MIMBRES PAINTED POTTERY,A STUDY IN NUMERICAL TAXONOMY.

A thesis

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by James Light

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Master of Arts

in Anthropology

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A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF ARTS

ABSTRACT

This thesis includes a review of some important points concerning archaeological taxonomy and concludes that taxonomy has been poorly understood by some proponents of the "new archaeology" (e.g. Hill and Evans 1972). Using concepts from the general field of numerical taxonomy, the purposes and desirable attributes of archaeological taxonomies are defined. It is proposed that "natural" taxonomies based on large numbers of attributes, analysed with equal weight by numerical techniques will yield typologies more useful for hypothesis generation and testing than arbitrary, single purpose typologies designed solely for testing specific hypotheses.

As an example of the proposed use of numerically produced, natural taxonomy, the Mogollon Black-on-white ceramic typology is reviewed and found to be inadequate in terms of objective type definition. The painted ceramics from the Galaz site, New Mexico (LA635), are analysed with two methods of cluster analysis, a divisive procedure and a relocation procedure, and with contingency table analysis to develop a more objective natural classification. The resultant types are validated by testing them against three independent provenience variables. The typology produced is quite similar to the traditional typology, but several traits suggested to be important by Cosgrove and Cosgrove (1932) and LeBlanc (1977) are shown to be non-diagnostic.

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INTRODUCTION

Past experiences in pottery analysis have convinced me that attempts to create ceramic taxonomies, and to infer social organization from the ceramic data, were seriously hampered by the kind of data that had been used in the past, that is, sherd samples (Deetz 1965, Hill 1970, Longacre 1970). As well, recent statements on archaeological taxonomy seem designed to change our taxonomic systems into narrow, single-purpose tools designed for hypothesis testing only, rather than the broader, more powerful tool that taxonomy has been shown to be in other disciplines. Therefore, I will demonstrate that, contrary to recent opinion, general typological systems can be of use in a wide variety of problems, especially in determining data patterns, and in hypothesis generation. To do this I will employ techniques of numerical taxonomy to test the traditional Mogollon Black-on-white typology.

Fortunately, I was able to obtain access to the ceramic collection from the Galaz Site, a Late Mogollon village in southwestern New Mexico (see Figure 1). This material was excavated in the 1929,1930,and 1931 field seasons by A. E. Jenks, and has been stored at the University of Minnesota unanalysed for the intervening fifty years. The collection consists of almost 1000 complete pots and many thousands of sherds.

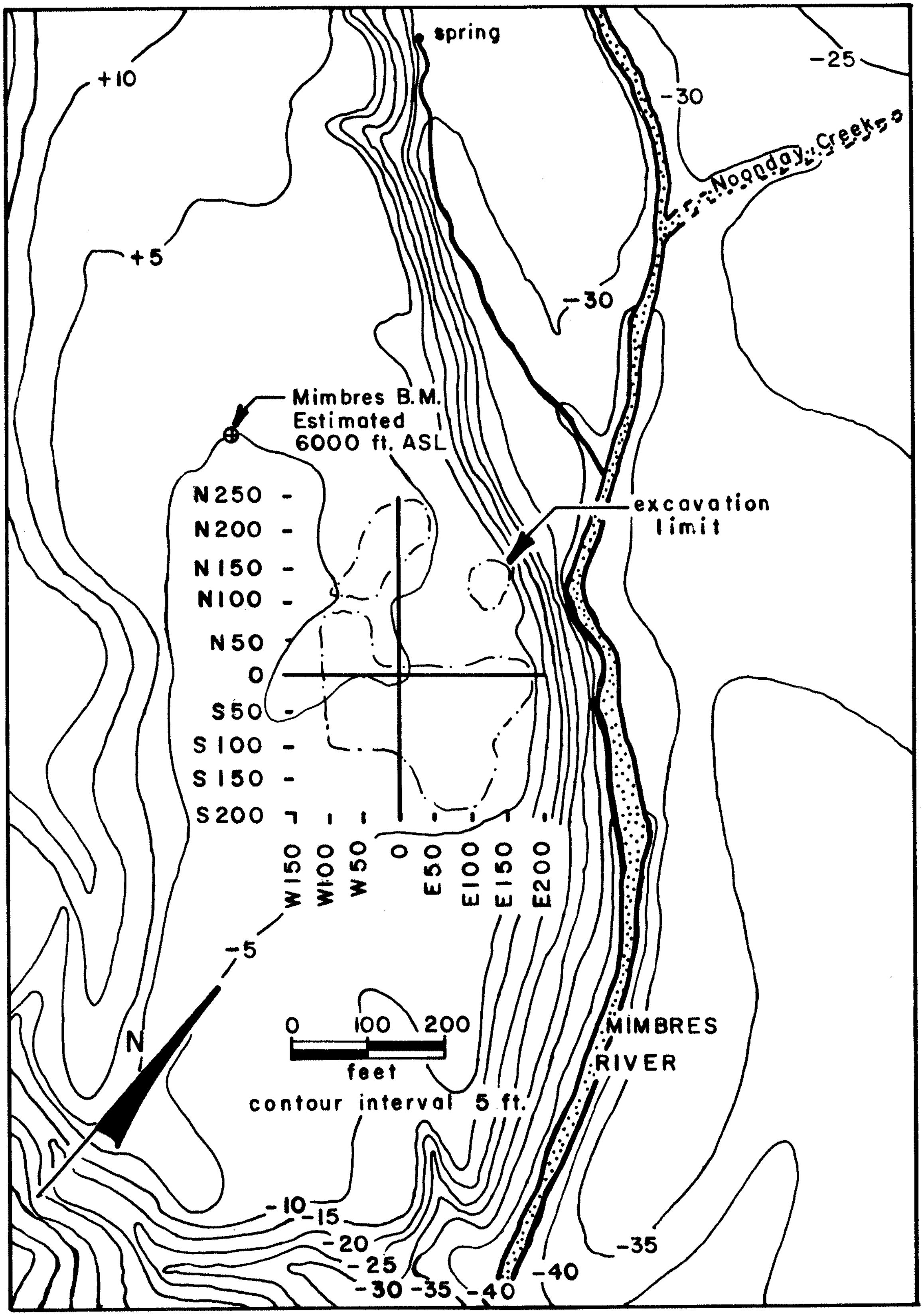


Figure 1: The Galaz site, New Mexico (LA635)

The Mogollon is one of the four main cultural groups which have been identified in the southwest area (see Figure 2). It is found mainly in southwest New Mexico, although it spills over into Arizona and northern Mexico. It has been divided into the Early Pithouse Period, the Late Pithouse Period, and the Surface or Classic Period. This development occured from approximately A.D. 600 to A.D. 1150, at which time the area was abandoned, for reasons unknown at this time (Haury 1936; Wheat 1955; LeBlanc and Whalen 1980). During this time the Mogollon peoples developed a unique black-on-white painted pottery with complex geometric designs, as well as realistic human and animal figures. These Black-on-white wares were first described in detail by H. S. and C. B. Cosgrove in their report on the excavations at the Swarts Ruin (1932:72:76).

J. J. Brody's recent book, Mimbres Painted Pottery (1977), provides some indication of the confused state of the Black-on-white typology in the Mimbres area. His descriptions (as well as those of many other researchers) are rife with vague terms which make accurate identification of Black-on-white types difficult. For example, Boldface Black-on-white "...merges with Mimbres Black-on-white. Visual differences between the two are often subtle and a matter of degree" (Brody 1977:84-85). He continues, saying that Boldface paintings are "not usually" as fine as the Mimbres, which are "usually more precise and have a much greater interplay of darks and lights" (Brody 1977:85). The

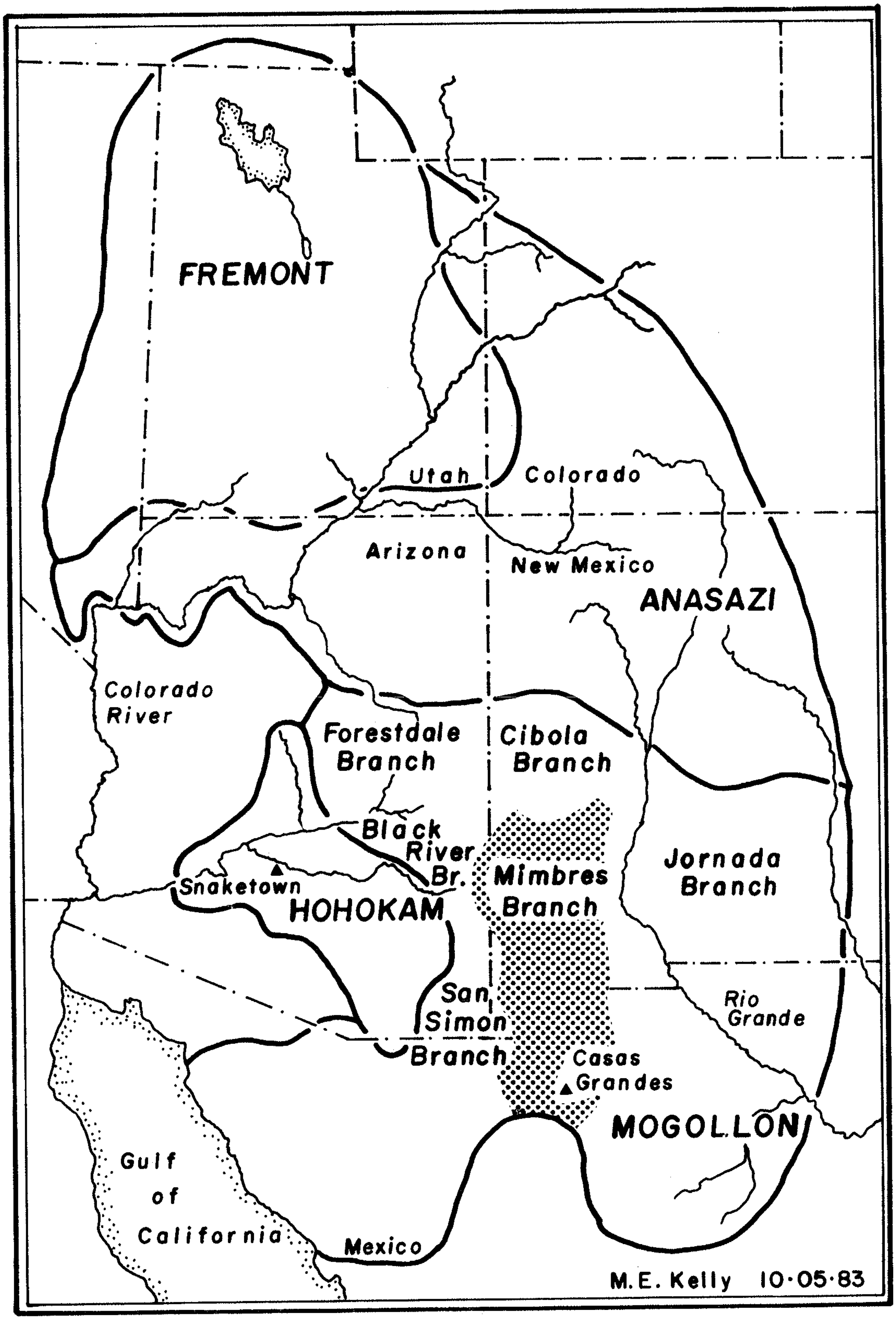


Figure 2: Southwest Culture areas (after Brody 1977).

confusion becomes even greater when we find that Boldface designs are indistinguishable from those on the earlier Three Circle Red-on-white pottery of the Late Pithouse period. Early examples of Boldface are only distinguishable by paste and slip colour, and because firing conditions are so variable even these are not consistent (Brody 1977:83).

What we see concerning the Late Pithouse and Surface Pueblo period painted ceramics, is that there is a continuous development of design elements, with few morphological changes. As Brody says: "Around the end of the tenth and beginning of the eleventh centuries they [Boldface and Classic Mimbres] were for all practical purposes identical" (1977:86). The painted designs, in contrast to the morphology, show a much larger range of variation, and thus have the potential for greater division into useful units. Even so, it is possible that there are no clear divisions, as Brody says in regard to Mimbres figurative paintings: so far as we know "any single figure or vignetted picture might have been made at any point on the [two hundred year] continuum" (1977:83).

The Mogollon black-on-white taxonomy also suffers from a lack of any theoretical guidance in its creation and use. Hill and Evans (1972) have suggested that there is a fundamental dichotomy between the approaches of the "empiricists" (old archaeologists) and the "positivists" (new archaeologists), when it comes to typology. They claim that empiricists believe that their types have inherent meaning, while positivists define the meaning of types in terms of theory and hypotheses, and that there is no meaning inherent in types or type systems. They suggest, therefore, that taxonomies are only useful when they are used as tests for specific hypotheses. I do not deny that taxonomic systems can be used in such a fashion. However, I will try to demonstrate that general, multipurpose taxonomies are not only possible, but that they are more useful. Further, I hope to show that such typologies do not do violence to a proper scientific method, as Hill and Evans suggest (1972).

In Chapters 3 and 4 there will be a discussion of what is the proper range of purposes for taxonomic systems. Much of this will be based upon recent advances in taxonomic techniques in the biological sciences. Sokal and Sneath (1973) have dealt in depth with biological problems, but have also dealt with the application of these techniques to other allied and non-allied disciplines. Using definitions of taxonomic procedure developed from this source, as well as from a number of archaeological sources (Redman 1978, Hill and Evans 1972, Spaulding 1953, Krieger 1944, Binford 1968), a technique of analysis will be developed which will, it is hoped, avoid the problems of the current Mogollon Black-on-white typology.

Chapter 2 contains a brief account of the current state of our knowlege of Mogollon prehistory. Chapter 3 is concerned with the nature of taxonomic systems, and in Chapter 4 the role of taxonomy in a scientific method will be discussed, and a method to implement this will be proposed. Chapter 5 concerns the current Black-on-white type descriptions, and Chapter 6 describes the attributes recorded on the Galaz material. In Chapter 7 the techniques used to reduce the attribute list to only those with useful variation are discussed, and in Chapter 8 the application of two techniques of cluster analysis to these attributes will be discussed. Chapter 9 contains the summary and conclusions.

Chapter 2

MOGOLLON PREHISTORY

Interpretations of Mogollon prehistory have changed radically and continually during the sixty years in which excavations have taken place. The chronology and phase descriptions presented here are largely taken from the work of the Mimbres Foundation, based at the University of New Mexico (LeBlanc 1976,1977; LeBlanc and Whalen 1980). Mogollon prehistory is broken down into three major time periods : the Early Pithouse period, the Late Pithouse period, and the Mimbres or Surface Pueblo period (Leblanc and Whalen 1980). These periods are distinguished by different site complexes, adaptive strategies and population sizes, and in some cases, have been subdivided into phases according to shifts in pottery types, architecture or other artifact types.

The Mogollon culture area was first defined by Emile Haury in 1936. His excavations at Mogollon Village and Harris Village led him to believe that the material found in southwestern New Mexico was sufficiently different from the surrounding Anasazi and Hohokam to warrant the definition of a new cultural tradition. A number of excavations in the Mimbres River valley had been carried out in the twenty years prior to Haury's work: Bradfield at Cameron Creek(1931), Nesbitt at Mattocks Ruin (1931,1938), Cosgrove and Cosgrove at Swartz (1932), but these had made no attempt to place the material in the context of the greater Southwest (see Figure 3).

Continued research in the Southwest has broadened the Mogollon to include most of southern New Mexico, as far east as the Pecos River, portions of east central and southeast Arizona, and perhaps parts of northern Mexico. LeBlanc and Whalen (1980:115) describe the Mogollon area as

> a large northwest-southeast cultural continuum bordered on one side by the Anasazi and on the other by the Hohokam. Along these contact zones, boundaries are fairly distinct with minor overlapping zones or 'hybridization'.

The Mogollon area is itself divided into several subareas which reflect local differentiation in the manifestation of architectural styles, ceramic types, and subsistence patterns.

The Galaz site is located in what has been called the heartland of the Mogollon, the Mimbres River area (see Figure 3). This area seems to have had less contact with outside groups, and thus may exhibit more stable artifact assemblages through time. It is in this area that most of the major village sites are found and where the greatest number of sites have been excavated. Thus, much of the Mogollon chronology and artifact taxonomy is based on sites from this area.

Mogollon culture developed indigenously out of what Willey calls a "Desert food-gathing pattern...that ...was

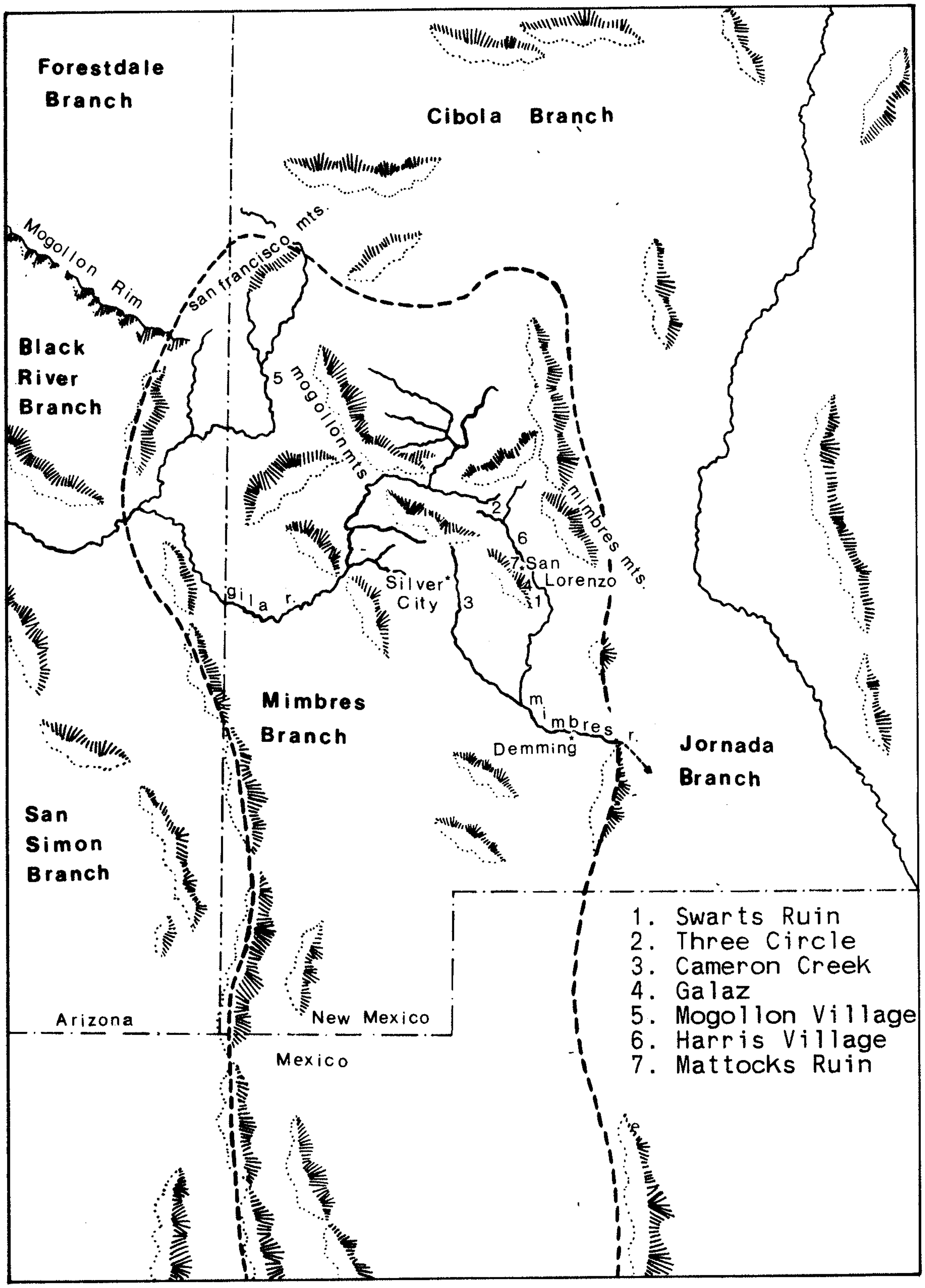


Figure 3: The Mimbres area, with site locator.

established in the Southwest before 5000 B.C. as the Cochise culture" (Willey 1968:181). All of the major subareas of the Southwest seem to have developed from this base, and by A.D. 400 there was "the establishment of successful village agriculture in the Mogollon, Anasazi, and Hohokam subareas" (Willey 1968:186). It is with these fully sedentary agriculturally-based villages that we are concerned here. The details of this development from Early Pithouse Period, to Late Pithouse Period, to Surface Pueblo or Classic Period will be dealt with below. During this development, population in the Mimbres area grew, village size grew, and there was a florescence in painted pottery which culminated in Mogollon Black-on-white ware in the Late Pithouse and Surface Pueblo periods.

The Early Pithouse period began at approximately A.D. 200 and lasted until A.D. 550 (LeBlanc and Whalen 1980:112) (see Table 1). These sites are characterised by their location on relatively inaccessable or isolated spots, often several hundred feet above arable land or water. Corn agriculture was practiced, but hunting and gathering probably played a large part in subsistence procurement, certainly larger than in the subsequent periods. The architecture consisted of round semi-subterranean pit houses, with the presence of some larger structures that were possibly communal in nature. Village size ranged from 1 to 80 pithouses per village. Pottery types were plain wares, with some occurrance of red ware (LeBlanc and Whalen

Table 1: Mogollon chronology, with associated ceramic types.

A.D.	Phases	Phases	Period	Black on White types	
1200					
		Animas			
1100					
	Mimbres	Mimbres	Pueblo	Classic	
1000					
	Three Circle				Transitional
900		Three Circle	Late		
				Bold	
800	San Francisco			Face	
			Pithouse		
700		San Francisco			Mogollon
				San	r-on-b
600		Georgetown		Francisco	
	Georgetown			Red	
500			Early		
400		Cumbres			
300			Pithouse		
	Haury 1936: 123	Anyon + LeBlanc 1978		Leblanc and Whalen 1980	

1980:112).

The Late Pithouse period begins approximately A.D. 550 and lasts till A.D. 950-1000. There is no cultural break or hiatus, even though the isolated locations are abandoned in favour of sites much closer to arable land and water, on river terraces, for example. Pithouse shapes change from round to D-shaped, to subrectangular, and eventually to rectangular. No subsistence changes are evident, but there are enough changes within the period in other characteristics to divide it into three phases: the Georgetown phase, the San Francisco phase, and the Three Circle phase (Haury 1936). Haury based his phase divisions on his excavations at Mogollon village, a small Georgetown and San Francisco phase site about 120 kilometers northwest of the Galaz site and outside the Mimbres Branch; and at the Harris village, a much larger site which has evidence of all three Late Pithouse phases, located about 8 kilometers northwest of Galaz, on the Mimbres River.

The basic descriptions of the phases of the Late Pithouse period have changed little since Haury published them in 1936, but his dates have been modified by modern dating techniques. The Georgetown phase, the earliest of the Late Pithouse period, has been dated by Anyon and LeBlanc at A.D. 550 to A.D. 650 (1980:161), while Haury simply placed it as pre A.D. 800 (Haury 1936:116). This phase is characterized by roughly circular pithouses, sometimes with one flattened side which had an inclined entranceway. Pottery types were mainly plainware and a red type called San Francisco Red.

The San Francisco phase, dated by Anyon and LeBlanc (1980:161) at A.D. 650 to A.D. 750 shows a slight evolution in domestic architecture towards subrectangular pithouses, still with inclined ramp entranceways on the long side. No masonry walling is found in either of these phases. Houses are constructed of adobe plastered on soil from the floor to the original soil level. Pottery types are San Francisco Red and Mogollon Red-on-Brown. All plain wares continue to be produced (Haury 1936:110).

The last Late Pithouse phase is the Three Circle phase, which Anyon and Leblanc date at A.D. 750 to A.D. 1000 (1980:161). Haury dated it as A.D. 900 to A.D. 1000 or shortly after (1936:116). Three Circle phase houses become completely rectangular, with a lateral entranceway. Masonry in whole or in part becomes common. It should be noted that there are several changes in roof supports and form concomitant with the house shape changes. These changes are dealt with in detail by Haury (1936) and Wheat (1955).

Mimbres Boldface Black-on-white pottery first appears in this phase, along with the other types listed for earlier phases (Haury 1936:facing 110). LeBlanc suggests that later in this period a new style developed, which he believes to be transitional between Boldface Black-on-white and Mimbres

Classic Black-on-white (Leblanc 1976:20).

The last Mogollon period in the Mimbres River area is the Mimbres or Surface Pueblo period which LeBlanc (1976) dates at A.D. 1000 to A.D. 1150, at which time the area was largely abandoned. Surface structures are found in this period, although some older pithouses remain in use as holdovers. The population in the Mimbres valley peaks during this period and there are several different site types, including major pueblos of several hundred people in perhaps 100 rooms, minor pueblos occupied by about 100 individuals, specialized sites of a few rooms only, and very late in the period, small sites in mountainous areas. LeBlanc estimates the population of the Mimbres region to be in excess of 10,000 people, and there is evidence of irrigation agriculture as well as a number of check-dam structures (LeBlanc 1976).

About A.D. 1150 the large pueblos were abandoned, for reasons which are unknown. Eventually, the Mimbres River valley was reoccupied by Animas phase peoples at A.D. 1175 (1976:5), and later still, by the Salado or Cliff phase at A.D.1425 and later (LeBlanc 1977:1). There are distinct cultural breaks between the Mimbres Period and the Animas phase, and again between the Animas and the Salado phases. The Animas phase is pertinent to the present problem only in that there is an Animas phase occupation overlying the Mogollon occupations at the Galaz site. This material is easily distinguished by the different construction techniques used and by different ceramic types, which do not seem related to the Mogollon Black-on-white tradition.

Chapter 3

THE TYPOLOGICAL DEBATE

In deciding upon a course of analysis for the Galaz ceramics two major questions must be answered. First, what kind of taxonomy do we want? Second, what procedure or procedures will obtain the desired result? The first question leads us into what has been a major concern of archaeologists for as long as there has been archaeology. On a theoretical level, taxonomy has occupied theorists since at least 1927, when, at the Pecos Conference they attempted to set up a uniform taxonomic system comparable to that used in the biological sciences (Kidder,1927).

One of the first and longest-lasting conflicts concerning archaeological taxonomy is whether types are inherent in an assemblage or are created by archaeologists. Two key explications of the differences in viewpoint are those by Krieger (1944) and Brew (1946). Krieger presented one of the first unified approaches to typology and its use in archaeology, and argued that there is a natural typology inherent in an archaeological assemblage. Brew argued that typologies are completely arbitrary, because the attributes are arbitrarily chosen, the techniques used to create the typology are unique to each archaeologist, and the purpose for which a typology is designed differs from case to case.

Krieger's perception of the purpose of a type is "to provide an organizational tool which will enable the investigator to group specimens into bodies which have demonstrable historical meaning in terms of behavior patterns" (1944:272). I doubt that any would question this as being close to what both schools of thought would call a useful purpose. Krieger's definition of a type is "a specific and cohesive combination of features of paste, temper, texture, hardness, finish, vessel shape, technique and arrangement of decoration, use of appendages,etc." (1944:277). Also, a type occupies a definable historical position, that is, its distribution is delimited in space, time, and association with other cultural material (1944:277-278).

I find no quarrel with these definitions of types and their purposes. Unfortunately, Krieger states that once we have created these types we will have an approximation of "that combination of mechanical and esthetic executions which formed a definite structural pattern in the minds of a number of workers" (1946:278). Perhaps this is the case; whether or not it is, we must question the utility of such a conclusion. The result would be what Binford (1972:198) calls "paleopsychology", and I believe is beyond the realm of what we in archaeology should be interested in.

Even though we may disagree with Krieger's ultimate aim, several of his concepts have continued usefulness in creating taxonomies. Krieger introduces a concept that will be discussed later, that individual variation and regional variation can be included within a type without destroying its usefulness: "Absolute consistency is neither possible nor necessary" (1944:278). Another important concept is that no criterion is "of basic or universally primary importance in forming a typology" (1944:278). Since no single attribute is basic, the combinations of features and the ways in which they correlate become more important than the presence or absence of any feature. These concepts are important because they limit the proliferation of pottery types based on what is probably individual variation, which would have ended in very large numbers of types with only a few members in each. As well, they help avoid the pitfall of weighting characters before the analysis begins.

In a later paper, Krieger responded to certain criticisms with a statement reinforcing his stand on natural typologies:

> On the other hand, it may be assumed that in any culture one generation learned from its predecessor that things were done in certain ways in order to achieve certain acceptable patterns of forms and aesthetic quality. An attempt by the archaeologist to devise types which may conform to "concrete human behaviors" is therefore far from hopeless, although it can never be achieved perfectly (Krieger,1965:145-146).

Without question individuals in every culture have certain ideas concerning the proper shapes, sizes and decoration of the artifacts they use. In this regard Krieger is correct. However, there are other attributes, such as chemical composition of clays, which may result from procedures of manufacture or environment which may not be part of the cognition of the artifact makers. These attributes, or the patterning of attributes, are important because they too can give us information useful in determining aspects of culture process. Therefore, these attributes should also be included in the typological process; it may be that they will tell us about different aspects of culture, but they are no less important.

J. O. Brew presented the other side of the typological debate in a consideration of typology which is part of his report Archaeology of Alkali Ridge, Southeastern Utah (1946:44-66). Brew makes the point that the prevailing systems of typology at that time, particularly the Pecos Classification system, were based on the biological system of nomenclature. There is little doubt that this was the case. In fact, Brew had no difficulty in quoting a number of Southwest archaeologists who used straight biological terms to describe relationships between pottery types (1946:58). On the other hand, the basic idea behind typology is to order objects into "groups (or sets) on the basis of their relationships" (Sneath and Sokal 1973:3). In biology, phylogenetic relationships are often used, but this does not preclude archaeologists from using other kinds of relationships, such as artifact similarity. What these early archaeological classifications attempted to do was to represent similarity in a coherent and consistent way.

Brew's mistake was to assume that because similar methods of representation were used, similar explanations of the relationships were also used. Admittedly, an archaeologist who uses biological terminology without at least redefining it is in error. However, this does not negate the accuracy of the representation of the relationships of the typology. It is for archaeologists to explain the relationships of types one to another, and to the cultural groups which created the artifacts, regardless of how we represent the similarities graphically.

Another of Brew's main points, one which is still being debated in archaeology, is that classification is arbitrary:

> 1) The system is "made" by the student. The diagnostic criteria are defined by him, and objects or cultures are placed in a particular class or type according to his designation: therefore:
> 2)..."Types" are not "found". The student does not "recognise" a type, he <u>makes</u> it and <u>puts</u> the object in it...
> 3) No typological system is actually inherent in the material. Systematic classifications are simplifications and generalizations of the natural situation (Brew,1946:46).

Unfortunately, Brew simply makes the statements and does not offer convincing arguments of their correctness. I suspect that Brew's concept of classification is in reality a dissection of the artifacts according to some arbitrary notion of the archaeologist. A dissection is the division of a group of artifacts according to some trait such as length, for example, when no modality is present in the length distribution. Classes created by dissection would have little chance of having any archaeological significance (Hodson 1982:24; Doran and Hodson 1975:159).

Simple observation of the cultural artifacts around us reveals that there are real, non-random associations of attributes which occur on our own artifacts such that we would include them in certain groups. To deny that artifacts such as Folsom points have any basic similarities among themselves makes any hope of scientific archaeology impossible. There are obvious similarities in these artifacts, there is a real pattern of attributes that occurs with regularity. Furthermore, what we do as archaeologists is dependent on the assumption that "human behavior is patterned or structured" (Hill 1966:10). To state, as Brew does that there is no typological system inherent in the material is to claim that the behavior of the makers of the artifacts we study was random. If this is so, we have no hope of anything more than describing the artifacts. On an intuitive level I must reject this.

Brew also states that "we need more rather than fewer classifications, different classifications, always new classifications to meet new needs' (1946:65). These statements are in reaction to what Brew perceived to be the major drawbacks of the Pecos classification system. As well, they were based in the prevailing school of thought in

American archaeology at that time, that the artifacts excavated were the facts, and we could learn about cultures by the way we studied these artifacts as items. This point has been justly criticised by the "positivist" school (cf. Hill and Evans 1972) because it does not include as facts either the correlations of attributes on individual artifacts, or of one artifact to another. If we assume that no such connection is possible, then of course we cannot make a typology which has relevance in terms of behavior. On the other hand, if we develop techniques which will enable us to determine if variability and correlation in our data is in some way causally related to behavior patterns, then we will be able to create better typologies which reflect behavior patterns. Albert C. Spaulding's pioneer work in "Statistical Techniques for the Discovery of Artifact Types" (1953) clearly shows that we can "discover the cultural significance inherent in archaeological remains" (1953:313). There are, of course, many other more recent examples of this, and newer techniques doing just that (Longacre 1970; Hill 1966,1970; Redman 1978). The basis of Brew's claim that we cannot determine the cultural significance of patterned behavior on artifacts may have been true at the time, but it is certainly no longer true.

To summarize Brew's ideas, first, he insists that typologies are arbitrary creations of the archaeologist. This of course can be true, and it is an important point to remember that any typology which we use can be designed with a purpose in mind. However, we must also remember that a typology can be designed with broader purposes in mind than simply organizing artifacts.

Second, Brew advocated the creation of multitudes of classifications. This, I think, is because classification seemed to be the goal of Brew's archaeological scheme. Given the prevailing theoretical bent at the time there was little else that could be done. A careful reading of Brew (1946) shows that his prime consideration in advocating the use of many classifications is a response to the seeming concretization of the typologies in use: "What A.N. Whitehead calls the fallacy of misplaced concreteness" (Whitehead quoted in Brew 1946:61). This is a reaction to attempts, as at the Pecos conference, to create absolute, final typologies, which can come to be thought of as the only correct description of taxonomic relationships when in fact they are just approximations. Obviously, no classification can ever be considered complete or final but, as Krieger has pointed out, we can still attempt - although imperfectly - to create typological systems of historical significance.

Since these two basic articles were written there has been a good deal of discussion of the principles and uses of typologies in archaeology. Without going into detail it is enough to say that the basic points on either side have not changed much, except in their theoretical underpinnings. A recent overview, along with a new theoretical presentation is found in the article by J. N. Hill and R. K. Evans: "A Model for Classification and Typology" (1972:231-273). Hill and Evans are the first, to my knowledge, to label the dichotomy presented here as a result of the "fundamental epistemological differences between this [the empiricist] and the 'positivist' model"(1972:233).

In Hill and Evans' view the empiricist school

> subscribes, at least implicitly,... to the metaphysical notion that all phenomena (including artefacts) have meanings or significance inherent in some sense within themselves. Each item has a single meaning, or very few meanings at most; and in archaeology it is the task of the archaeologist to discover these meanings (Hill and Evans 1972:233).

From this definition they deduce several logical consequences. First, "since our information or inferences are derived from the data,... we ought to gather our data before we make inferences" (1972:234). Second, "classification comes most properly before analysis and interpretation" (1972:234). I will not argue the validity of their definition of "empiricism", because in some cases it is applicable. However, their definition clearly does not apply to most taxonomic analyses. When an archaeologist attempts to produce a natural classification he does not necessarily imply any meaning to either the individual artifacts or to the resultant groups. Classification is a process of grouping artifacts according to similarities; only later in the analysis is meaning ascribed to the groups. If artifacts have "meanings or significance inherent in some sense within themselves" then an "empiricist" (as defined by Hill and Evans) would make no attempt to classify them into groups. This would merely obscure the inherent meaning.

The "positivist" view, as presented by Hill and Evans, is that artifacts or phenomena do not have any inherent meaning. Meaning is assigned to these phenomena, by the investigator, according to the problems, hypotheses, and theory to which he subscribes (Hill and Evans 1972:252). It follows from this that any classification must have a purpose, and since different investigators have different purposes, no one classification can be a 'best' typology. This is remarkably like Brew's opinion, although he reached this conclusion from a completely different approach. I think there are two major errors in Hill and Evans' approach. First, they confuse the meaning of 'best', and 'natural' in the taxonomic sense. They attribute some sense of finality to the word 'best', which necessarily implies the fallacy of misplaced concreteness. In fact, no such finality is necessary; obviously, when new data or better techniques come along the taxonomic system can be upgraded.

Second, they mistake the process of type creation with the process of pattern recognition. Hill and Evans argue that, because the hypothetico-deductive approach is best suited for processual archaeology, natural, best, or universal types are both impossible and not useful. They argue that scientific research should begin with hypotheses which, in order to be tested, demand certain types of data. Thus, any new hypotheses created by archaeologists with differing viewpoints or interests may require new types based on different attributes defined by their hypotheses. It is true that this can be an effective method of research. However, the examples they cite as being good examples of the positivist typological method are, in reality, examples of attribute pattern recognition, rather than of true type formation.

One example cited by Hill and Evans as a "positivist approach to typology" (1972:255) is the work of William Longacre (1964,1970), in which he hypothesized a connection between residence patterns and the distrubution of pottery design elements within a site. Members of different residence units would utilize design elements differently from one another, and this would be reflected in the archaeological assemblage. The point raised by Hill and Evans is that Longacre (and Hill in other similar research 1966, 1970) had to create types which "crosscut the standard types" because the latter "were not useful in isolating residence units" (1972:256). Here they are the victims of the very thing they decry earlier in their article: "the fallacy of misplaced concreteness" (1972:236). It is also a case of throwing the baby out with the bathwater; simply because some traditional types were not of use to them in particular examples, they throw out the idea of general typology.

A better course of action might have been to examine the traditional types and determine why they were inadequate and correct them. In fact, Hill and Evans have determined what was deficient about the traditional types: they were based on form and surface color only (1972:256). What the studies of Longacre and Hill show is the search for patterns of variability in the data which support their hypotheses. They did not make types. As Hill and Evans state: "Longacre found the expected, non-random distribution of pottery design elements" (1972:256).

Hill and Evans claim that these examples show that there is no such thing as a 'best' typology, when in fact they simply show the deficiencies of the typology prevalent in the southwest. These typologies, too, were created with a purpose in mind, that of providing a tool useful in dating sites and creating an accurate culture history. Obviously it would not include those variables such as minute style differences that Longacre and Hill found useful in their studies. I submit that this shows the inadequacy of one typology and not any general inadequacy of natural or inherent typologies. In other words, both the traditional typology and the so called typology described by Hill and Evans were narrow, single purpose systems, and suffer from the limitations of all such arbitrary typologies.

The second major point of Hill and Evans is that there is an infinite number of variables to measure on any one artifact, and that to create a natural typology it would be necessary to include them all, or at least most of these variables. Here, they again make use of a straw man, claiming that a natural typology must use all conceivable attributes:

> pursuing the natural and universally useful types the investigator tends to feel he must be cognizant of all (or most of) the attributes of the materials (1972:250).

Of course, as they show, and as is logically true, this is impossible to carry out. Fortunately, it is also unnecessary for a good and widely useful typology. Several criteria can be used to help in the reduction of possible attributes. For example, those attributes which show little or no variation throughout the assemblage will offer little to a typology. As well, we might exclude those attributes which were beyond the artifact makers' capability to either discern or affect. Peter H. A. Sneath and Robert R. Sokal in their book Numerical Taxonomy (1973:103,106), have listed certain types of attributes which might be inadmissible. These include "meaningless characters" which are attributes such as as the number of leaves on a tree (in a biological example). In archaeology a good example might be the number of atoms making up an artifact, or perhaps the name we have assigned to it. Second, logically correlated characters should be excluded; these are attributes that occur as a logical consequence of another attribute. Third, invariant characters need not be included because they cannot help us differentiate types. Sneath and Sokal also list other kinds of inadmissable characters, which do not apply to the archaeological situation.

Doran and Hodson(1975:101) also address the problem of an overabundance of possible variables, and reject the view of Hill and Evans. They give three guides for the inclusion of variables:

> first, by preserving the clear distinction between attribute and attribute state...; second, by avoiding redundancy...; and third, by common sense, by not going out of the way to look for irrelevance and obscurity (1975:101).

Suffice it to say that there are logical means for choosing and eliminating attributes.

As well, Sneath and Sokal have addressed the problem of how many attributes are enough. They give no clear estimate of the proper number, but they do state that as the number of attributes increases there will be less change in the taxonomy. In other words, as the number of characters increases, the number of characters with different attribute states needed to alter the typology increases. There is, in effect, a point of diminishing returns. Thus, if we add a new attribute to a typology created with 10 attributes, we might appreciably alter the types, while if we add one or even 10 attributes to a typology already based on 100 attributes, we might make no appreciable change (1973:107).

At this point it will be helpful to examine exactly what the purposes or useful properties of a typology are. Much of the literature on taxonomics is from biological work, but, in the last twenty years, students of taxonomy have realized that the process can be useful in many other areas of research, and have removed biological emphasis to leave a more purely theoretical basis to taxonomy. Sneath and Sokal's book on numerical taxonomy is a good example of this. This book deals with all aspects of taxonomy, from what the purposes of taxonomic systems are, and how they are made, to how we might represent them.

Sneath and Sokal begin with a discussion of the difference between "natural" and "arbitrary" classification. The nature of a taxonomy depends on its purpose, so that one could design taxonomies that are completely arbitrary - an alphabetical arrangement of pottery types, for example. However, the amount of information contained in such a system is minimal. Natural systems on the other hand, are based on overall similarity, and:

> are of great usefulness because when members of a group share many correlated attributes, the "implied information" or "content of information"... is high; this amounts to Gilmour's dictum that a system of classification is the more natural the more propositions can be made regarding its constituent classes (Sneath and Sokal 1972:25).

In reference to archaeological discussions we can see that Hill and Evans' idea of "best","universal", and "natural" misses the point. There are no absolutes, only approximations; in this J. O. Brew was right. What is clear is that some typologies are more useful than others, and thus one might have a "best" classification, but only at any one time, and only in a relative sense. No claim is made that a system should be static or unimprovable, simply that a system with a higher information content is more useful:

> A natural classification can be used for a great variety of purposes, while an artificial one serves only the limited purpose for which it was constructed. [But], as Sneath...has emphasised, natural or "general" classifications can never be perfect for all purposes, since this is a consequence of the way natural groupings are made (Sokal and Sneath 1973:27).

It should be noted that Sneath and Sokal do not imply that one should only do natural taxonomies, in preference to arbitrary. In archaeology, as in any other science, there is a need for both explanation of the variability and for understanding the ways in which this variability, or its opposite, patterning, occurred. Thus, there will always be a place for arbitrary typologies created to test hypotheses, but it is naive to suggest that, because this is an effective way to proceed in scientific endeavours, one should ignore general purpose classifications. Similarly, to suggest as Hill and Evans do (cf. 1972) that general or natural typologies are only good for culture historical problems, is incorrect:

> One branch of systematics, classification, has the relatively unexciting but supremely important function of ordering nature into a practically and generally useful system... Systematics in the wide sense also has the more challenging task of understanding the mechanisms which brought about this order. These two aspects of systematics are separable and should be separated (Sneath and Sokal, 1973:55).

Thus, we can see that some classifications should properly be done before analysis and interpretation. General typologies are most useful in summarizing the variability in data, and therefore, can be of great use in hypotheses formation. Arbitrary taxonomies are almost completely limited to the solution or testing of particular hypotheses and can only be done profitably as a part of the hypothetico-deductive method.

Doran and Hodson point out an added problem with narrow problem-specific typologies:

> choice of just a few attributes is sometimes excused by the claim that a specific hypothesis is being tested. This may appear a valid approach, but with such eclecticism it is difficult to escape the most regular of all archaeological pitfalls: the delusion that evidence, sought out perhaps unconciously to support a preconception, is somehow providing an objective test. (Doran and Hodson 1975:101).

To summarize to this point, I think it is clear that there can be better, more useful typologies than those created for special purposes. Although it is possible that some hypotheses may require special data which is not part of the general typology, it is more probable that the necessary data will occur in a natural typology. As well, a natural typology will be very useful in the formation of useful hypotheses, because it will detail for us the kinds of variability and patterning in the material. The suggestion that there is an impossibly large number of attributes available for us to choose from is, I think, a hold over from pre-numerical taxonomy days, when typologies were created largely in the archaeologist's head. The widespread availability of computers allows us to create more general typologies using a greater number of attributes, rather than the few gross attributes used at present.

The argument of an infinity of attributes, although logically valid, also fails from a practical standpoint. Granted, we could create an endless number of attributes in the same vein as determining the number of angels on the head of a pin. However, we can logically exclude many of these for some of the reasons mentioned above, and with continued research into the matter we can continue to narrow down the number of reasonable attributes. As well, the taxonomic process is guided by theory which will help us determine those attributes that will probably be useful. Contrary to the general viewpoint of Hill and Evans, classification, as well as their hypothetico-deductive model, can be guided by theory.

In a revealing review of a recent contribution to archaeological taxonomy, Aldenderfer (1983) points out that

> In the rush to create an archaeological science... the time-honored practice of building classifications and typologies of archaeological things has been left behind in the dust.... Rightly or wrongly, the practice of classification and typology was identified during the early development of the "New Archaeology" with all that was unproductive and static in the conduct of archaeology,...(Aldenderfer 1983:652)

It is time we rethink our positions concerning typology because I suspect that most practicing archaeologists would find the rigid system described by Hill and Evans (1972) unworkable. In this regard, Redman (1978:161) says that "there is a significant disjuncture between what I <u>believe</u>, in a theoretical sense,... and what I have actually <u>done</u>...". I believe that this problem arises directly out of the Hempelian notion of a proper scientific method which, until recently, has been widely accepted by "New Archaeologists". This will be discussed in more detail in the next chapter, however, the point I wish to make here is that the statements of Hill and Evans (1972) are neither completely accurate concerning the empiricist school, nor are they a good description of what most archaeologists actually do. Their article is still an important one because it is one of the few statements made by the "New Archaeology" on the proper place of taxonomy in an archaeological science. I think it is unfortunate that in the last decade the issues raised by Hill and Evans have not been of more concern to archaeologists. As Aldenderfer (1983:652) points out: because we have not discussed these issues does not mean that they are resolved.

Chapter 4

THE METHOD

Tuggles, Townsend, and Riley make the point that research "usually begins with a problem (which may be derived from data - observation conducted with an even more general problem in mind, or from the inadequacy of previous explanations or hypotheses)" (1972:6). This is an important point, because the protagonists of the Deductive-Nomological model would have us believe that research must be carried out in the form of: 1) the creation of an hypothesis, 2) the derivation of test implications, 3) the collection of data, and 4) the testing of the hypothesis. In fact, this is the process by which hypotheses are tested and laws developed, but not necessarily the actual logical route by which research progresses. This is an important distinction because we must begin to realize that research may take a variety of forms. Just because it is not formulated in the pattern expected by the positivists does not mean it is not good research. In the 'hard' sciences we find that research seldom follows this logical path nor is it expected to (cf. Watson 1968). It is simply that scientific proofs follow this logical chain of reasoning.

Recent discussions of scientific explanation in archaeology have dwelt on the fact that even though archaeologists have attempted for almost two decades to formulate a covering law suitable for use in Deductive-

Nomological explanations, we have been unable to demonstrate one that is non-trivial (Smith 1982:73; Flannery 1982; Miller 1982:84). As Renfrew states:

> it was both inevitable and desirable that Binford's aspirations for the "laws of cultural development" (Binford 1968:9) and the generally acknowledged need for explicit theorizing, should be met by an attempt to formulate clear explanatory procedures. But it was unfortunate, perhaps, that it was specifically to Hempel that the lawgivers should turn. Fritz and Plog (1970) and Watson, LeBlanc, and Redman (1971) turned for guidance to a paper by Hempel and Oppenheim (1948) that I had read and found (no doubt like other archaeologists) difficult to refute but impossible to use (Renfrew 1982:7).

Even though the D-N model has not proved to be very successful in aiding archaeologists to explain things, it has brought home the idea that we must be explicit about our assumptions, about our reasoning, and about our techniques. In this, I believe the new archaeology has been successful. This concern with method has resulted in the proposal of a number of new models of scientific explanation which promise to be more useful (see Renfrew, Rowlands, and Segreves eds. 1982). But explanation is not the main thrust of this thesis, archaeological taxonomy is; and it is the unfortunate, limiting effects on taxonomy which result from the strict D-N model and the hypothetico-deductive method which concern us here.

A close reading of Lewis Binford's exposition of the hypothetico-deductive method accurately places the process of classification in the research design:

> with the acceptance of a hypothetico-deductive method for archaeology and the use of a multiple-stage scientific procedure - observation and generalization, formulation of explanatory propositions, testing these against the archaeological data - it becomes evident that the analytical units employed in the initial stage may not be useful during the final stages of testing (Binford 1968:25).

Thus, generalization, which is a form of classification, can usefully be carried out as a beginning of research. One implication of this statement is that a research design must be flexible enough to allow the modification or abandonment of data and hypotheses as the research proceeds. As well, it avoids the narrow unilineal method described by Hill and Evans (1972).

Hill agrees that problems are useful as guides, but also states that hypotheses are mandatory: "there is no way of knowing what data are really relevant to problem solution unless we first provide tentative solutions or answers [hypotheses] to the problems prior to data collection" (1972:80). Hill's mistake is that he insists that taxonomy is only a step in the hypothetico-deductive method. It is possible to proceed this way, but it is important to remember that taxonomies can be useful in problem definition as well. I have no objection to research being carried out in the rigid hypothetico-deductive model, but I do not believe it to be the only way in which "explicitly scientific research" can be done. A good typological system can inform us of the variability and regularity in our artifact material. Redman has proposed a technique that is designed to do just this:

> Although the major portion of most research efforts is devoted to attribute selection and typological analysis, neither of these procedures, in themselves, produces information about past societies. Rather, they yield units to be used in distributional analyses, which are the basic elements of interpretive studies.... The overall objective of the artifact system described here is to delineate interpretable patterns of variability at different levels (i.e., single attributes, covarying attribute pairs, artifact types, and microvariation within types) and numerous patterns at any one level (Redman 1978:182-183).

This, I think, is a more reasonable approach to research.

Redman also includes a discussion of the problems of the type-variety system of classification (1978). As it has been used, the type-variety system suffers from a lack of flexibility, as Redman points out:

> The essential nature of the type-variety approach to classification is to summarize the variability in the data, often relating it to a single cause: chronological change. Hence, many micropatterns of variation are obscured and lost to the investigator (1978:160).

Redman also points out that in many cases the majority of artifacts cannot be placed into any existing class. This stems more from the monothetic nature of many archaeological typologies than from any basic flaw in type systems. Sneath and Sokal (1973:20) define monothetic groups as being "formed by rigid and successive logical divisions so that the possession of a unique set of features is both sufficient and necessary for membership in the group thus defined". Obviously, groups formed with such rigid definitions will often leave a great number of artifacts outside the defined groups. As any archaeologist can state from experience, it is rare to find an assemblage in which all artifacts exhibit the same set of attributes; the contrary is often true - variation in the extreme. This, I think, is the greatest drawback of the type-variety system.

We can avoid this drawback if we define types as polythetic groups in which artifacts are "placed together that have the greatest number of shared character states, and no single state is either essential to group membership or is sufficient to make an [artifact] a member of the group" (Sneath and Sokal 1973:21). This change allows for much more variability in the material, and brings us closer to what could be called a common sense approach to what a type is. It also has effects on the kinds of numerical techniques which can be used successfully in the creation of a taxonomy.

Redman proposes a merger of the two positions summarized above. He begins with the proposition that variability in artifacts is the "ultimate source of all archaeological knowledge" (1978:163). If an artifact type is completely regular in all its attributes it would have limited utility in a scientific sense, being more useful in a descriptive way, something which should not be disregarded. At any rate, it is probable that attributes which are true variables will be of most use to us in our studies.

In this regard, Redman defines three kinds of attributes (after Clarke 1968:71):

> Inessential attributes are those which do not vary significantly in the collection under study.
>
> Essential attributes are those whose values are found to vary with respect to at least one interpretive dimension of the assemblage.
>
> Key attributes are groups of two or more essential attributes that are found to covary within the assemblage being investigated (Redman, 1978:163).

These concepts are crucial to Redman's analysis because he is attempting to formulate a method for selecting attributes. These, in fact, are the methods which Doran and Hodson (1975) suggest as ways to narrow down the attribute list to a managable number through some procedure which is "both realistic and theoretically supportable" (Redman 1978:70). Inessential attributes would not contribute much of use to our understanding of variability. In the case of a universal presence the information is redundant; in the case of a unique character state the information is of historic, rather than of classificatory, interest.

Redman suggests the use of "tentative interpretive frameworks" at all stages of the analysis to aid in the selection of attributes and in the "cultural identification of patterning". Redman's interpretive frameworks are, it seems to me, intentionally vague, so that they will aid in determining the data necessary to test certain kinds of hypotheses rather than specific hypotheses. Hill and Evans (1972) imply that we cannot do meaningful research without explicit hypotheses to guide in data selection. However, here I agree with Redman that more tentative interpretive frameworks or problems may be of more use at the early stages of analysis. For example:

> Aspects of decoration are hypothesized to be directly related to patterns of interaction and organization (Redman, 1978:175).

This allows us to create typological systems which are sensitive to the kinds of variations which are of interest to us, while at the same time allowing us to create a typology which is good at what typologies do best: organizing data and illuminating variation. Once we see the kind of variation available for study we can begin to create more explicit hypotheses. Again, Binford correctly outlines the proper place of taxonomy in archaeology:

> It is only after you've carried out your search techniques and discovered relationships that you are in a position to ask questions that lead to explanations. Then, once you generate an explanatory proposition, you may be able to deduce the consequences of it for other sets of data which you didn't search. (Binford 1977b:277)

The most important point of Redman's proposal, in my opinion, is its reiterative nature. Using theory and general interpretive frameworks to determine the nature of the data we can create typologies which are of use in creating more specific, testable hypotheses. We also insure that the kind of data needed to test hypotheses is present. The easy criticism that we should not excavate material without prepared hypotheses ignores the realities of archaeological work and is probably not directly applicable to artifact studies anyway (cf. Tuggles, Townsend,and Riley 1972).

The general approach to be followed here, then, will proceed from attribute selection to the determination of essential attributes and key attributes, to a cluster analysis to determine types. These types will be described and compared to the provenience data for some corroboration or non-corroboration of their reality. In general, the attribute selection was guided by two major concerns. First was the desire to include the attributes traditionally used to distinguish Black-on-white types. These included paint and paste colour and gross stylistic attributes. The reason for this was to test the existing typological system in a quantitative manner. Second, as was suggested in the Introduction, the wide range of variability of the design elements seemed to offer the greatest chance of creating a useful taxonomy. Therefore, a detailed design element list as well as a more systematic attempt at design symmetry analyis were added.

The second phase of the artifact analysis will be an effort to eliminate non-essential attributes that do not contribute some variability to the study. This will be done by examining histograms of the data to determine obvious patterns of variability. Those attributes that have some variability will be used in the succeeding stages of analysis. Those that do not will be dropped from further analysis. Key attributes will be determined by cross-tabulation with other descriptive attributes and with provenience attributes, to determine which variables covary, and how. Finally, a cluster analysis will be run on the key and essential attributes to discover more complicated multivariate correlations. These clusters will be close to the final types that are the purpose of this analysis.

Finally, an attempt will be made to independently validate the resultant types. In the past, most archaeological applications of cluster analysis have, at best, used a comparison to previous, traditional typologies to validate numerically produced types (e.g., Whallon 1972; Christenson and Read 1977). This stemmed in part from a lack of available methods of cluster validation. Aldenderfer (1982) has examined several readily available techniques which can be used to determine if clusters have any reality. None of these methods are "at present... firmly established by statistical theory and most are biased in favor of certain types of clustering algorithms" (Aldenderfer 1982:70). Two of the methods he describes are factor analysis and discriminant analysis. These methods essentially plot the two major dimensions of variability so that one can judge the separation of the proposed clusters. One problem he does not mention with factor analysis is that it depends on assumptions concerning the normal distribution of the sample, which archaeological samples usually do not meet. Discriminant analysis, on the other hand, usually requires that at least some of the variables used be continuous (Helwig 1979).

Sokal (1977:9) has also discussed the problem of validation and has concluded that since no useful definition of a null hypothesis for cluster analysis has been proposed, the best test of significance is a comparison to a "preconcieved classification". The question of validation seems, still, to be an open one.

In order to validate the Galaz typology, I propose to utilize three techniques. First, since the clustering procedures seek to optimise a similarity criterion, it has been suggested (see Doran and Hodson 1975:184 for a discussion) that a discontinuity in the graph of similarity (or dissimilarity) criterion will indicate the most probable candidate for the best number of clusters. This procedure will be followed here in the choice of initial clustering solutions to be examined. Second, the resultant clusters will be tested against the provenience data to test for chronological or spatial patterning. In this case, it is fortunate that there are independently derived chronological indicators in the form of house type sequences and burial form sequences against which we can compare the types.

Finally, a comparison will be made against the traditional taxonomy. Even though it has serious shortcomings, the traditional Black-on-white typology has proven to be useful in some regards and it would be foolish to discard it untested.

Chapter 5

THE BLACK-ON-WHITE TRADITION

The Mogollon Black-on-white ceramic typology, like many other typologies, is basically a single use typology. That is, it was designed with one purpose in mind: to enable archaeologists to date artifacts and stratigraphic levels. This is not the only possible purpose for a taxonomic system; in archaeology there are three main uses: first, they have been extensively used as a dating tool. Second, they have been used for delimiting cultural areas, and in regional trade network analysis. Third, in more recent studies, ceramics have been used in studies of social organization (Deetz 1965, Longacre 1970, Hill 1970).

The most important dating tool in most of the Southwest is dendrochronology, because it gives absolute dates and can be used to date sites within very narrow time ranges. Radiocarbon dating, fission track dating, and obsidian hydration dating are also used, but are of limited utility (see Leblanc and Whalen 1980 for a discussion of their use in the Mogollon area). Radiocarbon dating is seldom accurate enough in an area where phases are often shorter than the standard deviations provided with the dates, nor are there enough dates for accurate calculation of phase dates, there being only five dates available as of 1980 (LeBlanc and Whalen 1980:156). The other techniques are quite recent in their inception and have not yet had much effect on Mogollon chronological problems.

Another important method of dating sites is the use of pottery types which have been dated at other locations. In the Mimbres area this is a very important technique because most of the Mimbres sites lie in an environmental zone where tree species useful for dendrochronology do not exist (LeBlanc and Whalen 1980:154). Thus, much of the chronology for the Mimbres area is based on dates from a very few sites; many sites, particularly the smaller ones, are dated only by the kind of ceramics found.

Therefore, any generally useful typology of Mogollon Black-on-white ceramics must be useful for chronological purposes. As well, because of the density of major sites in the Mimbres valley, a typology which can help delineate problems of trade and distribution would be helpful. Finally, a typology should be useful in distributional analyses within sites.

The traditional Mogollon Black-on-white typology was defined by H. S. and C. B. Cosgrove from the material excavated at the Swarts Ruin. They excavated a total of 777 painted pots, of which 691 were Classic Black-on-white, 78 were Boldface Black-on-white, and 8 were Classic Polychrome (essentially Classic Black-on-white with the addition of some coloured paint - usually a pale yellow) (1932:70). According to the Cosgroves the range of forms and sizes was the same for both Classic and Boldface. However, construction techniques differed somewhat, as did the decoration, so that the Cosgroves did "not hesitate to distinguish between them, for they are markedly different, both in decoration and in finish" (1932:76).

The Cosgroves definition of Classic Black-on-white is as follows:

> Classic decorated bowls are characterized by accurate, fine-lined brush work... in both geometric and naturalistic styles; by painted rims; by multiple parallel line borders...; by rarity of outside decoration...; by blending from black to red in the design as a result of overfiring...; by overruns of slip on the outside near the rim...; by occasional zigzag smears applied to the outsides of bowls by fingers dipped in the slip; and by unslipped exteriors of bowls, the exposed paste varying in color from creamy-grey to buff (1932:73-74).

In addition:

> The outsides and insides of bowls have been well smoothed with polishing stone (1932:72)
>
> It contains a large amount of fine to medium-fine quartz sand tempering. (1932:72)
>
> The paste fires from light gray to a gray-black, also from a yellowish-gray shading to a soft red brick. (1932:73)

Only brief mention is made of design elements, separating them into two classes of design, geometric and naturalistic (1932:74).

Boldface pottery is represented by the same range of sizes and shapes, and is built by coiling, as was the Classic type. The Cosgroves' description of Boldface is somewhat subjective, however, and leaves us with an ambiguous concept:

> The paste is more carefully kneaded than is that of Classic ware; it is harder and meticulous use of the polishing pebble before and after the slip was applied has produced a soft, satiny-feeling surface. The results of polishing may be seen not only on the interior of the bowl, but also, and even more distinctly, on the outer surface where overruns of slip have been spread by the stone. The decoration of these bowls is characterized by bold designs extending to the rim, by figures resembling a double flag or stalked triangles..., and by coarse waved and straight hachure with wide framing lines. When interlocked scrolls were drawn in conjunction with straight-line designs, the heavy brushwork persisted (1932:76).

And:

> Naturalistic figures are crude and unrealistic (1932:76);

Here we have some indication of the design elements associated with the Boldface pottery type. However, the description of the physical attributes is unclear.

What is clear from the description of Boldface pottery provided by the Cosgroves is that it is distinguished from Mimbres Classic by a matter of degree. "The paste is more carefully kneaded" for example. Another point the Cosgroves mention is the careful polishing of the Boldface pots. In fact, all Classic pots also show signs of polishing with a pebble to some degree, in some cases to a high degree. Even their description of the painted designs can be interpreted as simply a matter of degree, depending upon such unempirical, descriptive terms as "coarse lines" and "heavy brushwork", or "crude and unrealistic". One can seriously question the validity of these ceramic types on the grounds that the Black-on-white ware has such a large range of variation that the proposed component types, Boldface Black-on-white and Mimbres Classic Black-on-white, overlap both in design elements represented, and in physical attributes such as size, shape, and construction.

The Cosgroves attempted to place the two types chronologically by comparing the placement of the artifacts with the stratigraphy at Swarts. Although they felt the stratigraphic data to be "extremely bad" they were able to demonstrate slightly greater relative abundance of Boldface in earlier times than in late. While Classic pottery seemed to be much better represented in all time periods at Swarts, both types occurred in each of the stratigraphic zones from early to late at the Swarts site (Cosgrove and Cosgrove 1932:78).

Thus, we see that the Cosgroves' type descriptions are both vague and overlapping. As well, they were unable to show any clear stratigraphic separation of the two black-on-white types, nor did they establish any organizational pattern at the Swarts site that would account for differences in pottery design or construction. They did, however, realize that their typology was incomplete and called for more research, something which has not happened until quite recently. In result, the evidence presented by the Cosgroves can, at best, be interpreted as proof of some relatively slow change through time. Given the stratigraphic problems enumerated by the Cosgroves, one would be rash to place any more importance on the data than that.

LeBlanc and Khalil (1976) have proposed some refinements to the Mogollon Black-on-white type system, with the addition of flare rimmed bowls as a sub-type of Mimbres Classic. LeBlanc and Khalil argue that there is a significant association between the flare rimmed bowls and the use of certain design fields. These design fields differ from those that are most common in the more prevalent hemispherical bowls, in fact they seem to be a reversal. Thus, concentric lines are usually found just below the rim and above the geometric band in ordinary classic bowls, and in flare rimmed the concentric lines are found below the geometric band, which is itself usually found on the flared portion of the pot.

I do not question the association expressed by LeBlanc and Khalil experience with the Galaz collection confirms their results, although I have not tested it. However, one must question the importance of determining such an association. We would not be surprised to find a significant relationship between soda bottles with the labels on the outside, or of serving trays with designs on the inside. The difference in shape compels different design field usage. A more interesting fact would be that different shapes are treated the same. In short, the most interesting piece of information concerning the flare rimmed bowls is that they are a different shape; there is an obvious case for them being designated a sub-type. The associations found by LeBlanc and Khalil are at best a redundant measure of the same dimension of artifact variability (see Whallon 1982).

In other related research, LeBlanc (1976,1977) has also proposed a type transitional between Boldface and Classic Black-on-white. He suggests a stylistic evolution in the following fashion:

> Boldface began with very bold motifs, curvilinear scrolls, and an absence of hatched elements.... Later in the sequence hatchure was occasionally accomplished by using wavy lines as the hatching element. Design elements extend to the rim of the vessel. The transitional style is seen as having an improvement in execution of the painting and more varied designs. More objectively, we see that hatchured elements are made with straight fine lines. However, this hachure can be distinguished from its later Classic form in that either (1) the hatching lines extend into a large, solid elements (sic) or (2) they are bounded by lines much wider than the hatching lines. In either case, the designs still extend to the rim.
>
> The important thing is that it is a small step to separate the hatchure from solid elements or to enclose the hatchure with thin lines, which is what we find in the Classic style (LeBlanc 1976:20).

LeBlanc is obviously not redefining the Mogollon Black-on-white typology, rather, he is further attempting to subdivide the immense variability of Mogollon pottery. Unfortunately, these divisions seem to make little sense, even chronologically. In the same article quoted above, LeBlanc discusses and illustrates seven pots found beneath one floor of his re-excavation of the Mattocks site (LA 676) (see Nesbitt 1931, 1938 for the original excavation). These artifacts were found below the floor of room 431 (LeBlanc 1976:15) and LeBlanc suggests that these are probably all "associated with a single family". Examination of the pots illustrated, and classification according to his own criteria would lead one to believe that all three types are present in this one small group. At least one is assuredly a transitional bowl, and one is quite possibly a Boldface type. LeBlanc does comment on this, saying that the "variability is quite striking, making it hard to believe that the pots were made by members of this same family" (1976:15).

In an attempt to explain this variability in quality, LeBlanc suggests that there is a possibility of specialized potters in the Mimbres area, particularly during the Classic Period. There is some evidence that during the Classic Period Mimbres peoples may have made a rapid increase in their level of social organization due to their position as middle men in a trade network connecting Chaco Canyon and the Valley of Mexico. Evidence for this trade is the presence of parrot skeletal remains at Galaz, of a type not indigenous to the Mogollon area, and copper bells, which probably originated in Mexico. However, to suggest, mainly on the basis of pottery quality, that craft specialization is present is a large logical leap. A close reading of both the Cosgroves' and LeBlanc's type definitions shows they depend heavily on subjective evaluations of the ceramic decorative quality. Inherent in Leblanc's suggestion is the assumption that what we find today to be an exceptionally beautiful pot is the same as what the Mimbrenos found to be exceptional. There is as yet no corroborative evidence that this is the case.

Finally, the suggestion of craft specialization based on pottery quality suffers from a problem of circularity. If the types are mainly defined by standards of quality, and sites are dated mainly on the ceramics present, then the chronological sequence must be somewhat suspect. It seems unreasonable to place these artifacts in a chronological sequence based on quality and then to state that this shows the development of craft specialization. One could equally expect a greater standardization in an area of specialization as an increase in variability. At any rate, better definitions of types, and some degree of spatial patterning would seem to be necessary before any specialization is hypothesized.

It seems clear from the above definitions that the Mogollon Black-on-white typology suffers from a basic narrowness in its initial definition. Although it seems to have been useful in defining chronological phases, there is some question of the accuracy of these, since the types are based largely on subjective assessments of quality. A reexamination of the pottery types is therefore in order, to assure that future developments in phase definition and dating might rest on a more sturdy base.

Chapter 6

ATTRIBUTE DESCRIPTION

The growing use of numerical techniques has demonstrated, as a side effect, that the choice of attributes used to measure artifacts is one of the most important stages in taxonomy. Even so, there are no established methods which one can use in a particular case to define important attributes. Past experience, published results, intuition, and trial and error seem to be the only guides in this area. We would do well to keep in mind, though, the nature of attributes: what they measure, and what they represent.

There has been some confusion in recent literature over the use of the terms 'attribute', 'variable', 'attribute state', and 'dimension'. Some archaeologists use the term attribute to refer to a specific condition or value that is possible on a specific scale (Spaulding 1977; Sackett 1966; Cowgill 1982). Thus, red is an attribute of the variable "colour". Other archaeologists choose to define attribute in its more general sense as a variable, and to use the term attribute state to refer to the specific condition (Clarke 1968:139; Doran and Hodson 1975:99). In this, I choose the later. Therefore, attribute and variable will be used interchangeably here, to mean: "a logically irreducible character of two or more states acting as an independent variable" (Clarke 1968:138).

Perhaps a more difficult concept, and certainly a much vaguer one in the literature, is that of dimension (Whallon 1982; Binford 1972; LeBlanc 1975). The concept originated in factor analysis where it referred to a theoretical scale of measurement along which a sample of cases or artifacts could be placed. This dimension cannot normally be measured directly, but can be described by partially correlated real measures. A dimension of size, for example, could be calculated from the correlated measures of length, width, and height. Similarly, we can interpret some of the dimensions created as the result of a factor analysis to represent archaeologically useful scales of relative age, stylistic simmilarity, or any of a number of other possibilities, depending upon the real, measureable variables that were used in its creation.

Whallon (1982:130) states that dimensions are essentially the same as variables and that typology is the "search for, or the discovery of, discontinuities in the distribution of the data along one or more dimensions" (1982:130). These dimensions may in fact be represented exactly by a certain variable but, according to Whallon,

> in most cases, the dimensions underlying a typology cannot be measured directly, and we must rely on variables that are related significantly to these dimensions. Original variables in these cases are indirect and imperfect measures of the variability on which a typology is based (Whallon 1982:130).

Steven LeBlanc (1976:24) in contrast, defines a dimension as a variable. This view is based on a misunderstanding of the original meaning of the term in factor analysis; furthermore, it loses the useful property that a dimension of interest may be represented in the actual data by more than one variable. As well, each variable can be a more or less accurate predictor of the dimension's value.

This concept of dimension is important to the creation of typologies because it gives us a clearer understanding of the variability in the set of artifacts. It is, I believe, the underlying basis for Redman's analytic procedure of defining inessential, essential, and key attributes. With these concepts in mind we will now look at the actual attributes selected for the study of the Galaz pots, and at the process by which these attributes were either refined or discarded.

The attributes used to record the Galaz pots were chosen according to several criteria. Some were chosen because they had been used in traditional taxonomic systems. Others were chosen because research in other areas had shown them to be useful in socio-cultural problems (e.g., Longacre 1970; Hill 1970; Deetz 1968a). Still others were chosen after a preliminary survey of the pottery, and were based upon the variations that seemed - purely subjectively - to be important. In line with the point made earlier, that the Mogollon Black-on-white typology was based only on gross details of construction and design, a number of more detailed attributes of design were included. On the one hand, the intent was to maximize the number of variables without introducing any that were dependent or redundant (e.g., size and volume), while on the other hand, every effort was made to keep the attributes simple and easy to record, in order to keep the analysis time down.

Two basic kinds of attributes were chosen for the Galaz ceramic analysis. The first kind relates to morphological and construction characteristics. The second kind describes the designs painted on the pots. Most attributes were measured and recorded directly from the artifacts, but some of the design attributes were recorded from photographs taken at the time of the original analysis. This was necessitated by the many changes made in the format of several of the design layout measures. Table 2 shows the complete list of attributes recorded on the Galaz material; the various attribute states for each are shown in Appendix B.

Most of the variables in Table 2 are self-explanatory, only a few need further explanation. All attributes of colour were recorded subjectively, although at first an attempt was made to record colour according to a standard colour chart. This was abandoned because of the variations in colour on each pot. It was also found to be too time consuming in relation to the amount of information which could reasonably be expected. Even modern potters

Table 2: List of attributes recorded on Galaz Ceramics.

Paste colour	Rim direction
Exterior surface colour	Handle form
Interior surface colour	Sphere
Paint colour	Base
Interior surface finish	External decoration
Exterior surface finish	Design symmetry
Exterior surface treatment	Design segment
Temper	Band lines
Amount of temper	Base band lines
Form	Focus
Interior wear	Design layout
Surface modifications	Centre field
Kill	Naturalistic/geometric
Mends	Format
Vessel height	Design elements
Orifice diameter	Naturalistic elements
Body thickness	Pspec
Rim type	Pdesign

experience vagaries in colour rendition in the somewhat chancy business of firing pots. To expect the kind of colour accuracy in prehistoric pottery which must be measured with a standard scale seemed unreasonable.

Paste colour refers to the colour of the interior of the body of the pot. At first, separate categories were kept for those pots with surface colours different from the core colour, but as will be explained in the chapter describing the analysis, this was dropped. Although it is probably best to break a sherd in order to observe an unmarred exposure, this was not done due to the value of the Galaz collection.

Surface finish here refers to the methods used to even and smooth the surface of the vessel, including slipping (Shepard 1954:186). In the bowl sample the Interior Surface finish is uniformly slipped, therefore it does not apply in the analysis. This attribute is much more variable in the plain ware sample, as is the behavior of the Exterior Surface Finish. One related attribute is Surface Treatment, which here applies to the evidence of methods used in the final shaping of the vessels, such as striations left by scraping. This attribute only applies to the exterior surface in the bowl sample since all evidence of it is covered by the thick slip applied on the interior.

Temper, and Amount of Temper, were recorded because they have been shown to be extremely useful in ceramic identification. All Galaz pots with a visible fracture edge were examined under a binocular microscope for evidence of nonplastic inclusions. Tempering materials were identified visually and categorized into two size ranges, coarse (greater than 1mm.) and fine (less than 1 mm.), and five composition categories. The composition categories were grit, sand, angular sand, angular sand and mica, and coarse gravel. Grit refers to crushed quartzite; it is characterized by obvious fresh fractures, and was usually slightly larger than the other materials. Angular sand is also a quartzite like material, but exhibits some evidence of natural erosion. Fracture edges are somewhat rounded, but not as much as in the sand category. Sand refers to an aeolean sand, whose major constituent was quartz. The rounded, regularly sized grains were extremely noticeable. The categories angular sand and mica, and coarse gravel, were eventually dropped because of their rarity. About five examples of angular sand and mica were noted, but it is possible that some were missed. The mica particles were extremely small and very hard to see even under the microscope. Coarse gravel occurred as a temper most often in plain wares, and was exceptional in its size, having grains as large as 5 mm. in size. As well, it exhibited a wide variety of material constituents.

Amount of Temper refers to a subjective judgment made as to the relative amounts of nonplastic material to plastic material. Although the results of this variable seemed to be fairly consistent, a major problem was that in a collection of complete (or reconstructed) pots it is often difficult to inspect a clean fracture edge. In many cases the reconstruction process either covered or modified the edges. In other cases the fracture edges have been exposed to hundreds of years of environmental action. Thus, not enough pots could be recorded reliably to make the measure useful. It should be noted that this problem applies somewhat to the previous attribute as well, although it is not as critical.

Several attributes which were recorded for the entire collection but which lose their significance in the bowl sample include Form, Handle Form, External Decoration, and Surface Modifications. A list of forms can be found in Appendix B. These do not apply in the present analysis because non-bowl forms were specifically excluded. Surface modification refers to such techniques as incising, corrugations, punctations, and other techniques used to add design accent to the clay body, usually after the surface was smoothed (except in the case of corrugations). External decoration refers to the format of surface modifications, such as the location of additions. Handle forms refers to the various handle styles used, as well as to lugs added to the pots, presumably to aid in carrying. No examples of these two attributes were recorded on painted bowls.

Three size measures were recorded on all ceramic artifacts. The first, vessel height, was recorded by inverting the bowl or jar on a level surface and recording the height of the base with a leveled ruler. This was done because in its normal sitting position, a round bottomed bowl is difficult to level. Thus the vessel height includes the base thickness. Orifice diameter was measured across the widest point of the mouth of the pot, including the width of the rim at both ends. In some cases which were extremely warped, two measures of diameter were taken, one, the longest, the second, at right angles to the first. Body thickness was recorded at the base if possible, measured in millimeters. Thickness at the rim was not recorded, as initial inspection revealed it to be in fairly close agreement with the base thickness, although the rim measure was more variable. Since there is only one base, and any number of possible measures around the rim, the base was chosen.

The last two measures of the physical shape and construction of the vessels are Rim Type and Rim Direction. Rim Type refers to the shape of the rim, whether it was thinned, thickened, or flared for example. Rim Direction refers to the slope of the rim when the pot sits upright. This varied from horizontal out to horizontal in (in the case of some seed bowls). A related measure is that of Sphere, which applies specifially to open bowls. It was noted in an initial inspection that there appeared to be two basic forms of open bowls. The first may best be described as one half of a sphere. Thus the shape is rounded, with a vertically directed rim. The second is shaped as the bottom third of a sphere, so that the walls do not come to the vertical, and there is therefore a more open interior. This attribute was included because it was thought that these shapes might have some effect on the visibility of designs, and thus the placement of designs.

The design descriptions attempt to record two basic forms of information. First, what design elements are used? Second, where are these elements placed on the pot, and in relation to one another? The first category includes the design element list (see Appendix A), a list which essentially grew as the vessel recording procedure continued. A large number of these elements were taken from published studies of Southwest pottery, while the rest were added as they appeared, if they did not fit the previously defined elements. A discussion of the element list and its refinement appears in Chapter 7.

The Naturalistic elements include all recognizable painted figures. They range from animals such as deer, antelope, rabbits, humans, reptiles, and amphibians, to a variety of scenes involving one or more species or things. These last paintings were difficult to incorporate in the system since they often involved either multiple codes for the naturalistic element or a single code which referred to that specific scene. In the latter case the code would almost surely remain unique because of the improbability of an exactly repeated scene. Finally, it was decided to record them as to the kind of animals or people present as well as in a special code referring to a scene (see Appendix B).

Two variables related to the naturalistic elements are

PSPEC and PDESIGN. These were developed after initial analysis produced dissappointing results with the complete naturalistic element list. The first, PSPEC, codes the figures at a more general level of biological taxonomy, as birds rather that parrots or turkeys, for example. The second, PDESIGN, refers to a measure of the style of the naturalistic motif, rather than to its content. Thus a figure may be recorded as having geometric designs on its body, and not be recorded as a bird or fish.

One attribute which at first glance seemed to have many possibilities is the prsence of Band lines around the rim and just below it. These lines come in two basic widths and in many combinations. Recent work by Hill (1977), and Redman (1977) as well as others, has shown that analysis of certain attributes such as painted line width can allow us to determine the actual "signature" of individual potters. These were not included in the analysis of the Galaz material, for two reasons. First, it did not seem appropriate for the creation of a typology. Theoretically it would be possible to create a typology which would discriminate individual pots by individual potters, yet I can see little need for this in a general typology designed to be useful in a broader geographical range.

The second problem with this kind of analysis is that so far it has only been used on sherds, where, for example, line width variability is reduced by the size of the sherds.

Initially, an attempt was made to record this data for the Galaz material, but after a short time the problems of recording line width on whole vessels became insurmountable in the time available. Width measures on a single line drawn about the rim of the pot would vary so much that several individual measures would be required to determine the range of variation on a single pot. When a pot has as many as twenty lines painted around the rim the amount of data becomes unwieldy. This is not to say that data of this kind is not useful, only that its collection was too time consuming for the present problem. Fortunately, the band line problem was easily solved. A small sampling of the pots revealed that there were indeed two "modes" in line width, one at about 1 mm., the second at about 3 mm. There are rare examples of thicker lines, and these were recorded separately. Eventually, however, they were merged with the thick lines.

Base lines are similar to the band lines, except they are below the design field, usually forming a circle from 8 to 20 cms. in diameter, with an open, unpainted centre. These were recorded in the same fashion as the band lines; however, since they were much less common they eventually were merged into a single presence/absence element.

The rest of the design elements record the placement and symmetry of the overall designs. Symmetry records whether the design is symmetrical, and if so, in what fashion. Segment records the number of partitions which make up the complete design. A design may have bilateral symmetry and have four partitions, in two pairs. Design focus refers to the physical space upon which the designs are painted, in the centre, or high on the walls for example. Centre records the shape of the centre field which was most often left unpainted. It was usually circular but other shapes occured. Often, in the examples of naturalistic paintings placed in the centre, the attribute was coded as not applicable. Finally, Design layout refers to the form in which the design was painted. Examples are Bands, which are probably the most common form, or panels, in which the designs are framed much like a picture and placed below the rim.

The last group of descriptive attributes are those which record treatment of the vessel subsequent to its completion. These include a measure of interior wear in an attempt to determine if Black-on-white pots saw everyday use as containers. Base recorded the relative amount of wear on the exterior base of the pot, in an attempt to determine both use and relative life spans of these ceramic vessels. Finally, Kill recorded the type of treatment the pot received when it was interred as a grave good. Of the 568 bowls used in the sample, only 6% (34) were not found associated with burials, the remaining 534 bowls were usually "killed" by either being broken into pieces or by having a quarter sized hole punched in the bottom, usually, as it lay in position atop the burial.

One last attribute, a rare but interesting one, concerned the attempts by the prehistoric owners of the pots to repair damaged, but presumably still useful or valuable, pots. This occurred in the form of a pair or pairs of holes drilled along a fracture line, through which possibly leather or fiber laces were threaded and tied. One plain ware example has eight holes drilled along a crack which had split the pot in two. This attribute was much too rare to be of any use in the analysis, and was not used.

The last category of attributes is that of provenience. These include all the factors of location recorded when the artifact was found: burial number, room number, floor number, room type, burial position and orientation, and estimated age and sex of the associated burial. The location data will be vital in testing the pot types for patterning in time and space. Burial data may provide another chronological standard, as well as indicating social stratification and other organizational data, although that is not germane to the present problem.

This last group of data will be used mainly as corroborative evidence. Even though there may be significant correlations between these and attributes of other groups, these would not be used in the creation of a typology because it would be basing the typology on data not physically associated with the pot. This would limit the typology's usefulness, because any sherd or pot found outside its depositional context could not be typed. It will however, be the basis of the distributional analyses done after the typology is created.

Chapter 7

THE ANALYSIS OF THE GALAZ POTTERY

Although all ceramic items from the Galaz excavations were recorded, not all were used in the analysis. Table 3 shows the breakdown of the ceramic sample from Galaz. A complete typology of Mogollon ceramics would of course include the plain wares. They have shown considerable variation and may relate different aspects of the cultural system to us. For example, the plain ware handled pitchers have been suggested as a diagnostic artifact for Three Circle phase burials (LeBlanc and Whalen 1980:202). Plain wares were not included in this analysis for several reasons. The main one was the size of the problem. Analysis of plain bowls, pitchers, and ollas would each have added new ranges of variables to an already large list. Second, at the Galaz site there had been a conscious selection process by which painted bowls were collected and restored while plain wares were not. This occurred both in the field and in the lab. I suspect that many plain ware sherds were not collected at all. Most of the ones that were collected remain in boxes in the Laboratory of Anthropology, University of Minnesota. Since I did not have either the funds or the time to reconstruct the many plainware pots, I determined to leave them out of the present analysis. About thirty of the Mogollon Black-on-White bowls had to be reconstructed at the time of

Table 3: Ceramics Excavated at the Galaz site.

	Mogollon B-on-W	Plain Ware	Intrusive Ware	Lost	Damaged	totals
Bowls	568	96	26	60	11	761
Jars	99	112	5	11	0	227
Totals	667	208	31	71	11	988

the analysis.

Intrusive wares, and the later Animas phase wares, were not included in the analysis for the obvious reason that I hoped to create a typology of Mogollon ceramics. As well, LeBlanc and Whalen (1980:283) suggest that in the Animas phase, as much as 50 to 95 percent of the ceramic total is "plain brownwares, corrugated, and textured wares". I did not feel that the provenience data from Galaz was adequate to sort out the Mogollon plainwares from the intrusive and later plainwares. Thus, the figure of 31 intrusive pots includes only the painted wares, which have been tentatively identified as Tularosa Fillet Rim, Chupadero Black-on-white, and a number of unidentified redwares. No attempt was made to separate Mogollon Black-on-white pots which might have been made at sites other than Galaz. At present there is not enough data to do this successfully.

A number of pots (71) were not recorded becauses they were either lost in the fifty years since excavations took place or because they were misplaced in the collections. Since a careful search was made to find the missing artifacts, it is my belief that they have been lost. A perusal of the catalogued descriptions shows that most of the lost artifacts are painted bowls, most often with naturalistic paintings, and many of the small number of polychromes found at Galaz are missing. I suspect that the Galaz collection has suffered the same fate as many other old, valuable collections, and care must be taken or this scientifically valuable collection may soon reach the end of its usefulness to archaeology.

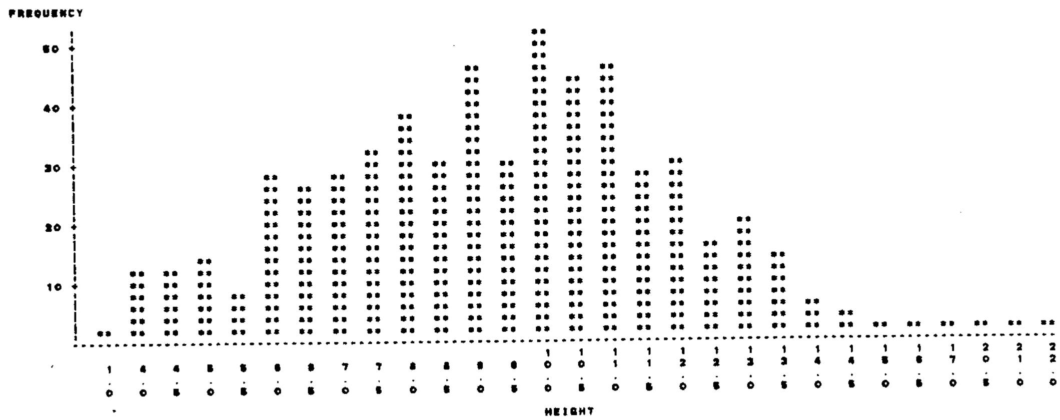
Painted jars were excluded from the analysis because they too would increase the number of variables in the analysis; variables which, for the most part, would be incompatible with those recorded for bowls. Plog (1980) discusses the problem of design variation caused by differences in available design fields and concludes that "the level of design similarity between the units may thus be affected if different design features are associated with... different vessels forms" (1980:19). Since the amount of design variation on the Mogollon painted bowls is already immense, all shapes other than two forms of bowls were excluded. These excluded forms include jars, ollas, flared-rim bowls (which LeBlanc and Khalil(1976) have proposed as a type), and effigy pots.

The final sample of 568 bowls comes from all contexts in the Galaz Site; most (522) were associated with burials which were found both intra and extramurally. Thirty four bowls were not associated with burials, twelve were associated with cremations. The contexts and associations will be discussed in more detail in a later section dealing with the tests of the results of the cluster analysis.

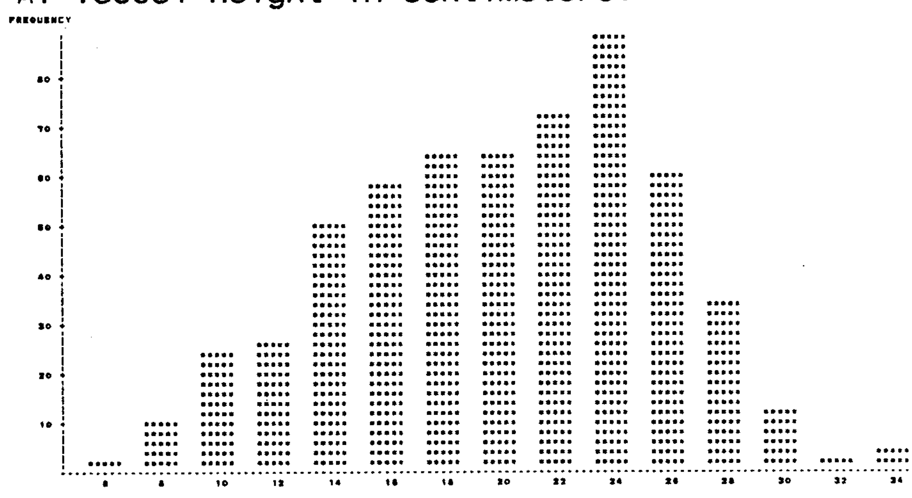
The first stage of the analysis of the Galaz sherds involved the selection of the attributes to be used to measure and record the pots. This procedure was made somewhat difficult by the nature of the material and the literature concerning Mimbres archaeology. When the Galaz pots were measured, photographed, and recorded, several of the more recent studies on the Mimbres area had not been published, or were unavailable (LeBlanc and Whalen 1980; LeBlanc and Khalil 1976; LeBlanc 1975,1977). This led to the decision to employ as many attributes as possible in recording the pots. At the time I reasoned that this would almost certainly include those variables which others might have or might yet conclude were important. Nothing has changed my mind on this point. However, there is left the chore of weeding out the non-significant variables, to leave us with those which express the major variation in the ceramics.

Because of the large range in size expressed in the Galaz sample, the various measures of size were the first to be analysed. Figure 4 shows the distribution of the variables vessel height, orifice diameter, and body thickness. As can be seen in the plots of these variables, they are each unimodal in distribution. All are somewhat skewed, but only slightly. In order to test if there was any hidden patterning, these variables were graphed according to the attribute states of the other morphological and design variables. No discernable difference in distribution was noted. As well, an index of size was defined as height divided by orifice diameter multiplied by 100. This was graphed and a linear relationship was evident. There were no discontinuities in the graph, nor were there any when the index was graphed against other attributes. Because of this exceedingly normal distribution, it was decided to drop the size variables from further analysis. This result was not unexpected, because in their description of Boldface and Classic pots from the Swarts site, Cosgrove and Cosgrove described the two as similar in "range of size" (1932:76). Nor was I able to find any other reference in the literature to suggest that size showed any chronological or spatial differentiation.

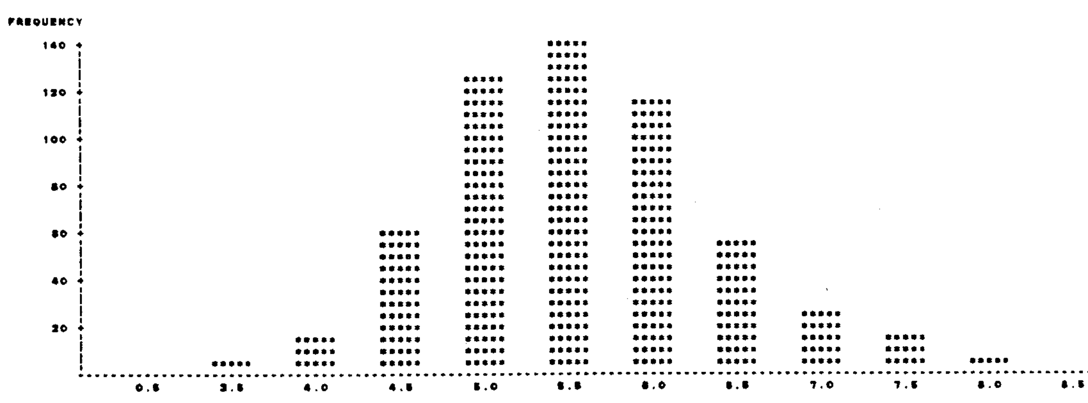
Two other attributes which were dropped quite early in the analysis were Rim type and Rim direction. Rim type showed almost no variation in the bowl sample (slightly more in the complete collection); 535 were plain rimmed, 22 were slightly thickened, 8 were thinned, 3 had a gentle thinning from the inside only. Rim direction showed more variation



A. Vessel height in centimeters.



B. Orifice diameter in centimeters.



C. Body thickness in millimeters.

Figure 4: Vessel height, orifice diameter, and body thickness.

(see Table 4), but when tested against other variables in contingency tables showed no significant associations except with the variable sphere. In this case it was extremely strong; this however is an artifact of the redundant nature of the two variables. Logically, for a bowl to be hemispherical in shape its rim must be vertical, and this is what the test revealed. Therefore, Rim direction and Rim type were dropped.

Table 4: Rim type and Rim direction.

Rim Direction	Frequency	Rim Type	Frequency
1. Out slope	235	1. Plain	535
2. In slope	12	2. Thinned Int.	3
3. Vertical	290	3. Thinned	8
4. Warped	31	4. Thickened	22
Totals	568		568

The next stage in the analysis called for contingency table analysis of the design and morphological variables, both against themselves, and against several provenience variables (Appendix D) in order to determine if they could contribute any useful measure of chronological or spatial variation. However, as the list of variables in Appendix B shows, many of the variables had a large number of states, so that problems were encountered when using the chi-square statistic because many of the cells had expected values below the normal limit of five. This problem was anticipated, but it was felt that at the early stages of the analysis it would be better to be a splitter rather than a lumper. Therefore, during the contingency table analysis it was necessary to begin collapsing the variables, testing the results at various stages along the way. In most cases, the splitting had been slightly excessive and had resulted in far too many cells, none of which exhibited any obvious patterning when tested. One example of a variable which required considerable collapsing is that of paste (Table 5).

The logic behind the use of a large number of subjective colour codes was that there was no clear way to determine the exact colours except to use a colour chart, and this was impractical because of the variation found in individual pots. Perhaps the original subjective codes were naive; however I felt that no data could be lost in the beginning by splitting into subjective levels of colour. Most of these states were merged either according to the colour of the core of the body or were collapsed with the irregular category if no other determination was possible.

This process of attribute collapsing was carried out for the rest of the variables as well. The final attribute list is shown in Table 6.

Some of the variables which deserve special mention here are Focus, Layout, and Centre. As the contingency

Table 5: Paste Colour before and after collapsing.

Original Codes	Final Codes
1. Light brown	1. Brown
2. Medium brown	2. Grey
3. Dark brown	3. Irregular
4. Light grey	4. Orange
5. Grey	5. Black
6. Dark grey	
7. Black	
8. Orange	
9. Light edges, grey core	
10. Black core, thin light edges	
11. Irregular	
12. Grey interior, brown exterior	
13. Cream	
14. Light interior, dark exterior	
15. Brown interior, grey exterior	
16. Light exterior, black interior	
17. Light brown edges, grey core	
18. Buff	
19. White	

table analysis progressed, it became obvious that these variables were redundant measures of how the painted designs were placed on the interior of the pot. In the case of Layout, it was simply ill conceived. In the case of Centre, there was not enough variation to be meaningful; some 90 percent of the pots had open circular centres in the design field. The other possible centre configurations, however, were important because they often coincided with full field designs. Focus was also ill conceived, partly because it was in some measure redundant with Layout. For example, Focus #2 represents designs painted high on the inside of the bowls, below the rim. At the same time, Layout #1,#3, and #4 are always redundant with Focus #2. As well, some of the other Layout attribute states may also be redundant with Focus #2. I decided therefore to drop all three variables and design a new one. Format is the result (see Table 6).

The design elements were not treated exactly the same as the other variables. This is because there were some unique problems caused by the relative rarity of some design elements and by the difficulty in equating design elements with one another. For example, in the early element list (Appendix A) there were several elements which were very large or complex (#84 or #124, for example) which were very difficult to break down into smaller units. In this regard I attempted to follow Clarke in that a design element should be a "logically irreducible character state" (1968:139). As the analysis progressed, it became clear that although certain designs could perhaps be split into parts, the parts never occurred singly. Thus it would have been redundant and complicated to divide them.

Table 6: Attributes Selected for Cluster Analysis.

Band
1. Design connects with rimband
2. Thick lines
3. Thin lines
4. Thick over thin lines
5. Thin over thick lines
6. Complex lines (three or more types in combination)
7. Rimband expanded approximately .5 cm on interior
8. No band lines present, design separate from rim

Exterior surface colour
9. Grey
10. Brown
11. Irregular

Exterior Surface Finish
12. Slip wash
13. Slip spills at rim
14. No external slip

Format (see Appendix A for sketches)
15. Full field wedges
16. Full field offset
17. Full field continuous
18. Wall panels
19. Wall continuous
20. Wall interlocked
21. Wall pendant elements
22. Chords
23. Centre
24. Centre and walls

Surface Treatment
25. Pebbled
26. Striated

Symmetry
27. Single
28. Bilateral
29. Trilateral
30. Quadrilateral
31. Asymetric

Paste
32. Brown
33. Grey
34. Irregular
35. Orange
36. Black

Paint Colour
37. Black
38. Red
39. Brown

Temper
40. Grit
41. Angular sand
42. Sand

Baseline
43. Present

Design Element List (see Appendix A for sketches)
44. Lightning bolts
45. Pendant triangles
46. Based triangles
47. Curved sided pendant triangles
48. Armed elements
49. Scalloped edges
50. Sawtoothed lines
51. Scrolls
52. Wavy line
53. Zig-zag line
54. Ribbed lines
55. Heavy lines
56. Light lines
57. Free triangles
58. Angular scroll
59. Hachure
60. Rectangles
61. Hachure with wide border
62. Checkerboard
63. Interlocked rectangles
64. Feather motif
65. Curvilinear areas
66. Diamonds
67. Pendant double curved triangles
68. Circles
69 Opposed sawtoothed areas
70. Opposed triangle band
71. Scalloped star
72. Cross-hachure
73. Opposed areas
74. Stepped rhomboids
75. Stepped elements

Pdesign
76. Geometric designs on naturalistic figures
77. Plain black figures
78. Figures outlined with wide line
79. Scenic
80. Figure is in negative relief

On the other hand some divisions in the design elements could not be supported because of either the rarity of the element, or because they usually occurred together. For example, elements numbers 29, 50, 51, 81, and 120 all refer to what could be called a stepped element, either alone or in combination, pendant or based (see Appendix A). Whether or not the figure is filled with hachure or painted solid adds another dimension that results in 10 separate states. The data is simply not massive enough to handle this kind of division. As well, I am uncomfortable with it on an intuitive level. These are basically the same shapes in different orientations. Therefore, after plots of the spatial distribution and contingency table analysis failed to point out any patterning, these elements were all lumped together (see Table 6).

Stephen Plog (1980:40-53) takes a somewhat different view, preferring to separate all such possible differences, based on the theory that each design element represents a decision on the part of the prehistoric artisan. I can only suggest that with the Mimbres ceramics there would again be endless complication and a great deal of redundancy. Take, for example, whether or not designs are hached or solid. Plog (1980:53 Fig.44) shows that these are different decisions on the part of the artisan. If this is the case, then what of the case where a certain design is repeated many times on an individual pot? In the Galaz collection only 34 percent of the pots have either single symmetry or no symmetry. The other 66 percent are Bilateral, Trilateral, or Quadrilateral in symmetry, meaning that the same design is repeated 2, 3, or 4 times. However, many of the repetitions of similar forms are opposites, in that what was hachured on one side of the pot is solid on the other. We have the case where both sides of a dichotomy are present on the same artifact. On the Galaz pots the decision was taken therefore to record the various shapes as they appeared, and to record separately the presence or absence of hachure.

The problem presented by Plog is a real one however, and there is no certainty that the approach taken here is a better one. I have taken a somewhat traditional, and perhaps intuitive approach to design element definition. As Hill (1970) states in regard to his analysis of the Broken K. Pueblo ceramics:

> The decorated sherds had to be examined individually and then divided into element classes. This was done largely on the basis of <u>feel</u>... (Hill 1970:23)

At the base of it all, one questions that it matters how design elements are arrived at as long as they are in some manner not easily reducible into simpler forms. My own belief is that these simple forms are easily recognisable cross-culturally, and that little can be gained from continued pondering of the decision process involved in the mind of the artist. Perhaps more important is the way they are put together.

The Naturalistic paintings also provided a number of problems. Originally these were coded as to the species represented if possible (see Appendix C). Due to the nature of Mogollon art many could not be identified beyond such catchalls as "quadruped" or "reptile/amphibian". Another problem was encountered with the pots with scenic paintings. Often, more than one species was present, and often they were doing something identifiable as opposed to a simple portrait scene. As well, many of the pictured animals and people were either decorated with geometric designs or were in the midst of an otherwise normal geometrically painted pot.

The original list of naturalistic figures was tested against other design and morphological variables, including the design elements. No significant associations were noted. When plotted on the site map, or tested against the provenance data there was also no significant result. The only pattern to emerge was that the pictographic images seemed to be more common in the southeast roomblock (Block 3) than in the others. However, no pattern of individual pictograph states was evident. Since some of the pictograph codes were subjective to an extent, it was decided to collapse the list to a more general level of biological taxonomy. This list is given in Appendix C. Again, when plotted and tested in contingency tables, no pattern emerged. This was a surprising and disappointing result. Catherine LeBlanc (1977, reported in S.LeBlanc and Whalen 1980:233) has shown that animal motifs are differentially distributed in the Mimbres area. She suggests that the model that best fits the data is one in which certain localities exhibit certain motif preferences; as distance increases from any one locality, the similarity in motifs decreases. This pattern of clinal distribution is consistent, she suggests, with the model of a regional exchange system in the Mimbres area. Considering that there is estimated to have been a hundred person sized Pueblo every three miles along the Mimbres River during the Classic Period (LeBlanc 1976:5), it is not hard to imagine considerable trade along the river. It was hoped that similar patterning might be discernable within the Galaz site.

Since naturalistic motifs did not seem to provide any interesting variability, they were also dropped from the general analysis. Instead, a variable, called Pdesign, was substituted in an attempt to measure stylistic differences in the representation of the motifs.

Chapter 8

CLUSTER ANALYSIS RESULTS AND TESTS

The final step in the analysis, once the attribute list had been finalized, was to decide on a form of cluster analysis suitable for the sample. This proved to be a more difficult assignment than any other part of the analysis. There is a truly bewildering array of techniques available. The literature describing these methods has been growing at such a rate that I will not attempt to summarize it. Recent, valuable introductions to the literature of cluster analysis are provided by Dunn and Everitt (1982), Everitt (1980), and Clifford and Stephenson (1975). More technical reviews are provided by Anderberg (1973), Cole (1969), and Jardine and Sibson (1971). Sneath and Sokal (1973) also provide a non-technical but theoretically oriented discussion of the place of cluster analysis in taxonomy.

The availability of cluster programs is the first limiting factor in the choice of a method of analysis. Fortunately, the University of Manitoba Computer Centre maintains the CLUSTAN 2 package of cluster programs written by David Wishart (1975). All program names referred to here are cluster methods available in the CLUSTAN package. The second major limiting factor in the choice of cluster methods is the size of the problem. Even with the condensed attribute list shown in Table 6, many methods could not be used due to the size of the Galaz data set. Thus, the choice of cluster methods was limited to two: iterative relocation (RELOCATE), and monothetic divisive methods (DIVIDE) (Wishart 1975)

The iterative relocation procedure begins by partitioning the sample into a user-specified number of clusters. It then begins alternative cycles of moving cases to more appropriate clusters, and then merging clusters which are most similar. This process of relocating and fusing (one pair at a time) continues until the user-specified minimum number of clusters is reached. The initial allocation of cases to clusters can be random, user specified (the output from another cluster procedure for example), or, in smaller problems, each individual may be treated as an initial cluster. One of the effects of this procedure is that different starting points in the data may result in different classifications, but there are methods available in the program to control for this problem.

The divisive procedures are of two kinds, nested and hierarchic. The nested procedure splits the entire sample according to the presence or absence of a single attribute which has been determined by some statistic (e.g. chi-square) to make the most significant distinction between groups. The next step divides the two subsets on the presence or absence of a second attribute into four groups. This process continues until the specified number of clusters has been reached.

The hierarchic procedure begins the same as the nested, but differs in that after the first step the sub-groups are treated individually, so that Group A may not split into subgroups until Group B may have split several times. In the nested procedure the results are balanced in that each group splits an equal number of times so that the only possible results are with two, four, eight, sixteen, and so on, number of groups. The hierarchic procedure can produce any number of groups because it continues splitting one sub-group at a time until the specified number is attained.

The hierarchic procedure would seem to be more reasonable in an archaeological context, because it does not force the continued splitting of groups. If a particular group is homogenous, it will not be split until all other less homogenous groups have been split. This is not the case in the nested procedure.

A hierarchic divisive procedure called "monothetic subdivisive classification" for archaeological use has been designed by Whallon (1971), and an application of this procedure to an archaeological assemblage has been published (Whallon 1972). He suggests (1972:31) that the divisive procedure is a good parallel of "primitive" classificatory schemes and thus is more applicable to anthropological use than polythetic procedures. This is perhaps the main difference between the divisive and the relocation procedures. The former are monothetic, in that groups are defined on the presence of a specific list of attributes, while the latter is polythetic, so that groups are defined on a measure of overall similarity. The presence of any one attribute state is not necessary for group membership. The two procedures thus make use of radically different concepts about the definitions, and shape of object clusters. Sokal (1977:4) takes a position contrary to Whallon, suggesting that "monothetic classifications are useful for taxonomic keys, but the resulting arrangement of natural objects is frequently unsatisfactory".

A second diffence between the two procedures is the reiterative nature of RELOCATE. This allows the movement of cases which may have been badly classified at an early stage in the analysis. A drawback to most hierarchic procedures is that once an object is placed in a group its position cannot change.

Both kinds of cluster analysis were used in this analysis, mainly because of these contrary views of the nature of clusters, and of the nature of classificatory systems. Until we better understand the nature of both primitive taxonomies and numerically produced "natural" taxonomies, it seems premature to limit our analyses to one numerical technique.

Although a number of cluster analyses were run on the Galaz data, only two will be discussed here. Other runs were done at various stages to various levels of attribute numbers. Most did not provide useful results, although some did produce individual clusters similar to those which we will discuss. In most cases only a single reasonable cluster would result from each of the early runs, as well as a number of uninterpretable clusters.

The first analysis to be discussed is the divisive procedure. Both nested and hierarchic analyses were done during this run; the nested technique was taken to five steps with thirty-two clusters as a result. The hierarchic technique was taken to forty clusters. Figure 5 shows the division tree produced by CLUSTAN for the nested division technique along with the measure of total dissimilarity coefficient.

The dissimilarity measure can be thought of as a measure of the amount of information gained at each step of the division. If we think of the complete sample as one group, the amount of information lost by grouping quite dissimilar objects together is quite large. As the procedure progresses, the amount of dissimilarity between members of each group decreases, and the total dissimilarity decreases. The decision about where to slice the graph to determine the appropriate number of clusters is an arbitrary one based on judgement. A usual place to slice the graph is at a point where the jump to the next division step is not large in relation to the last. In this case, an appropriate

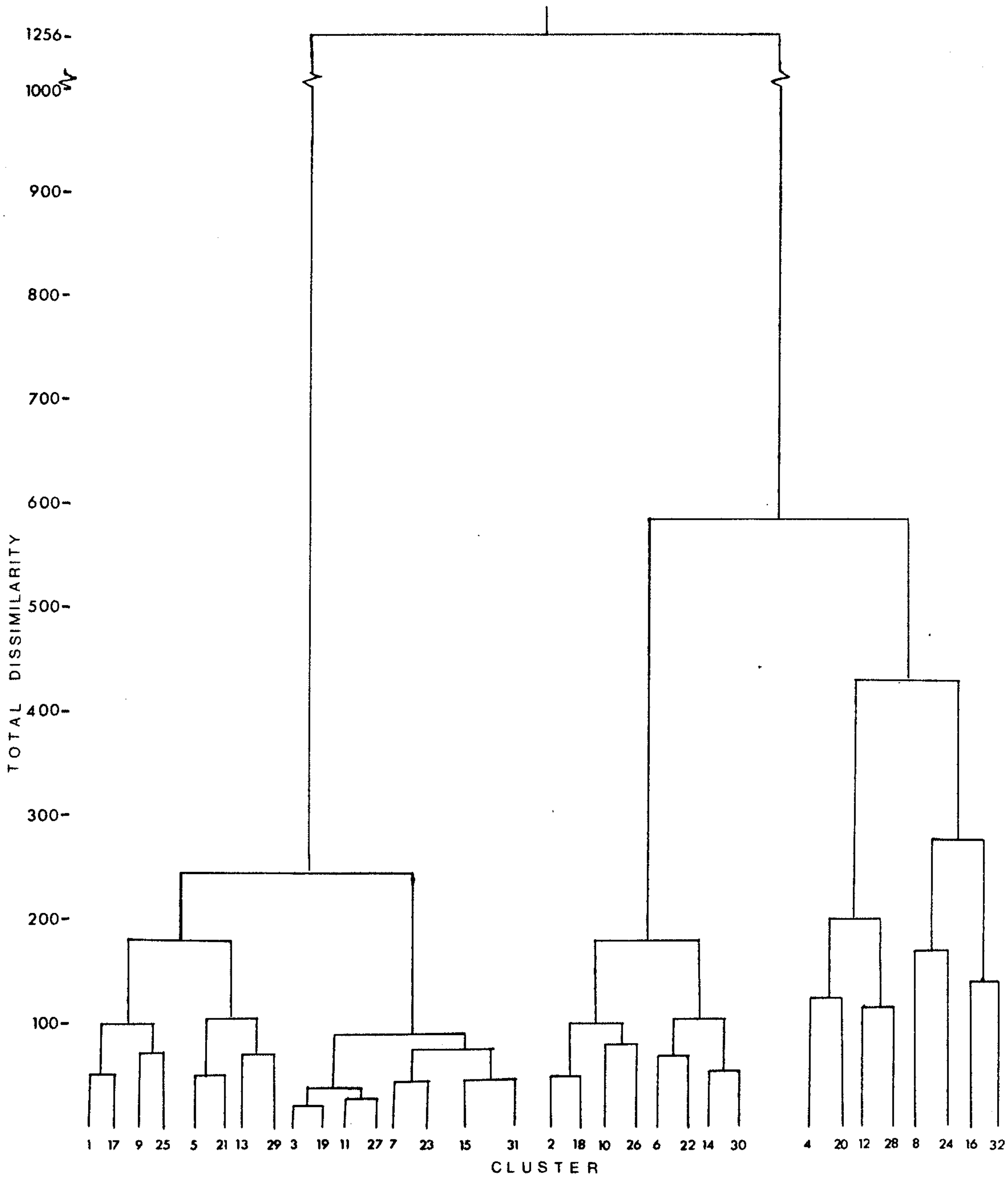


Figure 5: Dendrogram output of nested Procedure

point would seem to be at the ten cluster level. However, since the nested procedure only produces results in powers of two we will have to be satisfied with eight or sixteen clusters. Therefore, the resultant cluster groups for eight, sixteen, and thirty-two were stored and analysed using the Statistical Analysis System (Helwig and Council 1979). The thirty-two cluster solution was analysed even though it is beyond the optimum number because it was thought that this level of clustering might be more sensitive to small, possibly local distributions of pots. One problem with the divisive technique is that only four variables define all types at the sixteen cluster level. This may be sufficient for most taxonomic purposes but seems to be too few to find localized clusters within a site.

Figure 6 shows the output dendrogram from the hierarchic technique. The dissimilarity measure functions in the same fashion as in the nested division. In this case, the appropriate division step is not so clear, but cluster solutions for eight, sixteen, and thirty clusters were chosen.

The RELOCATE procedure allows one to specify both the initial and the final number of cluster groups. As well, it allows the user to specify initial group membership in the case where the initial number of clusters is less than the number of cases. In this case, CLUSTAN was allowed to randomly allocate the cases to thirty groups. Previous

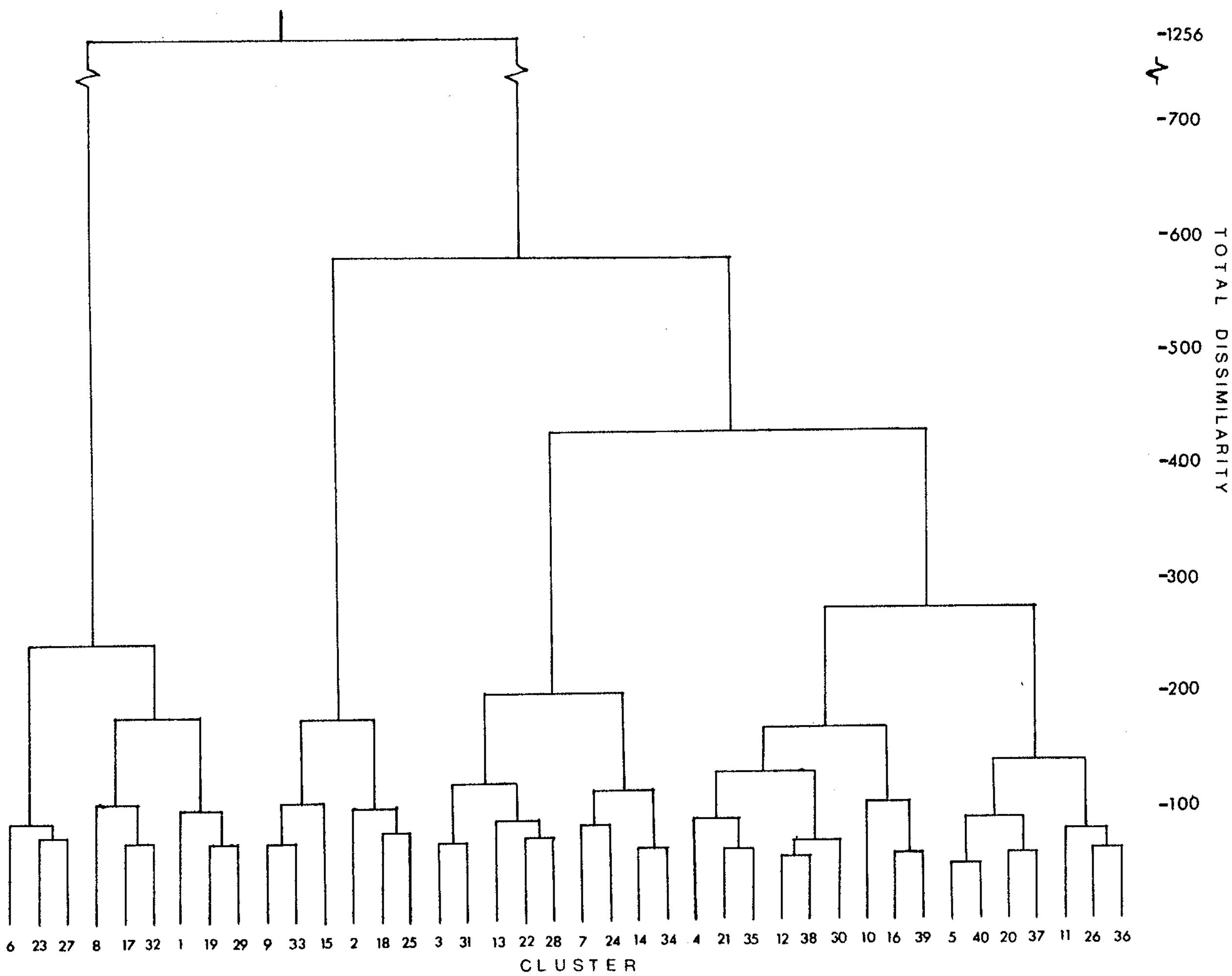


Figure 6: Dendrogram output from Hierarchic procedure.

runs, using a number of starting methods suggested by Wishart (1975:45) as ways to determine if the starting point could cause varying results, had shown that for the Galaz sample initial cluster allocation was not an important criterion.

For the RELOCATE technique, a dissimilarity measure called "squared Euclidean distance" was used. In this case a dendrogram is inappropriate because the relocation of cases makes the output non-hierarchic. Cluster members can be moved several times in each relocation cycle and at every relocation cycle. It is impossible to follow a case up or down in a linear fashion as is possible in divisive or other hierarchic procedures. Therefore, only the graph of the dissimilarity coefficient is used to determine the optimum number of clusters.

Figure 7 is the graph of the dissimilarity coefficient for the RELOCATE procedure. It shows a clear change in the trend of the dissimilarity measure at the twenty-three cluster level. The remainder of the graph shows no other obvious changes, but there is a slight jog followed by an upswing at the eleven cluster level. In order to compare the results with the divisive procedure results the solutions at the eight and thirty cluster levels were also analysed. It should be noted concerning Figure 7 that since the RELOCATE procedure is agglomerative the dissimilarity coefficient increases as the analysis proceeds rather than

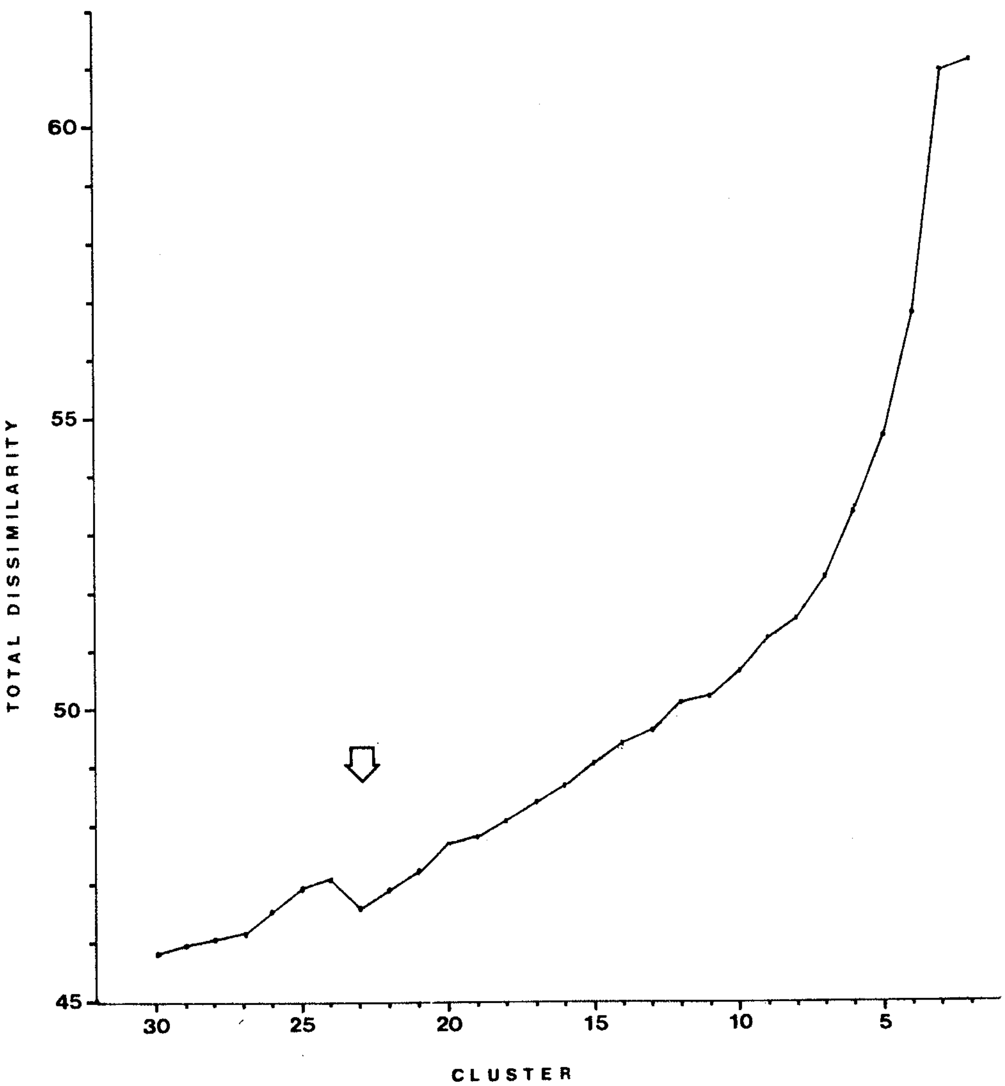


Figure 7: Graph of RELOCATE dissimilarity coefficient.

Table 7: Burial Sequence Categories.

Early	Middle	Late
Extramural Burial	Usually Extramural	Usually Intramural
No grave goods	Some Intramural	Turqoise and Shell common
If Bowls found then broken and scattered	Some turquoise and shell found	Burial pits oval
No turquoise or shell	Bowls randomly placed over body	Bowls killed, placed over skull
	Sometimes broken and scattered	Often many bowls
		Grave goods common

Note: Early and Middle were merged into a single 'Early' category.

decreasing as in the divisive procedure.

Three measures of chronological and spatial patterning were designed in order to test the cluster results from both procedures (see Table 7). The first, Burseq, was designed using published data on burial changes through time in the Mimbres area (LeBlanc and Whalen 1980:187-190,263-267, Cosgrove and Cosgrove 1932:23-29). At first, three categories were used: Early, Middle, and Late. Each referred roughly to one of the time periods of the San Francisco phase, the Three Circle phase, and the Classic Period, respectively. Analysis of the burial data showed that there was little hope of differentiating San Francisco and Three Circle phase material; only one case could be fairly confidently ascribed to the San Francisco phase. Therfore, the Early and Middle categories were merged into an Early category. Table 7 shows the categories and the criteria used to establish them. One problem with San Francisco phase burials is that they very seldom contain grave goods so that they were usually not considered as part of the sample. It was only late in this phase that burials included a single bowl, broken and scattered over the burial.

The second provenience variable designed to test the cluster groups is Roomblock. In all seven categories were created, including Classic roomblocks, extramural proveniences, pithouse proveniences, and pre-Animas proveniences. The Classic period dwellings were divided into four roomblocks; all rooms in each roomblock were probably contemporaneous. Figure 8 shows roomblocks one through four (roomblock code numbers are circled on the map). Roomblock #4 is fairly amorphous and I am unsure if this results from the excavating techniques used or because of the number of pithouse and extramural storage pits found in that area (not shown on map). Unfortunately, the data recorded at Galaz were not of sufficient quality to determine exact construction sequences and it is obvious that some rooms had several floors. There is no way to consistently determine whether these represent long habitations during a single phase or if rooms were abandoned

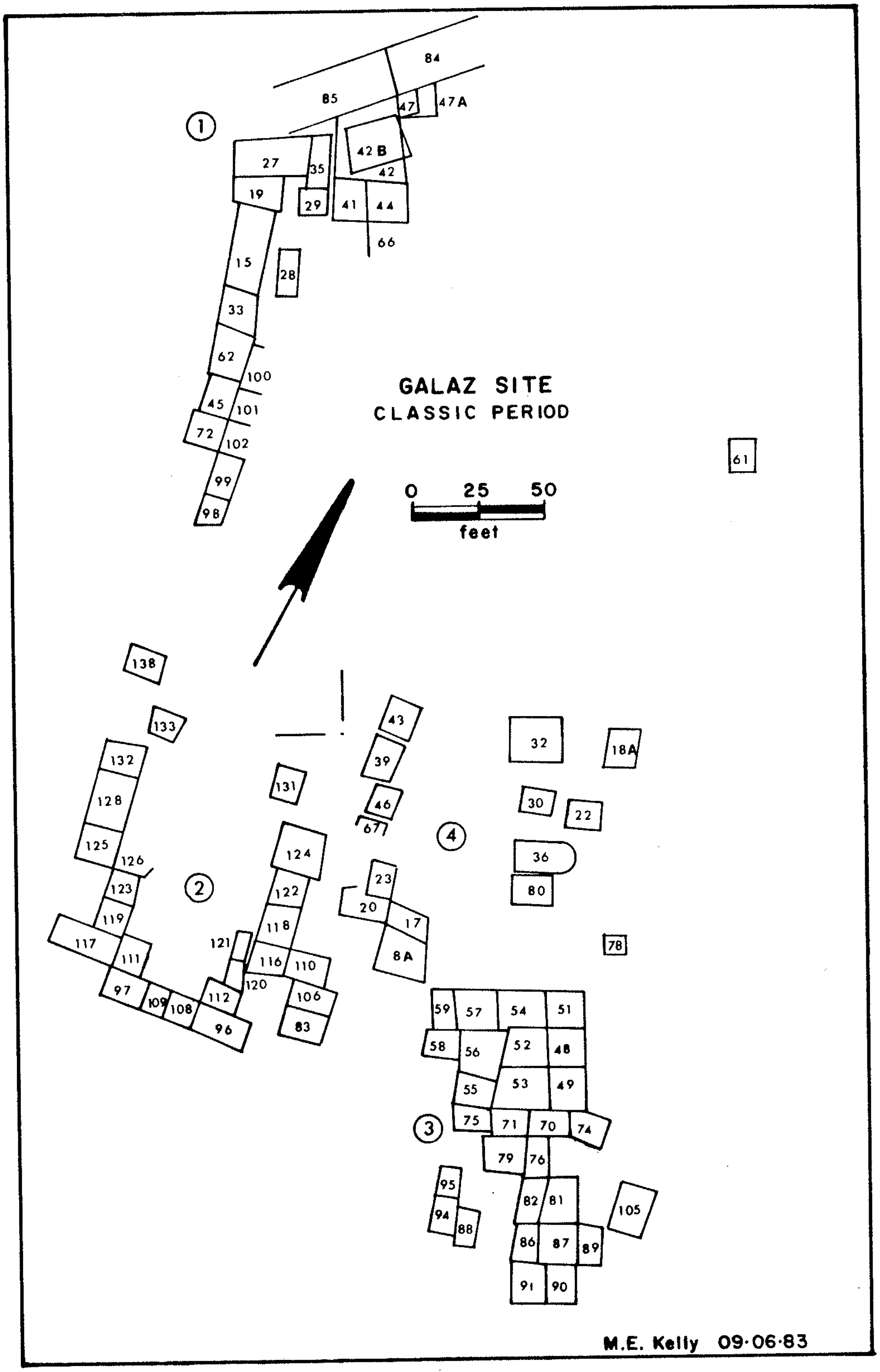


Figure 8: Galaz Classic roomblocks, block numbers are circled.

and reoccupied later with renovations.

All pithouses were included together as a seventh category even though a number were probably from earlier periods (see Figure 9). However, the sample of pots from pithouse phase rooms was too small to subdivide according to phases.

Category six was added to include extramural burials since there was no way to establish which roomblock they may have been associated with. Although depth of the burials was usually recorded there is little information concerning stratigraphy so that it was impossible to use relative depth to sort out the pithouse burials from the classic burials.

One further problem with the roomblock data is the Animas phase occupation which overlies part of the site (see Figure 10). In practice it was easy to eliminate Animas phase burials, as discussed earlier, and these were discarded before the analysis began. However, there are a number of obviously Mimbres-Mogollon burials under the Animas dwellings. Since it was impossible to determine whether the burials were extramural or below Mimbres phase dwellings which had been reoccupied, the Animas phase roomblock was coded separately, to indicate the Mogollon burials found beneath it.

The last test variable is called Context. Context is similar to Roomblock with the exception that all burials

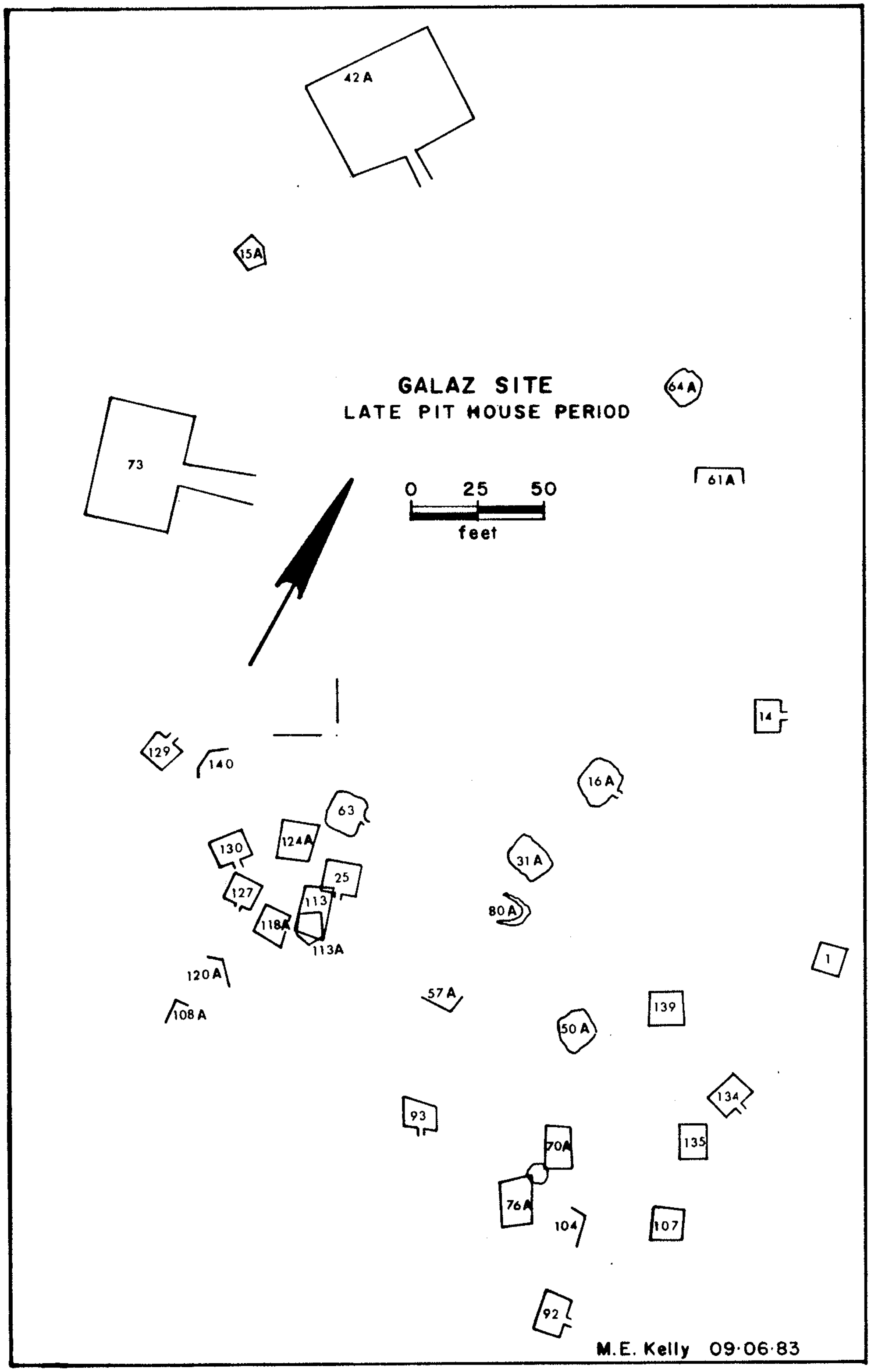


Figure 9: Galaz site, pithouses.

Table 8: Crosstabulation of Clusters by Provenience Measures.

Clustering Results

Test Variable	ND 8	ND 16	ND 32	HD 8	HD 15	HD 30	RL 8	RL 11	RL 23	RL 30
Burseq	S	S	#	S	*	#	S	S	#	#
Context	S				*		S	*	#	
Roomblock	S	S			*		*	*	#	

Note: S = significant association using chi-square

* = significant association using Snedecor and Cochran's criteria (1973:242).

\# = Non-significant but interesting cell distributions.

ND = Nested Division, HD = Hierarchic Division,

RL = Relocation.

found in Classic contexts are lumped together, while all pithouse burials are also lumped. In all there are four categories: pithouse, classic, extramural, and pre-Animas. The last category was included for the same reasons given for the Roomblock variable.

These three variables: Burseq, Roomblock, and Context are the primary scales against which the cluster results are tested. To some extent these three are related measures; this is unfortunate, but unavoidable. The Galaz provenience

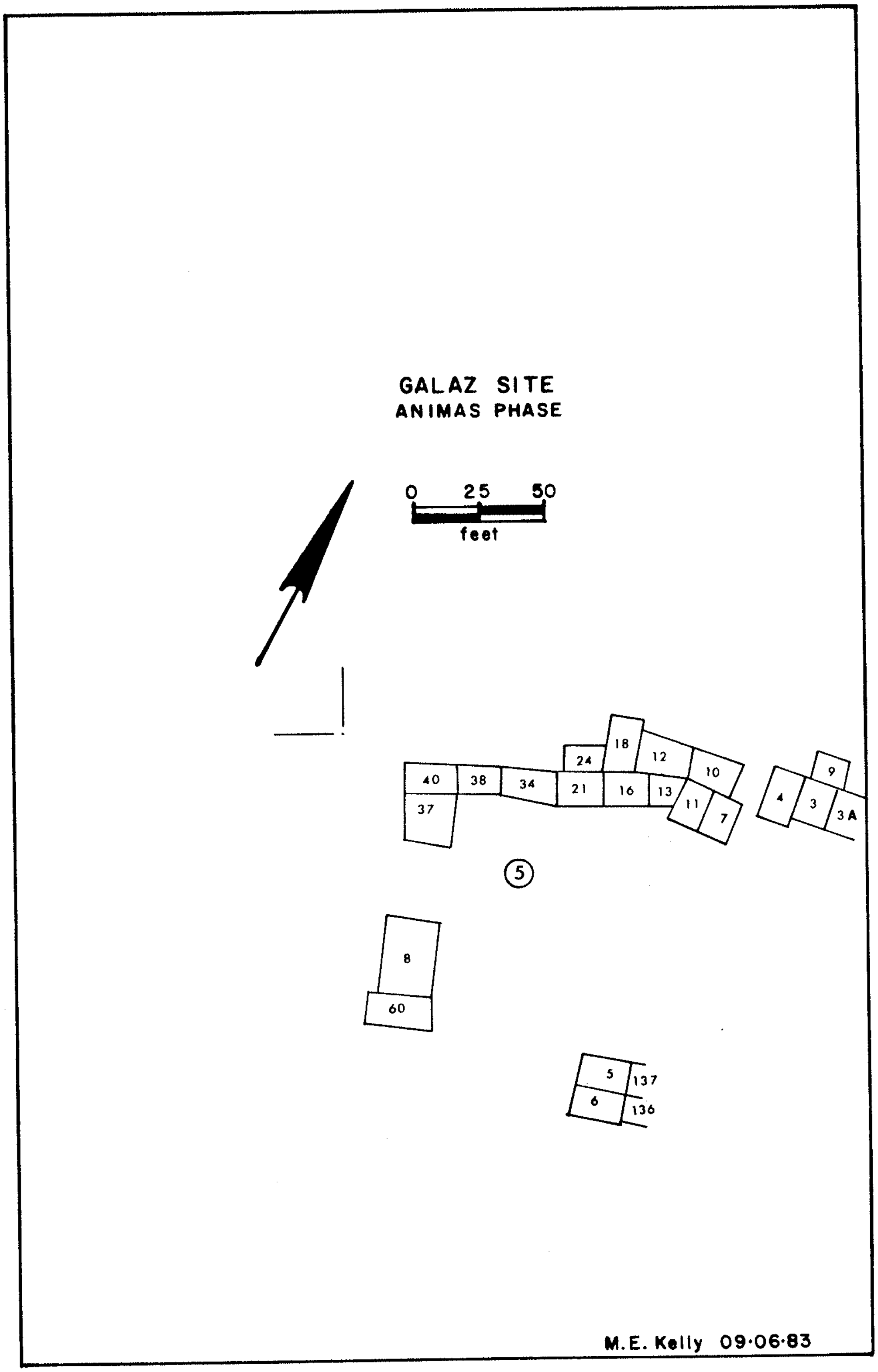


Figure 10: Galaz site, Animas phase roomblock.

data is not good enough for finer tests. Roomblock and Context are fairly closely related because they are based on the same chronology of changes in dwelling morphology. Roomblock was included because it differentiates within the Classic Period as well as between it and the Late Pithouse. It was thought that this might aid in discriminating differences in ceramic types within the Classic occupation. Although there is no evidence that all four Classic roomblocks are contemporaneous, it is reasonable to expect that some of them are, since the Classic Period is proposed (LeBlanc 1977:1) to have lasted a maximum of one hundred and fifty years. Thus, although these measures are related in form, it is hoped that the roomblock variable will also discriminate differences in social organization or exchange patterns within Galaz.

Ways in which these test measures might be improved all require more detailed data and analyses of the provenience data. Some of these data are available, for example, the recording of burial positions, pit sizes, and grave goods is fairly good at Galaz. Given more time and access to the excavation notes I am sure a more detailed sequence could be proposed. On the other hand, construction sequences of the various roomblocks is extremely difficult to determine because the methods by which walls were attached to one another at room corners were seldom recorded. This is unfortunate, because the technique of relative dating from construction sequence has been used with some success in the Southwest.

In order to test that the clusters produced by the three procedures differ from a random distribution, a chi-square test was performed on the contingency tables comparing each cluster with each of the provenience variables. The chi-square statistic compares the observed frequencies in each cell of a contingency table with the expected value for that cell. The expected value for each cell is calculated using the marginal distributions, under the assumption of the null hypothesis. Thus, the calculation is made assuming that the distributions of the two variables compared are independent so that knowing the value of one variable would not enable us to predict the value of the second variable. The difference between these two values, the expected and the observed, is squared, then summed for all cells, and then compared to the standard chi-square tables. A proper test using the chi-square statistic requires that the researcher determine in advance a point, called the level of rejection, at which he will reject the null hypothesis that the expected values and the observed values are drawn from the same population. A chi-square value greater than the rejection value indicates that to some degree we can predict the value of variable B given the value of variable A. The association revealed by the chi-square statistic is, however, subject to a probability value that tells us to what degree we risk being in error, that is, the possibility that there is no association even though the statistic indicates one. Common values chosed for the rejection level usually have associated pobabilities of .05 or .01 percent.

One further parameter of the chi-square statistic is that cells must have expected values of at least 5. This causes problems if the sample size is small, or if the number of attribute states is large. Snedecor and Cochran (1973:242) discuss this parameter, and conclude that the chi-square statistic may be used on tables in which the minimum expected value of 1 is present in no more than one quarter of the cells, and if the other expected values are much larger.

The results of the contingency table crosstabulations are summarized in Table 8 (complete contingency tables are presented in Appendix E). Significant associations at the .01 level which meet the strict chi-square parameters are marked with an S. Those which are significant using Snedecor and Cochran's (1973:242) criteria are marked with an asterisk. Those which are non-significant but which show interesting patterns on visual inspection of the tables are marked with a '#'.

Examination of Table 8 shows that the only consistently significant results are found at the eight cluster level, although, interesting results are present at the sixteen cluster level. The thirty cluster solutions show interesting but not significant results, due mostly to the large number of clusters. Dividing the sample up in this many clusters causes extremely low expected values in a large number of cells with the result that the chi-square test is not applicable.

Only the cluster solutions at eight cluster level will be examined here in detail. This decision was reached for three reasons. First, the solutions at greater levels are not as significant nor as consistent as the eight cluster level. Second, time constraints will not allow detailed examination of all the clusters at the sixteen and thirty cluster level, since the number of clusters to look at would be well over one hundred. Howwever, given the results summarized in Table 8, it would clearly be possible to define more detailed sub-types within the Galaz Site. Third, a typology which is designed to be useful in the context of the Mimbres valley would only be obscured by such within site variation. On the other hand, given a sample of ceramics from many Mogollon sites, such subdivisions might be included in the typology.

A more detailed summary of the results of the contingency table analysis at the eight cluster level is given in Table 9. In this table, cells which exhibit greater observed values than expected values are marked with an X. This was subjectively done in that no statistical measure of the disparity of the two values was used. However, examination of the complete contingency tables

(Appendix E) will show clear, positive associations. Those cells which show weak, yet significant associations are marked with an asterisk, Those which show positive associations but are non-significant are marked with a '#'. The significant values (X and *) are significant at the .01 level.

Close examination of Table 9 reveals a pattern of cluster associations with certain proveniences. As well, it shows that the hierarchic solution consistently shows the same patterns of positive associations as the nested solution. Cluster pairs A and I, D and K, G and N, and H and L, exhibit similar patterns of distributions when compared with the provenience variables, and also in some cases are the same size. I suspect the clusters with identical sizes, such as A and I, are those which separated early in the procedure. This would seem to indicate that they are fairly stable clusters. Since the results from the two divisive procedures are somewhat redundant, and since the results from the hierarchic clustering are different enough to be non-significant, the hierarchic solution will be dropped from further analysis.

The results from the RELOCATE procedure are somewhat different from the divisive results, although some clusters do show distributions similar to the nested division, Clusters B and V for example. One problem with the relocation procedure results is the two singlton clusters, T

Table 9: Eight Cluster Solutions with Positive Associations.

Cluster number	Burseq O	E	L	Context P	C	E	U	Roomblock 1	2	3	4	5	7	Size	Code
ND8-1			X			X				*				62	A
2		X		X					*				X	48	B
3										*				9	C
4			X				X				*	*		129	D
5			X			X								61	E
6		X			*		*	*			*			52	F
7	X				X			X						27	G
8							X			*		*		180	H
HD8-1			X			#				#				62	I
2		X		#					#				#	100	J
3			X			#	#				#			76	K
4							#		#	#		#		111	L
5					#					#				69	M
6	X				#			#						36	N
7			*					*						53	O
8			X			#								61	P

(continued)

Abbreviations: Burseq O = Unknown, E = Early, L =Late
Context P = Pithouse, C = Classic,
E = Extramural, U = Unknown
Note 1: Roomblock = 6 is equal to Context = Extramural
Note 2: X = significant, positive association.
* = significant, weak positive association.
# = non-significant, positive association.
Results are significant at the .01 level.
Note 3: ND = Nested Division, HD = Hierarchic Division,
RL = RELOCATE.

(Table 9 continued)

Cluster	Burseq			Context				Roomblock						Size	Code
number	O	E	L	P	C	E	U	1	2	3	4	5	7		
RL8-1	*		X		*					*		*		116	Q
2		X							X			X		78	R
3			X			X				*				144	S
4														1	T
5														1	U
6		X		X									X	69	V
7							X				*	*		85	W
8			X		X					X	*			74	Y

Abbreviations: Burseq O = Unknown, E = Early, L =Late
Context P = Pithouse, C = Classic,
E = Extramural, U = Unknown
Note 1: Roomblock = 6 is equal to Context = Extramural
Note 2: X = significant, positive association.
* = significant, weak positive association.
# = non-significant, positive association.
Results are significant at the .01 level.
Note 3: ND = Nested Division, HD = Hierarchic Division,
RL = RELOCATE.

and U. These developed quite early on in the procedure, appearing at about the sixteen cluster level, and remaining until the two and three cluster level. I am unsure why this happened; visual inspection of the pots does not reveal any obvious differences. Due to the problems of low cell values which would arise in the contingency table analysis, these two clusters were merged in calculating the chi-square statistic. As well, they will not be described in detail. Hindsight reveals that the ten cluster level might have been more appropriate for detailed analysis. This was not done due to time constraints.

Several interesting results should be noted concerning the cluster distribution displayed in Table 9. First, the convergence of Clusters B and V and their association with both early burial forms and pithouses clearly makes this an early type. The divisive procedures show these clusters to have a slight association with Roomblock 2 as well. This is either a result of the large number of pit houses which underly that block, or the block is transitional between Three Circle and Classic times. More detailed analysis of burial provenience and perhaps of the architectural detail would be needed to determine the answer.

Another interesting point is that there are more types which are identified as Late in the burial sequence that are extramural, than there are which are Late and associated with Classic contexts. This is unexpected and perhaps indicates that extramural burials continued as a common form of burial in the Classic period. On the other hand, the Roomblock variable also seems to indicate some weak localization of clusters with roomblocks. The fact that most are weak associations is to be expected; it seems unreasonable to expect no exchange between contemporaneous roomblocks, and if they are non-contemporaneous, even a few extra-local burials would weaken the association.

Table 10 lists the clusters produced by the nested division and the relocation procedures, along with their component attributes. A disturbing result of the clustering which is pointed out by Table 10 is the remarkable similarity of all clusters. Several variables appear to be present in high frequencies in all clusters. Attribute 25 for example, is present in all clusters so it can be of little use in discriminating types. This most probably indicates that these variables do not measure any important dimension of variability in the data. Whatever the cause, it is important to weed these variables out before type definition begins.

One method of determining which variables are truly patterned from those which are clutter is to compare the cluster frequencies with the overall frequencies. This is called the binary frequencies ratio, (Wishart 1975) and is the percentage occurance of an attribute in a cluster divided by the percentage frequency of the attribute in the population as a whole. Any variable with a binary frequencies ratio of 1 is thus present to the same extent within the cluster as without. All clusters from the two remaining procedures were examined to determine which attributes could be dropped. Any variable with a binary frequencies ratio of less than the arbitrarily chosen value of 1.5 was discarded.

One other factor that is important in the selection of the final attribute list for each cluster is the absolute frequency of the variable. Many variables exhibit very high binary frequencies ratios but also have such low sample

Table 10: Clusters and Component Attributes.

Cluster	Code	Size	Attributes Present
Nd8-1	A	62	37 27 23 25 9 41 5 33
2	B	48	1 14 9 25 41 45 37 28
3	C	9	27 15 9 25 59 9 37 33 45
4	D	129	28 25 41 59 9 37 33 45
5	E	61	23 27 25 39 41 76 9
6	F	52	1 25 45 9 28 37 41 13 12
7	G	27	27 25 9 37 14 39
8	H	180	37 30 25 9 59
RL8-1	Q	116	37 30 9 25
2	R	78	39 41 8 33 25 26 48
3	S	144	27 23 25 9 58 41
4	T	1	
5	U	1	
6	V	69	1 9 14 25 41 45 28
7	W	85	28 25 37 59 45 9 55 41
8	Y	74	59 43 2 25 9 37 33 41 45 14

Note: only attributes with greater than 50 percent cluster frequencies are listed.

frequencies that even a few examples in any one cluster is enough to give a high value. If this was the case, the attribute was dropped from the cluster description.

Table 11 shows the sorted attribute state lists for each of the clusters in the nested division and relocation procedures, except clusters T and U which were single occurrences. The attribute states are listed roughly in the order ot their frequency, from most to least. This is not exact due to the addition of some attributes which were not present in great frequencies but which had high binary frequencies ratios. The numbers beside each attribute state are the code numbers as presented in Table 6.

One thing which should be noted about Table 11 is that one could profitably look at those attribute states which do not occur in each cluster. Along with small binary frequencies ratios, this would indicate attribute states which were avoided in the manufacture of particular types. This was not done here due to time and space limitations, but it is an area of research which would probably give significant returns.

Examination of Table 10 clearly shows three types which are, in each case, made up of three clusters. This would seem to indicate that a reasonable cluster solution could be developed at a lower cluster level since very similar clusters, B and F for example, appear to have split. On the other hand, it might be that the cluster analyses are demonstrating variation which might be due to differences in social organization or chronological changes within the Galaz Site. In this case the clusters used here to describe types might usefully be thought of as sub-types.

The first type is represented by clusters B, F, and V.

Table 11: Final attribute lists by cluster.

Cluster A	Cluster B
37. Black Paint	1. Design connects rim
27. Single symmetry	14. No slip on exterior
23. Centre focus	45. Pendant triangles
5. Thin/thick band lines	28. Bilateral symmetry
76. Geometric pict.	15. Full field, wedges
77. Plain pict.	16. Full Field, offset
	17. Full field, continuous
Burseq Late	30. Quadrilateral symmetry
Context Extramural	Burseq Early
Roomblock 3	Context Pithouse
	Roomblock 2
Cluster C	**Cluster D**
27. Single symmetry	28. Bilateral symmetry
15. Full field, wedges	59. Hachure
59. Hachure	69. Opposed sawtoothed areas
14. No exterior slip	18. Wall, panels
80. Negative pictographs	19. Wall, continuous
3. Thin band lines	20. Wall, interlocked
Roomblock 3	21. Wall, pendand elements
	Burseq Late
	Context Unknown
	Roomblocks 4 and 5

(continued)

(Table 11 continued)

Cluster E 23. Centre Focus 27. Single symmetry 39. Brown paint 76. Geometric pictograph 77. Plain pictograph 78. Outlined pictograph 79. Scenic pictograph Burseq Late Context Extramural	Cluster F 1. Design connects rim 45. Pendant triangles 28. Bilateral symmetry 13. Slip spills at rim 12. Slipwash all over 54. Ribbed lines 55. Heavy lines 56. Light lines 30. Quadrilateral symmetry Burseq Early Context Classic/unknown Roomblocks 1 and 3
Cluster G 27. Single symmetry 19. Wall continuous 24. Centre, and wall focus 66. Diamonds 72. Cross-hachure Burseq Unknown Context Classic Roomblock 1	Cluster H 18. Wall, panels 19. Wall, continuous 20. Wall, interlocked 30. Quadrilateral symmetry 60. Rectangles 43. Base bands present 46. Based triangles 31. Asymmetric Context Unknown Roomblocks 3 and 5

(continued)

(Table 11 continued)

Cluster Q 37. Black paint 30. Quadrilateral 13. Slip at rim 26. Striated 4. Thick/thin band lines 5. Thin/thick band lines 6. Complex band lines Burseq Late Context Classic Roomblocks 3 and 4	Cluster R 39. Brown paint 26. Striated 13. Slip at rim 18. Wall, panels 19. Wall, continuous Burseq Early Roomblocks 2 and 5
Cluster S 27. Single symmetry 23. Centre focus 76. Geometric pictograph 77. Plain pictograph 5. Thin/thick band lines Burseq Late Context Extramural Roomblock 3	Cluster V 1. Design connects rim 14. No slip on exterior 45. Pendant triangles 28. Bilateral symmetry 51. Scroll 61. Bordered Hachure 15. Full field, wedges 16. Full field, offset 54. Ribbed lines 65. Curvilinear areas Burseq Early Context Pithouse

(continued)

(Table 11 continued)

Cluster W	Cluster Y
28. Bilateral symmetry	59. Hachure
59. Hachure	43. Baseband present
45. Pendant triangles	2. Thick band lines
55. Heavly lines	45. Pendant triangles
69. Opposed sawtoothed areas	46. Based triangles
74. Rhomboid band	18. Wall, panels
Context Unknown	19. Wall, continuous
Roomblocks 4 and 5	20. Wall, interlocked
	29. Trilateral symmetry
	73. Opposed areas
	69. Opposed sawtoothed areas
	75. Stepped elements
	49. Scalloped edges
	Burseq Late
	Context Classic
	Roomblock 3

The most stable feature of this type is that the design touches the rim in very nearly all the cases; there are no band lines between the rim and the geometric designs. The designs are most commonly bilateral and the format is full field. One result of the examination of the cluster attributes lists is the realization that the format types are not important except in the separation of full field from wall formats. In every case where format played a role in cluster formation, all wall formats grouped together and all fullfield formats grouped together. The full field is associated with the Pithouse phase, and the wall format with the Classic period.

A closer examination of the CLUSTAN output also reveals that Quadrilateral symmetry was present in about 30 to 40 percent of the pots in Clusters B, F, and V. This, combined with the bilateral symmetry frequencies of about 50 percent shows that only two basic forms of symmetry were used consistently in this type. This is important when compared to Type 2 in which there is a wider variety of symmetry states present.

Other variables which are important in Type 1 are curvilinear areas, scrolls, and pendant triangles. Also, hachure with wide border and the ribbed line element are associated with this type. LeBlanc has suggested (see Chapter 5 for discussion) that these last two are diagnostic of a transitional type between Boldface and Classic Black-on-white. This analysis suggests that these elements are more closely associated with the pithouse phase, and not at all with the Classic period occupation.

The provenience associations of Clusters B and F seem to point to two sub-types of Boldface which were either non-contemporaneous or perhaps were the result of some social relationships at the Galaz site. Cluster F exhibits a high degree of Format 7 (Wall, pendant elements), while Cluster B is predominantly full field. Also, Cluster B has no slip on the exterior while Cluster F has a high degree of either slip spills at the rim or slip smoothed into the exterior. Cosgrove and Cosgrove (1932) discussed slip on the exterior of Black-on-white pots, and concluded that Boldface had no spills on the exterior while Classic often had. Again, it is possible that Cluster F represents a transitional form but it is more likely that slip spills on the exterior are non-diagnostic.

The associations of Clusters B and F with Classic period roomblocks is difficult to explain; one possibility is that they were mis-attributed when excavated. Roomblock 2 has very complicated stratigraphy which was never completely figured out according to the excavation notes. Several pithouses also underly Blocks 1 and 3, and the practice of extramural burial in pithouse times makes it difficult to accurately identify their burials. What was a pithouse phase, extramural burial may appear to become Classic intramural burial when a surface Pueblo is constructed on top.

Type 2 is a combination of Clusters D, W, and Y. The designs are formated on the walls with opposed elements of all sorts: opposed sawtoothed area, stepped elements, and opposed areas. Also, there are a large number of design element used in this type; Cluster Y for example has a long list of design attributes which had high binary frequencies ratios and which occurred in significant numbers. Pendant triangles are found as in Type 1, but are usually with based triangles in opposition to them. Cluster Y and Clusters D and W may form subtypes although on what basis is not immediately apparent, however they do have significant associations with different rommblocks.

The close association of Clusters D and W with roomblocks would also point to the fact that burials listed as being in Roomblock 5 are in fact from Roomblock 4 since they could not be from Roomblock 5. It is possible that the Animas phase occupation simply renovated the rooms present or built directly over the remains of Roomblock 4, thus confusing the issue. Although the excavation data are unclear as to the exact extent of Roomblock 4, this result of the cluster analysis would suggest that a large portion lay under the Animas phase inhabitation and went unrecognized archaeologically.

Type 3 is represented by Clusters A, C, and S, and is clearly a grouping of the Naturalistic bowls. It is just as clear that the Pdesign variable either did not dissect the variation in naturalistic paintings or the other variable associations involved on these bowls was overwhelming. In any case, all three clusters are associated with late burials and Roomblock 3; Cluster S also exhibits an association with Extramural burials so it appears that even in what is probably late Classic times, the practice of extramural burial had not died out. On the other hand, it is also possible that the extramural burials are of the pithouse phase and the clustering did not discriminate them. I think this is unlikely because of the strong associations shown between Cluster S and Late burials, as well as with Roomblock 3 which seems to be the latest of all roomblocks. The number of intramural burials in that block is very large in relation to the rest of the site; as well, grave goods were common and abundant in Roomblock 3 so it is unlikely that Cluster S is describing a pithouse phase naturalistic type. It seems that the present data is inadequate in that it is unable to differentiate sub-types among the naturalistic painted pots. Perhaps a more detailed analysis of the designs on naturalistic bowls alone might be more fruitful. One success of the clustering in regard to the naturalistic bowls is Cluster C, in that all examples of negative naturalistic images are clustered together. It must be admitted that it would hardly take a cluster analysis to discover that 5 pots came from the same roomblock, yet it is reassuring to see some expected results, because cluster analyses are notorious for giving garbled data in an attractive presentation.

Examination of the other clusters reveals no other obvious types but does point out some interesting data.

Clusters Q and R both exhibit significant numbers of striated pots and have slip spills at the rim. Since Cluster Q is early and Cluster R is late this would seem to indicate that slip spilled at the rim is not a valid chronological indicator as suggested by the Cosgroves. Striations on the surface do not seem to be useful either and, as discussed above, the alternative surface treatment was not useful either because of its ubiquitousness. Thus it would seem probable that the Cosgroves were correct in their assessment of the morphological homogeneity of the Mogollon Black-on white wares.

LeBlanc's suggestion of a transitional type does not seem to be born out by the Galaz material. However, he reports having excavated additional pithouses at Galaz (LeBlanc 1976,1977) and it is possible that this new data would change the types created here. One problem with the Minneapolis Expedition's excavation was that they did not excavate the complete site or even complete areas. Excavation was done only where there were obvious surface pueblo remains. The practice in the pithouse phase of extramural burials meant that pithouses were poor places for archaeologists looking for bowls to dig. The Minneapolis Expedition soon learned where and where not to dig. The result may be an unknown bias in the sample.

It is interesting that, by and large, the types developed here are very similar to the ones first developed by Cosgrove and Cosgrove (1932). Designs connecting with the rim, scrolls, curvilinear areas and full field designs found in Type 1 are essentially the same as their description of Boldface Black-on-white. However, slip spills at the rim do not seem to be important nor is there any significant differences in paste characteristics between Classic and Boldface as they suggested. Type 2 conforms fairly well with the definition of Classic Black-on-white with the emphasis on the designs formated on the walls with an open centre and base band of some sort. Complex assortments of band lines below the rim are common and in the case of naturalistic bowls are usually in the form of thin lines over thick. Geometric bowls show an immense variety in decorative elements but seem to have only one or two thick band lines between the rim and the geometric designs as a rule. Symmetry is often trilateral or even asymetric whereas Type 1 is most often bilateral.

In sum, the traditional Black-on-white typology is largely confirmed by this analysis. Some few elements, such as slip on the exterior, and paste characteristics, and surface treatment are shown to be non-diagnostic, while symmetry, design format and a few design elements are shown to be diagnostic of Boldface and Classic types. There appears to be little evidence at Galaz for a transitional sub-type as suggested by LeBlanc, but there is enough significant cluster distribution within Galaz to indicate some chronological or social patterning.

Chapter 9

SUMMARY AND CONCLUSIONS

This thesis had two main problems defined at the outset. The first was to discuss the state of taxonomy in archaeology, the second was to apply the results of this discussion to an archaeological sample: the Galaz painted pottery. In reference to the first problem, I think it is clear that the new archaeology, as presented by Hill and Evans (1972) have abandoned in a theoretical sense, one of its most useful tools. By relegating taxonomy to a confined role of hypothesis testing, using small arbitrary data sets, they have destroyed the usefulness of a very efficient data reduction and hypothesis generating tool.

Developments in the field of numerical taxonomy have shown that there are ways to control for the problems suggested by Hill and Evans (1972). There are, for example, logical means for controlling the number of attributes which are necessary in type formation. As well, there are statistical techniques such as chi-square tests available that can be used to weed out redundant or useless variables. Furthermore, I think it is clear that typology is a useful method of hypothesis generation as well as a testing device. With large data sets and the availability of computer facilities, archaeologists will be facing more complicated data structures in the future and one important way of reducing this data to managable size is through the use of numerical taxonomy. Also, it is likely that the taxonomic process will bring out unsuspected relationships within the data. Taxonomic procedures such as cluster analysis and several others are best understood as search procedures in that they are designed to find and express relationships in complex sets of data about which there is little knowledge. If we do not utilize this available technology in its best application we will continue on in archaeology quite unsuspecting of the complexity of some of our data. With large collections of data it is not enough to create hypotheses without benefit of some knowledge of the patterns in the data. We must first recognise this variability so that we might generate useful and possibly more testable hypotheses. With no understanding of the structure of our data it is less likely that we might create hypotheses which can be tested by that data. Since our resource base in archaeology is continually diminishing we must utilize the data that we have already collected and not be quite so quick to formulate problems which need new data.

Two concepts of vital importance derived from the discussion of taxonomy should be repeated here. First, the concept that a taxonomy has more possible uses if it has been defined from a broad base of attributes. This is simply put: the more attributes used the more useful the taxonomy is likely to be. Second, the attributes which are selected should be weighted equally in the analysis since in most cases we have no prior knowledge of the proper weighting of the variables. Even in cases where we do have some prior knowledge, by using it in the analysis we might obscure some unsuspected relationships in the data. Again, numerical taxonomy is best understood as a search tool first, and a classificatory tool second.

The second problem outlined at the beginning was the analysis of the Galaz painted pottery in light of the discussion of taxonomy. This analysis of the Galaz material involved first a series of contingency table analyses to condense the data set, by weeding out variables which did not exhibit any patterned distribution with either other descriptive attributes or with provenience variables. The second phase of the analysis consisted of three cluster analyses, a nested divisive technique, an hierarchic technique, and a relocation technique, all of which are available as part of the Clustan package of cluster programs (Wishart 1975). The cluster solutions from these techniques were examined in general at the eight, sixteen, and thirty-two cluster levels, and in detail at the eight cluster level. It was found that all three techniques produced results which showed significant patterning when tested against three provenience variables.

These provenience variables had been chosen in an attempt to measure two kinds of patterning: chronological and spatial. This attempt was not completely successful but the variable Burseq certainly measures the time dimension although in a somewhat crude fashion. The other two variables, Roomblock and Context, are partially related measures of the location of the artifacts within the site and to some extent of the chronological dimension as well.

Only two cluster solutions were examined in detail: the nested division and the relocation. Both produced significant results when tested against the provenience variables with the chi-square test. The third technique displayed significant results with Burseq but not with the other test variables so it was dropped. Analysis of the output cluster attribute list showed that several ubiquitous variables were obscuring the patterning of attributes in the various clusters. These were removed by comparing the within cluster frequency of each attribute with its frequency in the whole sample. The final cluster attribute list clearly shows three clusters which were interpreted to relate quite closely with the traditional Mogollon Black-on-white typology.

Type 1 is quite obviously the same as Cosgrove and Cosgrove's definition of Boldface; it exhibits curvilinear areas, large scroll elements, and has the design painted right to the rim. Type 2 is a more amorphous type but is probably similar to Mimbres Classic. It exhibits a wide range of design elements and a broader range of acceptable forms of symmetry than does the Boldface which is usually bilateral or Quadrilateral. The Classic type is usually painted fairly high on the sides of the pot in a geometric band, usually with a one or two heavy framing lines above and below the design. Type 3 represents the naturalistic painted pots. It was hoped that some discrimination of the naturalistic bowls might result but this was not forthcoming. This is possibly the result of not having defined the proper form of variable to distinquish sub-types of the naturalistic pots. On an intuitive level, after handling the pots and examining the photographs, I feel there are differences within this group but I was unable to demonstrate it.

In summary, I think that it is clear that a taxonomy based on scientific principles can be done profitably as a means of reducing the data, and as a means of hypothesis generation. The analysis of the Galaz material clearly shows that the principles of numerical taxonomy, of natural clusters, and of large unweighted attribute lists are both sound and useful in archaeological analysis. It is to be hoped that archaeologists will reconsider the role of taxonomy in archaeology, and will use it for the broad range of purposes for which it is suited, and not just for hypothesis testing or artifact ordering.

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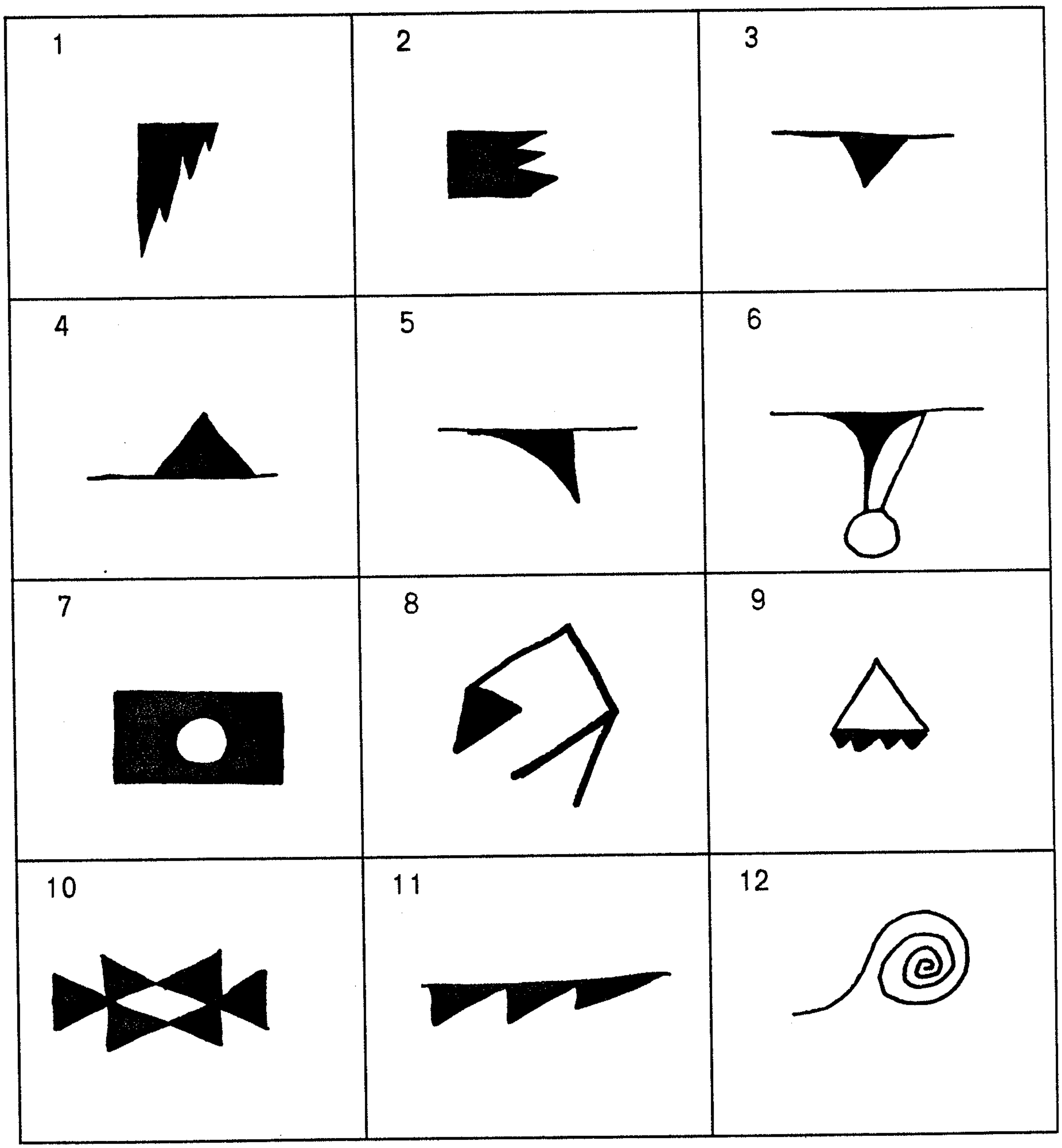
Appendix A

DESIGN ELEMENTS

Table 12: Design Elements



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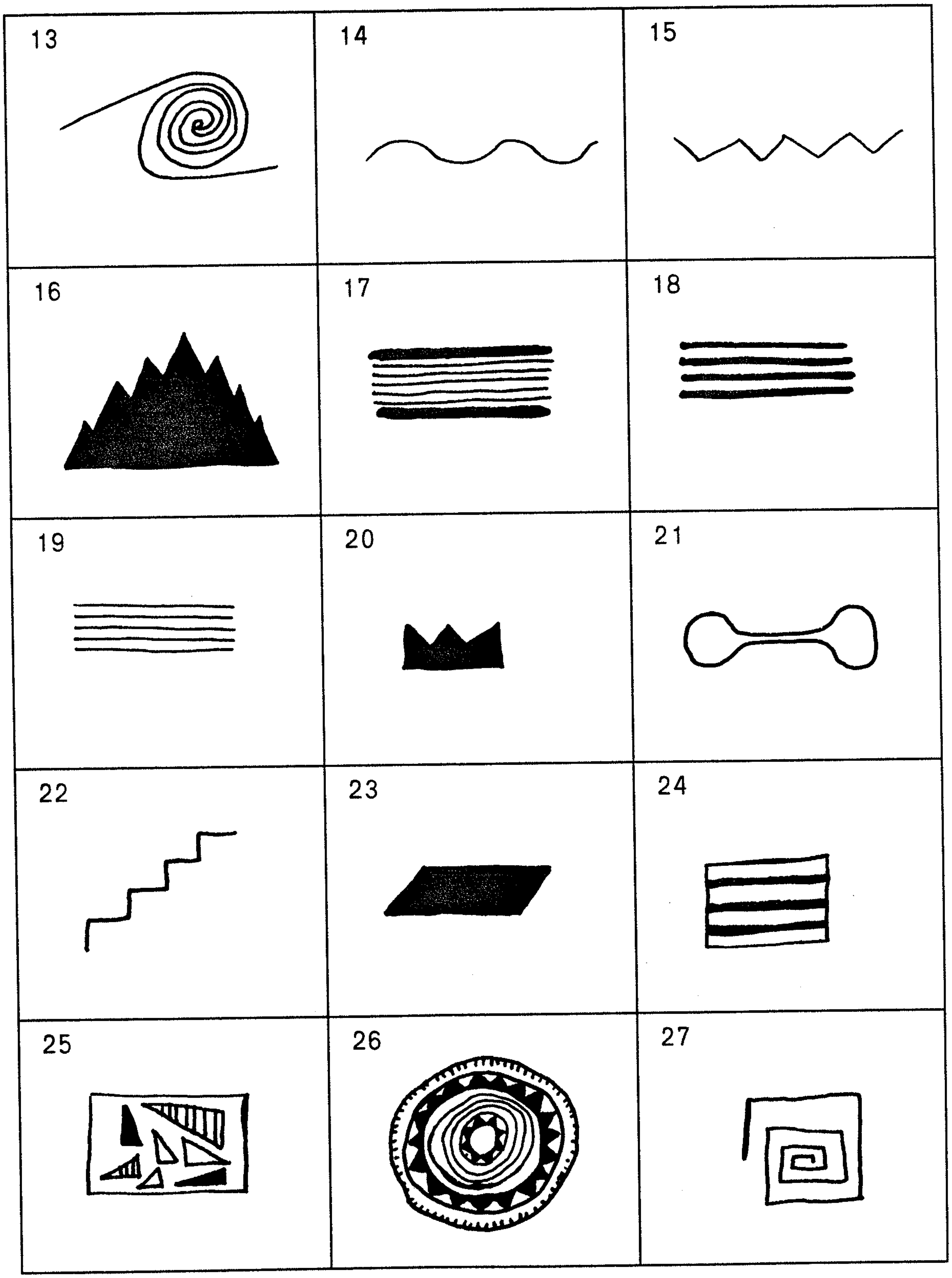

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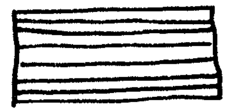
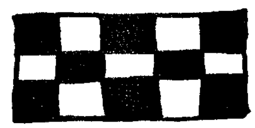
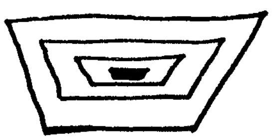
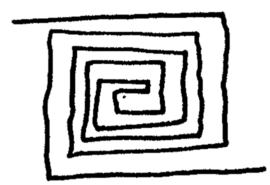
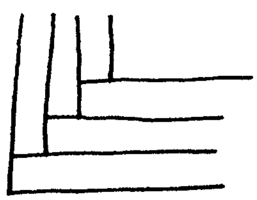
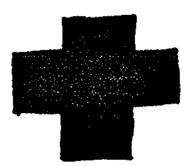
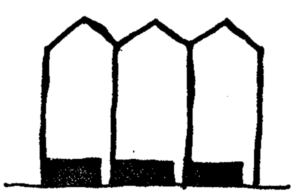
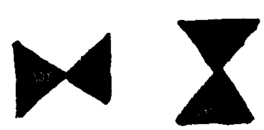
28 	29 	30 
31 	32 	33 
34 	35 	36 
37 	38 	39 
40 	41 	42 

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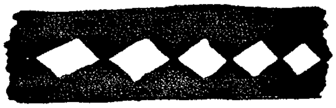
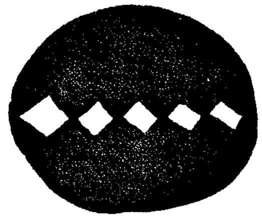
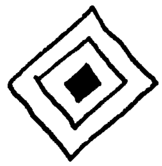
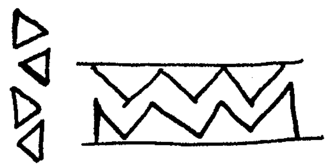
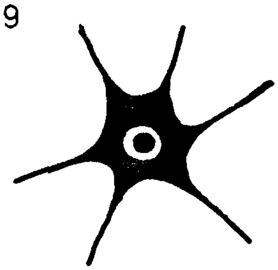
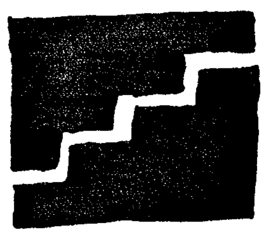
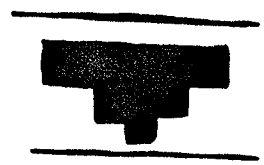
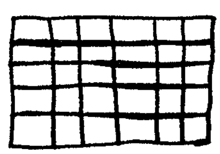
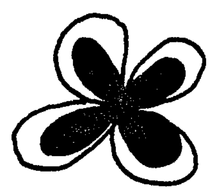
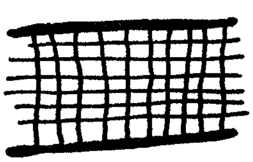
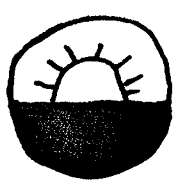
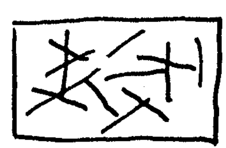
43 	44 	45 
46 	47 	48 
49 	50 	51 
52 	53 	54 
55 	56 	57 

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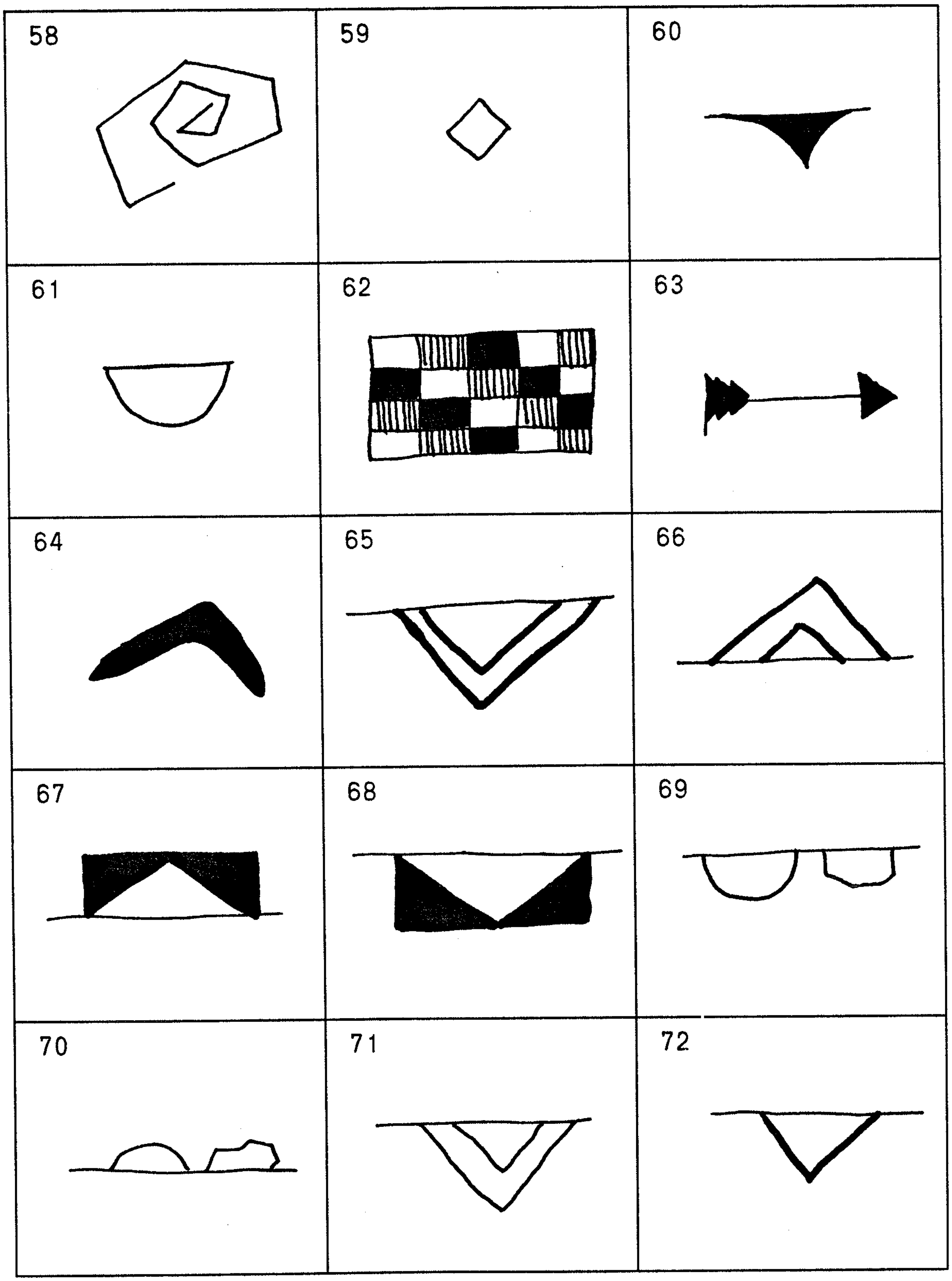

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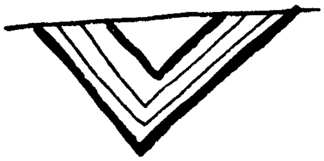
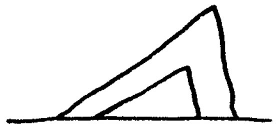
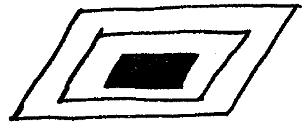
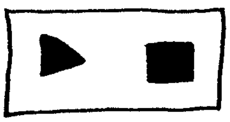
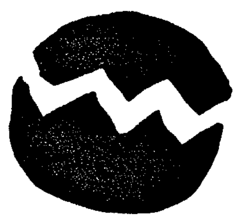
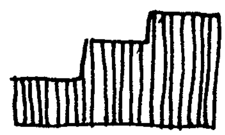
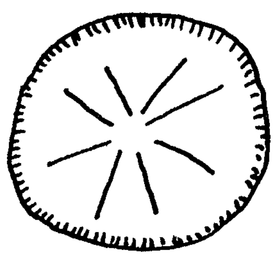
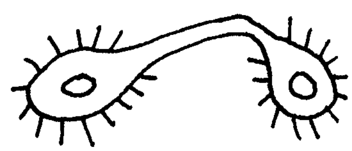
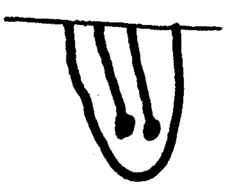
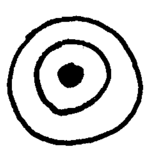
73 	74 	75 
76 	77 	78 
79 	80 	81 
82 	83 	84 
85 	86 	87 

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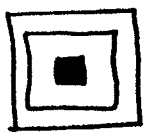
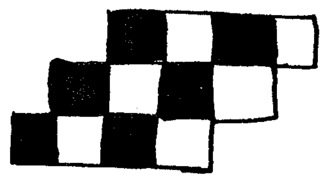
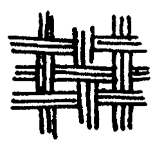
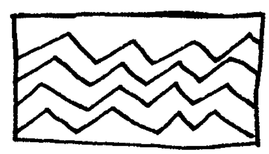
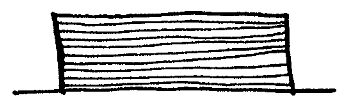
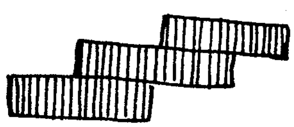
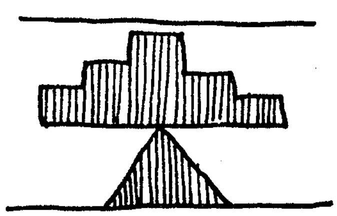
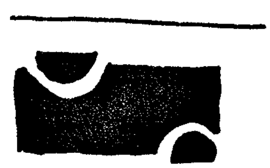
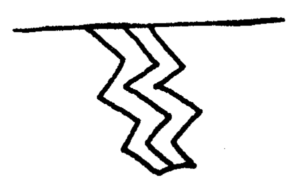
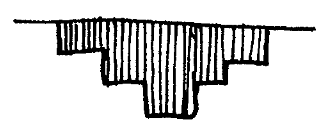
88 	89 	90 
91 	92 	93 
94 	95 	96 
97 	98 	99 
100 	101 	102 

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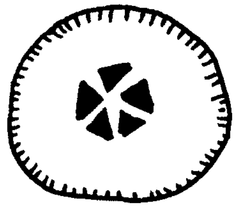
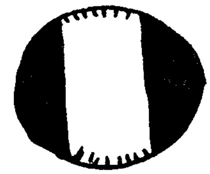
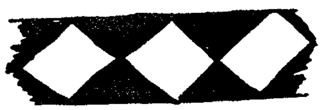
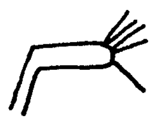
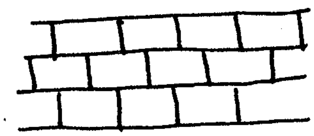
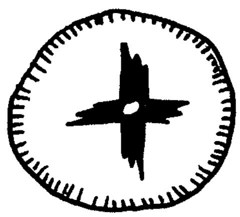
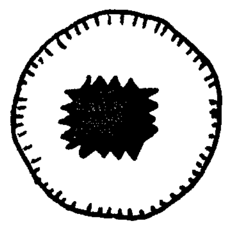
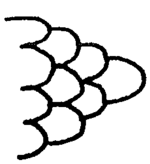
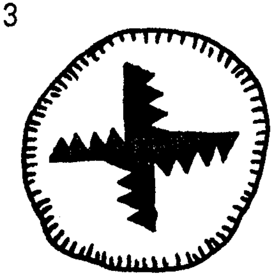
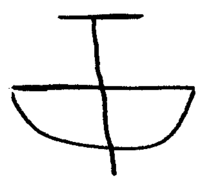
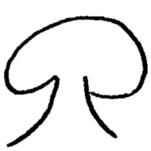
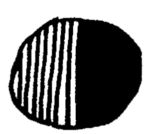
103 	104 	105 
106 	107 	108 
109 	110 	111 
112 	113 	114 
115 	116 	117 

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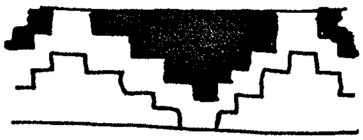
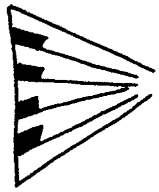
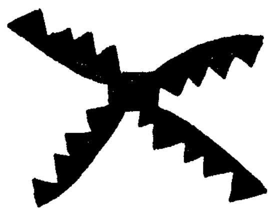
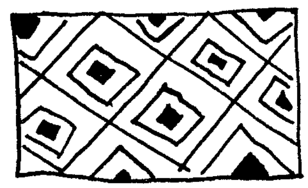
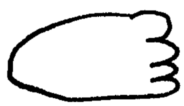
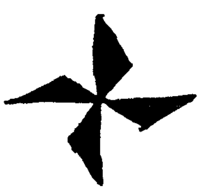
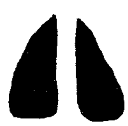
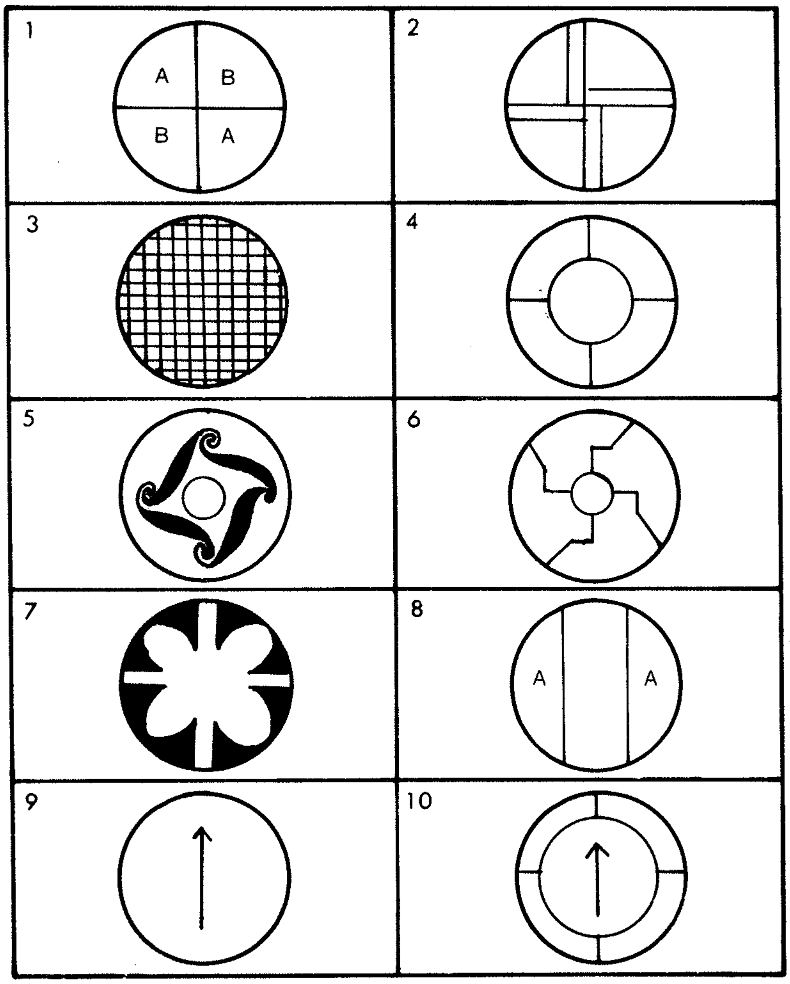
118 	119 	120 
121 	122 	123 
124 	125 	126 
127 	128 	



1. Full field Wedges
2. Full field offset
3. Full field continuous
4. Wall panels
5. Wall continuous
6. Wall interlocked
7. Wall pendant elements
8. Chords
9. Centre
10. Centre and walls

Figure 11: Design Formats

Appendix B

MORPHOLOGICAL AND DESIGN ATTRIBUTE LIST

Table 13: Attribute list.

Surface colour
1. White
2. Black
3. Buff
4. Grey
5. Brown
6. Red
7. Cream
8. Iregular
9. Orange Brown

Paint
1. Black
2. Red
3. Brown
4. Polchrome
   Black + Yellow
5. Polychrome
   Brown + Yellow

Base
1. Unworn
2. Rough
3. Worn
4. Heavily worn

Interior wear
1. Worn
2. Heavily worn
3. Burn stains

Kill
1. Present
2. Broken + Killed
3. Broken
4. Multiple kills

Naturalistic/Geometric
1. Naturalistic
2. Geometric
3. Both

Temper
1. Fine grit
2. Coarse Grit
3. Sand
4. Angular sand
5. Angular sand
   and mica
6. Coarse gravel

Decoration
1. Inside
2. Outside
3. Both
4. Rim
5. On flare
6. Corrugated rim
7. Full corrugated
8. Corrugated rim to
   shoulder
9. Corrugated band
   at shoulder

Centre
1. Open circular
2. Open square
3. Open oblong
4. Full centre
5. Open diamond
6. Open tristar
7. Open irregular
8. Open fourstar
9. Open rectangular

Mends
1. No
2. Two holes
3. Attempted
4. Four holes
6. Six holes
8. Reground rim

Sphere
1. Not applicable
2. One half sphere
3. One third sphere
4. Warped

Surface modifications
1. Incised
2. Punctate
3. Corrugated
4. Dragmarks
5. Spiral striations
6. Vertical striations
7. Verical Ribs
8. Patterned corrugations

Surface finish
1. Slip
2. Slip wash
3. Spills at rim
4. Spills all over
5. Spills smoothed in
6. Slip trailing

Base lines
1. One heavy
2. Two heavy
3. Three heavy
4. Four heavy
5. Multiple light over one heavy
6. Multiple light
7. One heavy/one light
8. One heavy over one sawtoothed
9. One very heavy

Surface treatment
1. Smooth
2. Pebbled
3. Rough, but smoothed
4. Striated
5. Rough
6. Diagonal corrugations
7. Horizontal striations
8. Applique

Rimtype
1. Plain
2. Flared
3. Gentle flare
4. Thinned
5. Thickened
6. Fillet

Rim direction
1. Out
2. In
3. Straight
4. Warped

Symmetry
1. Single
2. Bilateral
3. Trilateral
4. Quadrilateral
5. Continuous
6. Asymmetric

Handles and Lugs
1. Lugs at rim
2. Strap handle
3. Double strap handle
4. Braid handle
5. Shoulder lugs
6. Triple strap handle
7. Appendeges - wings etc.
8. Twist handle
9. Double twist handle
10. Neck lugs
11. Broken handle
12. Three twist handle
13. One lug
14. Twist and coil handle
15. Lugs below rim above shoulder
16. Horizontal handle
17. Four coil handle
18. Three coil handle
19. Handle over mouth

Focus
1. Rim
2. Walls
3. Multiple band
4. Panels
5. Wedges
6. Offset centre
7. Interlocked
8. Continuous
9. Chords

Form
1. Plain bowl
2. Flared bowl
3. Flat bottomed bowl
4. Oblong bowl
5. Square bowl
6. Plain jar
7. Short jar
8. Globular jar
9. Cup
10. Seed bowl
11. Effigy pot
12. Doughnut bowl
13. Pan
14. Straight sided bowl
15. Bowl with foot and fillet rim
16. Double bowl
17. Scoop
18. Seed bowl with lugs

Layout
1. Band
2. Lobes
3. Centre
4. Full field
5. Exterior
6. On pictograph
7. Band across centre

Format
1. Full field wedges
2. Full field offset
3. Full field continuous
4. Wall panels
5. Wall continuous
6. Wall interlocked
7. Chords
8. Centre
9. Centre and walls

Pdesign
1. Geometric
2. Plain black
3. Outlined
4. Scenic
5. Negative image

Pspec
1. Birds
2. Reptile/Amphibian
3. Mammals, large
4. Things, objects
5. Insects
6. Rodents
7. Quadrupeds
8. Humans
9. Weir animals
10. Fish

Appendix C

PICTOGRAPHIC ELEMENTS

Table 14: Original Naturalistic Subject List.

1. Parrots	33. Long tailed rodent
2. Quail/Grouse	34. Long thin fish
3. Swallows	35. Short fat fish
4. Owl	36. Bat
5. Crane/Stork	37. Weir/Mythologic
6. Turkey	38. Unidentifiable
7. Beaver	39. Scenic
8. Deer	40. Weir birds
9. Antelope	41. Bow and arrows
10. Mountain sheep	42. Throwing stick
11. Bears	43. Fish bones
12. Dogs	44. Gila monster
13. Mountain lion	45. Mythologic human
14. Rats/mice	46. Mythologic fish
15. Squirrels	47. Shell bracelet
16. Rabbits	48. Crow
17. Turtle	49. Beetle
18. Human	50. Mantis
19. Male	51. Circular insect
20. Female	52. Gor fish
21. Young human	53. Fish with spines
22. Lizard	54. Basket
23. Frog	55. Snail
24. Tadpole	56. Mosquitos/wasps
25. Grasshopper	57. Bird eating mouse
26. Tics/lice	58. Barracuda
27. Worms/caterpillers	59. Inchworm
28. Scorpions	60. Quadruped
29. Unidentified bird	61. Cricket
30. Unidentified insect	62. Fish swallowing man
31. Centipede	63. Bowl image
32. Toad	64. Coatimundi

Appendix D

PROVENIENCE VARIABLES

Table 15: Provenience variables.

Roomblock membership

1. 15, 19 27, 28, 29, 33, 35, 41, 42, 44, 47, 62, 66, 72, 84, 85, 98, 100, 101, 102.
2. 83, 96, 106, 108, 109, 110, 111, 112, 114, 116, 117, 118, 119, 120, 121, 122, 123, 124, 225, 126, 1228, 131, 132, 133, 138.
3. 48, 49, 51, 52, 53, 54, 55, 56, 57, 58, 59, 70, 71, 74, 75, 76, 79, 81, 82, 86, 87, 88, 89, 90, 91, 94, 95, 105, 107.
4. 8, 17, 18, 20, 22, 23, 24, 26, 30, 31, 32, 36, 39, 43, 46, 67, 80.
5. 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 16, 21, 34, 37, 38, 40, 60, 136, 137.
6. Extramural.
7. 14, 70a, 76b, 120a, 129, 130, 134, 135.

Context	Burseq
1. Pithouse	1. Early
2. Classic	2. Late
3. Extramural	
4. Unknown	

Roomblock

1. Northwest
2. Southwest
3. Southeast
4. Centre
5. Centre east
6. Extramural
7. Pithouse

Floor

1. Below first
2. Below second
3. Below third
4. Below surface
5. On first

Burial Orientation

1. North
2. Northeast
3. East
4. Southeast
5. South
6. Southwest
7. West
8. Northwest
9. Scattered

Roomtype

1. Pithouse
2. Early Rubble
3. Late Rubble
4. Transitional
5. Surface
6. Extramural

Position

1. Full flexed
2. Partially flexed
3. Extended
4. Head only
5. No head
6. Incomplete

Body

1. On back
2. On right side
3. On left side
4. On stomach
5. Sitting
6. Under bowl

Sex

1. Female
2. Male

Age

1. Prenatal
2. Infant (0-3)
3. Child (4-12)
4. Adolescent (13-18)
5. Adult (19-50)
6. Aged (50-)

Appendix E

CONTINGENCY TABLE RESULTS

Table 16: Contingency Table Summary

Ext. colour	Paste	44.432	10	.0001
Ext. colour	Int. paint	19.440	4	.0006
Ext. colour	Temper	22.458	6	.001
Paste	Temper	29.067	8	.0003
Ext. finish	Temper	19.666	10	.0326
Sphere	Temper	5.504	2	.0638 *
Ext. colour	Ext. finish	17.527	10	.0635 *
Ext. colour	Paint	19.440	4	.006
Band	Pictgeom	194.351	14	.001
Band	Baseline	74.327	7	.001
Baseline	Pictgeom	38.503	2	.0001
Baseline	Segment	62.587	8	.0001 *
Baseline	Symmetry	45.203	9	.0001
Baseline	Format	214.719	9	.0001
Segment	Symmetry	1626.545	32	.0001 *
Baseline	Kill	17.269	6	.0083
Kill	Format	75.103	54	.0303 *
Burseq	Pdesign 1	11036	2	.0040
"	Pdesign 2	7.512	2	.0234
"	Pdesign 3	8.249	2	.0158

(continued)

Note: * = non-significant

(Table 16 continued)

Burseq	D element8	31.902	2	.0001
"	D element11	19.070	2	.0001
"	D element13	6.011	2	.0495
"	D element16	21.837	2	.0001
"	D element18	51.300	2	.0001
"	D element20	5.704	2	.0577
"	D element22	21.855	2	.0001
"	D element26	6.020	2	.0493
"	D element30	5.944	2	.0512
"	D element7	5.220	2	.0735 *
"	Band	82.455	14	.0001
"	Format	40.009	18	.0021
"	Pictgeom	20.167	4	.0005
"	Symmetry	30.938	8	.0001
Context	D element5	8.567	3	.0356
"	Format	55.589	27	.0010 *
"	D element9	9.745	2	.0209 *
"	D element26	7.183	3	.0663
Roomblock	D element16	17.430	6	.0078
"	D element18	29.197	6	.0001 *
"	Band	85.537	56	.0067 *
"	Ext. finish	61.134	40.0173	
"	Burseq	107.509	16	.0001
"	D element9	16.390	2	.0118 *
	D element26	11.639	6	.0705

Note: * = non-significant

Table 17: Provenience by Cluster Contingency Tables

TABLE OF ND8 BY BURSEQ

ND8 BURSEQ

FREQUENCY EXPECTED	UNKNOWN	EARLY	LATE	TOTAL
1	5 6.4	12 19.5	45 35.0	62
2	3 5.0	39 15.1	6 27.9	48
3	1 0.9	2 2.8	6 5.2	9
4	12 13.4	33 40.7	84 74.9	129
5	7 6.3	10 19.2	44 35.4	61
6	7 5.4	21 16.4	24 30.2	52
7	8 2.8	4 8.5	15 15.7	27
8	16 18.7	58 56.7	106 104.6	180
TOTAL	59	179	330	588

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	86.252	DF= 14	PROB=0.0001
PHI	0.390		
CONTINGENCY COEFFICIENT	0.363		
CRAMER'S V	0.276		
LIKELIHOOD RATIO CHISQUARE	81.527	DF= 14	PROB=0.0001

Table of ND-8 by Burseq

TABLE OF ND8 BY CONTEXT

ND8 CONTEXT

FREQUENCY EXPECTED	PIT	CLASSIC	EXTRAM	UNKNOWN	TOTAL
1	0 2.2	39 38.0	17 13.8	6 8.2	62
2	7 1.7	28 29.4	11 10.6	2 6.3	48
3	0 0.3	7 5.5	2 2.0	0 1.2	9
4	5 4.5	73 79.0	29 28.4	22 17.0	129
5	1 2.1	34 37.4	21 13.4	5 8.1	61
6	1 1.8	34 31.9	7 11.4	10 6.9	52
7	1 1.0	19 16.5	5 5.9	2 3.6	27
8	5 6.3	114 110.3	33 39.8	28 23.8	180
TOTAL	20	348	125	75	588

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	40.728	DF= 21	PROB=0.0060
PHI	0.268		
CONTINGENCY COEFFICIENT	0.259		
CRAMER'S V	0.155		
LIKELIHOOD RATIO CHISQUARE	38.015	DF= 21	PROB=0.0128

Table of ND-8 by Context

TABLE OF ND8 BY ROOMBLK

ND8 ROOMBLK

FREQUENCY / EXPECTED	.	1	2	3	4	5	6	7	TOTAL
1	1 .	9 8.3	5 6.9	18 14.9	9 9.1	3 5.7	17 13.5	0 2.5	61
2	0 .	5 6.6	9 5.4	7 11.7	5 7.1	1 4.5	11 10.6	10 2.0	48
3	0 .	2 1.2	1 1.0	4 2.2	0 1.3	0 0.8	2 2.0	0 0.4	9
4	0 .	19 17.6	13 14.6	27 31.6	23 19.2	15 12.1	29 28.6	3 5.3	129
5	1 .	6 8.2	6 6.8	16 14.7	6 8.9	4 5.6	21 13.3	1 2.4	60
6	0 .	10 7.1	6 5.9	8 12.7	11 7.7	8 4.9	7 11.5	2 2.1	52
7	0 .	7 3.7	3 3.1	7 6.6	2 4.0	2 2.5	5 6.0	1 1.1	27
8	2 .	19 24.3	21 20.2	51 43.6	28 26.5	20 16.7	33 39.5	6 7.3	178
TOTAL	.	77	64	138	84	53	125	23	564

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	79.208	DF= 42	PROB=0.0005
PHI	0.375		
CONTINGENCY COEFFICIENT	0.351		
CRAMER'S V	0.153		
LIKELIHOOD RATIO CHISQUARE	68.501	DF= 42	PROB=0.0060

Table of ND-8 by Roomblock

TABLE OF HD8 BY BURSEQ

HD8 BURSEQ

FREQUENCY / EXPECTED	UNKNOWN	EARLY	LATE	TOTAL
1	5 6.4	12 19.5	45 36.0	62
2	10 10.4	60 31.5	30 58.1	100
3	6 7.9	19 24.0	51 44.2	76
4	10 11.5	36 35.0	65 64.5	111
5	6 7.2	22 21.7	41 40.1	69
6	9 3.7	6 11.3	21 20.9	36
7	6 5.5	14 16.7	33 30.8	53
8	7 6.3	10 19.2	44 35.4	61
TOTAL	59	179	330	568

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	64.933	DF= 14	PROB=0.0001
PHI	0.338		
CONTINGENCY COEFFICIENT	0.320		
CRAMER'S V	0.239		
LIKELIHOOD RATIO CHISQUARE	62.088	DF= 14	PROB=0.0001

Table of HD-8 by Burseq

TABLE OF HD8 BY CONTEXT

HD8 CONTEXT

FREQUENCY / EXPECTED	PIT	CLASSIC	EXTRAM	UNKNOWN	TOTAL
1	0 2.2	39 38.0	17 13.6	6 8.2	62
2	8 3.5	62 61.3	18 22.0	12 13.2	100
3	2 2.7	41 46.6	19 16.7	14 10.0	76
4	4 3.9	68 68.0	20 24.4	19 14.7	111
5	1 2.4	46 42.3	13 15.2	9 9.1	69
6	1 1.3	26 22.1	7 7.9	2 4.8	36
7	3 1.9	32 32.5	10 11.7	8 7.0	53
8	1 2.1	34 37.4	21 13.4	5 8.1	61
TOTAL	20	348	125	75	568

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	26.345	DF= 21	PROB=0.1936
PHI	0.215		
CONTINGENCY COEFFICIENT	0.211		
CRAMER'S V	0.124		
LIKELIHOOD RATIO CHISQUARE	27.135	DF= 21	PROB=0.1665

Table of HD-8 by Context

TABLE OF HD8 BY ROOMBLK

HD8 ROOMBLK

FREQUENCY / EXPECTED	.	1	2	3	4	5	6	7	TOTAL
1	1 .	9 8.3	5 6.9	18 14.9	9 9.1	3 5.7	17 13.5	0 2.5	61
2	0 .	15 13.7	15 11.3	15 24.5	16 14.9	9 9.4	18 22.2	12 4.1	100
3	0 .	9 10.4	7 8.6	16 18.6	15 11.3	9 7.1	19 16.8	1 3.1	76
4	1 .	11 15.0	14 12.5	29 26.9	18 16.4	14 10.3	20 24.4	4 4.5	110
5	1 .	8 9.3	7 7.7	22 16.6	10 10.1	6 6.4	13 15.1	2 2.8	68
6	0 .	9 4.9	4 4.1	11 8.8	2 5.4	2 3.4	7 8.0	1 1.5	36
7	0 .	10 7.2	6 6.0	11 13.0	8 7.9	6 5.0	10 11.7	2 2.2	53
8	1 .	6 8.2	6 6.8	16 14.7	6 8.9	4 5.6	21 13.3	1 2.4	60
TOTAL	.	77	64	138	84	53	125	23	564

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	53.874	DF= 42	PROB=0.1036
PHI	0.309		
CONTINGENCY COEFFICIENT	0.295		
CRAMER'S V	0.126		
LIKELIHOOD RATIO CHISQUARE	51.896	DF= 42	PROB=0.1409

Table of HD-8 by Roomblock

TABLE OF RL8 BY BURSEQ

RL8 / FREQUENCY / EXPECTED	UNKNOWN	EARLY	LATE	TOTAL
1	16 12.0	29 36.6	71 67.4	116
4	9 8.1	33 24.6	36 45.3	78
5	16 15.0	25 45.4	103 83.7	144
11	0 0.2	1 0.6	1 1.2	2
12	4 7.2	54 21.7	11 40.1	69
15	9 8.8	25 26.8	51 49.4	85
16	5 7.7	12 23.3	57 43.0	74
TOTAL	59	179	330	568

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	103.617	DF= 12	PROB=0.0001
PHI	0.427		
CONTINGENCY COEFFICIENT	0.393		
CRAMER'S V	0.302		
LIKELIHOOD RATIO CHISQUARE	100.812	DF= 12	PROB=0.0001

Table of RL-8 by Burseq

TABLE OF RL8 BY CONTEXT

RL8 / FREQUENCY / EXPECTED	PIT	CLASSIC	EXTRAM	UNKNOWN	TOTAL
1	2 4.1	74 71.1	24 25.5	16 15.3	116
4	3 2.7	47 47.8	18 17.2	10 10.3	78
5	1 5.1	89 88.2	41 31.7	13 19.0	144
11	0 0.1	2 1.2	0 0.4	0 0.3	2
12	9 2.4	42 42.3	13 15.2	5 9.1	69
15	3 3.0	41 52.1	19 18.7	22 11.2	85
16	2 2.6	53 45.3	10 18.3	9 9.8	74
TOTAL	20	348	125	75	568

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	47.138	DF= 18	PROB=0.0002
PHI	0.288		
CONTINGENCY COEFFICIENT	0.277		
CRAMER'S V	0.186		
LIKELIHOOD RATIO CHISQUARE	40.996	DF= 18	PROB=0.0015

Table of RL-8 by Context

TABLE OF RL8 BY ROOMBLK

RL8 ROOMBLK

FREQUENCY EXPECTED	.	1	2	3	4	5	6	7	TOTAL
1	1 .	16 15.7	14 13.0	30 28.1	18 17.1	13 10.8	24 25.5	2 4.7	115
4	0 .	9 10.6	14 8.9	14 19.1	10 11.6	10 7.3	18 17.3	3 3.2	78
5	2 .	19 19.4	15 16.1	39 34.7	19 21.1	8 13.3	41 31.5	1 5.8	142
11	0 .	1 0.3	0 0.2	0 0.5	1 0.3	0 0.2	0 0.4	0 0.1	2
12	0 .	12 9.4	11 7.8	9 16.9	8 10.3	4 6.5	13 15.3	12 2.8	69
15	0 .	12 11.6	6 9.6	17 20.8	15 12.7	13 8.0	19 18.8	3 3.5	85
16	1 .	8 10.0	4 8.3	29 17.9	15 10.9	5 6.9	10 16.2	2 3.0	73
TOTAL	.	77	64	138	84	53	125	23	564

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 20% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	80.510	DF= 36	PROB=0.0001
PHI	0.378		
CONTINGENCY COEFFICIENT	0.353		
CRAMER'S V	0.154		
LIKELIHOOD RATIO CHISQUARE	69.422	DF= 36	PROB=0.0007

Table of RL-8 by Roomblock