marcus 1983, Flannery et al. 1981) and Ecuador (cf. Damp 1984, Lathrap 1975, Lathrap et al. 1977, Marcos 1977, Stothert 1984, Zeidler 1977).

It is neither necessary nor particularly productive to enter into discussions on the utility of the term Formative in the present work; what is important to recognize is that where it has been used, the period is represented by widespread socioeconomic change. For example, in contrast to Archaic societies, Early Formative communities are typified by some permanent villages, some dependence on agriculture, the production of pottery and population increase. By the Late Formative differential community growth is evidenced by site-size hierarchies composed of administrative centers, secondary and tertiary centers and probably small villages and hamlets as well (Flannery and Marcus 1983, Whalen 1981). The presence of sites of different sizes and functions within a region suggests the formation of a hierarchically-ordered power structure--a power structure based on the differential control (exploitation) of a few over the majority of the population (e.g., Johnson 1982, Mayhew and

Levinger 1976).

With this in mind, I initiated field investigations in 1983 and 1984 at La Mula-Sarigua in order to: (1) determine the socioeconomic organization of community life during the 1st millennium B.C. and (2) examine questions about the emergence of hierarchically-ordered societies in Central Panama.

<u>Research Objectives</u>

To examine the factors and processes involved in change one needs an adequate data base to analyze and interpret; the kinds of data collected are contingent upon the types of research questions being asked. Prior to entering the field, a series of questions were drawn up which addressed issues thought to be of some importance in regional Formative studies. They are:

(1) Were habitation sites permanently occupied?

(2) Did agriculture precede, co-occur or follow sedentary village life?

(3) Was sedentary village life based on an agricultural economy?

(4) Were agricultural economies based on the production of maize?

(5) Was agriculture associated with environmental change and/or degradation?

(6) Did population size increase?

(7) Did technological change occur?

(8) Did craft specialization occur?

(9) Did exchange take place within and/or between sites?

(10) Were there spatial and/or functional variations within

and/or between sites?

(11) Did one, more than one, all or none of the above considerations change in the Formative of Central Panama?

In order to address these questions, baseline data were collected on the following characteristics at La Mula-Sarigua: (1) local environmental setting, (2) site size, (3) site chronology, (4) internal spatial plan, (features, activity areas, residential and public space, and burials), (5) resources utilized (location, density and seasonal availability [if applicable]), (6) goods produced and (7) technology.

It is clear, however, that one can not fully answer any of the questions posed above by looking at one site in isolation. Rather it is critical that site occupation be put into a regional and historical context. La Mula-Sarigua's regional role was established by reference to regional settlement-subsistence data for the 1st millennium B.C. gathered by the PSM. Its historical role was evaluated by reference to regional socioeconomic patterns which preceded (2500-1000 B.C.), coincided with (1000-200 B.C.) and followed (200 B.C.-A.D. 500) its major occupational episode.

Socioeconomic Structures and Change

Regardless of the theory one uses to explain change, most would agree that social and/or economic factors have figured importantly in studies of emerging hierarchically-ordered societies. Obviously, there is less agreement on how each of these factors is to be defined (e.g., Adams 1966, Bender 1985, Burnham and Ellen 1979, Dalton 1971, Frank 1970, Friedman and Rowland 1978, Gledhill and Larsen 1982, Harris 1979, Hindess and Hirst 1975, Sahlins 1972).

Herein, economic refers in part to the production process; it includes the exploitation of raw resources (e.g., land, flora/fauna, lithic, clay, etc.) and their transformation into useful objects in order to ensure the continued existence of a society (Patterson 1983). Social refers to the spatial/temporal distribution of people among different positions (roles and/or statuses) and their interrelationships (McGuire 1983:101). Social relations are not independent of the production process, i.e., they encompass them. That is, in the process of production (work),[3] people enter into specific relationships, relationships which in part reflect one's position in life. Positions can be divided along technical (task or skill) lines (e.g., in non-hierarchical societies) and/or social lines (e.g., hierarchical societies).[4] As such, the term socioeconomic is appropriate.

The term economic, as applied here, also encompasses the distribution and circulation of goods within and between social groups. Human groups are generally neither economically nor socially autonomous. In fact, a number of people (e.g., Bender 1978, 1981, Braun and Plog 1982, Hodder 1978, Howe 1986, Lourandos 1985, Meillassoux 1972, Saitta 1983--to name a few) have maintained and/or implied that the wider alliance and/or exchange system need consideration if one is to facilitate explanations pertinent to change. It is worthwhile citing Bender (1985:55) at some length here:

> Exchange and movement of people are validated within a context of social gathering and feasting, of exchanges of ritual, myth, and dance, all of which demand material provisioning. Such exchanges, moreover, make demands on time, which also has to be created by increased productivity. And since the alliance bonds are fragile and, insofar as they involve the exchange of marriage partners, often temporarily asymmetrical, reciprocity will be strengthened by the exchange of valued items (Berthoud and Sabelli 1979)... And they put pressure on production.
>
> Alliance and exchange systems also create an arena for processes of social differentiation. They are constituted on a notion of delayed return-in people and things-and of debt, the less benign face of reciprocity. Debts can be accumulated; debts must be repaid; repayment requires a labor input. And debts can be institutionalized via the alliance and exchange system, thus institutionalizing inequality.

The present study focuses on: (1) what, when, and where resources were used (produced and/or consumed) and (2) on when, where and how work was organized in order to identify the socioeconomic structure(s) present in Central Panama during the 1st millennium B.C. This study also examines the question of intensification in production by reference to the time periods which preceded and followed the 1st millennium B.C.

Significance of the Study

By providing baseline data for the 1st millennium B.C., the present research (1) contributes to interpretations of the prehistory of Central Panama for a time period which was previously <u>terra incognita</u> and (2) permits an examination of social and economic change within the region (when used in conjunction with already studied preceding and following time periods). In addition, these data allow for the examination of several issues currently being pursued in archaeology: (1) the organization of early Formative communities, (2) the emergence of hierarchically-ordered societies, in general, in the American tropics particularly, and in Central Panama specifically, and (3) the utility of focusing on socioeconomic factors in explaining change in prehistory.

Manuscript Contents

In this chapter I have outlined the research objectives, and their potential contribution to a set of specific, as well as broadly-defined, issues. Addressing these issues demands an interplay between theoretical constructs, relevant questions (posited in a regional and historical context) and data.

Chapter II provides background for the present study by discussing the history of archaeology in Panama, archaeological investigations in Central Panama and previous inquiries at La Mula-Sarigua; an outline of the present field research goals completes this section.

The field research design and data collection strategies are described in 2 parts (Chapters III and IV). Chapter III focuses on the probabilistic sample, i.e., systematic aligned transects; Chapter IV centers on the purposive sample, i.e., surface features and excavations. Each chapter closes with a general description of the various classes of materials collected from each sampling scheme.

The quantity and quality of data amassed were enormous; cataloguing, analyzing (5 researchers in 4 locations were involved in this stage) and recording at each stage of the project required coordination at a central point. I coordinated and incorporated all information into a number of databases using a microcomputer. Chapter V discusses the hardware and software used in managing, manipulating and retrieving the present body of data.

The next 3 chapters (Chapter VI--Lithics; Chapter VII--Ceramics; Chapter VIII--Organic Remains) are laboratory-oriented. It is here that I present detailed descriptions of the material remains, the methods used in their analysis and the results derived from the analyses.

Following is Chapter IX which provides interpretations of the data. This discussion attempts to identify socioeconomic patterns at La Mula-Sarigua by examining: (1) site chronology, (2) ceramic and lithic technology, (3) changes in site dimensions, (4) resources utilized and (5) spatial patterning of features and artifacts. Chapter X summarizes the data on subsistence and non-subsistence activities at La Mula-Sarigua and attempts to answer the research questions posed earlier in the present chapter. A discussion of the implications of the La

Mula-Sarigua data for changes in regional socioeconomic organization, for the emergence of hierarchical societies in Central Panama specifically, and for studies of change in general concludes this manuscript.

Endnotes

1. Per Crumley (1987:155), a structure is "a recognizable pattern of organization in something composed physically or sociohistorically of interdependent parts." Structures can be non-hierarchical or hierarchical (Johnson 1982, cf. Crumley 1979, McGuire 1983).

Non-hierarchically ordered structures are characterized by a limited number of task-oriented groups (Johnson 1982), and socioeconomic relations of generalized reciprocity (symmetry) and complementary (e.g., Leacock and Lee 1982). Problems of conflict are generally resolved along informal (consensual-based) lines.

In contrast, hierarchical structures are composed of non-reciprocal (asymmetrical) socioeconomic relations, more specifically on the domination of a minority over the majority of the population (Beteille 1977, 1981, Johnson 1982). Conflict is resolved by formal, arrangements; arrangements which force people "into sets of rule-regulated relationships (Britan and Cohen 1980)." These relationships are exploitative in that they explicitly restrict access to resources, people, knowledge, power, etc.

2. The Proyecto Santa Maria is described in some detail in Chapter II.

3. Production, work and labor are used interchangeably throughout this manuscript.

4. Following Patterson (1983:42), there are 3 ways in which production can be divided:

1. technical division where tasks are divided into different sectors, such as agriculture, fishing, mining, etc. In this instance, individuals largely specialize in work activities associated with one area of production to the exclusion of others;
2. technical division where the production process is separated into a series of "distinct" tasks, such as assembly-line production; that is, the task performed by each individual corresponds to one segment of the process; and

3. social division where the distribution of different tasks among individuals reflects the position they occupy in the social structure; and, therefore, the nature of exploitation.

CHAPTER II

BACKGROUND TO THE PRESENT STUDY

History of Archaeological Research in Panama

The objectives, as well as the techniques, of archaeological inquiries in Panama have greatly changed from the late 19th century to the present. Following Ranere, Cooke and Adams (1981), at least 4 major phases of activity can be recognized: (1) 1858-1925, (2) 1925-1940, (3) 1948-1968 and (4) 1968-present.

Pre-1858. Although we can be certain that the early Spanish colonists robbed many a tomb at the time of Conquest and in the succeeding years, we have no record of them. The first archaeological investigations come from the Royal Historian, Gonzalo Fernandez de Oviedo in 1522. His notes describe the opening of two tombs--tombs reputed to contain the remains of a cacique's father's servants, as well as great quantities of worked gold. Although maize and a war club were found, gold was not (Lothrop 1937). Between 1522 and 1858, there are spotty accounts of excavations with each focusing on the looting of graves in the hopes of recovering gold objects, e.g., those at Canas Gordas (in Lothrop 1919) and Rio Grande (Squier 1859).

1858-1925. The beginning of this period is marked by the location of three rich cemetery sites in the western province of Chiriqui: Bugaba (Merritt 1860), Bugabita (Otis 1859) and Boquete

(Bateman 1860-61). Their discovery spurred the widespread looting of tombs, particularly by the local Chiriqui population in search of gold objects (e.g., McNiel 1887). This activity continued throughout the phase. Objects were generally recovered for two purposes: private collections or the melting pot. The collections were eventually donated to or bought by major foreign institutions, such as, the Museum of the University of Pennsylvania, and the Peabody Museums of Yale and Harvard Universities. On the basis of these collections, and in the absence of records on stratigraphic and material contexts, initial attempts were made to describe and classify archaeological material remains (Holmes 1888, MacCurdy 1911, Osgood 1935, Zeltner de 1865). (See Shelton [1984] for a more thorough discussion on the history of archaeology in Chiriqui, western Panama).

1925-1940. While looting/salvaging continued (Ferrari 1928, Verrill 1927), this period saw the professionalization of archaeology in Panama by foreign institutions (e.g., Linne 1936, Lothrop 1937, 1942, Mason 1940, 1942, Nordenskiold in Linne 1929). As in the previous period, however, the focus remained on rich cemetery sites. Perhaps the most notable work of this period was that of Lothrop's at Sitio Conte, Central Panama; notable in the sense that it culminated in the publication of two volumes (1937, 1942). The major contribution of these volumes was the presentation of a regional chronological scheme based on careful field excavations at Sitio Conte and on a survey of materials from Cocle and Herrera provinces, and the description of high status ceremonial remains uncovered from Sitio Conte (Ladd 1964). Although Lothrop's field techniques do not measure up to today's standards, e.g., excavations were confined to graves and a restricted area around them (hence one can only speculate on intra-site activities) and graves were arbitrarily (rather than stratigraphically) divided into three categories based on size (Cooke 1972, Cooke and Camargo 1977, Linares 1977), the two volumes provide much information for more sophisticated lines of inquiries (e.g., Linares 1977).

1948-1968. Alongside a continued interest in cemeteries (Haberland 1957, 1960, 1962, Harte 1958, Lothrop 1954, McGimsey 1956, Stirling 1949) and the development of ceramic sequences (Baudez 1963, Ladd 1957, 1964, Linares 1968), this phase saw the introduction of: (1) regional purposive surveys along the western Pacific littoral of Panama (e.g., Linares 1966, Willey and McGimsey 1954) and (2) stratigraphic excavations in nonmortuary contexts, e.g., Monagrillo (Willey and McGimsey 1954), Cerro Mangote (McGimsey 1956) and Cerro Giron (Willey and Stoddard 1954). While the primary goal of these surveys and excavations by American and/or American-trained researchers was to refine Lothrop's 3-phase cultural typology based on ceramics,[1] the work overall gave researchers a greater awareness of regional diversity in cultural remains and ecology, and provided some general impressions on site density and demographic growth along Parita Bay (see Cooke 1972). Nonetheless, because of the preoccupation with ceramics little attention was paid "to the recovery of organic remains, the reconstruction of utility areas, the functional study of lithic artifacts, and so forth (Linares 1979)." In the absence of such information, statements on prehistoric lifeways (subsistence-settlement patterns), particularly those in pre- or non-ceramic contexts was not possible.

1968-Present. Despite a continued interest in the recovery of cemetery goods, e.g., Ichon's (1980) work in the Tonosi Valley, Azuero Peninsula, and in ceramic sequences, e.g., the work of Cooke (1972) in western Cocle, there is a major shift in the nature of archaeological research in Panama during this period. This should not be surprising given the widespread influence of the "new archaeology" at the beginning of the period (e.g., Binford and Binford 1968, Flannery 1972, Willey and Sabloff 1980). For the first time, research in Panama became problem-oriented. Investigators sought answers to questions which dealt with particular theoretical issues, specifically those relevant to the role of ecology in the evolution of adaptive strategies (Linares and Ranere 1980). A sample of such questions include (Linares 1979):

(1) What were the settlement-subsistence systems during the preceramic and Formative periods?

(2) What was the relationship between coastal and inland populations?

(3) What were the processes involved in the changes apparent in the archaeological record?

In an attempt to examine these questions, Linares carried out a systematic regional survey and site evaluation program in western Panama in 1968-1974 (see Linares and Ranere 1971, 1980, Linares, Sheets and Rosenthal 1975, Ranere 1972). Also incorporated into this field program was the use of small-scale excavations using modern recovery techniques, e.g., the careful removal of deposits according to natural and/or cultural stratigraphic units with hand tools, sieving through fine mesh, recording cultural materials and features as encountered, collecting carbon samples and removing bulk samples for the flotation and analyses of pollen (e.g., Ranere 1980a, Spang and Rosenthal 1980).

From 1973 to 1979, a number of small-scale stratigraphic excavations took place in the Parita Bay region, specifically to recover data pertinent to reconstructing the subsistence base of preceramic and early ceramic populations (e.g., Sitio Sierra [Cooke 1979], Aguadulce Rockshelter [Ranere and McCarty 1975], Monagrillo [Ranere and Hansell 1978], Cueva de los Ladrones [Bird and Cooke 1978] and Cerro Mangote [Ranere, Cooke and Hansell 1980]). Although this research added to an understanding of prehistoric diets and economies, it lacked the regional scope of the western Panama research. The one exception to these single site excavations was an archaeological survey in eastern Panama under the direction of Drolet (1980).

In order to transcend the limits imposed by small-scale, short-term projects, albeit still within an ecological/evolutionary framework, the Proyecto Santa Maria (PSM) was conceived. The PSM began fieldwork in 1981; it was a 4-year multidisciplinary study directed by Anthony J. Ranere and Richard G. Cooke. The immediate goal of the program was to survey systematically and evaluate sites in the Santa Maria River basin of Central Panama in order to collect data to: (1) reconstruct paleoenvironments, (2) determine the location, size, age and function of prehistoric settlements and (3) characterize the subsistence strategies of the prehispanic populations. Modern field recovery techniques were utilized, as well as modern laboratory analyses. The latter include: bone chemistry, macrobotanical, pollen and phytolith identifications, sediment analyses, detailed faunal, lithic and ceramic analyses, and the computerization of the data base. The ultimate goal was to make statements about the changing relationships between the environment and man (Cooke and Ranere 1984). Although approximately 600 sites were located and evaluated, the intensive investigation of large sites, such as La Mula-Sarigua, was outside the scope of the PSM goals. Nonetheless, the partial exploration and re-evaluation of La Mula-Sarigua by the PSM led to its more comprehensive investigation; the focus of the present research.

Ecological Setting of the Study Area: Central Panama

Central Panama can be divided into four distinct topographic provinces: the Central Highlands, the Caribbean Lowlands, the Central Pacific Plains and the Azuero Peninsula (Figure 3). Corresponding to these topographic provinces is great climatic variation, particularly between the northern and southern sides of the divide. For example, the Atlantic slope may receive as much as 5000 mm of rain a year whereas parts of the Pacific slope may receive as little as 1000 mm a year (Atlas de Panama 1975). On the Atlantic coast there are recognizable wet and dry seasons but even during the driest months of February and March there are 12 to 14 rainy days. On the Pacific coast seasonal variation is much more pronounced. During the 5-month dry period (December-April) rainfall is negligible (less than 10% of the annual total). During this period winds blow strongly from the northeast initiating upwelling in the Gulf of Panama and in Parita Bay (Glynn 1972). This upwelling allows for an increase in plankton biomass producing a seasonal increase in some organisms, such as shoaling fish, shellfish and shrimp (Forsbergh 1969, Schaeffer, Bishop and Howard 1958). By May the winds blow from the southeast bringing rain to the Pacific coast.

Parita Bay lies on the Pacific side of Central Panama in the northwest corner of the Gulf of Panama (Figure 3). In this part of Panama the land can be divided into five physiographic zones (Figure 4): (1) extensive mud flats occur seaward of a narrow

110 sites which probably date to this period (Weiland 1984); the latter are considered probable because most of them contain only manufacturing debris and flake tools. At present, these are best classified as "non-ceramic" since they may post-date 2500 B.C., even though pottery is absent from their surfaces (Cooke and Ranere 1984). Pottery may be absent for two reasons (Cooke and Ranere 1984): (1) the early Monagrillo pottery (dating to ca. 2500-1000 B.C.) does not preserve well when exposed on the ground surface and (2) some special activity sites, e.g., quarry/ workshops, never contained ceramics even though their occupants may have made and used pottery in other contexts or activities.

The results of the PSM survey, combined with results from previously excavated sites in Central Panama, clearly demonstrate that between 5000 and 1000 B.C., Central Pacific Panama was occupied by human groups living in coastal and inland positions in encampments and hamlets less than 3 ha in size (Cooke and Ranere 1984, Weiland 1984). The subsistence-settlement pattern which persists throughout this 4000 year period displays some obvious differences in the production, consumption and distribution of products, relative to the pre-5000 B.C. pattern.

First, pottery is added to the material inventory of the region at approximately 2500 B.C. (Ranere and Cooke 1987); this addition is not, however, accompanied by major changes in the lithic assemblages.

Second, pollen, phytolith and macrobotanical analyses indicate that some plant cultivation, specifically maize, is being practiced in some mid-level elevation locations (Piperno and Clary 1984, Piperno et al. 1985, Ranere and Cooke 1987); these same analyses indicate that in most locations the collecting of wild plants was more important. Faunal assemblages signify that hunting, fishing and shellfishing were major subsistence activities and that site occupation took place on a short-term (seasonal) basis (Cooke 1984, Hansell 1979, Ranere, Cooke and Hansell 1980). This diversity in subsistence practices, including the addition of cultivation, suggests a broadening of the resource base (compared to pre-5000 B.C.) and increased opportunity for specialization within and between social groups.

Burial data from this period show that social differences were minimal to non-existent (McGimsey, Collin and McKern 1966, Norr 1983). The implication is that an extension of the resource base had little to no visible impact on producing social distinctions.

1000-200 B.C. Prior to 1980, these 800 years were represented by sparse surface assemblages of incised pottery (Willey and McGimsey 1954), one cemetery (Harte 1958) and several looted, isolated burials (Cooke, personal communication); each had at one time consisted of shaft-tomb burials associated with funerary goods. This meagre information, however, did little to further our understanding of societal transformation in Central

Panama.

By 1983, the PSM had identified and assessed 20 sites dating to this period; some of which were clearly habitation sites. Sites were located in all physiographic zones. Most were no larger, nor more internally differentiated than those occupied prior to 1000 B.C. However, the La Mula-Sarigua site complex, initially reported by Willey and McGimsey (1954), was clearly an exception. The PSM's reassessment of the complex led to its identification as a large permanent agricultural settlement dating to this 1st millennium B.C. hiatus. It is the intensive investigation of this site and time period that forms the basis of the present research; the ultimate goal of which is to examine questions about the emergence of hierarchically-ordered societies in the Central Panama Formative.

200 B.C.-A.D. 500. Shortly after 200 B.C., many of the region's occupants were living in large (over 40 ha) sedentary, nucleated agricultural villages in the alluvial floodplains (e.g., Sitio Sierra [Cooke 1975]). Throughout the period of 200 B.C.-A.D. 500 there is an increase in the number and size of such villages occupying this physiographic zone (Cooke 1979, 1984, Cooke and Ranere 1984). After 200 B.C. coastal settlements are either abandoned or become specialized fishing/shell collecting stations (Cooke and Ranere 1984). Aquatic and terrestrial fauna continue to be exploited but agricultural products, particularly maize, become a significant component of the diet (Cooke et al.

1985).

Dating to the earliest part of this period (200 B.C.), there is evidence for a division of labor unlike that present prior to 1000 B.C.; specifically, craft specialization appears to occur by village as well as by individuals within a village (Cooke 1978a, 1984, cf. Ichon 1980, Ladd 1964). Nonetheless, status differences can not be positively identified for this period (Cooke 1984), although this may well be a sampling problem reflecting the fact that no Period IV cemeteries which are spatially isolated from habitation areas have been excavated.

Post A.D. 500. By A.D. 500, however, it is clear that a social transformation has occurred. Burial/artifact associations, particularly in the form of gold objects with some individuals in some sites, provide evidence for significant differences in social status (e.g., Sitio Conte [Ichon 1980, Linares 1977, Lothrop 1937, 1942]). Further, common conventions in the production of gold objects, bone artifacts and precious stone and a common ceramic tradition, albeit unequally distributed, have led at least one researcher (Linares 1977) to the opinion that this regional pattern represents an interaction sphere where historically related groups fought and were allied with each other in a fission/fusion process; certainly warfare and competition appear to be in full force. This was the situation at the time of contact (Cooke 1984, Helms 1979, Ichon 1980, Linares 1977, Linares and Ranere 1980, Linares et al.

1975). To define the conditions that brought about the socioeconomic transformation that was in progress by 200 B.C. and essentially in place by A.D. 500, it is necessary to focus on the antecedent period (1000-200 B.C.).

La Mula-Sarigua

Present Environmental Setting. La Mula-Sarigua (Plate 1) is presently located 2 km from the Parita Bay coastline and 1/2 km from the Parita River on an eroded fluvial terrace overlooking the Sarigua Alvina (salt flat). This was neither, however, its position vis-a-vis the coastline nor the river at the height of its occupation. Textural analysis of sediments extracted from cores and surface samples taken in front of the site indicates that the Parita River probably flowed alongside of the site, and the open sea was closer to the site during the 1st millennium B.C. (Cedeno 1986, Clary et al. 1984, Dere 1981, Hansell and Adams 1980, Hansell, Dere and Adams 1982). More specifically, the following progradational sequence has been documented for the site environs (Clary et al. 1984) (Figures 5a-c). At about 1000 B.C. a mangrove-covered active strandline existed at the seaward perimeter of the site. By about the time of Christ, the active strandline had migrated several hundred meters seaward but the site continued to be surrounded by mangrove. Bare alvina surfaces evolved around the site after A.D. 800. This progradational sequence is of some importance in terms of the attractiveness of the area for settlement and resource accessability. Given the high productivity of the coastline and mangroves for fish and molluscs (Hansell 1979), it may not be coincidental that the major occupation at La Mula-Sarigua dates from 1000 to 1 B.C. or at a time when coastal resources would have been adjacent to the site and easily exploited by its occupants. Of course, it may also not be coincidental that it is around 1000 B.C. that inland deforestation has reached its peak.

Landward of the site is a broad band of old alluvium. This alluvium is a remnant of ancient (Pliocene) floodplain deposits which formed when the Parita river flowed closer to the site and at higher elevations (CATAPAN 1971:374); the Parita is presently 1/2 km east of the site, and flows approximately 20 m below that of the old alluvium.[2] These deposits are primarily composed of clays, and are highly susceptible presently to erosion and low crop productivity in the absence of good land management. That the environs of La Mula-Sarigua suffers from the effects of long-term poor land management is obvious. For example, the northern sector of the site is dominated by sheet erosion and deeply-cut eroded gullies (Plates 2-4).

Proper and present land management entails maintaining a ground cover for protection from soil loss, and a drainage and cropping system that maintains or improves the structure and tilth of the soil. As a result, present land use rotates between cultivation, pasture and brush/scrub in any given year. During the years of the PSM and the present project (1982-1984), the alluvium--where cultivated--supported large amounts of sorghum, small amounts of peppers and beans and an occasional patch of manioc or maize.

Previous Research at the Site. In 1954 La Mula (He-30) was described as occupying a broad eroded slope and covering an area of at least 1/2 sq km (Willey and McGimsey 1954:110). On this exposed surface lay large quantities of shell and ceramics. Test holes made through some of the shell piles showed site deposits to be no more than a few cm in thickness. "Excavation was (therefore) hopeless (Willey and McGimsey 1954);" hence a small surface collection was made from all parts of the SE half of the site. As a major research goal was the construction of a cultural chronology based on pottery types, surface collection focused on the recovery of sherds. Nonetheless, total sample size was very small; a total of 126 sherds and 7 stone tools was recovered. Even Willey and McGimsey (1954:133) indicate that the sample may represent only a small segment of the total range of variation present at the site.[3]

Throughout this manuscript, I refer to the site under investigation as the La Mula-Sarigua complex (Pr-14); Willey and McGimsey (1954) describe La Mula (He-30) and Sarigua (He-16) as two separate sites. According to Willey and McGimsey (ibid.) both sites occur off the north side of the Parita River and the Parita Alvina; the latter of which took on a local name depending on which section of the alvina one found himself in. Presently, the entire alvina area is referred to as Sarigua.

In 1952, the Sarigua site consisted of a small shellmidden containing ceramics; it was situated on a small island in what was once an embayment of the old coast (presently in the middle of the Sarigua Alvina). The site took its name after that part of the alvina nearest the Parita River and the hamlet of La Mula (now called Puerto Limon). In contrast, the site of La Mula contained the remains of an extensive prehistoric village; it was situated on badly eroded slopes overlooking the Parita (presently Sarigua) Alvina and was a little over 1 km north of La Mula (Puerto Limon).

Since 1952, the local environment has changed dramatically. There has been rapid erosion on the mainland (the location of La Mula) with at least equally rapid deposition in the alvinas (the location of Sarigua). This phenomenon has increased the visibility of sites such as La Mula and decreased the visibility of sites like Sarigua. In fact, presently there are several, barely visible, shell concentrations in the middle of the alvina. They are associated with sparse amounts of lithic debitage and an occasional tool but no ceramics. The lack of ceramics should not be surprising given that it preserves very poorly in alvina contexts.

Given the above factors of changing local environment and poor ceramic preservation, it should not be surprising that the PSM was unable to relocate the site of Sarigua in 1982.

Nonetheless, it is highly probable that one of the barely visible alvina shell concentrations is actually the site of Sarigua.

That parts of La Mula and Sarigua are contemporary is clear. The PSM and the present researcher located a number of Sarigua Group ceramics (see Chapter VII) on the surface of La Mula. Given the temporal and spatial relationship of the two sites, we feel that they should be described as one large complex--La Mula-Sarigua--rather than as two isolated entities.

Thirty years after Willey and McGimsey visited La Mula-Sarigua (Cooke and Ranere 1984), its archaeological significance was realized when it was briefly reinvestigated by the PSM in 1982. This reinvestigation (limited to the eroded slopes) included a walking reconnaissance, a 5 sq m total surface pickup, and 3 small (1 sq m each) excavations.

An analysis of recovered materials indicated the following:

(1) The site minimally covered 65 ha.

(2) Much of the eroded surface is deflated leaving potsherds, lithics, shell, bone and other debris behind as a "lag" deposit; there are obvious material clusters on this exposed surface.

(3) Significant portions of the site are not eroded; excavations revealed stratified cultural deposits as much as 50 cm below the present eroded surface.

(4) One radiocarbon determination on shell was obtained, 870 $\pm$ 50 B.C. (Beta-6016) (corrected for isotope fractionation).

(5) Based on style, ceramics are predominately of types dating from the 1st millennium B.C.

(6) Lithics are abundant with chipped stone tools in the form of blade-like pointed flakes struck from prepared cores the most obvious; edge-ground cobbles characteristic of preceramic and early ceramic occupation are also abundant. Absent from sites pre-dating 1000 B.C. but well represented at La Mula-Sarigua are cylindrical manos and legless (breadboard) metates and polished celts; the latter are rare in pre-1000 B.C. sites.

(7) Faunal remains are well preserved both in the form of small shell dumps and clusters of aquatic and terrestrial bone.

(8) Carbonized floral remains exist; the presence of the mano/metate complex implied maize agriculture.

This preliminary assessment was sufficient to establish La Mula-Sarigua as the earliest large agricultural community, and perhaps regional center, recognized in Panama.

Both short field inquiries at La Mula-Sarigua, i.e., that of Willey and McGimsey (1954), and Cooke and Ranere (1984), were restricted to the eroded portion of the site. Further, materials were collected in only small sections along this exposed stretch and they were selective in nature. No attempt had been made to determine the extent of the site in uneroded areas.

Present Field Research Goals

In order to more fully investigate La Mula-Sarigua, a systematic survey and site evaluation program was designed and implemented under my direction in 1983 and 1984. The field research design employed probabilistic and purposeful sampling strategies in three phases (see Chapter III). These three phases were utilized to attain three interrelated field goals: (1) to systematically shovel test the uneroded portions of the site in order to locate site boundaries and determine the location and nature of buried deposits; (2) to systematically collect samples from the eroded surfaces in order to delineate the distribution and density of surface materials and features, as well as to determine the function and age of these materials/features; and (3) to excavate a small number of units in order to determine the presence/absence of buried cultural deposits in surface features, to delineate subsurface features and site stratigraphy, to collect samples in datable contexts, and to collect samples for the analyses of artifacts, faunal and floral remains, human remains, phytoliths, pollen and sediments.

Each phase is detailed in Chapters III and IV.

Endnotes

1. This refinement ended in a 6-phase sequence (Baudez 1963, Ladd 1964) and currently forms the basis for chronological divisions in Panamanian prehistory (e.g., Linares 1968, Torres de Arauz 1972, Cooke 1972). These divisions are based on the notion of culture area with each area contiguous with present-day political boundaries, e.g., Cocle Culture, Veraguas Culture, Azuero Culture, etc. More recently, Cooke (1976) has modified the 6-phase sequence into 7 numerical phases and has offered a counter-proposal (1984) for such divisions. In Panama, he links the Atlantic and Pacific watersheds into three contiguous north-south zones, i.e., the Western, Central and Eastern regions. He believes that this division "coincides better with the archaeological, documentary, and ethnographic evidence for cultural and linguistic boundaries, territory formation, and exchange networks than do earlier attempts to subdivide the Isthmus strictly according to the modern political divisions... (Cooke 1984:265)."

2. Large rivers, such as the Santa Maria, have large floodplains. They are subjected to seasonal flooding and, therefore, to extensive overbank silt deposits. The implication is that agriculturally productive land is a constantly renewable resource in these contexts.

This implication can not be argued for La Mula-Sarigua.

While the site is adjacent to an ancient band of alluvium, this band is at an elevation not subjected to flooding, nor was it during the occupation of the site. That is, this band's productiveness is not replenished by overbank silting. Therefore, proper land management becomes critical.

3. Willey and McGimsey did not recover a cross-section of material remains at La Mula-Sarigua. Consider the following differences: the presence of Sarigua ceramics were important in their chronological scheme; yet they do not mention them at La Mula-Sarigua. Today, they lie on the surface, albeit in small numbers. Willey and McGimsey (1954) record only 7 stone tools in their inventory; today they predominate in the surface material inventory. There are literally thousands of tools and associated debitage. Of particular interest is the absence of edge-ground cobbles in their inventory--a tool type which they figured to be an important chronological marker. This tool type can also be found in some numbers on the present surface.

Nonetheless, in all fairness to Willey and McGimsey, the site's surface was not nearly as exposed in 1952 as it is today. (See previous discussion in this chapter).

CHAPTER III

FIELD METHODOLOGY

Introduction

The major objective of the field investigations at La Mula-Sarigua was to collect data which would, upon analysis and interpretation, provide answers to the research questions posed in Chapter I. Some archaeological research questions can be investigated using relatively simple straightforward field procedures. For example, questions about the stratigraphy and preservation of cultural materials in a small rockshelter can be answered by excavating a single small test pit or trench (preferably catching both sides of the dripline). If, however, questions are concerned with patterns of settlement and human activities within a region or across a large site, small intuitive probes will not yield acceptable answers. Examination of the entire study unit (region or site), while an acceptable and even desirable approach on occasion, is usually not a feasible option for most archaeological projects. When a research goal is to generalize to the entire area from the part, then "how" the latter gets selected for examination becomes critical.

There are three methodological problems to consider when surveying: (1) from "where" to collect information, (2) "what" methods should be used in collecting it and (3) "how" should it be processed, analyzed and interpreted (Moser and Kalton

1972:53). If the survey results are to be generalized, then the area chosen for investigation should be selected according to the rules of statistical theory (discussed below). It is wrong to arbitrarily select small areas for study and then claim that they are representative of the larger area. This is not to imply that investigations must be based on statistical techniques to be of value. Clearly, the two approaches, e.g., probabilistic and purposive (arbitrary), accomplish different ends and at their best are complementary.

The immediate goals of the La Mula-Sarigua field strategies were outlined and elaborated on in Chapter II. These strategies were devised in order to identify and estimate a number of site characteristics: site size, site chronology, internal spatial plan, resource consumption and/or production and technology. To optimize the recovery of data which would permit these characteristics to be identified, the survey and site evaluation program at La Mula-Sarigua was implemented in two stages.

The initial stage utilized probabilistic sampling to determine the location and nature of site materials and features; the second stage incorporated purposive sampling to supplement information not recovered in the initial sampling. The probabilistic sampling technique chosen was the use of systematic aligned transects. The data collected from these transects was then used to guide the selection of areas for more intensive examination, e.g., intensive surface collection and/or excavation.

This chapter discusses in some detail the research design, site evaluation and discovery techniques and implementation of the probabilistic sampling strategy.

Research Design: Probabilistic versus Purposive Sampling

Substantive literature (Flannery 1976, King 1978, Plog et al. 1978) indicates that when only a fraction of a large area is to be covered it should be sampled; sample in this context refers to that part of the area that has been selected by accepted statistical methods. By statistically selecting areas to examine, one can ultimately make statements (estimates) about the region and/or site (target population) from the results of that sample. A major advantage to this method is that it forces one to examine areas for archaeological remains which might not otherwise be examined--either because previous research or intuition suggest such areas (or contexts) are unlikely to contain archaeological remains, or because access and/or visibility are problematic. In this manner, new site phenomena can be discovered and their elements quantified. It is important, however, to recognize that this method of selection is not necessarily the best way to "find" low-density or "unique" site phenomena but rather the best way to: (1) get a representative sample of site phenomena, (2) achieve maximum precision for a given outlay of resources and (3) avoid bias in the selection procedure (Moser and Kalton 1972). Bias in the selection process can result if sampling is done by a non-probabilistic procedure; if the boundaries of the sampled area do not include the entire site; and if some sections of the site are impossible to find. Any of these factors will cause systematic errors which cannot be eliminated or reduced by an increase in sample size or number.

An alternative to a probabilistic technique is purposive (or judgmental) sampling. This nonprobabilistic strategy assumes existing archaeological knowledge of a site or at least "good hunches about its structure and variability (Cowgill 1975:260)." In this instance sample selection is made by human choice; one might select surface features, such as house structures or particular artifact classes or probable areas of unique phenomena. While it may well be that other types of information are marginal for the purposes of a particular study and can reasonably be excluded, it is important to recognize that such exclusions are deliberate and the investigator should not delude himself or others into believing otherwise. The major disadvantage of judgmental sampling is that we can not estimate the reliability of our data (Blalock 1972). Despite this shortcoming and following Asch (1975), nonprobablilistic strategies can be useful in archaeological research to: (1) establish feedback between field data collection and sampling design as field research progresses and (2) increase the collection rate for unique or rare phenomena.

Each approach discussed above is useful for gathering some kinds of information but not other kinds. For example, locating features would best be determined through probabilistic sampling; describing their contents would best be determined through purposeful sampling. If the goals of field inquiries are to gather both types of information, employing one technique to the exclusion of the other would be very ineffective (Schiffer et al. 1978). In such a situation the ideal strategy would be one based on a combination of the two techniques; numerous studies (e.g., Flannery 1976, Mueller 1975, Plog et al. 1978, Schiffer et al. 1978) argue for such an approach. For example, probabilistic sampling could be used in the initial phase of a study to determine the overall location and range of features and/or materials within a site; if insufficient information has been gathered from the initial phase for the problem under study, then a secondary phase incorporating purposive sampling could be implemented. That is, the original results can be used to guide the selective placement of areas to more intensively collect or excavate. This approach has often been referred to as a multi-stage strategy (Binford 1964, Cowgill 1975, Flannery 1976, Mueller 1975, Redman 1987, Schiffer et al. 1978). To optimize data recovery, as well as to take advantage of previous site information, the present field research design employed this multi-phase strategy.

Phase I:[1] the Probabilistic Sample

Aerial photographs and a walking reconnaissance of the study area indicated that the site was bounded on three sides by natural features: salt flats to the north, swamps to the east and a stream channel--opening up to a large embayment--to the west; the site had no obvious natural boundary to the south (Figure 6).[2] The distance between the east and west boundaries is 2 km; the distance between the salt flats and the "visible" southern distribution of cultural materials is approximately 400 m; this 2 km x 400 m stretch is dominated by exposed eroded surfaces. To the south of this eroded zone the area exhibits little erosion and is dominated by a heavy vegetation cover, except where cultivated (Plates 5-7).

The primary probabilistic strategy chosen to discover site boundaries and to locate site features and materials was a systematic aligned technique. Some archaeologists (e.g., Jermann 1981, Plog 1976) have suggested that this strategy might not be the most efficient from a theoretical viewpoint or the most advantageous from a statistical viewpoint, relative to a systematic unaligned approach. However, after implementing this latter approach in a pilot study in the eroded zone in 1983 (discussed below), it became clear that it would be a rather impractical approach to investigating the noneroded zones at La Mula-Sarigua. Locating or gaining access to randomly selected units in the heavily vegetated areas would have been a difficult and extremely time-consuming task.

The sampling unit chosen was the transect. Transects, in contrast to quadrats, are the most practical sampling unit shape in that they: (1) are easier to locate and faster to inspect in the field (Judge et al. 1975); (2) have the potential of discovering a greater percentage of material than quadrats (Schiffer et al. 1978); (3) provide good estimates of site variability and general population characteristics (Plog 1976) and (4) are more cost-effective to survey (Schiffer et al. 1978).

The spacing between transects was 100 m, and between sampling points along them 25 m.[3] The setting of these lines and points required a 2-man team full-time both seasons (1983 and 1984) or a total of approximately 240 man days. The sampling of these points was normally accomplished by 3 (2-man each) teams but occasionally as many as 8 teams; coverage took 8 weeks or approximately 400 man days. Decreasing the intervals between transects would have entailed increasing their number in order to maintain the same areal coverage; this would have, in turn, significantly increased the time, labor and money necessary for completing this part of the fieldwork. (Note that these figures do not include time and labor necessary for mapping, intensive surface collecting and excavating). Increasing sampling intervals would have required reducing the number of transects which would have affected the precision of the survey results.

Sampling intervals were, therefore, a compromise between sample number and eventual rigorous inferences, and between time, money and labor availability. Although the spacing of the lines was held constant, the length varied from 100 m to 2 km. The average length was approximately 800 m. Transect lengths were determined by natural boundaries to the north, east and west and by the absence of material remains to the south. In other words, transects were extended southward until no more cultural materials were encountered.

Phase II: the Purposive Sample

The results collected from the transects and numerous walking reconnaissances were used to select areas and/or features to more intensively collect and to excavate. In general, methods of collection followed a systematic aligned strategy; excavation methods followed those standard for the larger regional PSM project. Excavation techniques are discussed in detail below; units selected for this technique are discussed in Chapter IV.

Site Evaluation/Discovery Techniques

The above discussion has focused primarily on "how" segments were selected for examination. The ensuing section describes methods of collection after segment selection.

A fundamental consideration in selecting an evaluation technique(s) is the physical characteristics of the local environment, a variable that affects the visibility of archaeological remains (Lightfoot 1986:485). Optimal visibility, obviously, occurs where the ground surface is exposed to the naked eye. In such cases, the most common strategy implemented is the pedestrian surface survey (systematically inspecting the surface at a given level of intensity, e.g., at 50 m intervals). Central to the use of this strategy is the belief that surface remains can provide significant distributional data on a gross scale, despite factors, such as agricultural disturbance, lateral displacement and collector activity (Dunnell and Dancey 1983, Lewarch and O'Brien 1981, Redman 1987, cf. Flannery 1976, Roper 1976, Tolstoy and Fish 1975). Dunnell and Dancey (1983), in particular, argue that "when the same care that is customary with excavation has been employed in surface collection, the assumption (that some surface deposits are useless and, therefore, should be rejected as a cultural resource) appears unfounded." The point is that surface remains are an important source of archaeological data for particular research problems.

Under conditions of dense vegetation and/or low surface visibility, the pedestrian surface survey is more problematical to implement. A variety of alternative procedures have been devised for discovering low visibility or subsurface deposits. Most commonly employed are: (1) subsurface probes, such as shovel testing, coring and augering (Krakker, Shott and Welch 1983, Lovis 1976, Lynch 1980, McManamon 1984, Stein 1986), (2) remote sensing (Ebert 1984) and (3) geophysical methods (Weymouth 1986). Judging from the number of publications on subsurface probes, it appears that this technique has been the most intensively and extensively utilized.[4]

Given the nature of La Mula-Sarigua's deposits (exposed and nonexposed surface), a combination of surface and subsurface techniques was used. At exposed surface stations a 1 sq m total surface pickup was made and, within a 25 m radius of the stake, the first 5 diagnostic lithics and 5 ceramics were picked up. (In the 1983 pilot study only 5 diagnostics, lithics or ceramics, were collected).[5] At nonexposed stations, e.g., pedestals and vegetated surfaces, a 30 cm diameter shovel test was dug and the residues screened through a 1/4" mesh.

Implementation of the Design

Pilot Study. A pilot study was undertaken in 1983 at La Mula-Sarigua to determine the feasibility and logistics of implementing a large scale survey and site evaluation program. The study was begun by establishing an east to west baseline and staking the line every 25 m across the north facing eroded slope using a transit and stadia rod; this baseline was tied into a geological survey benchmark located on the site and into datum points set by Richard Cooke in 1982 (Figure 7).[6] Oriented NW of the baseline and confined to the eroded zone, a 25 sq m grid system was selected; and a 1 sq m collection point for each 25 sq m quadrat was generated using a table of random numbers.

Given the abundance and dispersion of surface materials across the site, a 1 sq m station appeared adequate for revealing the density and distribution of materials. Each 1 sq m reference point was located using the above surveying equipment and a stake driven into the ground marked with flagging tape, SW grid coordinates and a catalog number. Three (2-man) teams followed with the material recovery phase of the project; occasionally, team size was increased by 2-5 teams.

At stations with exposed surface materials, two pickup strategies were implemented: (1) at each SW stake a 1 sq m total surface pickup was made; a Brunton compass was used to orient the unit and a metric tape to measure its size; (2) within a 25 m radius of each stake the first five time-diagnostic artifacts--ceramics (e.g., rim and decorated sherds and appendages) or lithics (e.g., chipped stone tools, celts and ground stone tools) --were flagged, their proveniences recorded (distance from the stake was paced and angle was determined using a Brunton compass) and then the material was picked up.

At noneroded pedestal stations or stations where no surface material was evident, a 30 cm diameter shovel probe was dug to sterile deposits, usually less than 1 m, and its residues sieved through a 1/4" mesh. All retrieved residues were bagged, labelled and taken to the laboratory for later analyses. In total 117 stations (63 of which were shovel probes) were collected. Results of surface and shovel tests and numerous walking reconnaissances of the site guided the purposeful selection of areas to surface collect more intensively and to hand excavate. In general, areas selected contained abundant materials thought to be diagnostic of the 1st millennium B.C.

Five surface features in the eroded sector were selected for intensive investigation. The boundaries of each were determined through visual observation and mapped with a plane table and alidade. Coinciding with mapping was the gridding of four of the features--2 shellmiddens, a burial and a probable house location--into 1 sq m quadrats. A total surface pickup by quadrat was implemented and diagnostics within each quadrat were mapped in place; direction and distance from the SW stake were determined using metric tapes. In addition, all diagnostics within a 25 m radius of each discrete feature were flagged, proveniences recorded using a Brunton compass and a metric tape and picked up.

The fifth feature--a quarry/workshop--contained thinning flakes from bifacial reduction, as well as preforms and finished points. The workshop covered an area of .7 ha. Rather than attempt to collect this feature by grid, all surface bifacial work was flagged and their locations mapped in place with a plane table and alidade or theodolite and EDM, and then picked up. All features will be discussed in detail in Chapter IV.

Thirteen (1 sq m each) units were selected for excavation at La Mula-Sarigua; ten were placed within the features discussed above, one through a pedestal, one through an eroded cut and one through a shellmidden previously excavated by Richard Cooke in

1982. All excavated units commenced by trowelling in natural layers or in 5 cm arbitrary levels (whichever came first) to a sterile base; isolatable features were removed separately. Excavated residues were sieved through a nest of meshes (1/4" and 1/8"); materials were bagged and bags labelled for laboratory curation and analyses. In situ materials, features, unit walls and floors were cleaned, photographed, mapped and/or profiled and one column sample (30 cm diameter x excavation depth), taken in natural or 10 cm arbitrary levels, was pulled from one wall of each unit for the laboratory analyses of pollen, phytoliths, sediments, botanical remains and other micro- and macro-materials not uncovered in the general excavation. This column procedure and size has been standard for the regional PSM project.

Diagnostics within a 25 m radius of each excavation not previously collected, e.g., the pedestal, the eroded slope and the shellmidden excavated by Cooke, were flagged, proveniences recorded with a Brunton compass and metric tape and materials picked up.

Although restricted to the eroded zone, results of this pilot study indicated that not only was a larger survey feasible but mandatory given unknown site boundaries in the noneroded zone. Moreover, given the continued rapid erosion of the site coupled with uncontrolled collecting by enthusiastic but untrained individuals, there was some urgency to investigate the site before the integrity of the archaeological record was much further compromised.

1984 Field Survey. In 1984 I returned to La Mula-Sarigua to survey more systematically and sample the site. The probabilistic strategy chosen was that of running parallel transects.

Twenty-three parallel transects crosscut eroded and noneroded zones. They were oriented north to south off the 1983 east to west baseline and were spaced 100 m apart; an additional 5 lines (spaced 100 m apart) were oriented east to west in the southeast sector of the site. In this latter sector the land is irregularly shaped and frequently truncated by swamps; an east to west orientation was, therefore, the most immediate practical solution to site coverage.[7] Stakes were placed at 25 m intervals along each line and numbers assigned. While orienting these lines and driving in stakes is a relatively straightforward exercise, the logistics of their placement and straightness was often problematical in the noneroded zone. This zone includes pockets of dense scrub forest, stinging nettle, prickly pear cactus and cholla. In addition, the area has been declared ecologically fragile and the clear-cutting of vegetation is prohibited. Where necessary, narrow access paths were cut with a machete; paths were well flagged as were stake locations. Unfortunately, the placement of each line and stake was less accurate than that of 1983 since each 100 m line was oriented using a Brunton compass and the distances between lines, as well as along each line, were determined either through pacing or using a 100 m long hemp rope marked off at 25 m intervals (Plate 8). A more accurate measuring system would have been preferable but the theodolite, EDM (electronic distance measuring device) and prisms ordered to survey and map the site did not arrive until three-quarters of the field season was completed. After only three days of use the EDM was damaged in transportation. The remaining line and stake placements were done with a theodolite and stadia rod. (See Figure 7 for line placements).

Irregardless of the year, material recovery strategies at collection points were generally the same (see above) and covered by 3 (2-man each) teams but occasionally by as many as 8 teams. In at least one instance increasing team size was necessary as the line setters were 1-1/2 km ahead of the testing crew; the crew complained about being unable to find their flagged stations. It did not take too long to discover that cattle had kicked out the stakes and eaten the tapes; part of the line had to be reset. The most pragmatic thing at the time was to increase crew size to keep up with the line setters.[8]

To summarize, stakes were placed at 25 m intervals along transect lines. On eroded surfaces, a 1 sq m total surface pickup was undertaken and the first 10 (5 ceramic and 5 lithic) diagnostics within a 25 m radius of the stake flagged, location recorded with a Brunton compass, distance paced and the material picked up. (Note: only 5 diagnostics were picked up in 1983 and particular type was not specified; this no doubt introduced collector bias. This bias was, hopefully, corrected by specifying number and type in 1984). When a stake was in a noneroded location a shovel probe was dug. In 1984, a 1 x 2 km area was systematically examined; 260 surface stations were collected and 631 shovel probes completed. Based on the results of this examination, 1 area was selected for intensive surface collection and 6 locations for excavation.

The area selected for intensive collection (70S275E) consisted of two adjacent shellmiddens in the eroded zone with enormous amounts of 1st millennium B.C. diagnostics dispersed between the two. Using a plane table and alidade, the entire area was gridded into 5 sq m quadrats (163) and then a 1 sq m collecting station within each 5 sq m unit was generated using a table of random numbers (a systematic unaligned sampling strategy). A total surface pickup for each 1 sq m unit was implemented; however, in three of the 5 sq m units the material was so dense that all 25 (1 sq m each) units were collected. Because so much diagnostic material remained after this intensive exercise, a diagnostic sweep was put into action, both within the gridded area and within a 25 m radius outside the gridded area. These diagnostics were flagged, their proveniences recorded using a Brunton compass and 60 m tapes and then picked up.

Six (1 sq m each) units were selected for excavation; five in the noneroded zone where shovel probes revealed the presence of stratified 1st millennium B.C. deposits and one in a pedestal in the eroded zone. All excavations proceeded as discussed above. A diagnostic sweep using a Brunton compass and metric tape took place in the vicinity of the eroded pedestal; such was not possible in the noneroded zone where the area is in pasture, ground visibility is nonexistent and the archaeological deposits are buried.

<u>1985/86 Fieldwork</u>. Three locations investigated in 1983 were briefly reexamined in 1985/86, i.e., Cooke's shellmidden, the diagnostically collected eroded slope and the bifacial workshop. Using the excavation techniques outlined above, the shellmidden was totally removed; a 1 sq m unit was put through the eroded slope. Three strategies were used to investigate the workshop: (1) in an area where bifacial thinning flakes clustered, a 5 sq m and a 2 x 2 m area were gridded into 1 sq m units and a total surface pickup by unit carried out; (2) one of the collected 1 sq m units was excavated and (3) the surface was intensively surveyed in all directions from these units. The survey was terminated when bifacial material was no longer encountered. Diagnostics were flagged, proveniences recorded with a theodolite and stadia rod (as were the gridded units) and materials picked up.

At the completion of the 1983, 1984 and 1985/86 fieldwork, a 1 x 2 km area had been systematically examined; 380 surface stations collected, 766 shovel probes completed, 6 surface features mapped and materials collected by 1 sq m grids,[9] as well as diagnostics within a 25 m radius of each feature collected and their locations recorded and 21 (1 sq m each) units excavated. Thirteen excavated units were placed through 6 surface features, 3 through eroded surfaces and 5 in the noneroded zone where shovel probes revealed the presence of stratified subsurface deposits containing 1st millennium B.C. materials.

Conclusions

Strictly speaking, reliable statements about the entire site can only be based on data collected from those areas that have been selected by statistical sampling schemes. The data collected in 1984 along the systematically aligned transects, and in 1983 along the 25 m wide transect, satisfy this requirement. An analysis of the materials collected (Chapters VI-VIII) from this strategy have allowed me to determine: (1) overall site boundaries based on the presence/absence of cultural material (Chapter IX) and (2) the density and distribution of buried and surface materials and features (Chapter IX). Nonetheless, chronological placement of these materials was dependent upon the results of the purposive sample. That is, it is very difficult to place materials in their proper stratigraphic context if they have been collected from small, deep shovel tests and deflated surfaces. To more accurately define site boundaries through time (Chapter IX), it has been mandatory to combine the results of the probabilistic survey with results of the test excavations discussed in Chapter IV, specifically the recovery of diagnostic materials in stratigraphic and radiocarbon dated contexts.

Endnotes

1. Phase and stage are used interchangeably in the present chapter.

2. There are several small shellmiddens in the Sarigua Alvina to the north of the site, stone tools and debitage beyond the western stream channel and post-1st millennium B.C. material to the south. This evidence suggests that La Mula-Sarigua is one loci in a series of spatially and/or temporally overlapping sites. This has been discussed in some detail in Chapter II.

3. Perhaps evenly distributed sampling stations and transects, e.g., 50 m spacing between lines and between collecting stations, would have been the ideal strategy but this would have significantly increased the time and labor necessary for cutting through the vegetation in the noneroded sector. In the end, there would have been very little to no time left for intensive surface collecting and excavating.

4. The major difference between surface and subsurface inspections is the space represented within a sampling unit. For example, 1 x 1 m surface units are viewed two-dimensionally, whereas .3 x .3 x 1 m subsurface units are viewed three-dimensionally (Lightfoot 1986:486).

5. Determining site chronology was essential to this project. The probabilistic sampling units (both surface and subsurface units) did not always reveal diagnostics which would allow me to ascertain the age of the site's deposits. For this reason, a diagnostic sweep was instituted within a 25 m radius of each collecting station (where possible).

6. A grid system oriented along cardinal directions was superimposed on the site using an arbitrary point in the eroded zone where occupational debris was heaviest at datum 0. Proveniences were recorded using a coordinate grid and measuring along each axis in meters, e.g., the provenience 320N183E is a point 320 m north and 183 m east of datum 0.

7. In retrospect, these lines should also have been oriented north to south for consistency in site sampling.

8. We had already been shovel testing for 5-1/2 weeks and we were all looking forward to this part of the project being completed. It was debilitating work, given the constant sun and high winds, and the substantial amount of paraphernalia/weight that each team had to carry into the field, never mind the added weight of recovered materials at the end of the day. A list of the supplies that each team carried into the field follows: a

machete, shovel (or coa), 1/4" screen, hand trowel, metric tape, Brunton compass, flagging tape, plastic bags, labels, clip board, data sheets, pens, pencils, penknife, water jug, aspirin and insect repellent.

9. A total of 774 grids were collected within the 6 features.

CHAPTER IV

EXCAVATIONS AND FEATURES

Introduction

In this chapter I will discuss those areas of the site that have been nonprobabilistically (purposively) selected for investigation, i.e., the intensive surface collections (features) and the excavations.

Numerous surface features were observed in walking reconnaissances, and in the setting of the baseline and transects. Inter-feature variation was considerable; they included shellmiddens, trash dumps, burials, lithic workshops and possible house locations. At least one surface feature of each functional type was chosen for investigation. To be chosen each had to contain either 1st millennium B.C. material or represent a unique cultural occurrence.

Excavations were placed in two types of deposits: (1) the collected features (with one exception) and (2) the noneroded zone where shovel test results indicated the presence of stratigraphic deposits containing 1st millennium B.C. material. In addition, all diagnostics within a 25 m radius of each feature were flagged, proveniences recorded and then collected.

The general techniques for collecting features and for excavating units have been discussed in Chapter III. The remainder of this chapter will describe the general contents of individual features, excavations and stratigraphy. I will also discuss how the results from nonprobabilistically selected samples can be used to shed light on the location and nature of occupation at La Mula-Sarigua.

Features

Five features were chosen for systematic collection, excavation, and 25 m radius diagnostic sweeps: 2 shellmiddens, 1 burial, 1 house location and 1 bifacial workshop. The first 4 features were selected because they contained and/or were surrounded by abundant 1st millennium B.C. materials. The workshop was selected because it was one-of-a-kind at La Mula-Sarigua. In fact, bifacial material is extremely rare in Panama in general. A sixth feature (a 1st millennium B.C. shellmidden [70S275E]) was intensively collected and a diagnostic sweep done; there was insufficient field time to carefully excavate these deposits.

Shellmiddens. In the present study, shellmiddens are defined as circumscribable shell dumps. The shell within these dumps do not appear to have been modified or utilized as tools; they are, therefore, interpreted as evidence for the use of molluscs as food.

74S40E: This 3 x 5 m midden is approximately 55 cm (at its highest point) above the surrounding eroded surface (Figure 8, Plate 9). There are few to no surface diagnostics within the confines of the midden itself but they are extremely abundant outside the midden; the latter have been collected using the strategy described above.

Prior to surface feature collecting, the midden was gridded into 1 sq m units and a total (shell, bone and artifacts) surface pickup by unit begun. Using the techniques discussed in Chapter III, one (1 sq m) unit was excavated at the midden's highest point.

Subsurface deposits 74S40E: The soil profile consists of two layers (B and C; A is missing [Figures 9, 10, Plates 10, 11]).

B: (red-purple silty clay; 9-36 cm in thickness). There are two, relatively intact, discrete shell lenses within this layer: (1) compacted oyster (disturbed to 51 cm below the surface in the W wall; there is little to no shell from the surface to the lower 16 cm of this disturbance, at which point there are only dispersed oyster fragments); (2) 34 cm bs in the NW wall there is a small (55 cm long by ca. 5 cm thick) clam lens underlying the oyster. A column sample taken through this latter lens exposed a hearth at ca. 40 cm bs (Plate 12). The hearth is associated with Lamula Group pottery (discussed in Chapter VII) and shell. The shell has been radiocarbon dated to 390 ± 70 B.C. (Beta-12931). The bulk of cultural material, e.g., pottery, flakes, shell and an occasional bone, are confined to the B layer.

C: (red-orange clay with bedrock fragments; 30-47 cm in thickness, except in the W wall where the deposits have been disturbed from the surface to 51 cm bs). There are a few weathered shell fragments in this layer as well as an occasional sherd or flake.

70S275E: This area measures approximately 1750 sq m and consists of two adjacent shellmiddens with enormous amounts of 1st millennium B.C. artifacts dispersed between the two (Figures 11, 12, Plate 13). It is the only feature that was not excavated. This was also the only feature that was collected according to a systematic unaligned strategy; this strategy has been discussed in some detail in Chapter III.

8S75E: This large (402 sq m) shellmidden contained dense amounts of surface material, such as stone tools and debitage, ceramics diagnostic of several time periods, faunal remains (e.g., deer, fish and molluscs) and human remains.

The initial gridded area (by 1 sq m units) measured 14 x 15 m. All material within these units was collected by 1 sq m units (Plate 14). As collection continued, however, it became clear that material was very diffuse on two sides and hence the collection area was expanded 2 x 5 m on the W side, and 13 x 14 m to the S and E (Figures 8, 13). Unlike other surface features, this one contained small pockets of aeolian sediments. Where a 1 sq m collecting station fell within these sediments, a small (30 cm in diameter) subsurface probe (with a hand trowel and no screen) was dug. The results of these probes were used to guide the placement of two (1 sq m each) excavation units.

Subsurface deposit 8S81E: There are 3 layers (A, B and C) in the soil profile (Figure 14, Plate 15).

A: (light brown aeolian silts; 5-26 cm thick). This layer was removed as one stratigraphic (natural) unit. There was little to no associated cultural material, except at the very bottom where large amounts of shell, bone, pottery and stone were present. These materials are identical to those on the midden surface.

B: (red-purple silty clay). This layer has been truncated and presently consists of two small, wedge-shaped pockets: (1) 30 cm long and averages 20 cm in thickness, and (2) 25 cm long by ca. 6 cm thick. The configuration of the bottom of A, as well as the density and distribution of cultural materials contained therein, suggests recent deposition into an erosion channel and onto an old eroded surface (B) (Plate 16). This process of erosion and deposition is very common in the eroded portion of the site. Over the long-term it results in exposed and buried deflated surfaces. The bulk of intact cultural materials, e.g., shell, bone, smashed pots and a small trash pit in the N wall column sample, are confined to layer B.

C: (red-orange clay; 8-23 cm thick). This layer has an occasional shell fragment and sherd associated with it.

Subsurface deposit 7S86E: There are 5 distinguishable soil types in the profiles (Figures 15, 16, Plates 17, 18). Only 2 layers (B and C) fit the descriptions of above; A is missing. The remaining 3 suggest post-occupation, but culturally-induced, modifications.

B: (red-purple silty clay; 10-15 cm thick wedge). There is little to no cultural material associated with this wedge. That which is present is in the form of an occasional shell fragment.

B-1 (?): (reddish sandy clay; 16-28 cm thick). There is an occasional shell fragment associated with this deposit. The separation between B and B-1 is represented by a sharp vertical demarcation in the profile. The absence of material and the configuration of both matrices suggest recent potting.

B-2 (?): (blackish gritty sediment; 24-31 cm thick). Cultural material, in the form of several diagnostic sherds, human bone fragments and fragmented shell, is confined largely to the upper 5 cm. The remaining sediments are limited to an occasional shell fragment. As with B and B-1, there is a relatively sharp demarcation separating the 3 soil types; all of which commence at the surface and lay side-by-side vertically. Recent human disturbance is the best interpretation of this situation.

C: (dense brown clay; 6-11 cm thick). This layer underlies that of B-2 and part of B-1. Material remains are absent.

C-1 (?): (red sandy sediment; 12-19 cm thick). This stratum is found below B and a portion of B-1. It is devoid of cultural material. C and C-1 are separable (vertically) in terms of color and texture of soil type. Human displacement is implied.

242S417E: Unlike other excavated units, this shellmound was divided and removed in 4 (50 sq cm each) quadrats; all but the NW quadrat will be discussed as one unit (Figure 17). The entire feature is overlain by a deposit of red-brown alluvial clay which varies from 2 to 16 cm in depth. This overburden has been removed as one natural unit, albeit by quadrat. The shellmidden itself contains massive numbers of sherds and shells, and several bone fragments and flaked stones. Two radiocarbon dates have been obtained on shell from the bottom of this overburden: 870 ± 50 B.C. (Beta-6016) and 790 ± 60 B.C. (Beta-21898); this shell was associated with Early and Aristide ceramic Groups (discussed in Chapter VII).

Subsurface deposits 242S417E: There are little to no subsurface sediments associated with this unit; it is largely comprised of shell (loose or compacted), and/or compacted burnt clay, and cultural material. Each level, therefore, will be described using these categories (Figures 18, 19, Plate 19).

1. SW, SE and NE quads (0-5 cm bs): loose shell containing 36 sherds, 3 flaked stone, and 8 fish bone fragments;
   (5-10 cm bs): loose shell, 19 sherds, 12 fish bone fragments;
   (10-15 cm bs): loose shell, 9 sherds, 1 utilized cobble and several bone fragments;
   (15-20 cm bs--feature bottom): compacted burnt shell mixed with patches of burnt clay, 4 sherds, 1 flake, 1 nut fragment, several bone fragments and a large pocket of charcoal.

2. NW quad: this quad was divided in half, and each half was

totally removed in 5 cm arbitrary levels; one half was reserved for flotation, and the other half for pollen and phytolith analyses. Cultural material was separated and bagged with each sample. Cultural material included:

(0-5 cm bs): 33 sherds, 1 flaked stone;
(5-10 cm bs): 47 sherds, 1 flaked stone, 1 possible flake;
(10-15 cm bs): 33 sherds;
(15-20 cm bs): 3 sherds, 1 cobble.

<u>Burial 74S82E</u>. In this area numerous human bone fragments and teeth are concentrated on the surface, as well as large quantities of 1st millennium B.C. diagnostics (Figure 8, Plate 20). A 2 x 5 m area was gridded and totally llected by 1 sq m units. Diagnostics within a 25 m radius of this 2 x 5 m area were also collected and their proveniences recorded. To determine the relationship between surface and subsurface remains, a 1 sq m excavation unit was begun. Upon uncovering a burial, 4 adjacent (1 sq m each) units were opened. Three of these 4 units contained trash pits consisting of shell and bone fragments, an occasional flake and minimal numbers of sherds.

<u>Subsurface deposits 75S84E</u>: Two soil layers are recorded for this unit (B and C; A is missing; see 75S83E, Figures 20, 21, Plates 21, 22).

B: (red-purple silty clay; 0-ca. 30 cm bs).
1. 0-10 cm bs: this layer contains small amounts of pottery, human bone and an occasional piece of eroded bedrock;
2. at 12 cm bs a feature was encountered in the NE quadrat; the feature was distinguished by soil color and a few human bone fragments; the S sector of this unit was composed almost entirely of eroding bedrock granules;
3. at 16 cm bs the entire feature was uncovered, i.e., an extended human burial (Plate 23). The burial

extended to a depth of 30 cm bs. Throughout the B layer (0-30 cm bs) occasional sherds, shell and eroded rock fragments were encountered, but nothing that could be directly associated with the feature.

C: (red-orange clay with bedrock granules; 30-35 cm bs [termination of excavation]). Culturally sterile.

Subsurface deposits 75S83E: Two walls were profiled in this unit; 3 layers (B, C and D; A is missing) are recognizable (Figures 20, 21, Plates 21, 22).

B: (red-purple silty clay; 60-85 cm thick). This layer is associated with the bulk of cultural material. There are at least two pits cut into this layer: feature 1 fill contains a concentration of shell fragments, ceramics and an occasional human bone. Pit fill from feature 2 is very different in color and texture; it is composed of a mixture of brown clayey-silts and weathered bedrock granules. Cultural material is minimal relative to feature 1. The quantity and quality of both feature contents indicate trash debris. Note: a column cut through feature 1 (W wall) uncovered a sherd and a piece of human crania 90 cm bs. A close inspection of the column sidewall indicated burrowing activity, hence the material should be considered intrusive.

C: (red-orange clay). This layer is 36 cm thick in the S wall and here forms a wedge within layer D (see Figure 20). It is absent from the W wall. The layer is culturally sterile.

C variant: (dense brown clay; ca. 15 cm thick). This clay type underlays layer B and parts of D in the W wall. It is absent in the S wall. It is devoid of cultural remains.

D: (soft yellow-red weathered bedrock; 15-38 cm thick). This layer displays an irregular contact with layers B and C. It is directly beneath B in parts of the S and W walls; and it is above C variant in the W wall. There is no cultural material associated with layer D.

Subsurface deposits 74S82E: The soil profile contains the B layer only; (see 75S83E, Figures 20, 21, Plates 21, 22).

B: (red-purple silty clay; 0-10 cm bs [excavation depth]. Very sparse material within this unit; i.e., an occasional bone and sherd.

Subsurface deposits 74S83E: The soil profile contains B layer only; A is missing; (see 75S83E, Figures 20, 21, Plates 21, 22).

B: (red-purple silty clay; 0-15 cm bs [excavation depth]).
1. 0-5 cm bs: abundant sherds and a half-dozen or so of human bone fragments; the bone is concentrated in the NE corner. The SE corner is devoid of material;
2. 5-10 cm bs: approximately 15 sherds, 1 stone and an increase in human bone concentrated in the NE corner. S sector is culturally sterile;
3. 10-15 cm bs: 12 sherds concentrated in NW quadrat; human bone is absent and the remainder of the unit is sterile.

Subsurface deposits 74S84E: As above, this unit contains only a B layer; (see 75S83E, Figures 20, 21, Plates 21, 22).

B: (red-purple silty clay; 0-20 cm bs [excavation depth].
1. 0-5 cm bs: handful of sherds;
2. 5-10 cm bs: feature in SW quadrat containing human bone and several sherds. The feature began at 8 cm bs and extended to 20 cm bs. The remainder of the unit (vertically and horizontally) was sterile.

Possible House Location 67S75E. Concentric clusters of fragmented shell occur on the surface. These are reminiscent of house locations described by Cooke (personal communication), Bort (personal communication) and Damp (1984), and discussed in Chapter IX. Numerous 1st millennium B.C. diagnostics are either adjacent to and/or co-occur with these clusters.

A 5 x 10 m area was gridded and totally collected by 1 sq m units; shell occurrences were drawn in place by unit (Figures 8, 22, Plates 24, 25). To observe the surface to subsurface relationship, as well as to test the concept that we might be dealing with a house location, two (1 sq m each) units were excavated. One unit cross-cut a shell/no shell boundary (63S80E) and one avoided surface shell altogether (64S77E).

Features occur in each unit; their contents, e.g., fish remains, flakes, abundant diagnostic sherds and a human digit suggest trash pits.

Subsurface deposits 64S77E: Two soil layers (B and C; A is missing) can be seen in the profile (Figure 23, Plate 26).

B. (red-purple silty clay; ca. 15 cm thick throughout). The bulk of the cultural material (sherds, shell, and small amounts of flakes and bone) is confined to this layer, except for the contents of two features revealed in the S sidewall at ca. 5 cm bs. One is a small (ca. 20 sq cm x 20 cm deep) shell-filled pit; the other an elongated (ca. 30 cm wide x 90 cm long x 30 cm deep) pit or trench filled with loose sediments, numerous shell fragments and some flakes.

C. (red-orange clay with bedrock granules; 15 cm bs to depth of excavation). With the exception of where the above features have cut into this stratum, this layer contains only a few shell fragments.

Subsurface deposits 63S80E: The soil profile (Figure 24, Plate 27) contains two layers (B and C; A is missing).

B: (red-purple silty clay; surface - 16 cm). This layer contains shell fragments, sherds and a few flakes. One feature has been positively identified, i.e., a trash pit which cuts through into the next layer (C) (Plate 28). This feature was removed separately by 15 cm levels; it extended down to 53 cm bs. The pit contents have been floated by level. Sherds from the top to the bottom of the pit have been refitted indicating that the pit fill is a single depositional unit. The sherds are reminiscent of 1st millennium B.C. materials found in datable contexts.

C. (red-orange clay with bedrock granules; 16 cm bs to depth of excavation, except where the feature has penetrated the floor). An occasional shell fragment is associated with this stratum.

Bifacial Workshop 570N174W. Unlike the above features, this workshop was somewhat diffuse. Based on an intensive walking reconnaissance of this severely eroded area, two surface pickup strategies were implemented: (1) two loci which contained large amounts of bifacial thinning flakes were gridded into 1 sq m units and a total surface pickup by unit was undertaken (1 area was 5 x 5 m, the other 2 x 4 m); and (2) from these two loci outward, all bifacial material was flagged, their locations mapped in place with a plane table and alidade or theodolite and EDM, and then picked up (Figure 25). To determine the nature of the subsurface deposits in this workshop area, one of the 1 sq m gridded squares was excavated.

Subsurface deposits 570N174W: Only one soil type was recognizable in this unit, a compacted red-mottled clay. The deposits were very shallow; cultural material included lithic debitage and 6 bifacial thinning flakes. All were encountered in the upper 2-3 cm. From 3-5 cm there were minimal amounts of debitage and no bifacial material. Excavation terminated at 5 cm bs.

Other Excavations by Grid Coordinates

40S118E. Excavation was begun at the crest of a vegetated pedestal and continued through an eroded sloping face (Figure 8, Plate 29). Three soil layers (A, B and C) can be viewed in profile (Figure 26, Plate 30).

A: (light brown aeolian silts; 16-36 cm thick). Totally devoid of cultural remains.

B: (red-purple silty clays; 10-17 cm thick). Artifacts are not particularly abundant in this excavation, relative to other units: a few sherds, flakes and shell fragments. Nonetheless, those that do exist are largely found within this layer.

C: (red-orange clay with bedrock granules; 22-28 cm thick); human occupation is absent.

Pedestal I. Like the above excavation, this one commenced at the zenith of a pedestal and proceeded through a sloping, eroded face (Plate 31). The soil profile (Figure 27, Plate 32) contains 3 layers (A, B and C).

A: (light brown aeolian silts; 5-12.5 cm thick); no associated cultural material.

B: (dark red clay; 12-18 cm thick); 1 sherd.

C: (red-orange clay; 26-30 cm thick); 19 sherds and 1 flake. Cultural remains are not found below 60 cm bs.

70S169E. There are tremendous numbers of 1st millennium B.C. diagnostics, bone and lesser amounts of shell exposed on the surface (Plate 33). Upon commencing the excavation, identical quantity and quality of material remains were encountered. The unit was, therefore, divided into a N and S sector and each 5 cm arbitrary level collected in bulk for flotation. Two strata are apparent: A and B.

A: (light brown aeolian silts; 2-3 cm thick). Abundant material (see above).

B: (red-purple silty clays; 17 cm thick). Abundant material as above but very sparse by 20 cm bs at which point the excavation was terminated. A radiocarbon date of 240 $\pm$ 90 B.C. (Beta-18863) has been obtained on shell from the 10-15 cm bs layer; the shell is associated with Lamula and Aristide ceramic Groups (discussed in Chapter VII).

The location of the following 5 excavations was based on the results of the probabilistic shovel testing.

14N494W. Three strata are clearly visible in this unit (B, C and D; A is either missing or not discernible [Figures 28, 29, Plates 34, 35]).

B: (red-brown silty clay; 21-36 cm thick with the exception of one cut which persists to 41 cm bs). This layer is a probable plow zone which in one section cuts deeper and through a very large 1st millennium B.C. feature. This feature rests on layer C; it is 55 cm long by 17.5 cm deep (at least based on the part that is exposed--it continues into the sidewalls) and it is lined with shell fragments. Shell from this feature has been radiocarbon dated to 270 + 70 B.C. (Beta-12728); this date is associated with Lamula ceramic Group (discussed in Chapter VII). Above this feature are large amounts of diagnostic sherds, some shell fragments and a few flakes. In the NW corner of layer B is an extremely dry brown clay wedge (3-16 cm thick) which is devoid of cultural material.

C: (compacted red clay; 10-45 cm thick). Relative to B, C has sparse amounts of ceramics, shell and lithics.

D: (dense brown clay; 10-18 cm thick). There is only an occasional shell fragment.

64N496W. The sediments in this unit are slightly different in color and composition than those units described above and below (Figure 30, Plate 36).

1: (very hard dry grey silt; 25-52 cm thick). This unit largely represents a plow zone (?) and an undefinable disturbed feature. Massive amounts of diagnostic and body sherds, and minimal amounts of stone are found throughout this strata; shell and bone are absent.

2: (brown-grey clay; ca. 13-46 cm thick). Very sparse amounts of ceramics are present.

11N398W. Several pieces of human bone and a molar, along with diagnostic sherds were revealed in a transect shovel test at this location. Four strata have been discerned (Figures 31, 32, Plate 37).

A: (light brown aeolian silt; 13-20 cm thick). Approximately 2 dozen body sherds are associated with this stratum.

B: (red-brown silty clay; 12-22 cm thick). Associated with this layer are enormous amounts of diagnostic and body sherds, small amounts of lithics, bone and carbon.

C: (compacted red clay; 7-30 cm thick) Large quantities of diagnostic and body sherds, and minimal amounts of lithics and carbon are dispersed throughout this stratum. Also contained in this layer (ca. 43-55 cm bd) is a bundle burial (Plate 38), perhaps representing more than one individual (sample #626 discussed in Chapter VIII); 2 cm lower and northeast of this burial was a small, very clear, concentration of shell, sherds (Lamula ceramic Group [Chapter VII]) and non-mammalian bone. The shell has been radiocarbon dated to 320 ± 90 B.C. (Beta-12729); the shell feature bottoms out at ca. 85 cm bd.

D: (dense brown clay; 6-25 cm thick). Relative to C, D has minimal numbers of slivered sherds, shell, and bone.

<u>14S396W</u>. Two strata have been recognized in this unit (A and B [Figure 33, Plate 39]).

A: (light brown silt; 23-30 cm thick). The "A" horizon is missing from at least 1/3 of this unit. This is a probable plow zone which contains small amounts of diagnostic sherds.

B: (red-brown silty clay; ca. 67 cm deep). There are several dozen sherds (many of which are diagnostic) and a dozen flakes. Below 35 cm the deposits are sterile.

<u>25S550W</u>. Two layers (D and E) are present in this unit; A, B, and C are missing (Figure 34, Plate 40).

D: (dense brown clay; 3-13 cm thick). Several dozen sherds and several flakes.

E: (dense grey clay; 11-18 cm thick). A dozen sherds and several flakes.

General Site Stratigraphy

Between 1983 and 1986, 21 (1 sq m each) units were excavated. Three types of locations were selected: (1) clearly delimited surface features (n=13 excavations in 6 features), (2) noneroded pedestals (n=3) in the eroded zone and (3) subsurface, stratified deposits (n=5) containing 1st millennium B.C. materials in the noneroded zone revealed by shovel testing.

With few exceptions and despite varying strata thicknesses within and between units, site stratigraphy follows 2 patterns: one pattern is restricted to those units excavated through eroded surfaces in the wet season, and the other pattern to those units excavated through noneroded surfaces in the dry season. The general difference between these 2 patterns is one of very subtle soil color; neither soil texture nor quality and/or quantity of cultural remains varies between the two. Hence it is highly likely that soil color distinctions are actually an artifact of the season. Seasonal differences occur in the amount of: (1) precipitation, (2) wind and (3) sun. Each of these factors taken alone or in combination can be seen to have an effect on soil color through differential moisture retention and/or drying. For example, during the wet season most days were very cloudy; there were occasional downpours; and the air was quite still. It often required 2-3 days for water to evaporate in open excavations. In the dry season, the sun was constant; it may have sprinkled one or two days; and the wind was quite strong. Excavation sediments dried out so rapidly that the walls and floors began to crack open in a matter of 2-3 days. That seasonal variation (as opposed to eroded versus noneroded surfaces) may be a factor in soil coloration is strengthened by the exposure of one unit (Pedestal I) which was cut into an eroded slope in the dry season (Figure 27); other exposed eroded units were cut into in the wet season, e.g., 40S118E (compare Figures 26 and 27). In Pedestal I, colors, textures, etc., are identical to those described for the <u>non</u>eroded, dry season excavations (compare Figures 27 and 31). Each pattern will be discussed separately; a comparison of the two can be seen in Table 1.

Table 1. A Comparison of Wet and Dry Season Soil Color.

Stratum	WET SEASON	DRY SEASON
A	light brown aeolian silt	light brown aeolian silt
B	red-purple silty clay	red-brown silty clay
C	compacted red-orange or dense brown clay with bedrock granules	compacted red clay
D	soft yellow-red extrusive bedrock	dense brown clay
E	-	dense grey clay with bedrock granules
F	-	grey-brown bedrock

<u>Eroded Surface Excavations</u>. The deepest unit excavated in the eroded zone, layer D, is composed of soft yellow-red bedrock; its thickness ranges from 15-38 cm. Layer D is clearly demarcated from layer C in the one unit (75S83E) where it occurs. It is this same bedrock which is seeing eroding out of various

exposed slope localities. There is no evidence of human occupation associated with the buried D layer.

Layer C generally consists of compacted red-orange clay and frequently contains bedrock granules in its matrix; its thickness is uneven and ranges from as little as 8 cm to as much as 47 cm. Thickness calculations are in part, however, an artifact of excavation technique, i.e., units were terminated when cultural material was no longer evident. In one unit, layer D is overlain by dense brown clay rather than red-orange clay. With the exception of an occasional feature being cut into the red-orange clay, cultural material, in the form of shell fragments, flakes and sherds, is minimal and widely dispersed throughout the units relative to layer B. The brown clay units are devoid of features and/or cultural materials.

Layer B is a red-purple silty clay; its thickness varies from 9-85 cm; it is this layer which contains most of the intact features, e.g., burials and trash pits, and the greatest quantity of artifacts, e.g., ceramics, flakes, bone, shell and carbon. A radiocarbon shell date of 390 ± 70 B.C. on shell is associated with these deposits. The separation of C and B rests on slight color differences, degree of compaction and density of cultural materials. It is this latter layer which forms the site surface in the majority of the units excavated in 1983. In these cases, the surface sediments are badly weathered as is much of the cultural material contained thereon.

With a thickness of 5-26 cm layer A is light brown aeolian silt and of recent origin. This layer is present only in those units where small patches of vegetation have trapped sediments. Little to no cultural material is associated with these silts. The boundary between layers B and A is quite clear and is based on differences in soil color, texture and the lack of material inclusions.

Noneroded Surface Excavations. In an area where sediment accumulations are very shallow (25S550W) basal deposits (layer F) were encountered 25 cm below the present surface. These deposits consisted of grey-brown bedrock uneveningly protruding into layer E. The latter layer is a dense grey clay which contains bedrock granules in its matrix and is 13-16 cm in thickness. Cultural remains in the form of ceramics and flakes are associated with this layer and are identical to but not as abundant as those found in the layer above.

This shallow unit was capped by 5-12 cm of dense brown clay (layer D). Artifactual material consisted largely of 1st millennium B.C. sherds and flake debris. Layers C, B and A are missing from this unit.

The deepest unit excavated in the noneroded zone (11N398W) was dug to a depth of 80 cm below the present surface. The bottom deposits (layer D) contained dense brown clay (10-31 cm in thickness) identical to that described above. In contrast to that above, and with one exception for the remainder of the noneroded zone units, material remains are largely absent from this clay. The one exception contained a small shell feature and small scatters of bone and ceramics. Shell from this feature has been radiocarbon dated to 320 ± 90 B.C. This layer is denser and less red than layer C, and thus separable from it.

Layer C is a very compact red clay and ranges in thickness from 7-30 cm where it is definable. The distinction between C and B is one of gradual and very subtle differences in color and compaction with the former being a bit redder and compacter. These differences are often masked by exposure and for this reason the division between C and B have often not been picked up when drawing wall profiles. Small amounts of cultural material, in the form of shell fragments, bone and ceramics, are evident in layer C deposits.

Layer B is a red-brown silty clay 13-46 cm in thickness where it can be clearly circumscribed. As with layer B units excavated in the eroded zone, this layer contains the greatest density of features and/or artifacts relative to lower and upper deposits. It is unfortunate that the upper parts of at least two of the noneroded zone features have been removed by plow activity. Nonetheless, shell obtained from an intact portion of one such feature has been radiocarbon dated to 270 ± 70 B.C.

Layer A is a dry light brown silt which contains abundant root hairs and grasses at the surface; it is 7-30 cm in thickness and has often been disturbed by the plow. Very little artifactual material is found within this layer.

Conclusions

Unlike the material collected from the probabilistic sample, an analysis of the material collected (Chapters VI-VIII) from the purposive operation have allowed me to determine: (1) the stratigraphy of the site, (2) site age based on the presence of diagnostic material in stratigraphic, radiocarbon dated contexts (Chapter IX), (3) the relationship of surface to subsurface features, (4) floral and faunal resources utilized (Chapter VIII) and (5) the disposition of human remains (Chapter IX).

A combination of the results from both strategies (i.e., those discussed in Chapter III and IV) have allowed me to determine: (1) site size through time (Chapter IX) and (2) probable internal spatial layout (Chapter IX). The implications of these results for interpreting socioeconomic forms have been addressed in Chapter X.

CHAPTER V

DATA MANAGEMENT

Introduction

When the La Mula-Sarigua field phase was implemented (Chapters III and IV), a recording form and guide for its completion were developed. At the termination of the field phase, information from several thousand forms had been processed using a microcomputer. One powerful advantage of the microcomputer (versus a mainframe) has been its portability; this allowed data management to begin while field work was being carried out. Following two years of laboratory analyses, data from a minimum of 8,000 records had been entered into three separate databases.

In short, a considerable amount of time and energy has been expended on computer-related activities throughout the course of this project. This should not be surprising given the enormous quantity of material recovered from La Mula-Sarigua which necessitated processing (from recording to analyzing and retrieving). That is, the primary tool used for storing, analyzing and retrieving data (data management) has been the microcomputer. It has also been used for graphics and word processing as well.

The major objectives in writing this chapter are twofold: (1) to describe the hardware, software and their applications in handling the present body of data and (2) to assess their utility for the management and final presentation of these data. This discussion is not meant to be a general evaluation and/or critique of microcomputers and their use in archaeology (cf., Gaines 1981, Graham and Webb 1982, Richards and Ryan 1985, Workshop Proceedings of the Society for American Archaeology 1986).

In the Beginning

Microcomputer technology and associated software have rapidly developed throughout the duration of this project (1983-1988). At the termination of the major fieldwork phase (1983-1984), the unit used was a KAYPRO IV-84. This uses a CP/M-80 operating system and has 2 floppy disk drives and 64 K Ram; the output device used was an EPSON FX/T-80 (9 pin) dot-matrix printer.

The first task was to set up a master site inventory or catalog. This was to include: (1) catalog number, (2) provenience, (3) operation type,--e.g., excavation, surface collection, shovel test, (4) environmental context,--e.g., alvina, pasture, eroded surface, (5) general material type,--e.g., pottery, stone, human bone, nonhuman, shell, (6) specific samples collected,--e.g., carbon, sediments, (7) screen size, (8) date and (9) recorder. Ultimately, I wanted to be able to retrieve any one and/or a combination of the above categories; for example, all proveniences that contained pottery or all shovel tests that contained pottery and/or stone. Retrieving this information by leafing through field data sheets (which number in the thousands) would have been impractical. The software chosen for this task was FYI 3000.[1]

FYI 3000. FYI 3000 ([TM] FYI, INC. 1983) is a menu-driven program, consisting of 8 separate programs totaling 77 K, which works with text typed with a word processing program, such as WORDSTAR, or with files imported from an outside source (for example, downloaded from a computer network). It does not have its own mode for entering text; that is, text must be generated separate from FYI 3000. Its main purpose is to establish filing systems in order to search for, find and retrieve information. The filing system is a collection of entries (paragraphs or text marked with *C and *E) in disk files, plus FYI's index files that manage the filing system. It uses key words or phrases to cross-index any type of information; these words or phrases can each be 64 letters or numbers in length. A single entry can have 500 unique key words and a single filing system can have up to 65,000 key words. Up to 255 disks (360K each) can be used for each filing system.

FYI searches for combinations of key words, linked with "and," "or" and "not" in the same search request, i.e., it is a relational database. After the desired information is retrieved, one has the option of sending the output to screen, printer or disk. Information saved to disk can then be edited or incorporated into other documents. Documentation is excellent, making this an extremely easy-to-use program.

The La Mula-Sarigua general inventory list "MASTER" is contained in 9 files on 3 floppy disks; printed it covers 225 pages (Appendix A, Tables 53-55) for a sample of MASTER entries and list of keywords). MASTER consists of 2419 entries and 4234 key words. It has been (and continues to be) the principal reference system for determining provenience, catalog number, method of collection and artifact associations, as well as for keeping track of the current location of different parts of the collection; a critical task when different personnel are analyzing different parts of the collection in different parts of the world.

While the above program is useful for general bookkeeping tasks, it is unable to retrieve and manipulate other types of data, such as nominal and numeric variables. This task was allocated to MINARK, version 3.5 (discussed below).[2]

The KAYPRO IV has been a very dependable microcomputer and has been sufficient for running programs, such as FYI 3000, early versions of MINARK and word processing. After 1-1/2 years of analyzing material and entering data, however, it became clear that this unit was inadequate in terms of disk capacity, retrieval speed and Ram. This was due to the growing number of entries (data file size) that needed manipulating (analyzing and retrieving) and graphics software that required memory in excess of 256K, as well as a graphics card; these latter programs were necessary for creating site base and distribution maps.

Life After the KAYPRO: Micro Fever

By late 1986 the KAYPRO IV was replaced with an IBM-XT compatible unit (BELTRON), MSDOS operating system; it has a 30 mb hard drive, 2 floppy drives, Hercules graphics card, 8087 math co-processor and a high resolution monitor. A NEC-P6 (24 pin) dot-matrix printer was added to the system at the same time. One additional peripheral device has also been used: a NUMONICS (Model 2200) digitizer. A modem (HAYES SMARTMODEM--1200 baud), used with the communications package KERMIT, facilitated rapid transfer of data files and manuscripts between Panama (A. Ranere and R. G. Cooke) and Philadelphia (P. Hansell).

In addition to the software discussed above, the following programs have been used in the completion of this project: (1) MINARK, version 4.02, for artifact entry, manipulation, retrieval and data extraction, (2) STATS-2, release 2.1, for multi-variable statistical analyses, (3) GMS, version 2.1, for material density and distribution maps, (4) AUTOCAD, version 2.52, for site basemaps, (5) SURFER, version 3.0, for contour and 3-dimensional representations of material remains, (6) WORDSTAR, version 3.0, (non-document mode) for editing ASCII text files and (7) WORDPERFECT, version 4.1, for word processing. I have also used several interfacing programs, such as (1) UNIFORM, version 3.1, to convert KAYPRO (CP/M-80) files to IBM (MSDOS) files and (2) GMS <---> AUTOCAD, version 1.0, to convert AUTOCAD drawing files to GMS basemap files and vice versa. Each of these programs will be briefly discussed below.[3]

MINARK (Quantitative Systems, Pty Ltd, 1984, 1986, 1987). This is a menu-driven archaeological database[4] management and analysis program consisting of approximately 30 separate program files totaling over 1.5 mb; each file corresponds to a different function, e.g., main menu, retrieval menu, data entry. Databases (sequential or hierarchical) are created within MINARK; each database can contain numerous data files but the maximum size of files should be about half the floppy disk capacity in order to allow space for copying the file for data file compression (the size limit for hard disk data files is 4 mb). The actual entering and/or editing of data into a file (in either interactive or batch mode) is done within records. A record (up to 5000 per data file) consists of a list of variables within a specific data entry form (up to 50 variables per form); each variable in a record is referred to as a field.

Although data entry formats are fixed within this program, it is non-restrictive, as a number of entry forms (lists of variables) can be used within one database; and a combination of variable types can be used within one record. Variables within an entry form can be one of seven types: integer or decimal number, nominal (attribute-states), status (yes/no or present/absent), calendar date, text string (commentary/note), evaluated (derived/computed) and lookup.

Retrieval generally involves selecting records or variables which satisfy a particular (relational or logical) criteria, for example: (1) CHIPTYPE = Unifacial point and FLAKTYP # Fragment (# means "not equal to" in MINARK); (2) RIMHT › 0.00 and RIMWID ‹ 4.00. Analyses are then performed on this subset. Results (which can optionally be sorted, e.g., numerically by provenience) can be output to screen, to printer or saved to disk. Saving to disk, particularly subsets, is extremely valuable with large data sets as it increases the speed of retrieval. That is, only the subset is scanned and analysis performed on that segment rather than scanning the entire database first and then performing the analysis.

At present the following mathematical functions can be performed within MINARK: descriptive statistics (means, standard deviations, minimum-maximum values), crosstabulations, chi-square contingencies, 2 variable regressions, 2 variable correlations, principal components analysis and derived-variable computations (i.e., +, -, *, /, etc. [see MINARK Manual 1986: 16.13 for a complete list of supported functions]). An example of a derived variable might be: [length] * [width] * [thickness].

Data can be graphically depicted through histograms, bar charts, pie charts and scattergrams; these graphics can be sent to screen, printer or plotter.

A number of special (e.g., SPSS, SAS or SYSTAT) and user-defined (e.g., REPORT and EXCHANGE) output formats can be specified within MINARK. The user-defined formats are invaluable for outputting files to be merged into another MINARK database or into GMS (discussed below), for merging data from external ASCII files of fixed or delimited formats, e.g., DBASE, or for merging ASCII data into external programs, e.g., SURFER. The special output formats need considerable editing (outside MINARK) for ease of use ultimately.

The manual is relatively easy to follow when setting up a new database; and the pop-up menus ease the data entry/editing process even further. Nonetheless, I have found that the documentation is less exact in describing procedures for retrieving, outputting and/or inputting external data--all vital reasons for entering data in the first place. With some effort and quite a bit of time, all are achievable.

Three sequential MINARK databases have been setup for the La Mula-Sarigua material, LITHIC, CERAMIC and LAMULA, a general database (see Appendix A, Tables 56-58) for a complete variable list for each database). Analyzed data has been entered/edited in approximately 9500 entries; 43 subsets have been stored. The mathematical functions used were: descriptive statistics, 2 variable correlations and the computation of derived variables. Frequency distributions (histograms) were also generated. Subsets have been extracted using the format programs in order to export data into the graphic programs GMS and SURFER and the statistical program STATS-2. All of this information is stored on the hard disk and backed up on floppies (n=12).[5]

STATS-2 (StatSoft, Inc., 1985, 1986). This statistical package can be used as a supplement to database management programs or as a "stand alone" package. Data can be directly entered into an electronic spreadsheet or it can be imported from programs, such as MINARK. While STATS-2 allows the user to work with basic parametric and non-parametric statistical functions, e.g., means, standard deviations, correlations, t-tests, it also allows one to perform comprehensive analyses of all the information available, e.g., multiple regressions, anova/ancova's and repeated measures anova. MINARK is not capable of performing these more sophisticated multi-variable analyses.

Hardware requirements are at least 256K of Ram and 2 disk drives; a hard disk and math coprocessor are highly recommended. Neither a graphics card, nor a graphics printer is required; all graphics are printed in ASCII code. The software consists of 14 programs (menu-driven) and consumes 745 K. The package is extremely easy to use and the manual takes one through the basic steps necessary to achieve simple results; the manual is less helpful when more complex analyses are required. Regarding the manual (1985, 1986:21), it "is not intended to be a tutorial in statistics. It is assumed that the user is somewhat familiar with the nature and appropriate uses of the statistics that he or she wants to calculate."

Nine subsets (lithics only) have been imported from MINARK and multiple regression analyses run.

GMS (Quantitative Systems, Pty Ltd, 1985, 1986). GMS (Graphic Mapping System) is a menu-driven mapping program which can prepare planview, feature, site and/or regional maps. The software consists of approximately 14 separate program files and consumes 352 K; 512 K Ram is recommended because of the memory-resident programs required for plotting to screen or to an external device. GMS can superimpose data extracted from other databases (such as, MINARK, DBASE, RBASE, ORACLE) onto basemaps that have been prepared through the digitizing of USGS quadrangles, site topographicals, feature topographicals, etc. Basemaps can be digitized directly through GMS or through AUTOCAD (discussed below) and imported into GMS. Basemaps can also be produced by preparing ASCII files of pairs of X/Y coordinates; an extremely inefficient (and perhaps inaccurate) method if thousands of points need recording. Irregardless of the input technique, basemap (BMP) files can be edited within GMS or with a word processor in non-document mode (see discussion below).

Data, e.g., artifact or feature locations, extracted from other databases (EXT files) must consist of X/Y coordinates for objects. Objects can be of two types: point or areal (series of connected points). The coordinate system used to pinpoint these objects[6] should be of the same type used to generate the basemap. EXT files can not be edited within GMS but must be checked with a word processor in non-document mode.

Neither BMP nor EXT files will plot accurately (if at all) if there are mistakes in either; and my experience, thus far, indicates that errors are very common in the initial processing of both types of information. The ability to edit these files is, therefore, extremely important.

Artifact, feature and/or basemap conventions, such as type (line, point, area), color, size and symbol are defined within GMS; symbols are those displayed on a standard keyboard, e.g., A, a, #, %, ', +, *, ., etc. Special symbol sets, however, can be defined through PLOTCALL (see below [Golden Software, Inc. 1986]) or AUTOCAD (Autodesk, Inc. 1986).

Output can be either to screen, an intermediate plot file (for repeated outputs of a given map or for large maps that need to be printed in sections), a printer or a plotter.

The GMS Manual has its positive and negative aspects. The actual process of digitizing basemaps is well covered but the scaling factors necessary for creating the final product are often very difficult to follow. In addition, the formats necessary for generating transfer (e.g., EXT) files are poorly outlined at best. In terms of hard copy output, maximum quality is achieved through the use of a plotter; dot-matrix printer produced copies through GMS have very poor resolution and are best used as working drafts only. Nonetheless, within GMS one can format files for import into PLOTCALL (see discussion below).

La Mula-Sarigua BMP files were digitized in AUTOCAD[7] and then converted to a GMS's BMP file through the program GMS <---> AUTOCAD (Julien 1987); EXT files were generated in MINARK and are stored on the hard disk and on 7 floppy disks; EXT files alone number 44.[8] The latter are numerous because separate files are required for plotting the distribution and density[9] of specific material types, e.g., a file for celts, a file for edge-ground cobbles, a file for collared jars, etc. If combinations of material types are desired, separate files must be drawn up for those as well.

<u>AUTOCAD</u> (Autodesk, Inc. 1982-1986). This is a computer-aided design and drafting program used to create objects consisting of one and/or a combination of the following types: points, lines, arcs, circles, traces, polylines, 3D lines, 3D faces and solids. These drawings can be considered mathematical databases with object position being stored as a coordinate in the database. The database is then translated to a screen image.

AUTOCAD programs consume about 1.9 mb; another 3 mb is recommended for drawing files. The programs need a minimum of 512 K Ram, at least one floppy disk drive and a hard disk. A math coprocessor is highly recommended if large, complex drawings are required as it reduces the time taken to open large files, to regenerate drawings and to make calculations. For example, a drawing that takes 150 seconds to regenerate on a machine without the chip will take 32 seconds with one installed (Omura 1987: 470).

Drawings are created in one of three ways: using cursor keys, a mouse or a digitizer. It is, however, only the digitizer with a stylus that can trace drawings, e.g., topographical maps--of particular importance for the present research.

The screen displays everything you draw. For example, if you trace a topographical map containing different types of information, such as contour lines, rivers, streams, grid systems, text, etc., all this will appear as one layer. As drawings as this nature become more complex (include more information), they become very cluttered. One way of getting around this is to organize the different types of information (feature types) into different layers; layers are like overlays. They can be displayed separately or combined.

Editing and/or modifying is accomplished in AUTOCAD and can be executed on parts of, or whole drawings. In addition, parts or whole drawings can be rescaled, as well as rotated. This is all done most efficiently by having a layered document. These same documents can be saved as DXF files (MSDOS ASCII text files) for editing with a non-document mode word processor. DXF files are often used to exchange drawings between AUTOCAD and other programs, e.g., GMS and SURFER (discussed below).

Final output can be to screen, to disk, to printer or to plotter. In general, printers are used for quick (draft-quality) preliminary copies of a drawing; they are also useful for getting nongraphic information, e.g., drawing status, settings, etc. For the highest resolution possible, it is necessary to use a plotter (but see discussion below on PLOTCALL).

The manual is excellent but intimidating--as are many aspects of the program. On-line help is limited to a description of functions and modes with a page reference to the manual (Orr 1987:106). Program prompts, selection methods and flexibility are oriented towards the advanced user. Flexibility, in particular, involves investing time and money into learning third-party add-ons and customization capabilities. In other words, ease of use is somewhat difficult for the novice user.[10]

The basemap for La Mula-Sarigua was generated in AUTOCAD by digitizing (tracing) a geodesic quadrangle (Puerto Limon quadrangle, scale 1:10,000) produced in 1971 by Panama's Instituto Geografico Nacional "Tommy Guardia." Traced information has been stored in 5 layers (LYR files); layers are: contour lines, river, scale and text, alvina and transect lines. The entire basemap, which consumes 200 K disk space, has been converted to a DXF file for importing into GMS.

GMS <---> AUTOCAD (Julien 1987). DXF formatted files can not be imported directly into GMS; they must be converted using DXFTOGMS. The conversion program uses the DXF formatted LYR files as its input. Each LYR file corresponds to a feature type in the GMS BMP (basemap) file. The input file must consist of either lines or polylines; a mixture of polylines, broken lines, or hatches will not transfer. If this mixture is desired BMP files digitized in GMS must be converted to DXF files (GMSTODXF) for input into AUTOCAD. Output will then have to occur through this latter package.

The GMS <---> AUTOCAD package is limited to the two conversion programs discussed above. There are, however, 4 text files included with the package which describe in a step-by-step fashion how to use the programs. They are very explicit and extremely easy to follow.

The basemap for La Mula-Sarigua has been converted from an AUTOCAD.DXF layered document into GMS using the DXFTOGMS program.

SURFER (Golden Software, Inc. 1987). This package consists of three menu-driven program disks (GRID, TOPO and SURF and PLOT [PLOTCALL referred to above is a file within PLOT]), consisting of 38 separate files. Its main function is to create contour maps (planview) and/or 3-dimensional surface plots of X/Y/Z data. X/Y data are locational coordinates, e.g., easting and northing; Z data are elevations, or densities of materials (e.g., the number of Lamula collared jar sherds per 1 sq m collecting unit). X/Y/Z data[11] (up to 10,000 each) can be entered at the keyboard into the built-in spreadsheet or it can be imported into the spreadsheet from an external ASCII data file, such as those produced in MINARK.

The spreadsheet recognizes two data formats: text and numeric. The sheet must contain only one format; the format can only be changed by deleting the data and re-entering it. It is important that imported text (ASCII) files be text values, not text codes. Maps cannot be produced from the latter.

Contour and 3-D plots require data to be put into a regularly spaced form. GRID creates regularly-spaced grids from irregularly spaced data put into the spreadsheet. The internal process is numerically intensive; and calculations are done repetitively to arrive at grid values. Duplicate values should be eliminated with a non-document mode wordprocessor.

Contour maps, based on the distribution and density of materials, are created from the X/Y/Z grid data using TOPO. There are default values for the immediate production of a map. There are also a number of user-defined options for contouring, e.g., changes can be made in map size, scale, curve tolerance, contour interval, type of contour line (e.g., solid, dashed, bold), labeling, smoothing, symbol sets, etc.

Three-dimensional surface representations are produced through the interactive program SURF. It's input file is that created in GRID. From this file SURF will produce perspective block diagrams ("fish-net" plots) or stacked contour plots. As above, default values can be used for a plot; or views can be changed by modifying (through the user-defined options) the tilt, rotation, surface-eye distance and visible surfaces. Changes can also be made in map size, labeling, symbol sets, etc.

In addition to the 17 pre-defined symbol sets, special sets and font types can be created and/or modified and saved to disk through PLOTCALL. It is these files that GMS and AUTOCAD can import.

Plot output can be to screen, printer or plotter. Unlike, GMS and AUTOCAD printer-produced maps, SURFER plots printed through PLOT are optimized for maximum resolution for the output device installed. That is, high-quality graphics can be produced using a dot-matrix or laser printer. GMS can, however, output data in a PLOT format; these can be run off through PLOT greatly enhancing the quality of final maps in the absence of a plotter.

The documentation is excellent and the package very easy to use. Unlike most programs, one can get immediate results by using the default values within each program. Most, however, will want to redefine values and the pop-up menus make the use of user-defined options very simple to execute. The primary limitation of the package is that data must be entered at the keyboard or from existing ASCII files which generally need editing. It is not possible to digitize information directly into GRID.

Selected subsets (n=3),[12] two produced in MINARK and one in AUTOCAD, were formatted for input into GRID. Both planview and 3-dimensional plots were generated for each subset.

UNIFORM-PC (Micro Solutions, Inc. 1984). The menu-driven UNIFORM is a multi-format program which enables work created on one machine (e.g., CP/M operating system) to be transferred to another machine (e.g., MSDOS operating system). UNIFORM operates by configuring one of the disk drives for a specific foreign format; for example, the B drive could emulate a CP/M system. Information transferal is accomplished by letting one computer, e.g., A drive, MSDOS system, read from and write to disks (text or data disks not program disks) in another computer's format (B drive format).

Most program disks are available for both types of operating systems. In the above example, data entered into MINARK (CP/M version on the KAYPRO-IV) was transferred, using UNIFORM, to an MSDOS format. The reformatted data was then accessed through the latter format's version of MINARK. The same procedure was instituted for both WORDSTAR and FYI 3000 files originally entered on the KAYPRO-IV unit.

The program is extremely easy to use and the documentation more than adequate.

Word Processing. Two software packages have been used for word processing--WORDSTAR (MicroPro International Corp. 1983) and WORDPERFCT (SSI Software 1985). The latter has mainly been used to compose the present manuscript and to convert WORDSTAR (MSDOS formats) to WORDPERFECT (MSDOS formats) documents. A detailed description of word processing packages goes beyond the goal of this chapter. Nonetheless, one feature of WORDSTAR requires definition, that is the non-document mode.

WORDSTAR is a word processing program which can be used in document and/or in non-document mode. In document mode, WORDSTAR adds computer-language bits of information to the text in order to operate special functions, such as, word-wrap, right margins, pagination, variable tabbing, etc. If these bits of information are inserted into a non-document file, the files will be misread by some programs. Therefore, in non-document mode these functions are switched off or altered. The use of non-document mode allows one to create data files in an ASCII format for use outside WORDSTAR; ASCII formatted files serve as common reservoirs of data that link various kinds of software together, e.g., MINARK and GMS or SURFER.

All data files extracted from MINARK have been edited using WORDSTAR's non-document mode.

Discussion

Throughout the field and laboratory phases of this project, a number of computer-related tasks have been employed. At the completion of the first field season, a MASTER site catalog database was designed using FYI 3000; MASTER has been edited and/or added to as various analyses have been completed. It is the primary site "bookkeeping" document. As the latter program was incapable of analyzing nominal and numeric variables, three additional databases (CERAMIC, LITHIC and LAMULA) were created using MINARK (results discussed in Chapters VI and VII). Basic mathematical functions were performed; histograms generated (Chapter VI) and subsets extracted for incorporation into the statistical package STATS-2 and the graphics mapping packages GMS and SURFER. Multi-variable mathematical functions were computed in STATS-2 (LITHIC database only [Chapter VI]). All extracted MINARK subsets were imported into GMS; a site basemap was initially prepared in AUTOCAD and also imported (using DXFTOGMS) into GMS. Planview density and distribution maps (by specific material and/or in combinations, e.g., Lamula Group ceramics, edge-ground cobbles, etc.), were produced in GMS. Planview and 3-dimensional maps (by specific material [from MINARK extracted subsets]) were created in SURFER. All map data was output in a PLOT format and then run off on a dot-matrix printer (24-pin) through PLOTCALL (Chapter IX).

An Afterthought: the Time Warp

Although microcomputing has been very practical from an analytical standpoint, it has been less productive (efficient) from a time standpoint, (note that the analytical stage took 2 years). For example, it has often taken days/weeks to "learn" a new program and/or to figure output formats for interfacing programs; particularly interfacing database information with graphics. A number of factors figure into this inefficient use of time: (1) poor documentation and (2) little to no "clue" as to how to interface programs.[13]

Endnotes

1. This program is available for MSDOS systems as well.

2. I began using MINARK, version 3.5, in 1984 on the KAYPRO. Since that time I have changed units and MINARK (available for both CP/M and DOS systems, floppy and/or hard disks) is now up to version 4.03; I am using version 4.02. The Toolkit program within this version, has made it possible to convert all

information entered on the old system, version 3.5, to the new system, version 4.02 or version 4.03.

3. Programs, such as MINARK and AUTOCAD, are capable of doing a variety of tasks not covered in this chapter. It has not been my goal to review each program's complete capabilities but rather to discuss those aspects that have been useful in dealing with the present set of data. I refer the reader to the "manuals" for a more complete coverage of each. In fact, much of the technical discussion in this chapter has been extracted from the manuals.

4. In MINARK database has been "used to mean a set of data recorded using a coherent set of variables, and stored as a single entity. It consists of a number of dictionary, index and data files linked together by the database software...(Johnson, 1986:12.1)."

5. We have all heard horror stories of others losing large amounts of information due to system crashes or to failure to backup work as it is completed. Of course, like many others, I was sure this couldn't happen to me. Wrong! I shutter to think about the amount of time and work I've lost on both accounts--and more than once. I have tried, though, to backup all work "in duplicate" on as frequent a basis as possible. As the manuscript has grown, I find myself "backing-up" at very frequent intervals --it has become an obsession.

The number of floppy disks given in parentheses throughout this chapter refer to one backup set.

6. Following Johnson (1986:20), in a Cartesian coordinate system (e.g., UTM's or site grid in meters), data in the database is recorded using the same X/Y system as that used in digitizing the basemap. In a "Geographic" coordinate system data in the database is stored as latitude/longitude (and perhaps UTM's), while basemap files are stored as cartesian X/Y coordinates on a specific map projection, such as Lambert Conical or Mercator. In this latter instance, a projection conversion needs to be carried out in order to convert latitude/longitude data into cartesian coordinates referenced to the basemap.

In GMS an X/Y coordinate system should be conventionally oriented with the X axis clockwise from the Y axis--all X/Y values should be positive, i.e., they should emanate from the SW corner of a site. This does not pose a problem in digitizing a basemap, but it does in proveniencing site data. How many of us setup a site grid system with the 0,0 point at the SW corner of the site, particularly if a part of the research problem is to define site boundaries? In this instance, one needs to recalculate database X/Y values to correspond with basemap values and re-enter the values into the database.

7. The basemap had already been digitized in AUTOCAD prior to receiving GMS. Rather than redigitize the map in GMS I converted the data.

Consultation with Ian Johnson of Quantitative Systems, Inc. Pty, Ltd, revealed the existence of GMS <---> AUTOCAD Transfer Programs; he, graciously, provided us with the programs. That is, we were able to convert all basemaps produced in AUTOCAD (DXF files) to GMS (BMP files).

The La Mula-Sarigua basemap has been prepared by Huguette Schaer.

8. Be forewarned, EXT files not only take large amounts of time to generate but gobble up huge amounts of disk space. The same is true for basemaps produced in AUTOCAD.

9. The density (clustering) of material remains does not plot well in GMS as only 1 Z value can be processed for the same X/Y location. For example, GMS will display a map of 3000 points (with 100 points in one location) as 2900 points.

10. For a review of AUTOCAD versus other CADD programs, see PC Magazine 1987, Vol. 6 (21):93-160. The contents of this paragraph have been extracted from that review.

The AUTOCAD discussion has been extracted from <u>Mastering AutoCad</u>, George Omura, Sybex Pub., San Francisco, 1987.

11. When importing data from a MINARK database, Z values must be edited with a non-document mode wordprocessor first. Editing time can be greatly reduced if the X/Y locations within a subset are sorted in numerical order prior to data extraction. In general, the entry of information into MINARK is record by record. Each record corresponds to one artifact and its associated attributes at one X/Y location; its Z value is, therefore, equal to one. If, for example, 35 celts occurred at one location, the output format would contain 35 records each with a Z value = 1. SURFER would see this as duplicated information and would be unable to process it. In the celt example, what SURFER is looking for is one X/Y value with a Z value equal to 35 and the elimination of all other Z values at that location.

12. Only those subsets which largely contained Z values greater than 1 were selected for input into SURFER. Three-dimensional plots can not be generated from planar-horizontal information; for example, if the input data largely contains Z values equal to one for each X/Y coordinate.

13. Software packages advertize what they "can" do, not what they can't do. Although many packages can be interfaced, very few mention with "which" ones and fewer with "how." I have spent a certain amount of time on ascertaining the "which" and "how." All have their limitations.

Important to present interpretations are those relative to the spatial patterning of material remains. Graphic representations have, therefore, been extremely important. Interfacing database packages with graphic packages has been particularly problematical. What has made this especially difficult is the fact that few, if any, are designed for archaeological purposes. That is, programs are generally developed for disciplines other than archaeology.

CHAPTER VI

LITHICS

Introduction

The most abundant cultural material at La Mula-Sarigua is stone, a fact which (in part) reflects the presence of a large (4-1/2 ha) boulder field of cryptocrystalline rocks within the site boundaries (Plate 41). The major objectives in analyzing this material were to: (1) classify tools based on technology, (2) determine tool function, (3) identify tool lithology,[1] (4) develop an on-site chronology and (5) assess the nature and degree of uniformity in stone tool production present at the site.

Method of Analysis

The entire collection of over 16,000 specimens was examined piece by piece. Initially, each piece was separated on the basis of manufacturing technique into a chipped or nonchipped category. Unmodified and/or naturally modified material, e.g., those exfoliated and/or spalled, were eliminated from the analysis. Secondly, pieces within each technological category were subdivided on the basis of gross morphology (e.g., cores, points, metates, celts). Thirdly, the collection was examined for the presence/absence of use-wear. Use-wear was identified with the aid of a hand lens (8X) and a binocular microscope (7-70X). Fourthly, and by reference to the results of experimental studies (e.g., Keeley 1980, Ranere 1975, 1980b, Semenov 1976), a list of attributes (technological and functional) was drawn up for use in describing and analyzing the lithic specimens. (See Appendix A, Table 56 for a complete list and description of attributes). Recording most of those attributes which required measurement was relatively straightforward and was accomplished by using sliding calipers, a goniometer (or 7X comparator) and a beam balance scale. An alternative technique was devised for measuring retouched and/or worked facets of edge-ground cobbles and manos. Their facet shape (profile) and size (profile depth) were delineated with a ceramic profiler; shape and size were transferred to graph paper. A straight line was drawn to connect the terminal points of the outline. Facet size, (the maximum height in cm from the drawn line to the profile outline) was measured with sliding calipers. (See Figures 35 and 36 for illustrations showing where attribute measurements have been taken on the predominant tool forms).

It should be made quite clear at this point that all lithic materials were put through the first three steps above; and that only those tool forms deemed to be of chronological significance (based upon a comparison with the regional lithic classification)[2] were analyzed attribute by attribute. For example, tools such as utilized flakes, spent cores, hammerstones and chipping debris, are widely distributed in space and time. All but the utilized flakes have been excluded from further scrutiny for the present study. Nonetheless, their provenience and quantity have been recorded in a MINARK General Inventory database (LAMULA [Appendix A, Table 58]); their distributions, as well as those considered in detail herein, have been plotted on maps (see Chapter IX for interpretations [Figures 45, 60-79]) produced in GMS (discussed in Chapter V).

All attribute determinations were recorded in a MINARK LITHIC database (discussed in Chapter V). Within MINARK, descriptive statistics, such as frequency distributions, means, minimum-maximum values and standard deviations, were generated in order to discern patterns within each attribute distribution.

Within STATS-2 (discussed in Chapter V) multiple regression analyses were computed in order to examine the degree of linear correlation between normally distributed attributes (where present); t values were calculated to ascertain their significance. A statistically significant t value indicates that "there is only a small (or perhaps negligible) probability that the observed difference is an accident of sampling (Arkin and Colton 1970:154)."

<u>Measures of Standardization</u>

Numerous authors (e.g., Gibson 1984, Rovner 1980, Shafer 1982, Shafer and Hester 1986, Shott 1986, Torrence 1979, cf. Tosi 1984) have argued for specialized production on the basis of uniformity (standardization) of the product. Most would agree that this concept can be estimated quantitatively by measuring the basic attributes thought to be significant in the manufacturing of particular tool forms, particularly, attributes of size and shape.

Repeatedly mentioned in the literature, relative to estimating the above concept, are statistical measures of central tendency and dispersion, i.e., the mean, variance and standard deviation. For example, Gibson (1982, 1984) suggests that consistency in technological attributes can be deduced from the presence of low statistical variance. With his sample of blades and flakes, he determined the distribution of nominal variables (bulb shape, degree of platform trimming, presence/absence of cortex, etc.) by frequencies and the distribution of interval variables (length, width, thickness) by the means and variances. On the basis of his results, he considers 9 attributes to be important in examining consistency; they are all nominal variables. Frequency distributions for these attributes show a very high consistency in flintknapping. Unfortunately, he does not assess the distribution of interval variables, nor does he discuss the role of low statistical variance within his sample. The latter role, however, has been discussed in some detail by Torrence (1979, 1984).

In his study of macrocore production, Torrence (ibid.) implies that evidence of standardization should be exhibited by an absence of variability in the shapes and sizes of particular tool types (see also Shafer 1981), as described by summary statistics, such as the mean, standard deviation and coefficient of variation. There should be low values for both the standard deviation and the coefficient of variation if conformity to a standardized form is present. Based on interval variables for the macrocore assemblages from two quarries, summary statistics produced high values (high variability) indicating that the cores were not produced to conform to a standardized form.

That the coefficient of variation (CV) can separate out degrees of tool standardization within and between samples has been investigated by Shott (1986). Using interval attributes of length, width and thickness and the CV, Shott (ibid.) was able to support his supposition that meaningful differences exist between two point assemblages; with one assemblage showing uniformly lower CV values than the other, i.e., the former is relatively more standardized than the other. These differences were statistically significant as supported by the calculation of "t" values.

Other investigators (e.g., Rovner 1980) have estimated low variability within and/or between technological attributes by using scattergrams and linear regressions. Attributes which cluster in a relatively narrow range of variation suggest standardization in tool morphology (shape); those which do not cluster imply less standardization.

The use of these parametric statistics, particularly linear regressions, assumes the following (Meddis 1975, Nie et al. 1975, Thomas 1987): (1) the sample of scores was drawn at random; (2) the sample was drawn from the same population and (3) the population was normally distributed.

Standardization and the Present Sample

Largely following the procedures outlined by Torrence (1979), the means and standard deviations were determined for each interval attribute for each major tool type. Frequency distributions (plotted as histograms) were used to reveal the presence of normally distributed populations for a specific attribute (see Appendix B); percent frequencies were determined for each nominal attribute for each major tool type (see Tables contained within this chapter). For interval data, the mean was simply the central tendency of scores within a population. Variability of scores from the mean was determined by calculating the standard deviation. If scores clustered closely together, the deviation (or distance) from the mean was small and so was the standard deviation. Conversely, if scores were spread far apart, the standard deviation was large.[3] For materials that have been modified prior to use, low variability suggests high similarity in manufacturing technique. A low variability attribute which could not be the result of technological modification, such as, width among tools which lack pre-use modification, was interpreted as raw material size selection.

The above interpretations are based on samples which display not only normality but which display one peak, i.e., are unimodal. Unfortunately, many of the attribute distributions for the La Mula-Sarigua tool types contained two or more peaks, i.e., they were bi- or multimodal. These distributions can be interpreted in one of three ways: (1) high variability and, therefore, little to no similarity in manufacturing techniques; this is especially likely if the peaks are not very discrete; (2) multiple populations, especially if there is more than one distinct peak, perhaps reflecting more than one time period (see unifacial point discussion below). The latter is quite probable given the deflated nature of the site (Chapter II-IV), its chronological history (Chapter IX) and the spatial distribution of particular tool forms (Chapter IX) or (3) small sample size.

If more than one attribute was normally distributed within a specific tool form, e.g., bit and butt widths among celts, then multiple regression analyses were run in order to determine attribute co-variances and to further test the proposition that scores within/between attributes have been drawn from the same population.

Additionally, scale-independent measures (ratios) were calculated for various combinations of interval attributes within a specific tool form; means and standard deviations were determined and their distributions examined. Interpretations of uniformity were given to those which displayed low variability.

Of course, the mere presence of a clearly recognizable tool form is an indication of increased (relative to pre-1st millennium B.C. tool forms [discussed in Chapter IX]) standardization in tool production.

Chipped Stone Tools

Technology and Tool forms. The major manufacturing (lithic reduction) technique used to produce chipped stone tools was percussion with a hammerstone, very occasionally used in conjunction with an anvil stone. For much of the La Mula-Sarigua sample, flaking was simple; there is no evidence on either cores or flakes for the preparation of core surfaces or platforms. Tool forms included in this sample are: cores, choppers, scraper-planes and unretouched (or minimally retouched) utilized flakes. A numerically smaller but important fraction of the chipped stone sample consists of cores which have been carefully prepared for the detachment of long, pointed flakes (unifacial points) and the unifacial points themselves. These cores are carefully prepared for the removal of the pointed flakes. This preparation involves removing small flakes from the face of the core in order to produce flakes with thin and relatively narrow bases for hafting.[4] This attention to core and platform preparation aimed at producing a particular flake shape is rare to absent among pre-1st millennium B.C. lithic assemblages. Also rare in earlier contexts but quite abundant at La Mula-Sarigua are scraper-planes. It is these two tool forms (pointed flakes and scraper-planes) that are described in some detail below.

Lithology. Eighty-six percent of the chipped tools are either sedimentary or metamorphic rock in type and belong to the siliceous rock class. Components are mainly chalcedony and quartz with traces of hematite, pyrolucite, clay and calcite. All are available within the site boundaries. The remaining 13.6% of these tools are igneous in origin; they are primarily tuff in texture and cryptocrystalline in composition; none of which occur on-site.

1. Unifacial points (196 whole specimens; 14 fragments) (Plates 42a-l, 43a-o)(Appendix B, Tables 59-70). Unifacial points have been removed from prepared cores composed of chalcedony (95.7%), or sandstone (3.3%). During the preparation stage the cortex has almost always been removed; 94.2% of the points lack cortex. Additional evidence for pre-detachment modification can be observed on the dorsal surfaces. Four dorsal ridge patterns are observable: (1) 2 parallel ridges (12.5%); (2) 1 central ridge (13%); (3) 1 off-center ridge (24%) and (4) a forked (Y-shaped) ridge (46.2%). The placement of these ridges are largely responsible for the cross-sections described below.

Points can be characterized by the presence of a stem (85%), opposed notches (78%), asymmetrical planview (92.3%) and one of two cross-section types: (1) triangular to wedge-shaped (70%) or (2) trapezoidal (26.5%).

From notch to base, stem forms may be elongated and/or expanded, constricted or straight. Base shapes range from straight (44.9%), to convex (34.6%) and concave (12.7%). Two specimens display ears. Clear shoulders are lacking on 34%; where present they are mainly asymmetrical (60%).

Post-core detachment modification occurs in the form of opposed or single-sided notching (94%), basal thinning (dorsally and/or ventrally [93%]) and edge retouch (19%).

Use-wear along the edges and/or the tip was observed on all but a handful of unifacial points. The latter group tend to have very eroded and/or freshly chipped edges. Edge-use patterns indicate that most points functioned as scrapers (convex, concave, straight and pointed) and/or knives (straight, concave and convex). Patterns on the tip suggest they have been used as perforators and gravers. A combination of these patterns normally appears on one tool. There are no impact fractures nor other indications that any of these artifacts were used as projectile points. The conclusion is that the majority of these tools are multi-purpose in function and were used in daily household activities. Interesting is the fact that similar points accompany female burials in the Sitio Sierra cemetery in association with a radiocarbon date of 240 ± 80 B.C. (Cooke and Ranere 1984:10). That these tools have been hafted is indicated by notching along with polish on the ventral and dorsal sides just above the shoulder. Polished facets also occasionally occur along the dorsal ridges, as well as other high spots.

Table 2. A Summarization of the Nominal Data for Unifacial Points (by Frequency).

Lithology:	chalcedony	(95.7%)
	sandstone	(3.3%)
Cortex:	present	(5.8%)
	absent	(94.2%)
Dorsal ridge patterns:	2 parallel	(12.5%)
	1 central	(13%)
	1 off-center	(24%)
	forked	(46.2%)
Stem:	present	(85%)
	absent	(15%)
Notched:	opposed	(78%)
	single	(16%)
	absent	(6%)
Planview:	asymmetrical	(92.3%)
	symmetrical	(7.7%)
Cross-section:	triangular/wedge	(70%)
	trapezoidal	(26.5%)
Base shape:	straight	(44.9%)
	convex	(34.6%)
	concave	(12.7%)
Shoulders:	present	(66%)
	absent	(34%)
Heat alteration:	present	(26%)
	absent	(74%)

Evidence for heat alteration (26%) is in the form of random surface discolorations and potlid fractures; heating occurred after the point was manufactured and used. This suggests that heat treatment was neither systematically nor purposively practiced and that the alteration of the specimens was accidental (perhaps quite recently due to fires set when tools were on ground surfaces).

Descriptions for the 196 whole specimens appear in Table 3 and for the 14 fragments in Table 4; attribute labels and acronyms are described in Table 5.

Table 3. Descriptive Statistics for Unifacial Points (Whole).

Attributes	Mean	Std Deviation	Min	Max
Length	4.657	.858	1.7	6.9
Width	2.544	.510	1.5	4.2
Thicknes	.781	.236	.2	1.5
Shoulder	2.495	.501	1.4	4.1
Midpoint	1.912	.463	.5	3.1
Tip	.295	.351	0.0	2.0
Base	1.726	.536	0.0	3.2
Notch	1.849	.650	0.0	3.0
Edgangl	45.066	10.843	25.0	90.0
Shobase	1.529	.464	.8	4.0
Lwxth	1.511	0.939	.3	12.4
Lengwid	1.885	0.446	.5	3.7
Widthck	3.465	1.137	.3	13.5

Table 4. Descriptive Statistics for Unifacial Points (Fragments).

Attributes	Mean	Std Deviation	Min	Max
Length	3.436	.750	2.3	4.5
Width	2.236	.505	1.7	3.4
Thicknes	.671	.230	.4	1.1
Shoulder	2.208	.539	1.6	3.4
Midpoint	2.078	.349	1.6	2.6
Tip	1.158	.540	0.0	2.0
Base	1.623	.436	1.0	2.5
Notch	1.508	.301	1.1	2.1
Edgangl	42.609	12.048	30.0	65.0

Table 5. Attribute Labels and Acronyms for Unifacial Points.

Attribute	Acronym
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum thickness of specimen in cm	THICKNES
Width of shoulder in cm	SHOULDER
Width of midpoint in cm	MIDPOINT
Width of tip in cm	TIP
Width of base in cm	BASE
Width of tool at notch(es) in cm	NOTCH
Angle of working edge, "spine" in degrees	EDGANGL
Shoulder/base width ratio in cm	SHOBASE
Length/width X thickness in cm	LWXTH
Length/width in cm	LENGWID
Width/thickness in cm	WIDTHCK

Frequency distributions for whole specimens for all but two attributes (Appendix B, Tables 59-70) indicate bi- or multimodal curves (often with very well-defined peaks). A preliminary interpretation of these curves does not support standardization for the collection as a whole; they do, however, imply the presence of multiple populations.[5] This interpretation is weakened, however, by the occurrence of two attributes (base and shoulder width) which display normality and very low variability (72% $\pm$ 1 SD for base width, 68% $\pm$ 1 SD for shoulder width) (Appendix B, Tables 64 and 66 respectively). In fact the two tend to co-vary as determined by a regression analysis, $r = .64$, $t\ (172) = 10.9$, $p = .0000$; unfortunately, this relationship is not statistically significant indicating that one of the assumptions necessary for the computation of "t" has not been met (discussed below).

Descriptive statistics for a derived attribute (shoulder/ base width ratio) elicited a mean of 1.529, .464 SD and minimum-maximum values of .88 - 4. Eighty-five percent of the specimens fall within ± 1 SD of the mean and over 96% within ± 2 SD of the mean (Appendix B, Table 69). It is interesting to note that the larger (earlier?) specimens begin to separate out while the smaller ones do not, i.e., this ratio does not display one population but two. Relative to the above insignificant "t," assumption #2 has been violated. That is, the La Mula-Sarigua point sample has not been drawn from the same population.

It is useful at this juncture in the analysis to compare the above results (i.e., multiple populations within/between attributes) with visual observations for similar point forms from the earlier (ca. 4000-1000 B.C.) site of Cueva de los Ladrones and the later (ca. 200 B.C.-A.D. 500) site of Sitio Sierra; comparative metric figures are as yet unavailable for these two sites. Nonetheless, at the former site, points are broad at the shoulders and stems are expanded and/or eared (cf. Plate 42a-e). At the latter site, points are relatively narrow at the shoulder and stems are elongated and straight to constricted (cf. Plate 42f-l). Both forms occur at La Mula-Sarigua, albeit in very small numbers. The majority of forms at La Mula-Sarigua are intermediate in size and shape (Plate 43a-o). The results of the present analysis do not allow me to conclusively separate out the above 3 forms; carefully measuring the attributes of those distinct forms found in earlier and later contexts, as well as determining the CV's and t values within and between populations, however, should shed light on estimating the degree of standardization in the La Mula-Sarigua point samples in the future.

2. Scraper-planes (190 specimens) (Plate 44a-m). All the specimens which fit this category are heavy hand held tools which have been unifacially flaked around their perimeter. There is no evidence of hafting. Worked edges are mainly toothed (or denticulated), but may be straight or concave as well. Wear polish frequently occurs on the edges. On some of the specimens use flakes and polish are found also on the ventral surface. Wear patterns suggest that this group of tools were used in woodworking activities (cf. Hester and Heizer 1972).

The majority have been made on cores (n=142; 5 of which are fragments), but there are a sizeable number (n=48) which have been made on large, thick flakes. Most (99%) are composed of chalcedony; two are composed of petrified wood.

A. Scraper-planes on cores (Plate 44g-m). Many (75.3%) of the cores retain their cortex; very few (4%) show evidence of heat-alteration. Cores can be classified as multidirectional (59.1%), unidirectional (27.4%), bidirectional (11.2%) or slightly modified (4.9%). In cross-section these tools are either domed (54.9%) or triangular to trapezoidal (44.2%). Perimeter retouch follows three patterns: (1) complete perimeter

(32.3%), (2) 1/4 of the perimeter (61.9%) and (3) 3/4 of the perimeter (1.4%). Planar surfaces may be flat (43.%), concave (22.5%), convex (18.3%) or undulating (16.2%).

Table 6. A Summarization of the Nominal Data for Scraper-planes on Cores (by Frequency)

Core type:	multidirectional	(59.1%)
	unidirectional	(27.4%)
	bidirectional	(11.2%)
	slightly modified	(4.9%)
Cortex:	present	(75.3%)
	absent	(24.7%)
Cross-section:	domed	(54.9%)
	triangular/trapezoidal	(44.2%)
Perimeter retouch:	complete	(32.3%)
	1/4	(61.9%)
	3/4	(1.4%)
Planar surface:	flat	(43%)
	concave	(22.5%)
	convex	(18.3%)
	undulating	(16.2%)
Heat-altered:	present	(4%)
	absent	(96%)

B. <u>Scraper-planes on flakes</u> (Plate 44a-f). Flake scraper-planes vary markedly from those made on cores in the above parameters. For example, the greater percentage (76.5%) of flakes lack cortex; there is no evidence of heat-treating. Cross-sections are more variable. Over 68% (68.7%) are triangular to trapezoidal in shape; 27.1% are domed; 2.1% are concave-convex; and 2.1% are biconvex. Perimeter retouch is found on only 1/4 of the tool in 72.2% of the specimens and on the complete perimeter in 22.7% of the specimens. Ventral surfaces are largely convex (47.9%); the remainder are: (1) flat

(18.8%), (2) concave (18.8%) and (3) undulating (14.6%).

Table 7. A Summarization of the Nominal Data for Scraper-planes on Flakes (by Frequency)

Cortex:	present	(23.5%)
	absent	(76.5%)
Cross-section:	domed	(27.1%)
	triangular/trapezoidal	(68.7%)
	concave/convex	(2.1%)
	biconvex	(2.1%)
Perimeter retouch:	complete	(22.7%)
	1/4	(72.2%)
Planar Surface:	flat	(18.8%)
	concave	(18.8%)
	convex	(47.9%)
	undulating	(14.6%)
Heat-altered:	present	(0%)
	absent	(100%)

Descriptions for the cores are in Table 8 and for the flakes in Table 9. Labels and acronyms are in Table 10.

Table 8. Descriptive Statistics for Core Scraper-planes.

Attributes	Mean	Std Deviation	Min	Max
Length	5.986	1.724	2.0	10.2
Width	6.530	1.635	3.2	11.2
Thicknes	3.947	1.265	1.3	9.1
Weight	173.020	111.317	13.7	552.4
Edgangl	70.957	12.063	41.0	118.0
Lwxth	3.782	1.646	.9	8.6
Lengwid	0.941	0.256	.2	1.7
Widthck	1.778	0.559	.7	3.6

Table 9. Descriptive Statistics for Flake Scraper-planes.

Attributes	Mean	Std Deviation	Min	Max
Length	6.167	1.411	3.3	9.1
Width	5.900	1.158	3.4	9.0
Thicknes	2.721	.651	1.5	4.7
Weight	103.285	51.284	24.9	244.8
Edgangl	66.551	11.333	40.0	125.0
Lwxth	2.936	1.103	1.1	6.1
Lengwid	1.066	0.244	.5	1.5
Widthck	2.251	0.521	.8	3.6

Table 10. Attribute Labels and Acronyms for Scraper-planes.

Attribute	Acronym
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum thickness of specimen in cm	THICKNES
Weight in grams	WEIGHT
Angle of working edge, "spine" in degrees	EDGANGL
Length/width X thickness in cm	LWXTH
Length/width in cm	LENGWID
Width/thickness in cm	WIDTHCK

Frequency distributions for all (but width) core attributes lack low variability (Appendix B, Tables 71-76). A width distribution curve (Appendix B, Table 72) displays 67% of the population ± 1 SD and 97.8% ± 2 SD. Flake attribute distributions (Appendix B, Tables 77-83) are even more variable than those for the cores; i.e., none display low variability. When comparative metric values are available for the regional sample, it may then be possible to assess the degree of uniformity among this class of tools.

3. Flake tools (n=725 thus far). Because the present study has focused on diagnostics, metric determinations and use-wear analysis for the flake tools are incomplete. Nevertheless, of those examined the following aspects have been observed.

In contrast to the unifacial points, most tools in this category show little to no purposive modification (retouch); that is, retouch is primarily the result of use. Use-wear may occur along the edge unifacially (scrapers) or bifacially (knives); a few specimens exhibit use retouch on their tips (gravers). Rarely does a flake display all of these patterns; this suggests that the majority of these tools were mono-functional. This latter pattern contrasts markedly with that observed for the unifacial points.

Scraper edges may be convex, concave or straight; knives are largely straight, although a few are convex. Lithology is overwhelmingly cryptocrystalline, though several are of quartz and several are of volcanics of an unspecified nature. The latter are utilized celt flakes.

Nonchipped Tools

Technology and Tool Forms. Both ground tools (those shaped by grinding) and polished tools (those shaped by chipping, pecking, grinding and polishing) are considered under the nonchip category. While ground stone tools are always shaped to some extent through use, many of the forms discussed below also display some pre-use modification, such as pecking. Each will be discussed in more detail where appropriate.

The major chronologically significant nonchipped tool types are edge-ground cobbles, milling stone bases, metates, manos, celts and chisels. In addition, and widely distributed in time and space, are numerous hammerstones, pecking hammers and pestles; with the exception of the pestles, this latter group will not be addressed further in this chapter.

Lithology. Nonchipped tool types (most are made from non-locally available rock which is igneous in type) have been classified on the basis of texture and composition of mineralogy. Because of variation within and between tool types, the lithology of each tool type will be described separately.

1. Edge-ground cobbles (n= 69; 49 of which are complete) (Plates 45a-h, 46a-c, 47a-c). These are hand held tools made on cobbles of igneous origin; the predominant composition being cryptocrystalline/dacite tuff. With few exceptions (6 out of a total of 69), cobble modification results from use rather than from purposive retouch. The few that have been retouched are bifacially flaked on at least one edge and then further modified through use (Plate 46a-c). One pattern common to each tool in this class is edge and/or end use for pounding or mashing; this pattern contrasts with that common on manos where either one or both surfaces are used. Edge/end ground facets are generally smooth, convex in shape and extend the full length of the tool. Facet numbers per tool range from as few as one edge to as many

as 3 edges and both ends. Utilized facets vary in depth; the deeper the facet the longer the use of the tool (see Figure 35 for an illustration of edge, end, surface, depth measurements). These presumably have been used against milling stone bases (Ranere 1980b). In addition to ground facets, many (60%) of these tools contain battered edges, ends and surfaces. The nature of battered facets indicates that edge-ground cobbles also served as choppers, end-, edge- or surface-battered hammers, pestles and/or anvils. Cobble cross-sections range from rectangular (39%), to triangular (32%), to oval (29%). A descriptive summary of the complete tools (n=49) (Table 11) and fragments (n=20) (Table 12) follows, as does a complete list of attribute labels and acronyms (Table 13):

Table 11. Descriptive Statistics for Edge-ground Cobbles (Whole)

Attribute	Mean	Std Deviation	Min	Max
Length	12.1	2.363	8.0	19.0
Width	7.363	1.825	5.0	12.4
Thicknes	5.153	1.127	3.0	8.6
Weight	771.488	433.674	266.2	2535.0
Shorfac	.414	.182	.1	.9
Longfac	.430	.212	.1	1.4
Surfac	.447	.200	.2	1.0
Lwxth	8.629	2.089	4.2	13.3
Lengwid	1.686	0.295	.8	2.3
Widthck	1.445	0.269	.9	2.2

Table 12. Descriptive Statistics for Edge-ground Cobbles (Fragments).

Attribute	Mean	Std Deviation	Min	Max
Length	8.01	2.147	4.2	11.5
Width	6.60	1.262	4.3	9.4
Thicknes	5.12	.979	3.5	7.3
Weight	406.945	147.638	138.3	666.0
Shorfac	.471	.107	.35	.6
Longfac	.367	.166	.15	1.0
Surfac	.250	.050	.20	.30

Table 13. Attribute Labels and Acronyms for Edge-ground Cobbles.

Attribute	Acronym
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum thickness of specimen in cm	THICKNES
Weight in grams	WEIGHT
Working facet of short ends in cm	SHORFAC
Working facet of longitudinal edges in cm	LONGFAC
Working facet of surfaces (top/bottom) in cm	SURFAC
Length/width X thickness in cm	LWXTH
Length/width in cm	LENGWID
Width/thickness in cm	WIDTHCK

Frequency distributions (Appendix B, Tables 84-86) of the first three attributes (whole specimens only) are highly suggestive of cobble size selection. That is, for length 71.4% of the variability is within ± 1 SD of the mean, for width 73.4% and for thickness 87.7%. Frequency tables for derived attributes (i.e., lwxth, lengwid and widthck [Appendix B, Tables 88-90]), also show very low variability about the mean.

A correlation matrix for length, width and thickness indicates co-variance (Table 14).

Table 14. Correlation Matrix for Edge-ground Cobbles.

	Length	Width	Thickness
Length	1.00	.69	.70
Width	.69	1.00	.70
Thickness	.70	.70	1.00

These relationships are statistically significant as determined by a multiple regression analysis. When thickness is the dependent variable, length t (46) = 3.13, p = .0033; width t (46) = 3.06, p = .0039. If width is the dependent variable, length t (46) = 2.97, p = .0049; thickness t (46) = 3.06, p = .0039; if length is the dependent variable, width t (46) = 2.97, p = .0049; thickness t (46) = 3.13, p = .0033. These results reinforce those of above, i.e., these tools represent one population.

2. Milling stone bases (n=11 fragments) (Plates 47d, 48). These are large boulders in which one surface has been smoothed (polished) through use. They do not exhibit pre-use modification although the dorsal surfaces are very weathered, often exfoliated, making positive identification next to impossible on these surfaces. Seventy percent (70%) of the bases are convex-concave in cross-section; 30% are plano-concave. All are of non-locally available granite (55%), cryptocrystalline/tuff (18%), quartz monzonite (9%), quartz syenite (9%) or monzonite (9%).

The following measurements were calculated for the entire collection of 11 fragments:

Table 15. Descriptive Statistics for Milling Stone Bases.

Attribute	Mean	Std Deviation	Min	Max
Length	19.127	9.815	8.2	39.
Width	11.473	5.667	4.7	23.
Thicknes	8.555	3.758	5.	15.5
Weight	1266.571	1201.520	256.5	3472.

Frequency distributions were not determined for these tools due to their fragmentary nature.

3. Manos (n=58 fragments; 5 complete). As with edge-ground cobbles, manos are hand held tools whose surfaces have been smoothed (polished) through use. Surface use is the result of grinding in a back and forth motion against metates. Unlike edge-ground cobbles, many of the manos display edge and/or end shaping (pecking). Many of these tools also exhibit battering along the ends, edges and/or surfaces indicating that they served as hammers, as well as grinders.

On the basis of shape and lithology, manos can be divided into at least 2 distinct groups: (1) bar manos and (2) other.

A. Bar manos. Those in this group (n=16 fragments) (Plate 49f-j) are rectangular in planview and largely plano-convex (57%) in cross-section, but may be biconvex (35.1%). Tools in this group have been shaped through pecking. They have been manufactured from quarried materials that are almost identical to those used for the breadboard metates; that is, they are porphitic tuff in texture. Tuff composition is: (1) cryptocrystalline rhyolite (70.6%), (2) cryptocrystalline dacite (17.6%), (3) cryptocrystalline rhyodacite (5.9%) and (4) rhyolite porphory (5.9%). There is evidence for one surface being used in over 95% of these specimens; perhaps two surfaces have been used on many as well but positive identification is difficult due to extreme surface weathering; 35% have been also used as hammers. Use facets vary in depth, the greater the depth the longer the use.

B. <u>Other manos</u>. Those in this group (n=42 fragments; 5 complete) (Plate 51a-c, 52e,f) are variable in planview from oval to spherical to rectangular. They are also more variable in cross-section: (1) biconvex (67.7%), (2) plano-convex (12.9%), (3) wedge-shaped (12.9%) or (4) rectangular (6.5%). Tools of this type have been made on cobbles of igneous (extrusive and intrusive) origin. The intrusive types are: granite, granodiorite, monzonite and monzodiorite (76%). The remaining 24% are extrusives of porphoritic and/or tuff in texture and composed of cryptocrystalline/dacite, /rhyolite, /rhyodacite or /andesite. There is clear evidence for 2 surfaces being used in 75% of this sample; 25% have been used (reused?) as hammers. One specimen is quite unusual in that it has been grooved on one surface and 2 edges (Plate 51a). As with bar manos, use facets vary in depth; again, the longer the use the greater the depth of the facet.

Descriptions for the bar manos are in Table 16 and for other manos in Table 17; attribute labels and acronyms are in Table 18.

Table 16. Descriptive Statistics for Bar Manos.

Attribute	Mean	Std Deviation	Min	Max
Length	8.237	3.240	3.9	12.9
Width	5.375	.457	4.4	6.1
Thicknes	3.925	.800	2.1	5.2
Weight	242.750	117.148	61.7	497.60
Shorfac	(insufficient observations)			
Longfac	.375	.103	.3	.6
Edgedres		(no observations)		
Enddres		(" ")		

Table 17. Descriptive Statistics for Non-bar Manos.

Attribute	Mean	Std Deviation	Min	Max
Length	9.048	4.334	3.4	23.5
Width	7.507	2.362	1.5	13.2
Thicknes	4.533	1.250	1.1	7.1
Weight	581.215	578.218	72.8	2834.9
Shorfac	.325	.096	.2	.4
Longfac	.905	.467	.4	2.7
Edgedres	.379	.225	.2	1.2
Enddres	.355	.093	.3	.6

Table 18. Attribute Labels and Acronyms for Manos.

Attribute	Acronym
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum thickness of specimen in cm	THICKNES
Weight in grams	WEIGHT
Working facet of short ends in cm	SHORFAC
Working facets of longitudinal edges in cm	LONGFAC
Pecking (?) along the longitudinal edges in cm	EDGEDRES
Pecking (?) along the short ends in cm	ENDDRES

Not one frequency distribution (Appendix B, Tables 94-97) exhibits unimodality and/or low variability. Factors which have no doubt affected these results are: (1) duration of use, (2) tool re-use and (3) small sample size for the bar manos.

4. Metates (n=79). Metates can be divided into at least two discrete categories on the basis of shape and lithology: (1) breadboard metates and (2) other.

A. Breadboard metates (n=67; 66 of which are fragments; 25 fragments have borders [lips]) (Plate 49a-e). Breadboard metates are relatively thin stone slabs with a raised rim along three sides; they lack legs and have been purposively manufactured through pecking from volcanic rocks which are porphyritic tuff in texture. Tuff composition is of 4 types: (1) cryptocrystalline rhyolite (88.1% of the specimens), (2) cryptocrystalline dacite (6.0%), (3) cryptocrystalline rhyodacite (3%) and (4) cryptocrystalline andesite (3%).

Use-wear, in the form of surface polish, is evident on only 5 pieces; the remainder are badly eroded. Wear is the result of a handstone (bar mano probable]) grinding back and forth across the surface. The whole specimen (Plate 50) measures 25 cm in width and 45 cm in length. Excluding the border, thickness varies from 3 to 1 cm. It is thinnest in the center of the working surface. In fact, the center of this specimen was broken in 6 pieces at its thinnest section. In cross-section this utilized tool is plano-concave. (Those that have not been used are generally bi-plano, such as those found in shaft-tomb burial contexts). A 2-1/2 cm high x 1-3/4 cm wide border (lip) surrounds the tool on three sides. For this specimen, rim width falls within the range of values calculated for the fragments, but rim height is almost 4 times greater than it is for the fragments.

Descriptive statistics for the fragments (Table 19) and attribute labels and acronyms (Table 20) are below.

Table 19. Descriptive Statistics for Breadboard Metates (Fragments).

Attribute	Mean	Std Deviation	Min	Max
Length	7.948	3.610	3.5	23.5
Width	6.522	2.605	2.7	14.
Bodyht	2.080	0.329	1.6	2.9
Rimht	.424	.159	.2	.8
Rimwid	1.944	.643	1.2	3.8
Rimleng	6.746	1.981	3.4	11.
Rimbodht	0.212	0.099	.05	.48
Dang	28.259	7.813	16.	46.

Table 20. Attribute Labels and Acronyms for Breadboard Metates.

Attributes	Acronyms
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum height (thickness) of metate table excluding rim in cm	BODYHT
Maximum rim height (excluding table thickness) in cm	RIMHT
Maximum rim width in cm	RIMWID
Rim length in cm	RIMLENG
Rim height / body height in cm	RIMBODHT
Dorsal angle from rim to dorsal surface in degrees	DANG

Frequency distributions (Appendix B, Tables 91-93) for four of the above attributes strongly suggest standardization in the manufacturing of these particular tools. Seventy-six percent (76%) of the variability of body height falls within ± 1 SD of the mean, 88% for rim width, 88% for rim height and 81% for rim:body height ratio.

A correlation matrix (Table 21) and the results of a multiple linear regression analysis follow:

Table 21. Correlation Matrix for Breadboard Metates with Rims.

	Bodyht	Rimht	Rimwid
Bodyht	1.00	.49	-.08
Rimht	.49	1.00	.33
Rimwid	-.08	.33	1.00

If bodyht is the dependent variable, then rimht, t (22) = 3.08, p = .005; and rimwid, t (22) = -1.44, p = .15; if rimht is the dependent variable, then bodyht t (22) = 3.08, p = .005; and rimwid t (22) = 2.22, p = .034. When rimwid is the dependent variable, then bodyht t (22) = -1.33, p = .158 and rimht t (22) = 2.22, p = .034. Again, these results objectively support an interpretation of one population.

B. <u>Non-breadboard metates</u> (n=10 fragments [legless variety]; 3 leg fragments, 1 of which contains a table surface [Plate 52a,b]). Metates have been shaped through pecking; their surfaces (tables) have been further modified through use. Use-wear is visible in the form of polish on all 11 tables; polish is the result of a handstone (mano) moving back and forth across the table. The end product is a tool that is plano-concave in cross-section (100%). All have been manufactured from volcanic rocks composed of: (1) cryptocrystalline/ rhyolite or andesite tuff (46%), (2) granite (38.5%) or (3) quartz monzonite (15.4%).

Metate legs are one of two shapes: tapered or round to square in cross-section (Plate 52c,d).

Descriptive measurements for the table fragments are in Table 22 and for the legs in Table 23.

Table 22. Descriptive Statistics for Metate Fragments.

Attribute	Mean	Std Deviation	Min	Max
Length	14.850	4.495	6.9	22.2
Width	9.560	2.844	5.9	14.9
Bodyht	4.690	1.703	2.6	7.8
Weight	842.300	590.790	250.5	2289.2

Table 23. Descriptive Statistics for Metate Legs.

Attribute	Mean	Std Deviation	Min	Max
Length	8.733	5.417	2.5	12.3
Width	6.600	2.476	4.7	9.4
Thickness	4.400	1.929	3.0	6.6

Frequency distributions were not determined for this group of tools due to their fragmentary nature and small sample size.

5. Pestles (n=15) (Plate 46d, 53h). Only 3 (2 complete, 1 fragment) of the 15 pestles can be considered mono-functional; the remaining 12 have been used also as edge-ground cobbles, anvils and end-battered hammers. Those portions of the tool that have been used as a pestle display pounding wear facets on at least one end. It is often difficult, however, to distinguish these facets from those recognized as pecking and end-battered hammers. That at least one may have been hafted is suggested by the presence of several deep grooves on both surfaces (Plate 53h). All have been made of cobbles or slabs composed of cryptocrystalline/dacite tuff (73.3%) or of cryptocrystalline/ rhyolite tuff (26.6%).

The two mono-functional pestles (whole) measure: 11.3 x 4.7 x 3.7 cm and 7.9 x 5.3 x 4.0 cm; they weigh 377.6 gm and 236.1 gm respectively. The fragment measures 4.3 x 5.2 x 3.8 cm and weighs 108.9 gm. Descriptive statistics for the remaining 12 specimens are in Tables 24 (whole) and 25 (fragments).

Table 24. Descriptive Statistics for Pestles (Whole).

Attribute	Mean	Std Deviation	Min	Max
Length	11.267	1.250	9.3	12.9
Width	6.067	1.181	4.4	7.3
Thicknes	4.933	0.841	3.9	6.1
Weight	550.400	150.715	333.2	762.0

Table 25. Descriptive Statistics for Pestles (Fragments).

Attribute	Mean	Std Deviation	Min	Max
Length	6.740	2.339	4.2	9.7
Width	5.600	1.020	4.3	6.9
Thicknes	5.000	0.914	3.8	6.1
Weight	281.620	126.299	138.3	449.6

Small sample size negated the utility of constructing frequency distributions.

6. Mortars (n=1 fragment) (Plate 46e). This convex-concave granite fragment measures 15.7 cm in length X 12.4 cm in width X 4.4 cm in thickness; weight is 1660 gm. All surfaces are very weathered; it is, therefore, not possible to determine whether this piece was intentionally manufactured.

7. Celts (n=154; 9 of which are complete). The whole specimens can be separated into 2 shapes: (1) pear-shaped (n=4) and (2) trapezoidal (n=5). Corresponding with each shape is a distinctive surface treatment. On the basis of this latter attribute, the majority of celt fragments (149) can be classified according to shape.

A. Pear-shaped (n=105 [67.7%]) (Plate 53c,d). The bit edge on these celts joins the sides without a break in the curvature. The entire surface of this end, which may constitute up to 1/2 of the tool's surface, is ground and polished. The remaining portion (poll or butt end) of the tool generally contains numerous flake scars; occasionally this portion has been pecked and (rarely) polished. This latter portion has symmetrical sides which converge into a slightly convex base. Some specimens display secondary flake scars on opposing sides suggesting impromptu modification for hafting or rehafting; many of the tools have snapped at the transition zone between the bit and butt sections. The base often contains chipped scars indicative of the primary manufacturing stage. Many of the tools have a slightly off-center ridge along their midlines. All specimens are biconvex in cross-section.

As with so many of the other tools found at La Mula-Sarigua, the majority (72%) of pear-shaped celts have been re-used, particularly as cores, hammers (edge, end or pecking) and occasionally as scrapers. When complete, they no doubt were used in chopping activities.

Lithic composition is either cryptocrystalline/dacite or /andesite tuff (51%) or dacite vitrophyre (49%). Calculations for the whole specimens (Table 26), fragments (Table 27) and combined (Table 28) are below, as are attribute labels and acronyms (Table 29).

Table 26. Descriptive Statistics for Pear-shaped Celts (Whole).

Attribute	Mean	Std Deviation	Min	Max
Length	8.575	1.921	5.7	9.7
Width	4.875	.096	4.8	5.0
Thicknes	2.150	.597	1.6	3.0
Midpoint	4.20	.503	3.7	4.9
Bitwidth	4.825	.126	4.7	5.0
Bitthick	1.175	.096	1.1	1.3
Butwidth	1.950	.129	1.8	2.1
Butthick	1.150	.100	1.0	1.2

Table 27. Descriptive Statistics for Pear-shaped Celts (Fragments).

Attribute	Mean	Std Deviation	Min	Max
Length	5.569	1.730	3.0	11.4
Width	4.953	1.247	2.6	8.0
Thicknes	2.606	.510	1.7	4.0
Bitwidth	6.031	1.263	4.4	8.0
Bitthick	1.267	.300	.9	1.9
Butwidth	1.997	.562	.8	3.1
Butthick	1.097	.484	.4	2.2

Table 28. Descriptive Statistics for Pear-shaped Celts (Whole and Fragments).

Attribute	Mean	Std Deviation	Min	Max
Bitwidth	5.694	1.059	3.5	8.0
Bitthick	1.185	.239	.7	1.9
Butwidth	1.957	.535	.8	3.1
Butthick	1.054	.453	.4	2.2
Bitwxth	4.663	0.828	3.5	6.5
Butwxth	1.985	0.670	1.1	4.5

Table 29. Attribute Labels and Acronyms for Celts.

Attribute	Acronym
Length // to axis of force in cm	LENGTH
Width perpendicular to axis of force in cm	WIDTH
Maximum thickness of specimen in cm	THICKNES
Width of bit in cm	BITWIDTH
Thickness of bit (1 cm from working edge) in cm	BITTHICK
Width of butt in cm	BUTWIDTH
Thickness of butt in cm	BUTTHICK
Bit width/bit thickness in cm	BITWXTH
Butt width/butt thickness in cm	BUTWXTH

Frequency distributions for six attributes (Appendix B, Tables 98-103) largely display unimodality and low variability, i.e., bitwidth (65.7% ± 1 SD); bitthick (76% ± 1 SD); butwidth (72.7% ± 1 SD); butthick (71% ± 1 SD); bitwxth (83% ± 1 SD) and butwxth (83% ± 1 SD).

Table 30. Correlation Matrices for Pear-shaped Celts.

	Bitwidth	Bitthick		Butwidth	Butthick
Bitwidth	1.00	.59	Butwidth	1.00	.74
Bitthick	.59	1.00	Butthick	.74	1.00

If bitthick is dependent upon bitwidth, then t (16) = 2.91 and p = .009; with butthick dependent upon butwidth t (22) = 5.12 and p = .0001.

B. Trapezoidal (n=35 [22.5%]) (Plate 53e-g). The slightly asymmetrical bit end of these celts forms a smooth curve which terminates at the sides. The side portions are broad, flat and demarcated by two parallel ridges. The sides are symmetrical and converge into a convex base. Many of the specimens appear to be fully polished (from bit to butt end); but it is difficult to determine if this is so for all tools of this type due to extreme surface weathering (particularly exfoliation), as well as to edge and/or surface battering (60%) through re-use. These tools are composed entirely of cryptocrystalline/dacite or /andesite tuff. See Table 31 for attribute determinations for the whole specimens, Table 32 for the fragments and Table 33 for a combination:

Table 31. Descriptive Statistics for Trapezoidal Celts (Whole).

Attribute	Mean	Std Deviation	Min	Max
Length	10.520	1.491	8.3	11.9
Width	4.860	.410	4.2	5.3
Thicknes	2.540	.635	1.5	3.2
Midpoint	4.400	.245	4.1	4.7
Bitwidth	4.820	.402	4.2	5.3
Bitthick	1.160	.207	1.0	1.5
Butwidth	2.475	.550	2.0	3.0
Butthick	1.620	.335	1.1	1.9

Table 32. Descriptive Statistics for Trapezoidal Celts (Fragments).

Attribute	Mean	Std Deviation	Min	Max
Length	6.947	1.722	3.9	10.1
Width	5.029	.760	3.9	6.4
Thicknes	2.153	.685	.9	3.7
Bitwidth	5.056	.693	4.1	6.1
Bitthick	1.437	.288	1.0	1.9
Butwidth	2.533	.609	1.7	3.5
Butthick	1.250	.327	.9	1.8

Table 33. Descriptive Statistics for Trapezoidal Celts (Whole and Fragments).

Attributes	Mean	Std Deviation	Min	Max
Bitwidth	5.070	.988	3.4	8.3
Bitthick	1.553	1.350	.7	7.0
Butwidth	2.521	.567	1.7	3.5
Butthick	1.447	.350	.9	1.9
Bitwxth	3.836	1.202	.6	6.1
Butwxth	1.798	0.587	1.1	3.2

Frequency distributions for the first two attributes (Appendix B, Tables 104-105) of the latter table suggest standardization. For bit width 82.6% of the scores are within ± 1 SD, 100% within ± 2 SD; for bit thickness 94.2% of the scores are within ± 1 SD and 100 % within ± 2 SD. Distributions for butt width and thickness (Appendix B, Tables 106-107) and for bitwxth and butwxth are bi-modal (Appendix B, Tables 108-109). Nonetheless, the sample size for each is small and intervals are usually only separable on the basis of one specimen. It is highly likely that an increase in sample size would reveal butt width and thickness to be unimodally distributed.

8. Chisels (n=3 complete specimens) (Plate 53a,b).

Although smaller, chisels resemble narrow pear-shaped celts in shape and trapezoidal celts in surface finish, i.e., fully polished. These 3 specimens display battering on the proximal end. They are biconvex in cross-section and are manufactured from volcanic rocks composed of dacite or dacite vitrophyre. Attribute determinations appear in Table 34.

Table 34. Descriptive Statistics for Chisels.

Attributes	Mean	Std Deviation	Min	Max
Length	7.433	.862	6.5	8.2
Width	3.033	.351	2.7	3.4
Thicknes	2.000	.200	1.8	2.2
Bitwidth	.933	.208	.7	1.1
Bitthick	2.467	.950	1.5	3.4
Butwidth	1.750	.354	1.5	2.0
Butthick	1.400	.424	1.1	1.7

Frequency distributions were not determined due to small sample size.

Discussion

The contrast between chipped and nonchipped tools is marked. The former were made in large numbers at La Mula-Sarigua. This is evidenced by the tremendous quantity of cores, hammerstones, debitage and finished products, such as the unifacial points and scraper-planes. All have been manufactured from material available from the local (on-site) chalcedony quarry. Nonchipped tools exhibit a very different pattern, particularly those which required pre-use modification, such as the breadboard metates, bar manos and celts. This latter group is well-represented in the La Mula-Sarigua lithic assemblage, yet none appears to have been manufactured at the site. There is no evidence of primary manufacturing, such as raw material or debitage. There is, however, much reworking and/or re-use of nonchipped tools. Further, all have been made on volcanic rocks not contained within the site's boundaries. This nonchipped tool pattern is precisely what one might expect if tools were made on materials which were not readily and/or easily accessible. It further suggests that these products were not only imported (considered in more detail in Chapter IX) but were viewed as valuable as well.

Use-wear analysis indicates that the following were major site activities: heavy woodworking and chopping (scraper-planes, celts, chisels), grinding, pounding and mashing (milling bases, edge-ground cobbles, pestles, metates and manos), scraping, cutting, and drilling, (unifacial points, utilized flakes), tool manufacturing (cores, hammerstones, debitage, finished tools) and tool maintenance (pecking hammers, debitage, reworked tools).

Standardization in tool production can be inferred for breadboard metates, pear-shaped and trapezoidal celts. Evidence for the presence/absence of standardization for unifacial points is inconclusive; nonetheless, a visual comparison of those present at La Mula-Sarigua to those present at earlier and later sites hints at the probability. The remainder of the lithic sample was either too fragmented or too small to assess. Despite these obstacles, i.e., small sample size and inconclusive evidence, it is expected that the degree of uniformity in manufacturing within tool forms will be forthcoming when comparative metric determinations are available for regional assemblages.

Selection for cobble shape and size can be inferred for edge-ground cobbles.

All chipped tools at La Mula-Sarigua were made on-site and all were made from on-site material. All nonchipped tools that required purposive shaping for a specific function were imported as finished products and all were made from off-site material. It is these latter tools (as a group) which show the highest degree of standardization in shape and size, although it is likely that the chipped unifacial points will prove to be quite uniform as well.

Unfortunately, diagnostic lithic materials (with one exception) do not occur in stratigraphic contexts at La Mula-Sarigua. To chronologically place these materials it has been essential to assess the present assemblage relative to regional lithic assemblages, as well as to on-site ceramic associations. This assessment is discussed in some detail in Chapter IX.

Endnotes

1. A large proportion of the tools, particularly nonchipped tools, are manufactured from volcanic rocks; none of which has been identified in a raw form on the site. The lithology of these tools has been analyzed in some detail by Barbara Jakub and Bessie Coughlin, Temple University geology students, under the supervision of Mary Lou Hill, Associate Professor of Geology, Temple University.

2. A comparison to the regional lithic assemblages is critical for understanding chronology at La Mula-Sarigua since all forms at the site thought to be significant time markers are restricted to the site's surface (eroded zone).

3. The most useful of distribution shapes is the unimodal, normal curve. In this instance, "scores tend to cluster around the mean, and the probability of obtaining a particular score decreases as the difference between the score and the mean

increases (Wood 1974:148)." In an ideal normal distribution the following percentage of scores holds: 68% of the scores will be within ± one standard deviation of the mean; 95% will be ± two standard deviations; and 99.7% will be ± three standard deviations (Minium and Clarke 1982:76). From this one should not conclude that all scores are normally distributed; clearly, there are distributions where there are more scores on one end than on the other, i.e., skewed. Even for these situations, however, the following generalizations can be made: the majority of the scores will be ± one standard deviation from the mean; the great majority and oftentimes all the scores will be ± two standard deviations from the mean; and all or all but a very few scores will be ± three standard deviations from the mean (Minium and Clarke 1982:78).

4. A minor reduction strategy is also visible at La Mula-Sarigua. This strategy is marked by the presence of bifacial thinning flakes and bifacially flaked tools (Plate 54i-j). Their presence is chronologically significant since bifacial flaking as a technique for shaping chipped stone tools disappears from Central Panama by 5000 B.C. (Cooke and Ranere 1984). Since 5000 B.C. is outside the focus of this present research, they will not be discussed in detail here.

5. To further separate out these populations, the sample was divided on the basis of the strongest bimodal attribute, i.e., width (Appendix B, Table 60). The sample was separated at 2.3 cm: large specimens were represented by all points that were ≥ 2.3 cm wide, and small specimens were those that were ≤ 2.2 cm. Means and standard deviations (by attribute) were determined for each size category. Distribution curves for all attributes continued to be bi- or multimodal in shape.

I have also considered the relationship of each size category as a product of function. The percent of tools by functional class (chip type) for each size category (whole specimens only) are approximately the same (Table 35).

Table 35. Unifacial Point Tool Type by Width Category.

Chip Type	≥ 2.2 cm	≤ 2.3 cm
Scrapers:		
convex	54.3%	62.0%
straight	33.3%	22.4%
concave	21.0%	18.9%
pointed	0.07%	5.1%
spoon-shaped	2.1%	0.0%
Knives:		
convex	46.3%	58.6%
straight	5.1%	12.1%
concave	21.0%	18.9%
Graver:	0.07%	0.0%
Saw:	0.07%	0.0%
Perforator:	6.5%	1.3%

The spatial distribution of each size category (see Figures 69 and 70) has also been determined; largely these categories overlap in distribution.

CHAPTER VII

CERAMICS

The primary goal of the La Mula-Sarigua ceramic analysis was to identify settlement loci spatially and temporally; a secondary goal was to compare the on-site chronology (Cooke, personal communication, Willey and McGimsey 1954) with the sequence established for the Central Region (Cooke 1984: Table 10.1, 1985, Cooke and Ranere 1984)[1] and thus to test the integrity of the latter.

Analytical Criteria

Initially, the present analytical method had to confront the affects of unusual environmental conditions at La Mula-Sarigua, where wind, rain and salt have altered the surface treatment of the sherds (n = ca. 10,000) to such an extent that it is impossible to reconstruct the nature of the slip or finish or to appreciate the high standards of workmanship of a large proportion of the sample.

Though certain types of paste in Central Panama do have chronological significance (Cooke 1972), they can not be used as precise time-markers (e.g., phase- or period-specific) when isolated from other typological criteria. For these reasons, and for the purposes of this dissertation, we disregarded body sherds which had no preserved salient typological characteristics and have concentrated on "diagnostics." The latter consist of rims, lips, collars, necks, bases, appendages (handles, lugs and feet) and decorated sherds, i.e., painted or plastic. One surface treatment was excluded from the diagnostic category, i.e., sherds which had a red wash or slip on vessel exteriors; this treatment is used from the 3rd millennium B.C. onwards (see also Cooke 1972). Light-colored slips, however, were recorded.

The emphasis on "diagnostics" was further justified by the fact that previous ceramic classifications from the Central Region of Panama (e.g., Cooke 1972, 1975, Ichon 1980, Ladd 1964, Lothrop 1942) have emphasized surface treatment (slip, polish, painted and plastic decoration) and vessel shape; technological characteristics (paste, temper and firing temperature) have been played down--even though the association between certain types of paste and decorative styles has not escaped the analysts' attention. Concentrating on surface treatment and vessel shape has enabled us both to compare sherds to existing classifications and to describe new categories accurately. We have not, however, ignored technological criteria in the analysis. In fact, the major contribution of this dissertation to Central Panamanian ceramic analysis has been the identification of pottery, dated to the 1st millennium B.C., which clearly exhibits an explicit relationship between paste and style.

Classificatory Schemes

The classificatory system used for the La Mula-Sarigua ceramics largely follows Cooke's suggestions. It incorporates published analyses, unpublished PSM data and data from excavated (but incompletely reported) sites, such as the Aguadulce Shelter, Monagrillo, Zapotal and Sitio Sierra. Nonetheless, as much of the information on Central Panama ceramic distributions is unreported, and as all these materials are being written up presently by Cooke, the present analysis should be considered an interim one. If it errs, it is on the side of simplicity.

In general, Central Region pottery becomes more intricate through time, both in a technological and decorative sense and with respect to an increase in the different kinds of pottery that are used during successive periods. For example, the early Monagrillo pottery employs no appendages, has only three basic shapes and limits decoration to red paint and simple incisions. By the end of the first millennium B.C., various kinds of pottery have appeared and are used contemporaneously: plain, black-painted, trichrome and plastic decorated; smudged and oxidized; quartzy, gritty and clean clays. For classificatory schemes to identify synchrony and diachrony, it is necessary that they concentrate on both individual attributes and combinations of attributes, i.e., specific and general characteristics need consideration.

There is no concrete evidence to contradict Cooke's (1972, 1976, 1984) hypothesis that once pottery appeared in Central Panama, it evolved stylistically in response to indigenous pressures alone. Categories grade into each other in a predictable fashion. In fact, Cooke has suggested (personal communication, 1988) that all Central Region pottery can be considered as belonging to a single "tradition"--the Central Panamanian "tradition." ("Tradition" is preferable to "school" [Smith 1962] as the latter term refers to a particular community of potters rather than to a region with a common ideology).

Within this "tradition" various "design styles" or "stylistic groups" can be identified: combinations of attributes which provide a particular visual (i.e., "ideological") effect; this effect is the result of certain combinations of surface treatment, decorative motifs' and shapes. In his dissertation, Cooke (1972) used the term "stylistic group" for materials with a particular type of painted decoration. For example, the Aristide "style" stands out for its use of a limited array of black painted designs; the Conte "style" for its combination of vivid colors and a bright white slip. This term was intentionally used to acknowledge the fact that particular design styles occur all over the Central Region of Panama, but that the same kind of clay is not necessarily used to make them.

The fact that "styles" often exist for a long period of time poses particular classificatory problems. At La Mula-Sarigua, for example, sherds painted in the Aristide style show up as early as 870 $\pm$ 50 B.C., while they are present at Sitio Sierra in contexts radiocarbon dated to the fifth century A.D. Obviously, some kind of varietal sub-classification, such as the "type" ("a group or class of items that is internally cohesive and can be separated from other groups by one or more discontinuities in attribute states [Rice 1987:276]") is necessary to pinpoint changing patterns within the style.

In past classifications, Cooke has tended to arrange plain or red-slipped pottery into "wares"--i.e., a ceramic class of shared technological attributes, such as composition, firing and surface treatment (e.g., Rice 1987:5). Nonetheless, this term is problematical when regional relationships are taken into consideration. For example, ware seems to be the most appropriate term for the "Monagrillo" pottery recovered at the type site (the Monagrillo shellmound). At other contemporary sites, however, pottery which has identifical shapes and design characteristics uses a slightly (but recognizably) different paste. We doubt, therefore, whether the term "ware" is the most appropriate.

In the introductory paragraphs to this chapter, I explained why eroded body sherds were discarded for classificatory purposes. This should not be interpreted as a rejection of the value of pastes for analytical purposes. At La Mula-Sarigua, four "paste" types are particularly distinctive: (1) a clean, temperless paste which fires to an orange-brown color; (2) a gritty paste which generally oxidizes buff; (3) a yellowish paste with lots of quartz inclusions and (4) a paste which fires to a bright orange color and which has inclusions of rounded hematite.

Nonetheless, there is no hard and fast rule that explicitly associates a particular paste with a particular design style or ware. Some styles change in paste characteristics through time, others use a variety of pastes and others use only one kind of paste.

A fourth specific term of analysis is the "mode" ("any ceramic attribute or group of attributes, including vessel form, that has significance in its own right" [Sharer 1978:92, cf. Ladd 1964:5]). The advantage of modal analysis is its ability to identify meaningful attributes on the smallest or most eroded of materials. Its major disadvantage is its tendency to view modes in isolation. For example, at La Mula-Sarigua it is not shell-stamping per se that is chronologically significant, but the way in which this mode is arranged on the vessel or is combined with other attributes or modes.

Since the goal of the ceramic analysis is to trace how La Mula-Sarigua grew and contracted and how artifactual distributions reflect social complexity, the present classification relies both on the classificatory criteria outlined above ("style", "type", "ware", "paste" and "mode") and a general term ("group"). The term "group" is intentionally neutral. It is simply a combination of ceramic materials which can be classified according to the above specific criteria, but which occur together in contexts that have either been dated radiometrically or by reference to specific stratigraphic contexts at other sites in the Central Region.

All modes and groups were recorded and entered into a MINARK CERAMIC database. (See Appendix A, Table 57 for a complete list and description of each). Using GMS (discussed in Chapter V), density and distribution maps (by group) were generated in order to determine the areal extent of occupation through time (Chapter IX).

Existing Nomenclature

I begin my description of the ceramics found at La Mula-Sarigua with a precis of the categories that have been defined by other archaeologists and that have been identified at the site. This discussion includes dating and suggests a revision of the existing classification.

Monagrillo. The Monagrillo Ceramic Complex was first described by Willey and McGimsey (1954) from the shellmound of the same name. This complex consisted of four types: Plain (and a Plain Variant), Red, Incised and Thin Yellow Ware. Pottery with similar shapes, but with a rather different paste, was later recovered by Bird and Cooke (1978a) from the Cueva de los Ladrones; it was attributed provisionally to the same complex.

Monagrillo pottery from the type site is associated with 8 reliable radiocarbon dates, with 5 from Cueva de los Ladrones and with 5 from Zapotal. These range from 2850 ± 100 B.C. to 1295 ± 100 B.C. (Cooke 1984: Table 10.2). The 2850 B.C. date from the Cueva de los Ladrones (Cooke 1984:277-278) was determined from

Crassostrea shells and was not corrected for 13C/12C fractionation. It is, however, out-of-phase with other dates at the site. This complex is also present at the Aguadulce, Carabali and Rio Cobre Shelters (all in the Santa Maria River drainage) but can not be confidently dated at these sites. We suggest that an age of 2500-1200 B.C. for the Monagrillo Complex is the most reasonable estimate.

The Monagrillo Complex pottery is characterized by: (1) low firing temperatures which produce brownish and fire-clouded surfaces and a very high proportion of sherds with fire cores, (2) uneven finishing, e.g., rims are often not smoothed and surfaces are irregular and pitted, (3) surface decoration limited to a red wash and (very occasionally) a crudely executed incised design (cf. Willey and McGimsey 1954:Figure 46), (4) simple shapes, such as slightly everted and inverted bowls and (5) an absence of collars and appendages. Cooke (personal communication, 1988) believes that this complex can be divided into two groups on the basis of firing and paste characteristics; he is still not certain, however, as to whether this division reflects chronological or regional differences.

Sarigua. The Sarigua Complex was originally described by Willey and McGimsey (1954:106-110) from a shellmound of the same name. This mound, no doubt, lies within the boundaries of the site described in this dissertation (discussed in Chapter II).

Willey and McGimsey (1954) describe Sarigua pottery as drab and thin-walled. Decorations are limited to incisions, punctations, applique ridges and stampings. Shapes include out-flared or recurved rims; neither are present in the Monagrillo Complex. Appendages are absent. Temper is quartz-sand with particles of grey, black and red rock. Pastes are granular and range in color from brick red to dark brown-black to light tans and greys. Surfaces are often smudged or fire-mottled.

The Sarigua Complex was originally placed chronologically between the Monagrillo Complex and later painted categories (Willey and McGimsey 1954:Figure 34). It has since been considered to date between 1500 and 500 B.C. (e.g., Haberland 1978, Willey 1971:283), but on relative rather than on radiometric grounds. In the 1960s it achieved a certain notoriety because of its apparent similarities with early Formative pottery types from Middle and South America and because it coincided with diffusionist explanations for the spread of Formative cultures in the Americas (e.g., Coe 1960, Lundberg 1977/78). Recent excavations and surface collections in Panama's Central Region, however, have made it clear that a very large inventory of plastic decorations, akin to those described by Willey and McGimsey (1954), accompany both bichrome and later polychrome pottery types (e.g., Cooke 1972, 1976). Consequently, their attribution to chronologically meaningful complexes has to be handled with care.

Cooke (personal communication, 1988) now believes that certain kinds of plastically-wrought decorative modes are continually executed on a yellowish-buff paste with high concentrations of quartz; this is the kind of clay that Willey and McGimsey (1954) describe for their Sarigua Complex pottery. Hence Cooke has suggested that the name "Sarigua" be maintained in the ceramic classification of the Central Region, but that it be restricted to this group of attributes alone (described in the following section on new ceramic categories). Although pottery under this rubric is still difficult to place temporally, the fact remains that they accompany Aristide bichrome sherds in the lowest houses at Sitio Sierra (with C-14 dates ranging from 240 ± 80 B.C. to A.D. 235 ± 80 [Cooke 1979]) and that they have disappeared from the archaeological record by the time true polychrome pottery (i.e., Conte style) appears in the Central Region. This suggests that they span the period 500 B.C.- A.D. 500.

Aristide. The Aristide style pottery is composed of simple designs on a slipped or natural background; it represents the earliest attempt by Central Region potters to decorate their wares with dark pigments. This pottery was originally named "Santa Maria" by Willey and Stoddard (1954). This designation was later changed to Aristide by Ladd (1964), who divided it into two types: Escota (black-painted decoration on a slipped or plain exterior surface) and Giron (black-painted decoration either on the interior of a bowl or on an everted rim). Cooke (1972, 1976, 1984) maintained the Escota and Giron types and added a third (Cocobo). Each of these types uses similar geometric designs in a specific manner on specific shapes: Escota, on the exterior of collared and collarless jars; Giron, on a flattened rim; and Cocobo, on the interior of a shallow bowl. The three types form a homogeneous "design style": the same basic motifs, such as combinations of parallel black lines and triangles with concave hypotenuses, are employed.

Aristide material is dated at Sitio Sierra between 240 ± 80 B.C. (I-9704) and A.D. 475 ± 110 (I-8556). It also occurs in rubbish lenses at Sitio Conte (Lothrop 1942) and in small quantities in sites in the Tonosi Valley (Ichon 1980). At La Mula-Sarigua, it occurs in contexts that are radiocarbon dated between 870 ± 50 B.C. (Beta-6016) and 220 ± 90 B.C. (Beta-18863).

Tonosi. The Tonosi style was initially described by Ichon (1980) on the basis of materials recovered from living and cemetery sites in the south of the Azuero Peninsula. It is characterized by combinations of white, red and black paint--usually red and black on a white slip, but sometimes white and black on a red slip with red and black line decoration. Ichon (1980) identifies two major "types", which reflect combinations of decorative modes and vessel shapes: (1) "La Bernardina a levre decoree" and (2) "Vases `doubles'." The paste employed in vessels executed in the Tonosi style is generally a fine, temperless blackish-brown material with carbon inclusions, probably intentionally included. This material has heretofore been dated to A.D. 200-500 by Ichon (1980) in the Tonosi Valley and A.D. 310 ± 90 (GIF-2346) for Sitio Sierra (Cooke 1972). Unpublished data from Sitio Sierra indicates, however, that these materials are earlier (Cooke, personal communication); they are associated with house floors dating to 65 ± 80 B.C. (I-9702), 25 ± 80 B.C. (I-9703), A.D. 115 ± 90 (I-9701) and A.D. 235 ± 90 (I-8613).

Conte. Cooke (1972) used the name "Conte" to describe the ceramics assigned by Lothrop (1942) to his Early Cocle Phase at Sitio Conte. These materials include both four-color polychromes and red-slipped wares; they share a number of shapes, such as "drooping-lip" plates. Currently, they are dated between ca. A.D. 500-800 (Cooke, personal communication).

Macaracas. This label was used by Ladd (1964) to describe the majority of Lothrop's Late Cocle polychromes. They are stylistically similar to the preceding Conte polychromes, but have a more cluttered decoration. Paste tends to be orange-red and paint is less purple than that observed on the Conte vessels. The characteristic Macaracas plates have round-lipped rims which use long pedestals. They are presently dated between A.D. 800-1100 (Cooke, personal communication).

Parita and El Hatillo. These designations have been used by Ladd (1964) to describe post A.D. 1100 polychromes found in sites from the Central Region of Panama. Designs are more geometricized than in the Conte and Macaracas styles. The El Hatillo style lacks purple paint completely.

The remainder of this chapter describes the results of the ceramic analysis by group, beginning with the earliest.

Groups

Monagrillo Group (2500-1200 B.C.). Only 7 rims fit this category (Figures 37a-g). All have forms and paste which are identical to those from the excavated Monagrillo phase sites. Figures 37a-d have a coarse, dirty clay typical of the Monagrillo type site; Figures 37e-g have a quartzy under-fired clay typical of the Aguadulce and Ladrones samples. All rims come from collarless vessels.

Aguadulce-Ladrones Group (1200-800 B.C.??). This group has been tentatively identified to include a small number of sherds (n=15) (see Figures 37h-j and Plate 55a), which combine a slapdash plastic decoration, a soft, under-fired quartzy paste and brownish-black or buff (when oxidized) surfaces. The decoration consists of irregular incisions, scratchings or punctations. Very similar material has been found at Aguadulce, Ladrones and Carabali Shelters in stratigraphically unequivocal positions. Intuitively they should date between the last stages of occupation at the Monagrillo shellmound (1295 ± 100 B.C.) and the occupational phase at La Mula-Sarigua (242S417E shellmound dated to 870 ± 50 B.C. and 790 ± 60 B.C. which does not include

Aguadulce-Ladrones Group sherds).

Early Group (+ 800 B.C.??). This is another tentative group which incorporates ceramics found in the La Mula-Sarigua 242S417E shellmound (noted above); it is associated with radiocarbon dates of 870 B.C. and 790 B.C. The predominant paste found in this context is not that of the later Lamula Group (discussed below), but rather a "dirty" clay paste with grit and quartzite inclusions which fires to a yellowish color. It is probable that this material is akin to Willey's "thin yellow" type from Monagrillo (Willey and McGimsey 1954).

1. 242S417E Unit. Five nearly complete vessels were found; their descriptions follow:

A. (Figure 37k). This has a thickened rim typical of the Lamula Group "interior-grooved" decorative mode. The animal lug, however, is unusual. The lower vessel wall is incredibly thin--as little as 4 mm in some places. The paste is different from that of the Lamula Group in being coarser, having less carbon and oxidizing to an orange color when fired. It also has large pieces of tuff and burnt oyster shell intentionally (?) included.

B. (Figure 37l). This fire-clouded rim has a "dirty" clay paste with a red band decoration on the exterior.

C. (Figure 37m). A "dirty" clay paste with "oval and tear-drop punctations" covering the neck and approximately one-half of the body. It is the only example of this decorative mode found complete enough to reconstruct the precise position on the vessel. Similar decorative modes are found on 17 additional samples across the site.

D. A much larger urn than above, with a rim diameter of ca. 20 cm. This has a wide, deep incision running circumferentially around the vessel at the bend between the neck and body. There is only one sherd from elsewhere on the site with this decorative mode (Plate 55b).

E. An undecorated vessel similar to B and C.

In addition to the above whole vessels, the 242S417E unit contains a number of other diagnostics (albeit fragments). Several fragments of a large black-painted vessel (Figure 41d). This has the later Aristide Group buff-quartz paste. This is an interesting association as it shows not only contemporaneity at this early date of black-painted decoration combined with plastically-wrought designs, but also the constancy from early times of the buff-quartzy paste for painted wares.

The fragments illustrated in Figures 38a and b have rims similar to those from whole vessels. Figure 38d is made of a buff-yellow, quartzy paste and has counterparts in the shell-stamped form illustrated in Figures 38e and f; they all share the same paste. Figure 41c is another Aristide Group black-painted sherd; paste is typical. Figure 38c has an exterior decoration of groups of vertical incised lines running from the rim to the mid-point of the vessel. This design is present at the Cueva de los Ladrones.

Although the total unit sample is small and represents a minimum number of vessels (MNV=11), it has anomalies which clearly associate it with groups of earlier dates and which separate it from groups with later dates. For example, the fine brown Lamula Group paste is not used. Rather, pastes are of "dirty" clays and at least one vessel (Figure 37k) uses some burnt oyster shell. Hence, on the basis of paste type and characteristic rim profiles of this unit, a tentative Early Group has been proposed, a group which spans the chronological gap between the Aguadulce-Ladrones and the Lamula Groups.

2. Outside the 242S417E Unit. Other materials which, on intuitive rounds, are possibly representative of the Early Group found outside the 242S417E unit are:

A. Flattened rims, with shell-stamping in zones on the exterior; these, however, have the very quartzy paste typical of the Sarigua Group (n=5) (Plate 55d);

B. Collar forms like those of the 242S417E unit, which have slashed diagonal or oblique incisions on exteriors (n=12) (Figures 38g-i);

C. Other rims with dirty yellowish paste which stand out in the sample from the clean clear brown paste of the Lamula Group (n=11);

D. Zoomorphic appendages like that of Figure 37k (n=3);

E. A design which suggests corn-cob impressing but which is probably shell-impressing (n=1) (Plate 55c).

Lamula Group (?500-1 B.C.). A large proportion of the pottery from La Mula-Sarigua has temper, paste, shapes and decorations that are distinctly different from those of the earlier Monagrillo, Aguadulce-Ladrones and the contemporaneous Aristide Groups. The clay used for the Lamula Group is very characteristic. There are three sub-types of paste within the Lamula Group: (1) fine, with few or no tuff/lava inclusions (used for La Mula Black-on-orange, Interior-grooved and Exterior-brushed varieties); (2) with some intentional (?) tuff inclusions and (3) with concentrations of tuff/quartzite inclusions. Generally speaking, the larger the vessel, the larger the size and quantity are the inclusions. A buff variant is also present--probably a clay that has less carbon. Under the microscope, fragments of carbonized wood are visible. This may be what gives a blackish hue to the fired clay. It is not known yet whether this represents organic material naturally included within the clay or an intentional and very idiosyncratic temper addition.

1. Nondecorated or Plastic-Decorated Sherds

A. Nondecorated. Both nondecorated and decorated vessels have distinctive rim types. Some of the non-decorated shapes which are very diagnostic of this group also occur on sherds at the bottom of the Sitio Sierra site deposits (240 B.C.), pressed into the basal clay; they are: (1) excurved (outflared) to slightly incurved bowls with a fine brown paste (n=29); (2) tecomates or incurved bowls with brown paste (n=14) (cf. Figure 38u); (3) same as #2 but with more tuff inclusions (n=18) and (4) bevelled tecomates (rims=2, bevels=18). Other diagnostic shapes are: (5) thin-bodied vessels with strongly everted lips that are flattened on the top (n=8) (Figures 38k-m); this shape also occurs with a quartzy Sarigua Group paste and a grooved decoration on the flattened rim (Figures 38n,o, cf. Figure 38v); (6) thin-bodied vessels with exterior brushing--this rim type only occurs with a fine brown paste (n=41) (Figures 38p,q); (7) thin-walled incurved bowls--no brushing on exterior (n=51) (Figures 38r,s); (8) incurved bowls with thickened rims that have been flattened and bevelled on the interior neck (Figure 38t); (9) wide mouth collared jars, the commonest Lamula rim form--in an unweathered state the majority of these jars have burnished interior and exterior rims with a fine brown paste (Figure 38v) and (10) another collared jar with a more outcurved rim than #9 (cf. Figures 38x-z). A total of 1866 rim, lip, neck and body fragments have been recorded for the collared jar vessel shape. Two additional surface treatments can be identified on collared jars: (1) brown paste with tuff inclusions (n=674) and (2) fine brown paste with a blood-red slip applied to the collar (n=28) (cf. Ichon 1980:67-68). This red-slipped type is present in radiocarbon-dated, stratigraphic contexts (70S169E unit) at La Mula-Sarigua (discussed below).

B. Plastic Decorated. A distinctive Lamula Group vessel form and most unusual decoration has fine brown paste and interior-grooving on the rim. The vessels are slightly excurved or incurved bowls with concentric grooves on the interior of the vessels below the lip (n=72) (Figures 38z-bb, Plate 55p). This pottery is extremely well made. Intact surfaces are smoothed but not burnished. Rims are carefully finished. Vessel bodies below the rim are very thin (<4 mm on some examples). We should point out that this combination of shape and decoration may have its antecedent in the

Early Group vessel illustrated in Figure 37k (242S417E unit) which also has this decorative treatment (discussed above). The latter's paste, however, is coarser.

There are a few Lamula Group cylinder vessels. Most are decorated with appliques (Figure 39a); one is deeply incised (Figure 39e).

The Lamula Group displays a great variety of plastic decoration. Much of it appears on sherds found together in excavation unit 70S169E; in the following list those decorative attributes found in this unit will be marked with an asterisk. Lamula Group plastic decoration "styles" are: (1) linear incising* (Figures 38o, 39a, Plates 55e-k); (2) interior incising on rim* (Figures 38z-cc, Plate 55o-r); (3) undulating incising (Figures 39f,g); (4) multiple line incising* (Plate 55s,t); (5) cross-hatched incising*; (6) oblique incising (Plate 55u-x; (7) light incising* (Plate 55y-bb); (8) incising and punctation (Figure 39n, Plate 56a-e); (9) half-moon oblique slashing* (Figures 39h-j, Plate 56f-l); (10) linear shell-stamping (Plate 56m-r), (11) zoned shell-stamping* (Figures 39k-m); (12) stamping with multiple-pointed instrument* (Figures 39n,o, Plate 56s); (13) punctation (Figures 39p-r); (14) tear-drop punctation*; (15) oval punctation*; (16)

linear appliqued nubbins (Figure 39s, Plate 56t,u); (17) appliqued filleting (Figure 39t); (18) shell-stamped filleting* (Figure 39c, Plate 56v-w) and (19) patterned burnishing*.

2. Painted Wares

A. Lamula Black-on-orange. This is perhaps the most surprising of the La Mula-Sarigua ceramic types in that it shows that painted wares had attained a high degree of sophistication by the second half of the 1st millennium B.C. The slip is a distinctive orange which contrasts with the brown of the underlying paste. This type seems to be represented exclusively by a sub-globular vessel with a tall collar (collar width is about 20 cm; body width about 35 cm). Orange slip covers the interior and exterior of the collar. The collar is typically decorated on the exterior with vertical black lines running from the lip to the shoulder (Figures 40a-d, Plate 57a-g, [compare with Javillo Bichrome, Ichon 1980, Figure 13d]). The rim is set off from the body by a black line. The decoration on the body is sandwiched between circumferential black lines at the neck junction and at the waist. The sample:

1. rim fragments without decoration (n=98);

2. necks and collars with no black paint (n=42);

3. Black-on-orange bodies with no black paint (n=156);

4. bodies with black paint (n=43);

5. rim fragments with black paint (n=27);

6. neck fragments with black paint (n=26);

7. neck fragments recognizable by shoulder form, slip not preserved (n=58).

B. Buff-slipped variety. A small sample of the Lamula Black-painted type has a buff, as opposed to an orange slip. This could be an intermediate stage in the erosion of the orange slip (n=18).

Aristide Group (800 B.C.-?). All the La Mula-Sarigua material that has black-painted designs (usually on a red-slipped ground) stylistically belongs to the Aristide Group (as defined originally by Ladd [1964:154-184]). This group has a quartz-sand based paste which fires buff, rather than brown, when fully oxidized. Usually the vessels are extensively fire-clouded, the result of uneven and/or under-firing. Following Ladd (1964) and Cooke (1976, 1984) the Aristide Group sherds are divided into three "types" (Giron Polychrome, Escota Polychrome and Cocobo Interior-banded); each type is based on different shape attributes. The Giron type has a black-painted decoration on a flattened rim; Escota has a black-painted decoration on either a collared jar with a sub-globular body or an incurved bowl with an external bevel and Cocobo has a black-painted decoration on the bowl interior.

1. Giron type: (n=142)

A. Giron banded lip variety. All the recovered Giron type sherds display either Ladd's "Radial Banded" or "Circumbanded" painted decoration. Although, some of the eroded sherds probably also had a "Scalloped" painted decoration as well (n=17) (Figures 40e-j). It is important to note that some of the Giron banded lip shapes present at the site of Sitio Sierra (radiocarbon dated between 240 B.C. and A.D. 475) are not present at La Mula-Sarigua--for example, a rim which is enlarged both in and out. The "Cross-hatched" decoration is also absent at La Mula-Sarigua.

B. Probable Giron banded lip rims: slightly everted and incurved bowls with flat rims that probably had a radial or circumbanded design. Ninety-three of these specimens had quartz paste only; 32 had brown paste.

2. Escota type: (n=250?) two distinct vessel shapes are present: an incurved bowl and a globular-bodied vessel.

A. Incurved bowls with geometric decoration on the exterior, beneath the lip and above the bevel (n=5, Figure 41a). This bowl shape is common at Sitio Sierra in the earliest houses (25 B.C.-A.D. 245).

B. Globular-bodied vessels: this group of sherds represents sub-globular, collared vessels (Figures 41f,g) with Escota decoration and quartzy paste. The most complete example comes from unit 242S417E (870 B.C. and 790 B.C.) (Figures 41d,e,h). Another sherd from this latter unit has a slap-dash black line decoration on a fire-clouded buff paste (Figure 41c).

C. Undefined vessel shape: body sherds with Escota decoration on a quartzy paste (n=28) (Figures 41i,j).

In addition to sherds with distinct vessel shapes and painted decoration, a number of red-slipped rims have been classified in the type Escota:

1. Collars from collared jars with quartz paste (n=23);

2. Necks from #1 above (n=10);

3. Rims with no slip left, due to weathering (n=65);

4. Rims from plates and bowls (n=20) (cf. Figures 41k,l).

A second group of rims from incurved bowls with exterior bevels and which have the quartz paste typical of the Aristide Group are also probably of the Escota type. They are:

1. Bevels only (n=38) (see Figures 41m-p for shapes);

2. Rims and bevels (n=50);

3. Rims of this type but without bevels (n=11).

A third group of rim fragments from incurved bowls displays an attribute (rim with an extension) typical of both the Aristide Group (Giron banded lip type) and the Tonosi Group (discussed below). These rims are probably all from effigy vessels. On the basis of paste, fragments can be assigned to either of two types:

1. Giron Polychrome (with quartz paste) (n=18);

2. Tonosí (with brown paste) (n=14) (cf. Ichon 1980).

3. Cocobo type: only two examples of the Cocobo Interior-banded type were recovered from La Mula-Sarigua.

A. One (Figure 41q) has a black decoration on a red ground. The other has a red exterior.

B. Cocobo type plates without surfaces and with quartz paste (n=17) (Figures 41k,l).

4. 70S169E UNIT (240 B.C.): this radiocarbon-dated, excavated unit is useful for determining the stages of the late Lamula/Aristide Groups. Many of the plastic-decorated sherds recovered here are illustrated (described above in the Lamula Plastic Decorated section and marked with an asterisk). These all have Lamula Group brown paste. The only sherds which have quartz paste are those of the Aristide Group. The sample is comprised of plastic-

Pg 165 missing from this copy

really ± 300 B.C.-A.D. 100.

1. Tonosi Polychrome: rims (n=8); bodies (n=1); necks (n=2).

2. "La Bernardina": rims with eroded decoration patterns (n=8).

3. White slipped sherds: these could be either Tonosi polychrome sherds or the buff variety of Lamula Black-on-orange slipped (n=9, 5 of which are from the same vessel).

Sarigua Group (??500 B.C.-??). At La Mula-Sarigua, there is a host of plastic-decorated designs and rim shapes that occur at Sitio Sierra on sherds found only at the very bottom of the site's deposits, or not at all. These display either Lamula Group paste or a very quartzy paste that fires buff. Some rim forms and designs, which use a heavy quartz paste, have tentatively been separated out and assigned to the Sarigua Group. These sherds are probably broadly contemporary with those of the Lamula, Tonosi and Aristide Group and might indicate an instance of inter-village specialization. They include:

1. Plastic-decorated sherds with heavy quartz inclusions and buff paste (n=12) (Figures 42f-i, Plate 58a-j).

2. Everted rims with plastic decoration (Figures 42j-l, Plate 58i). This is a very distinctive decoration; it is found on sherds scattered throughout the Sitio Sierra features and at the site of Sitio Conte (Lothrop 1942:

170). It has the typical 1st millennium B.C. vessel form, heavy rim and thin body; but the paste on the examples with the above illustrated rim type is quartzy or intermediate, as opposed to fine (n=15).

3. Down-turned rims on incurved bowls (Figures 42n,o). These rims are found in the bottom-most structures at Sitio Sierra; have a quartz paste (n=79).

4. Thin-walled vessel with flattened rim thickened to the interior and exterior (Figure 42p).

5. Incurved bowls with exterior bevelled rims, very thin body below the rim (Figure 42q).

6. Incurved bowls (Figure 42r).

7. Cylindrical vessel (Plate 58i).

<u>Sarigua/Aristide Group</u>:

1. Tecomates or incurved bowls with rounded lips and quartz paste (thin walled) (n=27).

2. Tecomates or incurved bowls with squared-off lips; quartz paste (n=29).

3. Tecomates with rounded lips (thick-walled); quartz paste (n=44).

<u>Conte Group</u> (A.D. 500-800). This material includes the classic Period V types--Conte Red and Guacimo Red-on-white slip (Ladd 1964). Three rim forms and one slip class are indicative of this period:

1. Droop-lipped plates (n=3) (cf. Figure 42s).

2. Flat rims (n=6) (cf. Figure 42t).

3. Grooved rims (n=4) (cf. Figures 42u,v).

4. Type Guacimo Red-on-white slipped (n=5).

Period VI-VII Group (A.D. 800-1500). Late occupation ceramics at La Mula-Sarigua have a clay that oxidizes to a bright orange color and incorporates the following tempers: (1) a crushed, greenish-brown metamorphic rock or (2) a mixed grit with hematite. Vessels forms are:

1. Collared jar rims (n=433) (Figures 42w-y).

2. Plates and bowls (n=24) (Figure 42z).

3. Tecomates (n=58) (Figures 42aa,bb) that are characteristic of "Delgado Red" type described by Ladd (1964).

Cylindrical Vessels: cylindrical vessels are characteristic of pre-A.D. 500 vessel shapes. At La Mula-Sarigua, they are made with Lamula Group fine brown paste and Aristide/Sarigua Groups quartzy paste and an intermediate buff paste. For example, Figure 39a has quartz paste; Figures 39b,c fine brown paste; and Figure 39d oxidized buff paste. Until the La Mula-Sarigua ceramic analysis has been completed and the results compared with the Sitio Sierra sample, it is difficult to divide these vessels into chronological groupings.

Discussion

Existing ceramic assemblages from the central region of Panama have been largely classified on the basis of surface treatment (painted and plastic decorations) and vessel shape, rather than on technological attributes (firing method, paste and temper). Nonetheless, Cooke (1972, personal communication) has acknowledged the fact that a combination of these characteristics is necessary in developing meaningful taxonomic systems. For this reason, he is presently reclassifying the regional assemblages on the basis of a combination of these criteria.

As the regional assemblages are being reclassified, and as a large percentage of the La Mula-Sarigua ceramic assemblage has poorly preserved surfaces, particularly those which might have contained painted decorations, it has been necessary to devise an interim taxonomic system (discussed in detail above) which would allow us to extract the greatest amount of spatial/temporal information possible. This interim scheme incorporates vessel shape, surface treatment (where present) and technological attributes.

The highest order considered in this scheme is the group (defined above). A minimum of nine groups has been described for the La Mula-Sarigua sample. These are: Monagrillo, Aguadulce-Ladrones, Early, Lamula, Aristide, Sarigua, Tonosi, Conte and Period VI-VII. Those characteristics which have been used to determine each group follow; (see Table 36 for a schematic simplification).

Monagrillo has been categorized (using existing nomenclature) on the basis of identical vessel shapes, rim forms, paste, absence of surface decoration and low firing temperatures which produce brownish, fire-clouded surfaces and fire cores; clay types vary. In contrast, sherds given the name Aguadulce-Ladrones (tentative new group) are distinguishable by the presence of similar surface treatments (crude irregular incisions), under-fired quartzy paste and brownish-black or buff (when oxidized) surfaces. A tentative second new group, Early, has been delineated based on similar rim profiles (flattened) and dirty clay pastes with grit and quartzite inclusions which fire to a yellowish color. At least one type also has large pieces of tuff and burnt oyster intentionally included. The paste common to this group is neither that of the earlier under-fired quartz, nor that of the later fine brown Lamula Group.

Lamula (new group) can be separated from all groups above on the basis of paste, temper, vessel shapes and surface decorations. Clay is often temperless and brown to brown-orange when oxidized; occasionally a temper of white tuff (often with crushed quartzite) has been added for strengthening the vessel. In addition to a greater variety of distinctive vessel shapes, this group is represented by greater diversity in surface treatments (painted, plastically-wrought and incised/excised).

Following existing nomenclature, an Aristide Group composed of three types has been recognized at La Mula-Sarigua. Each type uses similar polychrome painted geometric designs and/or particular shapes. In general, this group can be characterized by quartz-sand paste which fires buff, rather than brown, when fully oxidized; the vessels are generally extensively fire-clouded.

Tonosi (composed of two types, each of which combines distinctive geometric designs with vessel shapes) follows existing nomenclature. While its paste is similar to that of Lamula, it is darker brown when oxidized and appears to have more carbon included. This group can be discriminated further from Lamula in terms of rim shapes, body shapes and/or creamy white slip.

The group of Sarigua (existing nomenclature) can be segregated from all above on the basis of rim shape (rounded or squared-off lips), plastic decorations and heavy quartz paste.

Another formerly defined unit, Conte, can be isolated based on rim forms (droop-lipped, flat and grooved) and one slip class (red-on-white).

Because the emphasis of the present study has been on the 1st millennium B.C., we have combined Macaracas, Parita and El Hatillo and called it Period VI-VII Group. In addition to distinctive vessel shapes (collared jars, plates, bowls and tecomates) and painted decorations, this group can be identified by clays which oxidize to a bright orange and by two types of temper, i.e., a crushed, greenish-brown metamorphic rock and a mixed grit with hematite.

Table 36. A Summarization of Criteria Used To Define Groups.

	Form					
Group	Vessel	Rim	Surface Treatment	Paste	Temper	Firing
Monagrillo	X	X		X		X
Aguadulce-Ladrones			X	X		X
Early		X		X	X	
Lamula	X	X	X	X	X	
Aristide	X	X	X	X		X
Tonosi	X	X	X	X		
Sarigua		X	X	X		
Conte		X	X			
VI-VII	X		X		X	

An examination of stratigraphic and/or radiocarbon determinations associated with each group suggests the following chronological arrangement (Table 37):

Table 37. Interim Sequence of Diagnostic Ceramics on the Basis of La Mula-Sarigua Analysis.

Diagnostic Ceramic Group	Dates
Monagrillo	2800-1200 B.C.
Aguadulce-Ladrones	1200-800 B.C.??
Early	± 800 B.C.??
Lamula	?500-1 B.C.
Aristide	800 B.C.-A.D. 500??
Tonosi	?400 B.C.-A.D. 200
Sarigua	?500 B.C.-??
Conte	A.D. 500-800
Period VI-VII	A.D. 800-1500

It is clear from this sequence that Early, Lamula, Aristide, Tonosi and Sarigua Groups are broadly contemporaneous; Early begins a bit earlier. This seems to indicate that different kinds of ceramics were being made from different clay sources;

the implications of this are to be discussed in Chapter X.

On the basis of the above arrangement, a revision of the traditional periodization scheme for the central region of Panama is necessary (compare Tables 37 and 38).

Table 38. Traditional Ceramic Periodization for the Central Region of Panama (Cooke and Ranere 1984:24).

Period	Description	Diagnostic Ceramic	Dates
III A	Early Ceramic A	Monagrillo complex	2500-1000 B.C.
III B	Early Ceramic B	Sarigua-Guacamayo	1000-300 B.C.
IV	Black-painted & 3-colored pottery	Aristide & Tonosi	300 B.C.-A.D. 500
V	Polychrome pottery	Conte Polychrome	A.D. 500-700
VI	Polychrome pottery	Macaracas	A.D. 700-1100
VII A	Polychrome pottery	Parita Polychrome	A.D. 1100 -?
VII B	Polychrome pottery	El Hatillo Polychrome	A.D. 1300-1520

Heretofore, Periods III (1000-200 B.C.) and IV (200 B.C.-A.D. 500) have been separated by the presence of linear-zoned plastic decorations in the former period and black-line painting (Aristide) in the latter. At La Mula-Sarigua it is clear that the two not only appeared together but that they persisted side-by-side until the advent of Conte around A.D. 500.

Further, Aristide from La Mula-Sarigua overlaps with identical material from the bottom features at Sitio Sierra. The decorative and morphological types represented at La Mula-Sarigua occur at Sitio Sierra with radiocarbon dates of 240 B.C., 65 B.C., A.D. 115 and A.D. 235 (X = A.D. 12). The only recognizable shape/decoration types visible at La Mula-Sarigua are: (1) Giron

Banded lip sherds with Radial Banded or Circumbanded decorations and flattened rims; and (2) Escota sherds with globular and sub-globular shapes. (3) The Cocobo Interior-banded type is limited to two sherds. This latter type would seem to appear late in the record (? after A.D. 1). Hence, the distribution of the Escota and Giron Banded Lip types at La Mula-Sarigua indicates both a greater antiquity than formerly believed and contemporaneity with Lamula; an outer date of ca. 1 B.C. is, therefore, not out of line for the Lamula Group.

The spatial/temporal boundaries of La Mula-Sarigua have been determined on the basis of the interim sequence outlined in this chapter (Chapter IX).

Endnotes

1. The contents of this chapter (analysis and numerous communications with the present author) can be attributed to the time and efforts of Richard G. Cooke. Thanks to him need to go beyond manuscript acknowledgements. I can only hope that I have not distorted the facts too badly.

CHAPTER VIII

ORGANIC REMAINS

Introduction

Fauna is considerably more abundant than flora at La Mula-Sarigua. The former is represented by shell and bone (human and non-human); the latter is present in the form of macrobotanical remains, pollen and phytoliths.[1] Presumably, the latter are less abundant due, in part, to poor preservation, (a point which will be elaborated on later).

The non-human faunal remains have been analyzed to determine: (1) family and species (where possible), (2) skeletal elements, (3) numbers and/or weights and percentages, (4) ecology and (5) cultural modifications, e.g., shell tools, bone beads, etc. Floral samples were examined to verify: (1) the presence/absence of economic and/or wild plants and (2) family and species (where possible). Human remains have been investigated to determine: (1) sex, (2) age, (3) pathologies and (4) diet.

As the analytical procedures, quantity and quality of materials and completion of analyses are highly uneven and incomplete, each will be discussed separately.

Fauna

Faunal remains come from: (1) intensively collected (1 sq m units) surface features, e.g., shellmiddens and trash dumps; (2)

excavated units whose residues have been sieved through 1/4" and 1/8" mesh and (3) excavated bulk (particularly subsurface features) and/or column samples whose sediments have been processed with a flotation device; the residues from the latter samples have been further sieved through 1/4", 1/8" and 1/16" mesh.

Method of Analysis. Faunal remains were initially divided into two broad categories, shell and bone. The bone was further separated into two sub-categories: (1) fish, crab and shrimp and (2) non-fish, such as mammal, bird, reptile, frog/toad and unidentified bits.

All specimens within all categories were (where possible) identified to family and species level and skeletal element (for bone) using modern and/or archaeological comparative skeletal and shell collections from Central Panama which have been compiled by PSM personnel. Each species and/or part was counted, and/or weighed with a beam balance scale. Ecology was determined by personal observations, by reference to the literature, e.g., Sea Shells of Tropical West America (Keen 1971), as well as to the results of ethnographic work (e.g., Bennett 1968, Bort personal communication, Cooke personal communication). The identification of material thought to be culturally modified was confirmed or negated by comparing it to similar artifactual materials from other archaeological sites, such as Cerro Mangote (Cooke, Ranere and Hansell 1980, Hansell 1987).

Taxonomy. Checklists and percentages by taxa by species for the entire site (1st millennium B.C. contexts only) occur in Tables 39-42.[2]

Table 39. Checklist of Shell Taxa (Percentage X Weight).

Bivalves	
Anadara grandis (4.9%)	Mactra fonsecana (.1%)
Anadara similis*	Mulinia pallida*
Anadara tuberculosa (.8%)	Ostrea spp (61.8%)
Cardita affinis*	Pitar tortuosus (.1%)
Cardita laticostata*	Polimesoda maritima*
Chione spp*	Polymesoda inflata*
Chione subrugosa (4.0%)	Protothaca asperrima (4.6%)
Corbula spp*	Tellina laceridens (.1%)
Donax asper (.1%)	Tivela byronensis (1.4%)
Dosinia spp*	Trachycardium senticosum*
Dosinia dunkerii (.4%)	
Gastropods	
Cerithidea valida (.1%)	Natica unifasciata (7.6%)
Crepidula marginilis*	Natica unifasciata(operculum)*
Fasciolaria granosa (3.1%)	Polinices otis*
Hexaplex regius*	Polinices uber*
Littorina varia*	Prunum sapotilla*
Malea ringens (3.6%)	Terebra robusta*
Marginillidae*	Thais biserialis (.4%)
Melongena patula (1.8%)	Thais kiosquiformis (3.4%)
Nassarius luteostoma*	
Unidentified (1.6%)	

Table 40. Checklist of Non-terrestrial, Non-shell, Faunal Taxa (Percentage X Number).

Marine/Estuarine Fish	
Ariidae (17.7%)	Pomadasyidae*
Batrachoididae*	Pristis (.9%)
Belonidae*	Sciaenidae (2.0%)
Carangidae (3.1%)	Scombridae*
Carcharhinidae*	Serranidae*
Centropomidae*	Shark (3.7%)
Clupeidae*	Sphyraenidae (.9%)
Lobotidae*	Tetraodontidae (10.2%)
Unidentified (60.9%)	
Freshwater Species	
Chrysemys*	Macrobrachium*
Hoplias*	
Other Aquatic Fauna	
Bufo marinus*	Kinosternon*
Callinectes*	Sea turtle and/or crocidile*
Cardisoma*	

Table 41. Checklist of Terrestrial, Non-human, Faunal Taxa (Percentage X Number).

Mammalian	
Dayspus*	Odocoileus virginianus (9.0%)
Liomys?*	
Other - Unidentified to Species	
Artiodactyl*	Reptile*
Bird*	Rodents*
Lizard*	

Table 42. Other (Percentage X Number).

Homo Sapiens sapiens (36.0%)
Unidentified mammal (23.0%)
Unidentified non-fish (32.0%)

Although the above percentages give us some gross notion of relative importance of specific species within a category,[3] e.g., shellfish or fish, it tells us nothing about relative importance between categories, e.g., shellfish versus fish versus terrestrial fauna, particularly in terms of usable meat to the subsistence economy. In the present analysis, we have determined total biomass weight for fish and terrestrial fauna following procedures in Wing and Brown (1979:128) and for shellfish following Parmalee and Klippel (1974). Calculations have been determined for these classes from one controlled excavated sample (70S169E) which contains a radiocarbon determination of 240 ± 90 B.C. (Beta-18863) (Table 43). (See Appendix C, Table 112, for raw data).

Table 43. Percentages of Number of Individual Specimens and Biomass for Excavation Unit 70S169E.

	Fish	Non-Aquatic Fauna	Shellfish
% Specimens	86% (N=5101)	13.4% (N=790)	-
% Biomass	61.6% (4.5 kg)	23.0% (1.7 kg)	15.0% (1.1 kg)

Clearly, fish is comparatively more important than are terrestrial fauna or shellfish. A combination of fish and shellfish (76.6%), however, indicates that aquatic resources are the most important faunal contribution to the diet.

Ecology and Capturing Techniques of Aquatic Fauna. Without question, the site's faunal assemblage is overwhelming confined to shell and fish forms. All identifiable molluscs are from estuaries (brackish water) and/or shallow-water marine habitats of the intertidal zone; the latter zone is that area along the shore which extends from the low tide to the high tide position. The predominant species (Ostrea spp. [probably Crassostrea corteziensis]) is most commonly found in low-saline waters on mud bars or clinging to mangrove roots or dead shells. Also common in the sample are Anadara grandis, Anadara tuberculosa, Chione subrugosa, Fasciolaria granosa, Malea ringens, Melongena patula, Natica unifasiata, Protothaca asperrima, Thais kiosquiformis and Tivela byronensis; all are known to occur in some numbers on mud flats, under rocky ledges and/or mangrove mud environments. Given that all the molluscan species are indicative of a shallow-water and/or intertidal habitats, they could be easily gathered by hand or removed from their substrates with a simple digging stick or chisel and rock (Greengo 1952, 1961, Noe-Nygaard 1967, Olsson 1961).

The commonest fish in the sample (Ariidae [sea-cats] and Tetraodontidae [puffers]) are in-shore taxa with a tolerance for waters of low salinity. Also present, albeit in smaller numbers, are Carcharhinidae (sharks) which move in-shore and into river mouths; Carangidae (small jacks) which come into river mouths in shoals; and (rarely) Clupeidae (herrings) which come into river mouths at certain times of the year. All of the foregoing aquatic locations are prevalent near mangroves and/or at river mouths, such as the Parita. The only taxa present which prefers deeper waters is Sciaenidae (corvinas). Nonetheless, given the proximity of the shore to La Mula-Sarigua at the peak of occupation (see Figures 5a-c for a reconstruction), it is not unreasonable to assume that the sea lapped up against a rocky promontory to the north of the site; an ideal environment for corvina. In other words, all species captured were available immediately adjacent to the site, and could be seized with hook and line, traps and/or nets, rather than in the open seas with canoes (Ranere, Cooke and Hansell 1980).

There are no freshwater forms in the sample except for possibly a vertebra tentatively identified as Hoplias (fish), and a dactyl (?) of Macrobrachium (a large freshwater shrimp which tolerates brackish water).

Preservation and Taxonomy of Non-Shell Fauna. Pertinent to the presence/absence of specific non-shell fauna is differential preservation. For example, particular fish beaks and otoliths (e.g., Tetraodontidae) are very tough and hence are likely to survive over smaller, friable skeletal parts; larger, thicker skeletal parts will also differentially survive over these latter parts. These conditions clearly skew the relative percentages of faunal material (fish versus terrestrial fauna) in favor of fish; and likewise skew the relative percentages of fish identified (Ariids versus Clupeids [discussed below]).

Relative to samples collected from the recent PSM regional survey, and from previous excavations at the sites of Cerro Mangote, Aguadulce, Monagrillo and Sitio Sierra, the La Mula-Sarigua non-shell faunal sample presents a number of idiosyncracies.

Fish: Cranial Parts. The fish sample is quite rich in forms but depauperate in anatomical parts--a phenomenon which must be due to adverse site preservation conditions, such as acidic soils. For example, in both the 1/4" and 1/8" samples, there do not appear to be any identifiable fragments of premaxillae, dentaries or hyomandibulars (the best diagnostics), except sea-cats, puffers (which have extremely tough beaks) and several pieces of very large grouper (Serranidae) premaxillae. In fact, there are very few identifiable non-vertebral fragments, such as cranial, other than those of the traditional easily-identifiables, i.e., sea-cats, puffer and grouper, toadfish (Batrachoididae) and jacks (Carangidae) pterygiophores and articulars.

Otoliths. Fortunately, otoliths (being hard) survive well in these conditions and there are quite a few in the La Mula-Sarigua sample. In the 1/4" and 1/8" samples, sea-cats and corvinas are the dominant forms. In a number of cases, these can be identified to species or "species groups." For example, in the sea-cats, it is easy to distinguish between "cominata" otoliths and those of the "bagres," "barbudos," and "congos."[4] The corvina otoliths are sometimes identifiable to species and usually to genus; this is presently being worked out. Most of the corvina sample at La Mula-Sarigua is from large specimens of the genus Cynoscion. At present there are at least six species of this genus in the Bay of Parita--stolzanni, reticulatus, phoxocephalus, squamipinnis, leuciscus and albus.

In the 1/8" and 1/16" samples there are a number of tiny otoliths whose ultimate identification will compensate for the lack of identifiable cranial parts for small fish. It is important to keep in mind when interpreting the otolith record that not all fish have macroscopically identifiable otoliths and that others have tiny, fragile elements. For example, the puffers, whose beaks are very common in the La Mula-Sarigua sample, do not have otoliths at all. Carangidae (jacks, cojinuas, caballitos, etc.) have thin, friable and small otoliths and are rarely seen preserved in archaeological samples.

Vertebrae. The above problem posed by the cranial parts makes the identification of vertebrae an important item of the La Mula-Sarigua fish record. Some families, such as Carangidae, Sphyraenidae (barracudas), some Pomadasyids (puercas) and the Ariidae are readily identified. Nonetheless, the list as it stands should be considered as very preliminary. A family-based, general classification for vertebrae, using the atlas/axis and caudals for closer identifications, is presently under development (Cooke personal communication).

As is the case with all the Parita Bay archaeological samples, there is a notable absence of <u>Scombridae</u> (sierras), <u>Thunnidae</u> (bonito) and <u>Carangidae</u> (pelagic jacks).

<u>Non-Fish</u>. The mammalian sample is very depauperate in species. Aside from <u>Odocoileus</u> (white-tailed deer) whose bones are ubiquitous, the only other non-human mammals are rodents (mice and rats) and <u>Dasypus</u> (armadillo), the latter represented by few (modern?) scutes only.

There are, likewise, surprisingly few reptile fragments. The scarcity of turtle carapace fragments is equally puzzling; these are virtually indestructible and easily recognizable because of their internal structure. There are a few bits of phalanges which are from sea turtles and/or crocidiles. There is only one frog bone--a <u>Bufo marinus</u> humerus. Iguanids are limited to a few caudal vertebrae.

<u>Cultural Modifications</u>. Although the faunal assemblage has not been systematically examined as a non-food resource, modification is suggested by wear-patterns on small numbers of at least three of the molluscan species (<u>Anadara grandis</u>, <u>Fasciolaria granosa</u> and <u>Hexaplex regius</u>), on 1 antler tine (<u>Odocoileus virginianus</u>), one fish (shark) vertebra, and possibly one mammal bone (<u>Odocoileus virginianus</u>). The significance of each is discussed in Chapter IX.

Flora

Macrobotanical remains, i.e., wood charcoal and carbonized nut fragments, have been collected from: (1) sieved vertical excavations and (2) excavated bulk samples (particularly subsurface features) and/or column samples whose sediments have been processed with a flotation device and whose residues have been further sieved through 1/4", 1/8" and 1/16" mesh. Microbotanical remains, i.e., pollen and phytoliths, have been extracted from: (1) excavated bulk and/or column sediment samples, (2) sediments collected from in and around subsurface features and (3) sediment cores taken in the alvina just in front of the site.

Methods of Analysis. Microbotanical remains have been identified to family and species, where possible, using comparative collections and preliminary "keys" established by Clary (personal communication) and Piperno (personal communication). The macro remains are very few and limited to wood charcoal and one palm nut fragment; taxonomic classifications have not focused, therefore, on these remains.

Taxonomy. Pollen taxa occur in Table 44 and phytolith forms in Table 45.

Table 44. Pollen Taxa. (# in Core Only).

Avicennia#	Malvaceae
Cheno-Am	Moraceae#
Conocarpus#	Myrica?#
Convolvulacaeae?	Palmae (chrysophila?)#
Croton-type	Palmae (socratea?)#
Cyperaceae#	Pinus
Danea-type#	Piperales
E-R-A	Rhizophora#
Euphorbiaceae	Spores
Gramineae	Tricolporate
H.S. Compositae	Trilete Spores
Jatropha	Tourneforta?
Leguminosae	Typha?#
Lycopodium	Urticales
Malphigiaceae	Zea Mays
Unidentified	

Table 45. Phytolith Taxa (Core Data Unavailable).

Compositae	Curcurbita spp.
Maize (spp. ?)	
Unidentified	

In general, pollen and phytolith content was very low throughout all samples. Much of the pollen identified from the core represents mangrove vegetation. The only economic plant recognized beyond the family level is that of Zea mays; this has been found in both the core and in one 1st millennium B.C. feature.

The predominant identifiable phytolith form was Compositae; also present, albeit in small numbers, were phytoliths from

Curcurbita spp. (squash), cross-shaped forms of sizes too small to classify as maize, seeds and cross-shaped forms from maize of a probable primitive race. This latter form is found only in earlier contexts, such as Cueva de los Ladrones and Aguadulce, and not in later contexts, such as Sitio Sierra. Further, this primitive form has been isolated from Chalco teosinte but not from modern races of maize.

Particularly significant in the phytolith record of La Mula-Sarigua is the presence of Cucurbita found in association with Lamula Group ceramics and a radiocarbon date of 270 ± 70 B.C. The earliest date for squash prior to its recognition at La Mula-Sarigua had been from Sitio Sierra in association with house floors dating to 65-25 B.C.

Preservation and Taxonomy. Presumably phytolith content was low at La Mula-Sarigua due to poor preservation. Piperno (1985:255) notes that soils with large amounts of shell are "inimical environments for phytolith preservation." Such contexts contain high pH values--values which probably dissolve phytoliths. Many of the soil samples from La Mula-Sarigua contained innordinate amounts of shell.

Human Remains

Human skeletal material has been recovered from: (1) subsurface features (formal burials and trash pits) and (2) highly eroded surface features. In general, the human bone is in poor shape and often consists of masses of eroded long bone fragments. This is no doubt the result of adverse site preservation conditions (discussed above).

Method of Analysis. Remains have been visually examined for skeletal element, sex, age and pathologies (Norr personal communication, 1988). Stable carbon and nitrogen isotope ratios have been determined in order to assess the contribution of marine fauna, maize and/or terrestrial organisms to the populations diet. An attempt was made to analyze all human remains, but only 5 individuals had gas yields large enough and carbon:nitrogen ratios adequate for analyzing stable isotope ratios (Norr, personal communication). The following will, therefore, focus primarily on those 5 specimens.

Sex, Age and Pathology. The five specimens above were all adults; only one long bone fragment from the larger osteological sample was that of an infant. Rather than a true representation of the age structure of the La Mula-Sarigua population, these results suggest differential preservation of larger, thicker bones (discussed earlier). Sex was undeterminable for the entire sample. None exhibited pathologies as defined by Larsen (1987).

Chemical Analysis. On the basis of Norr (1983) and Norr and Coleman (1982), the ratio of stable carbon isotopes (13C/12C) or stable nitrogen isotopes (15N/14N) in bone collagen can be directly related to the ratio of stable carbon or nitrogen isotopes in the individual's diet. Diets rich in marine fauna are expressed by high values of both 13C/12C (defined as δ13C) and 15N/14N (δ15N); those diets abundant in terrestrial (C3 pathway) organisms display relatively lower values of both. Compared to marine resources, diets luxuriant in cultivated plants, such as maize, sorghum, sugar cane and millet (C4 pathway), exhibit higher 13C/12C values and lower 15N/14N values (see Figure 43 for a depiction of theoretical values).

From the present 5 samples, Norr (personal communication, 1988) has extracted bone collagen and determined carbon and nitrogen values for skeletal material from 3 buried contexts and from 2 surface settings (Table 46).

Table 46. Nitrogen and Carbon Values for the La Mula-Sarigua Skeletal Sample, N=5.

Sample #	δ15N o/oo	δ13C o/oo
626	+12.6	-10.3
11022	+12.2	-10.9
14	+11.7	-10.4
829 (sfe)	+11.0	-13.7
930 (sfe)	+10.1	-13.0

Plotting the distribution of these values against the theoretical values is useful for interpretation (Figure 43).[3] The 5 specimens neatly cluster into two groups; one group consists of 3 buried individuals found in 1st millennium B.C. contexts (one burial is broadly associated with a radiocarbon determination of 320 $\pm$ 90 B.C. [Beta-12729]), and one group consists of 2 individuals located on the surface in contexts which include (but are not limited to) 1st millennium B.C. materials. More specifically, this latter context also encompasses ceramics from Conte and Period VI-VII Groups. (See Chapters VII and IX for a discussion on ceramic groups).

Values for the buried cluster indicate that 1st millennium B.C. inhabitants were consuming a combination of maize and marine foodstuffs. This should not be surprising given the tremendous numbers of marine organisms in the site's deposits, as well as the presence of maize pollen and phytoliths. In contrast, values for the surface cluster suggest that these individuals (post A.D. 500 ?) ingested less maize and marine resources than cluster #1, and perhaps more C3 (terrestrial) organisms. Alternative explanations are: (1) extreme surface weathering may have altered the collagen despite good ratio values or (2) these individuals were consuming a combination of C3/C4/marine resources (Norr, personal communication).

Summary

The major contributions of the organic analyses are to interpretations of resources and environments exploited, methods of capture, diet and health status of La Mula-Sarigua residents during the 1st millennium B.C. Interpretations are discussed in the following Chapter (IX) and reconstructions in Chapter X.

Endnotes

1. A number of PSM personnel are responsible for the analyses of organic remains. By far, the greatest contribution came from Richard Cooke. He oversaw the initial separation process of the faunal remains and, ultimately, made final species identifications and quantifications on the bone (non-human) samples. Lynette Norr was responsible for the analyses of human remains. Pollen identifications were made by Karen Husum Clary; phytoliths by Dolores Piperno.

2. An asterisk (*) following a species means that the sample represents less than .1% of that taxa.

3. A common method of estimating the representation of animal species is to calculate MNI (minimum # of individuals). This method is contingent upon the recognition of identifiable elements. This method is meaningless for the La Mula-Sarigua sample as there are few identifiable elements.

4. At present, Cooke is working with specialists from the Smithsonian Tropical Research Institute, Panama, in order to refine the taxonomic identifications of tropical fish species in general, and the sea-cats specifically. The sea-cat list as it now stands contains common names; e.g., the fish locally called "barbudo azul" is very easy to distinguish on the basis of virtually all the cranial parts and the otoliths, provided that the latter do not have eroded edges. More than likely "barbudo azul" is <u>Felichtys pinnimaculatus</u> and "cominata" <u>Netuma platypogon</u>.

Cooke's work with the above specialists and with the archaeological otolith samples suggests that present taxonomies of <u>Ariidae</u> (sea-cats) that are based only on external characteristics might be erroneous (personal communication).

5. In Norr and Coleman (1982), $\delta^{13}C$ values range from -39 o/oo to--21 o/oo (mean = -27 o/oo) for C3 plants; $\delta^{13}C$ values range from -20 o/oo to -8 o/oo (mean = -11 o/oo) for C4 plants. Marine fauna have $\delta^{13}C$ values ranging from -8.7 o/oo to -18.0 o/oo (mean of -15 o/oo for invertebrates and -13 o/oo for vertebrates).

$\delta^{15}N$ values range from +15. o/oo to +20. o/oo for marine materials, and +8. o/oo to +10. o/oo for terrestrial matter.

CHAPTER IX

INTERPRETATIONS

Introduction

The data necessary, although perhaps not sufficient, for interpreting socioeconomic structures, particularly those in central Panamanian communities during the 1st millennium B.C., and specifically those at La Mula-Sarigua, have been analyzed in Chapters VI-VIII. This chapter considers the documentation of socioeconomic structures as a result of the foregoing analyses; the following chapter (X) seeks to describe and explain changes in the forms of these structures.

Currently, the above structures are documented through an analysis and interpretation of baseline data collected on the following site characteristics: (1) site size, (2) site chronology, (3) internal spatial plan (activity areas, features, domestic and public space, and burials [where possible]), (4) resources utilized (location, density and seasonal availability [if applicable]), (5) goods produced and (6) technology. Each of these aspects are considered below in some detail.

Chronology and Technology

There are presently 7 radiocarbon dates on shell and carbon collected from stratified contexts associated with diagnostic ceramics (and in one case with diagnostic lithics) from La Mula-Sarigua. The dates are: 870 ± 50 B.C. (Beta-6016), 790 ± 60 B.C.

(Beta-21898), 390 ± 75 B.C. (Beta-12931), 320 ± 90 B.C. (Beta-12729), 270 ± 70 B.C. (Beta-12728), 240 ± 90 B.C. (Beta-18863) and 20 ± 45 B.C. (SI-5689); shell dates have been C13/12 corrected.[1] These associations have provided absolute dates for the tentative on-site ceramic and lithic typological classifications. Such a development has been essential for the temporal placement and association of the enormous amount of surface materials gathered.

The artifact classifications, however, have not been developed in a void; they have, in part, been made possible by comparing on-site to regional ceramic and/or lithic taxonomies which have been established by using both relative and absolute dating techniques. Relative dates have been based on seriation and stratigraphy; absolute dates have been based on C-14 determinations of charcoal and/or shell associated with diagnostics from stratigraphic excavations.

In general, there is much greater variety in ceramic and lithic assemblages at La Mula-Sarigua than at sites which predate 1000 B.C. For example, the Monagrillo ceramics found at earlier sites are represented by very few vessel shapes, lack appendages and are rarely decorated (Cooke 1976, Willey and McGimsey 1954). During the 1st millennium B.C. there is a dramatic change in the ceramic inventory with an increase in vessel forms, the appearance of appendages, a greater variety in the interior and exterior treatment of vessels, and in pastes and temper. Based on the analysis presented in Chapter VII, the number of 1st millennium B.C. diagnostic sherds recovered from La Mula-Sarigua far exceed those of other time periods (Table 47). The majority belong to a newly-defined Lamula Group. This Group is associated with 5 radiocarbon dates which range between 390 B.C. and 20 B.C. Other 1st millennium B.C. ceramic Groups present at La Mula-Sarigua include decorative techniques which: (1) have not, heretofore, been described for earlier periods (e.g., Aguadulce-Ladrones [ca. 1200-800 B.C.] and Early [associated with dates of 870 B.C. and 790 B.C.]); (2) are either extremely rare or absent from sites which post-date the 1st millennium B.C. (Sarigua [?500 B.C.-?]) or (3) have not known to be contemporaneous (Aristide, Tonosi and Sarigua). Of particular interest is the association of Aristide (black-line painting) with dates of 870 and 790 B.C. This discovery is significant because formerly Aristide ceramics were thought to be the chronological marker for the 200 B.C.-A.D. 500 period (cf. Cooke 1984, Cooke and Ranere 1984).

Although quantitatively less numerous than those from before the christian era, post-1st millennium B.C. ceramics are represented at La Mula-Sarigua by Conte and Period VI-VII Groups (A.D. 500-800 and A.D. 800-1500 respectively).

Table 47. Percentage of Sherds by Ceramic Group.

Group	Percent
Monagrillo	.1%
Aguadulce-Ladrones	.3%
Early	.9%
Lamula	71.0%
Aristide	7.7%
Sarigua	5.2%
Tonosi	1.0%
1st Millennium B.C.	85.0%
Conte	.5%
Period VI-VII	12.4%

In contrast to earlier lithic assemblages and based on the analyses presented in Chapter VI, there are both continuities and changes in the inventory at La Mula-Sarigua. Pre-1st millennium B.C. sites in Central Panama are dominated by simple chipped stone industries. Lithic reduction strategies consist of little more than the production of flakes suitable for use without much post-detachment modification (Ranere 1984). Flakes are utilized at or near their manufacturing loci and are almost entirely of locally available material. Co-occurring with this industry are edge-ground cobbles which are used against cobbles of boulder bases, presumably to pound or mash plant foods (Ranere 1975, 1980b). Both edge-ground cobbles and boulder bases (defined as milling stone bases in the present manuscript) co-occur and continue to be important components of La Mula-Sarigua; they disappear from Central Panama lithic inventories by 200 B.C. In contrast, chipped stone technology changes after 1000 B.C. in important ways. Cores are carefully prepared for the production of long, pointed flakes. The end product is a pointed and tanged flake/point (Ranere 1984). Use-wear analyses on the present sample suggests that these tools are hafted and multipurpose (utilitarian) in nature; they have been used as knives, saws, scrapers, and perforators; oftentimes in combination on the same specimen. These flake/points are particularly abundant at La Mula-Sarigua and at a few other 1st millennium B.C. sites in Central Panama; they are extremely rare in pre-1000 B.C. contexts (cf. Bird and Cooke 1978b) but do persist in sites dating between 200 B.C.-A.D. 500. Also rare in pre-1000 B.C. settings (Ranere 1984), but plentiful at La Mula-Sarigua in 1st millennium B.C. contexts, are scraper-planes made on cores and flakes. Both flake/points and scraper-planes are made of locally available cryptocrystalline silica.

Though a few hafted polished stone implements--celts and chisels--have been recovered in earlier dated contexts in the Central Panama archaeological record, the former appear in great quantities for the first time at La Mula-Sarigua. In addition to the flake/points and celts, there are a number of other tool types, not found in pre-1000 B.C. contexts, which co-occur and are found in some numbers at the site, most notably legless metates with "breadboard" rims and cylindrical (bar) manos.

Numerically small, but nonetheless present, are metates (non-breadboard) and manos (non-bar), which co-occur. At Sitio Sierra, these are associated with house floors which date as early as 65 B.C.; regionally, this complex persists to contact (Cooke and Ranere 1984). (See Table 48 for percentages of the different tool forms).

Table 48. Percent of Tools by Form.

Tool Form	Percent
Edge-ground cobbles	9.2%
Milling stone bases	1.4%
Breadboard metates	8.5%
Bar manos	2.2%
Metates (non-breadboard)	1.7%
Manos (non-bar)	6.1%
Points	27.8%
Scraper-planes on cores	18.1%
Scraper-planes on flakes	6.1%
Pear-shaped celts	13.8%
Trapezoidal-shaped celts	4.6%

Noticeably absent from the La Mula-Sarigua lithic assemblage are chipped stone diagnostics commonly found in post-1st millennium B.C. settings, e.g., points made on true prismatic blades (post 200 B.C.), sharply tanged points (A.D. 500-700) and trifacial points (A.D. 1300-1520) (Cooke and Ranere 1984).

While the major focus of the present research is on the 1st millennium B.C., the discovery of two much earlier workshops for manufacturing bifaces should not go without notice. The largest workshop (site area = .7 ha [Figure 45]) occurs in the quarry and it has yielded several hundred thinning flakes, a number of bifaces (complete and fragmented) and 5 notched points. The second workshop occurs at the extreme west end of the site, on the edge of the alvina (Figure 45). It contains 4 thinning flakes and 1 biface fragment. These work stations were in operation sometime prior to 5000 B.C. as bifacial points and bifacial thinning as a lithic reduction strategy disappears from the archaeological record in Central Panama by this date (Ranere nd, Cooke and Ranere 1984). The recovery of a broken biface unifacially retouched to produce a stemmed point characteristic of the 1st millennium B.C. emphasizes the fact that these workshops predate the major occupation at La Mula-Sarigua (see Plate 54 for examples of this technology).

Site Size

Overall Site Boundaries. Site dimensions have been determined by mapping the distribution (presence) of cultural remains recovered from the probabilistic sample (Figure 46, cf. Figure 47 [absence] of materials); materials cover an area of approximately 218 ha. This sample includes the surface-collected, eroded zone (Figure 48), and the shovel-tested, largely noneroded zone (Figure 49). The 218 ha figure, of course, is based merely on the presence of cultural remains and does not take "time" into consideration.

Site Size Through Time. Change in site size over time has been established by plotting the distribution (point proveniences) of "diagnostic" ceramic Groups. As noted above, the definition of "time-sensitive" ceramic markers has been an easier task than that for lithics--primarily, because the former's occurrence has been firmly anchored by stratigraphy and radiocarbon determinations at La Mula-Sarigua; with one exception, diagnostic lithics do not occur in stratified or datable contexts. Rather their distribution is largely confined to the eroded zone which consists of deflated surfaces--many of which contain ceramics representative of every Group recognizable at La Mula-Sarigua. Nonetheless, plotting the distribution of "diagnostic" lithics individually, in combination and/or in combination with ceramic Groups has, in many cases, clarified the probable age(s) and/or association(s), of particular tool forms (discussed in more detail below). These results should be considered tentative, however; their verification awaits the completion of the regional lithic classificatory system.

For the reasons given above, I have relied mainly on the mapping of ceramic Groups in order to determine minimum site boundaries and minimum area occupied through time.[2]

Ceramic distributions

Monagrillo: (area = 1.3 ha [Figure 50]). This Group occurs in two small concentrations; they are separated by 500 m. Both areas exhibit ceramics from all Groups recognizable at La Mula-Sarigua; one loci is confined to the intensively-collected eroded zone (henceforth defined as the site's "nucleus") and the other to the noneroded zone (i.e., the location of 1984 excavations).

Aguadulce-Ladrones: (area = 4.4 ha [Figure 51]). Relative to Monagrillo, there is approximately a 3-fold growth in settlement. Expansion occurs in the nuclear zone, and there are two new localities: (1) 100 m E and (2) 100 m S of the nucleus.

Early: (area = 8.5 ha [Figure 52]). Settlement has approximately doubled over the previous period. Although locality #2 above is abandoned, the other 3 persist and two new positions are occupied: (1) 500 m NW and (2) 200 m NE of the nuclear zone.

Lamula:[3] (area = 58.0 ha [Figure 53]). Community growth is dramatic; settlement increases, relative to Early residence, by a factor of 7 and, relative to Aguadulce-Ladrones, by a factor of 13. Previously occupied zones persist and intensify; growth occurs in all directions (NW, NE and SE) except towards the SW; this latter area is only occupied during Period VI-VII.

Aristide: (area = 10.3 ha [Figure 54]). Approximately 9 localities at the site yielded Aristide ceramics. Their distribution corresponds to that of the Lamula Group, although there are 3 points (W and NW of the nuclear region) which fall outside this distribution.

Sarigua: (area = 6.6 ha [Figure 55]). This Group is represented by only 5 localities. The densest area occurs in the nuclear zone; 1 locality does not overlap with Lamula but does with Aristide (see extreme NW site sector).

Tonosi: (site area = 3.4 ha [Figure 56]). Tonosi is restricted to 4 sectors; two points do not coincide with any other Group.

<u>1st Millennium B.C. Groups</u>: Ceramic Groups dating to the 1st millennium B.C. have been discussed above. Their combined distribution is useful for determining 1st millennium B.C. site boundaries. A minimum site size of 70 ha has been estimated (Figure 57).[4] Unfortunately, this figure covers a period of approximately 800 years, and does not take into consideration inflational factors, such as residential relocation, community spatial arrangements and post-depositional movement (discussed in more detail in Chapter X).

There are very few sherds present at La Mula-Sarigua which suggest occupation for the first half of the 1st millennium A.D.; there are none which might denote settlement from ca. A.D. 200-500. This indicates that the site was abandoned for a period of at least 300 years.

<u>Conte</u>: (area = 10.9 ha [Figure 58]). Re-occupation occurs sometime during the period spanning A.D. 500-800. Relative to the 1st millennium B.C., resettlement is 16 times smaller; habitation loci (n=6) are greatly scattered. Four of these do <u>not</u> overlap with Lamula, Sarigua and Tonosi, and two locations are occupied for the first time: (1) NE central and (2) SW.

<u>VI-VII</u>: (area = 71.4 ha [Figure 59]). Relative to Conte, habitation locales have increased by a magnitude of at least 6. Regions occupied during the 1st millennium B.C., particularly those represented by Lamula ceramics, are resettled, albeit less densely (with one exception: the extreme NE sector) and

previously untouched areas are colonized, primarily, to the SW.

Lithic distributions

As noted above, the definition of site boundaries on the basis of "diagnostic" stone tools is a bit more problematical than for the ceramics. I have primarily plotted their distribution to determine: (1) probable age (by association with ceramic Groups) and (2) probable association between tool types.

Edge-ground Cobbles: Tools of this form are broadly distributed across the site (Figure 60), but they are largely concentrated in the "nuclear" area. As with the ceramics, this concentration is, no doubt, an artifact of collection strategy since this zone (eroded) was the most intensively collected. Nonetheless, their proveniences coincide with, or are slightly adjacent to, the distribution of Monagrillo through Lamula ceramic Groups. They are not found in areas where Tonosi, Conte and VI-VII Groups exist, except where the latter overlap with the former; that is, on deflated surfaces.

In contrast to most materials, I believe their distribution to be slightly skewed. Given their long history of use in Panama and the length of occupation at La Mula-Sarigua, specifically Monagrillo through the 1st millennium B.C., I would expect many more tools in this category than documented here. Visual site observations make it clear that many more did, in fact, occur at La Mula-Sarigua than are presently described. They have been (continue to be) stacked in numbers as large as 20-30 per clump in locations where they are easily picked up, such as alongside dirt roadways. Clearly, they are being removed from the site in some numbers; I am uncertain as to how they are being used in their "new" context.

These edged cobbles appear to be pounders/mashers used in the processing of foodstuffs, and are most often recovered with pottery in what appear to be domestic contexts. However, they are occasionally used as hammers and/or anvils in stone tool manufacturing, and, therefore, have been retrieved from lithic workshop areas as well.

Milling Stone Bases: This class of tool (Figure 61) either co-occurs, or is slightly adjacent to, edge-ground cobble locations (Figure 62). This implies that they have been used together. As such they span the Monagrillo-Lamula ceramic Group period. These bases, however, are less dispersed than the edge-ground cobbles; they are neither found in the quarry nor in the west end of the site. This should not be surprising since they were a mono-functional tool, apparently.

As with the edge-ground cobbles, it may well be that the number of milling stone bases observed in the present collection are underrepresented. Collector bias comes immediately to mind --these tools are incredibly bulky and heavy; they would be less likely to be picked up (and/or recorded) if there were more portable objects in the immediate vicinity of a collecting station.[5] It may also be that these implements are not as easy to recognize as other artifacts since they have no particular shape and are only recognized by use facet. It can not be documented that these tools have been/continue to be collected from the site but it is a possibility.

Breadboard Metates: Breadboard metates are found in at least 2 distinct clusters (Figure 63). While they cluster largely in the nuclear area, several are present in the NW sector. They are more concentrated than the edge-ground cobble/milling stone base complex.

The distribution of this tool form is consistent with Aristide, Lamula, and Sarigua ceramic Groups; they are not present in contexts which are specific to Conte, VI-VII and possibly Tonosi ceramics. This fits nicely with the regional data which points to their presence only in 1st millennium contexts.

As breadboard metates are highly susceptible to surface deterioration, and have been located only on eroded surfaces, which in the dry season accumulate aeolian deposits, it is likely that they are underrepresented in the La Mula-Sarigua archaeological record.[6]

Bar Manos: Although less abundant than the above metates (perhaps for the reason given in endnote #6), bar manos (Figure 64) are always found in conjunction with breadboard metates (Figure 65); although the reverse is not true. Nonetheless, their co-occurrence argues for their use together.

In contrast to the edge-ground cobble/milling stone complex, this complex is totally absent from the eastern sector of the site.

Non-breadboard Metates: This metate form is very dispersed across the site (Figure 66). Importantly, all are contained within areas where the VI-VII Group ceramics are distributed. Except for the nuclear area, non-breadboard metates are never located in positions where the breadboard/bar mano complex occurs.

Non-bar Manos: The above metates are usually found associated with non-bar manos (Figure 67, cf. Figure 68) but not vice versa; non-bar manos are much more numerous in the La Mula-Sarigua archaeological record than are their associated metates. Nonetheless, their dispersal also falls within the area where Group VI-VII ceramics have been recovered. They are not associated with Tonosi or Conte Groups.

Unifacial Points: On the basis of a frequency distribution for width (Appendix B, Table 60), the entire point category can be divided into two populations: group 1 (width $\geq$ 2.3 cm) and group 2 (width $\leq$ 2.2 cm). I am operating under the assumption that those which are wider date earlier than the narrower group (see Chapter VI discussion for a justification of this assumption).

Point distributions by width are not particularly enlightening in terms of shedding light on their probable age(s).

Relative to number and distribution, group #1's dispersal (Figure 69) best fits that of the Lamula ceramic Group, the edge-ground cobble/milling stone complex and the pear-shaped celts; group #2's distribution (Figure 70) fits the distribution of the Lamula and of the Aristide ceramics very nicely. Neither point group is found in areas exclusive to Tonosi, Conte, and VI-VII ceramics.

A comparison of the two point groups (cf. Figures 69, 70) indicates that not only are those $\geq$ 2.3 cm more abundant (70.4%) but more widely distributed across the site. Those $\leq$ 2.2 cm (29.%) are not only less numerous, less widely distributed but less densely clustered per ha than are those $>$ 2.2 cm. Nonetheless, the two groups definitely have overlapping spatial distributions.

Core Scraper-planes: These tools are numerous and tightly clustered across the site (Figure 71). With one exception, they are always slightly adjacent to Lamula ceramics; they are, however, known to occur as early as 4600-2300 B.C. in western Panama (Ranere 1980b:29). Interesting is the fact that edge-ground cobbles are always found in the same context as the core scraper-planes at La Mula-Sarigua although the reverse is clearly not true. They are never found in contexts specific to Tonosi, Conte and VI-VII ceramics.

Flake Scraper-planes: In contrast to the cores, flakes are less numerous and more widely dispersed. Where present (Figure 72) they are always found in association with core scraper-planes; the implication is that they were used together. Since it has been demonstrated elsewhere (Chapter VI) that these are both probably wood-working tools might they not form a toolkit with the flakes being used for fine planing (cf., Hester and Heizer 1972)?

Pear-shaped Celts: These are widely distributed across the site (Figure 73). Their distribution co-occurs with Lamula ceramics but not with locations specific to Tonosi, Conte or VI-VII Groups. As noted above under the discussion of unifacial points, the distribution of this celt form fits very closely to that for the edge-ground cobble/milling stone base complex and the points that are $\geq$ 2.3 cm in width.

Like so many of the other La Mula-Sarigua tools these celts have been reused, particularly as hammers, and more specifically as pecking hammers. It should, therefore, not be surprising that fragments are frequently found in association with milling stone bases and with manos and metates (cf. Figures 51, 66, 67). The latter association suggests the possibility that the broken celts were used for resharpening these implements.

Trapezoidal Celts: Many of the trapezoidal celts coincide with the distribution of pear-shaped celts; nonetheless, at least some of these tools are found in locales specific to VI-VII occupation (Figure 74). In other words, many of these tools may be of 1st millennium B.C. origin, but clearly some are not. As a class, their distribution more closely approximates the VI-VII ceramic Group.

The above ceramic and lithic distributions, relative and absolute dates, and documented spatial/temporal occurrences, make it clear that specific "diagnostics" do co-occur. This is best viewed in Table 49.

Table 49. Diagnostic Artifacts Present at La Mula-Sarigua and Probable Age.

Ceramic Group	Associated Lithics	Age Range
Monagrillo	Edge-ground cobbles Milling stone bases	2800-1200 B.C.?
Aguadulce-Ladrones	" "	1200-800 B.C.?
Early+	" "	± 800 B.C.
LaMula*	" "	
Aristide*+	Bar manos, breadboard metates, Stemmed flake points Pear-shaped celts, Core and flake scraper-planes	500-1 B.C.
	Breadboard metates, bar manos	
Sarigua*	" "	800 B.C.-?
Tonosi*	???	500 B.C.?
Conte	???	400 B.C.-A.D. 200
VI-VII		A.D. 500-800
	Non-breadboard metates, non-bar manos, trapezoidal celts	A.D. 800-1500

(+ and/or * Contemporaneous)

Resources Utilized

A variety of organic (Chapter VIII) and inorganic (Chapters VI and VII) substances are present at La Mula-Sarigua. Of the organic remains, bone and shell have been recovered in relatively larger numbers; considerably less abundant are carbonized plant remains, pollen and phytoliths. Differential preservation has no doubt affected the presence/absence and quantity of the organic remains (discussed in Chapter VIII).

Inorganic remains are present in the form of lithic and ceramic materials (discussed above in the chronology/technology section).

Faunal Sample. The dietary faunal sample is comprised largely of aquatic forms, specifically fish and shellfish (ca. 77% of the site biomass taken together). The non-aquatic fauna is depauperate in forms and quantity (ca. 23% of site biomass); white-tailed deer predominates.

Based on the dominant fish species, preferred species habitat and capture methods, it is clear that the La Mula-Sarigua inhabitants did not prefer to fish in the open sea. Rather, they chose to fish close to the shore where the biomass of the principal species in the sample (catfish [17.%] and puffer [10.2%]) is huge; both could have been caught with a hook and line from the shore. Most of the remaining fish species (e.g., sharks and jacks) could have been captured with gill nets and/or traps.

All shellfish would have been gathered from the mangrove-estuary system either by hand or with a simple digging stick. Although the bulk of the molluscan species were dietary items, shells from several species have been modified through use and hence functioned as tools. (See feature discussion below). In addition, both a number of shell fragments and fish vertebrae have been purposively shaped into beads (centers have been drilled and edges smoothed or polished).

Of possible significance is the prevalence of very large shark vertebrae, but no correspondingly large shark teeth. Shark teeth were important exchange items in latter Precolumbian times; they were used as (male?) ornaments and to stud macanas or wooden sword-clubs. Cooke (personal communication) has suggested that shark skins may have been used as shield covers and as protective clothing. Although this suggestion can not be fully tested at La Mula-Sarigua, large shark vertebrae do appear to co-occur with Period VI-VII ceramics at La Mula-Sarigua.

Floral Sample. The floral assemblage is represented by carbonized palm nut fragments, maize pollen and phytoliths, and squash phytoliths from 1st millennium B.C. deposits (see below).

Evidence from Human Remains. That maize was the major plant staple at La Mula-Sarigua during the 1st millennium B.C. has been supported by the carbon and nitrogen isotope ratio values (Chapter VIII). These values also indicate that marine resources contributed significantly to the populations diet; this latter is, of course, confirmed by relative faunal biomass estimates (Chapter VIII). Further, the absence of skeletal pathologies suggests that the combination of these two resources (maize and marine) constituted a nutritionally adequate diet (Larsen 1987, Wing and Brown 1979). The burial patterns of human remains are discussed below.

Internal Spatial Layout

The site's surface and subsurface have been extensively surveyed and collected; 6 large surface features have been intensively mapped and collected; and 21 small units have been carefully excavated. These investigations have yielded evidence for considerable intrasite variation, including "discrete" shell middens, concentrations of shell tools, lithic workshops, burials, a hearth, trash dumps and a possible house location.[7]

Shell middens, burials and trash dumps are visible both on and below the surface. Shell tools, lithic workshops and possible house locations are found only on the surface. The hearth was a subsurface feature. All subsurface features are in datable contexts. As the analyses of the content of these features are not yet completed, it will only be possible to describe them in a very general way.[8]

Spatial Variability: Features

Shell Middens: (e.g., Plates 4, 9-14, 19, 24, 25). There are numerous intact shell dumps across the site, both on the surface and below. The surface dumps commonly are composed of a variety of species, but there is the tendency for only one species to predominate, e.g., oyster. None of the shell in these middens appears to be modified or utilized as tools, and very little cultural material is incorporated within their matrices. These dumps are interpreted as evidence for the use of molluscs as food.

Shell Tool Concentrations: In contrast to the dumps, there are several small areas where specific shell species are used as tools. For example, there are large mangrove clams *Anadara grandis* with use-wear along approximately 1/3 of their edges. These wear patterns are not unlike those seen on modern day *Anadara* which have been used to scrape barnacles off boat bottoms. Also present on site are the large mud flat gastropod *Fasciolaria granosa*; this species has long, thick spires with short, thick spines. Many of the La Mula-Sarigua specimens have their spines ground down and often their spires broken off. This pattern is similar to that found on *Hexaplex* at Cerro Mangote (Ranere, Cooke and Hansell 1980). The wear patterns on these two species suggest their use as pestles (plant processing tools?).

Trash Dumps/Pits: (e.g., Plates 27, 28). Intact, circumscribable dumps are found on the surface; pits are found in all but one of the excavations. All dump/pit contents consist of what appear to be ordinary household refuse. Such refuse includes broken pots, flake debris, rarely a broken stone tool and food remains of marine and terrestrial fauna. Imported lithic tools are never found in these contexts.

Hearths: (Plate 12). Only one subsurface hearth was encountered. Small bits of charcoal, shell and several rim sherds were found inside and above the hearth. Shell from this context has been radiocarbon dated to 390 ± 70 B.C.

Burials: (Plates 23, 38). A variety of burial patterns have been observed at La Mula-Sarigua. The first pattern consists of a flexed body with the head in an upright position. The skeleton is that of an adult. There are no materials directly associated with the burial, but all materials directly above the burial are of 1st millennium B.C. origin. The second pattern consists of a bundle of disarticulated bones. It contains the partial remains of at least one adult. This bundle is associated with several broken black painted and incised pots and a small shell feature. The shell feature has been radiocarbon dated to 320 ± 90 B.C. The third pattern consists of the careless disposal of the dead. This is represented by human phalanges, skull and long bone fragments recovered from 2 subsurface trash pits dated to the 1st millennium B.C. on the basis of the associated pottery.

In addition to the above remains, human remains occur in two surface features. The combination of looting activity and erosion makes interpretation of these remains problematical.

Lithic Workshops: (e.g., Plate 59). The manufacturing of chipped stone tools took place at La Mula-Sarigua on a massive scale. Given the presence of a large cryptocrystalline (chert) cobble quarry on the site, this should not be surprising (Plate 41). Manufacturing is evident in the numerous concentrations of cores, unutilized flakes, hammerstones and finished products, such as the unifacial points (both discussed in detail below). Although it is not possible presently to determine if at least a part of the finished product was exported (this determination awaits the completion of the feature analyses), it is a possibility. Clearly the tool types which are so abundant at the site are widely distributed in the region.

In addition to manufacturing workshops, there are several small areas where volcanic tuff non-breadboard metates or breadboard metates and pecking hammers co-occur (detailed below).

In marked contrast to the cryptocrystalline silicate quarry, the small cryptocrystalline tuff outcrops at La Mula-Sarigua appear not to have been utilized; there is not a shred of evidence to suggest on-site celt manufacturing. Neither is there evidence for the manufacturing of metates, manos and polished stone beads. They have all been imported as finished products (see Chapter VI for a discussion on craft specialization).

Other Features: (Plates 24, 25, Figure 22). Architectural structures and house living floors have not been positively identified, although the intensive surface mapping and collecting of one surface shell feature is suggestive of such a location. This feature (3-1/2 m wide x 2-3/4 m long ?) is quite similar to the small elliptical, one-room dwellings found in coastal Ecuador, e.g., Real Alto and Loma Alta (Damp 1984:578). Visual observations at the central Panamanian site of Zapotal indicate an analogous dwelling configuration (Cooke, personal communication). A comparable disposal pattern has also been viewed among present-day Guaymi populations in western Panama

(Bort, personal communication). Positive identification for La Mula-Sarigua residence/disposal profiles awaits the completion of the feature analyses.

Spatial Variability: Artifacts

Results from the analyses presented in Chapter VI and VII have allowed me to determine overall intra-site layout[9] by interpreting--on a macro level--the spatial patterning (clustering) of two types of data: (1) diagnostic types individually and/or in combination, e.g., Lamula ceramic Group utilitarian jars and (2) nondiagnostic materials thought to represent specific activities, e.g., debitage.

The former patterns have in part, already been "delimited" as the result of defining site boundaries and/or areas by time period (discussed in yet more detail below). The latter patterns are defined by mapping the distribution and/or density of two types of data: (1) materials often used or produced together (Table 50) and (2) materials whose use and/or manufacturing implies a specific activity (Table 51). Obviously, only those materials known to occur at La Mula-Sarigua have been included in these tables.

Table 50. Materials Often Used and/or Produced Together.[10]

Material Associations	Activity
Wasted cores, unused flakes, hammerstones	Tool manufacturing
Manos, metates	Grinding seeds, maize
Edge-ground cobbles, milling stone bases	Grinding, pounding tubers
Mortars, pestles	Grinding foodstuffs

Table 51. Materials and Associated Activity.

Materials	Activity
Scraper-planes	Woodworking
Celts	Woodworking
Unifacial points	Utilitarian
Collared jars	Utilitarian

Wasted Cores, Unused Flakes and Hammerstones: (Figures 75-77a-d). The only chronologically-sensitive chipped stone tool types recovered from La Mula-Sarigua are unifacial points and scraper-planes, both 1st millennium B.C. markers. Tool types characteristic of later periods in Central Panama (e.g., blades, narrow tanged points, trifacial points) are completely absent from the inventory. This suggests that most of the manufacturing debris at the site can also be attributed to 1st millennium B.C. activities. The fact that 85% of the diagnostic ceramics recovered at the site were 1st millennium B.C. forms bolsters this conclusion.

An interpretation of the distribution and density maps indicates that there are a minimum of 5 very discrete, dense loci, i.e., manufacturing stations (Figure 76); station #2 is post-1st millennium B.C.; #'s 1, 3, 4 and 5 are in 1st millennium B.C. contexts. There are in addition a number of discrete, albeit considerably less dense, locations. The small cluster just north of #4 represents the bifacial workshop discussed above. That these locations are not overestimated is implied by the collection strategies, i.e., diagnostic tools were to be selected if present. If anything, the density of workshop debris is underestimated.

Non-breadboard Metates and Non-bar Manos: (Figure 68). Non-breadboard metates always occur with non-bar manos. In fact, their co-occurrence can be delimited to five very tightly-packed clusters, four of which do not overlap with 1st millennium B.C. ceramic Groups but do with the VI-VII Group. These tight clusters signify primary food processing areas sometime after the 1st millennium B.C.

Breadboard Metates and Bar Manos: (Figure 65). Without exception, bar manos are always associated with breadboard metates. They are confined to two very discrete loci--one of which is quite large areally (approximately 11 ha) and which contains approximately 80% of all breadboard/bar specimens. As above, these locales represent major food processing areas.

Edge-ground Cobbles and Milling Stone Bases: (Figure 62). The latter always coincide with the former. Their density and distribution suggest two large, and two small, food preparation centers.

Mortars and Pestles: (Figure 78). There are only one mortar fragment and 15 (3 are complete) pestles. They do not co-occur. While they may be associated elsewhere in Panama (Ranere 1980b), one can not argue for such an arrangement based on the La Mula-Sarigua sample.

Scraper-planes: (Figures 71, 72). The density and distribution of co-occurring flake and core scraper-planes indicate a minimum of 4 major and 3 minor woodworking stations. A comparison of these stations with the distribution of 1st millennium B.C., and with Lamula ceramic Groups (cf. Figures 57, 53), indicates that woodworking as a major activity occurred slightly adjacent to those areas where pottery was used and/or discarded. This pattern contrasts with that of the food-processing locales; the latter were concentrated within areas where pottery was used and/or discarded. This latter pattern is suggestive of domestic loci.

Celts: (Figures 73, 74). The density and distribution of the pear-shaped celts corresponds very closely to that of the core/flake scraper-plane toolkit (?). With the exception of the nuclear area, celts of this form tend to aggregate slightly adjacent to those which contain 1st millennium B.C. ceramics. This observation reinforces that of above; i.e., there are discrete woodworking centers across the site. Nevertheless, the fact that some of these celts have been used as hammers (as initially determined by use-wear analysis) is strengthened by their presence in a minor quarry workshop (just north of the bifacial workshop).

Trapezoidal celts do not coincide with the above toolkit. They do, however, tend to adjoin areas containing VI-VII Group ceramics. This juxtaposition of domestic and workshop loci may be similar to the 1st millennium B.C. pattern.

Unifacial Points: (Figures 69, 70). Although I have made an argument for at least 2 distinct populations of unifacial points (Chapter VI), use-wear analyses suggest that there are no differences in terms of function; most are multi-purpose utilitarian tools. For this reason, their density and distribution will be considered as one tool class (Figure 79) for the present discussion. Two patterns are apparent; either they coincide with ceramic Groups of the 1st millennium B.C. or they are slightly adjacent to them. They do not share, however, the same adjacent space as the woodworking stations discussed above; rather they are intermediate between these stations and ceramics. At the level of the present analysis, it would be speculative to go beyond these comments (but see endnotes #8 and #9).

To further develop the concept suggested above, i.e., that domestic versus workshop areas can be distinguished at a macro level, I now turn to the Lamula Group collared jars.

Lamula Group Collared Jars: (Figures 80-82a-d). Approximately 90% of the Lamula Group ceramics are from wide-mouthed collared jars. According to Cooke (personal communication), these jars are utilitarian in function. Plotting their distribution is useful, therefore, for determining possible loci of domestic activities. There are at least 7 relatively large and a number of smaller, discrete areas (Figure 81). That is, despite the intensive surface collections in some of these areas and despite the deflated nature of many of these surfaces, it is possible to separate out potential domestic locations (see endnotes #8 and #9). This observation is strengthened when Figures 76, 77a-d (lithic manufacturing stations) and Figures 81, 82a-d (collared jars) are compared. This comparison suggests a slight overlapping (e.g., Venn-like) between the two map types, particularly Figures 76 and 81. Such a correspondence indicates that tool production often occurred just adjacent to domestic areas.

Summary

Interpretations presented above indicate that many of the features common to hierarchically-ordered societies, and particularly those which characterized the late "Chiefdom" societies in Panama (Chapter II), made their initial appearance during the 1st millennium B.C. at La Mula-Sarigua. These features include large site size, differential distribution of and access to a variety of resources (natural and/or cultural), craft specialization, differential treatment of the dead and regional exchange. Each of these factors alone and/or in combination, along with historical context, has implications for the specific form socioeconomic structures will take. Each is to be discussed in some detail in Chapter X.

Endnotes

1. Table 52. La Mula-Sarigua Radiocarbon Determinations and Context.

Date	Laboratory	Sample #/Provenience	Context
870 ± 50 B.C.	(Beta-6016)	#S-2 (242S417E)	SHELL FEATURE
790 ± 60 B.C.	(Beta-21898)	? " "	" "
390 ± 75 B.C.	(Beta-12931)	#410 (73S40E)	(35-40 CM BS) ABOVE HEARTH
320 ± 90 B.C.	(Beta-12729)	#638 (11N398W)	(54-60 CM BD) BURIAL ASSOC.
270 ± 70 B.C.	(Beta-12728)	#531 (14N494W)	(25-36 CM BS) FEATURE
240 ± 90 B.C.	(Beta-18863)	#2005 (70S169E)	(10-15 CM BS)
20 ± 45 B.C.	(SI-5689)	SURFACE	(CARBON WITHIN SARIGUA POT)

2. <u>A note on calculating area</u>: I digitized (through AUTOCAD) the perimeter of clusters (as outlined on each map). If materials were separated by 100 m or more, they have generally been considered as separate entities. AUTOCAD keeps a running total of area (adds areas together). As such these areal figures must be considered "minimum" boundaries. I am sure that someone else would calculate the extreme ends and include everything in between but that seems very generous and in some cases would, no doubt, overestimate boundaries. Given the dispersion of early settlement and the concentration of settlement during Lamula ceramic Group times, it seems that the major change (by giving the maximum figures) would be to inflate areas occupied less intensively. For example, there are two clusters for Monagrillo occupation and these are separated by at least 500 m. I have calculated the area of each cluster area individually and added the 2 area figures together; this has elicited a figure of 1.3 ha. If I take the extreme boundaries 1.3 ha would become 9.6 ha. What is most important is that one be consistent in calculating areas occupied.

3. When reading the following, keep in mind that Early and Aristide Groups co-occur in stratigraphic contexts; and Aristide, Lamula, Sarigua and Tonosi co-occur as well, i.e., are contemporaneous.

4. Although it may appear that this estimate should be larger, e.g., if all 1st millennium B.C. ceramics group areas were added together, the fact is that many of the groups occupy the same space. Adding areas together, therefore, would be an artifact of the calculation method.

5. Keep in mind that the systematic collection strategy in 1983 was to pick up a total of "5" diagnostics (ceramic or lithic) within 25 m of a collecting stake; in 1984 the first "10" (5 lithics and 5 ceramics) were picked up (discussed in some detail in Chapter III).

6. Breadboard metates are relatively thin, neutral in color (given the background of dry-brownish sediments) and very porous. Fine silts rapidly deposit on their fragmented, eroded surfaces; I have located only one "whole" specimen (it had been broken into a number of fragments) (Plate 50). It was discovered approximately 10 cm below the surface in recently deposited (1984 dry season) windblown sediments on the periphery of an intensively collected feature, i.e., 70S275E.

7. Much of the "general" description contained within this section has been extracted from Hansell (1987).

8. A large proportion of field time was devoted to extensively surveying the site (probabilistic sample) and to intensively collecting surface features (purposive sample). These strategies were essential for determining ultimately the size and age of the site, as well as for determining intra-site/feature variability.

Due to the quantity and quality of materials collected, along with the obvious resources available, such as, labor, time, expertise, equipment, etc., the present research has had to focus primarily on the analyses of diagnostics and materials from the probabilistic sample in order to define overall site characteristics. The analyses of the contents of features has become a secondary goal; i.e., they are on-going. Relative to internal spatial patterning, overall site layout has been inferred from interpreting the clustering of: (1) diagnostic types individually and/or in combination and (2) nondiagnostic materials which generally signify specific activities.

A more refined description of internal site layout awaits the completion of the analyses of materials from intensively collected features. The results discussed in this manuscript are, therefore, subject to modification upon completion of the latter analyses (see also endnote #9).

9. There are a variety of statistical techniques useful for determining intrasite spatial patterning--on a micro level--(see Aldenderfer 1987, Carr 1984, 1985, Hietala 1984). They have not been used in the present analyses due to time constraints. Nonetheless, the data are being presently reorganized to accommodate these techniques. This reorganization combined with the data from intensively collected features should allow me to more confidentally spatially place the present material assemblages.

10. Activities represented by the occurrence of these tools alone and/or in combination have been well documented in the literature. For the Panamanian assemblages, each has been discussed in detail by Ranere (1980b) and Cooke and Ranere (1984). Similar associations have been cited in Carr (1984).

CHAPTER X

DISCUSSION

This chapter has three goals. Firstly, it attempts to describe and explain socioeconomic structure at La Mula-Sarigua within its historical context; secondly, it addresses the questions posed in Chapter I; and thirdly, it discusses the implications of #1 and #2 for studying change.

Socioeconomic Form at La Mula-Sarigua

La Mula-Sarigua was occupied for a period spanning 7000 years. The size of pre-1st millennium B.C. settlements at La Mula-Sarigua (excluding the bifacial workshops) ranged from 1.3 ha (Monagrillo) to 4.4 ha (Aguadulce-Ladrones).[1] Regionally, sites from this time period (over 200 have been examined) are never much larger than 3 ha. Occupation at La Mula-Sarigua reached its zenith during the 1st millennium B.C. More specifically, by the second half of the 1st millennium B.C., materials were distributed over a minimum of 58 ha (70 ha for the entire period) (see Figure 83). Regardless of which figure one uses, this site is at least two times larger than any of the 20 sites (and 17 times larger than 90% of the sites) identified by the PSM for the same time period (Cooke and Ranere 1984).[2] This noticeable decrease in site numbers with an equally conspicuous increase in the size of some sites during the first millennium B.C. suggests a spatial reorganization of human groups[3] (and by extension a reorganization of social relations) during this period with much of the population aggregated at La Mula-Sarigua; and perhaps a few other sites--1 of which is 9 ha and one 26 ha. The remaining 18 sites are 3 ha or less in size. On the basis of regional variability in site sizes, and there- fore, the unequal distribution of the population during this period, one might cautiously argue that a settlement hierarchy existed (see endnote #2) and that La Mula-Sarigua in all probability was the largest regional center (but see below).

Based on overall site area for the 1st millennium B.C., population size at La Mula-Sarigua is estimated to have been between 580 and 700. This estimate is based on a density of 10 persons per ha; similar figures have been estimated for other early sedentary communities in the New World (e.g., Damp 1984, Flannery and Marcus 1983, Marcus 1976, cf. Hassan 1981, Renfrew 1973, Roosevelt 1980). This figure would be significantly higher, however, if one based their estimates on the probable number of household clusters per ha as defined by Winter (1972, 1976). Winter (1976:228), using a figure of 5 persons per household cluster, has suggested densities between 16.6 persons/ha (10 household clusters in 3 ha) and 26 persons/ha (5 clusters in .95 ha) for Mesoamerican Formative villages. Applied to La Mula-Sarigua, the population could range anywhere from 963 (16.6 * 58 ha) to 1820 (26 * 70 ha) for the 1st millennium B.C.

Neither of these two figures nor the one above for La Mula-

Sarigua take the following into consideration: (1) residential relocation, a common practice in early sedentary communities, and particularly in tropical contexts where houses are often constructed of perishable materials like wood and thatch (Tolstoy and Fish 1975); and (2) continuity and/or duration of occupation. In fact, evidence suggests that community movement has a long history along Parita Bay. For example, prior to this period, transhumance was the pattern. Espinosa (1944) upon his second "entrada" in 1519 into the chieftain Parita's territory, speaks about the "old settlement" ("asiento viejo") which was different from the "new" settlement where he found Parita prepared for burial. Of course, it is possible that each site had a different function; but it is probable that even chiefly seats moved from time to time, in response to raiding more than anything (Cooke, personal communication). Even today along the coast, small communities are seasonally occupied, particularly during the dry season, for shellfish gathering and for in-shore fishing. Moreover, my figures assume a uniform population density--a very questionable assumption. In light of these considerations, it is difficult to argue strongly for a figure of 580-700 people for the 1st millennium B.C. La Mula-Sarigua settlement. However, a more refined estimate of population size at La Mula-Sarigua is not now feasible.

Intra- and inter-site spatial variation in activity areas (production activities) combined with an assumed moderately large sedentary population size at some sites during the 1st millennium B.C. have implications for the organization of material production (technical division of labor [defined in Chapter I]) (Tosi 1984). An activity area (specifically those at La Mula-Sarigua) is used here to describe a place where work (labor) was allocated for the production and/or utilization of material products. Each activity and/or area (detailed in Chapter IX) will be discussed separately; the implications of these activities for how labor might have been allocated (for the site and/or region) is examined therein.

Subsistence Activities. Prior to the 1st millennium B.C., the region was occupied by small transhumant social groups who subsisted on a combination of game, fish, shellfish, wild and domesticated plants (albeit in varying degrees depending upon site location). For example, at Cerro Mangote (a preceramic coastal site), faunal assemblages are predominantly mangrove/ estuarine species, including shellfish, fish, crab, shorebirds and racoon; white-tailed deer is also important. At the ceramic coastal shellmidden of Monagrillo, shellfish, in-shore fish and crab are major dietary items, as are white-tailed deer. Although plant remains have not been reported for either site, the presence at both sites of processing tools, edge-ground cobbles and milling stone bases, suggests that plants provided an important part of the diet (both wild and possibly domesticated given the occurrence of maize at contemporary inland sites).

At Aguadulce, a coastal plain preceramic/ceramic rockshelter, terrestrial fauna dominate, particularly white-tailed deer, armadillo, racoon, rodents, rabbit, reptiles, frogs, turtle and bird; also present are moderate amounts of fish, shellfish and crabs. In the preceramic site layers, seasonal swamp plant taxa are present (the major phytolith type being Marantha [arrowroot family]); the major macrobotanical remain is palm nut fragments; ceramic-bearing layers (associated with Monagrillo pottery) contain maize phytoliths. Edge-ground cobbles and milling stone bases were recovered in both ceramic and preceramic layers.

In contrast, aquatic resources in mid-elevation preceramic/ceramic locations (e.g., Cueva de los Ladrones) are minimal to absent; in these instances terrestrial fauna (white-tailed deer, peccary, agouti, paca, armadillo and rabbit) constitutes the major non-plant dietary component. Present, albeit in small numbers, are rodent, bird and lizard. Both maize pollen and phytoliths are present in the preceramic layers of some (but not all) sites. Commonly associated with intensive maize cultivation in later sites from Central Panama is the mano-metate complex; this complex is absent from all the above locations. Ranere and Cooke (1987) suggest that this implies that other agricultural crops were perhaps more important than maize in the diet--what these plants might have been is presently unknown. The size and distribution of settlements and the nature of the production system suggests that pre-1st millennium B.C. social groups consisted of several small families co-residing at specific locations temporarily. What the primary domestic unit was and how tasks might have been divided, e.g., along gender and/or age lines, is unknown (cf. Conkey and Spector 1984, Leibowitz 1983).

The 1st millennium B.C. subsistence economy at La Mula-Sarigua was based on a combination of cultivated plants, primarily maize and sea resources, i.e., shellfish and in-shore fish; relatively small amounts of white-tailed deer, armadillo, reptiles and rodents are present (Chapters VIII and IX).[4] The kinds of foodstuffs at La Mula-Sarigua are not significantly different from that of the previous period, however, the quantity, specifically that of maize, is quite different. That maize and sea resources were the important dietary items is supported by stable isotope analyses of the human remains (see Chapter VIII).

The cultivation of maize at La Mula-Sarigua reflects an intensification in one aspect of the subsistence endeavor. On the basis of site size and reliance on maize, it is likely that the site was occupied year-round at least by some groups. Perhaps a part of the population at La Mula-Sarigua migrated seasonally as well, continuing the pattern of seasonal transhumance which characterized earlier periods and which is still practiced today, albeit on a much reduced scale (see Rafferty [1985] for definitions of sedentariness).

What is important for the present discussion is how labor might have been organized, particularly in this instance where seed agriculture has become a major production activity; in such instances, "all other subsistence activities, even those indispensable to a balanced diet, are complementary. They are never undertaken at the expense of agricultural activities (Meillassoux 1981)." This latter statement is particularly apropos to those who live(d) in the highly seasonal environment of La Mula-Sarigua. In this part of Panama (the Pacific littoral) maize cultivation is hazardous; and precipitation during the first 60 days of growth is critical. One who plants in November or December (end of the wet season) for a February or March harvest runs a high risk of losing his crop through drought. The optimum period for planting is May or June. The population at La Mula-Sarigua must have scheduled cultivation activities according to seasonal changes in weather in order to ensure good harvests. The fact that harvests were adequate is supported by population size estimates, overall duration of occupation and the absence of nutritional deficiencies among the human skeletal remains (aquatic resources must also be considered).

Drawing upon the archaeological record of Western Panama (Linares and Ranere 1980) and its present-day analog, the Guaymi of Western Panama (cf. Bort 1976, Young 1971),[5] it is not unreasonable to assume that at La Mula-Sarigua agricultural activities were carried out by the household unit, i.e., this unit then could be considered the daily domestic production/consumption unit. Nonetheless, larger groups may have regularly cooperated in activities like clearing land, weeding fields and, less frequently, in harvesting. Among the Guaymi, such cooperation is reciprocal and is organized by and composed of males, although females often participate as well (Bort 1980:496, Young 1980:230).

Other subsistence activities represented at La Mula-Sarigua, e.g., fishing, shellfish gathering and hunting, may (although need not) have been the objects of collective investment of several domestic units. At La Mula-Sarigua, the predominant fishing technique was surely hook and line; the construction and use of nets, etc., was minimal. The latter argues against fishing as a group activity. Among the Guaymi, day-time hunting is a male group activity, night-time hunting is a solitary endeavor (Young 1971). It is difficult (if not impossible) to evaluate the organization of labor relative to hunting at La Mula-Sarigua; it is equally difficult to assess the organization of shellfishing activities.

Nonetheless, the subsistence mode at La Mula-Sarigua differs from the pre-1st millennium B.C. pattern and is accompanied by major technological changes; the implications of this combination are considered in more detail below.

Non-Subsistence (on- and off-site) Activities. The major non-subsistence activities documented were the manufacturing of stone tools and pottery. It would also appear that a certain amount of work went into the construction of shaft-tombs. Stone tools: It is clear that chipped stone tool production (some forms of which were the work of specialists [discussed in Chapter VI and below]) occurred on a massive scale at La Mula-Sarigua. With a quarry on-site, it is obvious that special expeditions were not necessary for the exploitation of the raw material; it seems reasonable to assume further that these raw materials could have been exploited and/or worked upon by anyone at any time and/or in conjunction with other activities. That a tremendous amount of the manufacturing debris is associated with probable domestic locations (Chapter IX) indicates that lithic production was carried out by most (if not all) households on the site, i.e., access to on-site quarry resources was not restricted. In contrast, raw materials used in the manufacturing of imported ground stone tool types would have required expeditions, that is, if they were made by "special task (labor) units" from La Mula-Sarigua. That these latter tools were standardized in form, and no doubt the work of at least part-time specialists, has been addressed in Chapter VI and below. The most obvious question to ask at this point is, "were these tools the work of specialists from La Mula-Sarigua?"

If the ground stone tools, particularly celts,[6] present at the site were manufactured by labor units from La Mula-Sarigua, then one would expect to recover toolkits associated with either their manufacturing and/or with their repair, e.g., pecking hammers, whetstones and pebble polishers; (e.g., the grave of a repairman with this associated paraphernalia has been recovered from Sitio Sierra in deposits dating between 240 ± 80 B.C. and 25 ± 80 B.C. [Cooke 1979]). One might also expect to recover skillfully reworked celts on site (Ranere 1980b). Although a number of pecking hammers have been retrieved from La Mula-Sarigua, there is no evidence to suggest that they might have been used to repair celts exclusively; neither whetstones nor polishers have as yet been identified. With the number of celts present at La Mula-Sarigua combined with the fact that they become damaged and dulled through use, one might assume that if site occupants had made these tools, they might have been equally as competent to repair them. Ninety-five percent of the recovered celts are fragments. While the majority of these fragments have been reused as hammers, there is little to no evidence (absence of repair toolkits and/or associated maintenance flake debris) to imply that they had been skillfully repaired prior to their reuse. On the basis of this evidence, the most parsimonious interpretation of these celts is that they were made by male specialists from another site. This is the earliest indication in the Central Panama prehistoric record for the existence of exchange networks.

Although celts are widely distributed across the site, other imported ground stone implements, specifically those used in food processing, are not (Chapter IX). Both breadboard metates and bar manos, and non-breadboard metates and non-bar manos (present in relatively small numbers) occur in some (domestic?) loci. This pattern can be interpreted in a number of ways. (1) Only some households had access to imported food processing tools--an unlikely scenario given the community's reliance on maize. (2) Grain processing occurred in discrete localities; they are clearly not as numerous nor as widely distributed as utilitarian points or pots (see below). Of course, given probable high breakage rates for points and/or pots, and a long use-life for metates and manos, we shouldn't expect the latter to be as numerous as the former. Whether discrete processing areas are present awaits the completion of the feature analyses. (3) Breadboard metates and bar manos may not have been in use as long as other tools; i.e., they may have been used only at the end of the 1st millennium B.C., and therefore, would be missing from some domestic contexts which were occupied earlier and then abandoned. Evaluating this proposition is contingent upon the completion of the regional classifications and the on-site feature analyses. (4) Breadboard metates and bar manos may simply be under-represented in the La Mula-Sarigua sample, i.e., their low numbers may be an artifact of the research collecting strategy and/or present-day collecting by local residents. As with the celts, unfortunately, the manufacturing location of metates and manos is unknown.

Specialized stone tool production akin to the off-site manufacturing of celts, breadboard metates and bar manos may have occurred at La Mula-Sarigua as well, since standardized unifacial points were produced in some numbers within the site's boundaries. Unlike the previously discussed implements, however, unifacial points are widely distributed across the site and are found either within or slightly adjacent to domestic loci. This indicates that the production of unifacial points may have been in the hands of most households; certainly they were used by most. Whether or not any of these points are being exported can not be assessed until the feature content analyses (e.g., flake:tool ratios) have been completed.

Pottery: Manufacturing locations have not been identified within La Mula-Sarigua site boundaries. There are, however, several locations where burnt clay is concentrated. Whether or not these represent ovens has not been investigated. One cannot argue, therefore, either for or against large scale pottery production at La Mula-Sarigua. Nonetheless, the fact remains that during the 1st millennium B.C., there are a minimum of 4 ceramic Groups which are broadly contemporaneous at La Mula-Sarigua.[7]

Unquestionably, each Group is manufactured with considerable care and appears to be represented by distinctive clay types, temper, paste, exterior and/or interior surface treatments, and/or vessel shapes. These differences, particularly clay types and temper, suggest that each Group was produced at a different locality. Of course, this needs to be verified through techniques such as neutron activation analysis, X-ray diffraction, etc. (Bronitsky 1986). There are at least three ways to account for the co-occurrence of these distinctive ceramic Groups at La Mula-Sarigua:

(1) they represent labor units from La Mula-Sarigua going off-site to manufacture pottery;

(2) they represent exchange with off-site social units;

(3) they represent the coming together of different social units at La Mula-Sarigua.

The first interpretation seems unlikely. A number of these ceramic Groups are widely distributed in Central Panama. Moreover, the plastically-decorated and painted wares contain designs (abstract motifs) which appear to reflect distinctive ideologies (Cooke 1984, personal communication). If the community at La Mula-Sarigua is comprised of specialized task units from different social groups (Stone 1962, cf. Howe 1986), one might expect some spatial segregation of ceramics by Group. Distribution maps of Lamula, Aristide, Sarigua and Tonosi ceramic Groups (Figures 53-56) do not generally display discrete localities by group; rather co-occurrence is the norm. This implies that #2 is the best interpretation of the data at present. Of course, this interpretation does not negate the possibility that such exchanges included people from other social groups (see below).

Relative to the pre-1st millennium B.C., this pattern implies an intensification in the distribution (exchange) of goods (and perhaps people as well). As with lithic manufacturing locales, comparative information on ceramic manufacturing locales is absent.

Burials: In contrast to pre-1st millennium B.C. patterns, it is during the latter half of the 1st millennium B.C. occupation at La Mula-Sarigua that regional burial practices become more variable. Those given the most careful treatment are buried away from habitation sites in formal disposal areas in isolated shaft-tomb cemeteries, such as Cerro Guacamayo (Harte 1958), and perhaps Juan Diaz (Cooke and Ranere, personal communication), with grave goods, most notably, breadboard metates and 1st millennium B.C. ceramics; those given the least careful treatment are buried within habitation zones, as is the case at La Mula-Sarigua. Practices at La Mula-Sarigua include bundle burials of disarticulated bones with grave offerings (?), flexed burials with no associated material and miscellaneous body parts disposed in trash pits. Despite the small sample size for 1st millennium B.C. burials, it does seem clear that differential treatment of the dead was widespread (cf. Dillon 1984). Ethnographic data indicate that the use of formal disposal areas is strongly correlated with increasing social distinctions (Binford 1971, Brown 1971, Goldstein 1976, Saxe 1970). The fact that some individuals were buried at a distance from habitation sites in large shaft-tombs and were accompanied by grave goods suggests that they might have held a higher social position within the society than those individuals buried within habitation sites in shallow pits without elaborate grave goods. These conclusions seem to argue for an emerging social hierarchy not clearly discernible from interpretations of the artifacts alone.

Relevant Questions

Site Permanence. Prior to the 1st millennium B.C., there is no evidence which suggests that settlements in Central Panama were permanently occupied. La Mula-Sarigua itself does not appear to be permanently occupied until 400-300 B.C., to judge from site size and the density of debris attributed to earlier occupations (i.e., those represented by the Monagrillo, Aguadulce-Ladrones and Early ceramic Groups). Certainly by 200 B.C., a number of large sites were permanently occupied; contemporary with them are a number of specialized processing (lithic and/or foodstuffs) stations.

Site Permanence and Subsistence Economy. The cultivation of some plants, particularly maize, was practiced considerably earlier (over 4000 years earlier, in fact) than the first evidence for permanent settlement in Central Panama. Nonetheless, the data from this 4000 year long period indicate that cultivated crops were probably not--and maize was certainly not--

major components of the diet (Ranere and Cooke 1987). Instead, a wide variety of wild plant foods and fauna, both terrestrial and aquatic, made up the bulk of the diet. This scenario is supported both by (1) botanical and faunal remains recovered from pre-1st millennium B.C. deposits and (2) stable carbon and nitrogen isotope ratios for human skeletal remains dating to this period from Central Panama (Norr 1983, 1988).

Coinciding with sedentism is an intensification in the cultivation of plants (maize and perhaps squash); shellfish and fish continue to be important components of the diet, while terrestrial fauna and wild plants were considerably less significant, at least at La Mula-Sarigua (also supported by Norr's analyses on human skeletal remains from La Mula-Sarigua, personal communication).

Further, indirect evidence for maize intensification during the 1st millennium B.C. is supported by the initial appearance of specialized maize processing equipment (manos and metates) and large numbers of forest clearing tools (celts).

Subsistence Economy and Maize Agriculture. Based on the foregoing, it does seem clear that 1st millennium B.C. groups were highly dependent upon maize agriculture.

Maize Agriculture and the Environment. On the matter of regional climatic change, the jury is out. The analysis and interpretation of pollen and phytolith data from La Yeguada (discussed in Chapter II) and other coring localities are presently underway. I will not, therefore, consider the consequences of possible changes until the verdict is in. I can, however, theorize on the <u>impact</u> of intensified agriculture on the local environment (specifically that surrounding La Mula-Sarigua).

Although La Mula-Sarigua sits adjacent to a band of alluvium, this band is not recent in origin and occurs at elevations not subject to flooding. In other words, it's productivity is not replenished by overbank silting--as is common along the larger rivers, such as the Santa Maria. Sustained crop production at La Mula-Sarigua, therefore, was contingent, in part, upon proper land management (see Chapter II). Poor land management over the past two to three decades, primarily overburning and overgrazing, has led to extensive sheet erosion, deeply entrenched gullies and low to no crop productivity over large areas in the vicinity of La Mula-Sarigua. An earlier episode of poor management leading to reduced productivity of La Mula-Sarigua agricultural lands is certainly plausible (although untested).

In addition to the above, one piece of information suggests that the La Mula-Sarigua environs had begun to change around the time of Christ; and that the surroundings had been considerably changed by the time of its Period VI-VII re-occupation (see Chapter II). By A.D. 1000 newly-formed alvinas were created in front (north) of the site (Clary et al. 1984). The presence of alvinas and lack of vegetation would have affected the livelihood of the site's occupants (as it affects area residents today) in at least three important ways. Firstly, during the dry season high winds pick up salty sands from the alvinas; these windstorms have a deleterious effect on agricultural production (Chang 1985) and they make life very unpleasant. Secondly, high rates of evapotranspiration would have reduced the availability of potable water (Chang 1985). And, thirdly, in addition to soil degradation, deforestation would have resulted in a loss of cooking wood.

The above discussion begs the question: was Mula-Sarigua less intensively occupied (depopulated?) at the end of the 1st millennium B.C. due (at least in part) to poor land management and/or the formation of the alvina? And if so, why was the site repopulated on a large scale in Period VI (sometime after ca. A.D. 1000)? Although each needs further investigation, there is some evidence, i.e., an abundance of handled tecomate jars in the late ceramic assemblage (Period VI-VII), which suggests that salt boiling was an important activity and that the alvinas themselves were being heavily exploited.

Population Dynamics. Given the data available (see endnotes #2 and #3), it is not possible presently to argue conclusively for/against population increase during the 1st millennium B.C. What does seem clear, however, is that people are grouping together in larger numbers and in fewer locations than in previous periods, and they are forming large permanent aggregated settlements, i.e., there is an increase in population density in a few sites. This may be more important than an increase in regional population numbers per se, particularly given its implications for labor allocation and for the emergence of a hierarchically-ordered power structure. Aggregated settlements are firmly entrenched (in some locations) by the time of Christ.

Technology. There are continuities and changes in both pottery and lithic production relative to pre-1st millennium B.C. assemblages. The following is a summation (where possible) of information presented in detail in Chapter IX.

Pottery which predates 1000 B.C. (e.g., Monagrillo) is found in widely scattered locations, albeit in relatively few sites (including La Mula-Sarigua), and in relatively small numbers. It is represented by few vessel shapes, lacks appendages and is rarely decorated. In contrast, ceramics of the following period are characterized by a number of diagnostic attributes; they display a variety of vessel forms, appendages, interior and exterior treatments, pastes and temper. Alone and/or in combination, ceramic Groups attributed to the 1st millennium B.C. are widely distributed throughout the region and occur in quantity at some sites, e.g., La Mula-Sarigua. This pattern continues and intensifies after the height of occupation at La Mula-Sarigua.

Lithic industries which predate the 1st millennium B.C. are dominated by simple reduction strategies which produce flakes suitable for use without much post-detachment modification (Ranere 1984). Flakes are usually made of locally available material and used at or near their production loci. Ranere (1980b) considers this industry to be household in nature as confirmed by the presence of cores and flakes in both large and small regional sites. Co-occuring with this industry is the edge-ground cobble/milling stone base complex which is used (neither tool requires pre-use modification) to mash/pound foodstuffs; probably also "in the hands of the household, or at least of the local community (Ranere 1980b)." This complex occurs and continues to be important at La Mula-Sarigua throughout much of the 1st millennium B.C.; it disappears by 200 B.C. in both Central and Western Panama.

In contrast, during the 1st millennium B.C. chipped stone technology changes in important ways. Cores are carefully prepared for the detachment of long, pointed flake/points; these have been modified (stemmed) for hafting and used in everyday household activities, e.g., scraping, cutting, perforating. In addition, some cores and large flakes have been carefully (albeit less so than the flake/points) unifacially flaked around their perimeter; they have been used for heavy woodworking activities in areas outside the household. Both the flake/points and scraper-planes are very abundant at La Mula-Sarigua (and perhaps a few other 1st millennium B.C. sites); at least at La Mula-Sarigua both have been produced on the site of locally available cryptocrystalline silica. Both occur in minimal numbers in a few sites pre-dating the 1st millennium B.C.; flake/points continue to be produced until ca. A.D. 500 in the Central Region.

Carefully manufactured ground stone tools (i.e., pear-shaped celts and chisels) do not appear in massive numbers in the region until the 1st millennium B.C. occupation at La Mula-Sarigua. They are clearly not manufactured on the site and they are not produced on locally available materials. Ground stone tools, such as legless breadboard metates and bar manos, occur for the first and last time during this period, both at La Mula-Sarigua and elsewhere in the region. As with the celts and chisels, they are neither produced locally nor are of local materials.

Some ground stone tools (e.g., non-breadboard metates, non-bar manos, trapezoidal celts and several stone beads) found at La Mula-Sarigua are reminiscent largely of post-1st millennium B.C. contexts. They occur in minimal numbers at La Mula-Sarigua but are particularly abundant in some sites which post-date the peak of occupation at La Mula-Sarigua (i.e., in Period VI-VII). Nonetheless, at Sitio Sierra table metates with legs and cobble-type manos do occur in small numbers on house floors dated between ca. 65 B.C.-A.D. 25, and stone beads occur in the 240 B.C. cemetery (Cooke, personal communication). Irregardless, evidence from La Mula-Sarigua suggests that none of these tools are locally produced, nor are they produced on locally available materials. Interestingly enough, with the exception of the beads, all imported ground stone tools (1st and post-1st millennium B.C.) serve utilitarian purposes; the food-processing implements, however, appear to be differentially distributed at La Mula-Sarigua (see above for alternative explanations for this distribution).

Craft Specialization and Exchange. There are two lines of evidence to suggest the existence of at least some specialized craft production (albeit perhaps part-time) during the 1st millennium B.C.: (1) use of standardized techniques of manufacture and (2) a high degree of consistency in the size and shape of the finished product (Torrence 1981). Production is neither specialized nor consistent prior to this time period; in subsequent periods specialized production of relatively uniform tools is commonplace.

The ceramic analysis (Chapter VII) was primarily undertaken in order to develop a classification of temporal relevance. Nonetheless, certain manufacturing trends are apparent. Although there is marked variety between the four ceramic Groups of the 1st millennium B.C.; there is much less variety within each Group. Within each Group, and/or "type" therein, there is a strong tendency towards technological uniformity, e.g., in vessel shape and size, and more careful treatment of the vessel surface. Such observations suggest that at least some groups (or individuals within groups) spent a considerable amount of time in ceramic production. This suggestion combined with that discussed above (i.e., each ceramic Group was probably the work of a different social unit), further suggests that at least some ceramic specialization occurred between (if not also within) communities.

One goal of the lithic analysis (Chapter VI) was to assess the nature and degree of uniformity within specific tool forms by systematically recording tool attributes, such as size (length, width, thickness, etc.) and shape (cross-section and planview). An interpretation of the results of that analysis implies specialization in the production of some ground stone tools, i.e., breadboard metates, pear-shaped and trapezoidal celts; the fragmented nature and/or small sample size of other ground stone tools negated such inferences. Although the evidence is inconclusive at the moment, there is also the strong suggestion that the unifacial points are also the work of specialists.[8] That the ground stone tools are produced off-site, and the points on-site, reinforces the notion that some specialization occurred between communities.

Early evidence for between community specialization can be interpreted in one of two ways: (1) it may imply some form of centralized craft production, and therefore, a centralized distribution center (Brumfiel and Earle 1987, Tosi 1984) or (2) it may imply cooperative (reciprocal) arrangements between communities (e.g., Levi-Strauss 1969, Sahlins 1972). The presence or absence of centralized craft production and distribution is difficult to assess conclusively given the lack of comparative data on raw material sources and manufacturing workshops in the region. Nonetheless, the PSM regional survey did not detect any evidence for redistribution centers among the 1st millennium B.C. sites examined (but see endnote #2). Further, there is no evidence which might suggest the presence of a fixed authority, i.e., an individual or small group, capable of extorting goods and/or services from a majority. Therefore, the flow of goods, specifically pottery and ground stone tools, between communities is more parsimoniously explained as a product of cooperative (as opposed to coercive) arrangements. Inter-community specialization combined with a mechanism for the distribution of such goods indicate multi-community interdependence on a scale not evident prior to the 1st millennium B.C. However, the mechanism(s) involved in these arrangements for the 1st millennium B.C. cannot be addressed without further reference to the wider socioeconomic sphere within which La Mula-Sarigua operated (discussed below).

<u>A Potential Mechanism for Change: Intensification and Regional Dynamics during the 1st Millennium B.C.</u>

Pre-5000 B.C. occupation in Central Panama consisted of widely dispersed, small transient groups whose resource base (subsistence) was composed of terrestrial hunting-gathering

(Ranere and Cooke 1987). This base was significantly broadened sometime around 5000 B.C. This broadening, which seems to have been carried out within a pattern of seasonal transhumance, included fishing, shellfishing and the small-scale cultivating (gardening) of maize (and other domesticates) in some mid-elevation locations (Piperno et al. 1985, Ranere and Cooke 1987). Despite the addition of pottery around 2500 B.C., there is little change in the lithic assemblage. Burial data displays little to no social differences. Nonetheless, the thoroughly cannibalized remains of 5 individuals recovered from preceramic contexts at the Aguadulce Shelter (Ranere and Greenfield 1981) suggests that all was not well. Ranere and Greenfield (1981) have interpreted this occurrence of cannibalism as an event triggered by extreme nutritional stress, as opposed to a ritual event.

La Mula-Sarigua was itself occupied during this period from ca. 2500-1000 B.C. as evidenced by the presence of Monagrillo, and Aguadulce-Ladrones ceramic Groups. The quantity and spatial distribution of these Groups at La Mula-Sarigua is not incongruent with short-term occupation.

During the 1st millennium B.C., however, this earlier pattern of settlement at La Mula-Sarigua gives way to one of permanent occupancy by a much larger population. The subsistence economy is characterized by the intensive exploitation of one resource in particular, i.e., arable land; the sea is also utilized but no more so than during the previous period at sites like Monagrillo and Zapotal.

Pertinent to the present discussion is the concept of self-sufficiency. It is apparent that the La Mula-Sarigua community was able to produce the foodstuffs it needed to maintain and perpetuate itself, primarily through the exploitation of arable land and the sea, both directly adjacent to the site. However, the initial step towards manipulating the former resource was the clearing of land, accomplished through the use of tools--celts--not manufactured by local residents but by males of another community. Although further labor input, e.g., in the form of preparing the field, planting, (perhaps) weeding and harvesting, was essential prior to processing the harvest, there is no archaeological evidence, such as digging sticks, digging stick weights or blades,[9] which suggests which tool(s) might have been used in these activities. Nonetheless, once the harvest was reaped, the staple crop--maize--was clearly processed with metates and manos. These also were manufactured by another community. Viewed in this light, it is clear that the La Mula-Sarigua inhabitants were not as self-sufficient as one might think by considering only proximity to resources as the sole determinant. Rather, the cultivation process (from field to table so to speak) of this population was dependent, in part, upon the resources, labor and skills of populations from other communities.

Manufacturing techniques of the 1st millennium B.C. are marked by both continuities and changes from previous periods. At La Mula-Sarigua (comparative data is unavailable for other 1st millennium B.C. sites), continuities are strongest for the edge-ground cobble/milling stone base complex; changes occur in the manufacturing of chipped stone, ground stone and ceramics. Changes in both lithics and ceramics are accompanied by increased standardization in the end-product, suggesting craft specialization. Based on the availability of the raw materials and standardization in production, craft specialists occur both at La Mula-Sarigua and other sites as well. However, this does not necessarily imply that craft production was a full-time occupation.

According to Meillassoux (1981), full-time specialization means the exclusive practice by an autonomous productive (specialized) unit of a non food-producing activity which requires the continuous transfer of foodstuffs in order to maintain its existence. There is no evidence to suggest the presence of such "autonomous productive units" at La Mula-Sarigua or at other 1st millennium B.C. sites (although one must remember that these sites have yet to be examined in any detail). Instead, some non-subsistence goods (albeit subsistence or utilitarian related [tools and ceramics][10]) are being produced and circulated between communities; part-time specialization is, therefore, implied.

Burial data provide hints of emerging social differences within the region (cf. La Mula-Sarigua graves and spatially isolated shaft-tomb cemeteries with grave goods). This pattern of social differentiation and intensification of production, circulation (of goods) and social interaction, initiated during the 1st millennium B.C., is further amplified over the next several hundred years (see Chapter II).

Rethinking La Mula-Sarigua

Within non-state agricultural communities socioeconomic relations are primarily held together by kinship ties and marriage alliances. Such communities tend to produce for two purposes: (1) their own subsistence and (2) a surplus to support a ceremonial fund, in the form of gifts and feasts. In ceremonial life lies "the seeds of increased demands, more food for feasting, more goods for exchange, more intensive relations between elder and initiates ...(Bender 1981:154)." Embedded in all of this is the need to intensify production for the purposes of intergroup gatherings and exchange, i.e., for the maintenance and continuance of the social relations. In fact it is these latter relations which structure the dissemination of goods (including land), services, people, knowledge and so forth.

Although the Panamanian ethnohistoric record is rich in descriptions of social relations, particularly those concerning alliances between chiefs,[11] (e.g., Espinosa 1913, Helms 1979, Oviedo 1944, Sauer 1966), it is noticeably depauperate in descriptions pertinent to non-elite lifeways and social interactions.

Given the dangers of extrapolating from ethnohistoric records (even the relatively reliable one from Panama) and the incompleteness of the archaeological record of Central Panama for the 1st millennium B.C., it is feasible only to discuss the "potential" processes involved in socioeconomic relations of the period. An interpretation of the evidence for this period suggests that communities concentrated on the production of specific kinds of goods and that these goods were circulated by cooperative relations of exchange. In addition to material provisioning, these relations encompass marriages, the latter of which form the basis of alliances between kin groups.[12] That some form of alliance system may have existed during this period can perhaps be deduced from the presence at La Mula-Sarigua of ceramic Groups with distinctive abstract motifs (representing particular ideologies of particular social groups).

Although such alliances facilitate inter-group cooperation, they can also set the stage for the emergence of social differences. This can be done in at least one of two ways (Bender 1985):

1. controlling access to socially valued material items.
2. controlling access to social or ritual knowledge deemed essential for initiation into adulthood and hence into marriage and economic independence;

At present there is no solid evidence to suggest that access to material items (e.g., lithic sources suitable for manufacturing breadboard metates, bar manos or celts) or knowledge was managed. It is necessary, however, to offer some explanation for the differential burial patterns which occurred during the 1st millennium B.C. Particularly germane to the present discussion is the singling out of individuals for interment in tombs in isolated cemeteries. It is possible that these tombs may have been part of a ceremony that occurred within a context of social gatherings and exchanges. In this case, ritual was a communal endeavor and "the individual singled out may have achieved `status' only in death (Bender 1985:57)" (cf. Dillon 1984). Alternatively, it may be that those singled out performed some important function while alive, e.g., in rituals and/or politics. These tombs then "may represent a body of knowledge to which access was limited--was to some degree institutionalized and controlled...[and] may signal slight social variation played out in life as well as death (Bender 1985:57)." Of course, the range of social variation, if present, can only be verified through additional research.

Concluding Remarks

More often than not, societal transformations have been examined within a framework which concentrates on predetermined categories, such as bands, tribes, chiefdoms and states (e.g., Fried 1967, Service 1962). Embedded within each category are descriptive traits based (often exclusively) on the end-products of societies, i.e., the surviving material remains; these traits presumably reflect how societies were organized. Unfortunately, such a strategy encourages researchers to pigeonhole societies into an either/or category, and/or to refine their list of traits if their data do not fit neatly into a particular category (e.g., Feinman and Neitzel 1984). The most notable example of the above scheme applied to Costa Rica and Panama has been that of Creamer and Haas' (1985).

An alternative, and perhaps more fruitful, approach to that above would be to focus on socioeconomic considerations (as I have attempted herein), although some may see this method as unnecessarily socially and/or economically deterministic. Nevertheless, such a focus does not deny the fact that societies face a variety of perturbations, e.g., environmental crises, increases in population density, hostilities within and/or between groups, etc., which obviously need consideration. But societies must ultimately make provisions to cope with such interruptions, as well as make arrangements for the regular replacement of workers, the division of labor and the distribution of goods; and these provisions must be made in a manner either acceptable to or forced upon its members (Howard 1986). That is, they are made within the confines of "particular" socioeconomic relations. And insofar as these relations are dynamic, they are susceptible to change. Such a view implies that it is neither possible to evaluate processes of change prior to defining the particular form(s) of the socioeconomic relations, nor is it possible to "slot" societies according to some predetermined classificatory system. In keeping with this view, I have attempted to define socioeconomic structures at La Mula-Sarigua (and elsewhere in Central Panama) during the 1st millennium B.C. while resisting the temptation to pigeonhole them.

Although the present research has provided much of the data necessary for defining the general form of socioeconomic structures for the period under investigation, it has not enabled me to identify and interpret the cause(s) and processes involved in the apparent transformation. Nonetheless, a definition of the general form is essential to the analysis of causes and, therefore, a necessary, but not sufficient base for explaining socioeconomic change during the 1st millennium B.C. in Central Panama. It is, however, a step in the right direction and provides a foundation upon which future research can be built.

Endnotes

1. These figures reflect the overall distribution of specific ceramic Groups. Given the incomplete analyses of the features, it is not possible presently to ascertain whether these figures represent the areal extent of houses, small activity areas, permanent and/or temporary occupation. Nonetheless, their areal

extent at La Mula-Sarigua is not inconsistent with that at the type site of Monagrillo; a site which was probably seasonally inhabited (Hansell 1979, Cooke, Ranere and Hansell 1980).

2. It is necessary to keep in mind that the regional PSM survey covered 2% of the Santa Maria River watershed and located sites based on the presence of preserved surface remains. In particular environmental contexts, such as the alvina, not all ceramic groups will preserve equally as well (if at all), e.g., Monagrillo and Aguadulce-Ladrones. Further, in areas of rapid alluviation early materials are buried under meters of earth and, hence, not visible on the surface. In contrast, the surfaces at La Mula-Sarigua are eroded and deflated making 1st millennium B.C. materials extremely visible.

With some sites buried, and/or parts of some surface sites buried, it is likely that PSM figures underestimate the sizes of some 1st millennium B.C. sites.

3. Relative population estimates have as yet to be determined for the region. Pre-ceramic and early ceramic period sites (perhaps) are representative of highly mobile groups; at least some later period sites reflect less mobility; in fact some are clearly sedentary locations. It is, therefore, problematical to compare numbers of people within and/or between sites and/or periods. (Also see endnote #2). In the absence of the above data, I am using site numbers, sizes and function (where available) to argue for/against population increase.

4. The faunal sample from La Mula-Sarigua, as do all the Panamanian archaeological faunal samples, reflect the proximity of specific habitats. Therefore, the relative proportions of animal food remains can be explained, in part, in terms of optimal foraging alone. For example, at La Mula-Sarigua it should not be surprising that the bulk of these remains (aquatic) comes from habitats adjacent to the site.

The poor representation of specific fauna at some sites, such as the white-tailed deer at La Mula-Sarigua (cf. Monagrillo [Cooke 1984, Table 10.4]), may represent further environmental degradation and a history of human over-hunting in the region, rather than specialization directed towards other resources (Cooke 1977, 1978b, 1984, Cooke and Ranere 1988).

To summarize: the relative proportions of particular faunal assemblages in specific archaeological sites reflect: (1) habitat, (2) abundance, (3) preservation (see Chapter VIII), (4) environmental degradation and/or (5) over-hunting.

5. Although it is dangerous to extrapolate results from Western Panama to the Central region, comparative ethnographic information is not available for the latter area.

6. Other ground stone tools manufactured outside the site's confines are metates and manos. Unlike celts, metates and manos are either self-sharpening, or require minimal pecking to their surfaces. Such pecking does not require a special toolkit, rather a variety of implements found on the site will suffice, e.g., edge-ground cobbles, pestles, cores, hammerstones. Because the manufacturing and/or repair of celts requires special paraphernalia (a toolkit), I have focused on this class of ground stone tools to argue for imported tools being the work of specialists outside the site.

7. At La Mula-Sarigua, Lamula, Aristide, Sarigua and Tonosi ceramic Groups appear to be contemporaneous in contexts dated between 400-200 B.C. It is possible, however, that temporal overlap between some of these Groups is slight or nonexistent. Additional excavations are necessary in order to verify absolute contemporaneity of these Groups.

8. An alternative explanation is that every household had access to the skills necessary to produce these tools and that their standardization represents a cognitive norm.

9. Given preservation conditions at La Mula-Sarigua it is highly unlikely that digging sticks would have survived. There are, however, two flakes with sickle sheen. The raw material for both tool types can be found within the sites boundaries. The production of neither would have required the skills of a specialist.

10. The majority of vessel shapes, e.g., plates, bowls, tecomates, indicate that most serve utilitarian purposes.

11. A few examples follow:

(1) Estas mugeres no las toman de lengua e gente extrana e los senores las procuran de las aver que sean hijas de otros senores o a lo menos de linaje de hombres principales (Oviedo 1944, Vol. 8:52).

(2) After the death and funeral of the old chief, (Oviedo writes), all the population assembled and the eldest men of the tribe carried the new chief to his sleeping quarters where they placed him in his hammock. Then all his vassals filed by, each one making a gift: maize, foul, fish, wild pig, venison, fruit and anything else the land produced. After this ceremony, dancing and drinking started and continued for two or three days. Songs recorded the genealogy of the preceding chiefs and their accomplishments. More particularly

the friendship and enmity between the dead chief and his neighbors were proclaimed and the causes set forth. After the conclusion of this musical analysis of the state of the tribe, the new chief dispatched messengers to the neighboring chiefs to announce the death of his predecessor and to inquire as to their attitude towards the new ruler. Advantage often was taken of this occasion to reconcile old breaches to cement former alliances...(Lothrop 1937:22)."

(3) Ritual games, e.g., the balseria (a stick-throwing game) have been documented for as early as the 16th century (Espinosa 1913:176). Nonetheless, it is likely that prehistoric Central Panamanian ceremonial sites, e.g., El Cano and Sitio Conte, may have been used to celebrate such games (Cooke 1984:289). The balseria, in particular, was practiced by the Guaymi (Ngawbe) until 1961 (Young 1971:216).

For the Guaymi, the balseria functioned as an agricultural ritual, as well as:

> "the last (and the only formal) step by which a Ngawbe achieved recognition as a man of great importance ...as a means by which a man could ultimately test his power by requesting the resources of his kinsmen...of importance to Ngawbe society as a whole was the function of balseria for periodic renewal of social interaction among dispersed people (Young 1971:211-212)."

12. Among the Guaymi such alliances serve to create networks of affinal rights and obligations in one generation and broaden the possible residence and land use rights in the next; land and other forms of property are collectively owned and use-rights administered by the senior members of the collective (Young 1971).

REFERENCES

Adams, Robert McC.
1966 The Evolution of Urban Society. Aldine, New York.

Adams, John K., C. Dere and P. Hansell
1982 Sedimentological Facies Associated with Archaeological Sites in Central Pacific Panama. Paper presented at the 11th International Congress on Sedimentology, Hamilton, Ontario.

Aldenderfer, Mark S. (ed.)
1987 Quantitative Research in Archaeology: Progress and Prospects. Sage Publications, Inc., Newbury Park.

Arkin, Herbert and Raymond R. Colton
1970 Statistical Methods. The Barnes & Noble Outline Series, New York.

Asch, David L.
1975 On Sample Size Problems and the Uses of Nonprobabilistic Sampling. In Sampling in Archaeology, edited by James W. Mueller, pp. 170-191. University of Arizona Press, Tucson.

Atlas de Panama
1975 Atlas de Panama. Panama.

Bailey, Geoff (ed.)
1983 Hunter-Gatherer Economy in Prehistory: A European Perspective. Cambridge University Press, Cambridge.

Bartlett, A.S. and E.S. Barghoorn
1973 Phytogeographic History of the Isthmus of Panama During the Past 12,000 Years (A History of Vegetation, Climate and Sea Level Change). In Vegetation and Vegetational History of Northern Latin America, edited by A. Graham, pp. 203-299. Scientific Publishing Company, New York.

Bateman, J. T.
1860/61 Account of a Visit to the Huacals or Ancient Graveyards of Chiriqui. Bulletin of the American Ethnographical Society 1:28-33.

Baudez, Claude F.
1963 Cultural Development in Lower Central America. In Aboriginal Cultural Development in Latin America: An Interpretative Review, edited by B. J. Meggers and C. Evans. Smithsonian Miscellaneous Collections, Vol. 146. Smithsonian Institution, Washington, D.C.

1970 Central America. Barrie & Jenkins, London.

Bender, Barbara
1978 Gatherer-Hunter to Farmer: A Social Perspective. World Archaeology 10:204-222.
1981 Gatherer-Hunter Intensification. In Economic Archaeology, edited by A. Sheridan and G. Bailey, pp. 149-157. BAR International Series 96, Oxford.
1985 Emergent Tribal Formations in the American Midcontinent. American Antiquity 50(1):52-62.

Bennett, Charles F.
1968 Human Influences on the Zoogeography of Panama. Ibero-Americana, No. 51. University of California, Berkeley.

Berreman, Gerald D. (ed.)
1981 Social Inequality: Comparative and Developmental Approaches. Academic Press, New York.

Berthoud, G. and F. Savelli
1979 Our Obsolete Production Mentality: The Heresy of the Communal Formation. Current Anthropology 20: 745-760.

Beteille, Andre
1977 Inequality Among Men. Basil Blackwell, Oxford.
1981 The Idea of Natural Inequality. In Social Inequality: Comparative and Developmental Approaches, edited by G. D. Berreman, pp. 59-80. Academic Press, New York.

Binford, L. R.
1964 A Consideration of Archaeological Research Design. American Antiquity 29:425-441.
1971 Mortuary Practices: Their Study and Their Potential. In Approaches to the Social Dimensions of Mortuary Practices, edited by J. A. Brown. Society for American Archaeology Memoirs 26.

Binford Lewis R. and Sally R. Binford (eds.)
1968 New Perspectives in Archaeology. Aldine Publishing, Chicago.

Bird, Junius and Richard G. Cooke
1978a La Cueva de los Ladrones, Datos Preliminares sobre la Ocupacion Formitiva. Actos del IV Simposium Nacional de Antropologia, Arqueologia y Etnohistoria de Panama, pp. 281-304. Panama.

1978b The Occurrence in Panama of Two Types of Paleo-Indian Projectile Points. In Early Man in America from a Circum-Pacific Perspective, edited by A. Bryan, pp. 263-272. Department of Anthropology, University of Alberta, Occasional Papers No. 1.

Blalock, Hubert M.
1972 Social Statistics, 2nd Edition. University of North Carolina Press, Chapel Hill.

Bort, John Roger
1976 Guaymi Innovators: A Case Study of Entrepreneurs in a Small Scale Society. Ph.D. Dissertation, Department of Anthropology, University of Oregon.
1980 Maranon: A Report of Ethnographic Research Among the Bocas Guaymi. In Adaptive Radiations in Prehistoric Panama, edited by O. F. Linares and A. J. Ranere, pp. 491-509. Peabody Museum Monographs, No. 5. Harvard University, Cambridge.

Braun, David P. and Stephen Plog
1982 Evolution of "Tribal" Social Networks: Theory and Prehistoric North American Evidence. American Antiquity 47: 605-625.

Britan, Gerald M. and Ronald Cohen (eds.)
1980 Hierarchy & Society: Anthropological Perspectives on Bureaucracy. Institute for the Study of Human Issues, Philadelphia.

Bronitsky, Gordon
1986 The Use of Materials Science Techniques in the Study of Pottery Construction and Use. In Advances in Archaeological Method and Theory, Vol. 9, edited by M. B. Schiffer, pp. 209-310. Academic Press, New York.

Brown, J. A. (ed.)
1971 Approaches to the Social Dimensions of Mortuary Practices. Society for American Archaeology Memoirs 26.

Brumfiel, Elizabeth and Timothy K. Earle (eds.)
1987 Specialization, Exchange, and Complex Societies. Cambridge University Press, Cambridge.

Burnham, P. C. and R. F. Ellen (eds.)
1979 Social and Ecological Systems. Academic Press, New York.

Carr, Christopher
1984 The Nature of Organization of Intrasite Archaeological Records and Spatial Analytic Approaches to Their Investigation. In Advances in Archaeological Method and Theory, Vol. 7, edited by M. Schiffer, pp.103-222. Academic Press, New York.

Carr, Christopher (ed.)
1985 For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique, and Theory. Westport Pub., Inc., Kansas City.

CATAPAN
1970 Final Report on the Catastro Rural de Tierras y Aguas de Panama. 3 Vols. Comision de Reforma Agraria de Panama.

Cedeno B., Hector Antonio
1985 El Medio Fisico del Area de Sarigua: Base para una Politica de Ordenamiento Espacial. Trabajo para Titulo de Licenciado en Geogragia, Universidad de Panama, Panama.

Chang, Rene
1985 La "Albinazion" del Litoral del Golfo de Parita. In Agonia del la Naturaleza, edited by Stanley Heckadon Moreno and Jaime Espinosa Gonzalez, pp. 125-135. Instituto de Investigacion Agropecuaria de Panama and Smithsonian Tropical Research Institute, Panama.

Chartkoff, John
1978 Transect Interval Sampling in Forests. American Antiquity 43:46-53.

Clammer, John (ed.)
1978 The New Economic Anthropology. St. Martin's Press, New York.

Clary, James H., Patricia Hansell, Anthony J. Ranere and Thomas Buggey
1984 The Holocene Geology of the Western Parita Bay Coastline of Central Panama. In Recent Developments in Isthmian Archaeology: Advances in the Prehistory of Lower Central America, edited by F. Lange. BAR International Series 212:55-83.

Coe, Michael D.
1960 Archaeological Linkages with Northern South America at La Victoria, Guatemala. American Anthropologist 62:363-393.

Conkey, Margaret W. and Janet Spector
1984 Archaeology and the Study of Gender. In Advances in Archaeological Method and Theory, Vol.7, edited by M. B. Schiffer, pp. 1-38. Academic Press, New York.

Cooke, Richard G.
1972 The Archaeology of Western Cocle Province of Panama. Ph.D. Dissertation, Institute of Archaeology, University of London.
1975 Excavaciones Arqueologicas en el Sitio AG-3 (Sitio Sierra), Distrito de Aguadulce, Cocle, Panama. Preliminary Report on File, Direccion de Patrimonio Historico, Panama.
1976 Panama, Region Central. Vinculos 2:122-140.
1977 Non-aquatic Animal Resources in Central Panama: Unforested Environments, Habitat Destruction, or Selective Hunting? Paper presented at the 42nd Annual Meeting of the Society for American Archaeology, New Orleans.
1978a El Hachero y El Carpintero: Dos Artesanos del Panama Precolombino. Revista Nacional de Cultura (Panama) 2:17-38.
1978b Maximizing a Valuable Resource: The White-Tailed Deer in Prehistoric Central Panama. Paper presented at the 43rd Annual Meeting of the Society for American Archaeology, Tucson.
1979 Los Impactos de las Comunidades Agricolas sobre los Ambientes del Tropico Estacional: Datos del Panama Prehistorico. Actas del IV Symposio Internacional de Ecologia Tropical 3:917-973.
1984 Archaeological Research in Central and Eastern Panama: Review of Some Problems. In The Archaeology of Lower Central America, edited by F. Lange and D. Stone, pp. 263-302. University of New Mexico Press, Albuquerque.

Cooke, Richard G. and Marcela Camargo
1977 Cocle y su Arqueologia: Una Breve Historia Critica. La Antigua, Ano 6(9):115-172.

Cooke, Richard G. and Anthony J. Ranere
1984 The "Proyecto Santa Maria": A Multidisciplinary Analysis of Prehistoric Adaptations to a Tropical Watershed in Panama. In Recent Developments in Isthmian Archaeology: Advances in the Prehistory of Lower Central America, edited by F. Lange. BAR International Series 212:31-53.
1988 Precolumbian Influences on the Zoogeograpy of Panama: An Update based on Archaeofaunal and Documentary Data. Manuscript in Possession of the Authors.

Cooke, Richard G., Dolores Piperno, Anthony J. Ranere, Karen Clary, Patricia Hansell, Storrs Olson, Wilson Valerio L. and Doris Weiland
1985 La Influencia de las Poblaciones Humanas sobre los Ambientes Terrestres de Panama entre el 10,000 A.C. y el 500 D.C. In Agonia de la Naturaleza, edited by S. H. Moreno and J. E. Gonsalez, pp. 3-25. Instituto de Investigacion Agropecuaria de Panama and Smithsonian Tropical Research Institute, Panama.

Cowgill, G. L.
1975 A Selection of Samplers: Comments on Archaeo-Statistics. In Sampling in Archaeology, edited by James W. Mueller, pp. 258-274. University of Arizona, Tucson.
1977 The Trouble with Significance Tests and What We Can Do About It. American Antiquity 42:350-368.

Creamer, Winifred and Jonathan Haas
1985 Tribes vs Chiefdoms in Lower Central America. American Antiquity 50:738-754.

Crumley, Carole L.
1979 Three Locational Models: An Epistemological Assessment of Anthropology and Archaeology. In Advances in Archaeological Method and Theory, Vol. 7, edited by M. B. Schiffer, pp. 141-173. Academic Press, New York.
1987 A Dialectical Critique of Hierarchy. In Power Relations and State Formation, edited by T. C. Patterson and C. W. Gailey, pp. 155-169. American Anthropological Association, Washington, D.C.

Dalton, George
1971 Economic Anthropology and Development. Basic Books, New York.

Damp, Jonathan E.
1984 Architecture of the Early Valdivia Village. American Antiquity 49:573-585.

Dere, C. E.
1981 The Geologic and Paleogeographic Setting of an Archaeological Site on the Southwestern Coast of Parita Bay, Panama. M.A. Thesis, Temple University, Philadelphia.

Dillon, Brian D.
1984 Island Building and Villages of the Dead: Living Archaeology in the Comarca de San Blas, Panama. Journal of New World Archaeology VI(2):49-65.

Drennan, Robert D. and Carlos A. Uribe (eds.)
1987 Chiefdoms in the Americas. University Press of America, Lanham.

Drolet, Robert P.
1980 Cultural Settlement Along the Moist Caribbean Slopes of Eastern Panama. Ph.D. Dissertation, University of Illinois.

Dunnell, R. and W. Dancey
1983 The Siteless Survey: A Regional Scale Data Collection Strategy. In Advances in Archaeological Method and Theory, Vol. 6, edited by M. B. Schiffer, pp. 267-287. Academic Press, New York.

Earle, Timothy K.
1987 Chiefdoms in Archaeological and Ethnohistorical Perspective. Annual Review of Anthropology, Vol. 16:279-308.

Ebert, James I.
1984 Remote Sensing Applications in Archaeology. In Advances in Archaeological Method and Theory, Vol. 7, edited by M. B. Schiffer, pp. 293-362. Academic Press, New York.

Einhaus, Catherine Shelton
1984 Formative Settlement in Western Chiriqui, Panama. Ph.D. Dissertation, Department of Anthropology, Temple University, Philadelphia.

Espinosa, Gaspar de
1913 Relacion Hecha por Gaspar de Espinosa...(1517). In El Descubrimiento del Oceano Pacifico, Vol. II, edited by J. T. Medina. Imprenta Universitaria, Santiago (Chile).

Feinman, Gary and Jill Neitzel
1984 Too Many Types: An Overview of Sedentary Prestate Societies in the Americas. In Advances in Archaeological Method and Theory, Vol. 7, edited by M. B. Schiffer pp. 39-102. Academic Press, New York.

Fernandez de Oviedo y Valdes, Gonzalo
1944 Historia General y Natural de las Indias, Islas y Tierra Firme del Mar Oceano. Gorgona, edited by J. Natalicio. Editorial Guarania, Asuncion del Paraguay.

Ferrari, Agustin
1928 Arqueologia de Rio Grande. Carta Enviada al Secretario de Instruccion Publica, Panama. Manuscrito.

Flannery, Kent V.
1972 The Cultural Evolution of Civilizations. Annual Review of Ecology and Systematics, Vol. 3:399-426.

Flannery, Kent V. (ed.)
1976 The Early Mesoamerican Village. Academic Press, New York.

Flannery, Kent V. and Joyce Marcus (eds.)
1983 The Cloud People. Academic Press, New York.

Flannery, Kent V., Joyce Marcus and Stephen A. Kowalewski
1981 The Preceramic and Formative of the Valley of Oaxaca. In Supplement to the Handbook of Middle American Indians, Vol. 1. ARCHAEOLOGY, edited by Jeremy A. Sabloff.

Forsbergh, E. D.
1969 On the Climatology, Oceanography and Fisheries of the Panama Bight. Bulletin Inter-American Tropical Tuna Commission, 14:49-385.

Frank, Andre Gunder
1970 On Dalton's 'Theoretical Issues in Economic Anthropology.' Current Anthropology 11:67-71.

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

Friedman, Jonathan and M. J. Rowland (eds.)
1978 The Evolution of Social Systems. University of Pittsburgh Press, Pittsburgh.

Gaines, S. W. (ed.)
1981 Data Bank Applications in Archaeology. University of Arizona Press, Tucson.

Gazin, C. Lewis
1956 Exploration for the Remains of Giant Ground Sloths in Panama. Smithsonian Institution Annual Report 4272:341-354.

Gibson, Eric C.
1982 Upper Paleolithic Flintknapping Specialists?: The Evidence from Corbiac, France. Lithic Technology XI(3):41-49.
1984 Reconstructing Corbiac: The Context of Manufacturing at an Upper Paleolithic Quarry. In Prehistoric Quarries and Lithic Production, edited by J. E. Ericson and B. A. Purdy, pp. 139-146. Cambridge University Press, Cambridge.

Gledhill, John and Mogens T. Larsen
1982 The Polanyi Paradigm and a Dynamic Analysis of Archaic States. In Theory and Explanation in Archaeology, edited by C. Renfrew, M. J. Rowlands and B. A. Segraves, pp. 197-229. Academic Press, New York.

Glynn, Peter W.
1972 Observations on the Ecology of the Caribbean and Pacific Coasts of Panama. Biological Society of Washington, Bulletin 2:13-30.

Goldstein, L.
1976 Spatial Structure and Social Organization: Regional Manifestations of Mississippian Society. Ph.D. Dissertation, Northwestern University, Evanston. University Microfilms, Ann Arbor.

Graham, I. and E. Webb (eds.)
1982 Computer Applications in Archaeology 1981. University of London, Institute of Archaeology.

Greengo, R. E.
1952 Shellfish Foods of the California Indians. Kroeber Anthropological Society Papers, No. 7:63-114.

Haas, Jonathan
1982 The Evolution of the Prehistoric State. Columbia University Press, New York.

Haberland, W.
1957 Excavations in Costa Rica and Panama. Archaeology 10:258-263.
1962 The Scarified Ware and the Early Cultures of Chiriqui (Panama). Proceedings of the Thirty-fourth International Congress of Americanists 1:381-389. Vienna.
1978 Lower Central America. In Chronologies in New World Archaeology, edited by R. E. Taylor and C. W. Meighan. Academic Press, New York.

Hansell, Patricia
1979 Shell Analysis: A Case Study from Panama. M.A. Thesis, Temple University, Philadelphia.
1987 The Formative in Central Pacific Panama: La Mula-Sarigua. In Chiefdoms in the Americas, edited by R. D. Drennan and C. A. Uribe, pp. 119-138. University Press of America, Lanham.

Hansell, Patricia and John K. Adams
1980 The Application of Sediment Analysis to Cultural Deposits. Paper presented at the 45th Annual Meeting of the Society for American Archaeology, Philadelphia.

Hansell, Patricia, C. E. Dere and J. K. Adams
1982 Textural Analyses: A Geoarchaeological Case Study. Paper presented at the 11th International Congress on Sedimentology, Hamilton, Ontario.

Harris, Marvin
1979 Cultural Materialism: The Struggle for a Science of Culture. Vintage Books, New York.

Harte, E. M.
1958 Mountaintop Burials. Panama Archaeologist (Canal Zone) 1:29-31.

Hassan, Fekri A.
1981 Demographic Archaeology. Academic Press, New York.

Helms, Mary W.
1979 Ancient Panama. University of Texas Press, Austin.

Hester, T. R. and R. F. Heizer
1972 Problems in the Functional Interpretation of Artifacts: Scraper Planes from Mitla and Yagul, Oaxaca. Miscellaneous Papers in Archeology, Contribution No.14:107-123. University of California, Department of Anthropology.

Hindess, Barry and Paul Q. Hirst
1975 Pre-capitalist Modes of Production. Routledge and Kegan Paul, London.

Hodder, Ian
1978 The Maintenance of Group Identities in the Baringo District, Western Kenya. In Social Organisation and Settlement, edited by D. Green, C. Haselgrove and M. Spriggs, pp. 47-74. BAR, Oxford.
1985 Postprocessual Archaeology. In Advances in Archaeological Method and Theory, Vol. 8, edited by M. Schiffer, pp. 1-26. Academic Press, New York.

Hodder, Ian (ed.)
1982 Symbolic and Structuralist Archaeology. Cambridge University Press, Cambridge.

Holmes, W. H.
1888 Ancient Art of the Province of Chiriqui. Bureau of American Ethnology, Smithsonian Institution, Fifth Annual Report. U.S. Government Printing Office, Washington, D.C.

Howard, Michael C.
1986 Contemporary Cultural Anthropology. 2nd Edition. Little, Brown and Company, Boston.

Howe, James
1986 The Kuna Gathering. University of Texas Press, Austin.

Ichon, Alain
1980 Archeologie du Sud de la Peninsule d'Azuero, Panama. Etudes Mesoamericaines Serie 2 (3). Mission Archeologique et Ethnologique Francaise au Mexique, Mexico.

Jermann, J. V.
1981 Archaeology, Space, and Sampling: Methods and Techniques in the Study of Pattern in Past Cultural Activity. Ph.D. Dissertation, University of Washington. University Microfilms, Ann Arbor.

Johnson, Gregory A.
1982 Organizational Structure and Scalar Stress. In Theory and Explanation in Archaeology, edited by Colin Renfrew, M. J. Rowlands and B. A. Segraves, pp. 389-421. Academic Press, New York.

Johnson, A. W. and T. Earle
1987 The Evolution of Human Society: from Forager Group to Agrarian State. Stanford University Press, Stanford.

Judge, W. James, J. I. Ebert and Robert K. Hitchcock
1975 Sampling in Regional Archaeological Survey. In Sampling in Archaeology, edited by James W. Mueller, pp. 82-123. University of Arizona Press, Tucson.

Keeley, Lawrence H.
1980 Experimental Determination of Stone Tool Uses: A Microwear Analysis. University of Chicago Press, Chicago.

Keen, A. Myra
1971 Sea Shells of Tropical West America. Stanford University Press, Stanford.

King, T. F.
1978 The Archeological Survey: Methods and Uses. Office of Archeology and Historic Preservation, Washington, D.C.

Kohl, P.
1981 Materialist Approaches in Prehistory. Annual Review of Anthropology 10:89-118.

Krakker, James, Michael J. Shott and Paul Welch
1983 Design and Evaluation of Shovel-Test Sampling in Regional Archaeological Survey. Journal of Field Archaeology 10:469-480.

Ladd, John
1957 A Stratigraphic Trench at Sitio Conte, Panama. American Antiquity 22:265-271.
1964 Archaeological Investigation in the Parita and Santa Maria Zones of Panama. Bureau of American Ethnology, Bulletin 193.

Larsen, Clark Spencer
1987 Bioarchaeological Interpretations of Subsistence Economy and Behavior from Human Skeletal Remains. In Advances in Archaeological Method and Theory, Vol. 10, edited by M. B. Schiffer, pp. 339-445. Academic Press, Inc., New York.

Lathrap, Donald W.
1975 Ancient Ecuador: Culture, Clay and Creativity 3000-300 B.C. Field Museum of Natural History, Chicago.

Lathrap, Donald W., J. G. Marcos and J. A. Zeidler
1977 Real Alto: An Ancient Ceremonial Center. Archaeology 30(1):3-13.

Leacock, Eleanor and Richard Lee (eds.)
1982 Politics and History in Band Societies. Cambridge University Press, Cambridge.

Leibowitz, Lila
1983 Origins of the Sexual Division of Labor. In Woman's Nature: Rationalizations of Inequality, edited by M. Lowe and R. Habland. Pergamon Press, New York.

Levi-Strauss, Claude
1969 The Elementary Structures of Kinship. Beacon Press, Boston.

Lewarch, Dennis and Michael J. O'Brien
1981 The Expanding Role of Surface Assemblages in Archaeological Research. In Advances in Archaeological Method and Theory, Vol. 4, edited by M. B. Schiffer, pp. 297-342. Academic Press, New York.

Lightfoot, Kent G.
1986 Regional Surveys in the Eastern United States: The Strengths and Weaknesses of Implementing Subsurface Testing Programs. American Antiquity 51 (3):484-504.

Linares, Olga F.
1968 Cultural Chronology in the Gulf of Chiriqui, Panama. Smithsonian Contributions to Anthrpology, No. 8. Smithsonian Institution, Washington, D.C.

1977 Ecology and the Arts in Ancient Panama. Studies in Pre-Columbian Art and Archaeology 17, Dumbarton Oaks.

1979 What is Lower Central American Archaeology? Annual Review of Anthropology 8:21-43.

Linares, Olga F. and A. J. Ranere

1971 Human Adaptation to the Tropical Forests of Western Panama. Archaeology 24:346-355.

Linares, Olga F. and A. J. Ranere (eds.)

1980 Adaptive Radiations in Prehistoric Panama. Peabody Museum Monographs, No. 5. Harvard University, Cambridge.

Linares, Olga F., Payson D. Sheets and E. Jane Rosenthal

1975 Prehistoric Agriculture in Tropical Highlands. Science 187:137-145.

Linne, S.

1929 Darien in the Past: The Archaeology of Eastern Panama and North-Western Colombia. Goteborgs Kungel, Vetenskaps-och Vitterhets-Samhalles Handlingar. Femte Foljden, Ser. A, 1, 3, Bd 1, nr 3. Elanders boktryckeri aktiebolag, Gothenberg.

1936 Archaeological Field Work in Chiriqui, Panama. Ethnos 1:95-102.

Lothrop, Samuel

1919 The Discovery of Gold in the Graves of Chiriqui, Panama. Museum of the American Indian, Heye Foundation, Indian Notes and Monographs, Vol. VI(2). New York.

1937 Cocle: An Archaeological Study of Central Panama, Part I. Memoirs of the Peabody Museum of Archaeology and Ethnology 7. Harvard University, Cambridge.

1942 Cocle: An Archaeological Study of Central Panama, Part II. Memoirs of the Peabody Museum of Archaeology and Ethnology 8. Harvard University, Cambridge.

1954 Suicide, Sacrifice and Mutilations in Burials at Venado Beach. American Antiquity 21:226-234.

Lourandos, Harry

1984 Intensification and Australian Prehistory. In Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity, edited by T. D. Price and J. A. Brown, pp. 385-423. Academic Press, New York.

Lovis, William, Jr.

1976 Quarter Sections and Forests: An Example of Probability Sampling in the Northeastern Woodlands American Antiquity 41:364-372.

Lundberg, E.
1978/79 South American-Middle American Contacts: The Evidence from Lower Central America. Journal of Steward Anthropological Society 9(1/2):77-97.

Lynch, Mark
1980 Site Artifact Density and the Effectiveness of Shovel Probes. Current Anthropology 21:516-517.

McGimsey, Charles
1956 Cerro Mangote: A Preceramic Site in Panama. American Antiquity 22(2):151-161.

McGimsey, Charles, M. B. Collin and T. W. McKern
1966 Cerro Mangote and its Population. Paper presented at the 37th International Congress of Americanists, Mar del Plata.

McGuire, Randall H.
1983 Breaking Down Cultural Complexity: Inequality and Heterogeneity. In Advances in Archaeological Method and Theory, Vol. 6, edited by M. Schiffer, pp. 91-142. Academic Press, New York.

McManamon, F.
1984 Discovering Sites Unseen. In Advances in Archaeological Method and Theory, Vol. 7, edited by M. B. Schiffer, pp. 223-292. Academic Press, New York.

McNeil, J. A.
1887 Gold and Bronze Relics, and Guaymi Indians. American Antiquarian, Vol. 9, Chicago.

MacCurdy, George G.
1911 A Study of Chiriquian Antiquities. Memoirs of the Connecticut Academy of Arts and Sciences, Vol. 3.

Marcos, Jorge G.
1977 Real Alto: Is Valdivia Really the Early Formative of Ecuador? Paper presented at the 42nd Annual Meeting of the Society for American Archaeology, New Orleans.

Marcus, Joyce
1976 The Size of the Early Mesoamerican Village. In The Early Mesoamerican Village, edited by Kent V. Flannery, pp. 79-90. Academic Press, New York.

Mason, J. Alden
1940 Ivory and Resin Figurines from Cocle. University Museum Bulletin 8(4):13-21.

1942 New Excavations at Sitio Conte, Cocle, Panama. Proceedings, 8th American Scientific Congress, Vol. 2:103-107. Washington, D.C.

Mayhew, B. H. and R. L. Levinger
1976 On the Emergence of Oligarchy in Human Interaction. American Journal of Sociology 81:1017-1049.

Meddis, Ray
1975 Statistical Handbook for Non-Statisticians. McGraw-Hill Book Company (UK) Limited, Berskshire.

Meillassoux, C.
1972 From Reproduction to Production. Economy and Society 1:93-105.
1981 Maidens, Meal and Money: Capitalism and the Domestic Community. Cambridge University Press, Cambridge.

Merritt, J. King
1860 Report on the Huacals, or Ancient Graveyards of Chiriqui. American Ethnological Society. New York.

Minium, Edward W. and Robert B. Clarke
1982 Elements of Statistical Reasoning. John Wiley & Sons, Inc., New York.

Moser, C. A. and G. Kalton
1972 Survey Methods in Social Investigation. Basic Books, Inc., Publishers, New York.

Mueller, James W. (ed.)
1975 Sampling in Archaeology. University of Arizona Press, Tucson.

Nance, Jack D.
1983 Regional Sampling in Archaeological Survey: The Statistical Perspective. In Advances in Archaeological Method and Theory, Vol. 6, edited by M. B. Schiffer, pp. 289-356. Academic Press, New York.

Nance, Jack D. and Bruce F. Ball
1986 No Surprises? The Reliability and Validity of Test Pit Sampling. American Antiquity 51 (3):457-483.

Nie, N. H., C. H. Hull, J. G. Jenkins, K. Steinbrenner and D. H. Bent
1975 SPSS: Statistical Package for the Social Sciences. 2nd Edition. McGraw-Hill Book Company, New York.

Noe-Nygaard, Nanna
1967 Present-day "Kitchen Middens" in Ghana. Geografisk Tidsskrift. Kobenhavn 66. bd., pp. 191-197.

Norr, Lynette
1983 Prehistoric Subsistence and Health Status of Coastal Peoples from the Panamanian Isthmus of Lower Central America. Paper in lieu of Masters Thesis, University of Illinois.
1988 Unpublished Data Gathered for the Completion of the Doctoral Dissertation, University of Illinois, Urbana. Manuscript in Preparation.

Norr, Lynette, and Dennis D. Coleman
1982 Dietary Interpretations of 13C/12C in Prehistoric Bone Collagen from a Tropical Coastal Environment. Paper prepared for Chemical Analyses of Ancient Skeletal Material, edited by Linda Klepinger.

Omura, George
1987 Mastering AutoCad. Sybex, San Francisco.

Olsson, A. A.
1961 Mollusks of the Tropical Eastern Pacific, Particularly from the Southern Half of the Panamic-Pacific Faunal Province (Panama to Peru). Panama-Pacific Pelecypoda. Paleontological Research Institution. Ithaca, New York.

Orr, Joel N.
1987 Upwardly Mobile Cadd. In PC Magazine 6(21):93-199.

Osgood, Cornelius
1935 The Archaeological Problem in Chiriqui. American Anthropologist 37:234-243.

Otis, F. M.
1859 The New Gold Discoveries on the Isthmus of Panama. Harper's Weekly, August 6. New York.

Parmalee, P. W. and W. E. Klippel
1974 Freshwater Mussels as a Prehistoric Food Resource. American Antiquity 39(3):421-434.

Patterson, Thomas C.
1983 The Theory and Practice of Archaeology: A Workbook. Prentice-Hall, Inc., Englewood Cliffs.

Patterson, Thomas C. and Christine W. Gailey (eds.)
1987 Power Relations and State Formation. American Anthropological Association, Washington, D.C.

Piperno, Dolores
1983 The Application of Phytolith Analysis to the Reconstruction of Plant Subsistence and Environments in Prehistoric Panama. Ph.D. Dissertation, Department of Anthropology, Temple University, Philadelphia.
1985 Phytolith Taphonomy and Distributions in Archeological Sediments from Panama. Journal of Archaeological Science 12:247-267.
1987 Phytolith Analysis: An Archaeological and Geological Perspective. Academic Press, Orlando.

Piperno, D.R., and K. Husum-Clary
1984 Early Plant Use and Cultivation in the Santa Maria Basin, Panama. Data from Phytoliths and Pollen. In Recent Developments in Isthmian Archaeology: Advances in the Prehistory of Lower Central America, edited by F. Lange. BAR International Series 212:85-122.

Piperno, D.R., K. Husum-Clary, R.G. Cooke, A.J. Ranere and D. Weiland
1985 Preceramic Maize from Panama: Phytolith and Pollen Evidence. American Anthropologist 87(4):871-878.

Plog, Stephen
1976 Relative Efficiences of Sampling Techniques for Archaeological Surveys. In The Early Mesoamerican Village, edited by Kent V. Flannery, pp. 136-158. Academic Press, New York.

Plog, Stephen, Fred Plog and Walter Wait
1978 Decision Making in Modern Survey. In Advances in Archaeological Method and Theory, Vol. 1, edited by M. B. Schiffer, pp. 383-421. Academic Press, New York.

Price, Barbara J.
1982 Cultural Materialism: A Theoretical Review. American Antiquity 47:709-736.

Price, T. Douglas and James A. Brown (eds.)
1984 Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity. Academic Press, New York.

Rafferty, Janet E.
1985 The Archaeological Record on Sendentariness: Recognition, Development, and Implications. In Advances in Archaeological Method and Theory, Vol. 8, edited by M. B. Schiffer, pp. 113-156. Academic Press, New York.

Ranere, Anthony J.
1972 Early Human Adaptations to New World Tropical Forests: The View from Panama. Ph.D. Dissertation, Department of Anthropology, University of California at Davis.
1975 Toolmaking and Tool Use Among the Preceramic Peoples of Panama. In Lithic Technology: Making and Using Stone Tools, edited by E. Swanson, pp. 173-209. Mouton, The Hague.
1980a The Rio Chiriqui Shelters: Excavation and Interpretation of the Deposits. In Adaptive Radiations in Prehistoric Panama, edited by O. Linares and A. Ranere, pp. 250-266. Peabody Museum Monographs, No. 5. Harvard University, Cambridge.
1980b Stone Tools and Their Interpretation. In Adaptive Radiations in Prehistoric Panama, edited by O. Linares and A. Ranere, pp. 118-137. Peabody Museum Monographs, No. 5. Harvard University, Cambridge.
1984 An Approach to Dating Surface Lithic Collections from Central Panama. Paper presented at the 49th Meeting of the Society for American Archaeology, Portland.
nd The Manufacture and Use of Stone Tools During the Preceramic in the Santa Maria River Basin of Central Panama. In Cazadores y Recolectores en America: Cultura y Medio Ambiente durante el Pleistoceno y Holoceno, edited by G. Correal Urrego and Richard G. Cooke. In press.

Ranere, Anthony J. and Richard G. Cooke
1987 From Hunting-Gathering to Village Agriculture in the Humid Tropics: A 4000 Year Long Process In Central Panama. Paper presented at the 52nd Annual Meeting of the Society for American Archaeology, Toronto.

Ranere, Anthony J., Richard G. Cooke and John K. Adams
1981 Environment, Settlement and Subsistence in Pre-Historic Central Panama. Research Proposal submitted to the National Science Foundation, Anthropology Program, Washington, D.C.

Ranere, Anthony J., Richard G. Cooke and Patricia Hansell
1980 Food Procurement in the Parita Bay Region of Panama: 5000 B.C.-A.D. 500. Paper presented at the 45th Annual Meeting of the Society for American Archaeology, Philadelphia.

Ranere, Anthony J. and Leonard Greenfield
1981 The Evidence for and Implications of Nutritional Cannibalism During the Preceramic in Central Panama. Paper presented at the 46th Annual Meeting of the Society for American Archaeology, San Diego.

Ranere, Anthony J. and Patricia Hansell
1978 Early Subsistence Patterns along the Pacific Coast of Panama. In Prehistoric Coastal Adaptations, edited by B. Stark and B. Voorhies, pp. 43-59. Academic Press, New York.

Ranere, Anthony J. and Richard McCarty
1975 Informe Preliminar sobre la Excavacion de un Sitio Preceramico en Cocle, Panama. In Actas del IV Simposium Nacional de Antropologia, Arqueologia, y Etnohistoria de Panama. Pp. 483-493. Universidad de Panama e Instituto Nacional de Cultura.

Redman, Charles L.
1987 Surface Collection, Sampling, and Research Design: A Retrospective. American Antiquity 52:249-265.

Renfrew, Colin
1973 Monuments, Mobilization and Social Organization in Neolithic Wessex. In The Explanation of Culture Change: Models in Prehistory, edited by Colin Renfrew, pp. 539-558. University of Pittsburgh Press, Pittsburgh.
1977 Alternative Models for Exchange and Spatial Distribution. In Exchange Systems in Prehistory, edited by T. K. Earle and J. E. Ericson, pp. 71-90. Academic Press, New York.

Renfrew, Colin and John F. Cherry (eds.)
1986 Peer Polity Interaction and Socio-politcal Change. Cambridge University Press, Cambridge.

Rice, Prudence M.
1987 Pottery Analysis: A Sourcebook. University of Chicago Press, Chicago.

Richards, J. D. and N. S. Ryan
1985 Data Processing in Archaeology. Cambridge University Press, Cambridge.

Roosevelt, Anna Curtenius
1980 Parmana: Prehistoric Maize and Manioc Subsistence Along the Amazon and Orinoco. Academic Press, New York.

Roper, D. C.
1976 Lateral Displacement of Artifacts Due to Plowing. American Antiquity 41:372-374.

Rovner, Irwin
1980 An Application of Bordes' Paleolithic Handaxe Typology to the Study of Classic Maya Lithics. Lithic Technology IX(1):26-29.

Sahlins, M. D.
1972 Stone Age Economics. Aldine, London.

Saitta, Dean J.
1983 On the Evolution of "Tribal" Social Networks. American Antiquity 48(4):821-824.

Sauer, Carl Ortwin
1966 The Early Spanish Main. University of California Press, Berkeley.

Saxe, A. A.
1970 Social Dimensions of Mortuary Practices. Ph.D. Dissertation, University of Michigan. University Microfilms, Ann Arbor.

Schaeffer, Milner B. Yvonne, M. M. Bishop and Gerald V. Howard
1958 Algunos Aspectos del Afloramiento en el Golfo de Panama. Boletin de la Comision Inter-Americana del Atun Tropical 3(2):112-132. La Jolla, California.

Schiffer, Michael B., A. P. Sullivan and T. Klinger
1978 The Design of Archaeological Surveys. World Archaeology 10:1-28.

Semenov, S. A.
1976 Prehistoric Technology. Harper and Row Publishers, Inc., Great Britain.

Service, Elman
1962 Primitive Social Organization: An Evolutionary Perspective. Random House, New York.

Shafer, Harry J.
1981 Maya Lithic Craft Specialization in Northern Belize. Paper presented at the 80th Annual Meetings of the American Anthropological Association, Los Angeles.
1982 Ancient Maya Uses of Chert in Northern Belize. Paper presented at the 47th Annual Meeting of the Society for American Archaeology, Minneapolis.

Shafer, Harry J. and Thomas R. Hester
1983 Ancient Maya Workshops in Northern Belize, Central America. American Antiquity 48:519-543.
1986 Maya Stone-Tool Craft Specialization and Production at Colha, Belize: Reply to Mallory. American Antiquity 51:158-166.

Sharer, Robert J.
1978 The Prehistory of Chalchuapa, El Salvador: Pottery and Conclusions, Vol. 3. University of Pennsylvania Press, Philadelphia.

Shott, Michael
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. Journal of Anthropological Research 42(1):15-51.

Smith, W.
1962 Schools, Pots and Potters. American Anthropologist 64: 1165-1178.

Society for American Archaeology and Society of Professional Archeologists
1986 Proceedings of the National Workshop on Microcomputers in Archaeology, New Orleans.

Spriggs, M. (ed.)
1984 Marxist Perspectives in Archaeology. Cambridge University Press, Cambridge.

Stein, Julie K.
1986 Coring Archaeological Sites. American Antiquity 51:505-527.

Stirling, Matthew W.
1949 Exploring Ancient Panama by Helicopter. National Geographic Magazine 97:227-246.

Stone, Doris
1962 The Talamancan Tribes of Costa Rica. Memoirs of the Peabody Museum of Archaeology and Ethnology 43(2). Harvard University, Cambridge.

Stone, Glen Davis
1981 On Artifact Density and Shovel Probes. Current Anthropology 22:182-183.

Stothert, Karen E.
1984 A New Look at Guangala Society and Economy: A Discussion of the Origin and Development of Chiefdoms on the Santa Elena Peninsula, Ecuador. Paper presented at the 49th Annual Meeting of the Society for American Archaeology, Portland.

Squier, Ephraim George
1859 More About the Gold Discoveries of the Isthmus. Harper's Weekly, August 20. New York.

Thomas, David Hurst
1987 Refiguring Anthropology. Holt, Rinehart, Winston, New York.

Tilley, Christopher
1982 Social Formation, Social Structures and Social Change. In Symbolic and Structural Archaeology, edited by Ian Hodder, pp. 26-37. Cambridge University Press, Cambridge.

Tolstoy, P. and S. K. Fish
1975 Surface and Subsurface Evidence for Community Size at Coapexco, Mexico. Journal of Field Archaeology 2:97-104.

Torrence, Robin
1979 Macrocore Production at the Melos Obsidian Quarries. Lithic Technology VIII(3):51-60.
1984 Monopoly or Direct Access? Industrial Organization at the Melos Obsidian Quarries. In Prehistoric Quarries and Lithic Production, edited by J. E. Ericson and B. A. Purdy, pp. 49-64. Cambridge University Press, Cambridge.

Tosi, J. A.
1971 Inventariacion y Demostraciones Forestales, Panama. Zonas de Vida. FAO, Roma.

Tosi, Maurizio
1984 The Notion of Craft Specialization and Its Representation in the Archaeological Record of Early States in the Turanian Basin. In Marxist Perspectives in Archaeology, edited by M. Spriggs, pp. 22-52. Cambridge University Press, Cambridge.

Vargas-Arenas, Iraida
1987 Arqueologia, Cienca y Sociedad; Ensayo sobre Teoria Arqueologica y la Formacion Economico Social Tribal en Venezuela. Instituto de Investigaciones Economicas y Sociales, Universidad Central de Venezuela. Manuscript in possession of the author.

Verrill, A. Hyatt
1927 Excavations in Cocle Province, Panama. Museum of the American Indian, Heye Foundation, Indian Notes 4(1):47-61.

Weiland, Doris
1984 Prehistoric Settlement Patterns in the Santa Maria Drainage of Central Pacific Panama: A Preliminary Analysis. In Recent Developments in Isthmian Archaeology: Advances in the Prehistory of Lower Central America, edited by F. Lange. BAR International Series 212:31-53.

Weymouth, John W.
1986 Geophysical Methods of Archaeological Site Surveying. In Advances in Archaeological Method and Theory, Vol. 9, edited by M. B. Schiffer, pp. 311-395. Academic Press, New York.

Whalen, Michael E.
1981 Excavations at Santo Domingo Tomaltepec: Evolution of a Formative Community in the Valley of Oaxaca, Mexico. Memoirs of the Museum of Anthropology University of Michigan 12.

Willey, Gordon
1971 South America: An Introduction to American Archaeology. Vol. 2. Prentice-Hall, Englewood Cliffs.

Willey, Gordon and Charles McGimsey
1954 The Monagrillo Culture of Panama. Papers of the Peabody Museum of Archaeology and Ethnology, 49(2). Harvard University, Cambridge.

Willey, Gordon R. and Jeremy A. Sabloff
1980 A History of American Archaeology. 2nd Edition. W. H. Freeman and Company, San Francisco.

Willey, Gordon R. and Theodore L. Stoddard
1954 Cultural Stratigraphy in Panama: A Preliminary Report on the Giron Site. American Antiquity 19.

Wing, Elizabeth S. and Antoinette B. Brown
1979 Paleonutrition: Method and Theory in Prehistoric Foodways. Academic Press, New York.

Winter, Marcus Cole
1972 Tierras Largas: A Formative Community in the Valley of Oaxaca, Mexico. Ph.D. Dissertation, University of Arizona, Tucson. University Microfilms, Ann Arbor.
1976 Differential Patterns of Community Growth in Oaxaca. In The Early Mesoamerican Village, edited by Kent V. Flannery, pp. 227-234. Academic Press, New York.

Wood, Gordon
1974 Fundamentals of Psychological Research. Little, Brown and Company, Boston.

Young, Philip D.
1971 Ngawbe: Tradition and Change Among the Western Guaymi of Panama. Illinois Studies in Anthropology, No. 7. University Illinois Press, Urbana.

1980 Notes on Guaymi Traditional Culture. In Adaptive Radiations in Prehistoric Panama, edited by O. F. Linares and A. J. Ranere, pp. 224-231. Peabody Museum Monographs, No. 5. Harvard University, Cambridge.

Zeidler, James A.
1977 Early Formative Settlement in the Chanduy Valley, Southwest Ecuador. Paper presented at the 42nd Annual Meeting for the Society for American Archaeology, New Orleans.

Zeltner, A. de
1865 Sepulturas Indias del Departamento de Chiriqui en el Estado de Panama. El Felix, August 15.

FIGURES AND PLATES

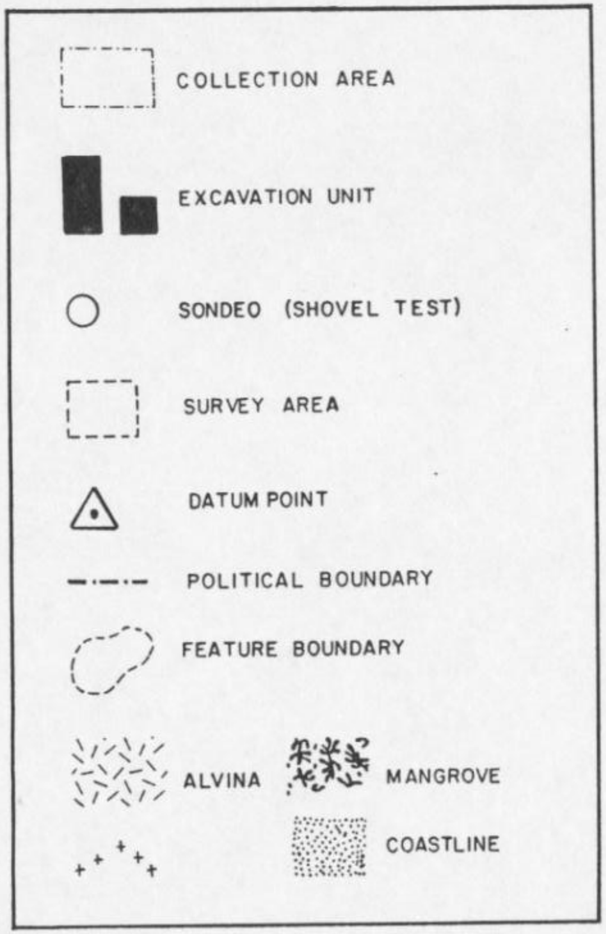


Figure 1. Key to Maps.

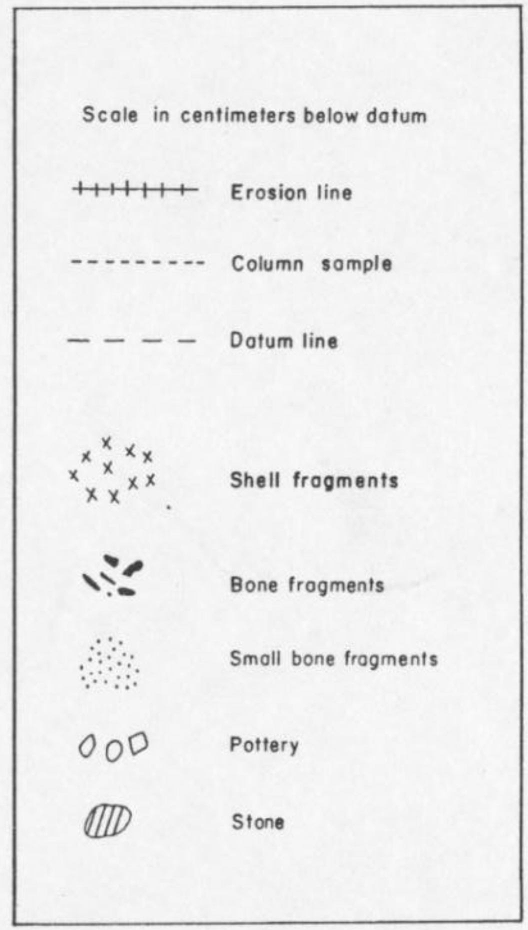


Figure 2. Key to Excavation Profiles.

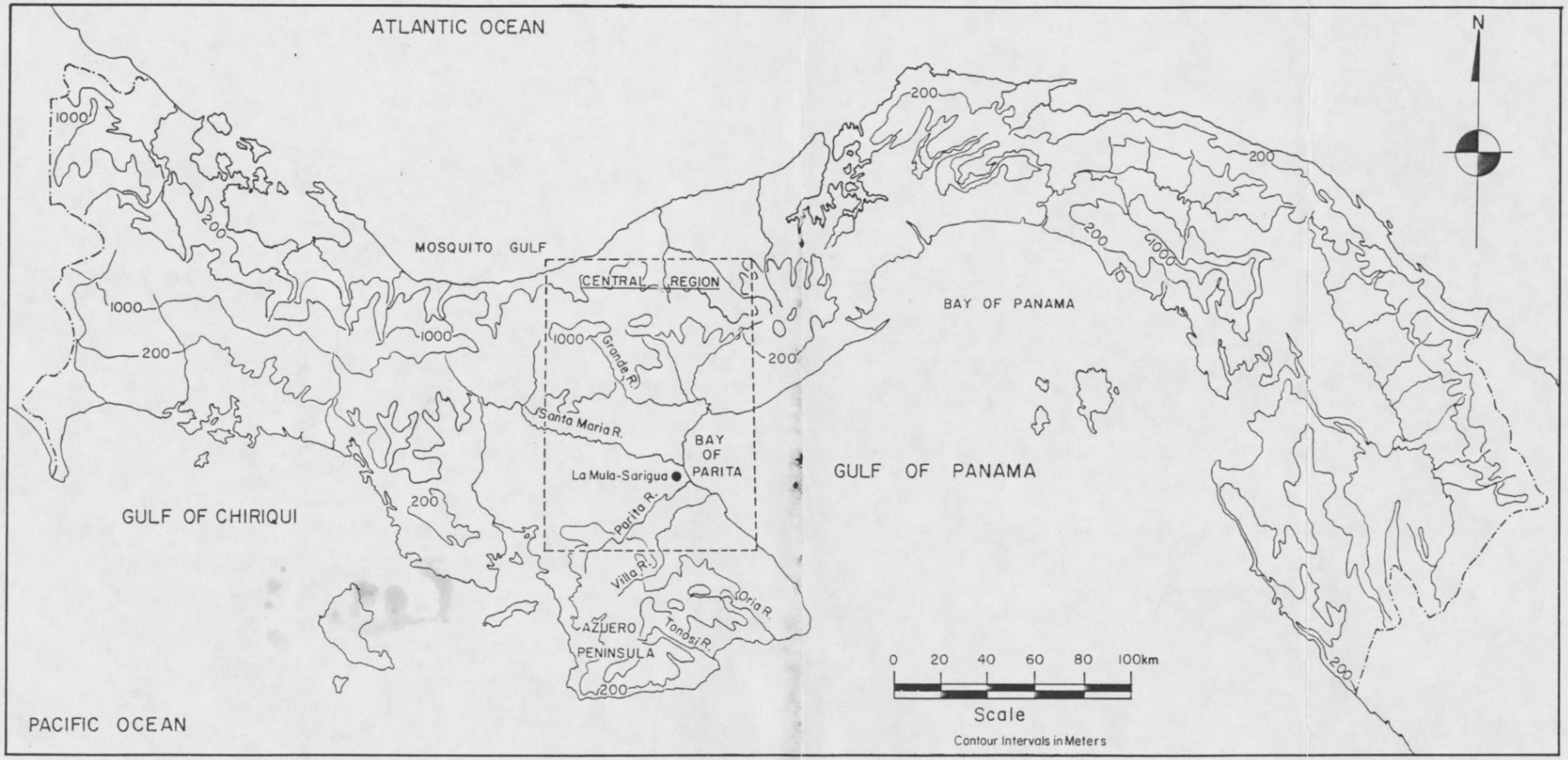


Figure 3. Locational Map of Panama, Central Region and La Mula-Sarigua.

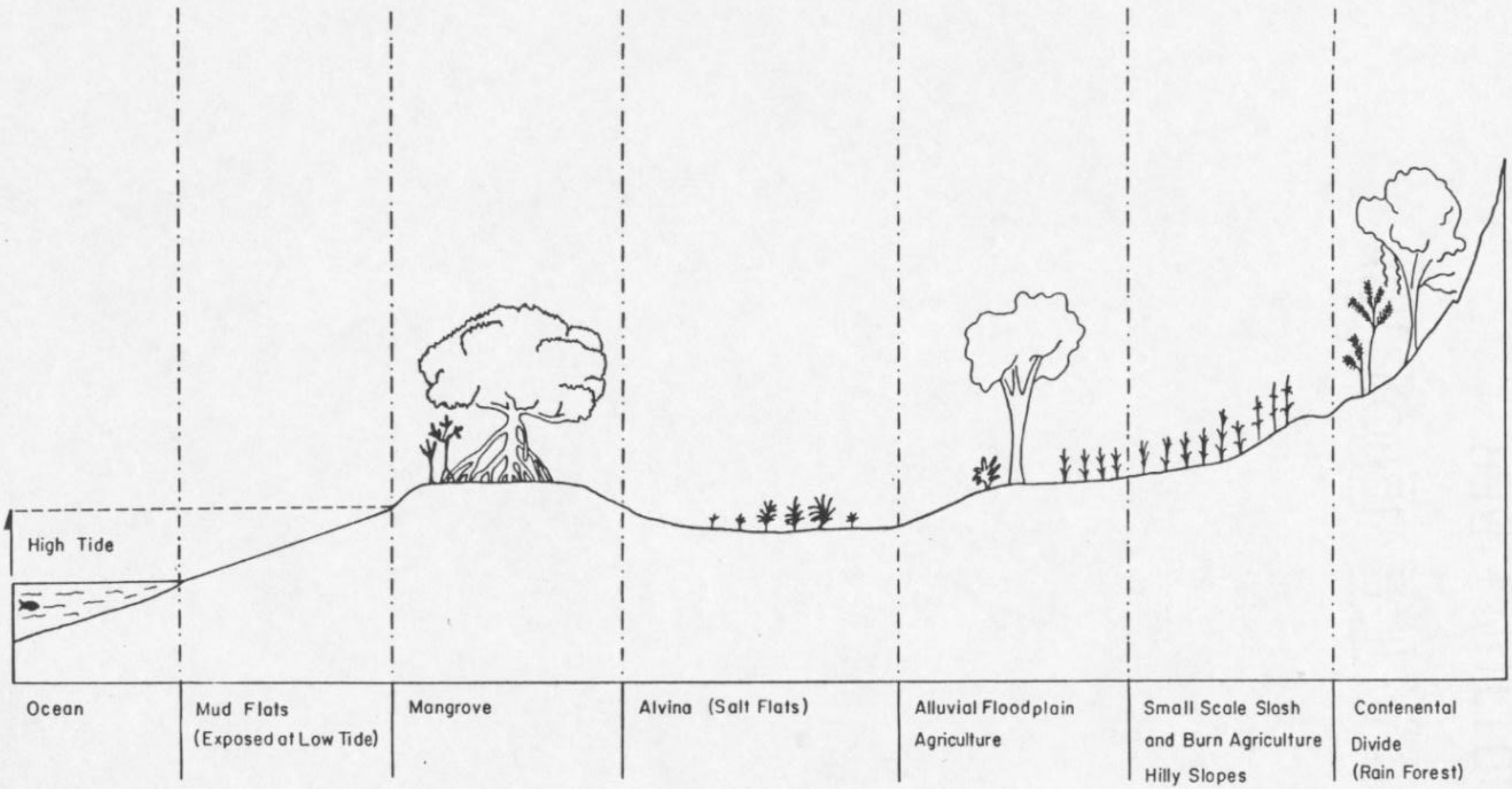
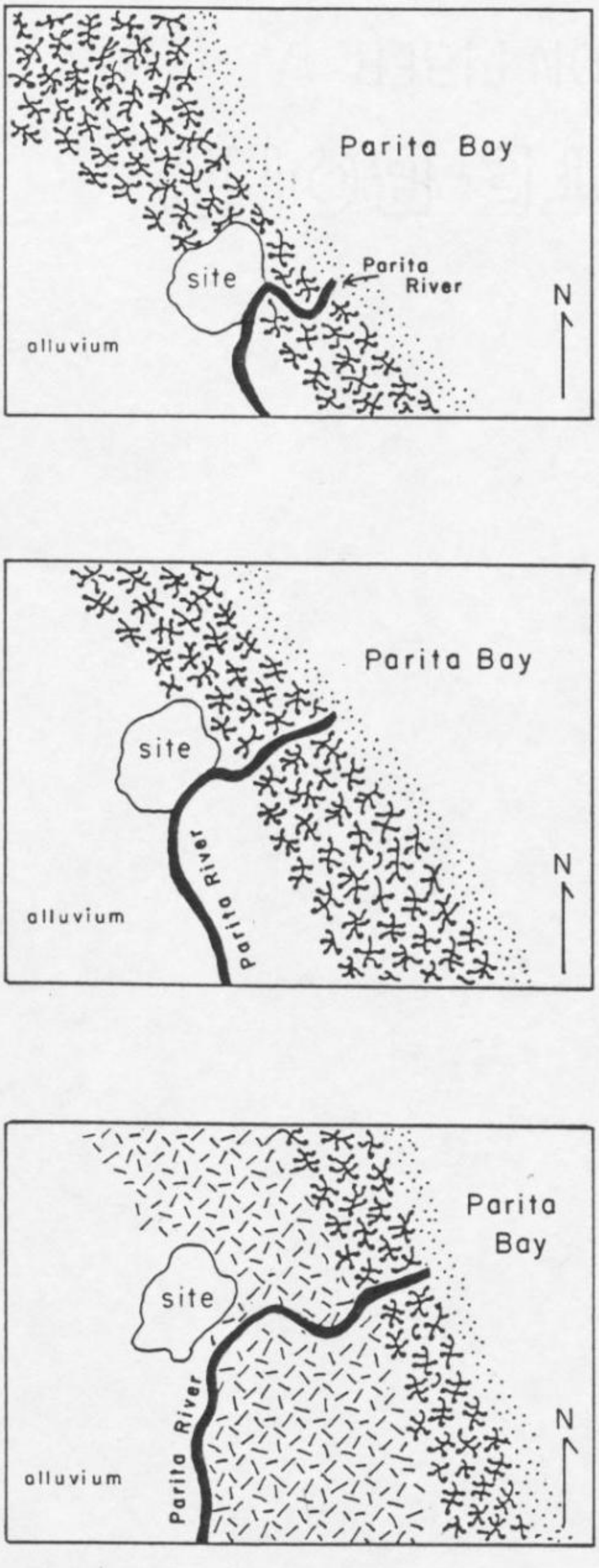


Figure 4. Schematic of Physiographic Zones in Central Panama (Not to Scale).



a. 1000 B.C.

b. A.D. 1

c. A.D. 1000

Figure 5. Reconstruction of Environs of La Mula-Sarigua (Not to Scale).

Plate 1. Aerial View of La Mula-Sarigua; Sarigua Alvina in Foreground.

Plate 2. Eroded Surface in the Northern Sector of La Mula-Sarigua.

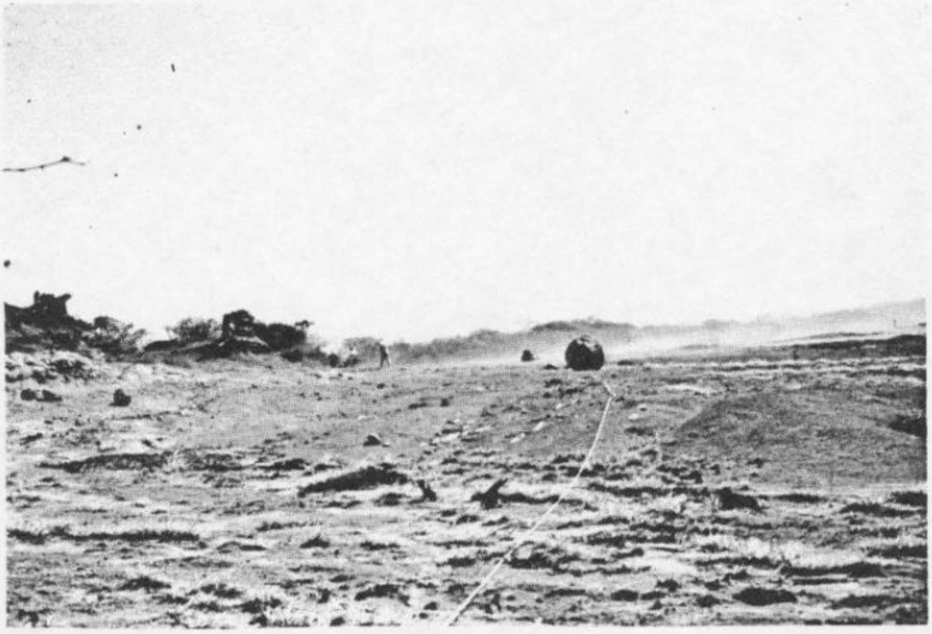


Plate 3. Eroded Surface (left); Alvina (right).

Plate 4. Eroded Surface, Gullies and Shellmidden Feature; Mangrove-fringed Alvina in Background.

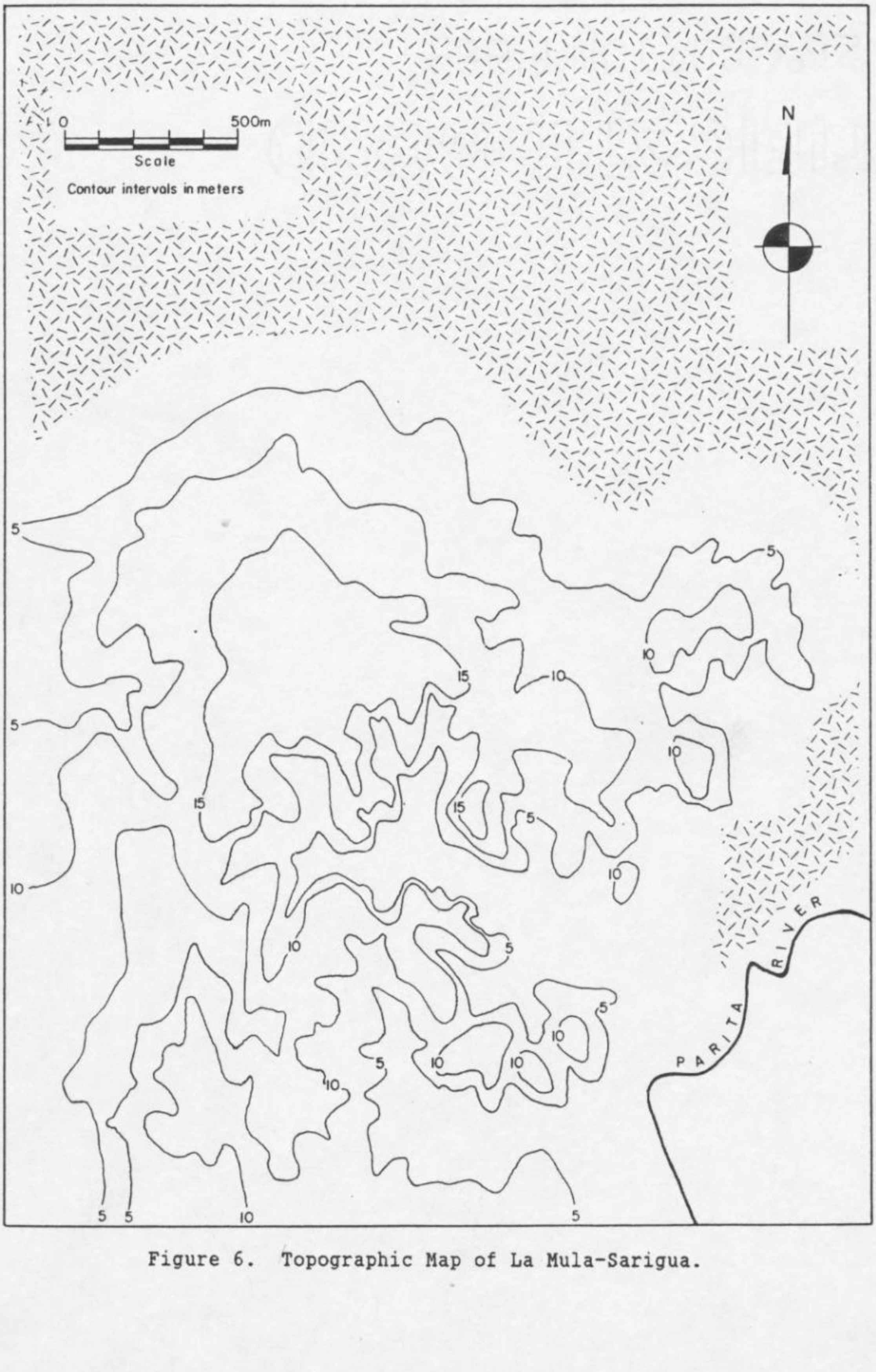


Figure 6. Topographic Map of La Mula-Sarigua.

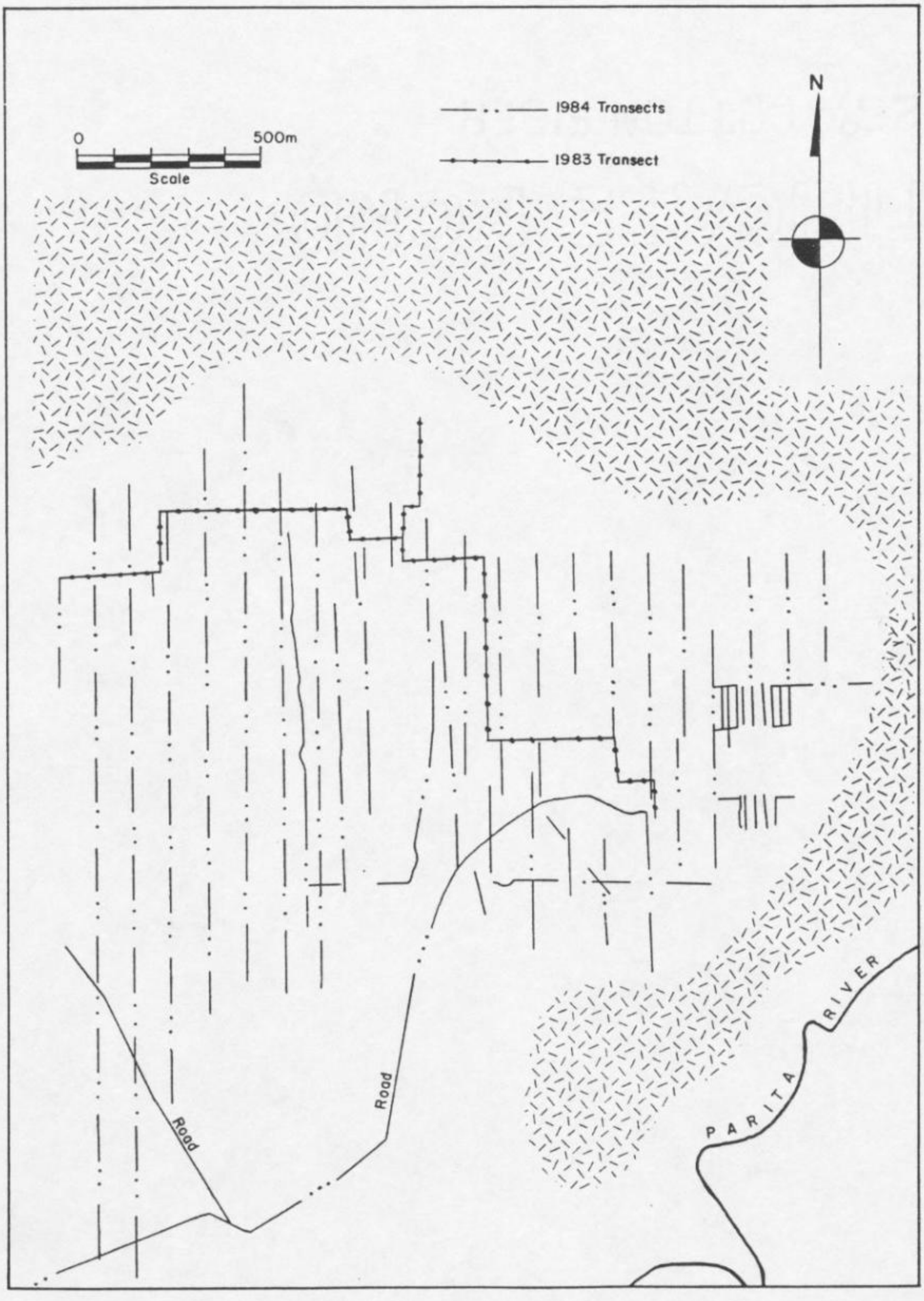


Figure 7. Survey Transects--Probabilistic Sample.

Plate 5. Eroded versus Noneroded Interface.

Plate 6. Sorghum Field.

Plate 7. Ca. 360 Degree View of Nonexposed, Noneroded Surfaces (Dry Season).

Plate 8. Survey Transect in Nonexposed Surface Area.

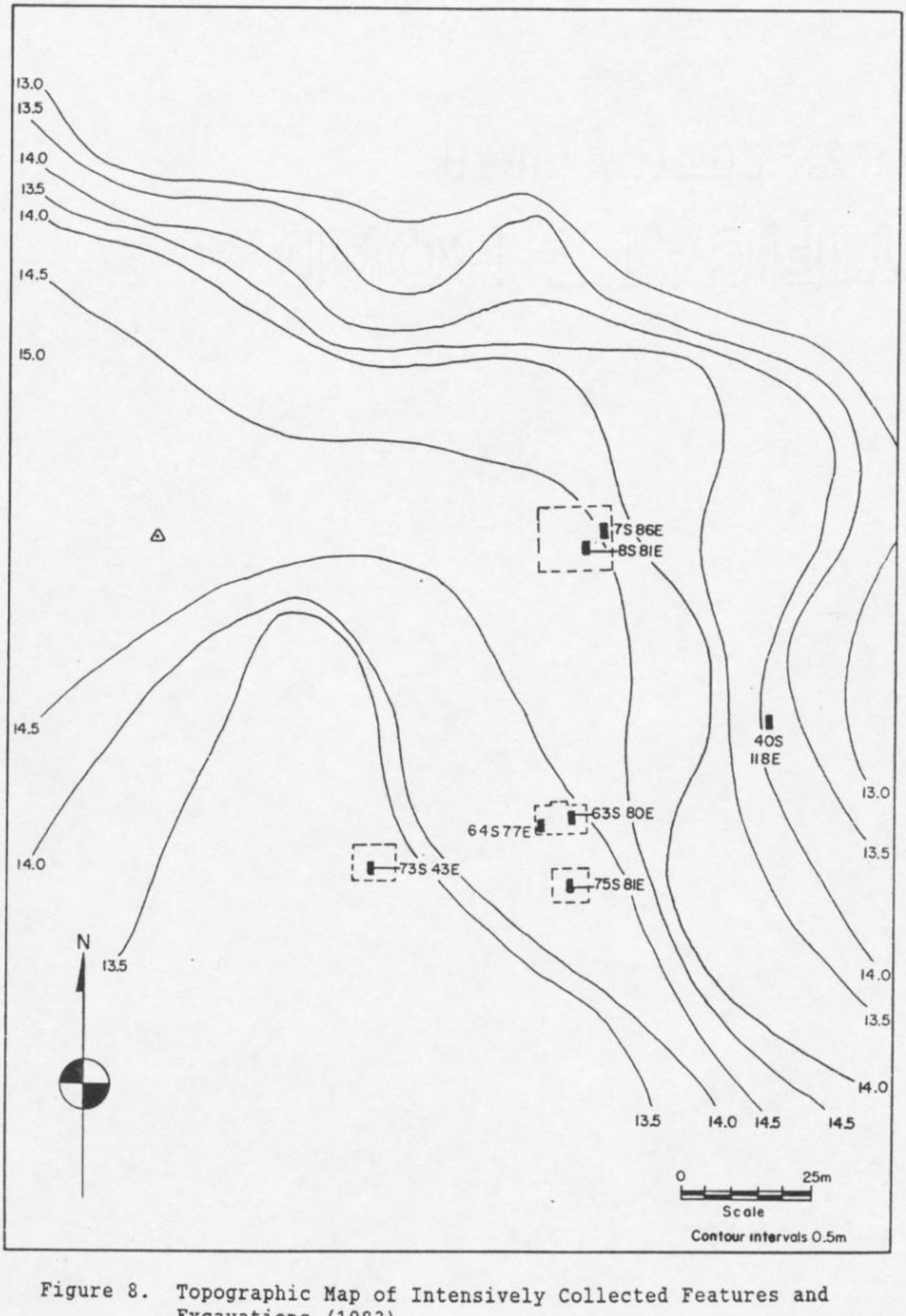


Figure 8. Topographic Map of Intensively Collected Features and Excavations (1983).

Plate 9. Shellmidden Feature 70S40E.

Plate 10. Profile (North Wall) 70S40E.

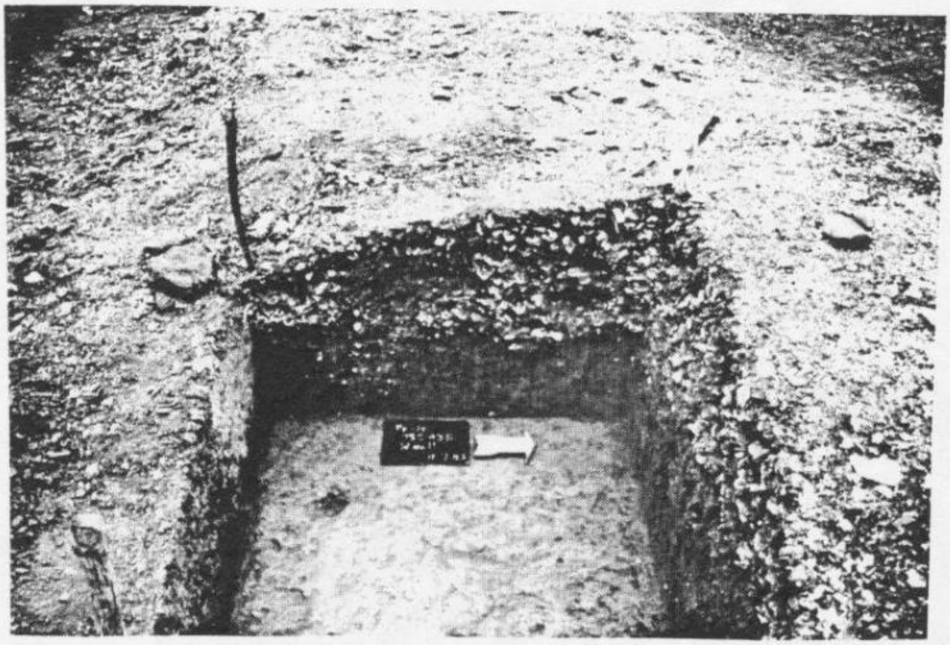


Plate 11. Profile (West Wall) 70S40E.

Plate 12. Hearth (Northwest Wall) ca. 40 cm bs 70S40E.

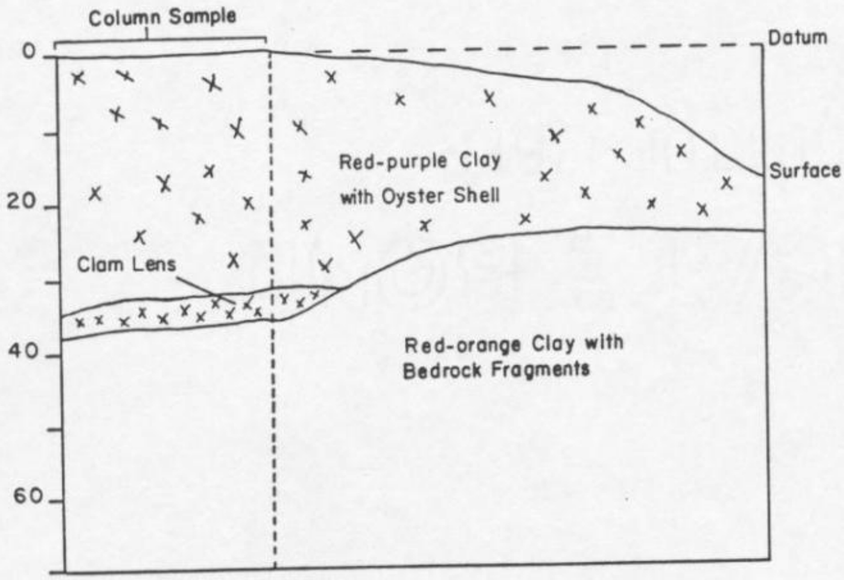


Figure 9. Profile (North Wall) 70S40E.

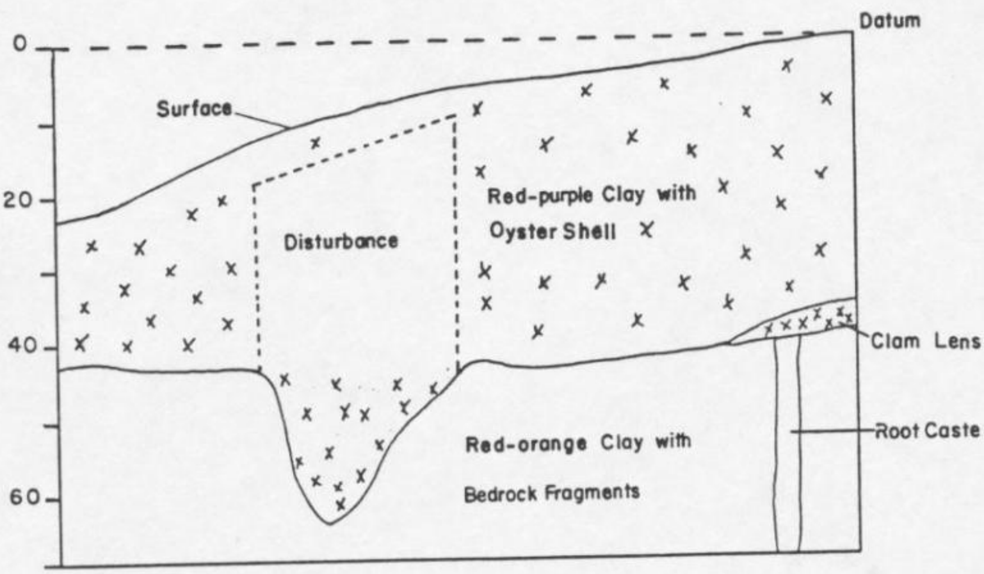


Figure 10. Profile (West Wall) 70S40E.

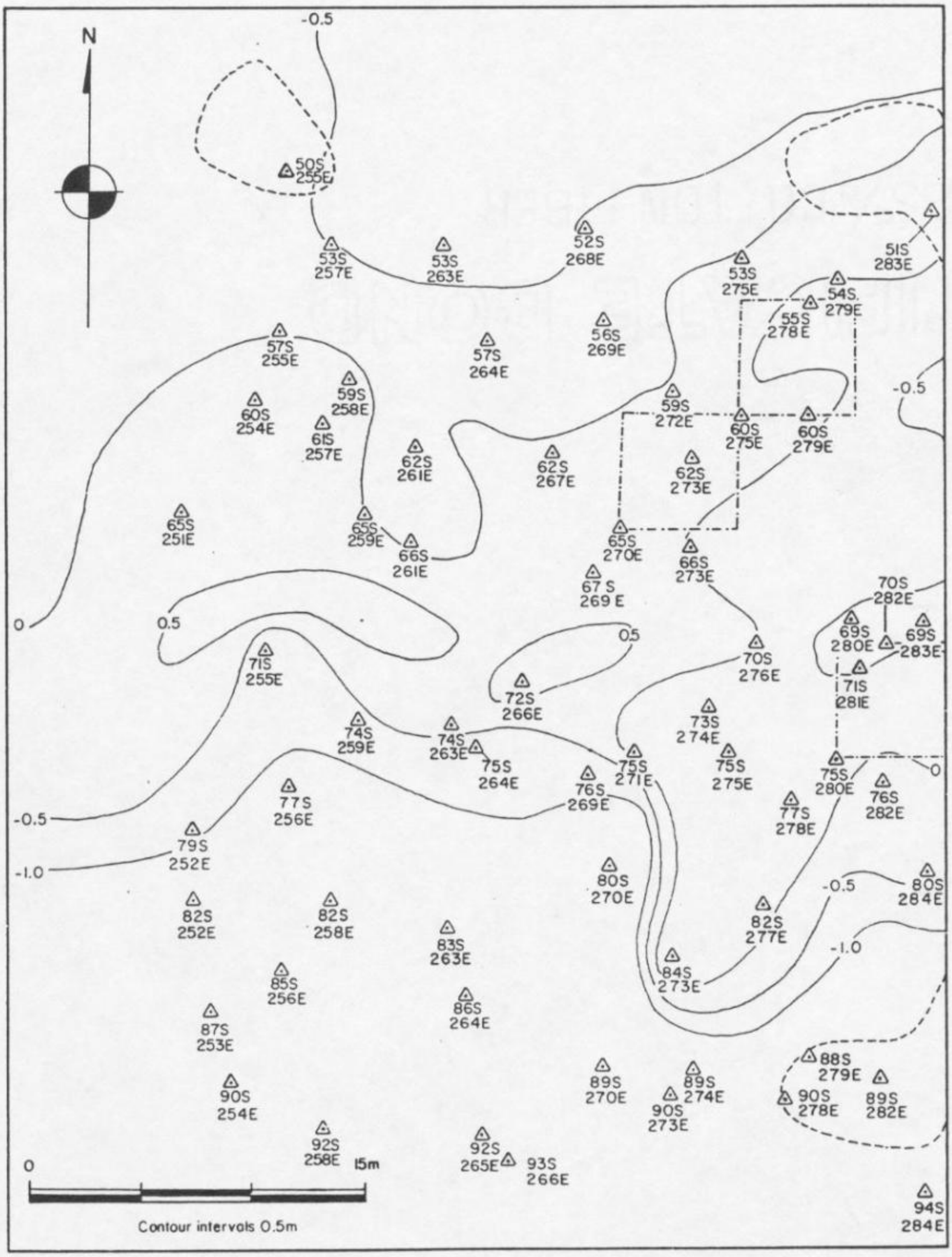


Figure 11. Topographic Map (1 of 2) of Shellmidden Feature 70S275E.

Plate 13. Shellmidden Feature 70S275E.

Plate 14. Shellmidden Feature 8S75E.

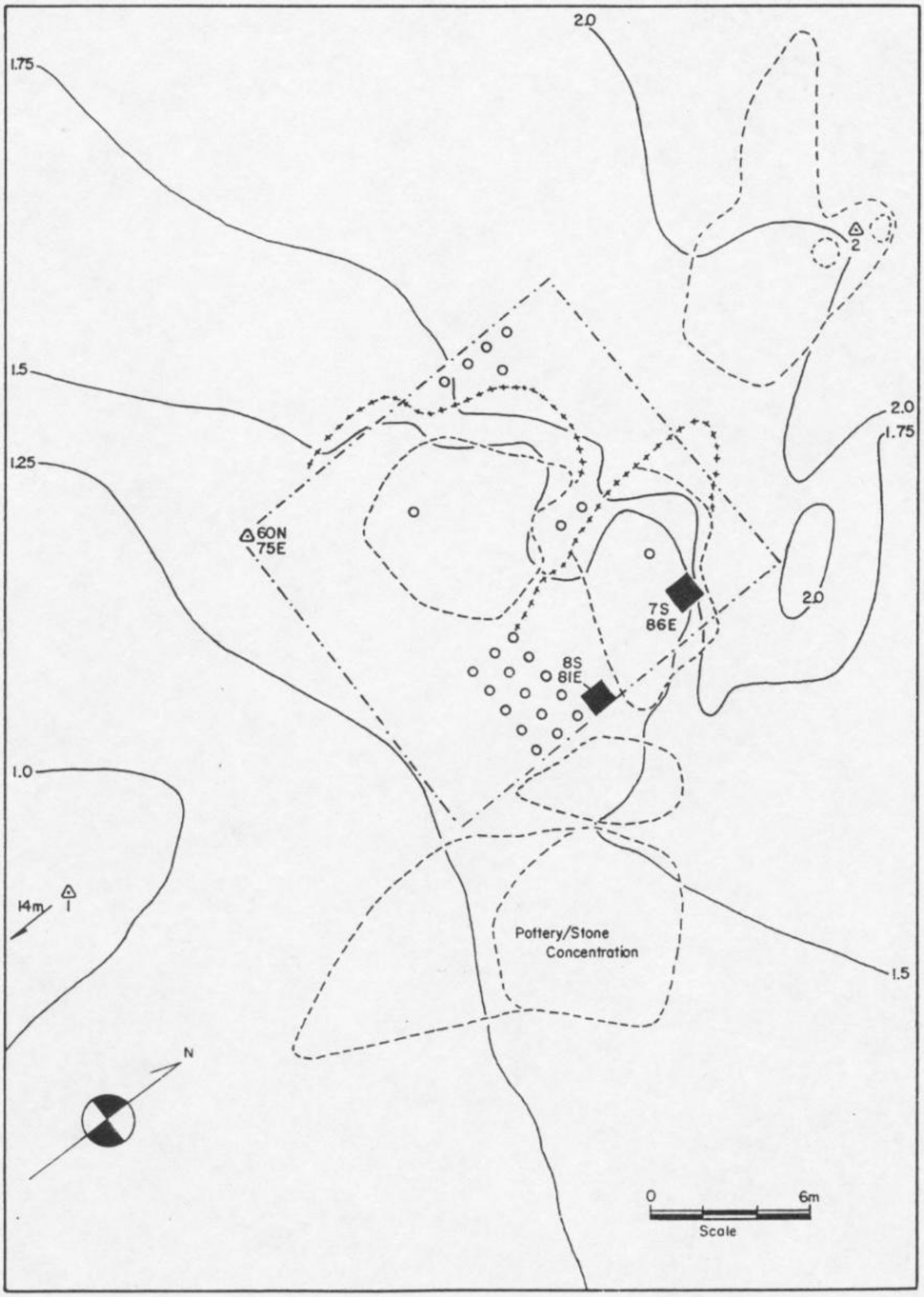


Figure 13. Topographic Map of Shellmidden Feature 8S75E.

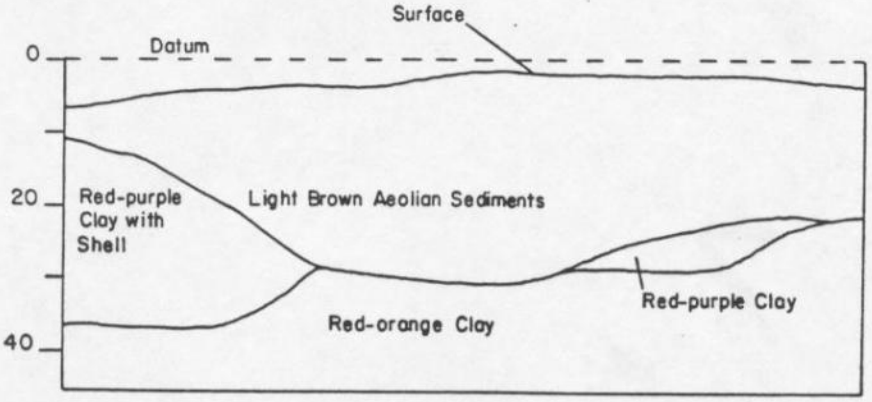


Figure 14. Profile (West Wall) 8S81E.

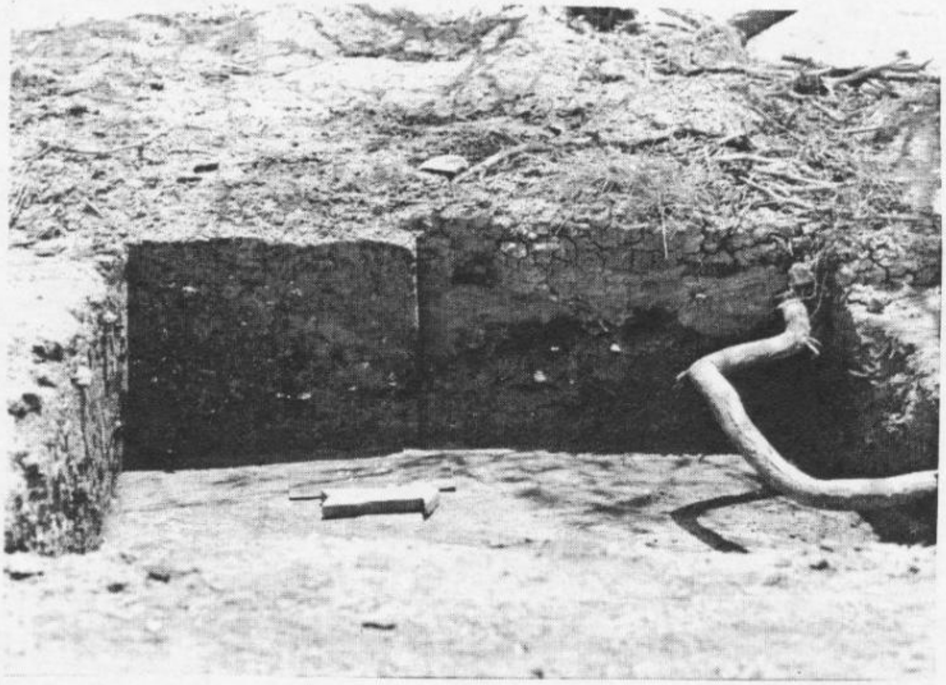


Plate 15. Profile (West Wall) 8S81E.

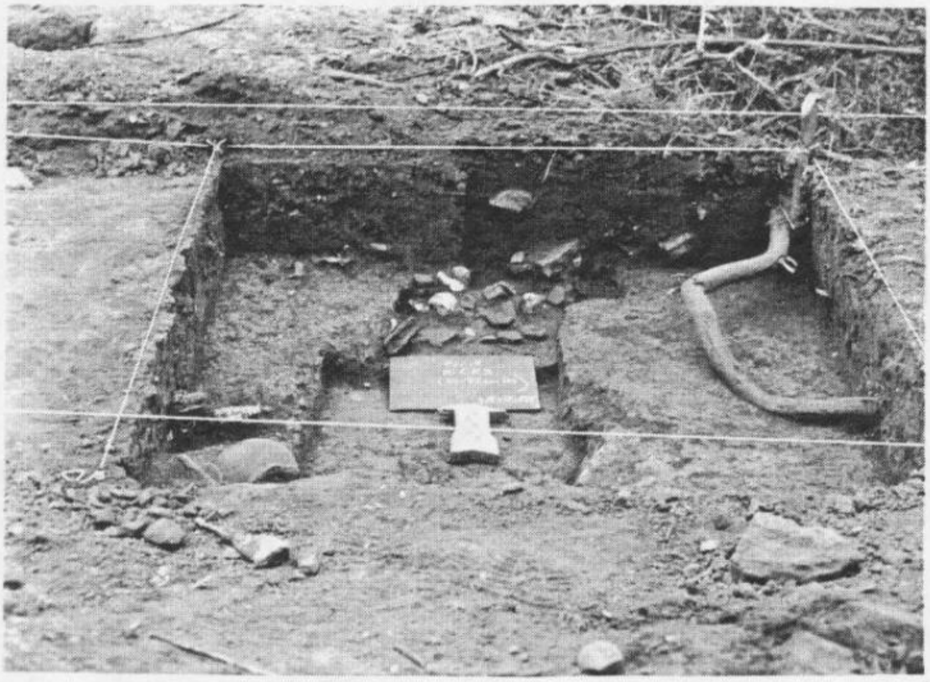


Plate 16. Erosion Gully in the Center of Excavation 8S81E.

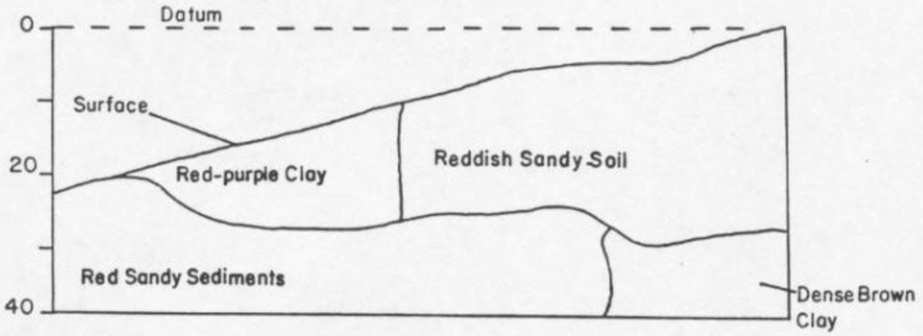
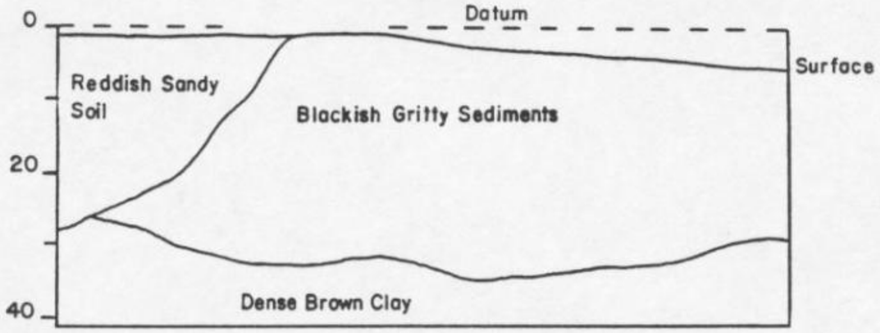


Figure 15. Profile (South Wall) 7S86E.



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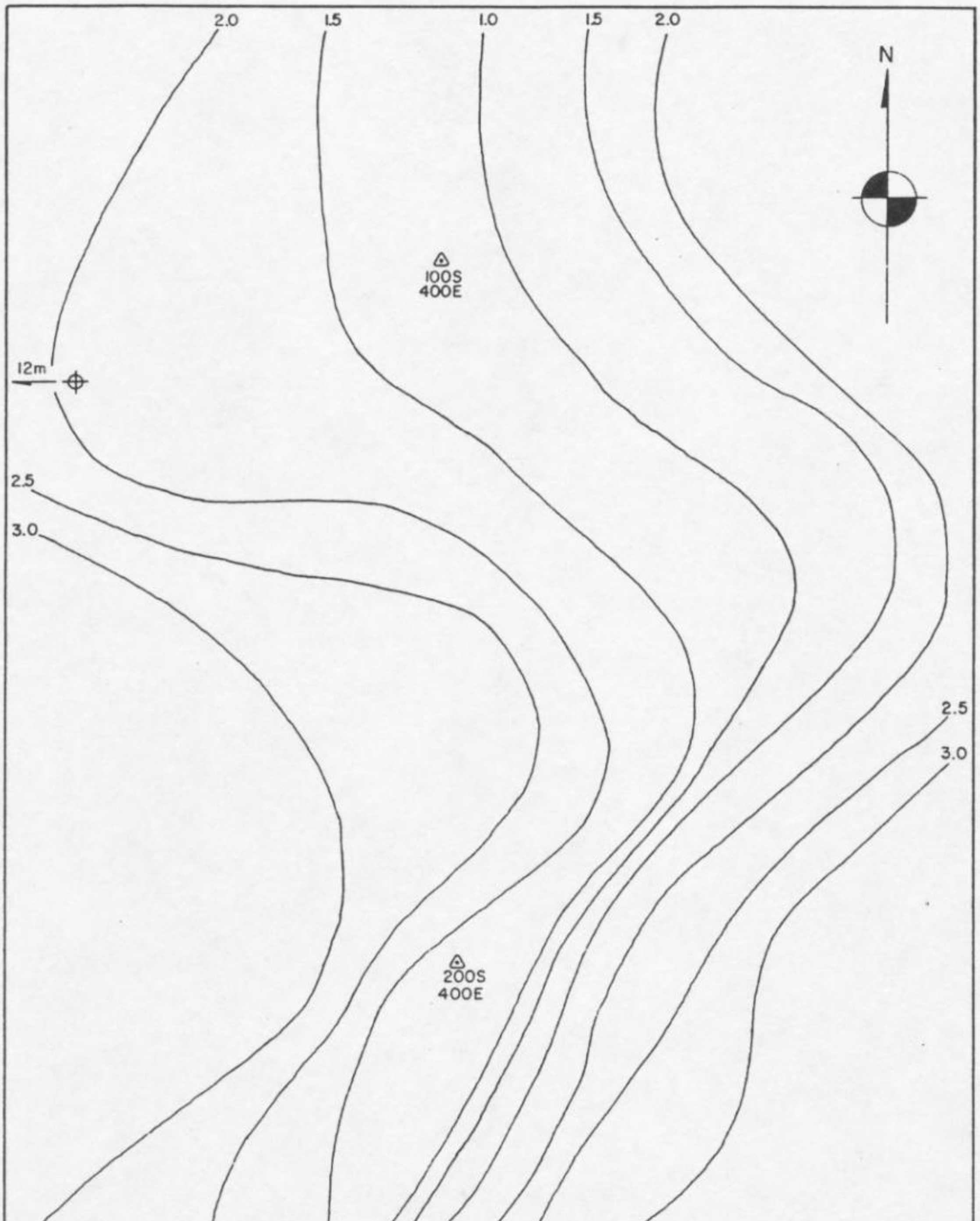


Figure 17. Topographic Map of Shellmidden Feature 242S417E.

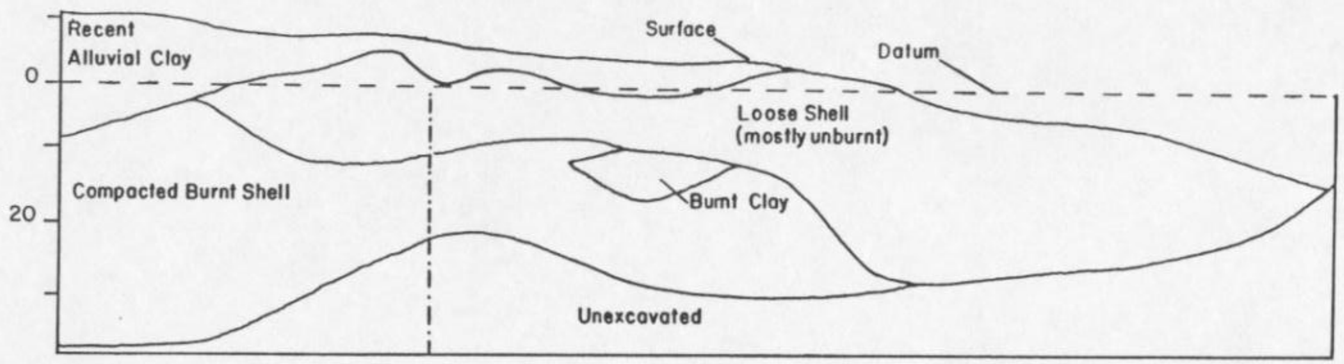


Figure 18. Profile (North Wall) 242S417E.

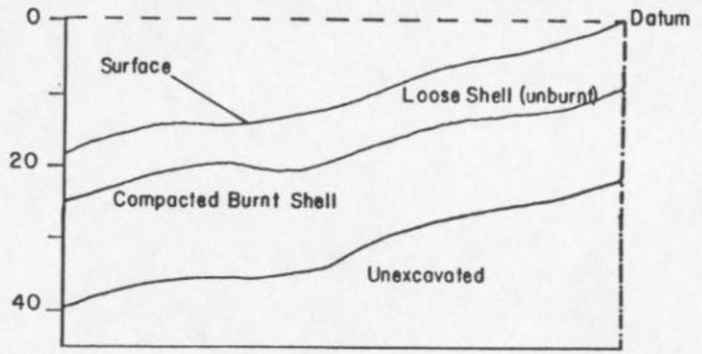


Figure 19. Profile (West Wall) 242S417E.

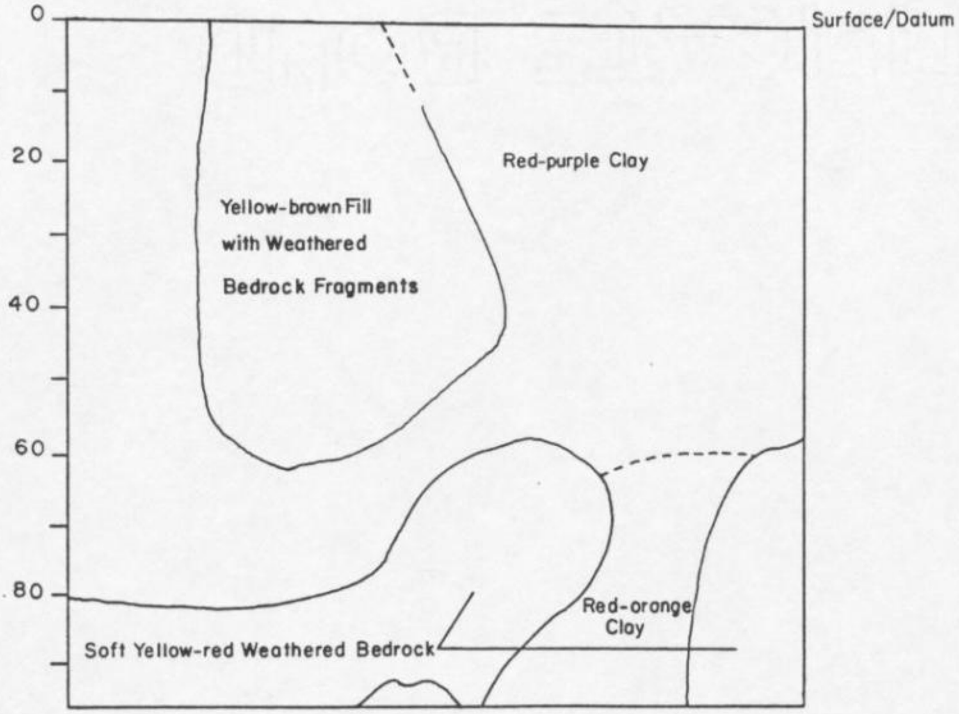


Figure 20. Profile (South Wall) 75S83E.

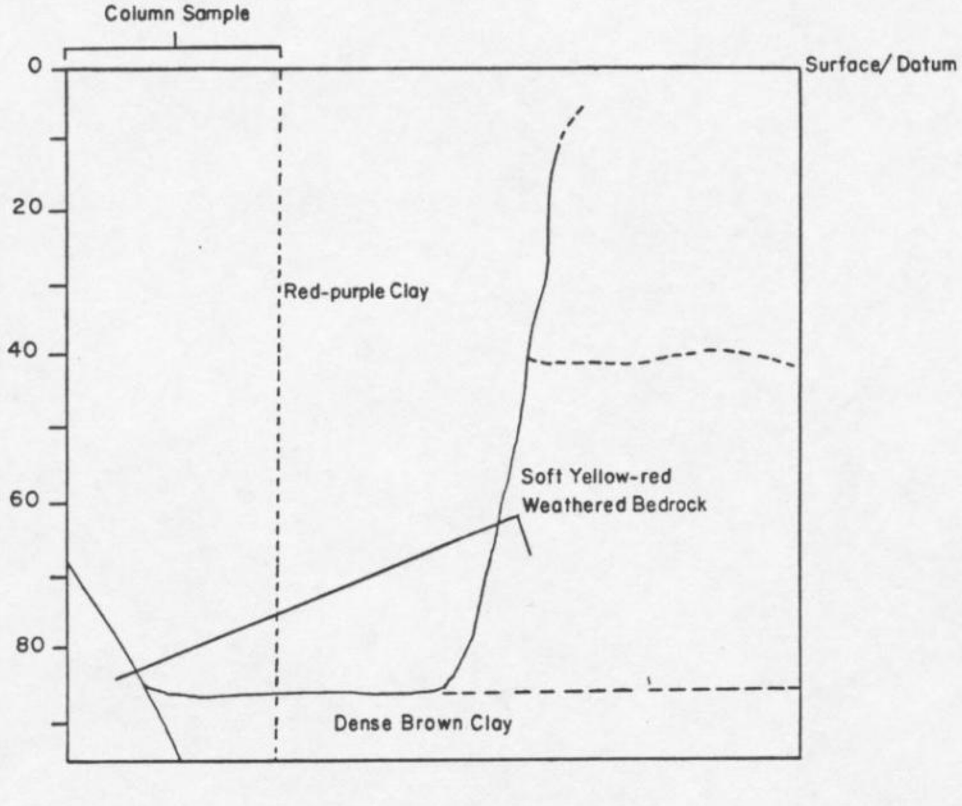


Figure 21. Profile (West Wall) 75S83E.

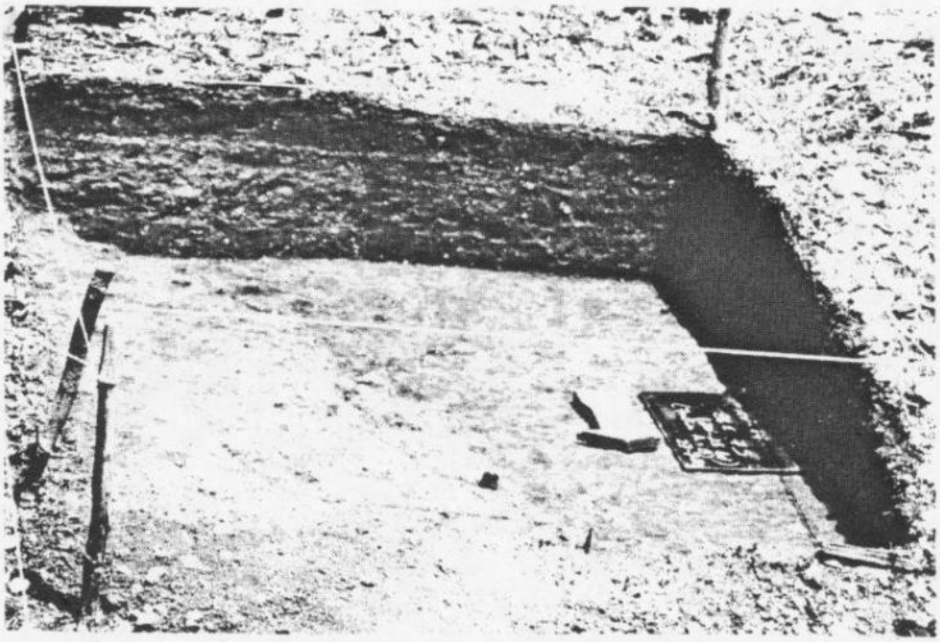


Plate 17. Profile (South Wall) 7S86E.

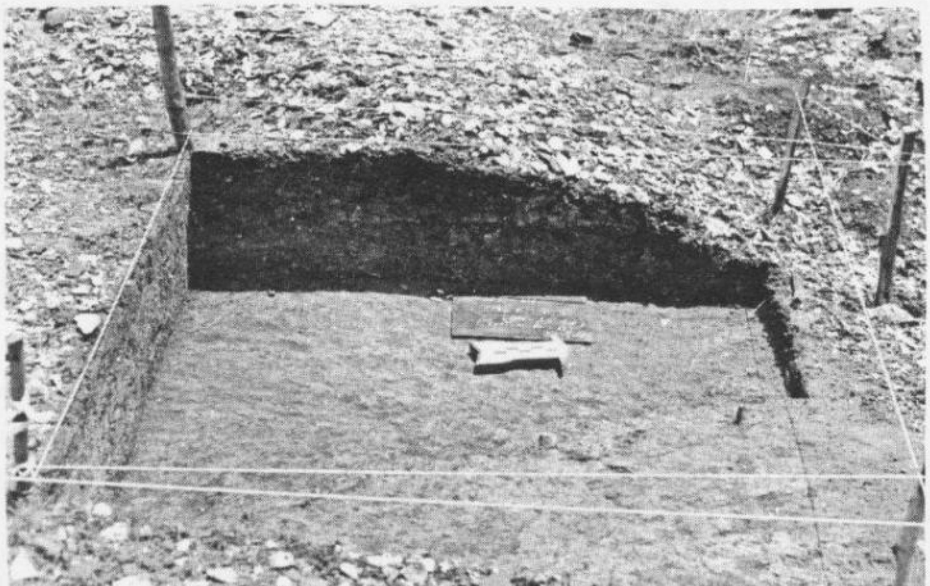


Plate 18. Profile (West Wall) 7S86E.

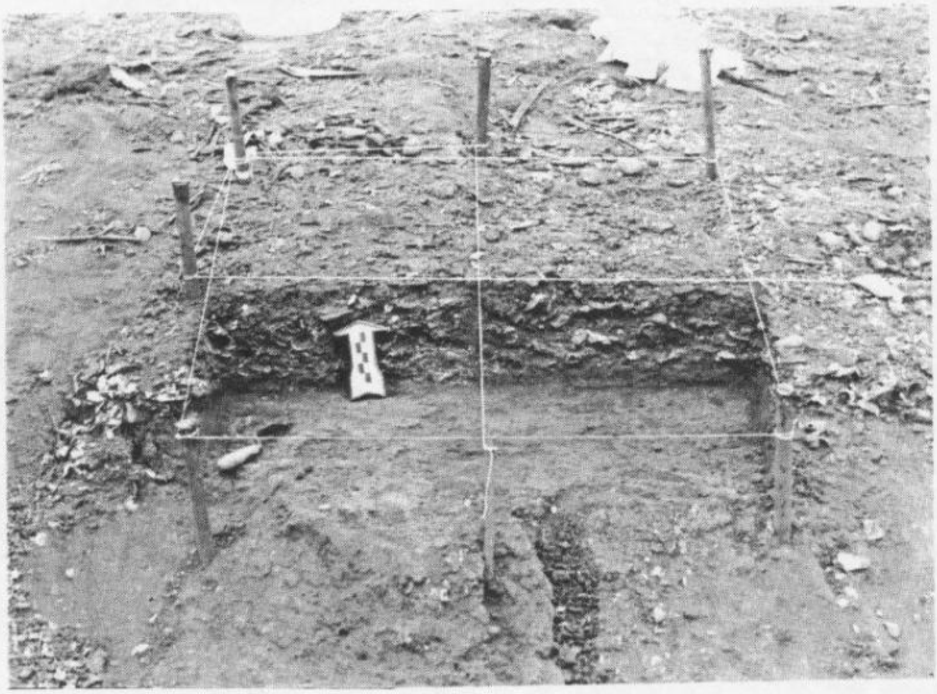
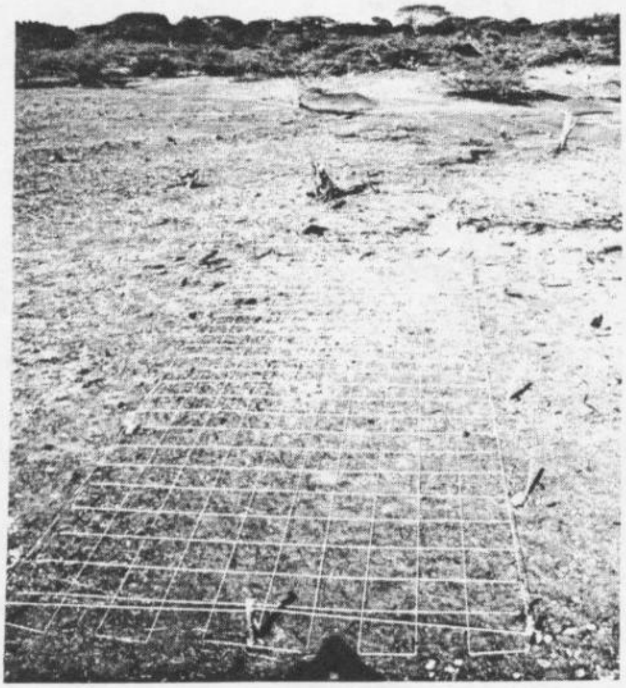


Plate 19. Profile (North Wall) 242S417E.



Platc 20. Surface Burial Feature 74S82E.

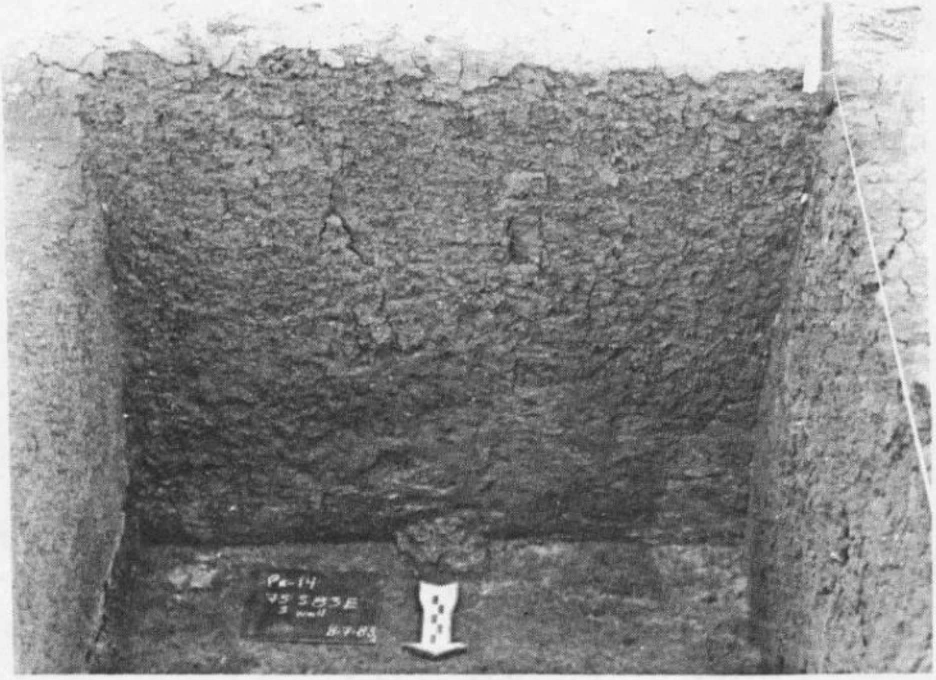


Plate 21. Profile (South Wall) 75S83E.

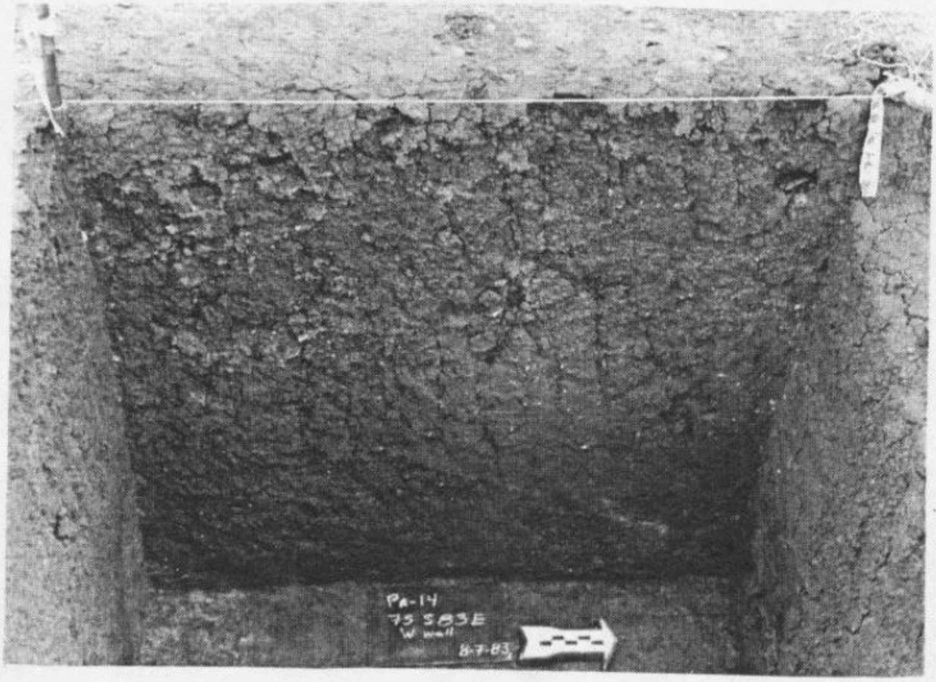


Plate 22. Profile (West Wall) 75S83E.

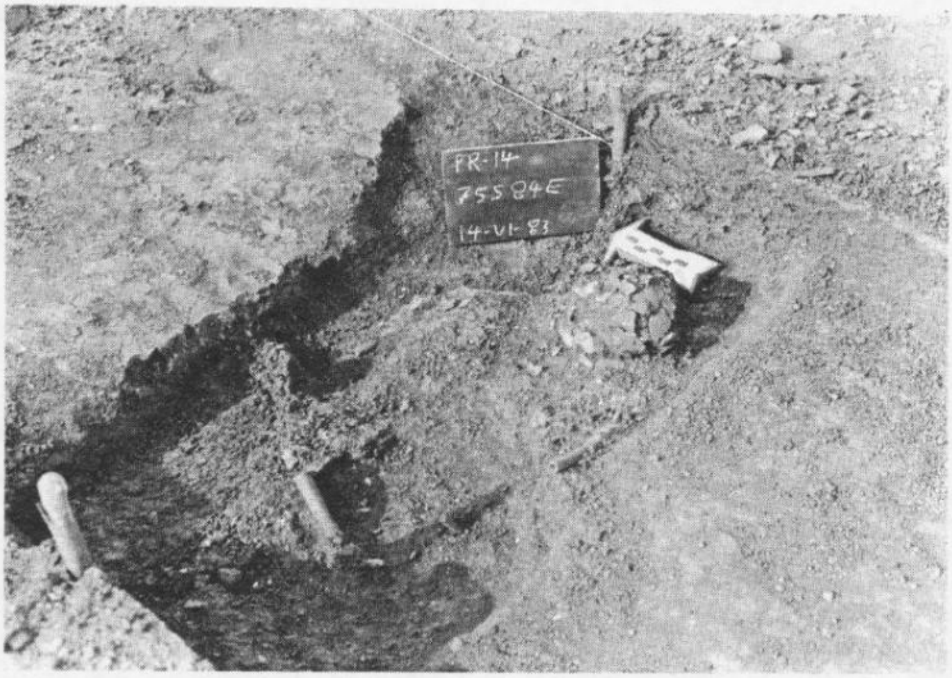


Plate 23. Subsurface Burial Feature 75S84E.

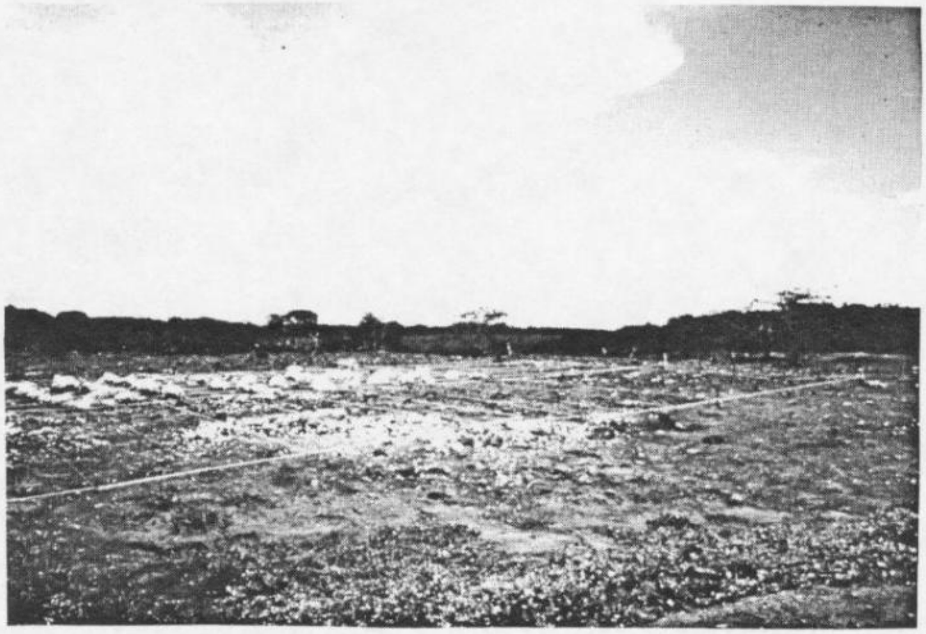


Plate 24. Shellmidden Feature (Possible Household Area) 67S75E.

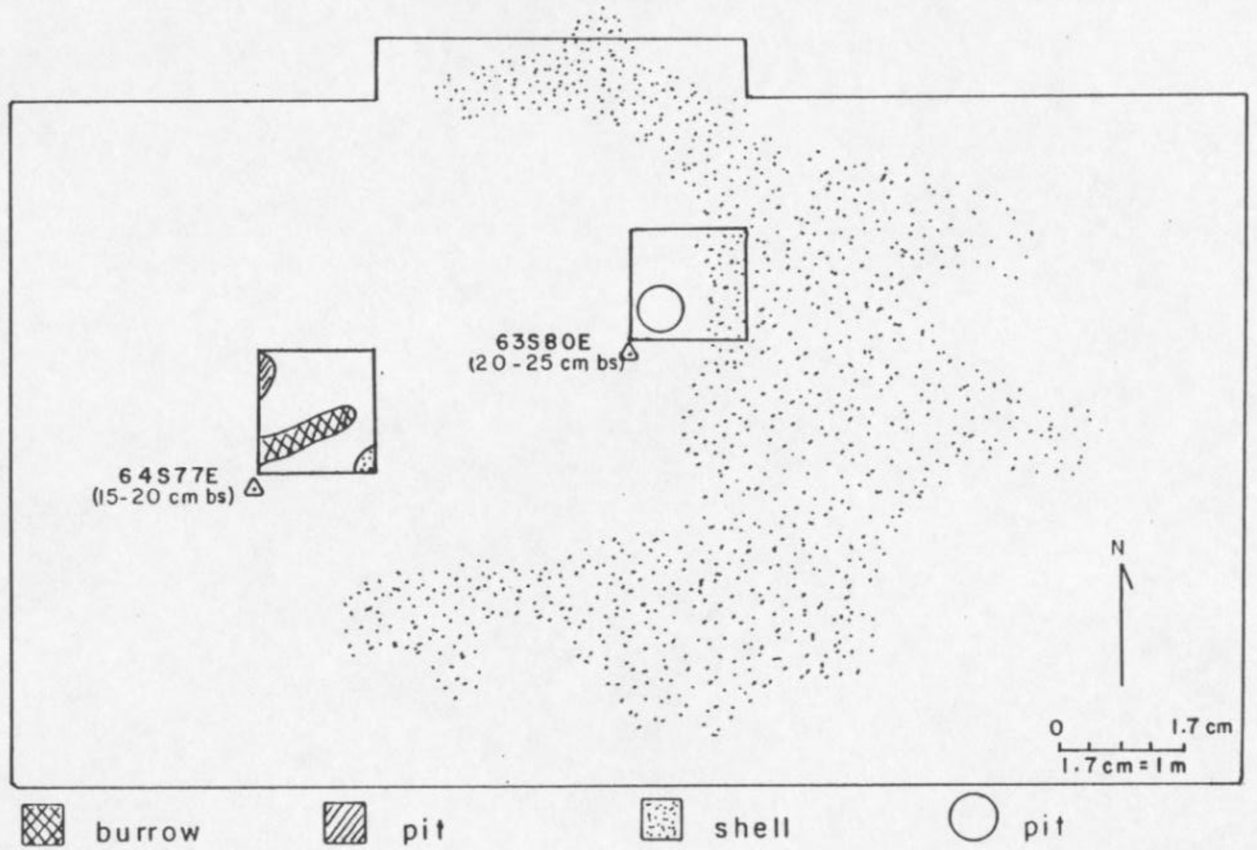


Figure 22. Shellmidden Feature (Possible Household Area) 67S75E.

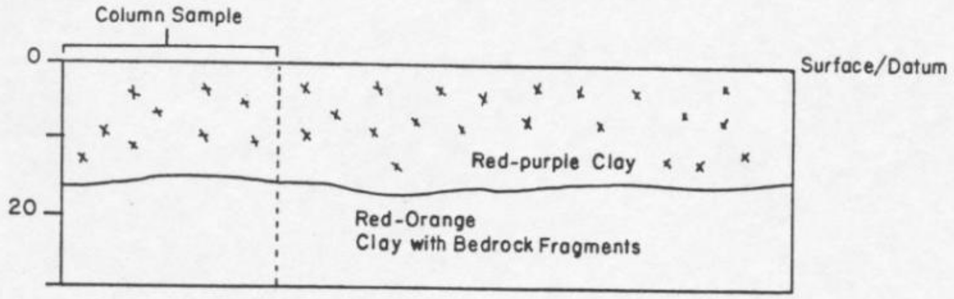


Figure 23. Profile (North Wall) 64S77E.

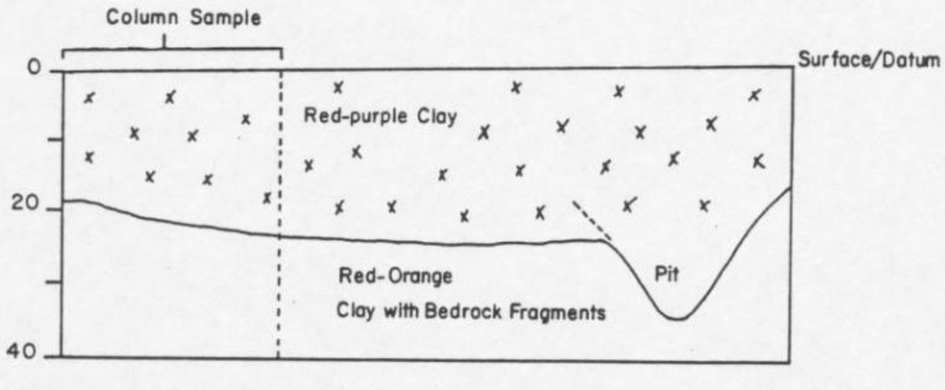


Figure 24. Profile (South Wall) 63S80E.

Plate 25. Shellmidden Feature (Possible Household Area) 67S75E.

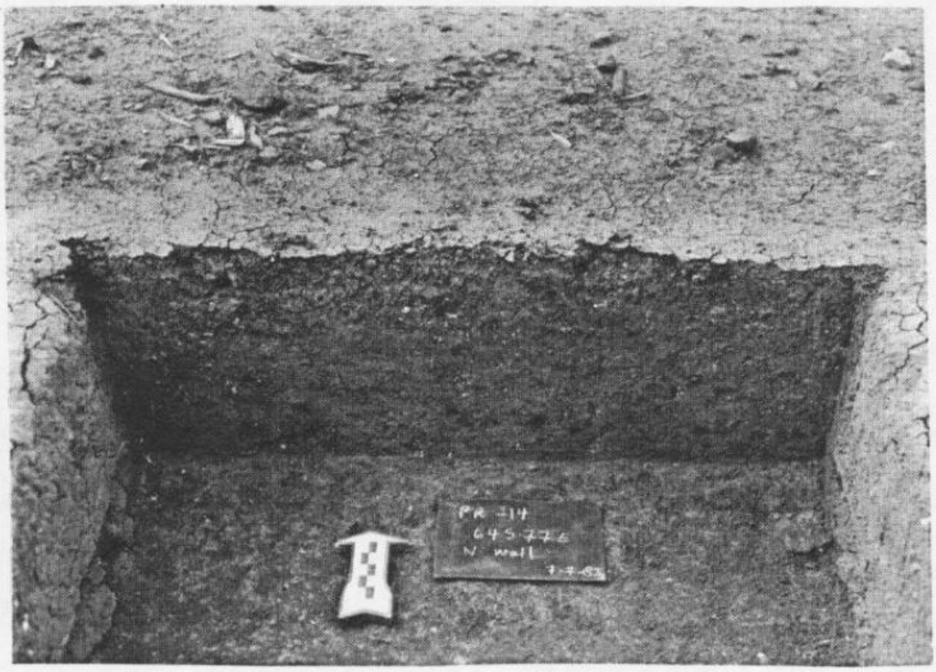


Plate 26. Profile (North Wall) 64S77E.

Plate 25. Shellmidden Feature (Possible Household Area) 67S75E.

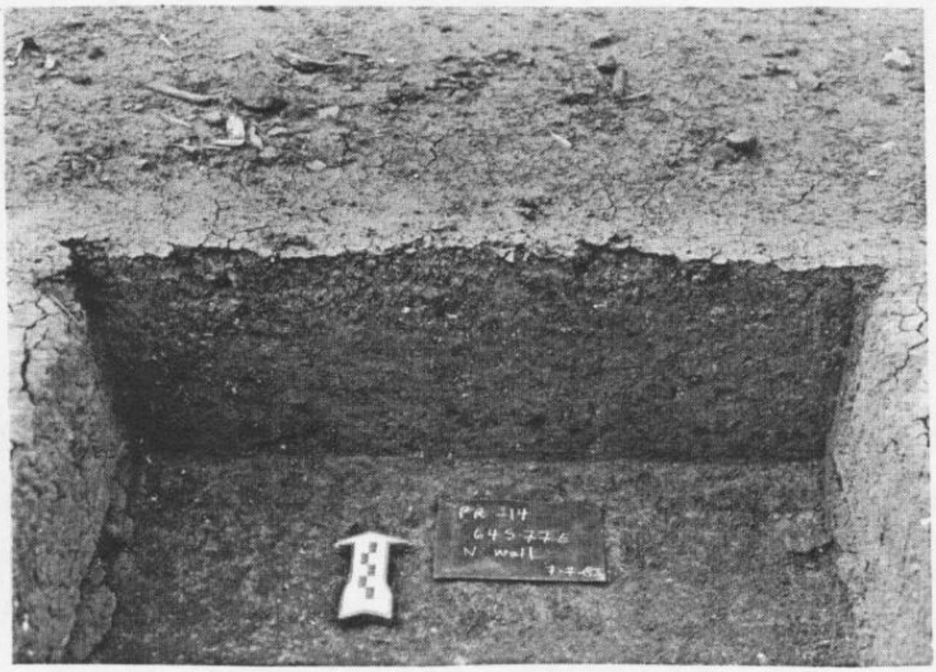


Plate 26. Profile (North Wall) 64S77E.

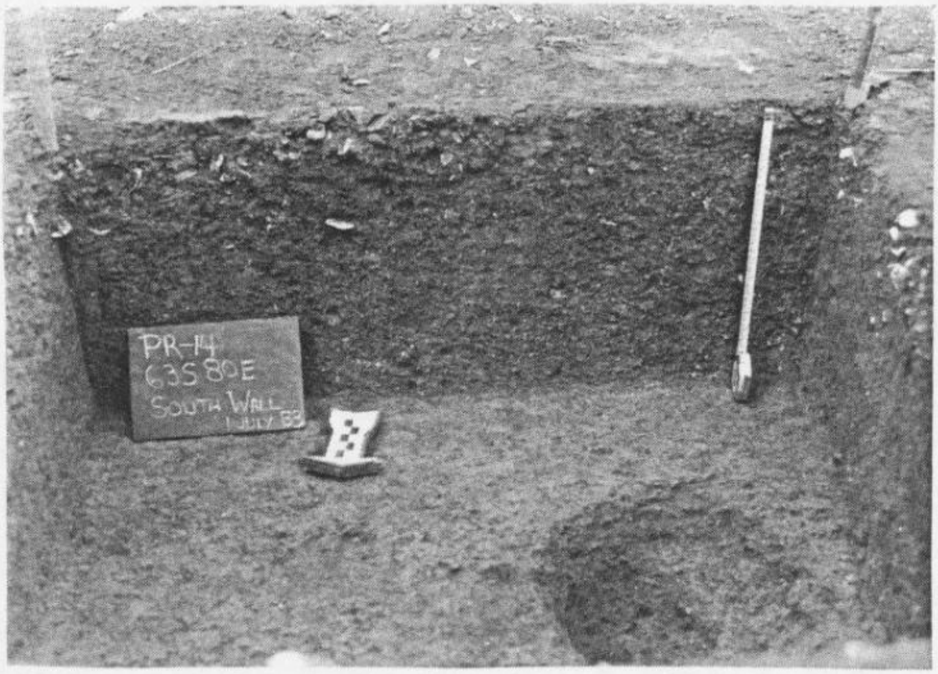


Plate 27. Profile (South Wall) 63S80E.

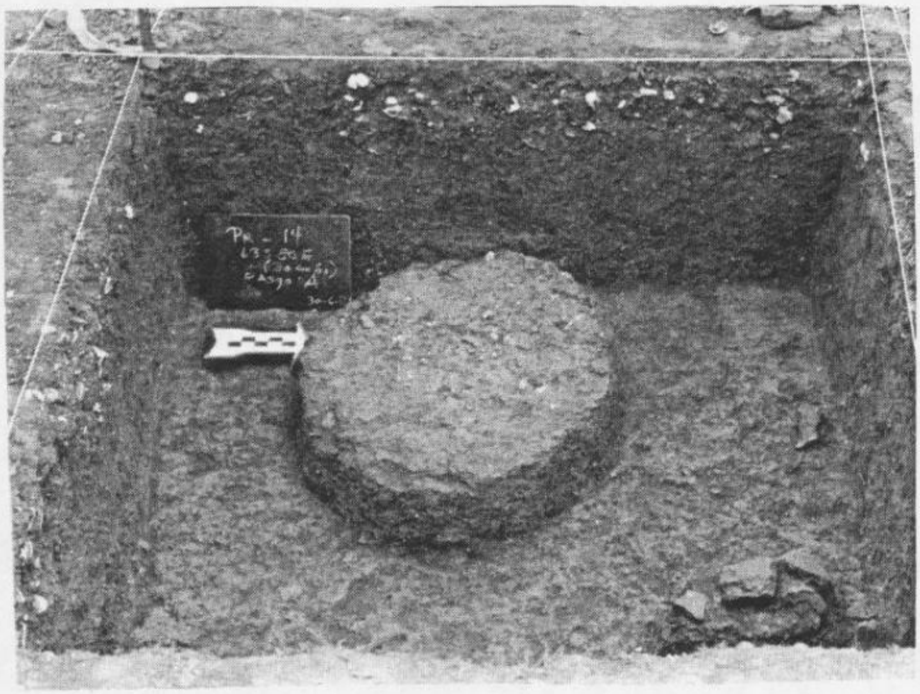


Plate 28. Pit Feature 63S80E.

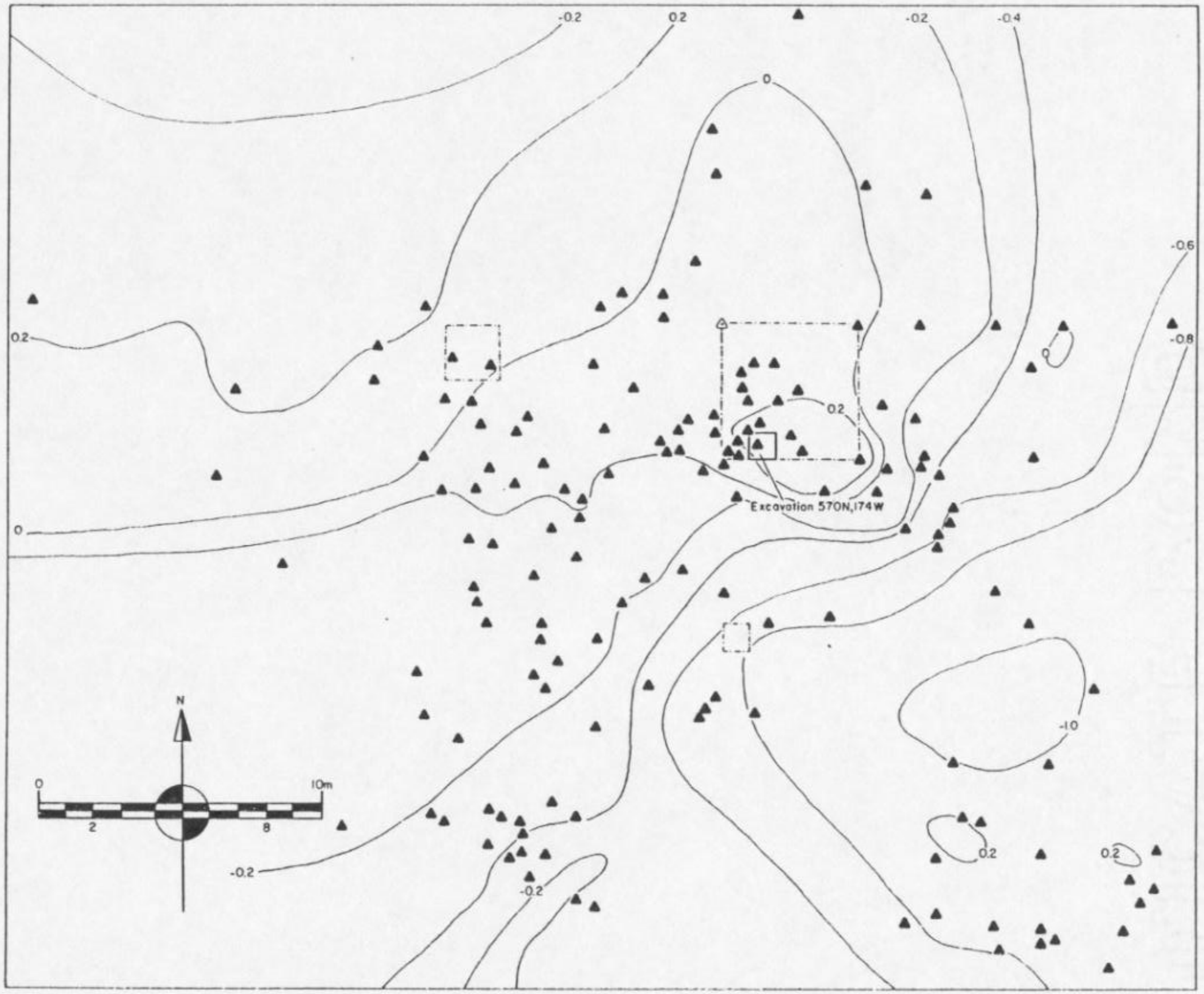


Figure 25. Topographic Map of Bifacial Workshop 570N174W.

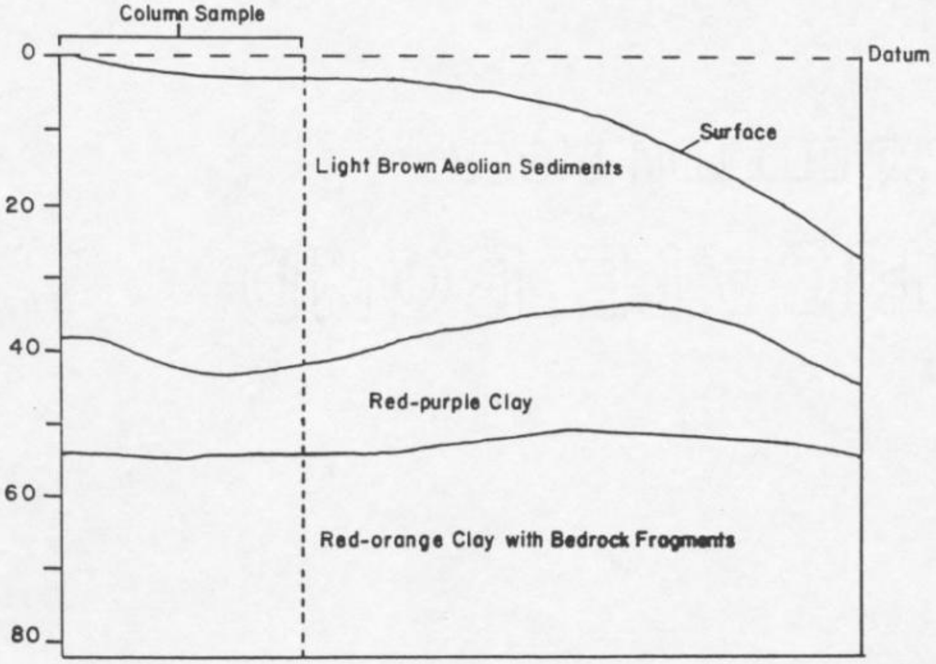


Figure 26. Profile (West Wall) 40S118E.

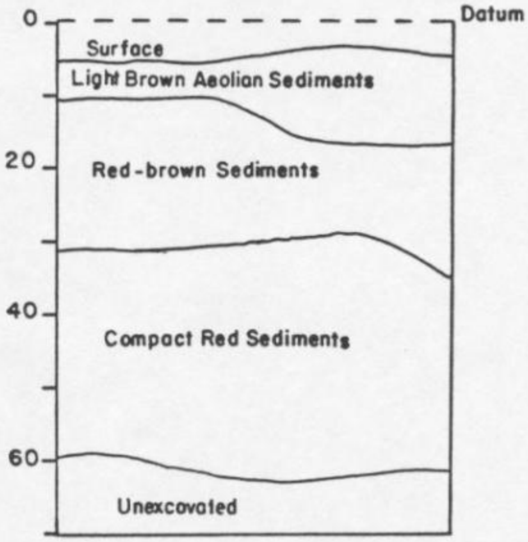


Figure 27. Profile (South Wall) PED I.

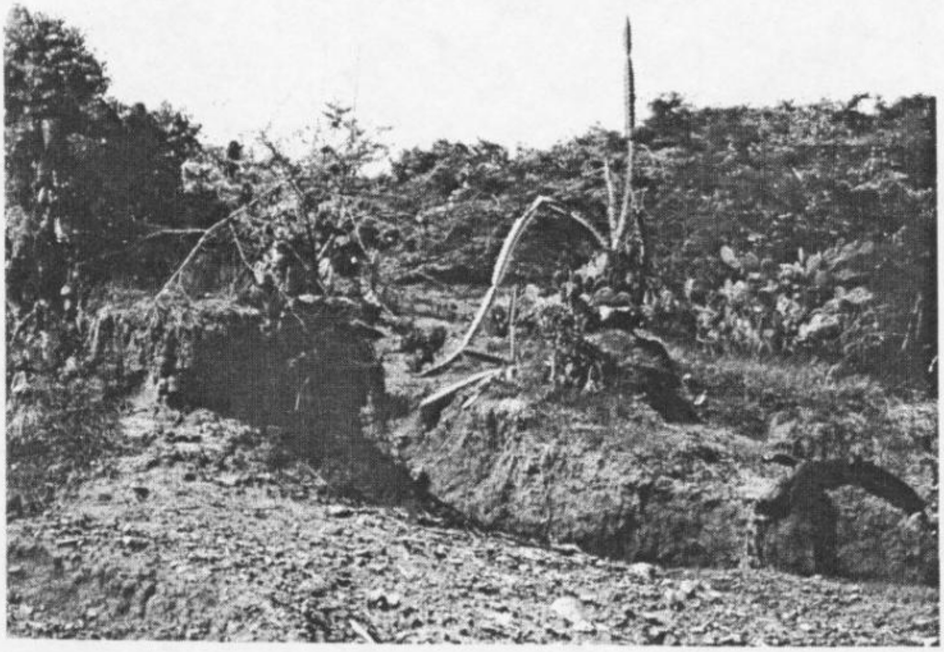


Plate 29. Pedestal 40S118E.

Plate 30. Profile (West Wall) 40S118E.

Plate 31. Pedestal PED I.

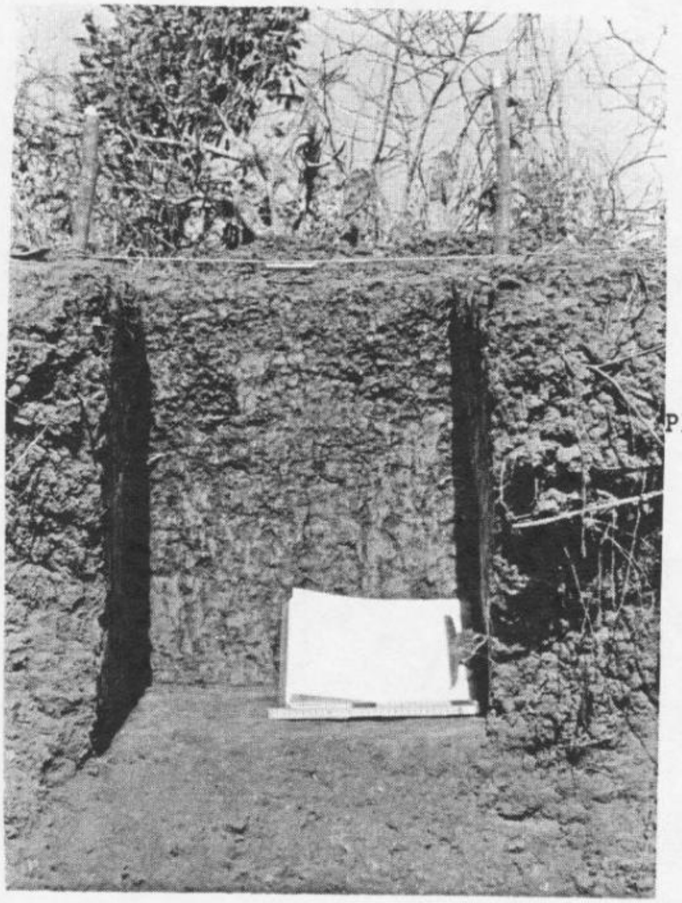


Plate 32. Profile (South Wall) PED I.

Plate 41. Quarry.

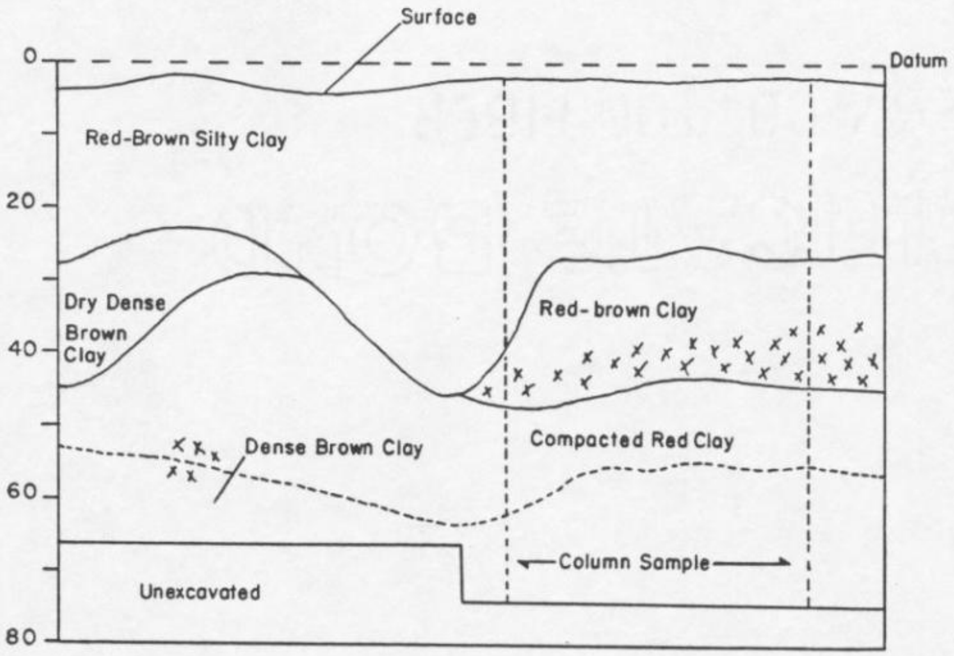


Figure 28. Profile (North Wall) 14N494W.

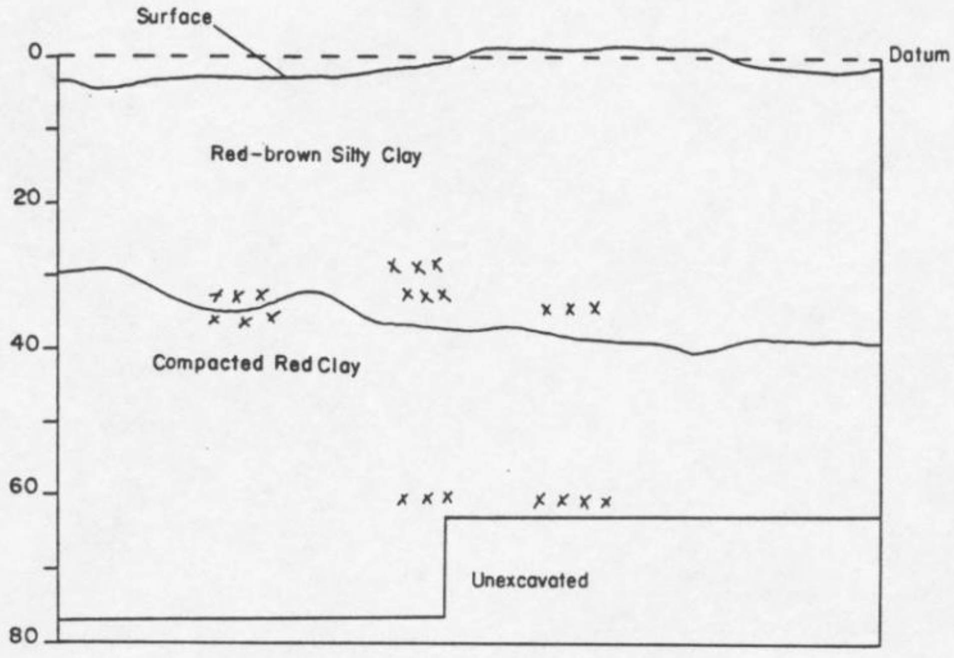


Figure 29. Profile (East Wall) 14N494W.

Plate 33. Area 70S169E.

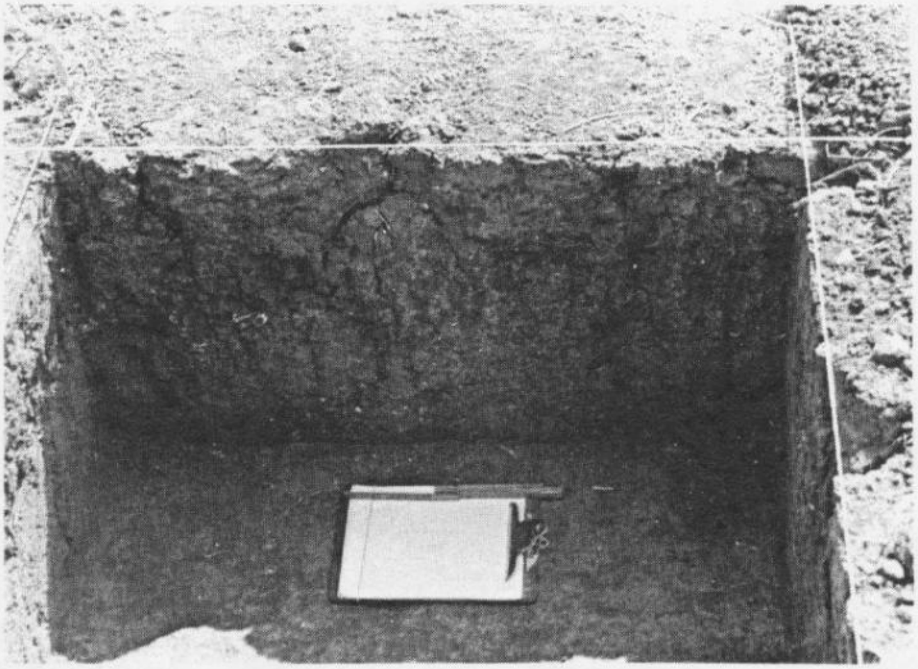


Plate 34. Profile (North Wall) 14N494W.

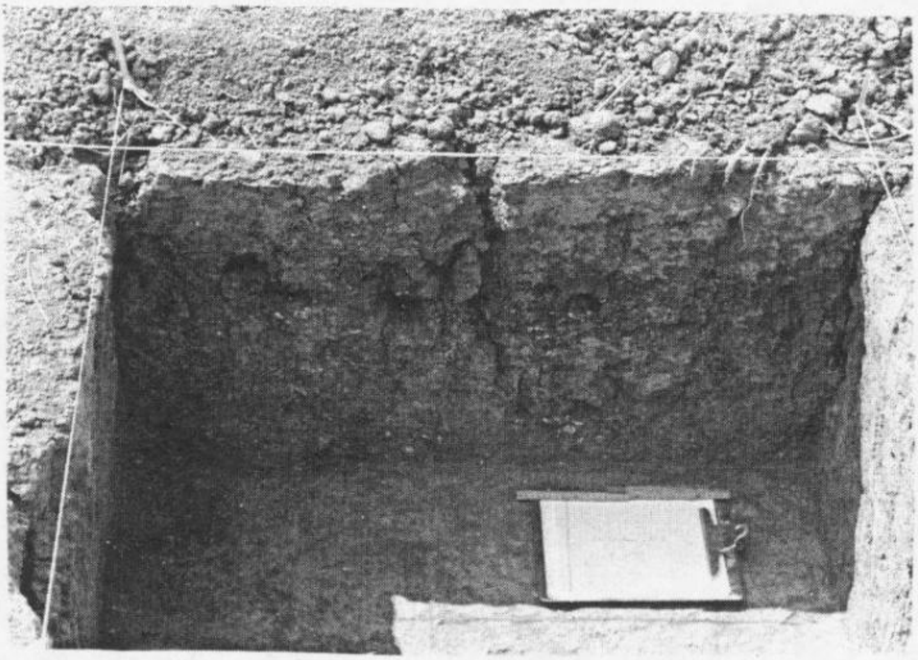


Plate 35. Profile (East Wall) 14N494W.

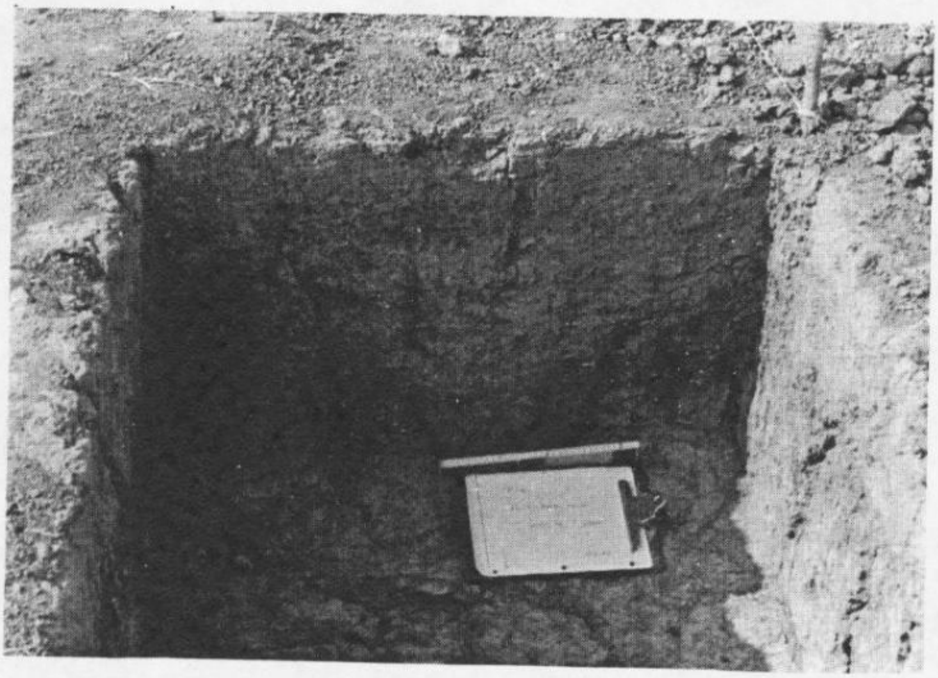


Plate 36. Profile (West Wall) 64N496W.

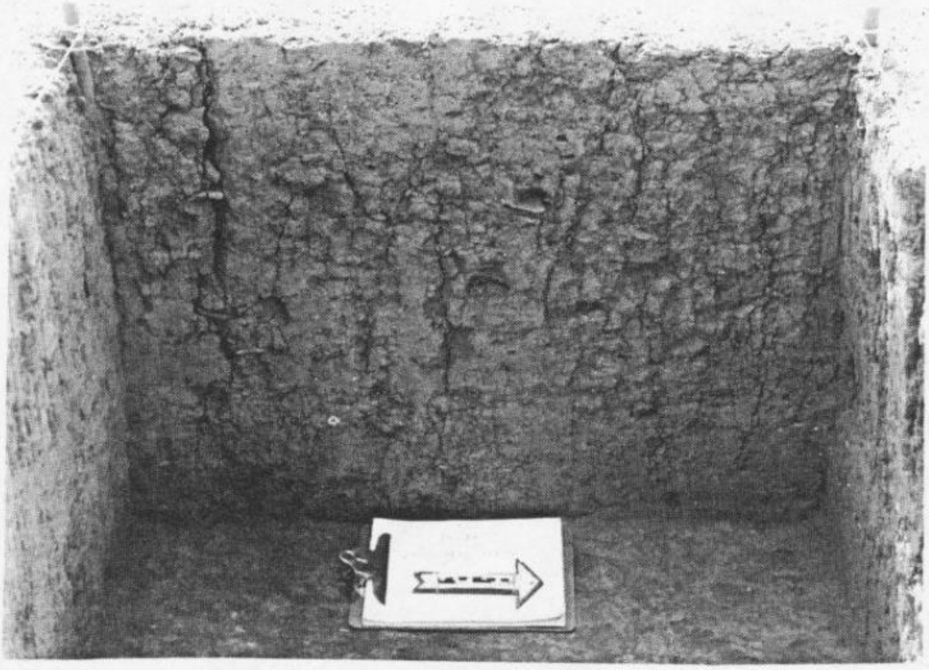


Plate 37. Profile (West Wall) 11N398W.

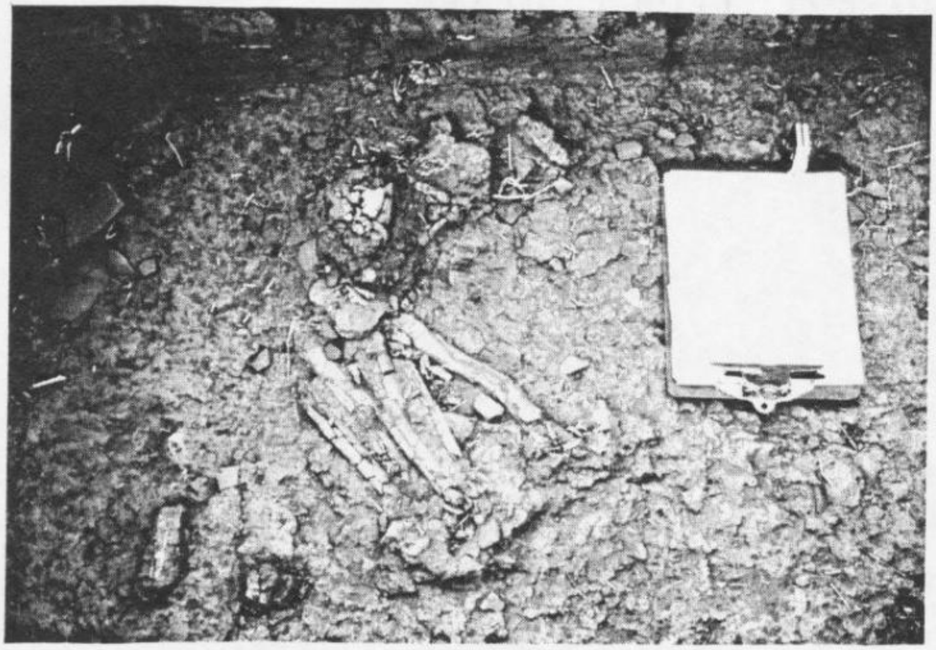


Plate 38. Subsurface Burial Feature 11N398W.

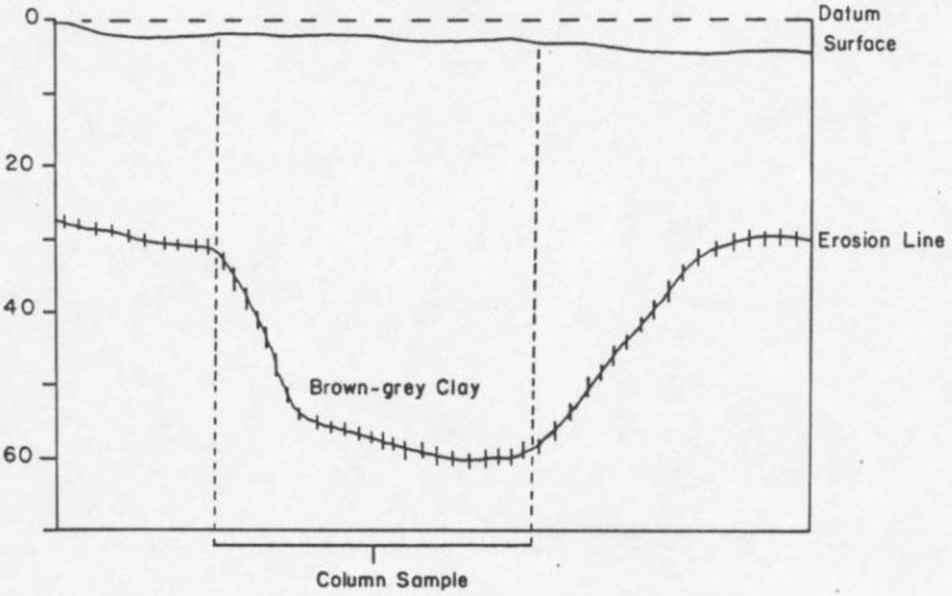


Figure 30. Profile (West Wall) 64N496W.

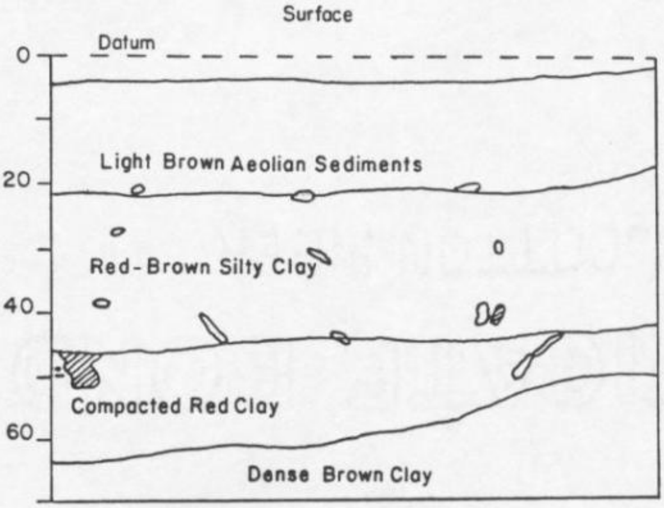


Figure 31. Profile (West Wall) 11N398W.

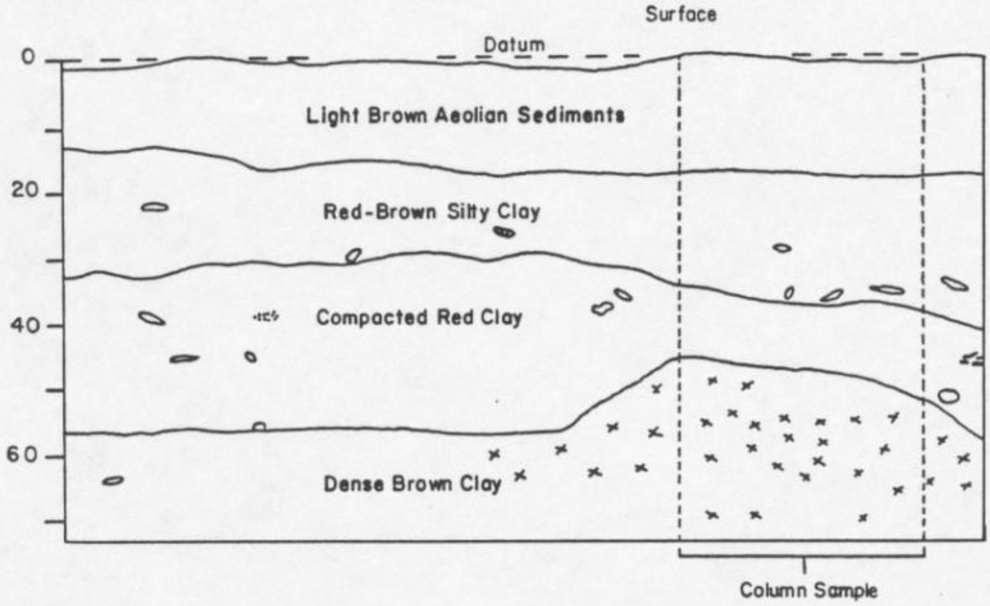


Figure 32. Profile (North Wall) 11N398W.

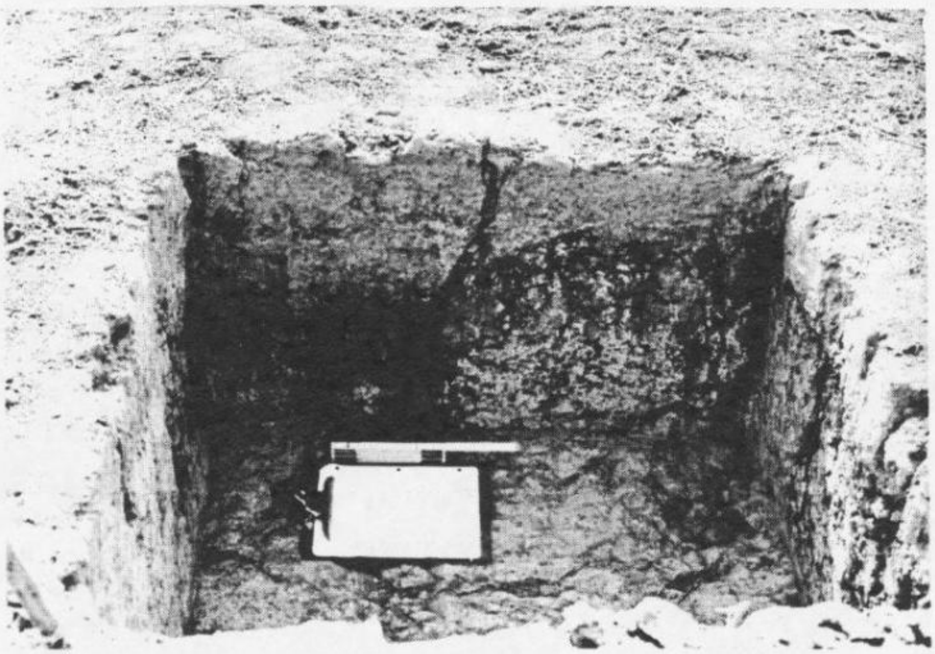


Plate 39. Profile (South Wall) 14S396W.

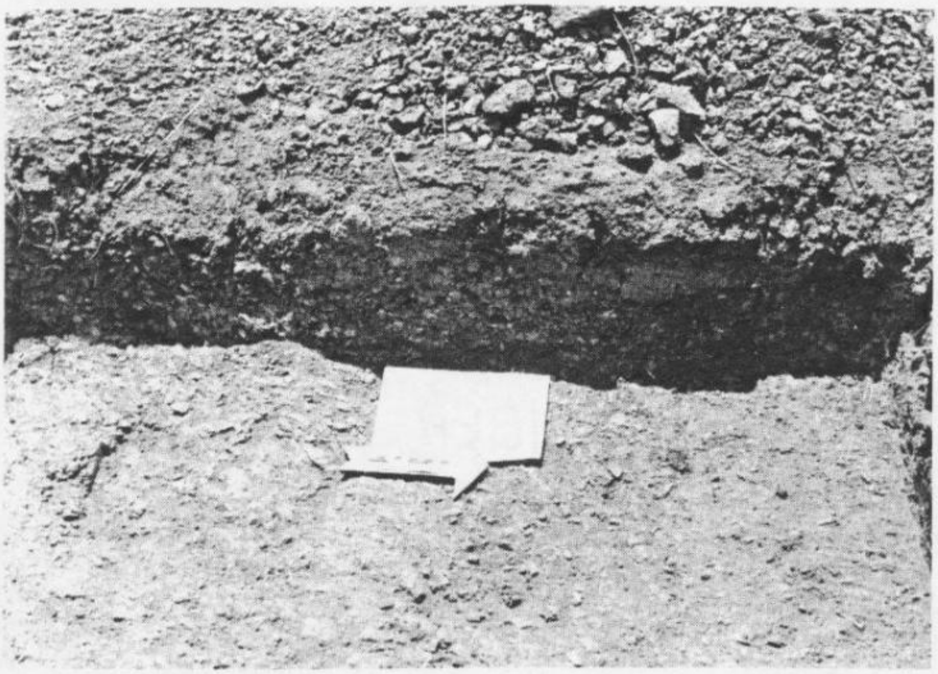


Plate 40. Profile (West Wall) 25S550W.

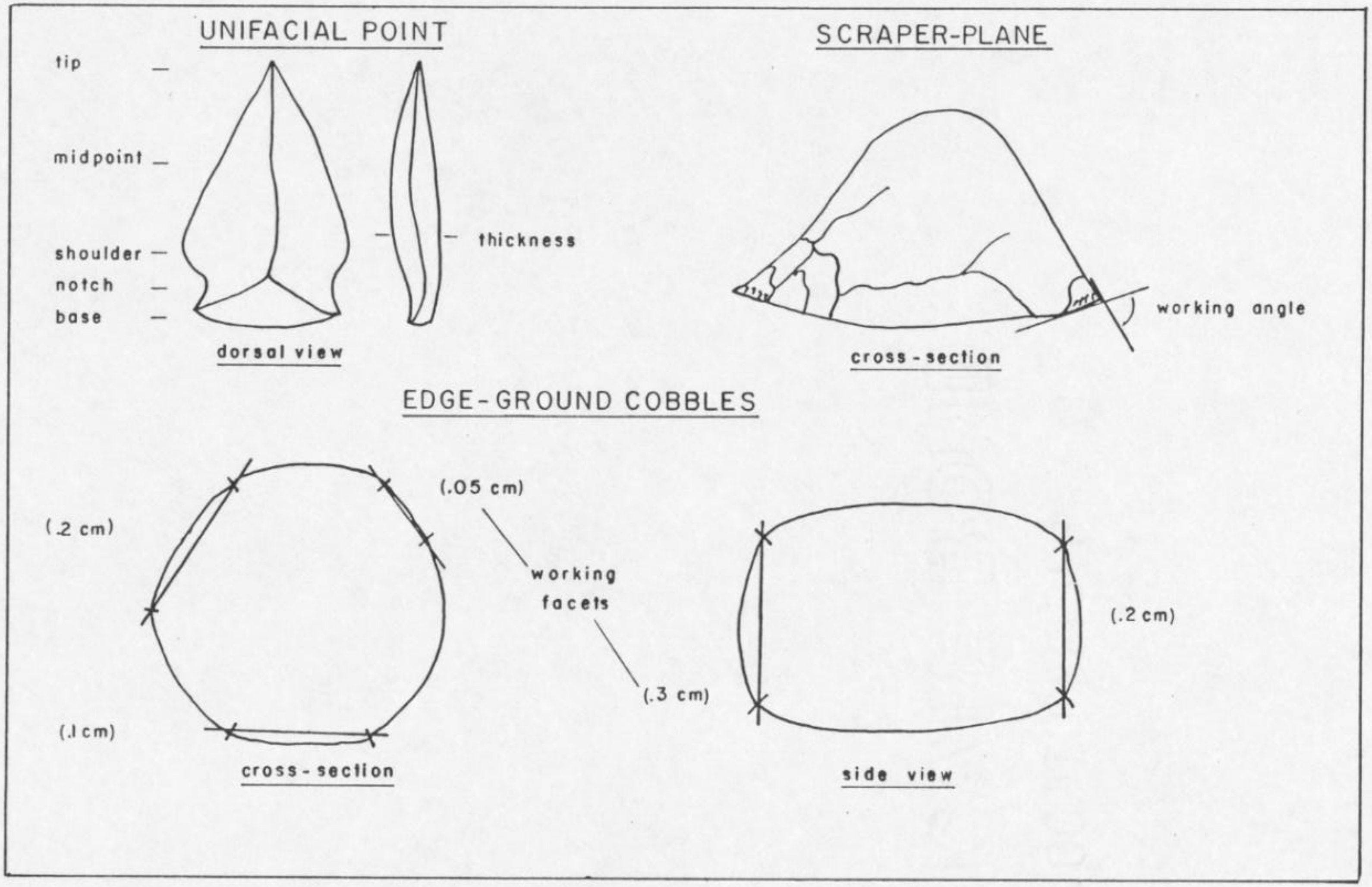


Figure 35. Tool Measurement Placements of Unifacial Points, Scraper-planes and Edge-ground Cobbles (Not to Scale).

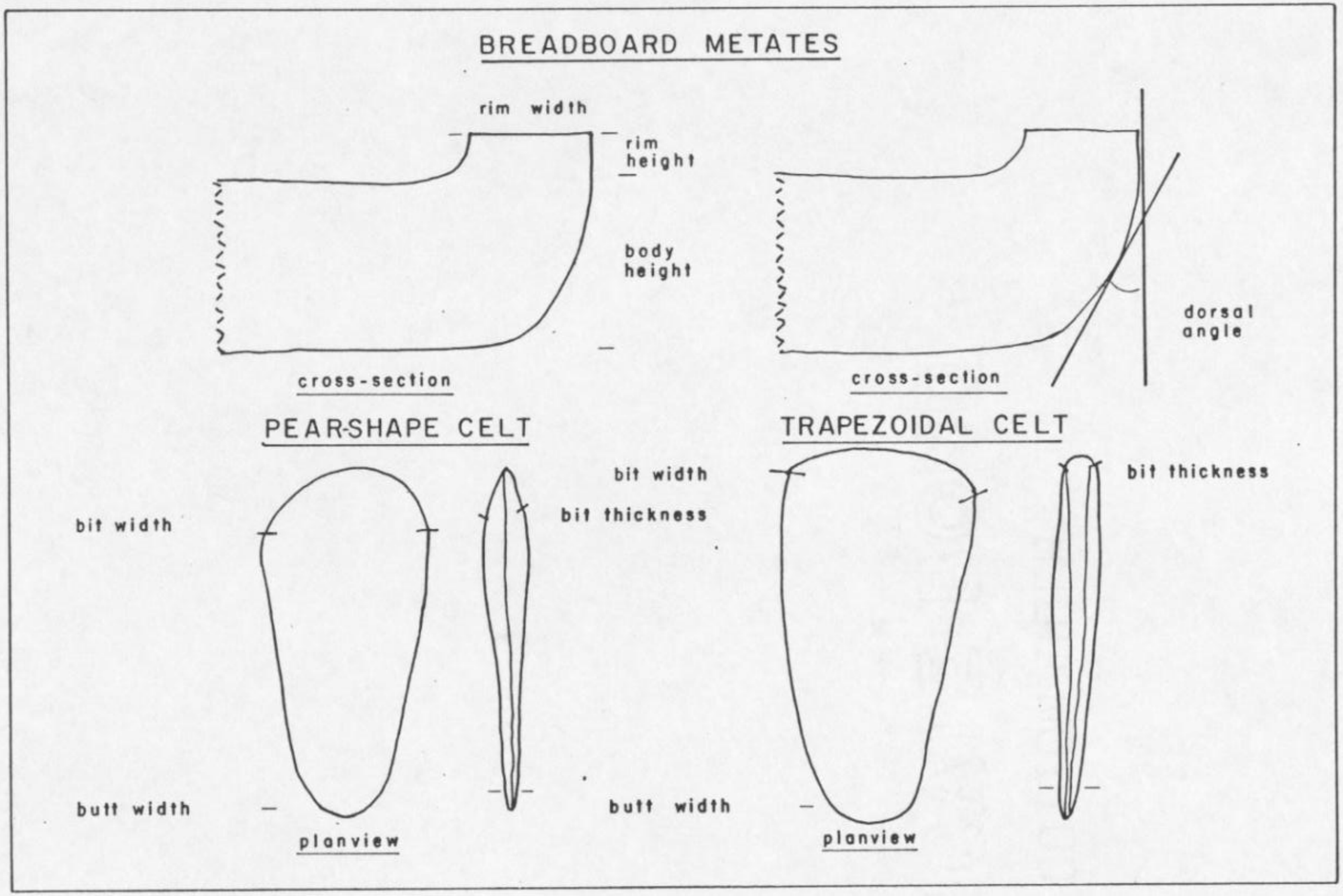


Figure 36. Tool Measurement Placements of Breadboard Metates, Pear-shaped and Trapezoidal Celts (Not to Scale).

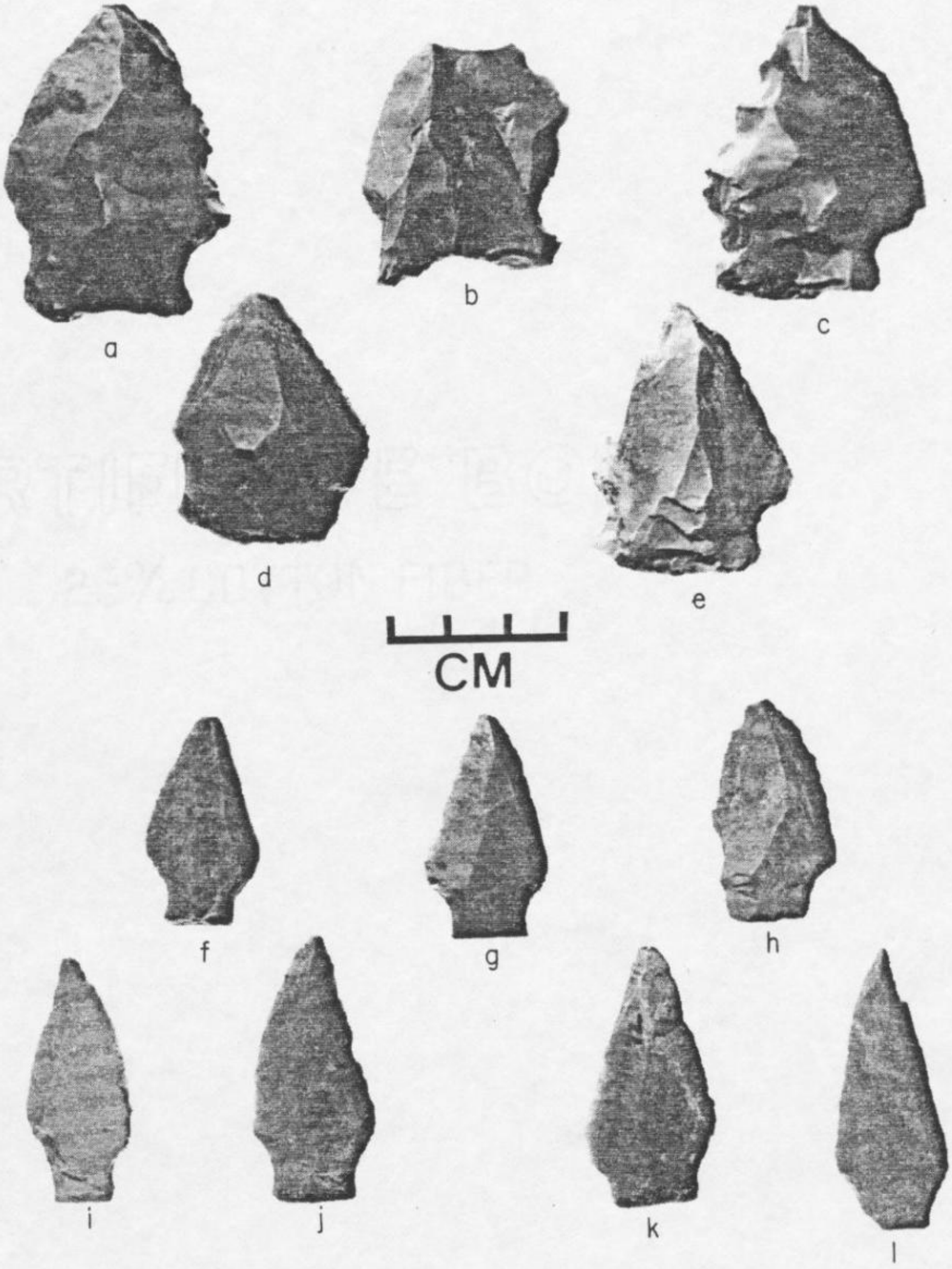


Plate 42. a-l, Unifacial Points.

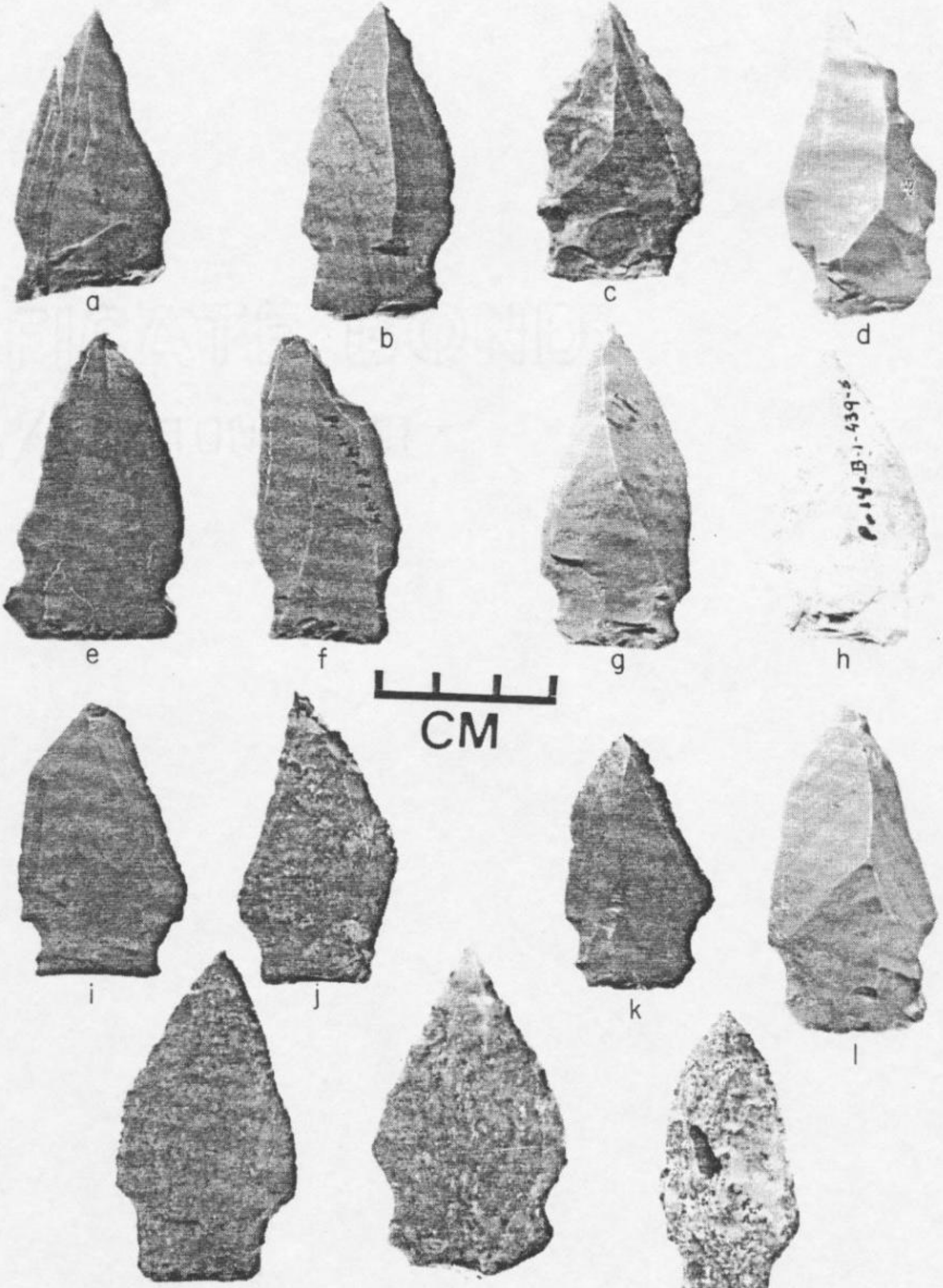


Plate 43. a-o, Unifacial Points.

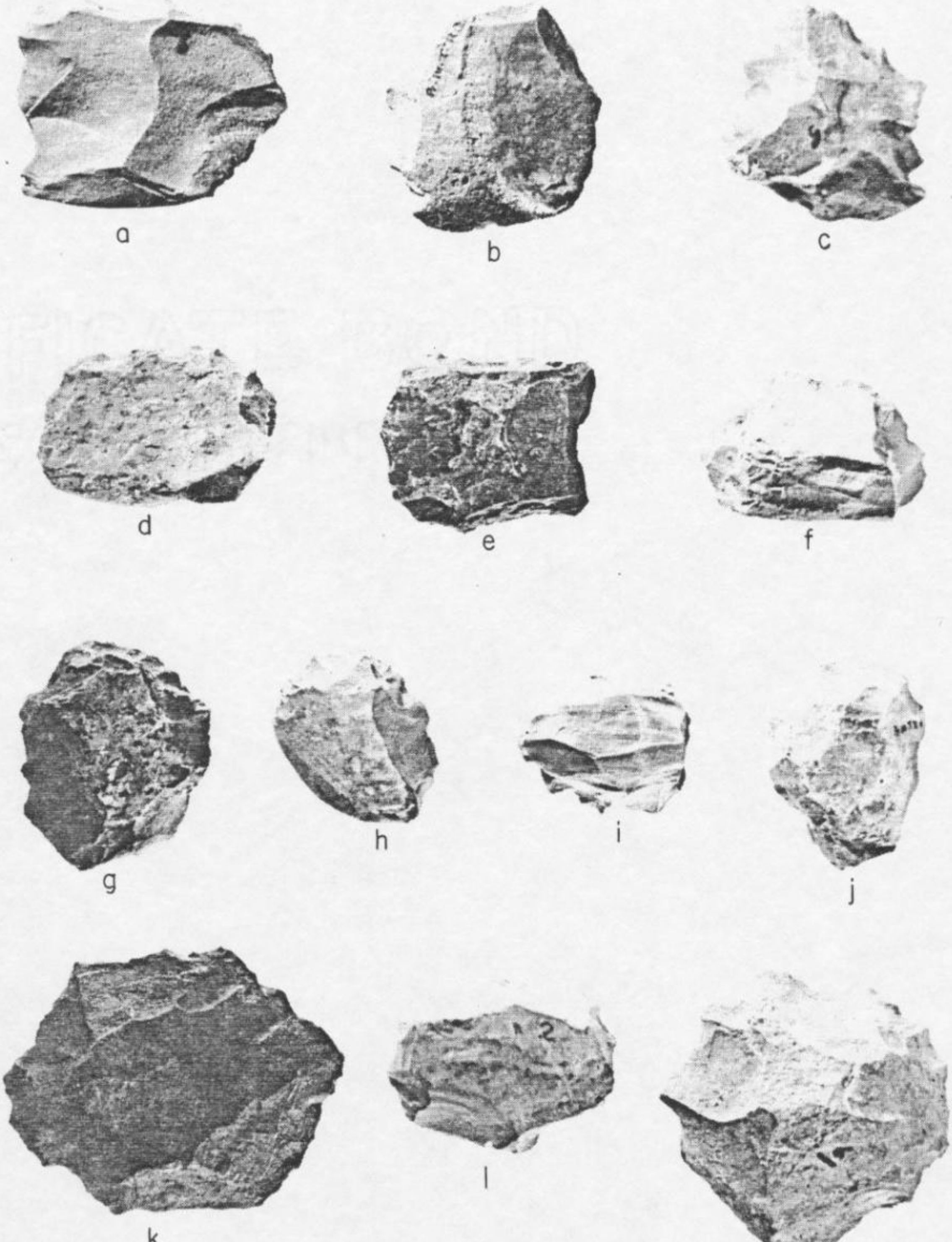


Plate 44. Scraper-planes. a-f, Scraper-planes on Flakes; g-m, Scraper-planes on Cores.

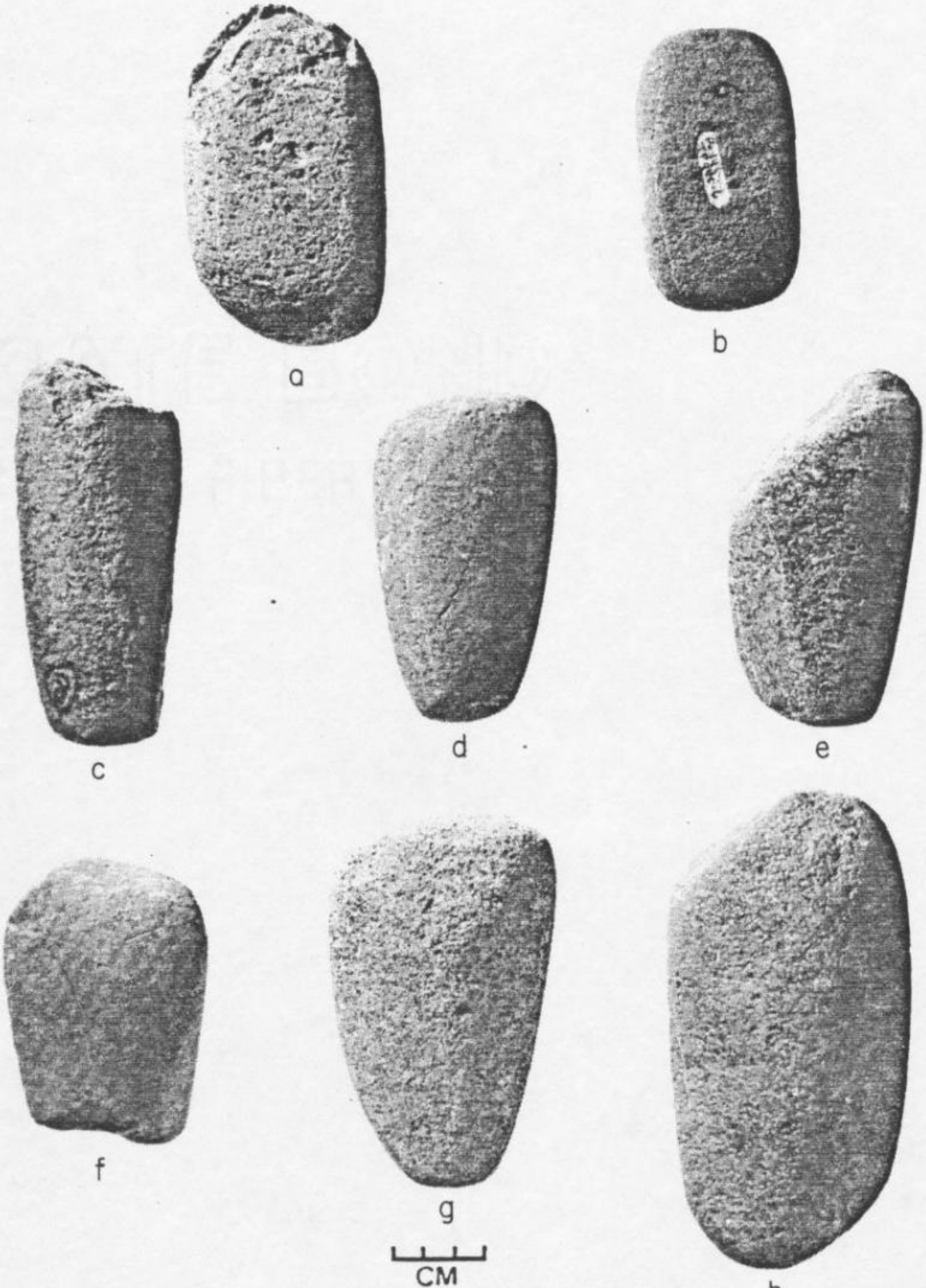


Plate 45. a-h, Edge-ground Cobbles.

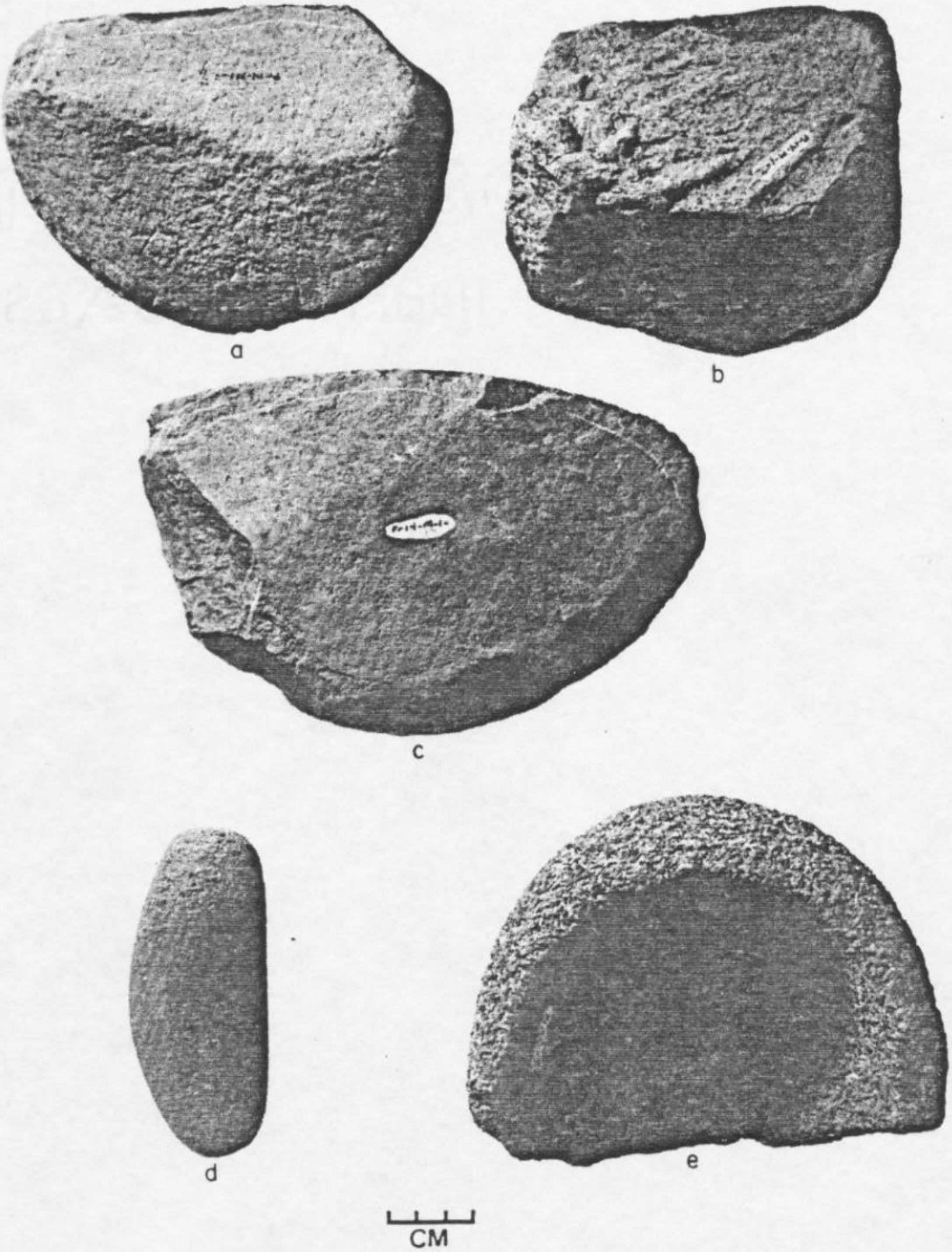


Plate 46. Edge-ground Cobbles, Pestle and Mortar. a-c, Edge-ground Cobbles; d, Pestle; e, Mortar.

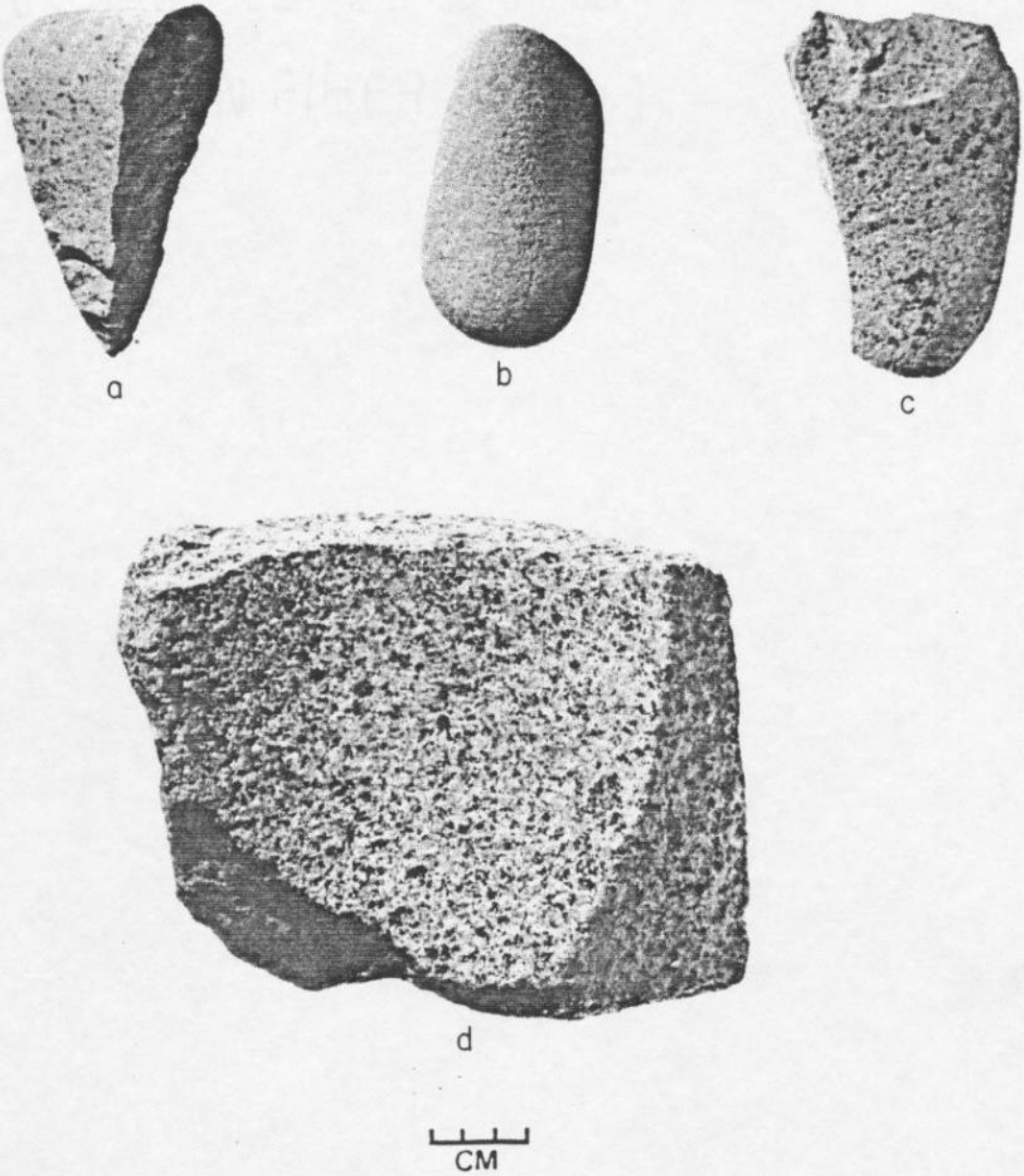


Plate 47. Edge-ground Cobbles and Milling Stone Base. a-c, Edge-ground Cobbles; d, Milling Stone Base.

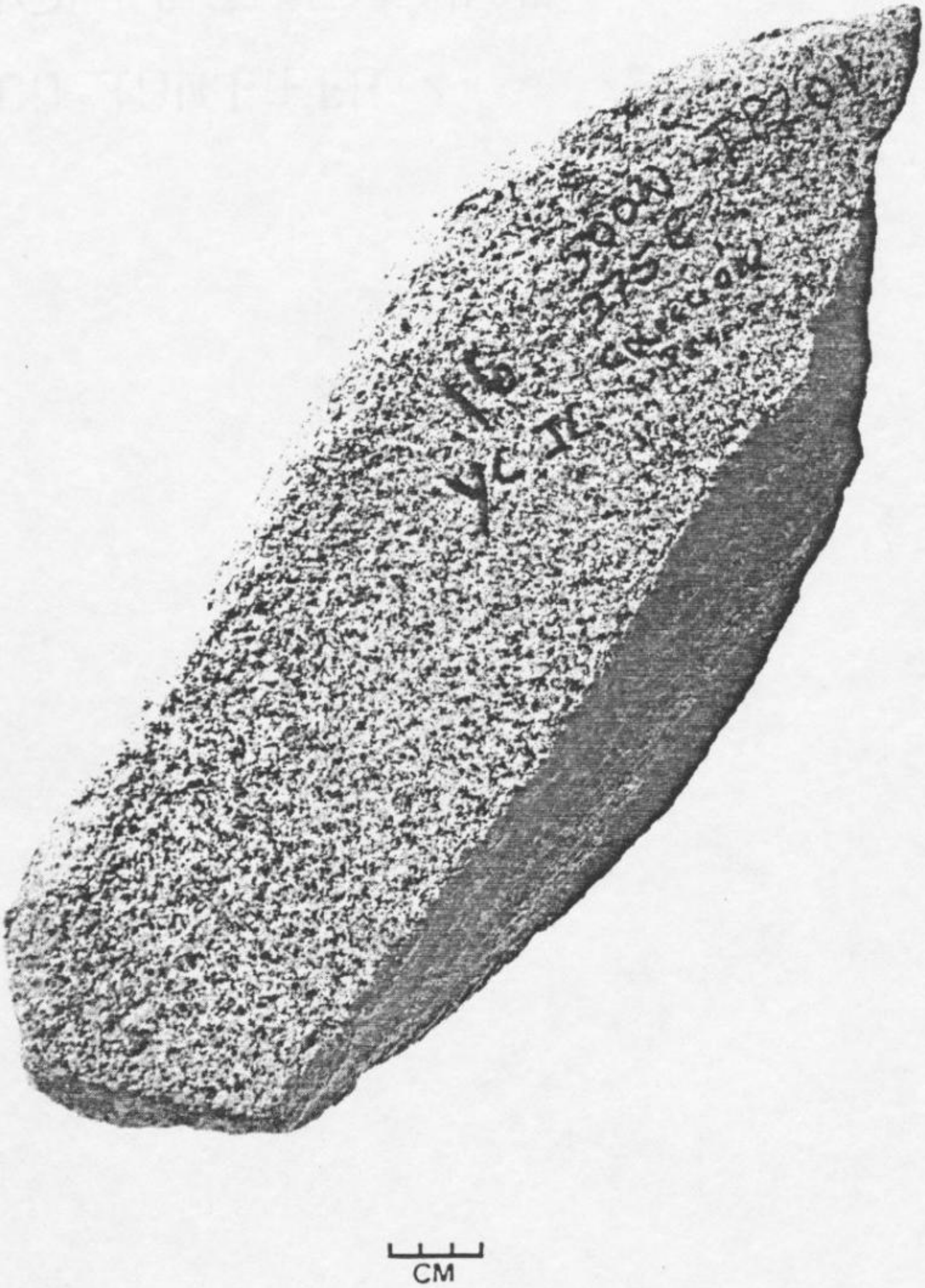


Plate 48. Milling Stone Base.

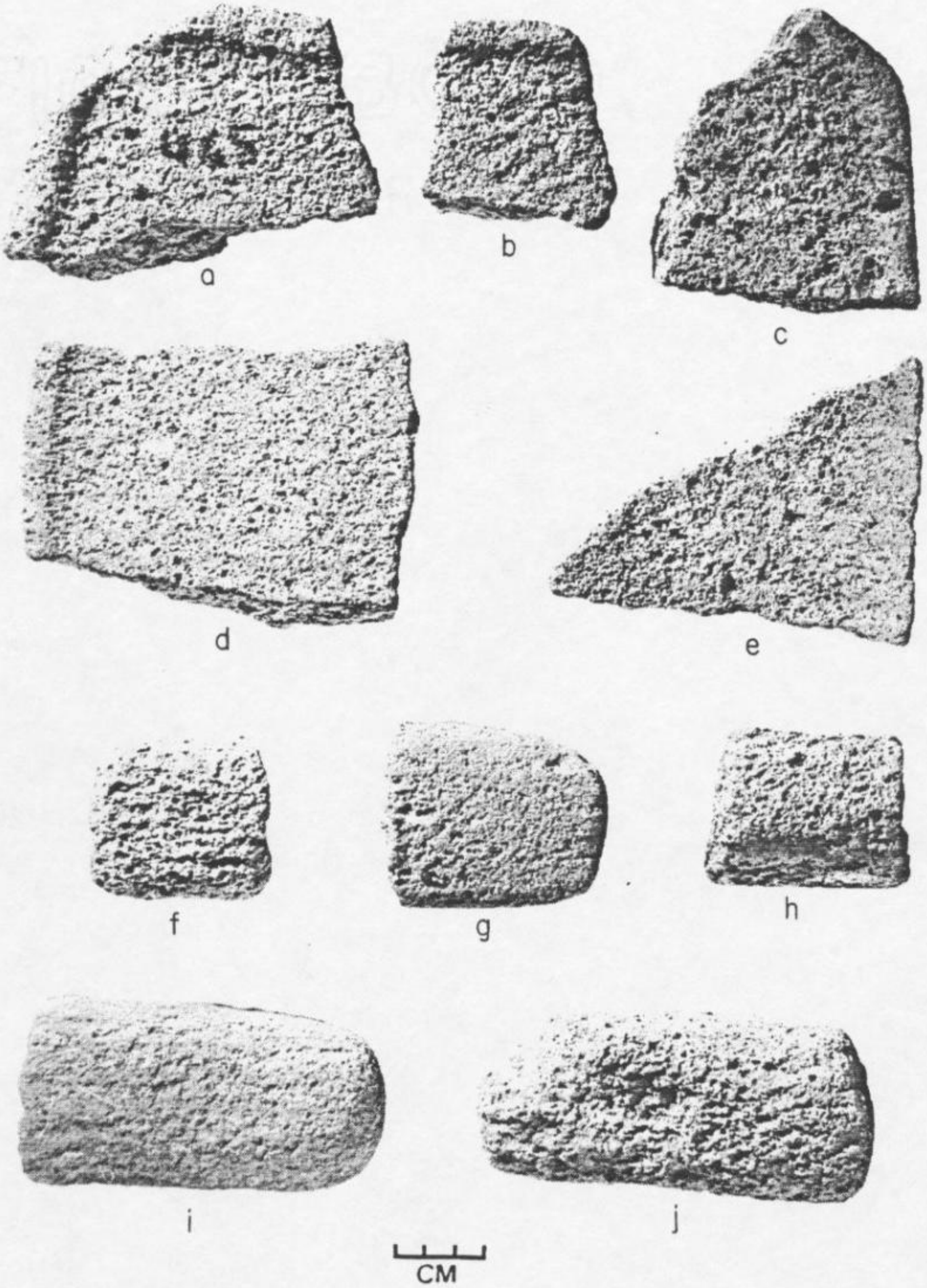


Plate 49. Breadboard Metates and Bar Manos. a-e, Breadboard Metates; f-j, Bar Manos.

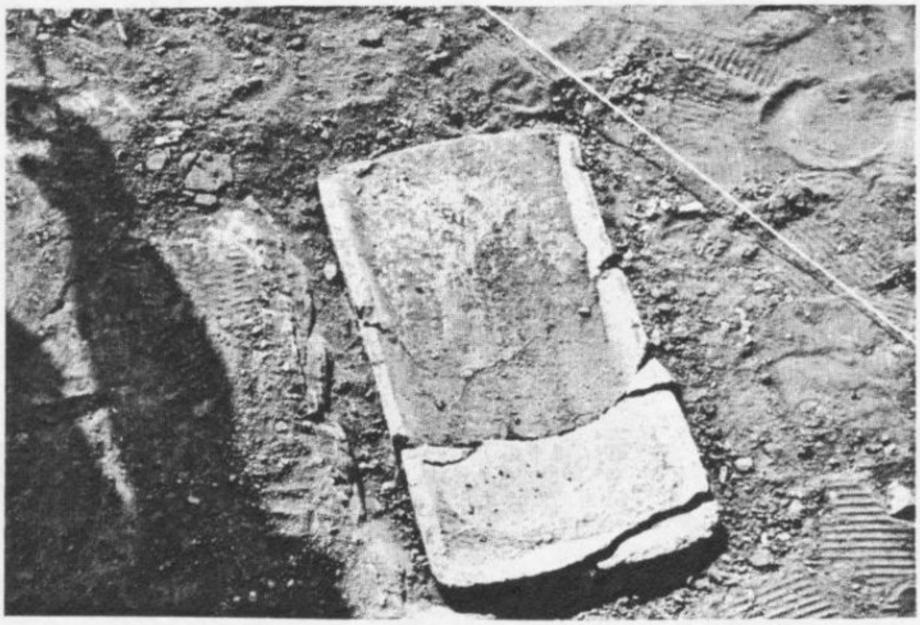


Plate 50. Breadboard Metate.

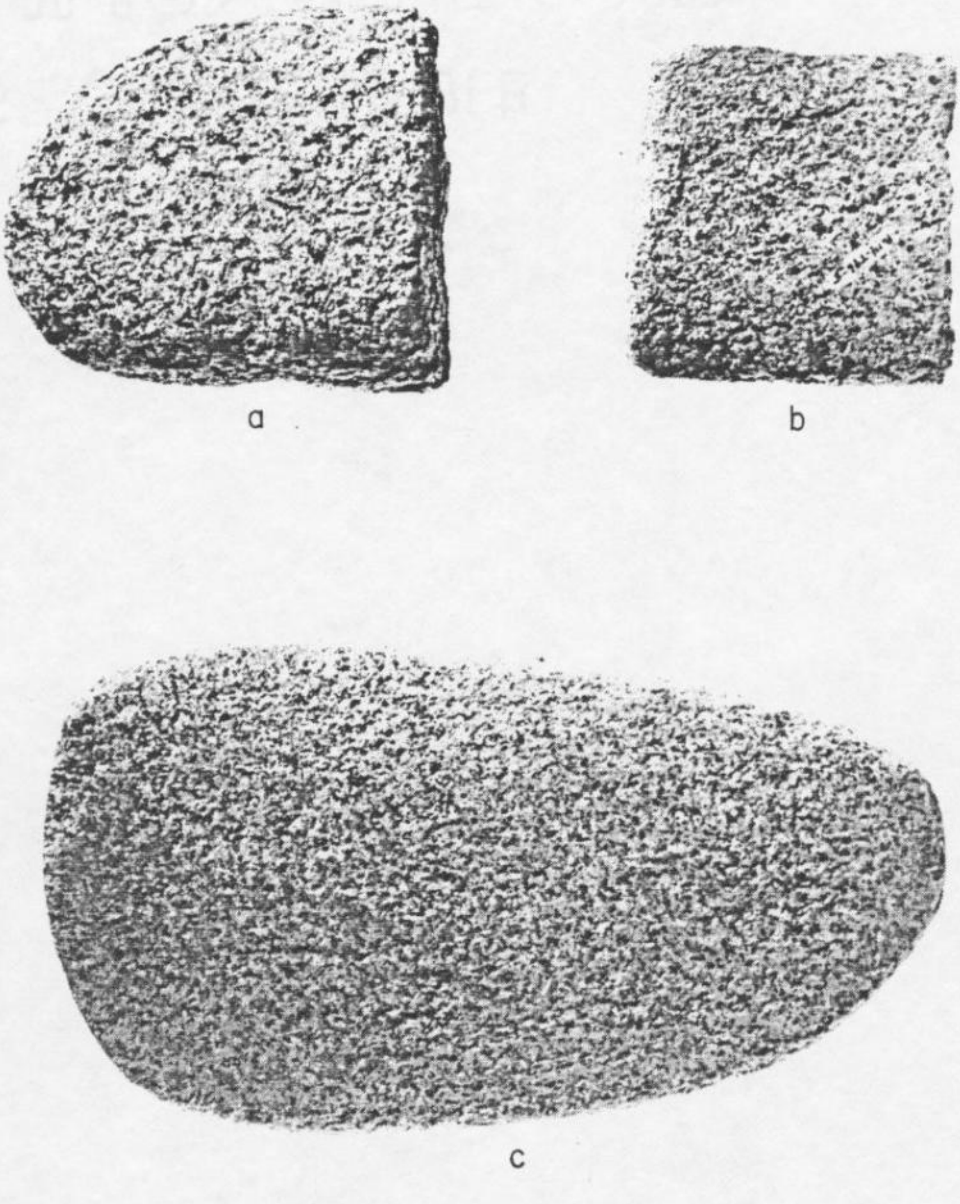


Plate 51. a-c, Non-bar Manos.

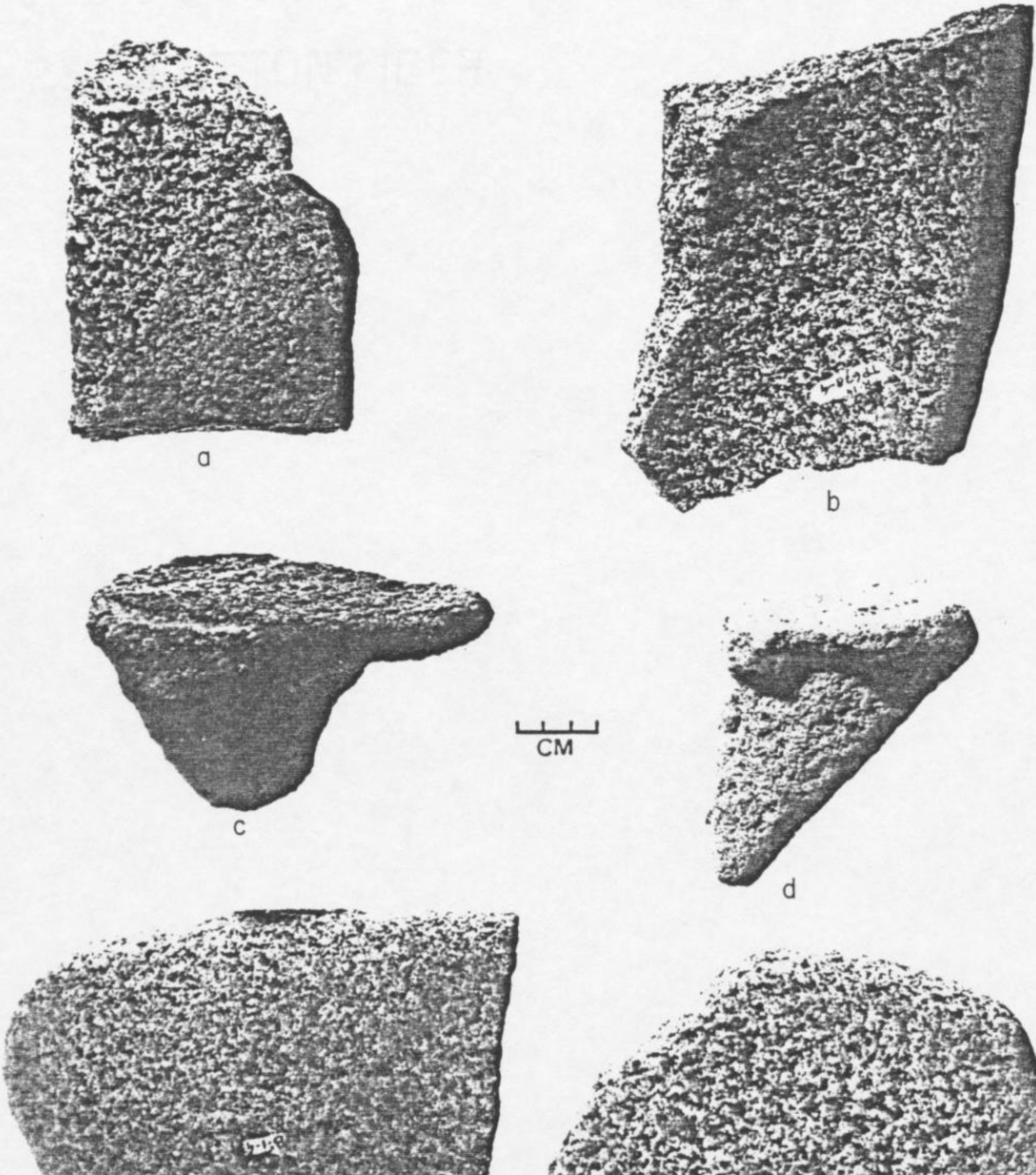


Plate 52. Non-breadboard Metates, Metate Legs and Non-bar Manos.
a,b, Non-breadboard Metates; c,d, Metate Legs;
e,f, Non-bar Manos.

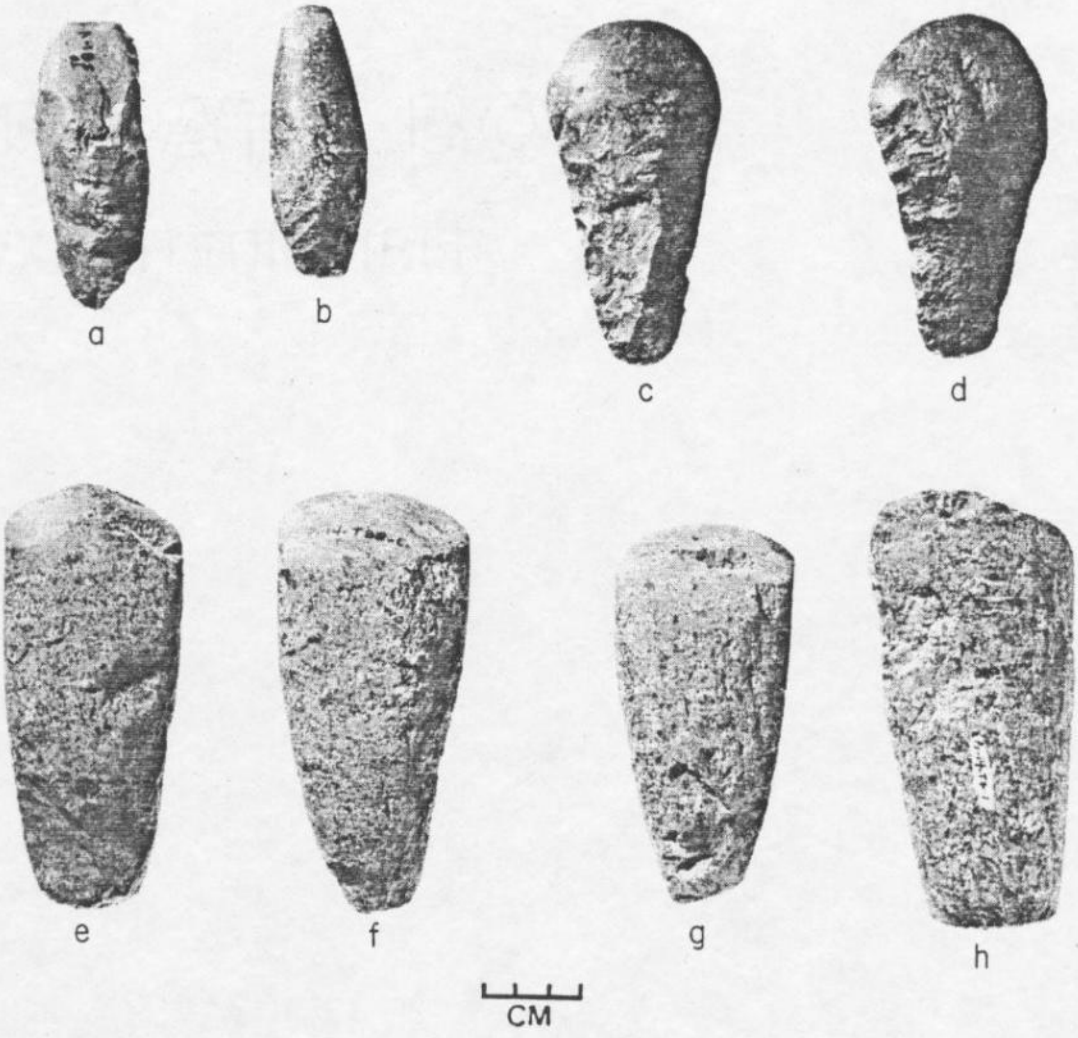


Plate 53. Chisels, Pear-shaped and Trapezoidal Celts, and a Pestle. a,b, Chisels; c,d, Pear-shaped Celts; e-g, Trapezoidal Celts; h, Pestle.

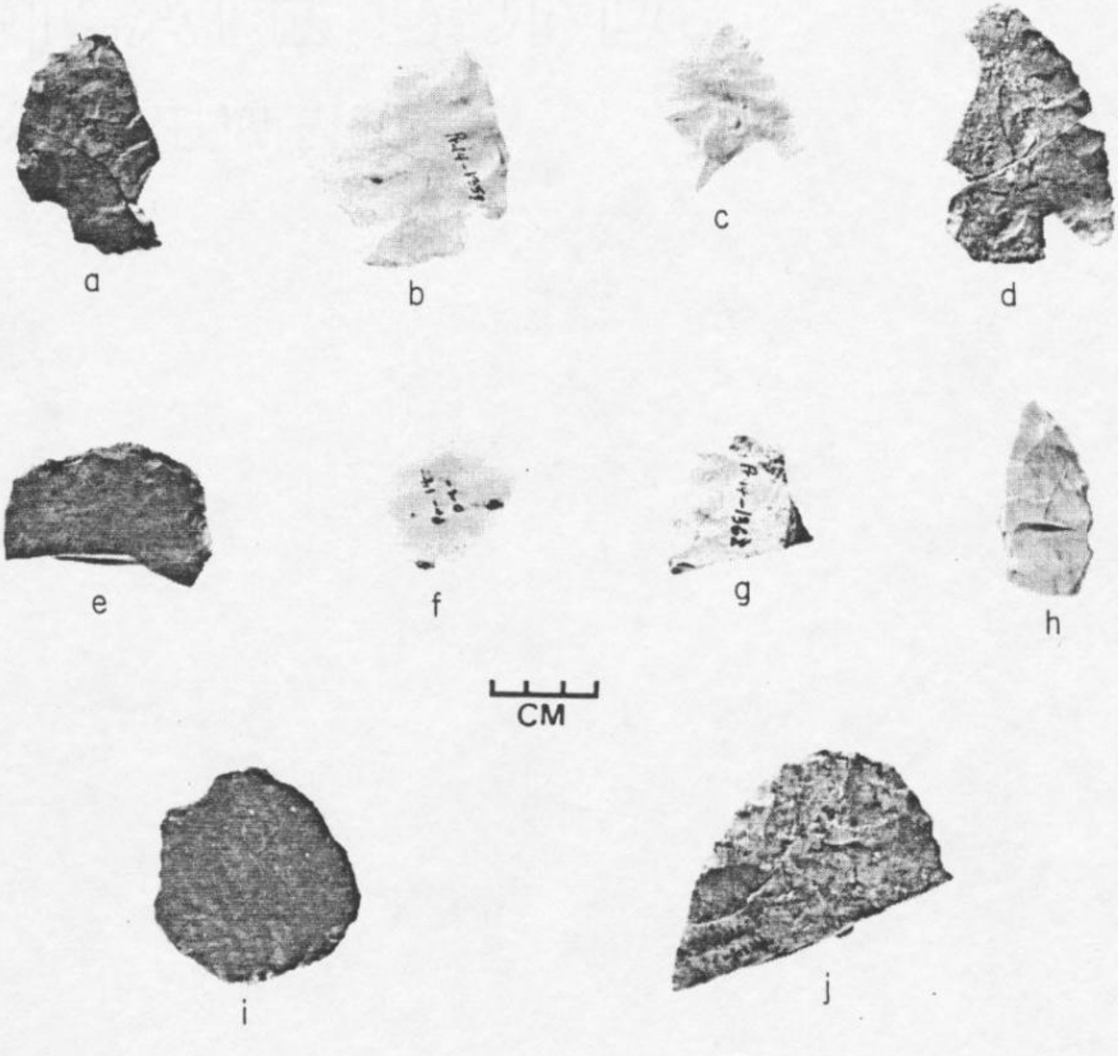


Plate 54. a-j, Bifacial Material.

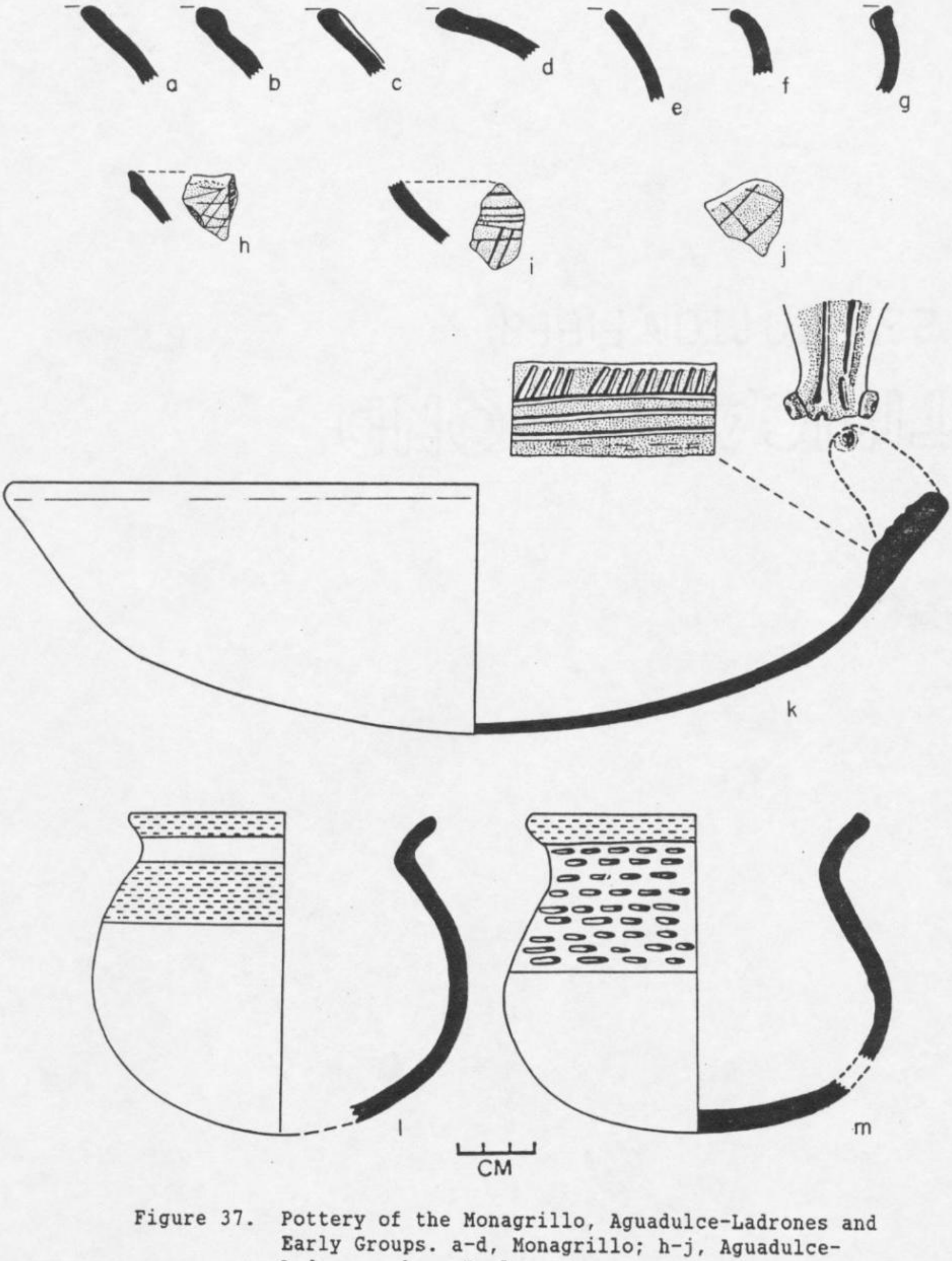


Figure 37. Pottery of the Monagrillo, Aguadulce-Ladrones and Early Groups. a-d, Monagrillo; h-j, Aguadulce-Ladrones; k-m, Early.

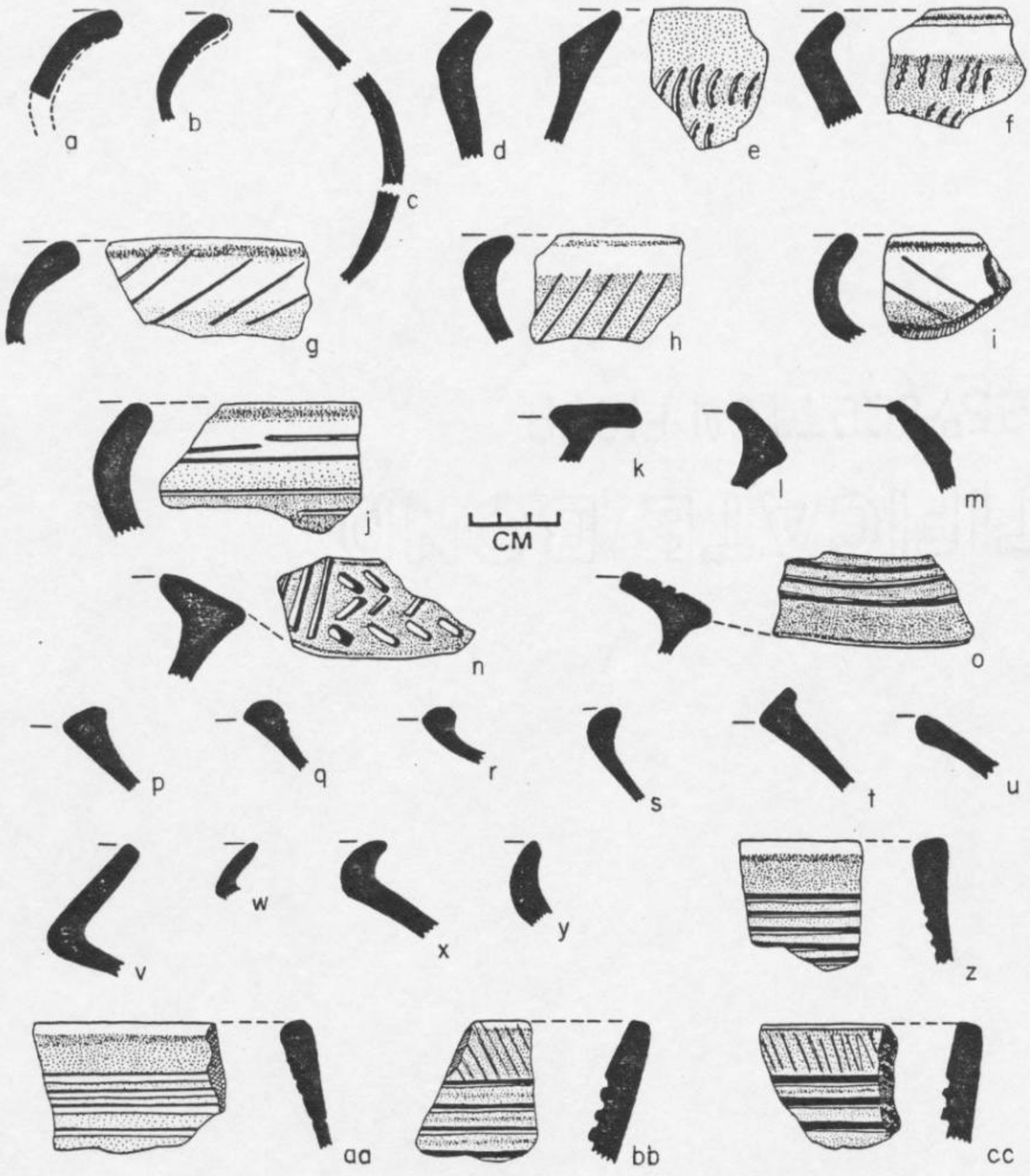


Figure 38. Pottery of the Early and Lamula Groups. a-j, Early; k-cc, Lamula.

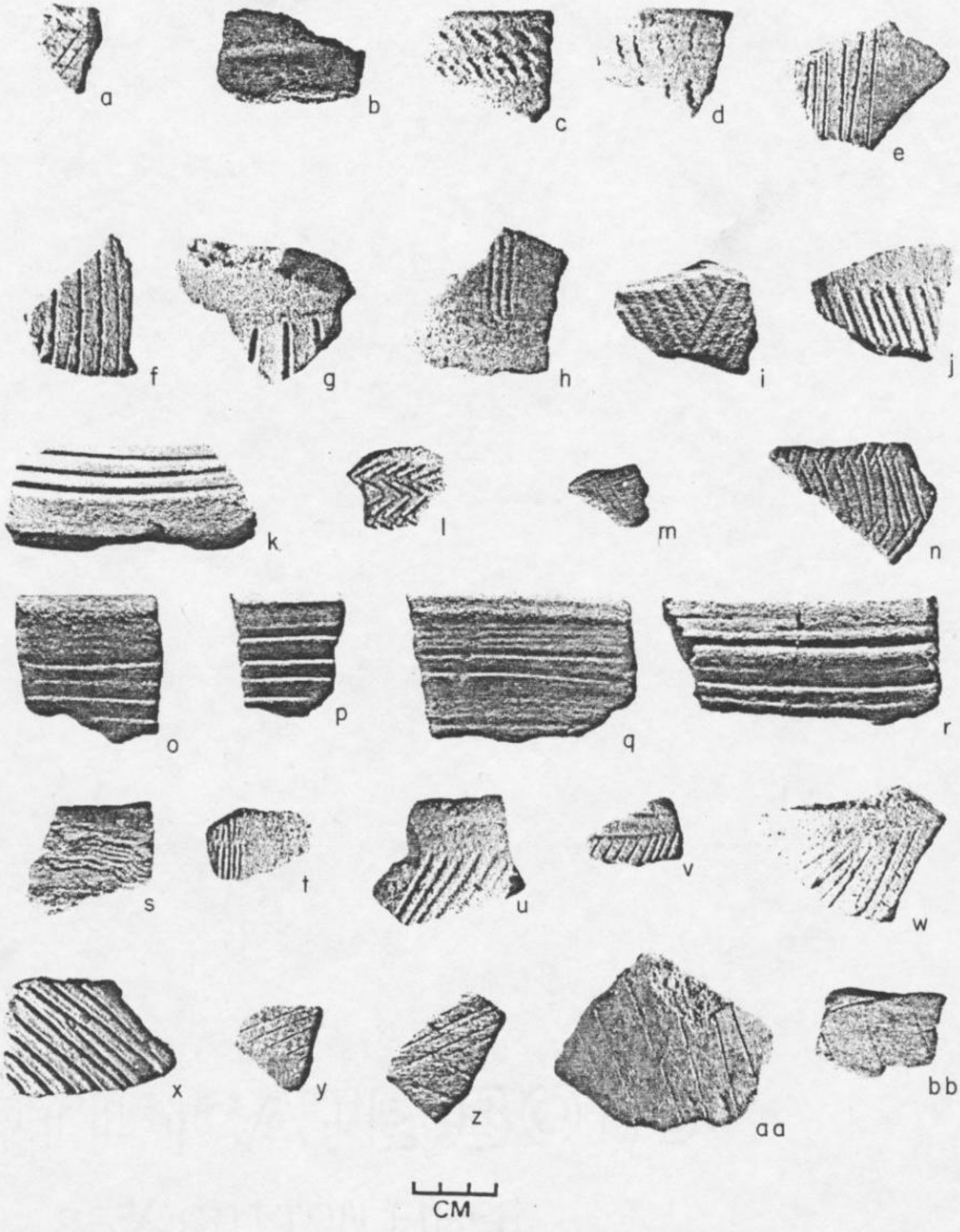


Plate 55. Pottery of the Early and Lamula Groups. a-e, Early; f-bb, Lamula.

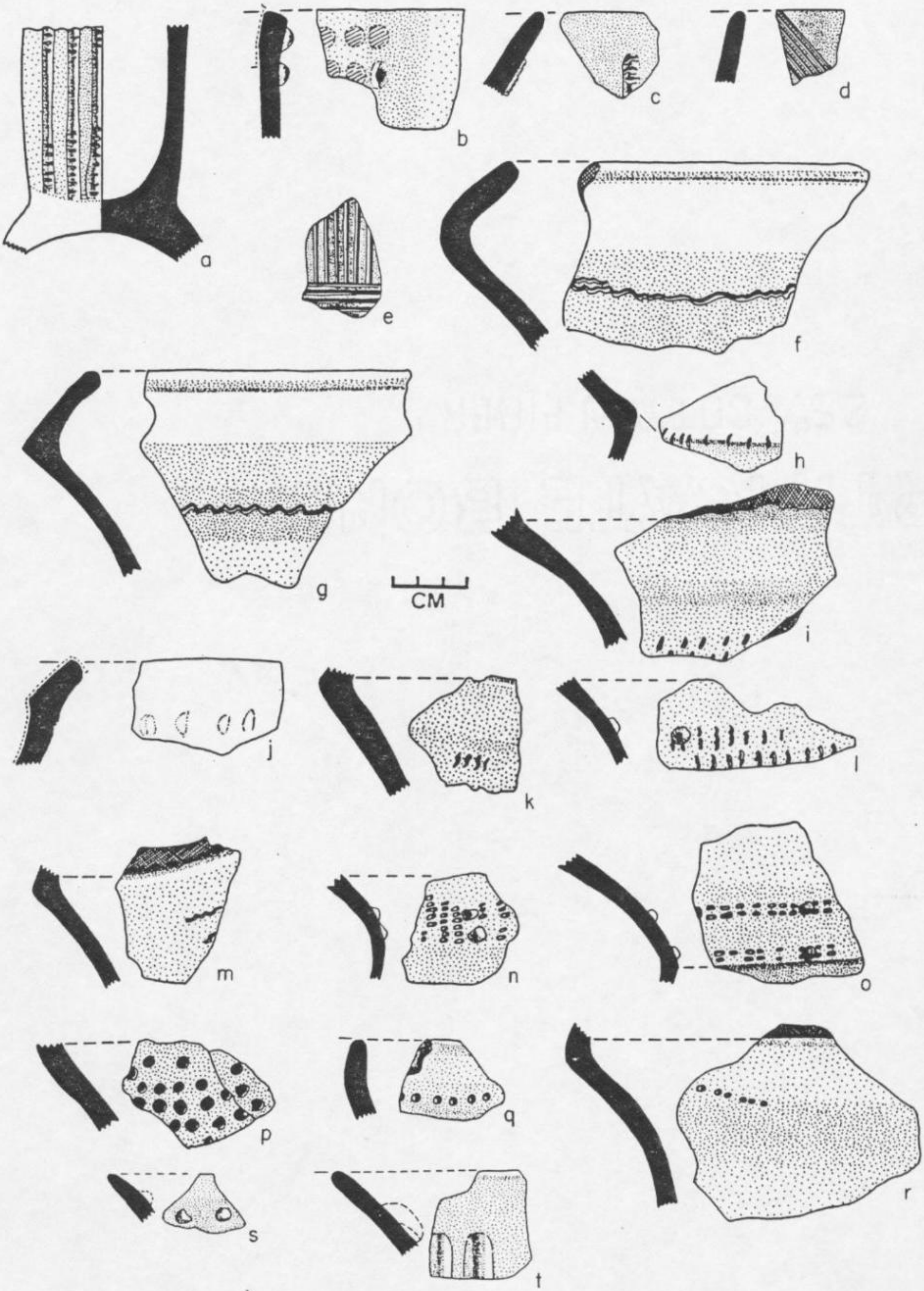


Figure 39. a-r, Decorative Styles of Lamula Group Pottery.

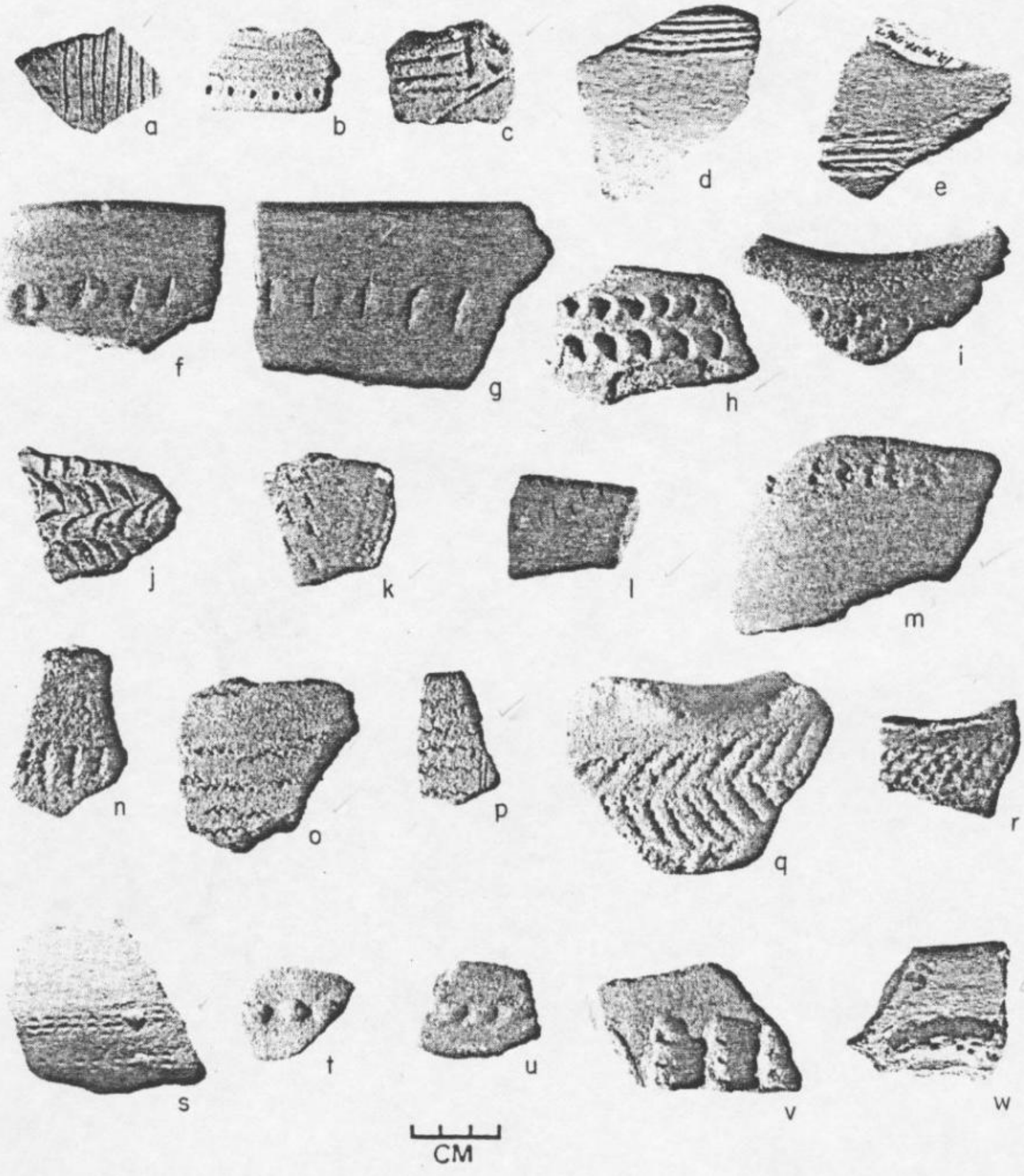


Plate 56. a-w, Decorative Styles of Lamula Group Pottery.

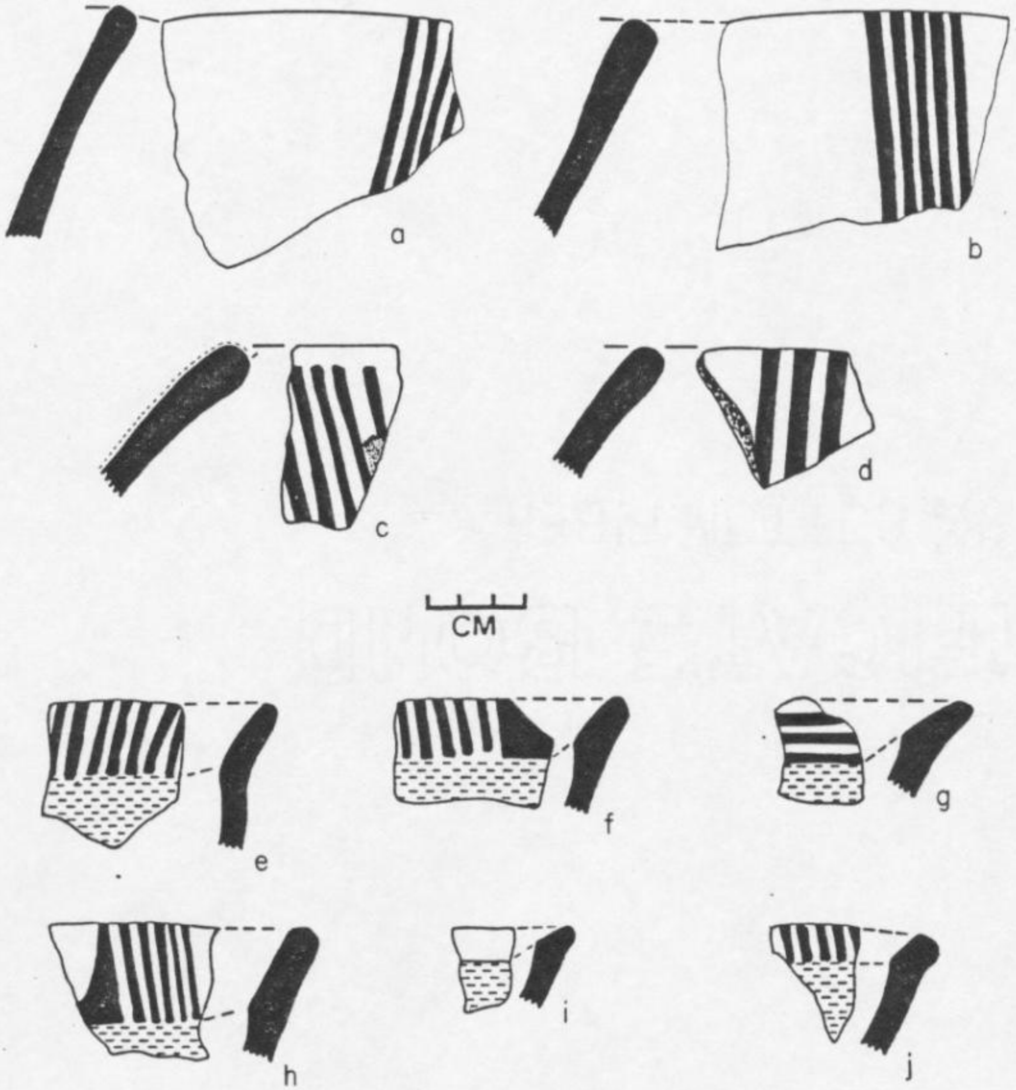


Figure 40. Painted Pottery of the Lamula and Aristide Groups. a-d, Lamula Black-on-orange Type; e-j, Aristide Polychrome, Giron Type.

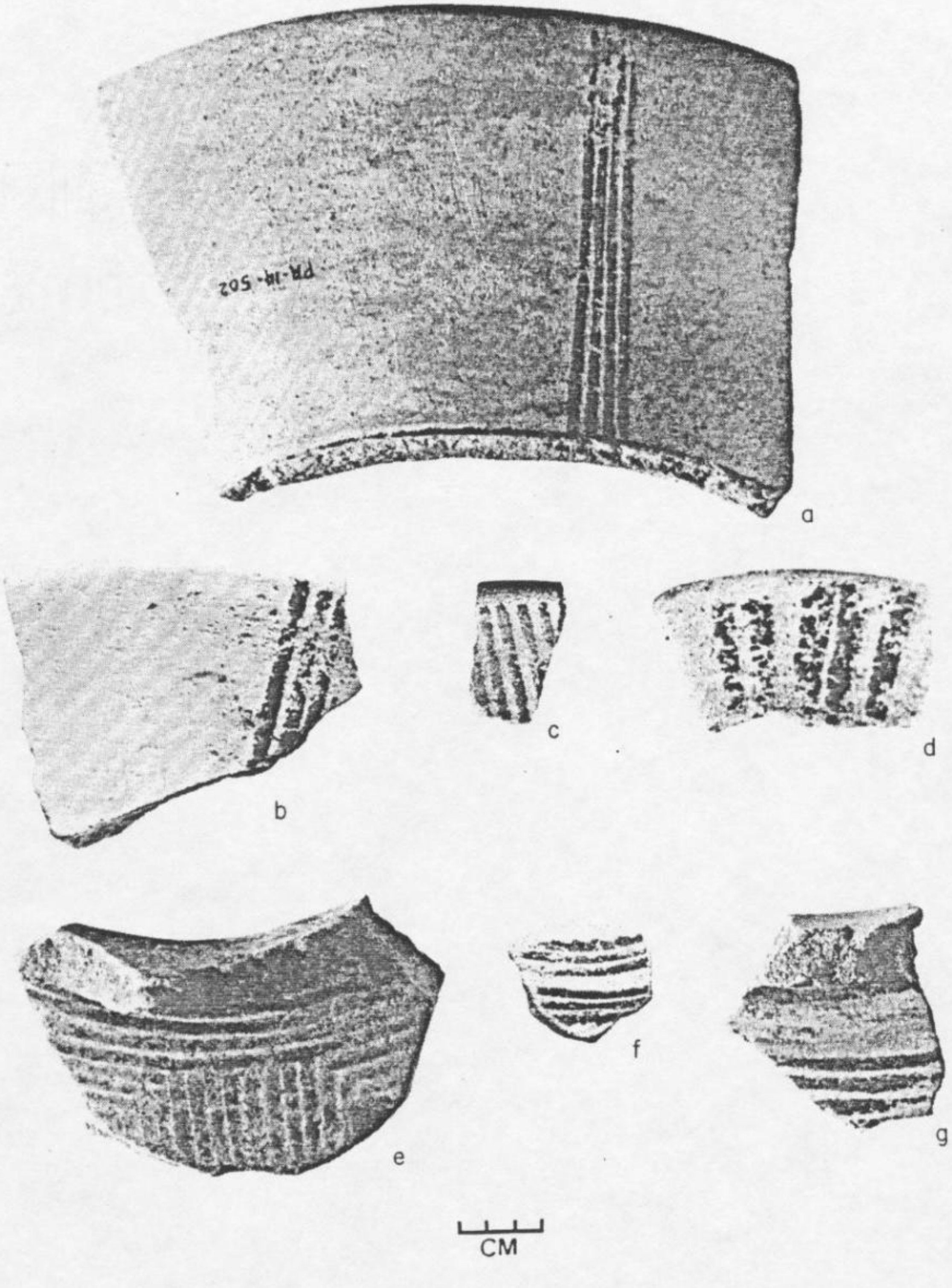


Plate 57. a-g, Lamula Group, Black-on-orange Type.

Figure 41. Pottery of the Aristide Group and Cocobo Interior-banded Type. a-h, Aristide Group, Giron Polychrome; i-p, Aristide Group, Escota Polychrome; q, Cocobo Interior-banded.

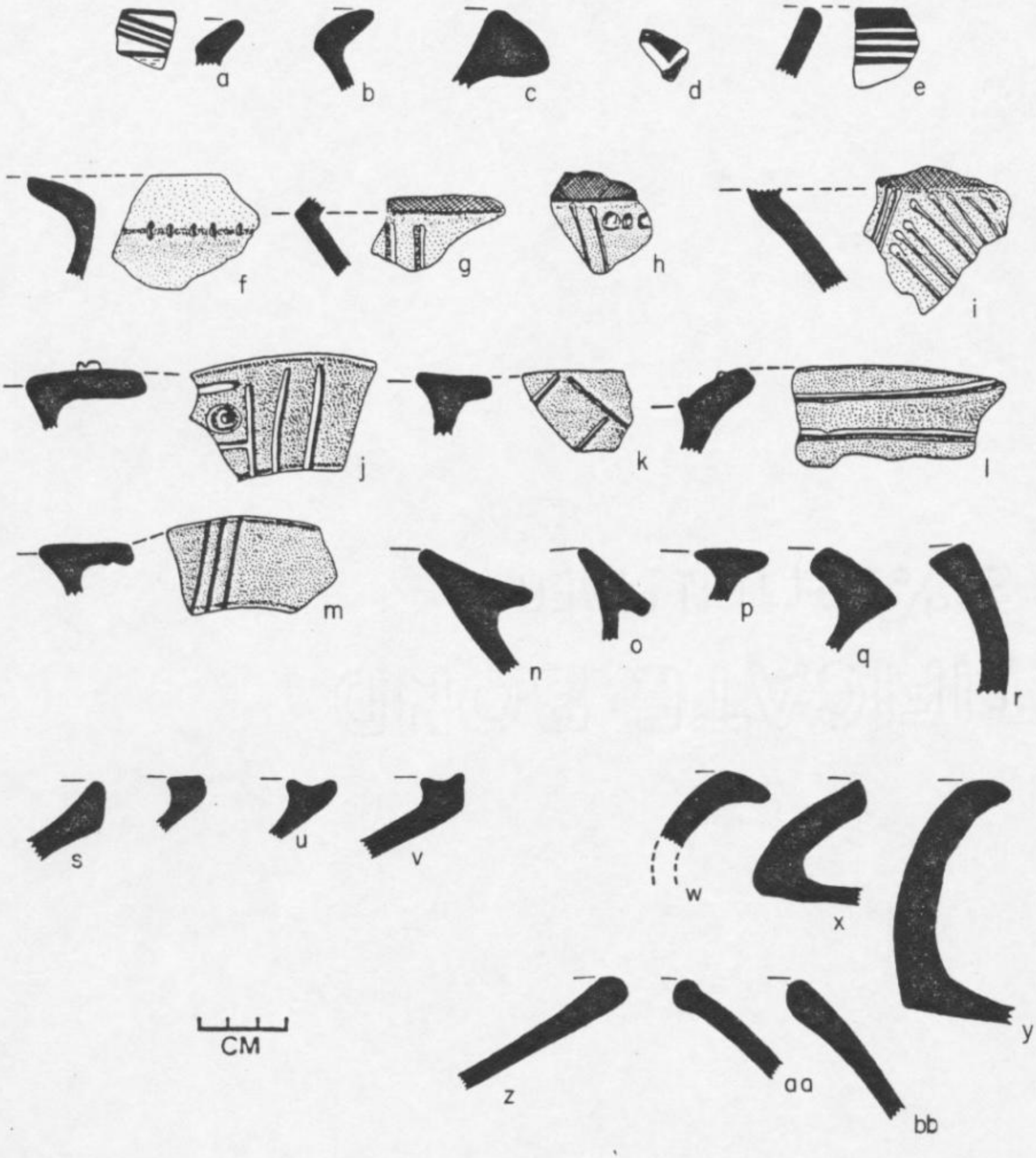


Figure 42. Pottery of the Tonosi, Sarigua, Conte and VI-VII Groups. a-e, Tonosi; f-r, Sarigua; s-v, Conte; w-bb, VI-VII.

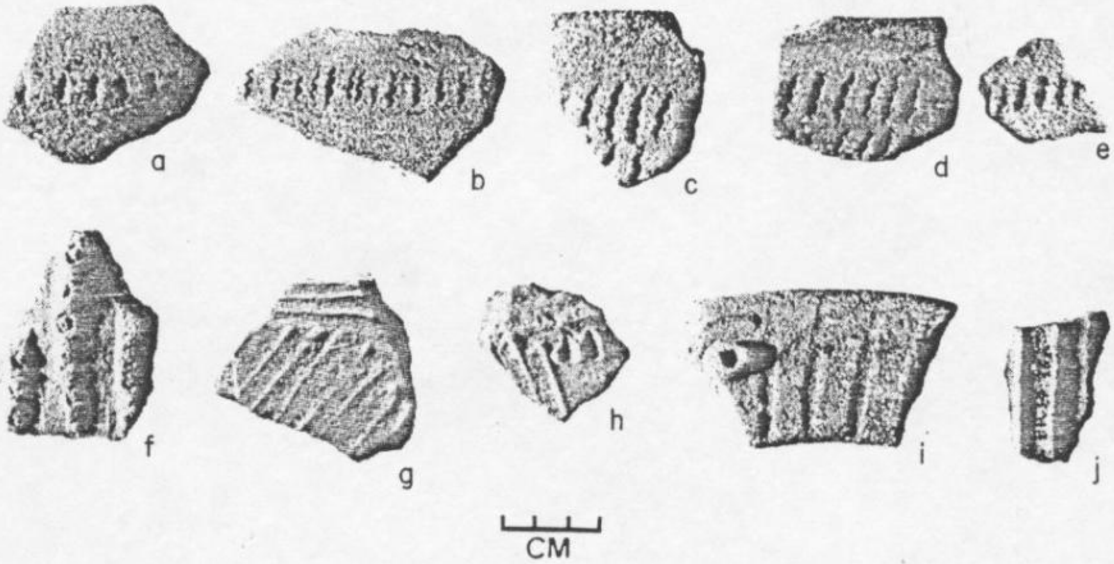


Plate 58. a-j, Pottery of the Sarigua Group.

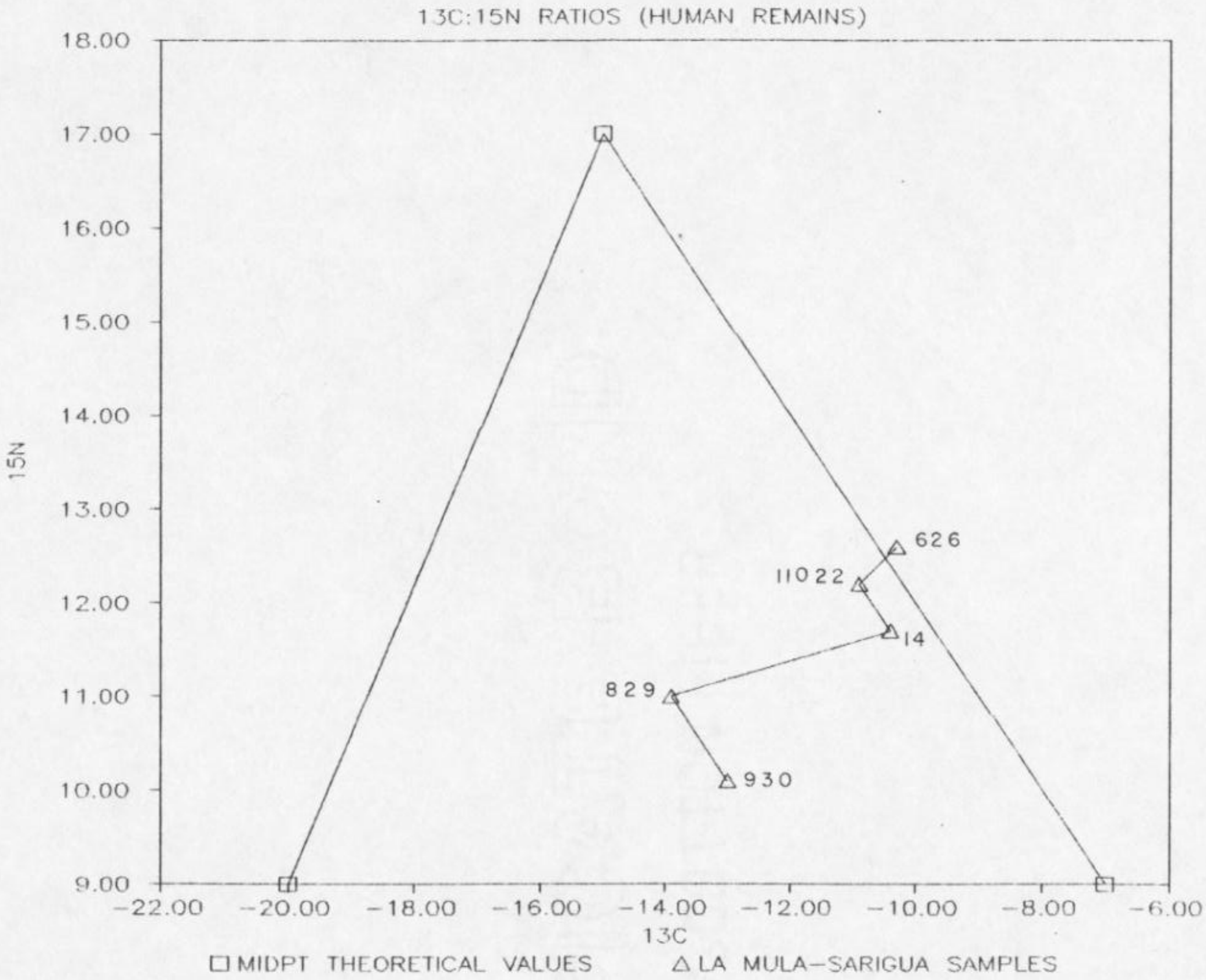


Figure 43. Carbon and Nitrogen Isotope Ratios--Theoretical Values and the La Mula-Sarigua Sample.

b	Bifacial Material	
o	Material Present	
.	Material Absent	
s	1 m sq Surface Stations with Material	
^	Sondeos with Material	
m	Monagrillo Group	
a	Aguadulce-Ladrones Group	
e	Early Group	
O	Lamula Group	
A	Aristide Group	
s	Sarigua Group	
t	Tonosi Group	
C	Conte Group	
.	VI-VII Group	
O	Edge-ground Cobbles	
G	Milling Stone Bases	
B	Breadboard Metates	
#	Bar Manos	
^	Non-breadboard Metates	
m	Non-bar Manos	
^	Unifacial Point Width $\geq$ 2.3 cm	
o	Unifacial Point Width $\leq$ 2.2 cm	
c	Core Scraper-planes	
f	Flake Scraper-planes	
o	Pear-shaped Celts	
^	Trapezoidal Celts	
c	Cores	
h	Hammers	Debitage
$	Untilized Flakes	
*	Pestles	
^	Mortars	
o	Unifacial Points	
j	Lamula Collared Jars	
∫	PARITA RIVER	

Figure 44. Key for GMS Distribution Maps (in Order of Appearance).

Figure 45. Distribution of Bifacial Material.

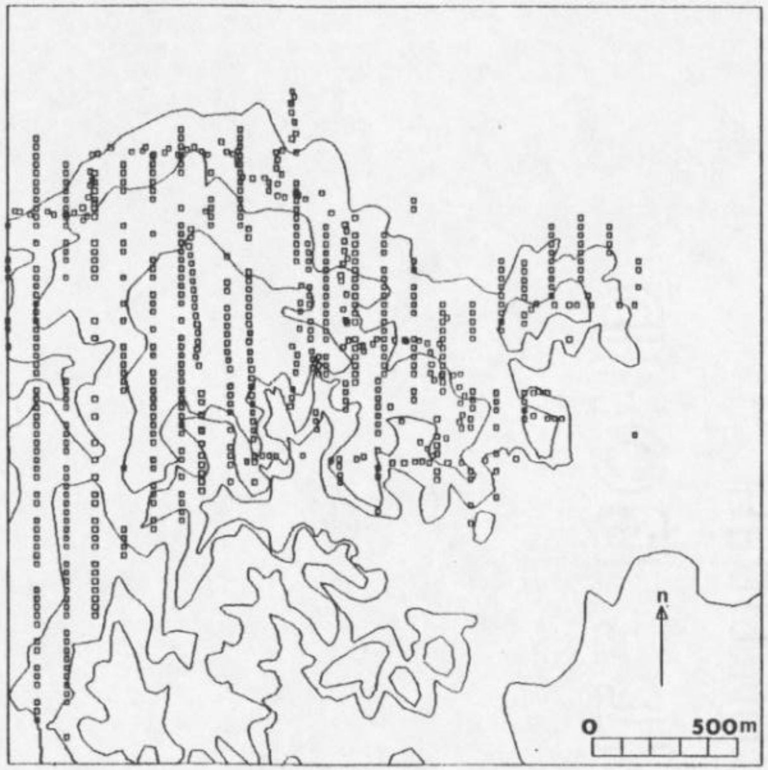


Figure 46. Presence of Cultural Material based on the Probabilistic Transect Samples.

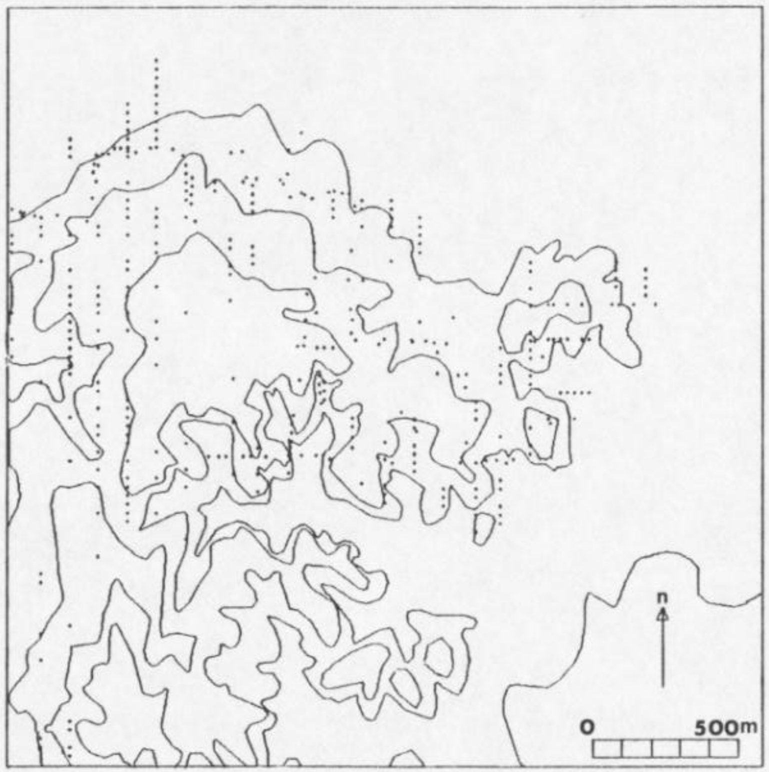


Figure 47. Absence of Cultural Material based on the Probabilistic Transect Samples.

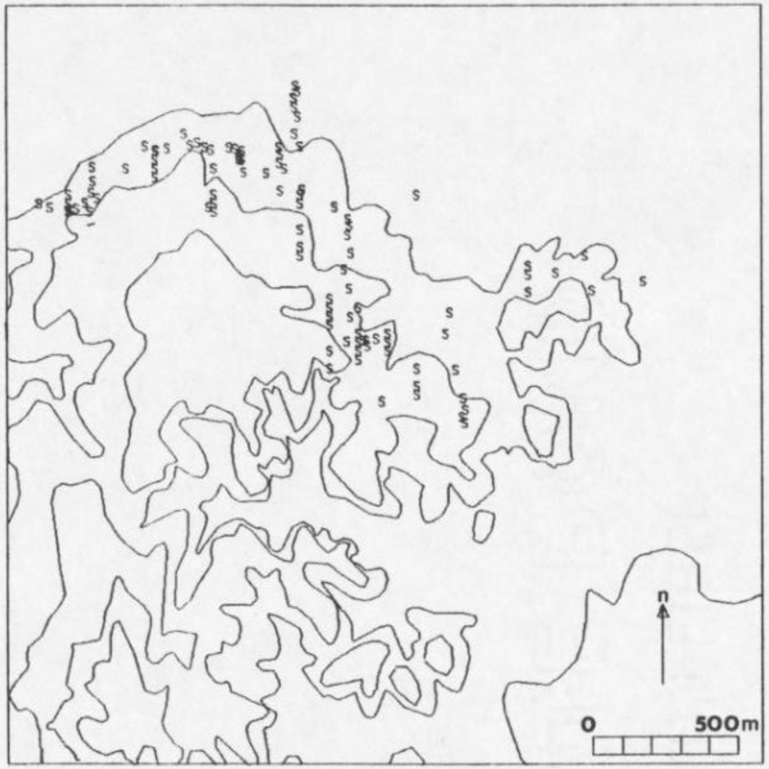


Figure 48. Presence of Cultural Material based on the Surface Collected Probabilistic Transect Samples.

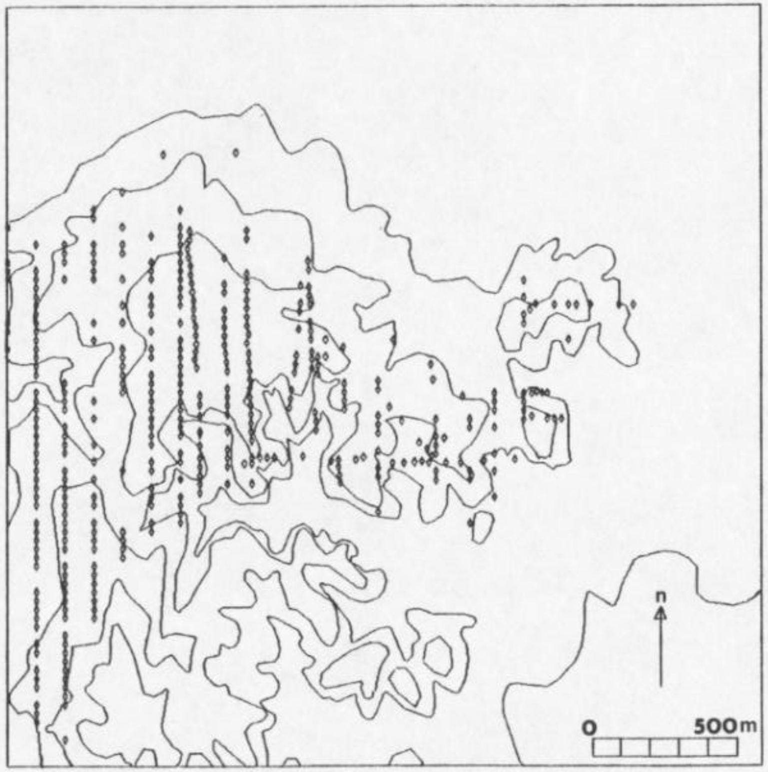


Figure 49. Presence of Cultural Material based on the Shovel Tested Probabilistic Transect Samples.

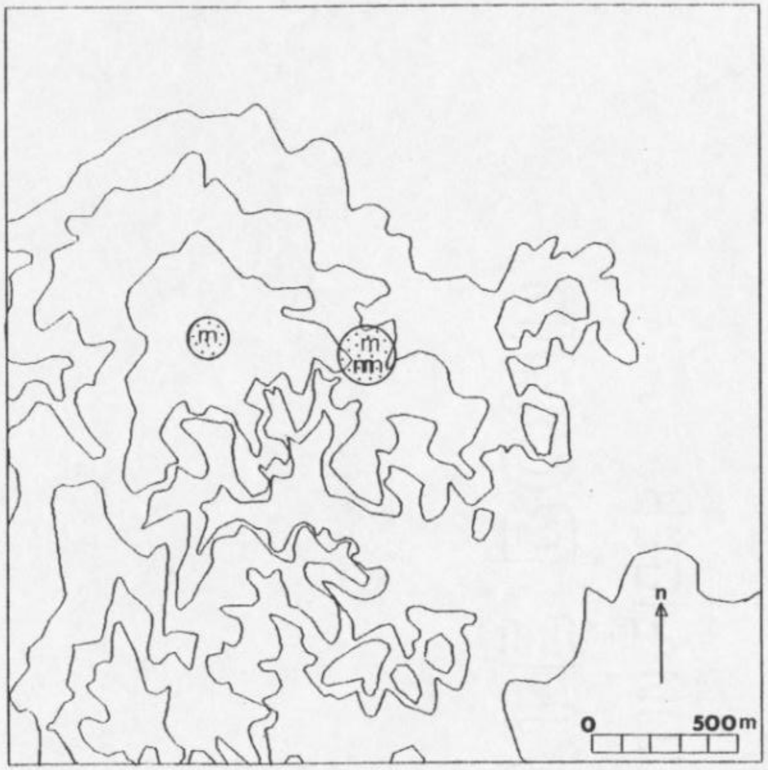


Figure 50. Distribution of Monagrillo Group Pottery.

Figure 51. Distribution of Aguadulce-Ladrones Group Pottery.

Figure 52. Distribution of Early Group Pottery.

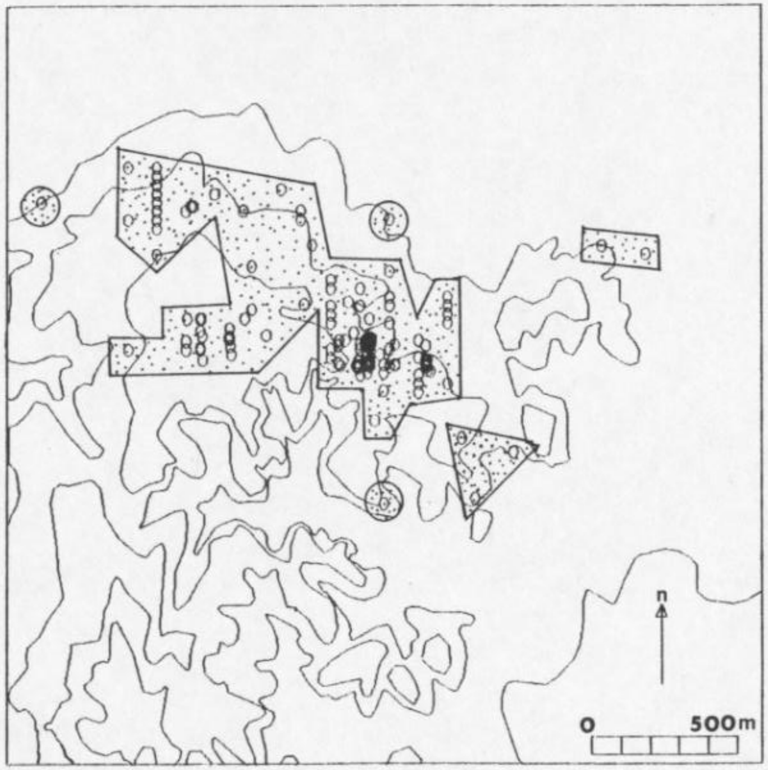


Figure 53. Distribution of Lamula Group Pottery.

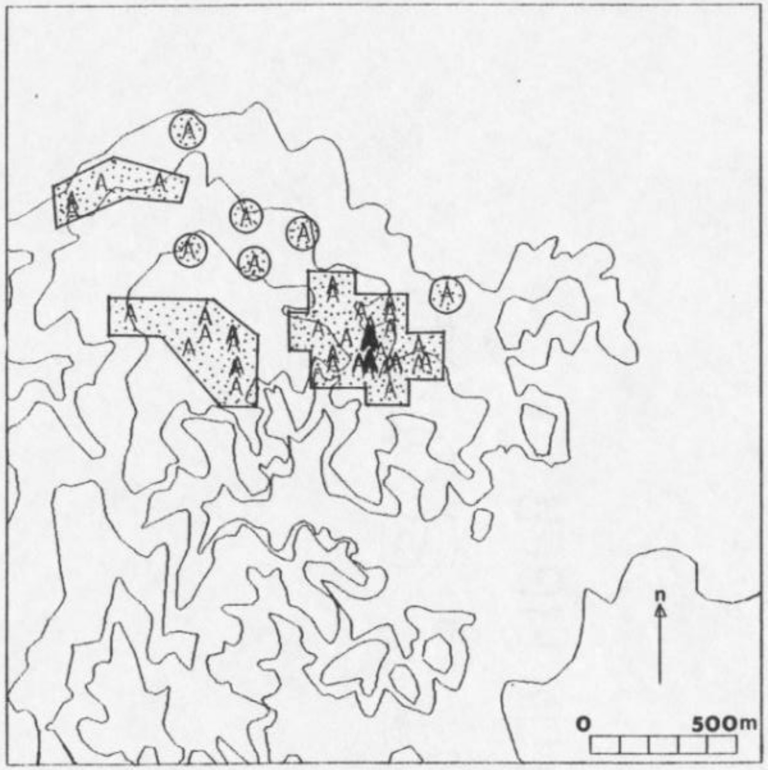


Figure 54. Distribution of Aristide Group Pottery.

Figure 55. Distribution of Sarigua Group Pottery.

Figure 56. Distribution of Tonosi Group Pottery.

Figure 57. Distribution of all 1st Millennium B.C. Pottery Groups.

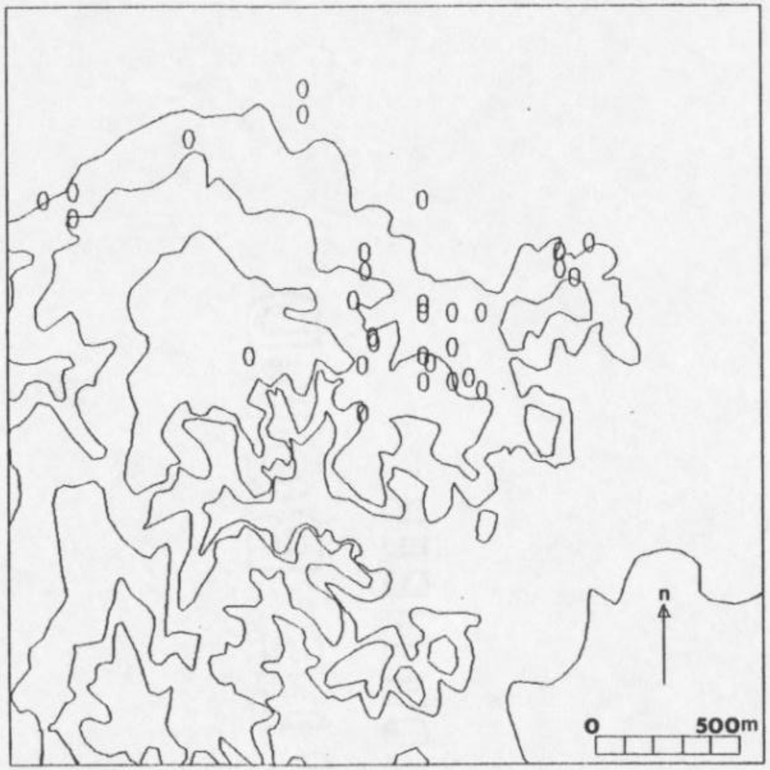


Figure 60. Distribution of Edge-ground Cobbles.

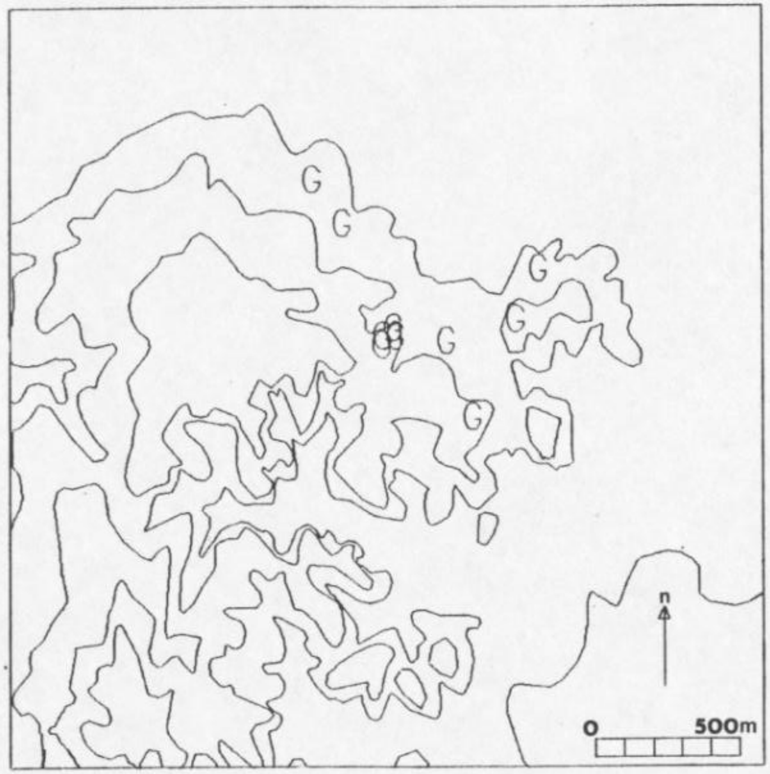


Figure 61. Distribution of Milling Stone Bases.

Figure 62. Distribution of Edge-ground Cobbles and Milling Stone Bases.

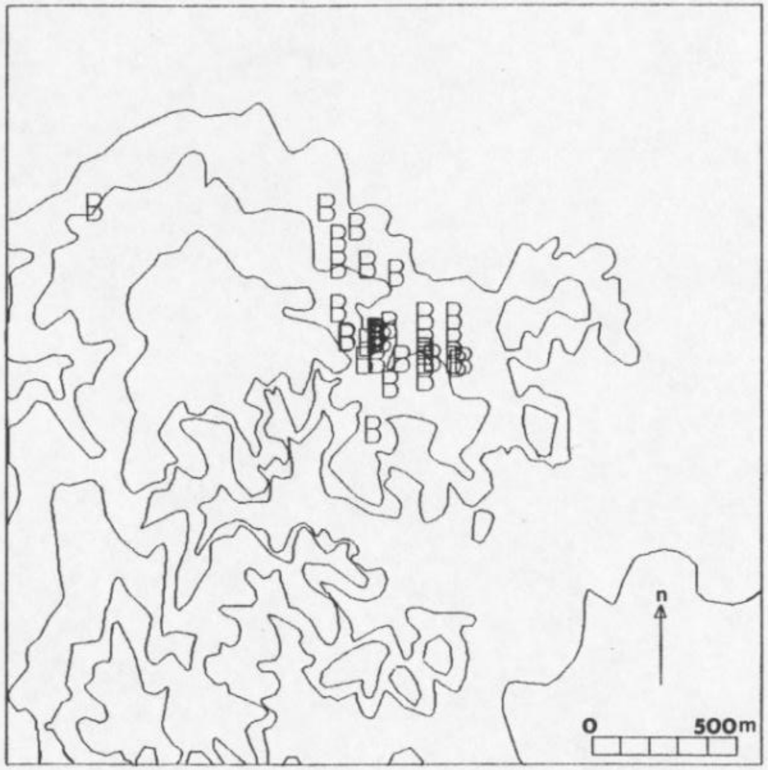


Figure 63. Distribution of Breadboard Metates.

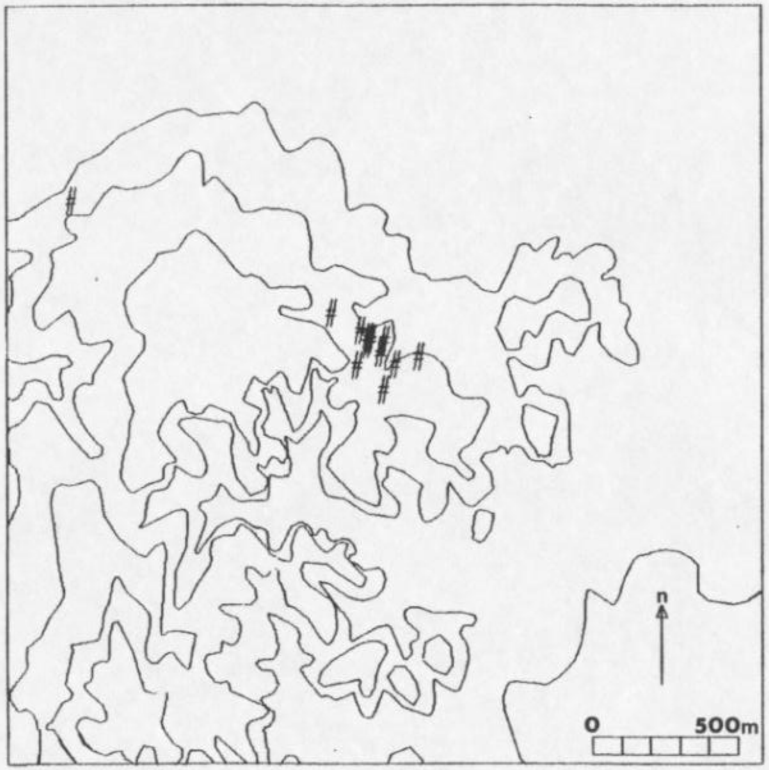


Figure 64. Distribution of Bar Manos.

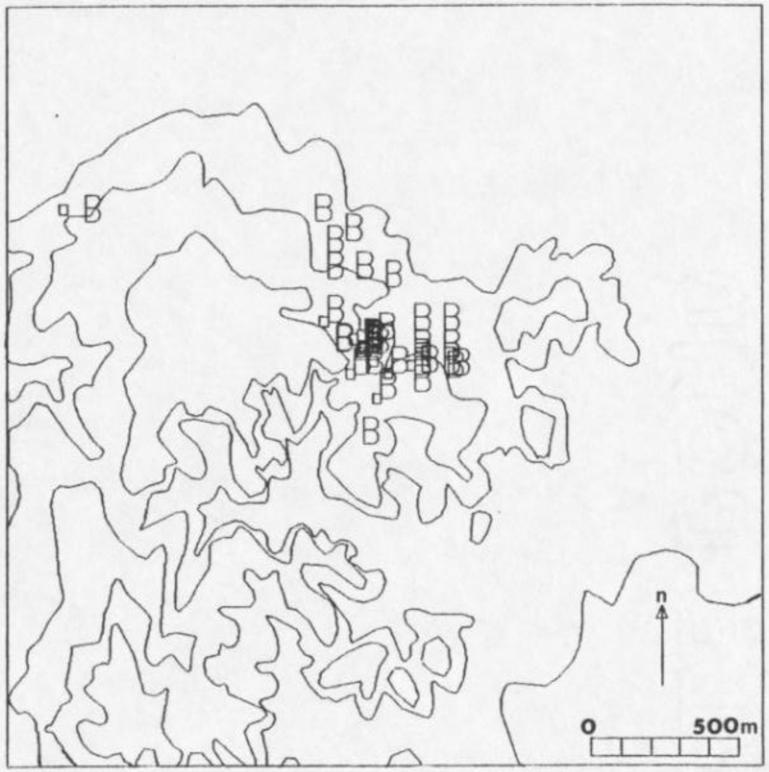


Figure 65. Distribution of Breadboard Metates and Bar Manos.

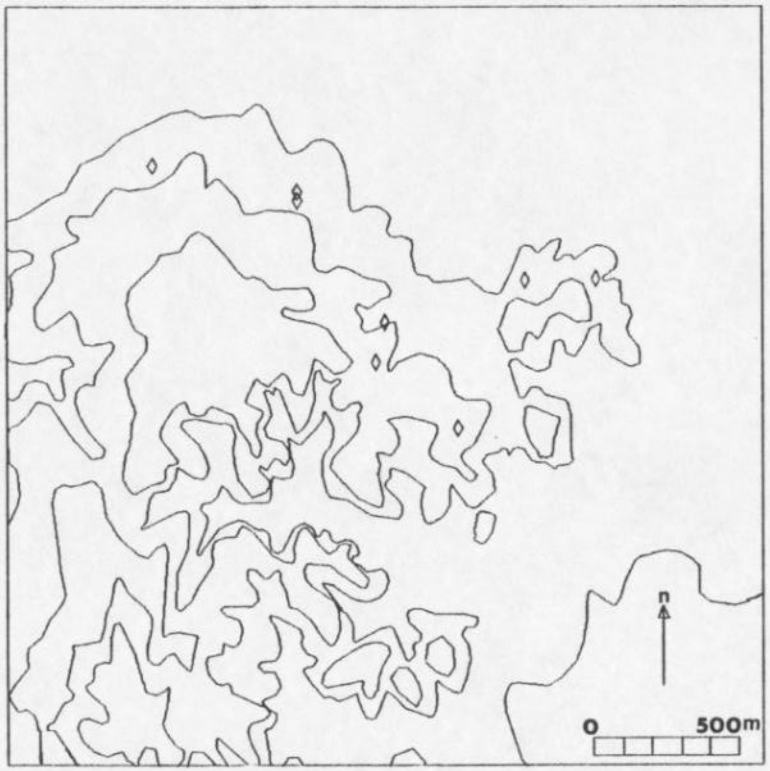


Figure 66. Distribution of Non-breadboard Metates.

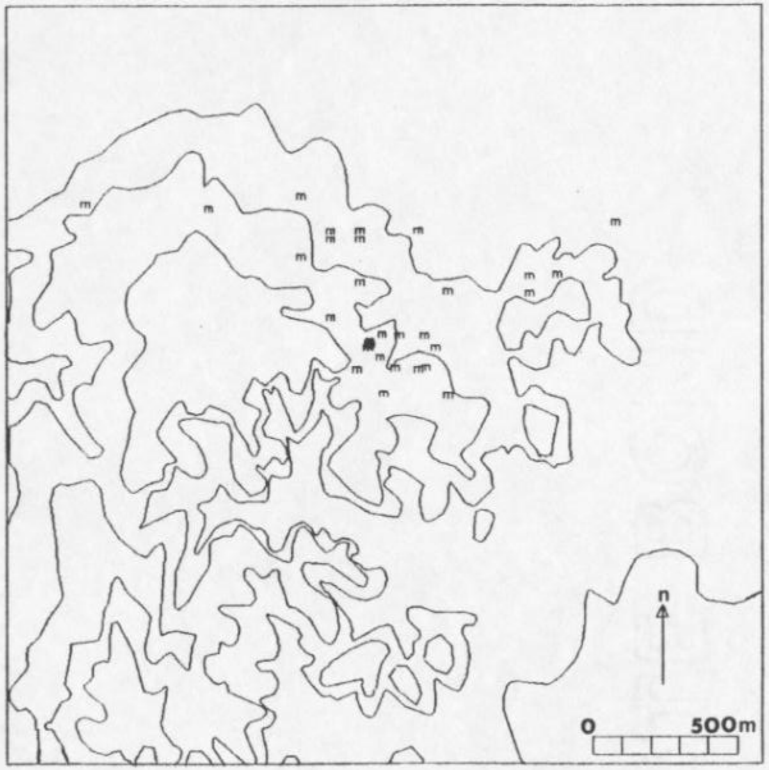


Figure 67. Distribution of Non-bar Manos.

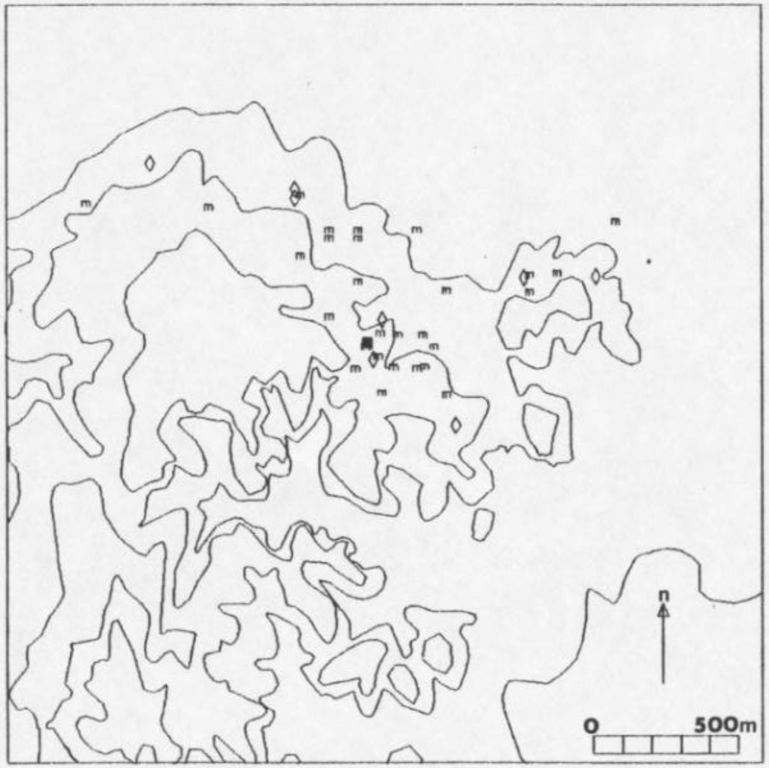


Figure 68. Distribution of Non-breadboard Metates and Non-bar Manos.

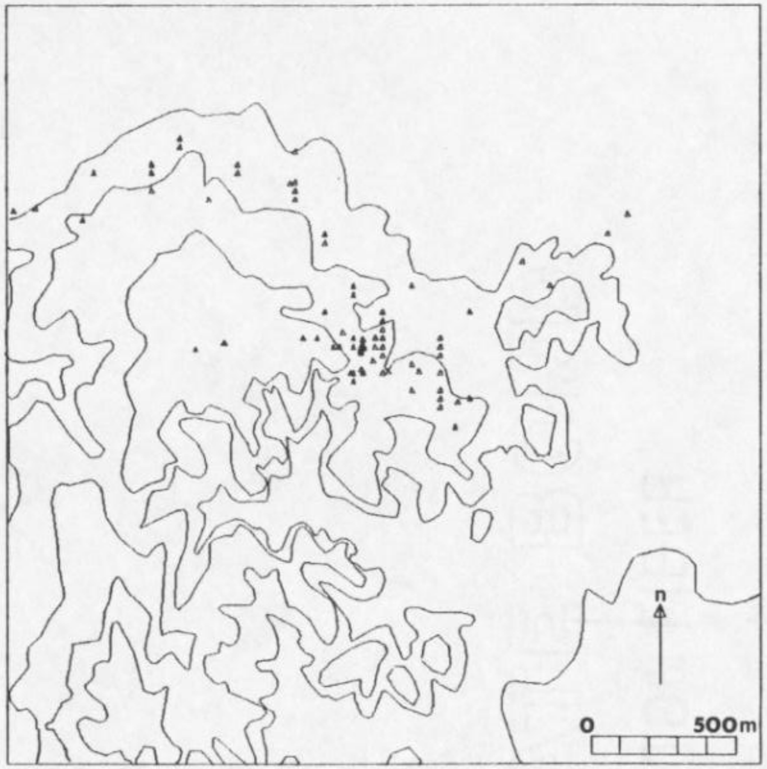


Figure 69. Distribution of Unifacial Points with a Width of ≥ 2.3 cm.

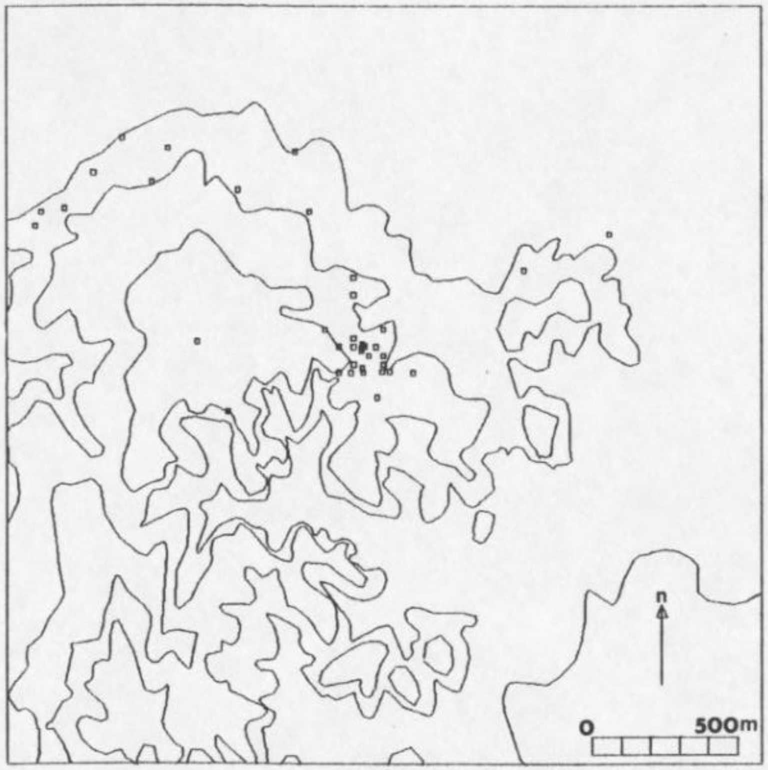


Figure 70. Distribution of Unifacial Points with a Width of ≤ 2.2 cm.

Figure 71. Distribution of Core Scraper-planes.

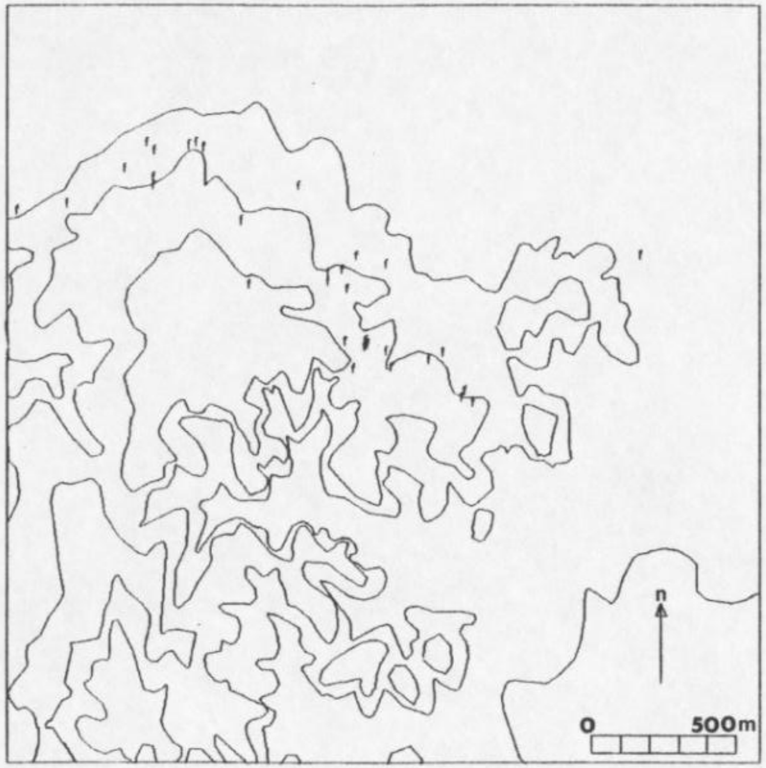


Figure 72. Distribution of Flake Scraper-planes.

Figure 73. Distribution of Pear-shaped Celts.

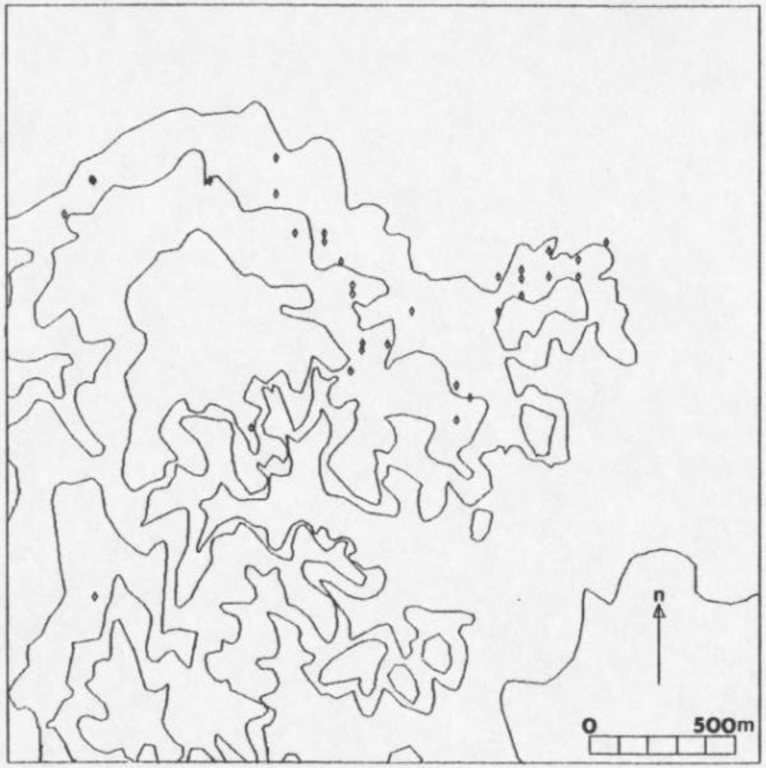


Figure 74. Distribution of Trapezoidal Celts.

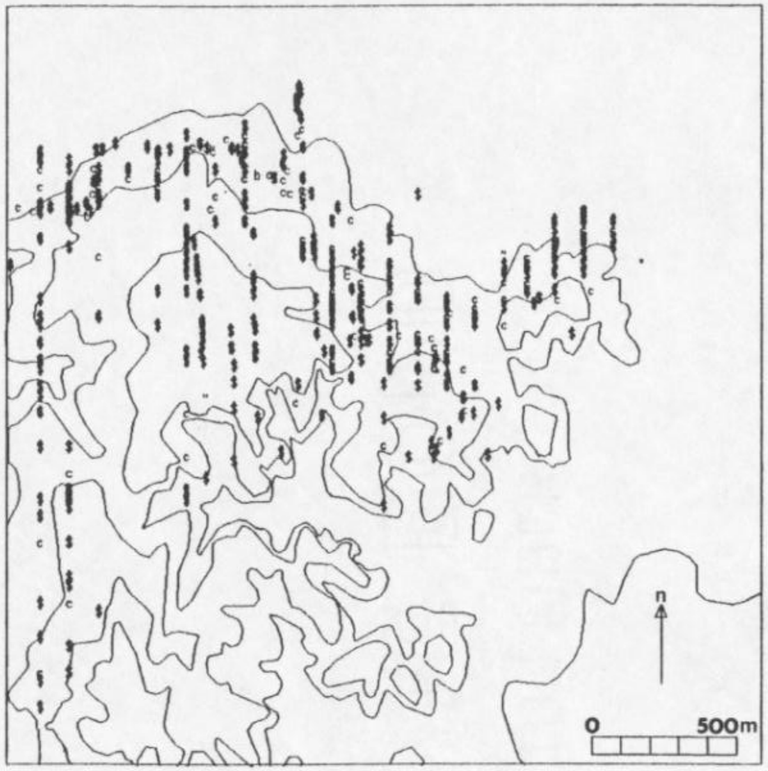


Figure 75. Distribution of Cores, Hammerstones and Unutilized Flakes.

Plate 59. Lithic Workshop.

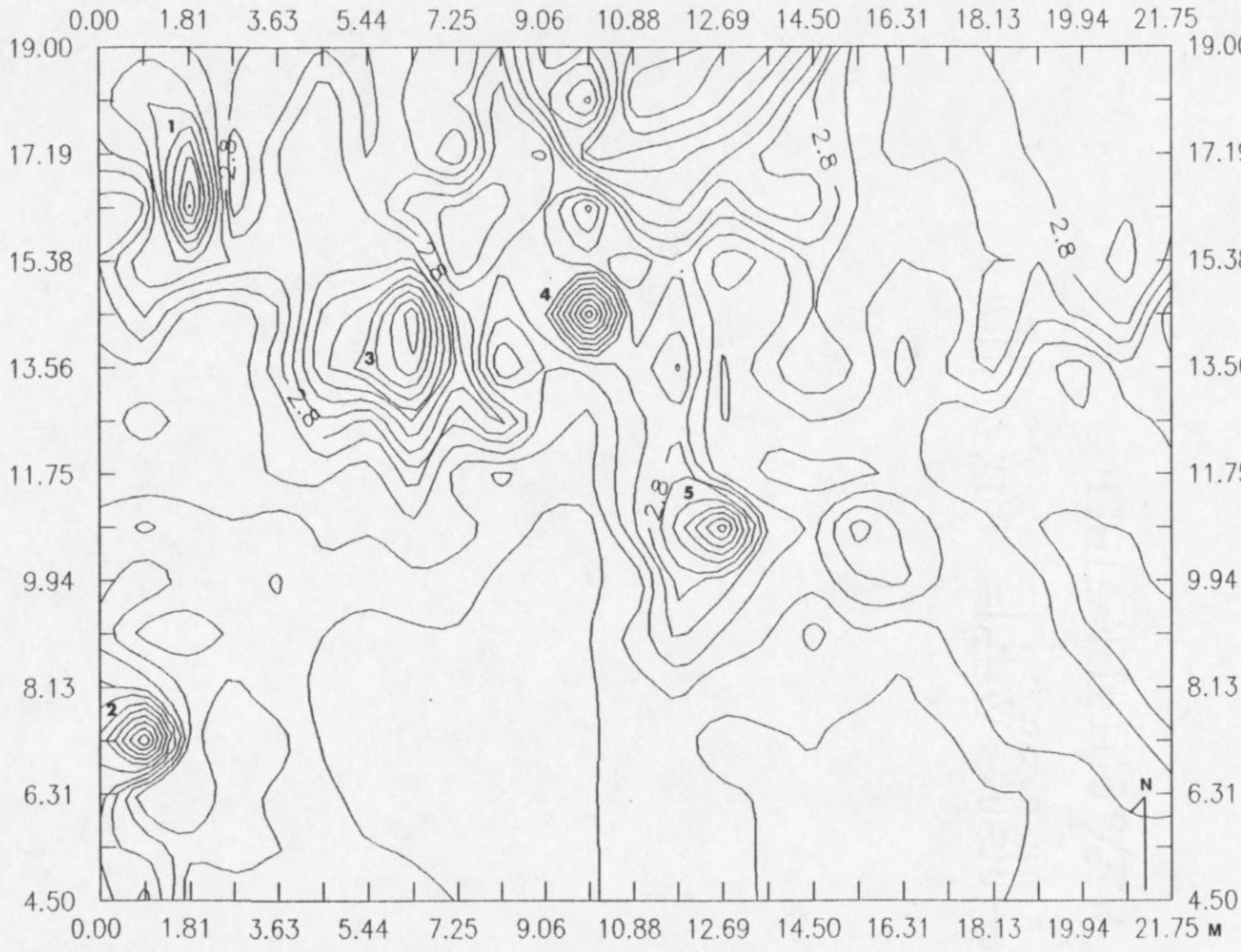


Figure 76. Density and Distribution of Cores, Hammerstones and Unutilized Flakes.

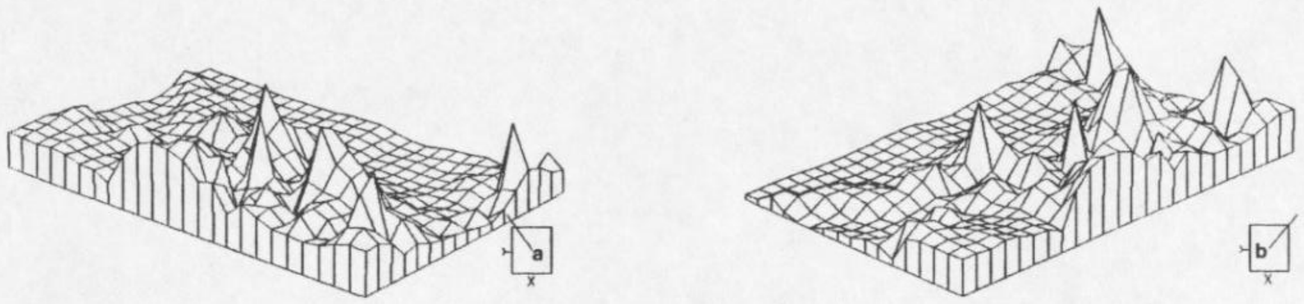


Figure 77. Three-dimensional Representations of the Density and Distribution of Cores, Hammerstones and Unutilized Flakes. a, View from the Northwest; b, View from the Northeast; c, View from the Southwest; d, View from the Southeast.

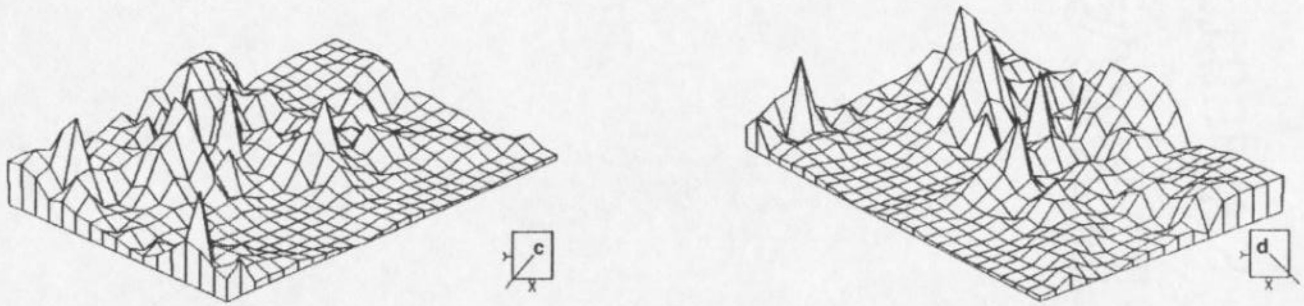


Figure 78. Distribution of Mortar and Pestles.

Figure 79. Distribution of All Unifacial Points.

Figure 80. Distribution of Lamula Group Collared Jars.

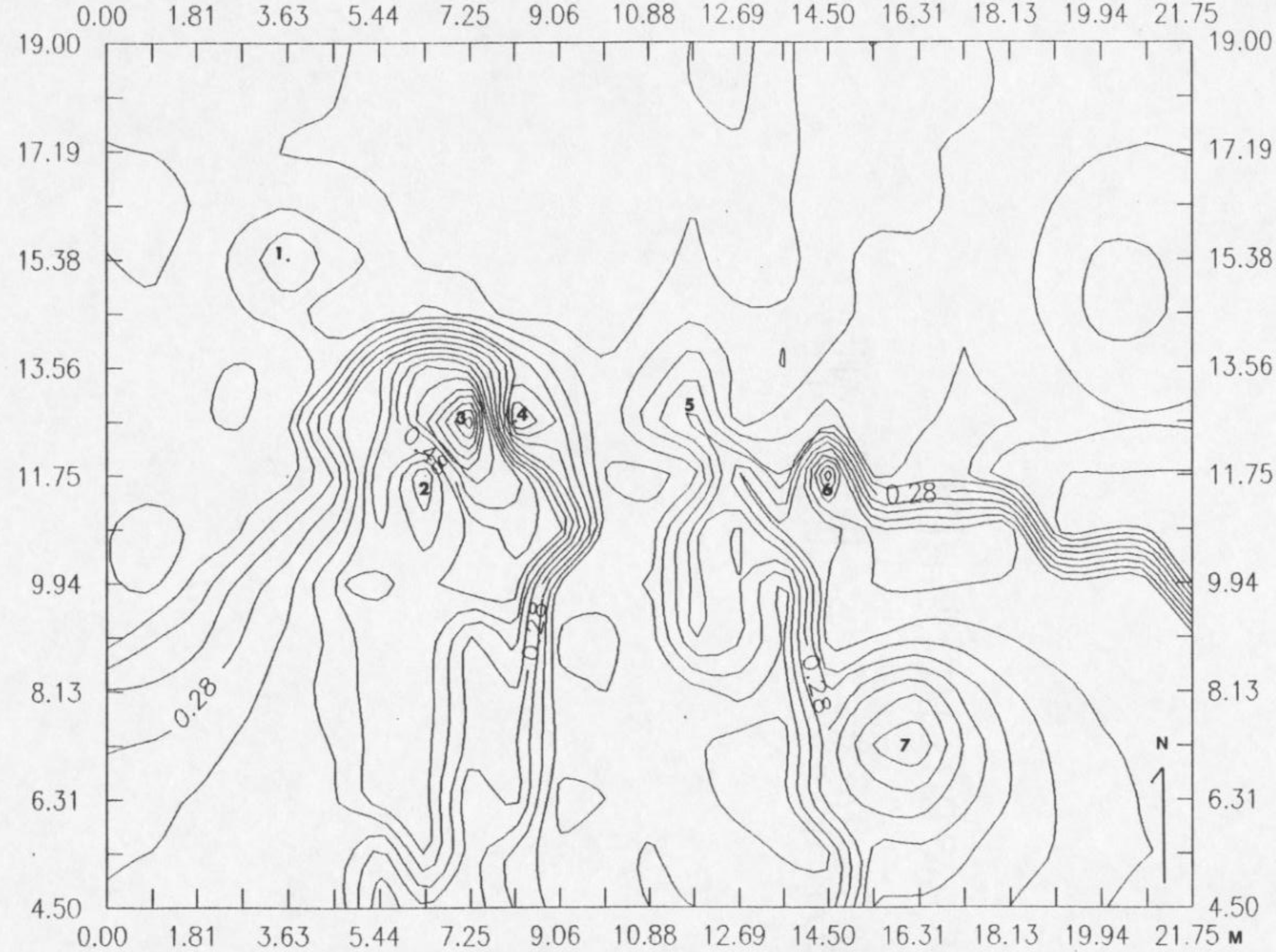


Figure 81. Density and Distribution of Lamula Group Collared Jars.

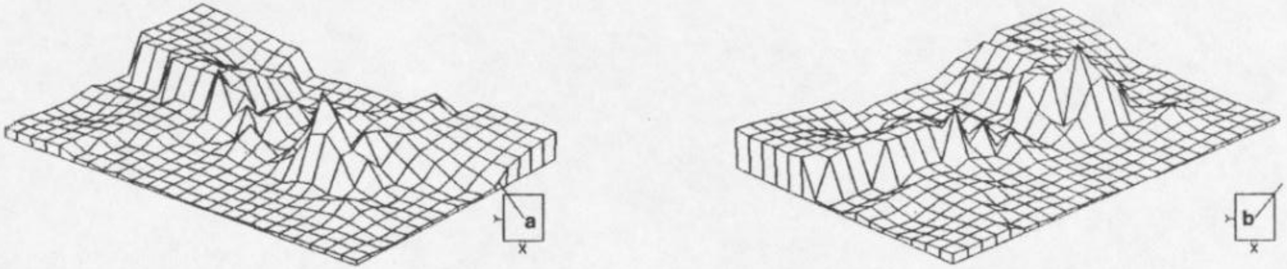
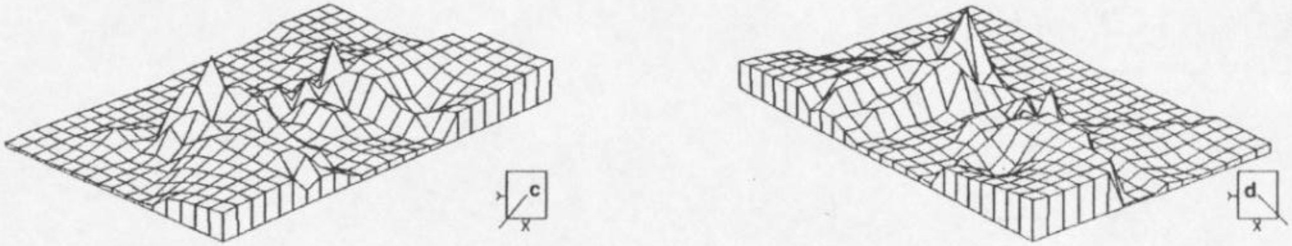


Figure 82. Three-dimensional Representations of the Density and Distribution of Lamula Group Collared Jars. a, View from the Northwest; b, View from the Northeast; c, View from the Southwest; d, View from the Southeast.



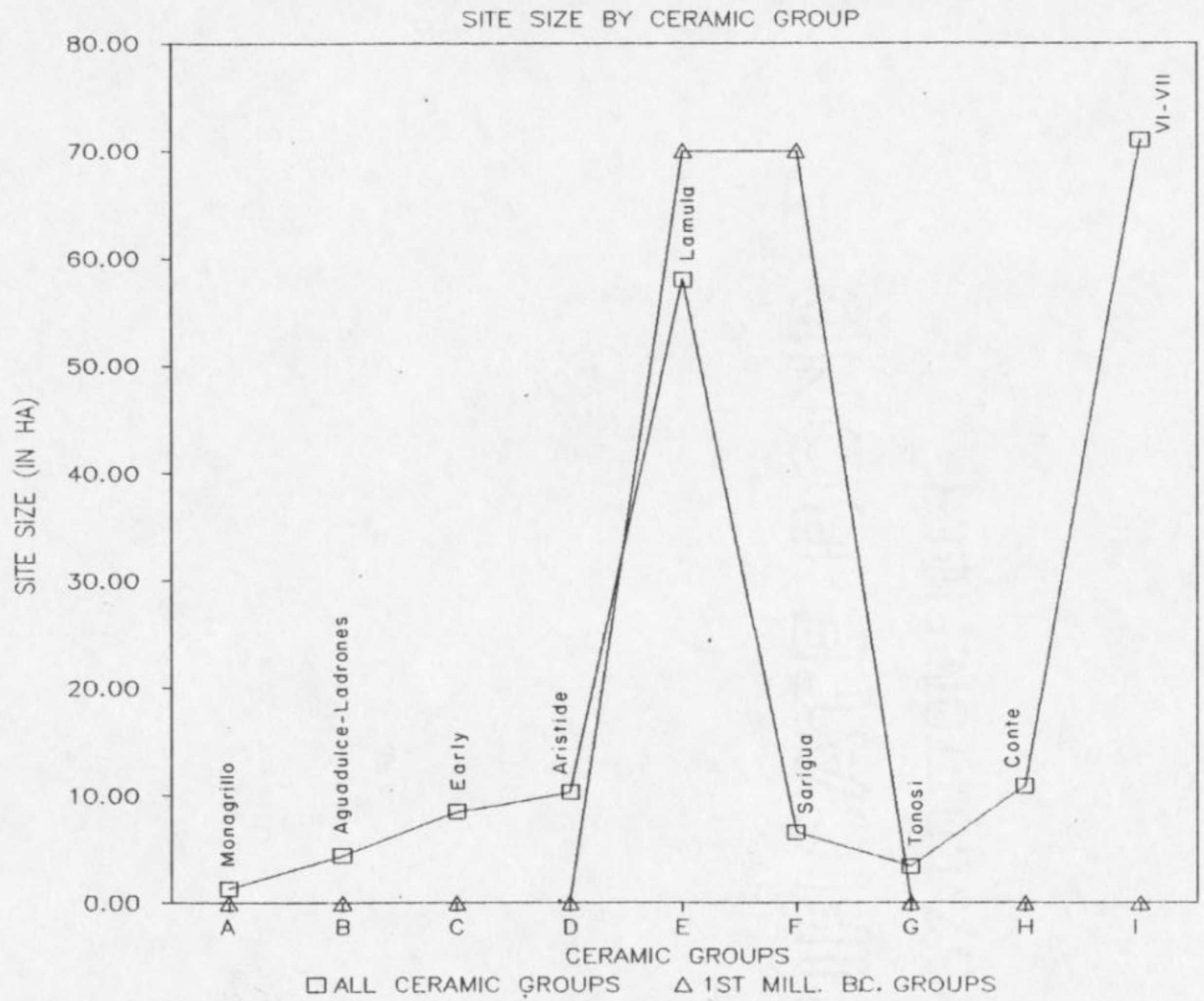


Figure 83. Site Size (in Ha) based on the Distribution of Ceramic Groups.

APPENDIX A

Database Variable Labels and Definitions

Table 53. Sample of MASTER Entries.

```
Point|Unit Size/Operation|Screen Size|Feature|Name/Date| Catalog#

*C
273S409E 1mX1m Surface              -        -      -       PR-14-T-0
*K
273S409E/1983/WET SEASON/ERODED/SLOPE/TRANSECT/SURFACE
COLLECTION/NOTHING/PR-14-T0*E

*C
231S414E 1mX1m Surface              -        -  AT,AV/8.8  PR-14-T-1
*K
231S414E/1983/WET SEASON/ERODED/GULLY/TRANSECT/SURFACE
COLLECTION/STONE-TU/POTTERY/PR-14-T-1*E

*C
214S404E 1mX1m Surface/Diagnostics -     -  AT,AV/8.8  PR-14-T-2
*K
214S404E/1983/WET SEASON/ERODED/GULLY/TRANSECT/SURFACE
COLLECTION/DIAGNOSTICS/STONE-TU/POTTERY/PR-14-T-2*E

*C
194S416E 1mX1m Surface/Diagnostics-      -  AT,AV/8.8 PR-14-T-3
*K
194S416E/1983/WET SEASON/ERODED/MESA/TRANSECT/SURFACE COLLECTION/
DIAGNOSTICS/STONE-TU/POTTERY/PR-14-T-3*E

*C
160S409E 1mX1m Surface/Diagnostics-      -  AT,AV/8.8 PR-14-T-4
*K
160S409E/1983/WET SEASON/ERODED/ROAD/TRANSECT/SURFACE COLLECTION/
DIAGNOSTICS/STONE-TU/PR-14-T-4*E

*C
139S422E    Sondeo/Diagnostics   1/4"    -  AT,AV/8.8 PR-14-T-5
*K
139S422E/1983/WET SEASON/ERODED/GULLY/TRANSECT/SONDEO/
DIAGNOSTICS/STONE-TU/PR-14-T-5*E

*C
114S406E    Sondeo/Diagnostics   1/4"    -  DW,EG/8.8 PR-14-T-6
*K
114S406E/1983/WET SEASON/ERODED/TRANSECT/SONDEO/DIAGNOSTICS/
STONE-TU/POTTERY/PR-14-T-6*E

*C
76S410E     Sondeo/Diagnostics   1/4"    -  DW,EG/8.8 PR-14-T-7
*K
76S410E/1983/WET SEASON/ERODED/TRANSECT/SONDEO/DIAGNOSTICS/
STONE-TU/POTTERY/PR-14-T-7*E
```

Table 54. Sample of MASTER Dictionary (Alphanumeric Keywords), Number of Entries Per Provenience and Catalog Number.

Entry#	Provenience#	Entry#	Provenience#	Entry#	Provenience#
1	#1	1	1050W475N	1	1150W25S
3	0,125E	1	1050W475S	1	1150W275N
1	0,75E	1	1050W500N	1	1150W300N
1	0,76E	1	1050W500S	1	1150W325N
1	0,8.5N	1	1050W50N	1	1150W350N
1	0,80E	1	1050W50S	1	1150W400N
1	0,81E	1	1050W525N	1	1150W50N
1	0,82E	1	1050W525S	1	1150W75N
1	0,83E	1	1050W550N	1	11N110E
1	0,84E	1	1050W550S	1	11N320E
1	0,85E	1	1050W575N	1	11S66E
1	0,86E	1	1050W575S	1	11S67E
1	0,87E	1	1050W600N	1	11S68E
1	0,88E	1	1050W600S	1	11S69E
1	0,89E	1	1050W625S	1	11S70E
1	1025E150N	1	1050W650S	1	11S71E
1	1025E175N	1	1050W675S	1	11S72E
1	1025E200N	1	1050W700S	1	11S73E
2	1025E225N	1	1050W725S	1	11S74E
1	1025E250N	1	1050W750S	1	11S75E
1	1050W,0	1	1050W75N	1	11S76E
1	1050W1000S	1	1050W75S	1	11S77E
1	1050W100N	1	1050W775S	1	11S78E
1	1050W100S	1	1050W800S	1	11S79E
1	1050W1025S	1	1050W825S	1	11S80E
1	1050W1050S	1	1050W850S	1	11S81E
1	1050W1075S	1	1050W875S	1	11S82E
1	1050W1100S	1	1050W900S	1	125S27E
1	1050W1125S	1	1050W925S	1	12S66E
1	1050W1150S	1	1050W950S	1	12S67E
1	1050W125N	1	1050W975S	1	12S68E
1	1050W125S	1	10S66E	1	12S69E
1	1050W150N	1	10S67E	1	12S70E
1	1050W150S	1	10S68E	1	12S71E
1	1050W175N	1	10S69E	1	12S72E
1	1050W175S	1	10S70E	1	12S73E
1	1050W200N	1	10S71E	1	12S74E
1	1050W200S	1	10S72E	1	12S75E
1	1050W225N	1	10S73E	1	12S76E
1	1050W225S	1	10S74E	1	12S77E
1	1050W250N	1	10S75E	1	12S78E
1	1050W250S	1	10S76E	1	12S79E
1	1050W25N	1	10S77E	1	12S80E

Entry#	Catalog #	Entry#	Catalog #	Entry#	Catalog #
1	PR-14-1040	1	PR-14-1041	1	PR-14-1042
1	PR-14-1043	1	PR-14-1044	1	PR-14-1045
1	PR-14-1046	1	PR-14-1047	1	PR-14-1048
1	PR-14-1070	1	PR-14-11025	1	PR-14-1108
1	PR-14-1071	1	PR-14-11026	1	PR-14-11080
1	PR-14-1072	1	PR-14-11027	1	PR-14-11081
1	PR-14-1073	1	PR-14-11028	1	PR-14-11082
1	PR-14-1074	1	PR-14-11029	1	PR-14-11083
1	PR-14-1075	1	PR-14-1103	1	PR-14-11084
1	PR-14-1076	1	PR-14-11030	1	PR-14-11085
1	PR-14-1077	1	PR-14-11031	1	PR-14-11086
1	PR-14-1078	1	PR-14-11032	1	PR-14-11087
1	PR-14-1079	1	PR-14-11033	1	PR-14-11088
1	PR-14-108	1	PR-14-11034	1	PR-14-11089
1	PR-14-1080	1	PR-14-11035	1	PR-14-1109
1	PR-14-1081	1	PR-14-11036	1	PR-14-11090
1	PR-14-1082	1	PR-14-11037	1	PR-14-11091
1	PR-14-1083	1	PR-14-11038	1	PR-14-11092
1	PR-14-1084	1	PR-14-11039	1	PR-14-11093
1	PR-14-1085	1	PR-14-1104	1	PR-14-11094
1	PR-14-1086	1	PR-14-11040	1	PR-14-11095
1	PR-14-1087	1	PR-14-11041	1	PR-14-11096
1	PR-14-1088	1	PR-14-11042	1	PR-14-11097
1	PR-14-1089	1	PR-14-11043	1	PR-14-11098
1	PR-14-109	1	PR-14-11044	1	PR-14-11099
1	PR-14-1090	1	PR-14-11045	1	PR-14-111
1	PR-14-1091	1	PR-14-11046	1	PR-14-1110
1	PR-14-1092	1	PR-14-11047	1	PR-14-1111
1	PR-14-1093	1	PR-14-11048	1	PR-14-1111b
1	PR-14-1094	1	PR-14-11049	1	PR-14-1112
1	PR-14-1095	1	PR-14-1105	1	PR-14-1113
1	PR-14-1096	1	PR-14-11050	1	PR-14-1114
1	PR-14-1097	1	PR-14-11051	1	PR-14-1115
1	PR-14-1098	1	PR-14-11052	1	PR-14-1116
1	PR-14-1099	1	PR-14-11053	1	PR-14-1117
1	PR-14-11	1	PR-14-11054	1	PR-14-1118
1	PR-14-110	1	PR-14-11055	1	PR-14-1119
1	PR-14-1100	1	PR-14-11056	1	PR-14-112
1	PR-14-11001	1	PR-14-11057	1	PR-14-1120
1	PR-14-11002	1	PR-14-11058	1	PR-14-1121
1	PR-14-11003	1	PR-14-11059	1	PR-14-1122
1	PR-14-11004	1	PR-14-1106	1	PR-14-1123
1	PR-14-11005	1	PR-14-11060	1	PR-14-1124
1	PR-14-11006	1	PR-14-11061	1	PR-14-1125
1	PR-14-11007	1	PR-14-11062	1	PR-14-1126
1	PR-14-11009	1	PR-14-11063	1	PR-14-1127
1	PR-14-1101	1	PR-14-11064	1	PR-14-1128

Table 55. Sample of MASTER Dictionary (Other than Alphanumeric Keywords).

Environmental contexts:		
AEOLIAN	ALLUVIUM	ALLUVIUM EDGE
ALVINA	ALVINA EDGE	ALVINA ?
BOSQUE	BOSQUE EDGE	CHARCO BANK
COLINA	CULTIVATED	DEPRESSION
ERODED	ERODED EDGE	FALLOW FIELD
FIELD	FIELD EDGE	GRASS COVERED
GRASS EDGE	GULLY	HILL
HILL BASE	MESA	MESA EDGE
OLD CHANNEL	PASTURE	PASTURE EDGE
PLAIN	PLAIN EDGE	QUARRY
QUARRY EDGE	QUEBRADA	ROAD
ROAD EDGE	SLOPE	SLOPE BASE
SLOPE WASH	SORGHO	SORGHO EDGE
VALLEY	WASH	WASH EDGE
Operation type:		
BIFACIAL OPERATION	CONTROLLED	DIAGNOSTIC COLLECTION
EXCAVATION	FLOTATION	ISOLATED FIND
MAPPED	NO COLLECTION	SONDEO
SURFACE OPERATION	TP OPERATION	TRANSECT
TROWEL TEST		
Feature type:		
BURIAL	BURIAL ?	BURNT EARTH
BURROW	CACIQUE ?	CULTURAL
CULTURAL ?	FEATURE	HEARTH
MIDDEN	MODERN DUMP	MOUND
PEDESTAL	PIT	PIT ?
SHELLMIDDEN		
Material type:		
BEAD	BIFACIAL	BONE
BURIAL	CARBON	CRANIA
CUCURBITA	DATABLE SHELL	DATED SHELL (W/DATE)
FISH	GLASS	GLAZED POTTERY
HUMAN	MAIZE	MANDIBLE
NO MATERIAL	NUT FRAGMENT	PHYTOLITHS (W/ID)
POLLEN (W/ID)	POTTERY	POTTERY DIAGNOSTIC
SHELL	STONE	STONE-TU
STONE DIAGNOSTIC	TEETH	
Sample type:		
CARBON	COLUMN	PHYTOLITH
POLLEN	SHELL	SOIL
Season and Year:		
DRY	WET	1983

1984 1985 1986

Table 56. MINARK Lithic Database Labels and Variable Types.

Variable	Label	Variable Type
XCOORD	X (easting) coordinate	Positive decimal #
YCOORD	Y (northing) coordinate	Positive decimal #
CATNO	Catalog number	Text string
COLUNIT	Collection unit #	Text string
UNITYPE	Collection type	Nominal/attribute 1)surface 2)excavation 3)sondeo
ARTICAT	Artifact category, general	Nominal/attribute 1)core 2)flake 3)tool, chipped 4)tool, non-chipped 5)fragment 6)unmodified nodules
CORETYP	Core type	Nominal/attribute 1)unidirectional 2)bidirectional 3)multidirectional 4)bipolar 5)bifacial 6)blade 7)pointed flake 8)slight modification 9)fragment 10)heat treated 11)bipolar product 12)cortex
FLAKTYP	Flake type	Nominal/attribute 1)decortication 2)debitage, no cortex 3)shatter 4)core rejuvenation 5)bifacial thinning 6)resharpening 7)celt flake 8)bipolar

9)blade, prismatic
10)blade, 1/w >=2
11)pointed flake
12)normal, 1 <1/w <2
13)wide flake, 1/w <=1
14)thick flake, w/t <2
15)macroflake, 1xw>50 mm
16)microflake, 1 <=25 mm
17)heat treated
18)blade fragment
19)flake fragment
20)blade-flake
21)other (see comments)
22)spall
23)polish

CHIPTYP   Chipped stone tool type   Nominal/attribute

1)convex scraper
2)concave scraper
3)straight scraper
4)pointed scraper
5)keeled scraper
6)spoon-shaped scraper
7)straight-edged knife
8)backed by retouch
9)opposed notches
10)perforator
11)bifacial point
12)unifacial point
13)trifacial point
14)biface (preform)
15)unifacial chopper
16)bifacial chopper
17)graver
18)burin
19)saw
20)chisel
21)scraper-plane
22)wedge
23)denticulate
24)grater-board inset
25)stemmed
26)convex-edged knife
27)concave-edged knife
28)natural backed flake
29)notched
30)pick
31)other (see comments)

NONCHIP Non-chipped tool type Nominal/attribute

1)end-battered hammer
2)edge-battered hammer
3)spheroid hammer
4)anvil
5)mano
6)metate
7)edge-ground cobble
8)edge-battered cobble
9)milling stone base
10)pestle
11)mortar
12)nutting stone
13)celt
14)axe
15)adze
16)chisel, polished
17)polished fragment
18)other (see comments)
19)fragment
20)breadboard metate
21)surface-battered ham
22)pecking hammer
23)breadboard rim
24)piccador
25)metate leg
26)grooved
27)polisher

EDGERET Edge retouch Nominal/attribute

1)right lateral
2)left lateral
3)bilateral
4)terminal
5)proximal
6)corner
7)point
8)complete perimeter
9)ventral (metate)
10)dorsal (metate)
11)rim (metate)
12)1 edge (mano/edgie)
13)2 edges (mano/edgie)
14)3 edges (mano/edgie)
15)1 end (mano/edgie)
16)2 ends (mano/edgie)
17)4 or > edges (mano/")
18)bit perimeter
19)partial perimeter

SURFRET	Surface retouch	Nominal/attribute 1)unifacial dorsal 2)unifacial ventral 3)bifacial, one side 4)bifacial, > one side 5)bifacial, complete 6)crushing 7)ventral (metate) 8)dorsal (metate) 9)rim (metate) 10)1 surface (mano/edgie) 11)2 surfaces (mano/ ") 12)3 or > surfaces (")
EDGEUSE	Edge retouched by use	Nominal/attribute 1)right lateral 2)left lateral 3)bilateral 4)terminal 5)proximal 6)corner 7)point 8)complete perimeter 9)ventral (metate) 10)dorsal (metate) 11)rim (metate) 12)1 edge (mano/edgie) 13)2 edges (mano/edgie) 14)3 edges (mano/edgie) 15)1 end (mano/edgie) 16)2 ends (mano/edgie) 17)4 or > edges (" ") 18)bit perimeter (celt) 19)partial perimeter (")
SURFUSE	Surface retouched by use	Nominal/attribute 1)unifacial dorsal 2)unifacial ventral 3)bifacial, 1 side 4)bifacial, > 1 side 5)bifacial, complete 6)crushing 7)ventral (metate) 8)dorsal (metate) 9)rim (metate) 10)1 surface (mano/edgie) 11)2 surfaces (mano/ ") 12)3 or > surfaces (" ")

EDGANGL	Angle of working edge, "spine" in degrees	Positive whole #
SHORFAC	Use facet of ends in cm, (mano/edgie)	Positive decimal #
LONGFAC	Use facet of edges in cm, (mano/edgie)	Positive decimal #
SURFAC	Use facet of surfaces in cm, (mano/edgie)	Positive decimal #
LENGTH	Length//to axis of force in cm	Positive decimal #
WIDTH	Width perpendicular to axis of force in cm	Positive decimal #
THICKNES	Maximum thickness of specimen in cm	Positive decimal #
CROSSEC	Cross section	Nominal/attribute 1) plano-convex 2) trapezoidal 3) triangular 4) concave-convex 5) other (see comments) 6) biconvex 7) diamond-shaped 8) wedge-shaped 9) plano-concave 10) plano (mano/edgie) 11) rectangular (" ") 12) spherical (mano/") 13) ovoid (mano/edgie) 14) sexagonal (mano/") 15) tabular 16) five-sided (mano/") 17) convex-concave ("") 18) domed (scraper-plane)
BODYHT	Maximum table height (excluding rim) in cm, (metates)	Positive decimal #
RIMHT	Maximum rim height (excluding table) in cm, (metates)	Positive decimal #

RIMWID	Maximum rim width in cm, (metates)	Positive decimal #
RIMLENG	Rim length in cm, (metates)	Positive decimal #
DANG	Mean dorsal angle from rim to dorsal surface in degrees, (metates)	Positive whole #
WEIGHT	Weight in grams	Positive decimal #
LITHOLGY	Lithology	Nominal/attribute 1)cryptocrystalline 2)agate 3)quartz crystal 4)quartz, milky 5)petrified wood 6)andesite 7)basalt 8)dacite 9)volcanic, unspecified 10)sandstone 11)granite 12)vesicular igneous 13)other (see comments) 14)crypto/rhyolite tuff 15)diorite 16)crypto/rhyodacite tuff 17)crypto/dacite tuff 18)crypto/andesite tuff 19)quartz monzonite 20)quartz monzodiorite 21)granodiorite 22)monzodiorite 23)trachyte 24)monzonite 25)rhyodacite porphory 26)rhyolite porphory 27)andesite porphory 28)quartz syenite 29)quartz diorite 30)latite 31)syenite 32)rhyodacite 33)dacite vitrophyre 34)dacite tuff 35)diabase

GRAIN	Texture of material	Nominal/attribute 1)fine <2 mm 2)medium (2-10 mm) 3)coarse >10 mm 4)porphyritic (comb) 5)clastic
HOMOGEN	Homogeneity of material	Nominal/attribute 1)homogeneous 2)heterogeneous
EDGEDRES	Edge dressing (?) in cm, (manos)	Positive decimal #
ENDDRESS	End dressing (?) in cm, (manos)	Positive decimal #
SHOULDER	Width of shoulder in cm, (points)	Positive decimal #
MIDPOINT	Width of midpoint in cm, (points)	Positive decimal #
TIP	Width of tip in cm, (points)	Positive decimal #
BASE	Width of base in cm, (points)	Positive decimal #
NOTCH	Width at notch in cm, (points)	Positive decimal #
STEMSHAP	Shape of stem, (points)	Nominal/attribute 1)symmetrical 2)asymmetrical 3)elongated 4)straight 5)expanded 6)constricted 7)other (see comments) 8)absent
BASESHAP	Shape of stem base, (points)	Nominal/attribute 1)straight 2)concave 3)convex 4)notched 5)earred 6)absent 7)other (see comments)

SHOLSHAP	Shoulder shape, (points)	Nominal/attribute 1)symmetrical 2)asymmetrical 3)absent
RIDGPLAC	Placement of dorsal ridge, (points)	Nominal/attribute 1)parallel ridges 2)central ridge 3)off-center ridge 4)absent 5)other (see comments) 6)forked ridge
DORSMOD	Basal flake scars on dorsal side, (points)	Boolean (Yes/no)
VENTMOD	Basal flake scars on ventral side, (points)	Boolean (Yes/no)
POINTVEW	Planview of point	Nominal/attribute 1)symmetrical 2)asymmetrical 3)other (see comments)
CELTVIEW	Planview of celts	Nominal/attribute 1)pear-shape 2)trapezoidal-shape 3)fully polished 4)bit polished 5)other (see comments)
BITWIDTH	Width of bit in cm, (celts)	Positive decimal #
BITTHICK	Thickness of bit 1 cm from working edge in cm, (celts)	Positive decimal #
BUTWIDTH	Width of butt in cm, (celts)	Positive decimal #
BUTTHICK	Thickness of butt in cm, (celts)	Positive decimal #
BUTTSHAP	Shape of butt end, (celts)	Nominal/attribute 1)straight 2)converging

		3) symmetrical sides 4) asymmetrical sides 5) pointed base 6) straight base 7) other (see comments) 8) asymmetrical base 9) symmetrical base 10) convex
PLANVIEW	Planview for ground & polished tools	Nominal/attribute 1) rectangular 2) triangular 3) spherical 4) oval 5) other (see comments)
PLANSFE	Planar surface, (scraper-planes)	Nominal/attribute 1) planar 2) convex 3) concave 4) undulating 5) other (see comments)
IDCONF	Confidence level of identification	Nominal/attribute 1) secure 2) probable 3) questionable
RECORDER	Name of analyst	Text string
COMMENT	Comments	Text string

<u>VARIABLES USED BY TOOL FORM</u>

LITFORM Lithics entry form (general)

XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
ARTICAT	CORETYP	FLAKTYP	CHIPTYP	NONCHIP
EDGERET	SURFRET	EDGEUSE	SURFUSE	EDGANGL
LENGTH	WIDTH	THICKNES	CROSSEC	LITHOLGY
GRAIN	HOMOGEN	IDCONF	RECORDER	COMMENTS

METFORM Metate, milling stone, mortar entry form

XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
ARTICAT	NONCHIP	EDGERET	SURFRET	EDGEUSE
SURFUSE	LENGTH	WIDTH	BODYHT	RIMHT
RIMWID	RIMLENG	DANG	CROSSEC	PLANVIEW
LITHOLGY	GRAIN	HOMOGEN	IDCONF	RECORDER
COMMENTS				

MANOFORM	Mano, edge-ground cobble, pestle entry form				
	XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
	ARTICAT	NONCHIP	EDGERET	SURFRET	EDGEUSE
	SURFUSE	EDGEDRES	ENDDRES	LENGTH	WIDTH
	THICKNES	SHORFAC	LONGFAC	SURFAC	CROSSEC
	PLANVIEW	WEIGHT	LITHOLGY	GRAIN	HOMOGEN
	IDCONF	RECORDER	COMMENTS		
PNTFORM	Unifacial point entry form				
	XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
	ARTICAT	FLAKTYP	CHIPTYP	EDGERET	SURFRET
	EDGEUSE	SURFUSE	EDGANGL	LENGTH	WIDTH
	THICKNES	CROSSEC	POINTVEW	SHOULDER	MIDPOINT
	TIP	BASE	NOTCH	STEMSHAP	BASESHAP
	SHOLSHAP	RIDGPLAC	DORSMOD	VENTMOD	LITHOLGY
	GRAIN	HOMOGEN	IDCONF	RECORDER	COMMENTS
CELTFORM	Celt entry form				
	XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
	ARTICAT	FLAKTYP	CHIPTYP	NONCHIP	EDGERET
	SURFRET	EDGEUSE	SURFUSE	EDGANGL	LENGTH
	WIDTH	THICKNES	CROSSEC	CELTVIEW	MIDPOINT
	BITWIDTH	BITTHICK	BUTWIDTH	BUTTHICK	BUTTSHAP
	LITHOLGY	GRAIN	HOMOGEN	IDCONF	RECORDER
	COMMENTS				
SCPLFORM	Scraper-plane entry form				
	XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
	ARTICAT	CORETYP	FLAKTYP	CHIPTYP	NONCHIP
	EDGERET	SURFRET	EDGEUSE	SURFUSE	EDGANGL
	LENGTH	WIDTH	THICKNES	WEIGHT	CROSSEC
	PLANSFE	LITHOLGY	GRAIN	HOMOGEN	IDCONF
	RECORDER	COMMENTS			

Table 57. MINARK Ceramic Database Labels and Variable Types.

Variable	Label	Variable Type
XCOORD	X (easting) coordinate	Positive decimal #
YCOORD	Y (northing) coordinate	Positive decimal #
CATNO	Catalog number	Text string
COLUNIT	Collection unit #	Text string
UNITYPE	Collection type	Nominal/atttribute 1)surface 2)excavated 3)sondeo
CERACAT	Ceramic category, e.g., rim	Nominal/attribute 1)rim 2)body 3)appendage 4)pedestal 5)neck 6)collar 7)base 8)shoulder 9)other (see comments) 10)fragment 11)bevel
APPEND	Appendage type	Nominal/attribute 1)strap handle 2)round handle 3)zoomorphic lug 4)lug strap handle 5)other (see comments)
MODE	Attribute(s) of significance	Nominal/attribute 1)continuousUndulation 2)linearDeepPunctation 3)odd modes 4)shell stamping 5)tecomateIrregScratch 6)half-moon slashes 7)interior grooving 8)diamonds & brushing 9)lightObliqueIncision 10)Tonosi trichrome

11)filletAppliqueIncis
12)EscotaBlack-on-red
13)LaMula trichrome
14)excisionBrdIncision
15)incisionW/DpPunc/Sla
16)blob nubbins, linear
17)incisions
18)patterned burnishing
19)GironBandLipRadial
20)tearDrpOvaloidRdPunc
21)Escota w/ext bevel
22)CocoboInteriorBand
23)scarification
24)flatEvertRimExcision
25)cylindrical vessel
26)small strap handles
27)thinAppliqRidgVertAp
28)Conte polychrome
29)GuacimoRed-whiteSlip
30)Period V type
31)zoomorphic lug
32)modelled appendage
33)miscellaneous lug
34)eye-like nubbins
35)semicircular lugs
36)Jobero type
37)miscell appendage
38)unassign polychrome
39)Parita polychrome

VESFORM Vessel shape Nominal/attribute
1)collared vessel
2)collared jar
3)tecomate
4)plate
5)cylindrical vessel
6)cylindrical drum
7)bowl
8)effigy vessel
9)globular vessel
10)rimless vessel
11)goblet-shaped vessel
12)vase double
13)urns
14)other (see comments)
15)incurved bowl
16)LaBernadina decore

VESSIZE	Vessel size	Nominal/attribute 1)small 2)medium 3)large
PASTE	Paste color and inclusions	Nominal/attribute 1)brown 2)brown w/quartz 3)red 4)buff 5)tempered w/quartz 6)fires orange 7)absent 8)other (see comments) 9)fine 10)tuff 11)yellow dirty 12)brown tuff 13)red slip
TEMPER	Temper type	Nominal/attribute 1)absent 2)present 3)grit 4)crushed rock 5)tuff
PAINT	Paint color	Nominal/attribute 1)red 2)black 3)white slip 4)buff 5)other (see comments) 6)absent 7)black-on-orange 8)buff 9)black-on-buff
RIMTHICK	Rim thickness	Positive decimal #
VESFUNC	Vessel function	Nominal/attribute 1)funerary 2)utlitarian 3)luxury 4)other (see comments)

CHRONO	Absolute or relative date	Nominal/attribute 1)C-14 (see comments) 2)Phase IIIA 3)Phase IIIB 4)Phase IV 5)Phase V 6)Phase VI 7)Phase VIIA 8)Phase VIIB
GROUP	Temporal type	Nominal/attribute 1)Monagrillo 2)Aguadulce-Ladrones 3)Lamula 4)Sarigua 5)Aristide 6)Tonosi 7)Conte 8)Period VI-VII 9)Early
RECORDER	Name of analyst	Text string
COMMENTS	Comments	Text string

VARIABLES USED

CERFORM Ceramic entry form

XCOORD	YCOORD	CATNO	COLUNIT	UNITYPE
CERACAT	APPEND	MODE	VESFORM	VESSIZE
PASTE	TEMPER	PAINT	VESFUNC	RIMTHCK
GROUP	CHRONO	RECORDER	COMMENTS	

Table 58. MINARK Lamula Database (General Database) Labels and Variable Types.

Variable	Label	Variable Type
XCOORD	X (easting) coordinate	Positive decimal #
YCOORD	Y (northing) coordinate	Positive decimal #
CATNO	Catalog number	Text string
COLUNIT	Collection unit #	Text string
OPTYPE	Operation type	Nominal/attribute 1)surface-1 sq m unit 2)sondeo 3)diagnostic 4)feature 5)excavation
CULTMAT	Cultural material	Boolean (Yes/no)
SONAREA	Sondeo surface area in sq m	Positive decimal #
SONDEPTH	Sondeo depth in m	Positive decimal #
FLAKES	Flakes by number	Positive whole #
FL/TOOLS	Flake/tools by number	Positive whole #
SPALLTL	Spalled tools by number	Positive whole #
POINTS	Unifacial points by number	Positive whole #
GRAINSET	Grater board insets by #	Positive whole #
BIFACMAT	Bifacial material by #	Positive whole #
BBMET	Breadboard metates by number	Positive whole #
METATE	Metates (other) by number	Positive whole #
BARMANO	Bar manos by number	Positive whole #
MANOS	Manos (other) by number	Positive whole #
MILLBASE	Milling stone base by #	Positive whole #

MORTAR	Mortars by number	Positive whole #
EDGIES	Edge-ground cobbles by #	Positive whole #
CELTS	Celts by number	Positive whole #
CELT/FL	Celt flakes by number	Positive whole #
SCRAPLAN	Scraper-planes by number	Positive whole #
CORES	Cores by number	Positive whole #
HAMMERS	Hammerstones by number	Positive whole #
COREHAM	Core/hammerstone by number	Positive whole #
POTTERY	Pottery by number	Positive whole #
SHELL	Shell	Boolean (Yes/no)
NHBONE	Nonhuman bone	Boolean (Yes/no)
HUMBONE	Human bone	Boolean (Yes/no)
RECORDER	Name of data enterer	Text string
COMMENTS	Comments	Text string

VARIABLES USED

FACTFORM General material classes entry form

XCOORD	YCOORD	CATNO	COLUNIT	OPTYPE
SONAREA	SONDEPTH	CULTMAT	FLAKES	FL/TOOLS
SPALLTL	POINTS	GRAINSET	BIFACMAT	BBMET
METATE	BARMANO	MANOS	MILLBASE	MORTAR
EDGIES	CELTS	CELT/FL	SCRAPLAN	CORES
HAMMERS	COREHAM	POTTERY	SHELL	NHBONE
HUMBONE	RECORDER	COMMENTS		

APPENDIX B

Lithic Histograms

Table 59. Unifacial Point Frequency for Length, N=196.

	Frequency	0 10 20
Missing or < 1.0 :	0.0%	0
1.0 - 1.2 :	0.0%	0
1.2 - 1.4 :	0.0%	0
1.4 - 1.6 :	0.0%	0
1.6 - 1.8 :	1.0%	2 **
1.8 - 2.0 :	0.0%	0
2.0 - 2.2 :	0.0%	0
2.2 - 2.4 :	0.0%	0
2.4 - 2.6 :	0.0%	0
2.6 - 2.8 :	0.0%	0
2.8 - 3.0 :	0.0%	0
3.0 - 3.2 :	1.5%	3 ***
3.2 - 3.4 :	1.5%	3 ***
3.4 - 3.6 :	3.1%	6 ******
3.6 - 3.8 :	6.6%	13 *************
3.8 - 4.0 :	5.6%	11 ***********
4.0 - 4.2 :	7.1%	14 **************
4.2 - 4.4 :	10.7%	21 *********************
4.4 - 4.6 :	9.2%	18 ******************
4.6 - 4.8 :	11.2%	22 **********************
4.8 - 5.0 :	7.7%	15 ***************
5.0 - 5.2 :	7.1%	14 **************
5.2 - 5.4 :	5.6%	11 ***********
5.4 - 5.6 :	8.2%	16 ****************
5.6 - 5.8 :	3.1%	6 ******
5.8 - 6.0 :	2.6%	5 *****
6.0 - 6.2 :	4.1%	8 ********
6.2 - 6.4 :	1.0%	2 **
6.4 - 6.6 :	0.5%	1 *
6.6 - 6.8 :	1.0%	2 **
6.8 - 7.0 :	1.5%	3 ***

Table 60. Unifacial Point Frequency for Width, N=196.

		Frequency	0 10 20 30
Missing or < 1.0 :	0.0%	0	
1.0 - 1.2 :	0.0%	0	
1.2 - 1.4 :	0.0%	0	
1.4 - 1.6 :	0.5%	1	*
1.6 - 1.8 :	5.1%	10	**********
1.8 - 2.0 :	6.1%	12	************
2.0 - 2.2 :	14.3%	28	****************************
2.2 - 2.4 :	8.7%	17	*****************
2.4 - 2.6 :	12.8%	25	*************************
2.6 - 2.8 :	21.4%	42	*************************>>>
2.8 - 3.0 :	10.7%	21	*********************
3.0 - 3.2 :	9.7%	19	*******************
3.2 - 3.4 :	4.6%	9	*********
3.4 - 3.6 :	2.6%	5	*****
3.6 - 3.8 :	1.5%	3	***
3.8 - 4.0 :	1.5%	3	***
4.0 - 4.2 :	0.0%	0	
4.2 - 4.4 :	0.5%	1	*
4.4 - 4.6 :	0.0%	0	

Table 61. Unifacial Point Frequency for Thickness, N=196.

		Frequency	0 10 20
Missing or < 0.1 :	0.0%	0	
0.1 - 0.2 :	0.0%	0	
0.2 - 0.3 :	0.5%	1	*
0.3 - 0.4 :	0.0%	0	
0.4 - 0.5 :	5.1%	10	**********
0.5 - 0.6 :	8.2%	16	****************
0.6 - 0.7 :	20.4%	40	************************>>>
0.7 - 0.8 :	19.4%	38	************************>>>
0.8 - 0.9 :	10.2%	20	********************
0.9 - 1.0 :	9.2%	18	******************
1.0 - 1.1 :	14.3%	28	****************************
1.1 - 1.2 :	5.1%	10	**********
1.2 - 1.3 :	4.1%	8	********
1.3 - 1.4 :	2.6%	5	*****
1.4 - 1.5 :	0.5%	1	*
1.5 - 1.6 :	0.5%	1	*

Table 62. Unifacial Point Frequency for Length/Width Ratio, N=196.

```
                        Frequency   0         10         20

Missing or < 0.0 :  0.0%     0
       0.0 - 0.2 :  0.0%     0
       0.2 - 0.4 :  0.0%     0
       0.4 - 0.6 :  0.5%     1  *
       0.6 - 0.8 :  0.0%     0
       0.8 - 1.0 :  0.5%     1  *
       1.0 - 1.2 :  2.0%     4  ****
       1.2 - 1.4 :  7.7%    15  ***************
       1.4 - 1.6 : 12.8%    25  *************************
       1.6 - 1.8 : 23.5%    46  *************************>>
       1.8 - 2.0 : 17.3%    34  ***********************>>
       2.0 - 2.2 : 16.3%    32  **********************>>
       2.2 - 2.4 :  9.7%    19  *******************
       2.4 - 2.6 :  2.6%     5  *****
       2.6 - 2.8 :  4.1%     8  ********
       2.8 - 3.0 :  0.5%     1  *
       3.0 - 3.2 :  0.5%     1  *
       3.2 - 3.4 :  1.0%     2  **
       3.4 - 3.6 :  0.5%     1  *
       3.6 - 3.8 :  0.5%     1  *
       3.8 - 4.0 :  0.0%     0
       4.0 - 4.2 :  0.0%     0
       4.2 - 4.4 :  0.0%     0
       4.4 - 4.6 :  0.0%     0
       4.6 - 4.8 :  0.0%     0
```

Table 63. Unifacial Point Frequency for Length/Width*Thickness Ratio, N=195.

```
                        Frequency   0         10         20         30

Missing or < 0.0 :  0.0%     0
       0.0 - 0.4 :  0.5%     1  *
       0.4 - 0.8 :  3.6%     7  *******
       0.8 - 1.2 : 30.6%    60  *********************>>>>>
       1.2 - 1.6 : 31.1%    61  **********************>>>>>
       1.6 - 2.0 : 17.9%    35  *****************>>>>
       2.0 - 2.4 : 10.2%    20  ********************
       2.4 - 2.8 :  4.1%     8  ********
       2.8 - 3.2 :  1.0%     2  **
       3.2 - 3.6 :  0.5%     1  *
       3.6 - 4.0 :  0.0%     0
```

Table 64. Unifacial Point Frequency for Base Width, N=193.

	Frequency		0 10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.3 :	0.0%	0	
0.3 - 0.6 :	0.5%	1	*
0.6 - 0.9 :	1.6%	3	***
0.9 - 1.2 :	10.9%	21	*********************
1.2 - 1.5 :	16.6%	32	*********************>>>
1.5 - 1.8 :	28.0%	54	*********************>>>
1.8 - 2.1 :	14.5%	28	****************************
2.1 - 2.4 :	14.5%	28	****************************
2.4 - 2.7 :	7.3%	14	**************
2.7 - 3.0 :	5.2%	10	**********
3.0 - 3.3 :	1.0%	2	**
3.3 - 3.6 :	0.0%	0	

Table 65. Unifacial Point Frequency for Notch Width, N=194.

	Frequency		0 10 20
Missing or < 0.1 :	8.2%	16	****************
0.1 - 0.3 :	0.0%	0	
0.3 - 0.5 :	0.0%	0	
0.5 - 0.7 :	0.5%	1	*
0.7 - 0.9 :	0.5%	1	*
0.9 - 1.1 :	0.5%	1	*
1.1 - 1.3 :	5.2%	10	**********
1.3 - 1.5 :	12.4%	24	************************
1.5 - 1.7 :	17.5%	34	************************>>>
1.7 - 1.9 :	10.3%	20	********************
1.9 - 2.1 :	18.0%	35	************************>>>
2.1 - 2.3 :	10.8%	21	*********************
2.3 - 2.5 :	9.8%	19	*******************
2.5 - 2.7 :	2.1%	4	****
2.7 - 2.9 :	2.6%	5	*****
2.9 - 3.1 :	1.0%	2	**
3.1 - 3.3 :	0.5%	1	*
3.3 - 3.5 :	0.0%	0	
3.5 - 3.7 :	0.0%	0	

Table 66. Unifacial Point Frequency for Shoulder Width, N=183.

	Frequency		0 10 20
Missing or < 1.0 :	0.0%	0	
1.0 - 1.2 :	0.0%	0	
1.2 - 1.4 :	0.0%	0	
1.4 - 1.6 :	2.2%	4	****
1.6 - 1.8 :	3.8%	7	*******
1.8 - 2.0 :	8.7%	16	****************
2.0 - 2.2 :	10.9%	20	********************
2.2 - 2.4 :	10.9%	20	********************
2.4 - 2.6 :	16.4%	30	********************>>>
2.6 - 2.8 :	21.3%	39	********************>>>
2.8 - 3.0 :	8.2%	15	***************
3.0 - 3.2 :	7.7%	14	**************
3.2 - 3.4 :	4.9%	9	*********
3.4 - 3.6 :	2.2%	4	****
3.6 - 3.8 :	1.1%	2	**
3.8 - 4.0 :	1.1%	2	**
4.0 - 4.2 :	0.5%	1	*

Table 67. Unifacial Point Frequency for Midpoint Width, N=194.

	Frequency		0 10 20
Missing or < 0.3 :	0.5%	1	*
0.3 - 0.5 :	0.0%	0	
0.5 - 0.7 :	0.5%	1	*
0.7 - 0.9 :	0.0%	0	
0.9 - 1.1 :	2.1%	4	****
1.1 - 1.3 :	4.6%	9	*********
1.3 - 1.5 :	9.3%	18	******************
1.5 - 1.7 :	10.3%	20	********************
1.7 - 1.9 :	17.5%	34	*************************>>>
1.9 - 2.1 :	18.0%	35	*************************>>>
2.1 - 2.3 :	17.0%	33	*************************>>>
2.3 - 2.5 :	9.3%	18	******************
2.5 - 2.7 :	3.1%	6	******
2.7 - 2.9 :	4.6%	9	*********
2.9 - 3.1 :	2.6%	5	*****
3.1 - 3.3 :	0.5%	1	*

Table 68. Unifacial Point Frequency for Tip Width, N=194.

		Frequency	0 10 20
Missing or < 0.0 :	1.5%	3	***
0.0 - 0.1 :	34.5%	67	************************>>>
0.1 - 0.2 :	4.1%	8	********
0.2 - 0.3 :	12.4%	24	************************
0.3 - 0.4 :	16.0%	31	************************>>>
0.4 - 0.5 :	9.8%	19	*******************
0.5 - 0.6 :	4.1%	8	********
0.6 - 0.7 :	5.7%	11	***********
0.7 - 0.8 :	2.6%	5	*****
0.8 - 0.9 :	2.6%	5	*****
0.9 - 1.0 :	1.0%	2	**
1.0 - 1.1 :	2.1%	4	****
1.1 - 1.2 :	1.0%	2	**
1.2 - 1.3 :	0.5%	1	*
1.3 - 1.4 :	0.0%	0	
1.4 - 1.5 :	0.0%	0	
1.5 - 1.6 :	1.0%	2	**
1.6 - 1.7 :	0.0%	0	
1.7 - 1.8 :	0.0%	0	
1.8 - 1.9 :	0.0%	0	
1.9 - 2.0 :	0.0%	0	
2.0 - 2.1 :	1.0%	2	**
2.1 - 2.2 :	0.0%	0	

Table 69. Unifacial Point Frequency for Shoulder/Base Ratio, N=181.

	Frequency	0 10 20	
Missing or < 0.3 :	0.0%	0	
0.3 - 0.5 :	0.0%	0	
0.5 - 0.7 :	0.0%	0	
0.7 - 0.9 :	0.6%	1	*
0.9 - 1.1 :	6.1%	11	***********
1.1 - 1.3 :	27.1%	49	***********************>>>
1.3 - 1.5 :	26.5%	48	***********************>>>>
1.5 - 1.7 :	17.1%	31	***********************>>>
1.7 - 1.9 :	10.5%	19	*******************
1.9 - 2.1 :	2.8%	5	*****
2.1 - 2.3 :	2.2%	4	****
2.3 - 2.5 :	2.2%	4	****
2.5 - 2.7 :	2.2%	4	****
2.7 - 2.9 :	0.6%	1	*
2.9 - 3.1 :	0.0%	0	
3.1 - 3.3 :	0.6%	1	*
3.3 - 3.5 :	0.6%	1	*
3.5 - 3.7 :	0.6%	1	*
3.7 - 3.9 :	0.0%	0	
3.9 - 4.1 :	0.6%	1	*
4.1 - 4.3 :	0.0%	0	

Table 70. Unifacial Point Frequency for Width/Thickness Ratio, N=196.

```
                 Frequency   0         10         20         30

Missing or < 0.0 :  0.0%     0
       0.0 - 0.5 :  0.5%     1  *
       0.5 - 1.0 :  0.0%     0
       1.0 - 1.5 :  0.5%     1  *
       1.5 - 2.0 :  1.0%     2  **
       2.0 - 2.5 : 12.2%    24  ************************
       2.5 - 3.0 : 17.9%    35  ************************>>>
       3.0 - 3.5 : 23.5%    46  ***********************>>>>>
       3.5 - 4.0 : 14.8%    29  ********************>>
       4.0 - 4.5 : 20.4%    40  ***********************>>>>
       4.5 - 5.0 :  4.1%     8  ********
       5.0 - 5.5 :  3.6%     7  *******
       5.5 - 6.0 :  0.5%     1  *
       6.0 - 6.5 :  0.0%     0
       6.5 - 7.0 :  0.5%     1  *
       7.0 - 7.5 :  0.0%     0
       7.5 - 8.0 :  0.0%     0
       8.0 - 8.5 :  0.0%     0
       8.5 - 9.0 :  0.0%     0
       9.0 - 9.5 :  0.0%     0
      9.5 - 10.0 :  0.0%     0
     10.0 - 10.5 :  0.0%     0
     10.5 - 11.0 :  0.0%     0
     11.0 - 11.5 :  0.0%     0
     11.5 - 12.0 :  0.0%     0
     12.0 - 12.5 :  0.0%     0
     12.5 - 13.0 :  0.0%     0
     13.0 - 13.5 :  0.5%     1  *
     13.5 - 14.0 :  0.0%     0
```

Table 71. Scraper-plane (Core) Frequency for Length, N=137.

	Frequency	0	10 20 30
Missing or < 0.0 :	0.0%	0	
0.0 - 0.7 :	0.0%	0	
0.7 - 1.4 :	0.0%	0	
1.4 - 2.1 :	0.7%	1	*
2.1 - 2.8 :	0.7%	1	*
2.8 - 3.5 :	2.9%	4	****
3.5 - 4.2 :	8.0%	11	***********
4.2 - 4.9 :	10.2%	14	**************
4.9 - 5.6 :	15.3%	21	*********************
5.6 - 6.3 :	18.2%	25	*************************
6.3 - 7.0 :	13.9%	19	*******************
7.0 - 7.7 :	10.9%	15	***************
7.7 - 8.4 :	8.8%	12	************
8.4 - 9.1 :	3.6%	5	*****
9.1 - 9.8 :	5.1%	7	*******
9.8 - 10.5 :	1.5%	2	**

Table 72. Scraper-plane (Core) Frequency for Width, N=137.

	Frequency	0	10 20 30
Missing or < 3.0 :	0.0%	0	
3.0 - 3.7 :	0.0%	0	
3.7 - 4.4 :	8.0%	11	***********
4.4 - 5.1 :	10.2%	14	**************
5.1 - 5.8 :	13.9%	19	*******************
5.8 - 6.5 :	14.6%	20	********************
6.5 - 7.2 :	15.3%	21	*********************
7.2 - 7.9 :	16.1%	22	**********************
7.9 - 8.6 :	10.2%	14	**************
8.6 - 9.3 :	5.1%	7	*******
9.3 - 10.0 :	5.1%	7	*******
10.0 - 10.7 :	0.7%	1	*
10.7 - 11.4 :	0.7%	1	*

Table 73. Scraper-plane (Core) Frequency for Thickness, N=137.

	Frequency		0 10 20 30
Missing or < 1.0 :	0.0%	0	
1.0 - 1.6 :	0.7%	1	*
1.6 - 2.2 :	3.6%	5	*****
2.2 - 2.8 :	6.6%	9	*********
2.8 - 3.4 :	24.8%	34	*************************>>>
3.4 - 4.0 :	22.6%	31	*************************>>>
4.0 - 4.6 :	12.4%	17	*****************
4.6 - 5.2 :	10.9%	15	***************
5.2 - 5.8 :	10.2%	14	**************
5.8 - 6.4 :	3.6%	5	*****
6.4 - 7.0 :	2.2%	3	***
7.0 - 7.6 :	0.0%	0	
7.6 - 8.2 :	0.7%	1	*
8.2 - 8.8 :	0.7%	1	*
8.8 - 9.4 :	0.7%	1	*

Table 74. Scraper-plane (Core) Frequency for Weight, N=137

	Frequency		0 10 20
Missing or < 12.0 :	0.7%	1	*
12.0 - 62.0 :	11.7%	16	****************
62.0 - 112.0 :	22.6%	31	*************************>>>
112.0 - 162.0 :	19.7%	27	***************************
162.0 - 212.0 :	13.1%	18	******************
212.0 - 262.0 :	10.2%	14	**************
262.0 - 312.0 :	8.0%	11	***********
312.0 - 362.0 :	6.6%	9	*********
362.0 - 412.0 :	2.9%	4	****
412.0 - 462.0 :	3.6%	5	*****
462.0 - 512.0 :	0.0%	0	
512.0 - 562.0 :	0.7%	1	*

Table 75. Scraper-plane (Core) Frequency for Length/Width * Thickness Ratio, N=137.

	Frequency	0	10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.7 :	0.0%	0	
0.7 - 1.4 :	2.9%	4	****
1.4 - 2.1 :	7.3%	10	**********
2.1 - 2.8 :	22.6%	31	************************>>
2.8 - 3.5 :	19.0%	26	**************************
3.5 - 4.2 :	15.3%	21	*********************
4.2 - 4.9 :	8.8%	12	************
4.9 - 5.6 :	8.0%	11	***********
5.6 - 6.3 :	8.8%	12	************
6.3 - 7.0 :	2.2%	3	***
7.0 - 7.7 :	2.9%	4	****
7.7 - 8.4 :	1.5%	2	**
8.4 - 9.1 :	0.7%	1	*
9.1 - 9.8 :	0.0%	0	

Table 76. Scraper-plane (Core) Frequency Width/Thickness Ratio, N=137.

	Frequency	0	10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.2 :	0.0%	0	
0.2 - 0.4 :	0.0%	0	
0.4 - 0.6 :	0.0%	0	
0.6 - 0.8 :	1.5%	2	**
0.8 - 1.0 :	3.6%	5	*****
1.0 - 1.2 :	9.5%	13	*************
1.2 - 1.4 :	11.7%	16	****************
1.4 - 1.6 :	16.8%	23	***********************
1.6 - 1.8 :	16.1%	22	**********************
1.8 - 2.0 :	10.9%	15	***************
2.0 - 2.2 :	7.3%	10	**********
2.2 - 2.4 :	5.8%	8	********
2.4 - 2.6 :	9.5%	13	*************
2.6 - 2.8 :	2.2%	3	***
2.8 - 3.0 :	2.2%	3	***
3.0 - 3.2 :	1.5%	2	**
3.2 - 3.4 :	0.7%	1	*
3.4 - 3.6 :	0.0%	0	
3.6 - 3.8 :	0.7%	1	*
3.8 - 4.0 :	0.0%	0	

Table 77. Scraper-plane (Core) Frequency for Length/Width Ratio, N=137.

		Frequency	0 10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.1 :	0.0%	0	
0.1 - 0.2 :	0.0%	0	
0.2 - 0.3 :	0.7%	1	*
0.3 - 0.4 :	0.0%	0	
0.4 - 0.5 :	0.0%	0	
0.5 - 0.6 :	4.4%	6	******
0.6 - 0.7 :	10.9%	15	***************
0.7 - 0.8 :	13.1%	18	******************
0.8 - 0.9 :	24.8%	34	**********************>>>
0.9 - 1.0 :	8.8%	12	************
1.0 - 1.1 :	14.6%	20	********************
1.1 - 1.2 :	5.8%	8	********
1.2 - 1.3 :	7.3%	10	**********
1.3 - 1.4 :	5.1%	7	*******
1.4 - 1.5 :	0.7%	1	*
1.5 - 1.6 :	1.5%	2	**
1.6 - 1.7 :	0.7%	1	*
1.7 - 1.8 :	1.5%	2	**
1.8 - 1.9 :	0.0%	0	
1.9 - 2.0 :	0.0%	0	

Table 78. Scraper-plane (Flake) Frequency for Length, N=48.

		Frequency	0 10 20
Missing or < 3.0 :	0.0%	0	
3.0 - 3.6 :	2.1%	1	*
3.6 - 4.2 :	2.1%	1	*
4.2 - 4.8 :	10.4%	5	*****
4.8 - 5.4 :	16.7%	8	********
5.4 - 6.0 :	22.9%	11	***********
6.0 - 6.6 :	6.3%	3	***
6.6 - 7.2 :	12.5%	6	******
7.2 - 7.8 :	14.6%	7	*******
7.8 - 8.4 :	4.2%	2	**
8.4 - 9.0 :	4.2%	2	**
9.0 - 9.6 :	4.2%	2	**

Table 79. Scraper-plane (Flake) Frequency for Width, N=48.

	Frequency	0 10 20	
Missing or < 3.0 :	0.0%	0	
3.0 - 3.5 :	2.1%	1	*
3.5 - 4.0 :	0.0%	0	
4.0 - 4.5 :	6.3%	3	***
4.5 - 5.0 :	12.5%	6	******
5.0 - 5.5 :	20.8%	10	**********
5.5 - 6.0 :	12.5%	6	******
6.0 - 6.5 :	16.7%	8	********
6.5 - 7.0 :	10.4%	5	*****
7.0 - 7.5 :	14.6%	7	*******
7.5 - 8.0 :	0.0%	0	
8.0 - 8.5 :	0.0%	0	
8.5 - 9.0 :	2.1%	1	*

Table 80. Scraper-plane (Flake) Frequency for Thickness, N=48.

	Frequency	0 10 20	
Missing or < 1.0 :	0.0%	0	
1.0 - 1.3 :	0.0%	0	
1.3 - 1.6 :	2.1%	1	*
1.6 - 1.9 :	6.3%	3	***
1.9 - 2.2 :	8.3%	4	****
2.2 - 2.5 :	22.9%	11	***********
2.5 - 2.8 :	14.6%	7	*******
2.8 - 3.1 :	10.4%	5	*****
3.1 - 3.4 :	22.9%	11	***********
3.4 - 3.7 :	6.3%	3	***
3.7 - 4.0 :	2.1%	1	*
4.0 - 4.3 :	2.1%	1	*
4.3 - 4.6 :	0.0%	0	
4.6 - 4.9 :	2.1%	1	*

Table 81. Scraper-plane (Flake) Frequency for Weight, N=48.

	Frequency		0 10 20
Missing or < 20.0	0.0%	0	
20.0 - 45.0	10.4%	5	*****
45.0 - 70.0	18.8%	9	*********
70.0 - 95.0	20.8%	10	**********
95.0 - 120.0	20.8%	10	**********
120.0 - 145.0	10.4%	5	*****
145.0 - 170.0	4.2%	2	**
170.0 - 195.0	8.3%	4	****
195.0 - 220.0	4.2%	2	**
220.0 - 245.0	2.1%	1	*
245.0 - 270.0	0.0%	0	

Table 82. Scraper-plane (Flake) Frequency for Length/Width Ratio, N=48.

	Frequency		0 10 20 30
Missing or < 0.0	0.0%	0	
0.0 - 0.1	0.0%	0	
0.1 - 0.2	0.0%	0	
0.2 - 0.3	0.0%	0	
0.3 - 0.4	0.0%	0	
0.4 - 0.5	0.0%	0	
0.5 - 0.6	2.1%	1	*
0.6 - 0.7	4.2%	2	**
0.7 - 0.8	6.3%	3	***
0.8 - 0.9	18.8%	9	*********
0.9 - 1.0	8.3%	4	****
1.0 - 1.1	16.7%	8	********
1.1 - 1.2	14.6%	7	*******
1.2 - 1.3	12.5%	6	******
1.3 - 1.4	6.3%	3	***
1.4 - 1.5	6.3%	3	***
1.5 - 1.6	4.2%	2	**
1.6 - 1.7	0.0%	0	
1.7 - 1.8	0.0%	0	
1.8 - 1.9	0.0%	0	
1.9 - 2.0	0.0%	0	

Table 83. Scraper-plane (Flake) Frequency for Length/Width* Thickness Ratio, N=48.

	Frequency		0 10 20 30
Missing or < 0.0 :	0.0%	0	
0.0 - 0.5 :	0.0%	0	
0.5 - 1.0 :	0.0%	0	
1.0 - 1.5 :	4.2%	2	**
1.5 - 2.0 :	14.6%	7	*******
2.0 - 2.5 :	33.3%	16	****************
2.5 - 3.0 :	4.2%	2	**
3.0 - 3.5 :	14.6%	7	*******
3.5 - 4.0 :	10.4%	5	*****
4.0 - 4.5 :	8.3%	4	****
4.5 - 5.0 :	6.3%	3	***
5.0 - 5.5 :	2.1%	1	*
5.5 - 6.0 :	0.0%	0	
6.0 - 6.5 :	2.1%	1	*
6.5 - 7.0 :	0.0%	0	

Table 84. Scraper-plane (Flake) Frequency for Width/Thickness Ratio, N-48.

	Frequency		0 10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.2 :	0.0%	0	
0.2 - 0.4 :	0.0%	0	
0.4 - 0.6 :	0.0%	0	
0.6 - 0.8 :	0.0%	0	
0.8 - 1.0 :	2.1%	1	*
1.0 - 1.2 :	0.0%	0	
1.2 - 1.4 :	0.0%	0	
1.4 - 1.6 :	10.4%	5	*****
1.6 - 1.8 :	0.0%	0	
1.8 - 2.0 :	16.7%	8	********
2.0 - 2.2 :	18.8%	9	*********
2.2 - 2.4 :	22.9%	11	***********
2.4 - 2.6 :	6.3%	3	***
2.6 - 2.8 :	10.4%	5	*****
2.8 - 3.0 :	4.2%	2	**
3.0 - 3.2 :	2.1%	1	*
3.2 - 3.4 :	2.1%	1	*
3.4 - 3.6 :	2.1%	1	*
3.6 - 3.8 :	2.1%	1	*
3.8 - 4.0 :	0.0%	0	

Table 85. Edge-ground Cobble Frequency for Length, N=49.

		Frequency	0 10 20 30
Missing or < 7.0	0.0%	0	
7.0 - 8.5	2.0%	1	*
8.5 - 10.0	14.3%	7	*******
10.0 - 11.5	26.5%	13	*************
11.5 - 13.0	26.5%	13	*************
13.0 - 14.5	16.3%	8	********
14.5 - 16.0	8.2%	4	****
16.0 - 17.5	2.0%	1	*
17.5 - 19.0	2.0%	1	*
19.0 - 20.5	2.0%	1	*
20.5 - 22.0	0.0%	0	

Table 86. Edge-ground Cobble Frequency for Width, N=49.

		Frequency	0 10 20
Missing or < 4.0	0.0%	0	
4.0 - 5.1	2.0%	1	*
5.1 - 6.2	28.6%	14	**************
6.2 - 7.3	24.5%	12	************
7.3 - 8.4	20.4%	10	**********
8.4 - 9.5	12.2%	6	******
9.5 - 10.6	4.1%	2	**
10.6 - 11.7	4.1%	2	**
11.7 - 12.8	4.1%	2	**
12.8 - 13.9	0.0%	0	
13.9 - 15.0	0.0%	0	

Table 87. Edge-ground Cobble Frequency for Thickness, N=49.

	Frequency	0 10 20
Missing or < 2.0 :	0.0%	0
2.0 - 2.9 :	0.0%	0
2.9 - 3.8 :	4.1%	2 **
3.8 - 4.7 :	32.7%	16 ****************
4.7 - 5.6 :	36.7%	18 ******************
5.6 - 6.5 :	14.3%	7 *******
6.5 - 7.4 :	6.1%	3 ***
7.4 - 8.3 :	4.1%	2 **
8.3 - 9.2 :	2.0%	1 *
9.2 - 10.1 :	0.0%	0
10.1 - 11.0 :	0.0%	0

Table 88. Edge-ground Cobble Frequency for Weight, N=49.

	Frequency	0 10 20
Missing or < 250.0 :	0.0%	0
250.0 - 400.0 :	10.2%	5 *****
400.0 - 550.0 :	20.4%	10 **********
550.0 - 700.0 :	24.5%	12 ************
700.0 - 850.0 :	16.3%	8 ********
850.0 - 1000.0 :	10.2%	5 *****
1000.0 - 1150.0 :	10.2%	5 *****
1150.0 - 1300.0 :	0.0%	0
1300.0 - 1450.0 :	0.0%	0
1450.0 - 1600.0 :	2.0%	1 *
1600.0 - 1750.0 :	2.0%	1 *
1750.0 - 1900.0 :	0.0%	0
1900.0 - 2050.0 :	0.0%	0
2050.0 - 2200.0 :	0.0%	0
2200.0 - 2350.0 :	2.0%	1 *
2350.0 - 2500.0 :	0.0%	0
2500.0 - 2650.0 :	2.0%	1 *

Table 89. Edge-ground Cobble Frequency for Length/Width Ratio, N=49.

	Frequency	0 10 20
Missing or < 0.0 :	0.0%	0
0.0 - 0.2 :	0.0%	0
0.2 - 0.4 :	0.0%	0
0.4 - 0.6 :	0.0%	0
0.6 - 0.8 :	0.0%	0
0.8 - 1.0 :	2.0%	1 *
1.0 - 1.2 :	4.1%	2 **
1.2 - 1.4 :	8.2%	4 ****
1.4 - 1.6 :	26.5%	13 *************
1.6 - 1.8 :	26.5%	13 *************
1.8 - 2.0 :	14.3%	7 *******
2.0 - 2.2 :	14.3%	7 *******
2.2 - 2.4 :	4.1%	2 **
2.4 - 2.6 :	0.0%	0
2.6 - 2.8 :	0.0%	0
2.8 - 3.0 :	0.0%	0

Table 90. Edge-ground Cobble Frequency for Length/Width * Thickness Ratio, N=49.

	Frequency	0 10 20
Missing or < 0.0 :	0.0%	0
0.0 - 1.2 :	0.0%	0
1.2 - 2.4 :	0.0%	0
2.4 - 3.6 :	0.0%	0
3.6 - 4.8 :	4.1%	2 **
4.8 - 6.0 :	6.1%	3 ***
6.0 - 7.2 :	14.3%	7 *******
7.2 - 8.4 :	20.4%	10 **********
8.4 - 9.6 :	18.4%	9 *********
9.6 - 10.8 :	20.4%	10 **********
10.8 - 12.0 :	12.2%	6 ******
12.0 - 13.2 :	2.0%	1 *
13.2 - 14.4 :	2.0%	1 *
14.4 - 15.6 :	0.0%	0
15.6 - 16.8 :	0.0%	0
16.8 - 18.0 :	0.0%	0
18.0 - 19.2 :	0.0%	0
19.2 - 20.4 :	0.0%	0
20.4 - 21.6 :	0.0%	0
21.6 - 22.8 :	0.0%	0
22.8 - 24.0 :	0.0%	0

Table 91. Edge-ground Cobble Frequency for Width/Thickness Ratio, N=49.

	Frequency		0 10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.3 :	0.0%	0	
0.3 - 0.6 :	0.0%	0	
0.6 - 0.9 :	0.0%	0	
0.9 - 1.2 :	16.3%	8	********
1.2 - 1.5 :	44.9%	22	**********************
1.5 - 1.8 :	30.6%	15	***************
1.8 - 2.1 :	4.1%	2	**
2.1 - 2.4 :	4.1%	2	**
2.4 - 2.7 :	0.0%	0	
2.7 - 3.0 :	0.0%	0	

Table 92. Breadboard Metate Frequency for Body Height, N=25.

	Frequency		0 10 20
Missing or < 1.0 :	0.0%	0	
1.0 - 1.2 :	0.0%	0	
1.2 - 1.4 :	0.0%	0	
1.4 - 1.6 :	0.0%	0	
1.6 - 1.8 :	16.0%	4	****
1.8 - 2.0 :	20.0%	5	*****
2.0 - 2.2 :	24.0%	6	******
2.2 - 2.4 :	20.0%	5	*****
2.4 - 2.6 :	16.0%	4	****
2.6 - 2.8 :	0.0%	0	
2.8 - 3.0 :	4.0%	1	*
3.0 - 3.2 :	0.0%	0	

Table 93. Breadboard Metate Frequency for Rim Height, N=25.

	Frequency		0 10 20
Missing or < 0.0	0.0%	0	
0.0 - 0.2	0.0%	0	
0.2 - 0.4	32.0%	8	********
0.4 - 0.6	48.0%	12	************
0.6 - 0.8	16.0%	4	****
0.8 - 1.0	4.0%	1	*
1.0 - 1.2	0.0%	0	
1.2 - 1.4	0.0%	0	
1.4 - 1.6	0.0%	0	
1.6 - 1.8	0.0%	0	
1.8 - 2.0	0.0%	0	

Table 94. Breadboard Metate Frequency for Rim Width, N=25.

	Frequency		0 10 20
Missing or < 1.0	0.0%	0	
1.0 - 1.5	20.0%	5	*****
1.5 - 2.0	40.0%	10	**********
2.0 - 2.5	24.0%	6	******
2.5 - 3.0	8.0%	2	**
3.0 - 3.5	4.0%	1	*
3.5 - 4.0	4.0%	1	*
4.0 - 4.5	0.0%	0	
4.5 - 5.0	0.0%	0	
5.0 - 5.5	0.0%	0	
5.5 - 6.0	0.0%	0	

Table 95. Breadboard Metate Frequency for Rim to Body Height Ratio, N=27.

	Frequency	0	10 20 30
Missing or < 0.0 :	0.0%	0	
0.0 - 0.1 :	7.4%	2	**
0.1 - 0.2 :	37.0%	10	**********
0.2 - 0.3 :	37.0%	10	**********
0.3 - 0.4 :	14.8%	4	****
0.4 - 0.5 :	3.7%	1	*
0.5 - 0.6 :	0.0%	0	
0.6 - 0.7 :	0.0%	0	
0.7 - 0.8 :	0.0%	0	
0.8 - 0.9 :	0.0%	0	
0.9 - 1.0 :	0.0%	0	

Table 96. Mano (Bar) Frequency for Width, N=16.

	Frequency	0	10 20
Missing or < 4.0 :	0.0%	0	
4.0 - 4.3 :	0.0%	0	
4.3 - 4.6 :	6.3%	1	*
4.6 - 4.9 :	6.3%	1	*
4.9 - 5.2 :	12.5%	2	**
5.2 - 5.5 :	18.8%	3	***
5.5 - 5.8 :	37.5%	6	******
5.8 - 6.1 :	6.3%	1	*
6.1 - 6.4 :	12.5%	2	**
6.4 - 6.7 :	0.0%	0	

Table 97. Mano (Bar) Frequency for Thickness, N=16.

	Frequency	0 10 20	
Missing or < 1.5 :	0.0%	0	
1.5 - 1.9 :	0.0%	0	
1.9 - 2.3 :	6.3%	1	*
2.3 - 2.7 :	6.3%	1	*
2.7 - 3.1 :	6.3%	1	*
3.1 - 3.5 :	0.0%	0	
3.5 - 3.9 :	6.3%	1	*
3.9 - 4.3 :	37.5%	6	******
4.3 - 4.7 :	31.3%	5	*****
4.7 - 5.1 :	0.0%	0	
5.1 - 5.5 :	6.3%	1	*

Table 98. Mano (Other) Frequency for Width, N=47.

	Frequency	0 10 20	
Missing or < 0.0 :	2.1%	1	*
0.0 - 1.1 :	0.0%	0	
1.1 - 2.2 :	2.1%	1	*
2.2 - 3.3 :	0.0%	0	
3.3 - 4.4 :	2.1%	1	*
4.4 - 5.5 :	10.6%	5	*****
5.5 - 6.6 :	25.5%	12	************
6.6 - 7.7 :	17.0%	8	********
7.7 - 8.8 :	10.6%	5	*****
8.8 - 9.9 :	8.5%	4	****
9.9 - 11.0 :	12.8%	6	******
11.0 - 12.1 :	6.4%	3	***
12.1 - 13.2 :	0.0%	0	

Table 99. Mano (Other) Frequency for Thickness, N=47.

	Frequency	0 10 20	
Missing or < 0.0 :	2.1%	1	*
0.0 - 0.6 :	0.0%	0	
0.6 - 1.2 :	2.1%	1	*
1.2 - 1.8 :	0.0%	0	
1.8 - 2.4 :	2.1%	1	*
2.4 - 3.0 :	4.3%	2	**
3.0 - 3.6 :	12.8%	6	******
3.6 - 4.2 :	10.6%	5	*****
4.2 - 4.8 :	23.4%	11	***********
4.8 - 5.4 :	19.1%	9	*********
5.4 - 6.0 :	6.4%	3	***
6.0 - 6.6 :	14.9%	7	*******
6.6 - 7.2 :	2.1%	1	*

Table 100. Pear-shaped Celt Frequency for Bit Width, N=35.

	Frequency	0 10 20	
Missing or < 3.5 :	0.0%	0	
3.5 - 4.2 :	5.7%	2	**
4.2 - 4.9 :	14.3%	5	*****
4.9 - 5.6 :	25.7%	9	*********
5.6 - 6.3 :	22.9%	8	********
6.3 - 7.0 :	14.3%	5	*****
7.0 - 7.7 :	11.4%	4	****
7.7 - 8.4 :	5.7%	2	**
8.4 - 9.1 :	0.0%	0	
9.1 - 9.8 :	0.0%	0	
9.8 - 10.5 :	0.0%	0	

Table 101. Pear-shaped Celt Frequency for Bit Thickness, N=26.

	Frequency	0	10 20 30
Missing or < 0.5	0.0%	0	
0.5 - 0.7	0.0%	0	
0.7 - 0.9	3.8%	1	*
0.9 - 1.1	19.2%	5	*****
1.1 - 1.3	50.0%	13	*************
1.3 - 1.5	11.5%	3	***
1.5 - 1.7	11.5%	3	***
1.7 - 1.9	0.0%	0	
1.9 - 2.1	3.8%	1	*
2.1 - 2.3	0.0%	0	
2.3 - 2.5	0.0%	0	

Table 102. Pear-shaped Celt Frequency for Butt Width, N=44.

	Frequency	0	10 20 30
Missing or < 0.5	0.0%	0	
0.5 - 0.8	0.0%	0	
0.8 - 1.1	2.3%	1	*
1.1 - 1.4	11.4%	5	*****
1.4 - 1.7	15.9%	7	*******
1.7 - 2.0	22.7%	10	**********
2.0 - 2.3	20.5%	9	*********
2.3 - 2.6	11.4%	5	*****
2.6 - 2.9	9.1%	4	****
2.9 - 3.2	6.8%	3	***
3.2 - 3.5	0.0%	0	

Table 103. Pear-shaped Celt Frequency for Butt Thickness, N=46.

	Frequency	0	10	20
Missing or < 0.3	0.0%	0		
0.3 - 0.6	15.2%	7	*******	
0.6 - 0.9	23.9%	11	***********	
0.9 - 1.2	21.7%	10	**********	
1.2 - 1.5	19.6%	9	*********	
1.5 - 1.8	13.0%	6	******	
1.8 - 2.1	4.3%	2	**	
2.1 - 2.4	2.2%	1	*	
2.4 - 2.7	0.0%	0		
2.7 - 3.0	0.0%	0		
3.0 - 3.3	0.0%	0		

Table 104. Pear-shaped Celt Frequency for Bit Width/Bit Thickness Ratio, N=24.

	Frequency	0	10	20
Missing or < 0.0	0.0%	0		
0.0 - 0.5	0.0%	0		
0.5 - 1.0	0.0%	0		
1.0 - 1.5	0.0%	0		
1.5 - 2.0	0.0%	0		
2.0 - 2.5	0.0%	0		
2.5 - 3.0	0.0%	0		
3.0 - 3.5	0.0%	0		
3.5 - 4.0	20.8%	5	*****	
4.0 - 4.5	20.8%	5	*****	
4.5 - 5.0	29.1%	7	*******	
5.0 - 5.5	12.5%	3	***	
5.5 - 6.0	8.3%	2	**	
6.0 - 6.5	4.1%	1	*	
6.5 - 7.0	4.1%	1	*	

Table 105. Pear-shaped Celt Frequency for Butt Width/Butt Thickness Ratio, N=43.

	Frequency	0 10 20
Missing or < 0.0 :	0.0%	0
0.0 - 0.3 :	0.0%	0
0.3 - 0.6 :	0.0%	0
0.6 - 0.9 :	0.0%	0
0.9 - 1.2 :	2.3%	1 *
1.2 - 1.5 :	18.6%	8 ********
1.5 - 1.8 :	27.9%	12 ************
1.8 - 2.1 :	16.2%	7 *******
2.1 - 2.4 :	16.2%	7 *******
2.4 - 2.7 :	9.3%	4 ****
2.7 - 3.0 :	4.6%	2 **
3.0 - 3.3 :	2.3%	1 *
3.3 - 3.6 :	2.3%	1 *
3.6 - 3.9 :	0.0%	0
3.9 - 4.2 :	0.0%	0
4.2 - 4.5 :	0.0%	0

Table 106. Trapezoidal Celt Frequency for Bit Width, N=23.

	Frequency	0 10 20 30
Missing or < 3.0 :	0.0%	0
3.0 - 3.5 :	4.3%	1 *
3.5 - 4.0 :	0.0%	0
4.0 - 4.5 :	17.4%	4 ****
4.5 - 5.0 :	30.4%	7 *******
5.0 - 5.5 :	21.7%	5 *****
5.5 - 6.0 :	8.7%	2 **
6.0 - 6.5 :	13.0%	3 ***
6.5 - 7.0 :	0.0%	0
7.0 - 7.5 :	0.0%	0
7.5 - 8.0 :	0.0%	0

Table 107. Trapezoidal Celt Frequency for Bit Thickness, N=19.

	Frequency	0	10 20 30
Missing or < 0.5 :	0.0%	0	
0.5 - 0.7 :	0.0%	0	
0.7 - 0.9 :	5.3%	1	*
0.9 - 1.1 :	21.1%	4	****
1.1 - 1.3 :	31.6%	6	******
1.3 - 1.5 :	15.8%	3	***
1.5 - 1.7 :	10.5%	2	**
1.7 - 1.9 :	5.3%	1	*
1.9 - 2.1 :	5.3%	1	*
2.1 - 2.3 :	0.0%	0	
2.3 - 2.5 :	0.0%	0	

Table 108. Trapezoidal Celt Frequency for Butt Width, N=14.

	Frequency	0	10 20 30
Missing or < 1.0 :	0.0%	0	
1.0 - 1.4 :	0.0%	0	
1.4 - 1.8 :	7.1%	1	*
1.8 - 2.2 :	28.6%	4	****
2.2 - 2.6 :	21.4%	3	***
2.6 - 3.0 :	21.4%	3	***
3.0 - 3.4 :	7.1%	1	*
3.4 - 3.8 :	14.3%	2	**
3.8 - 4.2 :	0.0%	0	
4.2 - 4.6 :	0.0%	0	
4.6 - 5.0 :	0.0%	0	

Table 109. Trapezoidal Celt Frequency for Butt Thickness, N=15.

```
                    Frequency   0         10         20         30

    Missing or < 0.6 :  0.0%     0
           0.6 - 0.8 :  0.0%     0
           0.8 - 1.0 :  6.7%     1  *
           1.0 - 1.2 : 20.0%     3  ***
           1.2 - 1.4 : 20.0%     3  ***
           1.4 - 1.6 : 13.3%     2  **
           1.6 - 1.8 : 13.3%     2  **
           1.8 - 2.0 : 26.7%     4  ****
           2.0 - 2.2 :  0.0%     0
```

Table 110. Trapezoidal Celt Frequency for Bit Width/Bit Thickness Ratio, N=19.

```
                    Frequency   0         10         20

    Missing or < 0.0 :  0.0%     0
           0.0 - 0.6 :  0.0%     0
           0.6 - 1.2 :  5.2%     1  *
           1.2 - 1.8 :  0.0%     0
           1.8 - 2.4 :  0.0%     0
           2.4 - 3.0 : 10.5%     2  **
           3.0 - 3.6 : 21.0%     4  ****
           3.6 - 4.2 : 26.3%     5  *****
           4.2 - 4.8 : 21.0%     4  ****
           4.8 - 5.4 :  5.2%     1  *
           5.4 - 6.0 :  5.2%     1  *
           6.0 - 6.6 :  5.2%     1  *
           6.6 - 7.2 :  0.0%     0
```

Table 111. Trapezoidal Celt Frequency for Butt Width/Butt Thickness Ratio, N=14.

	Frequency	0	10 20
Missing or < 0.0 :	0.0%	0	
0.0 - 0.3 :	0.0%	0	
0.3 - 0.6 :	0.0%	0	
0.6 - 0.9 :	0.0%	0	
0.9 - 1.2 :	14.2%	2	**
1.2 - 1.5 :	14.2%	2	**
1.5 - 1.8 :	35.7%	5	*****
1.8 - 2.1 :	14.2%	2	**
2.1 - 2.4 :	7.1%	1	*
2.4 - 2.7 :	7.1%	1	*
2.7 - 3.0 :	0.0%	0	
3.0 - 3.3 :	7.1%	1	*
3.3 - 3.6 :	0.0%	0	

APPENDIX C

Faunal Identifications and Quantifications

Table 112. 70S169E Unit, Faunal # Individual Specimens (NISP), and Skeletal Weight.

Species	#	Skeletal Weight (in grams)
	NON-FISH	
Bird	1	.3
Carnivore	1	.2
Crab	2	.3
Homo Sapiens	6 frags/2 teeth	.9
Odocoileus spp	8	13.9
Reptile unident.	1	.2
turtle	1	.3
Chelonia	10	9.3
Lacertilia	1	.1
Kinosternon	1	.2
Anura	1	> .1
Rodent (small)	1	.1
Prob.mammal (lge)	65	34.3
Prob. mammal	139	16.3
Bits, non-fish	326	23.3
Bits, unident., (non-fish prob)	216	7.9
Tiny frags., (prob. mammal)	16	.9
	FISH	
Ariidae otoliths	43	11.5
skull	331	37.55
spines	175	15.1
vertebrae	330	23.2
	879	87.25
Batrachoides	9	.5
Belonidae	1	.05
Carangidae		
Vomer/Selene		
pterigiophores	245	4.8
facial	7	1.1
Carangid vert.	44	6.25
Centropomus		
assorted	6	1.7
	302	13.85
Clupeidae		
assorted	7	7.7
Pomadasyidae		
supraethmoides	2	.35

Sciaenidae		
vertebra	1	.5
otoliths	6	1.3
tooth	1	.05
	8	1.85
Shark	27	4.1
Tetraodontidae		
head/vertebrae	73	15.7
Unident		
skull/spine	2196	98.3
vertebrae	1597	64.3
	3793	162.6

PARTIAL SHELL LIST
(0-5 CM BS)

Anadara grandis	60.9
" *tuberculosa*	26.8
Cerithidea valida	1.4
Chione subrugosa	69.0
Donax asper	2.5
Dosinia dunkeri	10.7
Mactra fonsecana	.5
Malea ringens	32.6
Nassarius luteostoma	.9
Natica unifasciata	235.6
Ostrea spp	174.8
Pitar tortuosus	9.1
Polinices uber	22.1
Protothaca asperrima	136.3
Tellina laceridens	11.0
Thais biserialis	48.3
" *kiosquiformis*	68.9
Tivela byronensis	4.2
Unidentified	46.8
	962.4