THE PHASE I ARCHEOLOGICAL RESEARCH PROGRAM FOR THE KNIFE RIVER INDIAN VILLAGES NATIONAL HISTORIC SITE, PART III: ANALYSIS OF THE PHYSICAL REMAINS

Edited by
Thomas D. Thiessen

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LIST OF ABBREVIATIONS USED

The following abbreviations/acronymns appear in the four parts of this volume:

BP	before the present (calculated from AD 1950)
C-14:	carbon-14, or radiocarbon
IASP	Interagency Archeological Salvage Program
KNRI	Knife River Indian Villages National Historic Site
KRF	Knife River Flint
MWAC	Midwest Archeological Center
MNI	minimum number of individuals
NARS	National Archives and Records Service
NISP	number of identified specimens
NPS	National Park Service
RCYBP	radiocarbon years before present (calculated from AD 1950)
SHSND	State Historical Society of North Dakota
SIRBS	Smithsonian Institution River Basin Surveys
SMU	Southern Methodist University
TL	thermoluminescence
TRSS	Tongue River Silicified Sediment
UGA	University of Georgia
UND	University of North Dakota
WU	Washington University

PREFACE

In 1974, the Congress of the United States authorized the establishment of the Knife River Indian Villages National Historic Site in Mercer County, North Dakota, to preserve archeological vestiges of the Hidatsa and Mandan Indians and to commemorate the cultural history and lifeways of those important native peoples of the Northern Plains. Starting in 1976, the National Park Service undertook an extensive program of archeological and ethnohistorical research designed to illuminate the archeological and historical resources of the newly- authorized park. This research, which was termed the Phase I research program for the park, was cooperatively carried out by the Service's Midwest Archeological Center and the Department of Anthropology of the University of North Dakota, as well as by researchers at other academic institutions in the United States, most notably the Department of Anthropology of the University of Missouri-Columbia.

This volume of the Midwest Archeological Center's *Occasional Studies in Anthropology* series reports the results of that decade-long research program. It is issued in four parts, each of which deals with a particular aspect of the research. Part I (Chapters 1-10) describes the overall program in general, particularly emphasizing the objectives and methodology employed in the research. Part II (Chapters 11-16) recapitulates a series of ethnohistorical studies that complements the archeological research and provides an ethnohistorical backdrop against which the archeological record of Hidatsa culture change can be interpreted. Part III (Chapters 17-21) summarizes the analysis of various classes of material remains recovered during the research program, principally the pottery, lithics, modified and unmodified fauna, and Euroamerican trade goods. Part IV (Chapters 22-27) broadly interprets the park's archeological record and offers a revised culture-historic taxonomy for what is proposed as the Knife region of the Middle Missouri subarea.

Most of the chapters contained in this volume were completed circa 1985-1986. Some effort has been made to update aspects of the data and conclusions offered in them by referencing certain key published and unpublished studies which have appeared since that time, but the lack of time and funds has precluded a comprehensive revision of the entire corpus of papers contained herein. Nevertheless, it is believed that this summary of the Knife River Indian Villages Phase I research program will be of substantial interest to Plains scholars and considerable utility in telling the story of the Hidatsa and Mandan Indians to the public.

CHAPTER 17

KNRI AND UPPER KNIFE-HEART REGION POTTERY ANALYSIS

Stanley A. Ahler and Anthony A. Swenson

INTRODUCTION

This chapter contains a summary of the comparative analyses of ceramic collections from sites in the KNRI, the upper Knife-Heart region, and in selected adjacent areas in the Northern Plains. This is a long-term project which has involved data from more than 7,000 pottery vessels from more than forty sites in the study area. Central to this study has been the coding of stylistic and other data on the individual vessels according to a consistent analytic format applied across all collections. Both Ahler and Swenson (1985b) designed the coding system used for the ceramic collections, a system which grew out of an earlier scheme (Swenson and Ahler 1978) applied in limited ways to several of the KNRI collections. Swenson coded most of the ceramic vessel information used in this study and conducted or oversaw the collection of other data on body sherds, provenience codes, etc. Swenson was assisted at times by Amy Drybred in both the vessel coding and in collecting other data. Swenson conducted error checks and edited the ceramic data files generated for the 7,000 vessel sample, and he conducted several preliminary data tabulations which were used by Ahler for the analytic batch definitions for the pottery study. Ahler conducted all the subsequent computerized ceramic studies and wrote all sections of this chapter.

In addition to the general objective of providing a detailed description of the ceramic assemblages from KNRI and other regional sites, the KNRI ceramic comparative study has had three major goals.

The first goal has been to use the ceramic data to develop a working culture-historic scheme or cultural chronology for the upper Knife-Heart region and for selected sites in the adjacent Garrison region. As noted in Chapter 2, many previous investigations in the region and subarea have resulted in culture-historic classifications applied to the study area, but few of the previous schemes have actually been grounded in a regional data base. Problems and limitations have been noted for each of the previously defined cultural taxonomies. In addition, many of the regional sites have not been classified in the previous schemes. A revised cultural chronology has been developed by Wood (1986c) for the region, based primarily on data available just as the KNRI program was beginning. The intent here is to provide an updated cultural taxonomy for the region, ordering the sites for which ceramic data exist into a chronological framework, and examining that ordering relative to the chronometric data available for the region. The chronological ordering based on ceramic data will serve as the beginning point and organizational framework for summarizing and studying lithic and vertebrate faunal data sets from regional village sites. These studies will be treated in succeeding sections of the final KNRI synthesis.

The second goal is to identify ceramic variables and attributes in the regional collections which exhibit chronological change, and then to explore hypotheses which provide possible explanations for such change. It is widely recognized that major changes in ceramic assemblages occurred in regional collections during the post-contact period. Competing hypotheses currently attribute much of this change to 1) technological variation induced by epidemics and changing economic strategies in the post-contact period, or to 2) stylistic variation reflecting long-term cultural changes, idea diffusions, and migrations of new social groups into the region. Because of the documented drastic effects of epidemics on native populations and their related social, political, and settlement organizations, the hypothesis of technological change has been given wide credibility by previous researchers. The hypothesis of ceramic change due to diffusion and migration has not previously been well developed, but it will be explored further in this section. The problem of actually distinguishing technological change from stylistic change will be addressed here for the first time, making use of chronological data which are essential to a study of this kind.

The third goal is to compare Mandan and Hidatsa ceramic assemblages on both the historic and prehistoric time levels to address more fully the oft-repeated idea that the two tribal groups have basically indistinguishable material culture in the archeological record. This comparative study of Mandan and Hidatsa archeology is actually interrelated with the stylistic variation hypothesis discussed in the previous paragraph. Due to a lack of comparative data from many sites having Mandan tribal affiliations, such comparisons can only be preliminary, at best, at this time. In addition, we will explore a broader comparison of ceramic assemblages in the study area, comparing those most clearly attributable to the Hidatsas and their ancestors with study samples from purported Hidatsa origin areas in eastern North Dakota and from other locations outside the Missouri trench.

This chapter contains several major sections. Immediately following is a brief section on the vessel coding and other analytic methods used in the comparative ceramic study. Next is an explanation of the process used to define the analytic "batches" which form the individual analytic units used in the comparative study, including a site-by-site discussion of analytic batch content. The following section presents the results of the study of regional culture-history and cultural taxonomy derived from the ceramic data base. This study involves manipulation of the ceramic batch data using both factor analysis and cluster analysis. A working cultural chronology is then developed for the upper Knife-Heart region and for certain sites in the Garrison region which will be further refined and tested using data from lithic and other data sets. The next section contains an assessment of several notable chronological changes in ceramic data with reference to competing hypotheses concerning both technological and stylistic variation. The next section provides more detailed attribute analyses and fine-scale comparisons among certain assemblages from the study area, focusing on the question of Mandan and Hidatsa distinctions in the archeological record. A following section deals with the topic of extra-regional comparisons relevant to the origin of the Hidatsas and relationships between the Hidatsas and the Crows. The concluding section provides a very general summary of major findings of the ceramic study, giving an explanatory hypothesis for ceramic change in the study area.

CERAMIC ANALYTIC METHODS

The ceramic analysis reported here is relatively unconventional in that it focuses on study of vessel attributes rather than on ceramic typology as the primary basis for intrasite and intersite comparisons. Precedents for attribute analysis do in fact exist in the literature for the subarea (e.g., Deetz 1965; Calabrese 1972; C. Johnson 1977a, 1977b; Lee 1980). There are two primary reasons why attribute analysis is emphasized in the KNRI program. One is because ceramic typologies are poorly developed for the region, with many currently used types having been developed from data bases from outside the region. The second is because the typological approach is felt to be inadequate for capturing the wide array of stylistic and technological data on the ceramic collections which is needed to address the main problems identified for the study. This limitation has been recognized by other researchers (Calabrese 1977:34) with regard to Middle Missouri ceramic studies in general, and with regard to the study area since the outset of the KNRI program (Ahler 1978:48; Wood 1986b:73-74). This emphasis on attributes is not intended to say that typology has no place in regional ceramic studies; to the contrary, typology will continue to be a useful analytic tool as typological groups are carefully defined with reference to the range of attribute content in the regional ceramic samples.

Following the pattern of most Middle Missouri subarea studies, emphasis is placed on analysis of the rim portion of ceramic vessels, with lesser attention paid to vessel body parts and body sherd analysis. This is because the majority of vessel decoration occurs on the rim area and because major changes in vessel form are also best seen in this part of the vessel. Thus, study of stylistic and possibly of technological and functional characteristics can best be done using data derived from the vessel rim and orifice area.

Rim Sherd Analysis

A new vessel attribute coding system (Ahler and Swenson 1985b) was specifically designed to conduct the comparative analysis reported here. This coding system is a considerably revised version of an earlier system (Swenson and Ahler 1978) also designed to collect data on KNRI and related ceramic collections. The Ahler and Swenson (1985b) system is designed specifically to collect attribute data on individual ceramic vessels defined from rim sherds or the rim portion of relatively complete vessels. The rationale for the system and a detailed explanation of its application are contained in the coding manual; only a brief overview of the basic concepts of the code system will be presented here.

Basic to the ceramic code system (Ahler and Swenson 1985b) is the concept of vessel zones, or the idea that each vessel can be segmented into a series of formally defined segments or parts. Recording the presence or absence (use or non-use) of these zones identifies the basic vessel and rim form, and the identification of zones also allows the recording of stylistic and metric data according to specific area on the vessel surface. Because vessel zones will frequently be referred to in this section, the concept of zones can be briefly elaborated upon. Seven zones are recognized. Zone 1 is the vessel body, defined by continuous inward curvature in all directions, which occurs on all vessels. Zone 2 is the neck area and the straight or outflared rim area above the neck, defined by inward curvature in horizontal plane and excurvature or no curvature in the vertical plane. Zone 3 is the S part of an S-shaped rim, defined by inward curvature in all planes. Zone 4 is the excurvate part of a recurved S-rim, with a curvature direction similar to that in zone 2. Zone 5 is the brace area on the vessel, created by folding a band of clay downward from the lip and welding it to the inside or outside rim surface. Zone 6 is a fillet or band or strip of clay applied to the vessel surface somewhere below the lip. Zone 7 is the vessel lip area, where the inner and outer vessel walls cease to be parallel and where they join; this zone occurs on all vessels. Zones 2 through 6 are optionally present in a vessel; the particular combination of zones which was used defines the rim form class for a vessel.

In sherds, zones are recognized by the curvature of the sherd, and junctures between zones (particularly between zones 1, 2, 3, and 4) are defined by inflection points, or points at which the direction of curvature reverses itself (Shepard 1968:226). The presence of particular zones allows an objective separation of rim and body sherds. In this study, any sherd with a portion of zone 2 or any higher zone (3-7) present is considered by defintion to be a rim sherd. Any sherd which contains only zone 1 is a body sherd and is so analyzed. The ceramic coding system (Ahler and Swenson 1985b) is designed specifically for study of rim sherds.

Several conventions have been followed to further streamline the data coding process. For example, neck sherds or rim sherds which exhibit only zone 2 and which do not contain parts of any higher zones or the lip are not fully coded using the Ahler and Swenson coding system. This is done because such sherds often contain very little stylistic data, which the code system focuses upon. Data on exterior surface treatment are recorded for zone 2 or neck sherd fragments as a group for each analytic batch or unit. Another efficiency move has been to restrict the vessel coding process to vessels represented by rim sherds of size grade 2 or larger (those not passing through a 0.5 inch square mesh screen opening). Rim sherds in size grade 3 (circa 1/4 inch) are isolated but are not fully coded under the present system.

In the present ceramic study the focus is on individual ceramic vessels rather than individual rim sherds. This means that prior to coding, rim sherds are compared and refits or matches into vessels of common origin are made. This matching by vessels is conducted both on the basis of actual refits along fractures as well as on the basis of close similarities in decoration, paste, and vessel form. Size grade 3 rim sherds are involved in the refitting process and are included in the coded vessel data if they are seen to match size grade 2 or larger rim sherds. Allowance is made in the vessel provenience coding for vessels represented by rim parts occurring in two or more site proveniences falling in different analytic units; in such cases, the vessel is counted as occurring once in each analytic unit unless there is reason for giving precedence to one archeological context of occurrence over the other.

A wide variety of both nominal- and interval-scaled data is recorded on individual vessels. Nominal data include information on rim form, data on the presence and shapes of individual vessel zones which are used (angular or curved zone junctures and lip shape classes), exterior surface treatment in zones 1 and 2, decorative technique by zone, decorative pattern by zone, presence of residues, appendages, and special rim modelling procedures. Metric data include measurements of decorative element width and spacing on various vessel zones, vessel wall thickness at several locations, zone heights and inflections at various locations, and vessel orifice diameter at the lip. Vessel ware and type classifications are also coded. Provenience codes include site, site subareas, excavation unit numbers, and time periods, horizons, and features within excavation units. The reader should refer to Ahler and Swenson (1985b) for a detailed description of all of these variables.

Vessel ware and type classifications will be used to some extent in the present discussion, and the coding system used for these classes requires some explanation in this context. While there is considerable disagreement as to what the concepts "ware" and "type" mean in the

Middle Missouri subarea, the definitions applied by Lehmer (1954:41) are probably the most widely accepted (Calabrese 1977). Lehmer identified wares as groups which have in common basic vessel fabric, paste characteristics, and rim form characteristics, while types occur within wares and designate different forms of decoration within a single ware. Thus, the relationship between wares and types is hierarchical, with wares based on rim form variation being the more encompassing groups, and with types based on decoration being subordinate within a given ware.

We have deviated somewhat from these concepts when recording ware and type classes in this study. We have found it useful to incorporate certain decorative information into the definition of wares or ware-like groups as used here, this being based on the fact that chronological variation in vessel decorative details can be observed for vessels within a single rim form class. For example, cord diameter and cord impression spacing in cord-impressed decoration can be seen to change with time; if this is not taken into account in ware defintions, the ware classes tend to lose their value for historical or chronological analysis. Additionally, we have recorded type in two ways in the present coding system. Types which have been formally defined in the literature as occurring with specific, formally defined wares have been recorded. In addition, we record a "new type" class which simply reflects the dominant decorative technique applied to a vessel. Decorative pattern is generally ignored in this type classification, and decoration location is also given little consideration. In instances where more than one decorative technique occurs, the "primary" or "linear" technique is used to determine the "dominant" decorative technique. Linear techniques include cord impression, trailing/incising, stab-and-drag impression, and cord-wrapped-tool impression. Decorative techniques which consist of individual non-linear impressions (e.g., tool or finger marks) constitute "secondary" techniques and do not determine the dominant decorative technique unless they are used alone on the vessel.

The ware classes actually coded in the ceramic study consist of both a series of formally defined wares developed for study of regional and near-regional ceramic samples and also a series of less formally defined quasi-ware-like classes developed to encompass the range of variation seen in the regional samples. Formally defined ware classes used here include Knife River ware and Deapolis Collared ware which are formally defined based on regional samples (Lehmer et al. 1978:190-199, 208-209); Le Beau S-Rim ware which was originally defined for extra-regional samples (Hurt 1957:24-41; Wood 1967:67-68) but which has been redefined for regional samples (Lee 1980; Breakey and Ahler 1985); and Riggs ware and Fort Yates ware which were also defined for samples from outside the region (Wood and Woolworth 1964:16- 21; Lehmer 1966:29-31) but which have been redefined for regional samples (Riggs ware in Calabrese 1972:19-20; Fort Yates ware in Lee 1980).

Ware-like classes include Transitional S-Rim ware and Knife River Fine ware which were originally used to describe pottery from two of the three major villages in the KNRI (Ahler and Weston 1981:86-89; Ahler and Swenson 1985a:325-326) and which have relatively narrowly defined limits for inclusion. Also used are Unnamed Straight Rim ware and Unnamed S-Rim ware which are much more loosely defined and which in essence incorporate all substantially intact rim sherds which cannot be classified according to any of the other ware groups. These two classes have been found to include the majority of the pottery from sites belonging to the Scattered Village complex (Lovick and Ahler 1982:73-75; Ahler and Mehrer 1984). Because of this, the latter two groups can in certain contexts have analytical significance, but it should be kept in mind that in general they are undefined catch-all classes, bounded only by basic rim form, and therefore can include very heterogeneous ceramic samples.

Body Sherd Analysis

Two types of information are systematically recorded for body sherds (zone 1 fragments). One is exterior surface treatment, recorded by counts according to several classes: smoothed/plain, simple-stamped, check-stamped, cord-roughened, brushed, cob-impressed, decorated (trailed/incised or punctate), and indeterminate. Cob-impressed, which occurs extremely rarely, and indeterminate are usually ignored in data analysis. Combinations of smoothing and other treatments (e.g., stamping) are not recorded, and if any treatment other than smoothing could be observed at any scale, then the specific, non-smooth treatment is recorded. Similarly, combinations of decoration and other surface treatments are not recorded; decoration takes precedence in recording. Surface treatment was recorded only for size grade 2 and grade 1 sherds (larger than 1/2 inch mesh). Surface treatment for size grade 3 sherds generally was not used because of the interaction thought to exist between size class and surface treatment class (Ahler 1984a:66). In most cases, all available grade 1 and grade 2 body sherds were classified by surface treatment; in rare instances, only a representative sample of available sherds was so classified.

The second body sherd variable recorded is maximum thickness. This was recorded only for size grade 2 sherds (bounded by 1/2 inch and 1 inch screen opening sizes) due to the suspected relationship between maximum observable thickness on a sherd and its overall size. Maximum thickness was recorded to the nearest 0.1 mm, taking care not to incorporate the curvature of the sherd in the thickness measurement. Eroded and split sherds were not measured. In many instances, a systematic sampling procedure was used to measure only a representative sample of all available grade 2 body sherds from a given context. Body sherd thickness is recorded under the assumption that it measures in large part the relative skill of the potter, although it is recognized that vessel wall thickness will be a function of many other functional, technological, and stylistic considerations (cf. Braun 1983).

Another body sherd variable which may be of significant analytic value but which was not recorded in the present study is impression width or impression spacing in simple-stamped surface treatment. It has been casually observed that the width of simple-stamp groove impressions in regional samples appears to increase by a factor of two or more in post-contact period collections as compared to prehistoric age collections. Systematic study of this variable is probably warranted.

ANALYTIC BATCH DEFINITIONS

Above the level of the individual vessel, the basic unit of comparison in the ceramic study is the "analytic batch" which consists of the collection of ceramic vessels and body sherds from what is thought to be a chronologically and/or culture- historically distinct context. Several general principles are applied to determine if a single batch unit or if multiple batch units should be used for the ceramic sample from a given archeological site. If a site is thought to contain a single component occupation, then the entire site collection might constitute a single analytic batch. If a site collection cannot be subdivided on the basis of archeological context into more than one sample which might have culture-historic significance, then the sample is also treated as a single analytic batch. This might be the case where the study collection derives from a general, uncontrolled surface collection. If there is reason to believe that multiple periods of occupation or multiple cultural components occur in a site, then composite, single-batch samples which would mask or lump such variation are generally excluded from consideration. If a site contains midden deposits of significant physical depth and apparent chronological depth, then the site sample might be subdivided on the basis of stratigraphy or chronometric dates into two or more analytic batches. This is particularly the case with ceramic data from deep, chronometrically dated midden deposits in several of the KNRI sites (e.g., Lower Hidatsa and Big Hidatsa). If relatively deep midden deposits occur in a site but cannot be dated, then multiple analytic batches will usually be defined based on stratigraphy and visible contrasts in frequencies of ceramic attributes known to be of historical significance. If large samples exist from spatially discrete areas within a site, then multiple batch units might be maintained based on spatial locus, primarily to allow the potential for intrasite comparisons, should significant spatial variation occur.

The actual process of batch identification and definition was a fairly complex and site-specific undertaking. Because the definition of batches, particularly in cases where more than one batch is defined for a site, is a relatively important element in interpretation of the analytic results and for future use of the data presented here, this process will be discussed in some detail on a site-by-site basis.

The batch definition process occurred after all ceramic vessels available from all sites had been coded according to the Ahler and Swenson (1985b) scheme, after the data files had been checked for errors and accuracy, and after body sherd data were recorded and checked. In most cases, the likely batch structure for a site was determined by the archeological context units reflected in the sample. For example, if the site sample consisted of a surface collection, then only one batch could occur; if the sample came from multiple shallow excavations, then multiple spatially stratifed batches could possibly occur; and if the sample came from multiple deep excavations, then multiple spatially and chronologically separate batch samples might occur. In the KNRI sites, the stratified deposits had in many cases been chronometrically dated or approximately dated based on trade artifact content and artifact class ratios, and the batch structure paralleled analytic unit definitions developed previously in the major descriptive reports on test excavations from each of the sites (e.g., Ahler et al. 1980; Ahler and Weston 1981; Ahler and Mehrer 1984; and Ahler and Swenson 1985a).

In many of the other tested sites in the region which were less fully analyzed and less well dated, exploratory studies of the ceramic data across site stratigraphy and among excavation units were conducted to determine the most appropriate batch structure for the site. This is particularly the case for sites tested in the 1968 Wood-Lehmer program (see Chapter 2). In such instances, we specifically examined data on rim form classes, ware classes, lip shape, new type (dominant decorative technique), and body sherd surface treatment across archeological context to determine the approriate batch structure for a site. These variables were chosen for study because variation across these classes could be relatively easily perceived without reference to multivariate procedures, and because previous research with ceramic samples in the region has shown these variables to be sensitive to chronological and culture-historic variation. For example, ware and rim form classes are known to change significantly through time, with unbraced straight and S-rim forms being particularly common in prehistoric periods and with straight braced forms being extremely common in post-contact periods (e.g., compare the early and late component assemblages from Amahami Village, Lehmer et al. 1978). Similarly, lip shape is thought to vary considerably through time, with heavily modelled flattened and T- or L-shaped lips being particularly indicative of culture-historic units such as the Scattered Village complex (Lovick and Ahler 1982:73). Type based on dominant decorative technique has been shown to vary considerably through time at several stratified sites (e.g., Ahler and Weston 1981:109; Ahler and Swenson 1985a:139-140). Surface treatment has also been long recognized as a taxonomically sensitive variable (Bowers 1948:113, 122), with Nailati phase pottery in particular characterized by relatively high frequencies of check-stamped surface treatment (Calabrese 1972:69). In no case was the intent at this time to provide a chronological or taxonomic placement for the samples using these variables; rather, the intent was merely to determine if significant intrasite contrasts existed in the data samples warranting separate analytic treatment.

Ware class, rim form class, and type frequencies, exclusive of lip sherds and other relatively indeterminate classes, were tabulated by excavation unit and excavation level or feature within a site. Lip shape class frequencies and body sherd surface treatment class frequencies were similarly tabulated for inspection. After examining each of these data sets, the data samples from all contexts were collapsed or organized into working batch units according to the similarities and contrasts which were perceived. In many cases, chi-square tests were applied to the data distributions to determine if significant differences existed, and the samples were organized by analytic batch using the chi-square row or column totals as a guide for the existence of particularly strong contrasts among intrasite contexts. In some instances where samples were large and where significant differences in content by archeological context were not observed, multiple batch units were maintained anyway for a single site to allow more detailed intrasite comparisons should such be useful for any reason.

The rationale for considering various sites outside the KNRI for inclusion in the comparative study has been discussed in some detail in Chapter 7. That section also presents quantitative data on the number of pottery vessels and body sherds incorporated into the comparative analysis from off-KNRI sites. A more detailed discussion of the content of each batch, particularly for multi-batch sites, follows. The analytic batches are assigned code numbers to facilitate computerized analysis of composite ceramic data and other data from each batch. An overall summary of batch numbers, names, content according to intrasite archeological context, vessel counts, and body sherd counts included in the study by site and by analytic batch is presented in Table 17.1.

0,1,2,3. On-A-Slant (32MO26).

The ceramic data used here derive from pottery in nine features and one other nonfeature context from the 1980 excavations at this village site at the mouth of the Heart River in the lower Knife-Heart region (Ahler, Schneider, and Lee 1981). The coded data on ceramic vessels are essentially the same as those presented in the paper on Slant Village pottery by Breakey and Ahler (1985). The features and contexts at the site can be subdivided into two groups, designated "early" and "late," based primarily on relative density of historic metal trade artifacts. Both groups appear to be post-contact in age. Based on historic data and oral traditions concerning the site, it is likely that the early period relates to the first half of the eighteenth century while the late period relates to the last half of that century, although these dates are not

Table 17.1. Analytic batch identifications for the upper Knife-Heart region comparative analysis, with data on ceramic samples used in the analysis.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
0	Slant Village, early large	32MO26	105	early component features, "large" vessel fragments (Breakey and Ahler 1985)	23	896	455	yes
1	Slant Village, late large	32MO26	105	late component features, "large" vessel fragments (Breakey and Ahler 1985)	21	869	320	yes
2	Slant Village, early small	32MO26	105	early component features, "small" vessel fragments (Breakey and Ahler 1985)	62	-	-	no
3	Slant Village, late small	32MO26	105	late component features, "small" vessel fragments (Breakey and Ahler 1985)	50	-	-	no
4	Molander	32OL7	88	total of 1966 and 1968 samples as a unit	106	677	182	yes
5	Pretty Point	32OL8	89	total 1968 sample as a unit	108	378	336	yes
6	Smith Farm	32OL9	90	total 1968 sample as a unit	19	60	42	yes
7	Lower Sanger	32OL11	91	total 1968 sample as a unit	84	313	244	yes
8	Upper Sanger, time period 1	32OL12	92	1968 Test 1, L1 only	47	104	42	yes
9	Upper Sanger, time period 2	32OL12	92	1968 Test 1, L2-4 only	74	396	126	yes
10	Upper Sanger, time period 3	32OL12	92	1968 Test 1, L5-7 only	78	279	126	yes
11	Upper Sanger, time period 4	32OL12	92	1968 Test 2, all	42	144	84	yes
12	Upper Sanger, other	32OL12	92	all 1968 not included above	17	43	31	no
13	Mile Post 28	32OL13	93	total 1968 sample as a unit	100	283	105	yes
14	Cross Ranch, test 1	32OL14	94	1968 Test 1 sample	58	189	102	yes
15	Cross Ranch, house 3	32OL14	94	1969 House 3 sample	98	-	-	yes
16	Cross Ranch, house 7	32OL14	94	1969 House 7 sample	235	-	-	yes
17	Cross Ranch, other	32OL14	94	all not included above	30	-	-	no
18	Bagnell	32OL16	95	all 1968 test sample as a unit	-	-	-	no
19	Greenshield	32OL17	96	all 1968 and 1973 test material	102	939	445	yes

Table 17.1. Continued.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
20	Hensler, test 1	32OL18	62	1968 Test 1 only	67	331	147	yes
21	Hensler, test 2	32OL18	62	1968 Test 2 only	90	534	154	yes
22	Hensler, other	32OL18	62	Bowers 1963 surf. coll.	22	14	13	no
23	Mandan Lake, test 1, time period 1	32OL21	98	1968 Test 1, L2-5	34	136	124	yes
24	Mandan Lake, test 3, time period 1	32OL21	98	1968 Test 3, L1-6 and F4, F6, F7	108	311	230	yes
25	Mandan Lake, test 4, time period 1	32OL21	98	1968 Test 4, L1-4	114	680	168	yes
26	Mandan Lake, time period 2	32OL21	98	1968 Test 1, L6-7, F1 Test 3, L7, F5 Test 5, L1, F9	53	240	180	yes
27	Mandan Lake time period 3	32OL21	98	1968 Test 5, L2-6, F10	42	328	179	yes
28	Shoreline	32OL103	101	total 1968 sample as a unit	56	248	135	yes
29	Mahhaha, time period 1	32OL22	99	1968 Test 2, L1 and Test 3, L1	47	359	84	yes
30	Mahhaha, time period 2	32OL22	99	1968 Test 2, L2-3 and Test 3, L2-3	126	1122	168	yes
31	Mahhaha, time period 3	32OL22	99	1968 Test 2, L4 & F4 and Test 3, L4-5 & F4, F6	78	196	176	yes
32	Mahhaha, time period 4	32OL22	99	1968 Test 2, L5-6 and Test 3, L6-7; Test 4, L1-2	128	294	232	yes
33	Mahhaha, time period 5	32OL22	99	Test 2, L7,8 and Test 3, L8,9, F8 and Test 4, L3, F9, F10	71	604	238	yes
34	Clark's Creek	32ME1	81	total 1968 sample as a unit	84	752	101	yes
35	Fort Clark	32ME2	82	all material from the site	27	120	107	yes
36	Lyman Aldren	32ME3	83	all 1968 surface collection	102	165	78	yes
37	Alderin Creek	32ME4	84	selected sample of pottery from features in the 1968 house excavation	125	630	168	yes
38	Deapolis	32ME5	59	all surface mat'l as a unit	309	62	48	yes
39	White Buffalo Robe, late	32ME7	60	1978 features, only those identified as Heart River phase in the 1980 report	54	566	201	yes

Table 17.1. Continued.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
40	White Buffalo Robe, early	32ME7	60	1978 features, only those identified as Nailati phase in the 1980 report	54	1207	200	yes
41	Amahami, late	32ME8	58	1970-1972 excavation, all Knife River phase rims plus body sherds from late component features	202	240	190	yes
42	Amahami, early	32ME8	58	1970-1972 excavations, all early component rims plus body sherds from early component features	127	574	275	yes
43	Buchfink	32ME9	54	all UND/NPS mat'l as a unit	54	62	62(61)	yes
44	Lower Hidatsa, time period 1 (revised)	32ME10	55	AC Unit 2, Horizon 1 AC Unit 3, Horizon 1,2 AC Unit 4, Horizon 1 from 1981 report	77	721	674	yes
45	Lower Hidatsa, time period 2 (revised)	32ME10	55	AC Unit 1, Horizon 1 AC Unit 2, Horizon 2 AC Unit 3, Horizon 3,4 AC Unit 4, Horizon 2 from 1981 report	87	902	788	yes
46	Lower Hidatsa, time period 3 (revised)	32ME10	55	AC Unit 1, Horizon 2,3,4,5 AC Unit 2, Horizon 3,4,5 AC Unit 3, Horizon 5,6 from 1981 report	159	1629	1476	yes
47	Lower Hidatsa, time period 4 (revised)	32ME10	55	AC Unit 1, Horizon 6 AC Unit 2, Horizon 6,7 AC Unit 3, Horizon 7,8 from 1981 report	97	920	862	yes
48	Lower Hidatsa, time period 5 (revised)	32ME10	55	AC Unit 3, Horizon 9-11 AC Unit 4, Horizon 4,5 from 1981 report	70	701	611	yes
49	Lower Hidatsa, time period 6 (revised)	32ME10	55	AC Unit 4, Horizon 6,7,8,9 from 1981 report	74	761	692	yes
50	Lower Hidatsa, mixed, misc. (revised)	32ME10	55	AC Unit 4, Horizon 3 AC Unit 5, Horizon 1 (all) AC Unit 8, all from 1981 report	95	180	175	no
53	Lower Hidatsa, Lehmer 6/1	32ME10	55	AC Unit 6, Horizon 1 from 1981 report	37	-	-	yes
54	Lower Hidatsa, Lehmer 6/2	32ME10	55	AC Unit 6, Horizon 2 from 1981 report	51	-	-	yes

Table 17.1. Continued.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
55	Lower Hidatsa, Lehmer 6/3	32ME10	55	AC Unit 6, Horizon 3 from 1981 report	26	-	-	yes
56	Lower Hidatsa, Lehmer 7/1	32ME10	55	AC Unit 7, Horizon 1 from 1981 report	39	-	-	yes
57	Lower Hidatsa, Lehmer 7/2	32ME10	55	AC Unit 7, Horizon 2 from 1981 report	22	-	-	yes
59	Sakakawea, time period 1	32ME11	57	AC Unit 3, Horizon 1,2,3 AC Unit 8, Horizon 1,2,3 AC Unit 9, Horizon 1 AC Unit 11, Horizon 0,1,2 (all) AC Unit 12, Horizon 1 AC Unit 13, Horizon 1,2 from 1980 report	112	835	301	yes
60	Sakakawea, time period 2	32ME11	57	AC Unit 3, Horizon 4,5,6 AC Unit 8, Horizon 4,5 AC Unit 9, Horizon 2,3 AC Unit 12, Horizon 2,3 AC Unit 13, Horizon 3,4 from 1980 report	103	1075	581	yes
61	Sakakawea, time period 3	32ME11	57	AC Unit 8, Horizon 6 AC Unit 9, Horizon 4 AC Unit 12, Horizon 4 AC Unit 13, Horizon 5 from 1980 report	21	158	136	yes
62	Sakakawea, inside later houses	32ME11	57	AC Units 4-7,10, All from 1980 report	53	840	-	yes
63	Sakakawea, other	32ME11	57	AC Units 1,2,14,15 - all else, from 1980 report	117	222	-	no
64	Big Hidatsa, time period 1	32ME12	56	Time Period 1, 1985 report	23	271	215	yes
65	Big Hidatsa, time period 2	32ME12	56	Time Period 2, 1985 report	108	1168	1013	yes
66	Big Hidatsa, time period 3	32ME12	56	Time Period 3, 1985 report	174	2046	1798	yes
67	Big Hidatsa, time period 4	32ME12	56	Time Period 4, 1985 report	127	1596	1420	yes
68	Big Hidatsa, time period 5	32ME12	56	Time Period 5, 1985 report	92	1160	1023	yes
69	Big Hidatsa, time period 6	32ME12	56	Time Period 6, 1985 report	24	361	327	yes

Table 17.1. Continued.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
70	Big Hidatsa, time period 7	32ME12	56	Time Period 7, 1985 report	7	68	60	yes
71	Big Hidatsa, other	32ME12	56	Time Period 0,8,9,10,99 & unassigned in 1985 report	60	378	351	yes
72	Stanton Ferry	32ML6	52	all UND/NPS mat'l as a unit	55	311	303	yes
73	Poly	32ME407	53	all UND/NPS mat'l as a unit	89	202	189(191)	yes
74	Elbee	32ME408	63	all UND/NPS pottery; stone from AC Units 1,2,3,5 in 1984 report	32	85	34	yes
75	Scovill	32ME409	65	all UND/NPS mat'l as a unit	36	127	123(129)	yes
76	Hotrok	32ME412	66	all UND/NPS mat'l as a unit	7	40	40(39)	no
77	Forkorner, east and central	32ME413	67	Site Areas 0,4,5 from 1984 report	87	218	211	yes
78	Forkorner, west	32ME413	67	Site Area 3 from 1984 report	70	242	221(234)	yes
79	Hump	32ME414	69	all UND/NPS mat'l as a unit	53	52	49(49)	yes
80	Youess	32ME415	70	all UND/NPS mat'l as a unit	192	500	457(490)	yes
81	Stiefel	32ME202	51	all surface collection, excluding Knife River ware vessels	60	207	209	yes
82	Rock	32ME15	73	rims from Houses 6,7 in Lehmer, Wood, Dill 1978	61	150	127	yes
83	Star	32ME16	74	all site mat'l exclusive of Woodland sherds, as a unit	10	27	29	no
84	Grandmother's Lodge	32ME59	75	all site mat'l as a unit	5	2	2	no
85	Like-A-Fishhook	32ML2	76	all site mat'l as a unit	25	154	105	yes
86	Nightwalker's Butte	32ML39	77	a sample of mat'l from various parts of the site	91	1227	599	yes
87	Mondrian Tree	32MZ58	64	all pottery excluding possible IMM vessel; Zone 1 in 1983 report	23	264	271	yes
88	Hagen	24DW1	103	random sample of vessels from all parts of site	299	117	118	yes
89	Hintz, house 3	32SN3	78	House 3 only, 1963 report	100	156	170	yes
90	Hintz, house 4	32SN3	78	House 4 only, 1963 report	82	118	121	yes

Table 17.1. Concluded.

Batch	Site and Batch Name	Site Number	Site Code	Batch Content	Number of Vessels Coded	Number of Body Sherds S.T.	Number of Body Sherds Thick.	Used in Quan?
91	Arzberger	39HU6	104	Houses 2,3,4, 1956 report	196	473	327	yes
92	Flaming Arrow	32ML4	102	all UND pottery collection	9	99	96	no
93	Sharbono	32BE419	108	all UND surface collection	17	33	32	yes
94	Taylor Bluff, late	32ME366	109	all late component mat'l in UND/NPS collections	-	-	-	no
95	Taylor Bluff, early	32ME366	109	all early component mat'l in UND/NPS collections	-	-	-	no
96	Angus	32OL144	107	all UND collections from lower ceramic component	-	96	-	no
97	PG	32OL148	106	all UND collections from main ceramic component	-	20	-	no
98	Running Deer	32ME383	68	all UND/NPS collections	13	33	41(27)	no
99	Cross Ranch, Late Woodland	several		material from 1980-1981 tests in Late Woodland sites; 1981, 1982 reports	-	152	-	no
100	Sagehorn	32ME101	87	total 1968 sample as a unit	9	80	42	no
Total sample, including material not used in quantitative analyses					7004	36522	22757	
Total sample, excluding material not used in quantitative analyses					6558	35514	22288	

Notes: S.T. = surface treatment analysis.
Thick. = maximum thickness measurement; numbers in parentheses indicate the sample measured by E. L. Mehrer in Ahler and Mehrer 1984, used as a check on Swenson measurements.
Quan? = included in quantitative comparative analyses (factor, cluster analyses) ?

certain and slightly earlier dates than these are thought possible. In the Breakey and Ahler paper (1985:22), the coded ceramic vessels are also subdivided into large and small vessels fragments, with the cutoff based on an approximate surface area of 11 square centimeters or greater for the combined rim sherds in the vessel. Based on both sherd size and relative chronology, four analytic batches were originally defined for this study, early large (0) and late large (1) sherds, and early small (2) and late small (3) sherds.

Breakey and Ahler (1985) demonstrate that chronological contrasts in the ceramic data sets, while visible for all sherds large and small, are accentuated when large vessel fragments only are considered. Therefore, the data from large vessels are thought to be more desirable for comparative studies. After some consideration, we decided to exclude batches 2 and 3 based on small vessel sherds from most comparative studies, under the assumption that the small sherd data sets are subject to the greatest degree of mixture. Because the body sherd data could not be separated according to the respective large and small rim sherd classes, composite information from all early and all late samples was used to accompany the early large vessel data (batch 0) and the late large vessel data (batch 1). In summary, batch 0 data consist of information on 23 large rim fragments and associated body sherd data from Features 9, 21, 41, and 51 in the 1980 excavations. Batch

1 data consist of data on 21 large rim fragments and associated body sherd data from Features 5, 48, 71, 76, and 81 and from levels 4 and 5 of excavation unit 15 in the 1980 excavations. Body sherd surface treatment data are taken directly from Breakey and Ahler (1985:8), while grade 2 body sherd thickness data are taken from a systematic sample of sherds from each time unit at the site.

4. *Molander (32OL7)*.

The ceramic data from the Molander site derive from two test excavations, one consisting of a 5 x 5 ft square dug in 1966 by the State Historical Society of North Dakota (SHSND) in an unknown location (unreported), and the second consisting of a 5 x 5 ft square dug in a midden area in the northeast margin of the site in the 1968 Wood-Lehmer testing program (Wood 1986c). The 1968 test penetrated circa 2.0 ft of midden deposit. All information suggests that both ceramic samples derive almost entirely from a single post-contact period component of occupation. The sample is homogeneous across the two excavation levels in the 1968 test. Therefore, virtually all materials in the 1966 and 1968 tests are combined into a single analytic batch for the present analysis. Exceptions include a single Fort Yates Cord Impressed vessel (number 0880012) and a single Unnamed S-Rim Cord Impressed vessel (number 0880094) which appear to derive from much earlier use of the site area and which are therefore excluded from the analysis. All available body sherds are included in the surface treatment data for batch 4, and a systematic sample of grade 2 body sherds from all site contexts was measured for maximum thickness information.

5. *Pretty Point (32OL8)*.

Ceramic data from the Pretty Point site derive entirely from two test pits dug there in the 1968 Wood-Lehmer testing program (Wood 1986c). One 5 x 10 ft test penetrated to 2.5 ft below surface, while a second 5 x 5 ft test extended to circa 3.5 ft below surface. Examination of the selected pottery variables by depths within the deposit and across the two test units shows the sample to be relatively homogeneous. It appears that the site deposits in the tested area consist of roughly a one ft deep midden with a substantial overburden of relatively sterile wind-blown silt and sand. On this basis, all ceramic data from all levels of both tests are assigned to batch 5 for the Pretty Point site. All available body sherds are used for the surface treatment and thickness measurements for this batch.

6. *Smith Farm (32OL9)*.

The total ceramic sample from this site derives from a single 5 x 5 ft test unit dug there in the 1968 Wood-Lehmer testing program (Wood 1986c). The test pit, in the northeast edge of the site, penetrated circa 1.0 ft of midden removed in a single excavation level. Lacking any way to objectively examine heterogeneity within the site, the single test sample is treated as a unit as batch 6. All available body sherd data for this test are also included with this batch designation.

7. *Lower Sanger (32OL11)*.

All ceramic data for this site derive from the 1968 Wood-Lehmer testing program (Wood 1986c). Samples derive from three test pits, a 5 x 5 ft square circa 1.5 ft deep in a between-house midden, a 5 x 10 ft unit circa 1.0 ft deep within a house depression, and a 2 x 10 ft trench circa 4.0 ft deep dug into a fortification ditch. Comparisons of key ceramic data by depth within test units and among test units shows the site ceramic sample to be highly homogeneous. On this basis, all ceramic data from the site are combined into the single batch 7 analytic unit. All available body sherds are used to develop the body sherd data set for this batch.

8,9,10,11,12. *Upper Sanger (32OL12)*.

Data used for the KNRI comparative analysis from the Upper Sanger site derive from the 1968 Wood-Lehmer testing program (Wood 1986c); data from a more extensive test at the site in 1969, reported in Stoutamire (1973), are not considered here due to lack of time for their organization and analysis. The 1968 tests consist of a single test unit (test 1) excavated in seven arbitrary levels in a midden nearly five ft deep in the main part of the site and a circa 7 x 8 ft test (test 2) dug to expose several features in a shallow house floor in a second part of the site on a lower terrace. The 1968 sample also contains a few surface artifacts and materials salvaged from a feature (F3) along the river bank in the lower terrace part of the site. Comparison of selected ceramic variables across levels in test 1 and between test 1 and test 2 indicates considerable heterogeneity in the pottery sample. The strongest differences are between test 1 as a whole and test 2 as a whole, best characterized by a much higher frequency of check-stamped body sherd treatment in test 2. The general impression is that the test 2 sample is older than any other materials in the site. Ceramic data are not randomly distributed among levels in test 1, although stratigraphic patterns are difficult to discern.

Based on this, it seemed desirable to preserve the general stratigraphic sequence in test 1 as well as the distinction between test 1 and test 2 in the batch definitions. Batch 8, potentially the latest material in the site, derives from level 1 in test 1; batch 9 from levels 2-4 in test 1; batch 10 from levels 5-7 in test 1; and batch 11 is comprised of all materials in test 2. All other ceramics from the site surface and from salvaged features are included as "other" material in batch 12, not thought to be particularly useful for analytic purposes. All available body sherds were used for surface treatment data for each batch, while a systematic sample of circa 42 sherds from each excavation level or discrete feature, collectively comprising about 50 percent of the site sample, was used for body sherd thickness measurement.

13. Mile Post 28 (32OL13).

The ceramic sample from this site derives from a single 5 x 5 ft test unit dug there in the 1968 Wood-Lehmer testing program (Wood 1986c) and from two adjacent 5 x 5 ft tests dug there in 1969 by the University of Missouri (Calabrese 1972:8). Because of the physical proximity of these tests and the shallow depth of midden deposits there (1.0 ft), it has been assumed that the pottery from the three test pits could be treated as a single sample, designated here as batch 13. Ceramic vessel data derive from all three test units. Body sherd surface treatment data derive from the 1968 test sample only, and the body sherd thickness measurement data derive from a systematic sample of the 1968 test body sherd sample. Body sherds from the 1969 tests were not located and were not used in the analysis. Calabrese (1972:5) considered the Mile Post 28 site to be a spatial continuation of the nearby Cross Ranch site (32OL14), and he lumped ceramic samples from the two sites for purposes of analysis. Maintaining Milepost 28 as batch 13 separate from Cross Ranch allows us to more formally compare the two site samples.

14,15,16,17. Cross Ranch (32OL14).

The ceramic data from the Cross Ranch site derive from a single 5 x 5 ft test unit dug in the 1968 Wood-Lehmer testing program (Wood 1986c) and from subsequent more extensive excavations conducted at the site in 1969 by the University of Missouri (Calabrese 1972). The 1968 test penetrated about 1.5 ft of midden in an area between houses 5 and 6. Houses 3 and 7 were completely excavated in 1969, and the test pit area between houses 5 and 6 was also expanded considerably in 1969 (Calabrese 1972:7-8). Midden deposits are shallow at the site, and vertical stratification of deposits is not thought to be significant. The spatial extent of the samples from the site is substantial, and for that reason, the batch structure for the Cross Ranch site maintains the integrity of large spatially separate samples, at least with regard to ceramic vessels. Batch 14 is comprised of ceramic vessel data from the 1968 test 1 at the site; body sherd surface treatment data derive from the full body sherd sample from test 1, and body sherd measurements derive from a sample of the test 1 body sherd sample. Batches 15 and 16 are comprised, respectively, of ceramic vessel data from the house 3 and house 7 excavations conducted in 1969. Body sherds from the 1969 excavations were not studied (either from the houses or from the expanded tests), and the body sherd data derived from the 1968 test (batch 14) are assumed to be applicable for use with the batch 15 and 16 ceramic vessel data sets. Batch 17 is comprised of ceramic vessels which, due to incomplete catalog information, could not readily be related to either the test excavation area or to the house 3 or house 7 excavations. These vessels are probably from the 1969 expanded tests or are from surface collections. This is a catchall batch which has no spatial context, and data included therein are useful only if a larger site-wide sample of vessel information is desired.

18. Bagnell (32OL16).

A single 5 x 5 ft test unit circa 2.0 ft deep was dug in an outside-house midden at this site in the 1968 Wood-Lehmer testing program (Wood 1986c). In the years 1970-1973, D. J. Lehmer conducted extensive excavations at this site which have not been formally reported (cf. Lehmer et al. 1973; Angus 1975; Pepperl 1976). Ceramic samples from the 1968 test have been physically integrated with the 1970-1973 excavation samples. These materials are now in storage at the SHSND in Bismarck. The rim sherds are presently organized according to Lehmer's rim form groups rather than by provenience. The site reportedly has two superimposed components (Lehmer et al. 1973), but it proved impossible to find time to identify and extract representative subsamples of either the rim sherds or body sherds for general site analysis or for more detailed study of intrasite variation. Therefore, ceramic data from Bagnell are not included in the present study. The batch number is assigned because data on lithic materials and vertebrate fauna from the 1968 test unit are available for study, and they are designated as batch 18 for such purposes.

19. Greenshield (32OL17).

Ceramic data from this site derive from two episodes of test excavation. The first involves the excavation of three 5 x 5 ft test units during the 1968 Wood-Lehmer testing program (Wood 1986c). Two of the tests penetrated midden about a foot or less in depth, while the third was excavated to circa 2.3 ft below surface. The second data set derives from D. J. Lehmer's excavation of a trench measuring about 5 x 25 ft across a trash filled ditch in another part of the site in 1973 (Nicholas and Johnson 1986). Although there is indication that the site was briefly and sequentially occupied by the Mandans and then the Arikaras in the AD 1790s (Osgood 1964:164; Thwaites 1969, 1:203-204; Nicholas and Johnson 1986:192), most artifacts from the site tests cannot be organized stratigraphically due to shallowness of the midden or due to the recovery procedures. In the interest of increasing sample size, materials from both the 1968 and 1973 tests are combined here into a single analytic batch. Body sherd surface treatment information is collected for all available body sherds from all contexts, and body sherd thickness measurements are taken for a systematic sample of sherds from both the 1968 and 1973 tests and from unprovenienced body sherd lots from the site (probably from the 1973 test).

20,21,22. Hensler (32OL18).

The ceramic data from this site derive primarily from the 1968 Wood-Lehmer testing program (Wood 1986c). Two 5 x 5 ft test pits were dug in the site at unknown locations. One extended to a depth of circa 1.5 ft while the other was dug to circa 3.5 ft. A small sample of surface material collected by Alfred Bowers in 1963 and included in the University of Missouri collections was also studied. The ceramic data exhibit no significant variation with depth in either test unit. A significant difference in rim form does occur across the two test units, with straight rims being more common in test 1 and with S-rims of various forms being more common in test 2. Both samples to some degree appear internally heterogeneous, possibly indicating the presence of highly disturbed deposits altered by pothunting, etc. On the basis of the rim form differences between tests, batch 20 is defined to include materials from test 1 only and batch 21 includes materials from test 2 only. Other materials from the site surface are included in a residual unit, batch 22. All available body sherds from both tests were studied for surface treatment data, and a systematic sample of body sherds from each test was examined for thickness measurements.

23,24,25,26,27. Mandan Lake (32OL21).

Ceramic data included from the Mandan Lake site for the designated batches derive from the 1968 Wood-Lehmer testing program (Wood 1986c). The site was more extensively tested than most in the 1968 testing program, allowing the definition of several analytic batches. Five tests were dug at unknown locations in the site. Tests 1, 3, 4, and 5 were apparently 5 x 5 ft in size and penetrated midden varying from circa 2.5 to 3.5 ft in depth. Test 2 was smaller and shallower, and no artifacts exist for that test unit. Ceramic data distributions vary significantly according to stratigraphy within some units as well as among test units as a whole. In tests 1 and 3 Le Beau ware is most common in the upper excavation levels and becomes less common in lower levels. All of test 4 compares favorably in ceramic content to the upper parts of tests 1 and 3. These samples seem to represent a relatively later period of occupation at the site. Relatively high frequencies of Fort Yates ware and Unnamed Straight and S-Rim wares occur in the lower parts of tests 1 and 3 and in the uppermost part of test 5. These samples appear to relate to a second, earlier time period. In the mid to lower levels in test 5 Fort Yates ware is relatively common and check-stamping is decidedly more common than anywhere else in the site. These samples seem to reflect a third, yet earlier time period.

Five analytic batches are defined to account for both the chronological variation apparently reflected in the site and the spatially discrete origins of several samples. Batch 23 is thought to be late period and includes material from levels 2-5 in test 1. Batch 24 is also late period and includes materials from levels 1-6 in test 3 and associated features 4, 6, and 7. Batch 25 is also late period and includes all materials from test 4. Batch 26 is a composite of all middle period samples from all test units, including test 1, levels 6-7 and Feature 1; test 3, level 7 and Feature 5; and test 5, level 1 and Feature 9. Batch 27 is presumably the earliest in the site and includes all materials from levels 2-6 and associated Feature 10 in test 5. Two other vessels from surface contexts were coded but were not assigned to an analytic batch. Radiocarbon dates exist for batches 23, 25, and 27 (Table 8.3). The available dates from the three contexts do not differ greatly from each other and do not confirm the supposed chronological trend, although this may simply indicate a relatively short period of occupation for the entire site. All available body sherds were used for surface treatment data collection, while a systematic sample of sherds from each batch context was used for grade 2 thickness measurements.

28. Shoreline (32OL103).

The ceramic data from this site derive from a small surface collection and a single 5 x 5 ft test unit dug in the 1968 Wood-Lehmer testing program (Wood 1986c). The ceramic sample appears internally heterogeneous with Le Beau, Fort Yates, and Unnamed S-Rim wares each occurring in some frequency, and with no stratigraphic pattern being apparent in the three excavated levels. Check-stamping is relatively common, but is most common in higher excavated levels than in lower levels, the reverse of what is seen in some stratified sites. The small sample gives the appearance of representing more than one component or of being mixed, but it cannot be meaningfully separated for purposes of finer-scale analysis. All materials from the 1968 work at the site are therefore considered under the single analytic batch 28. All available body sherds were used for surface treatment data, while a systematic sample of grade 2 sherds were used for thickness measurements.

29,30,31,32,33. Mahhaha (32OL22).

All ceramic data from this site derive from the 1968 Wood-Lehmer testing activities conducted there (Wood 1986c). The 1968 testing there was relatively extensive, and the site contains stratified deposits, leading to the definition of several analytic batches for this site. Five tests were dug at the site in 1968. Test 1 was a 5 x 5 ft square in relatively shallow midden, extending to circa 0.9 ft below surface. Tests 2 and 3 were adjacent 5 x 5 ft squares in an area where midden was approximately 4.0 ft deep. Test 4 was a 5 x 5 ft square in a 1.5 ft deep midden area. Test 5 was an irregular unit dug primarily to expose and remove cache pits in a graded area. The artifact sample from the testing is quite voluminous, and the decision was made to focus the ceramic analysis on materials in tests 2, 3, and 4 where stratification was most evident. Pottery from tests 1 and 5 was not analyzed, although study of the samples from those units might eventually place those samples and their associated lithic and faunal materials in a meaningful culture-historic framework. Data for selected ceramic variables were plotted by vertical excavation level in tests 2, 3, and 4, and clear evidence of stratigraphic change was indicated. The patterns in tests 2 and 3 are quite similar, while the data in test 4 fit best with the lowermost levels in tests 2 and 3. In general, the patterns involve a high frequency of check-stamped surface treatment, Fort Yates ware, and Unnamed wares in the lowermost levels, changing to low check-stamping frequencies and high Le Beau ware frequencies in higher levels, this changing to high Knife River ware frequencies in highest levels.

Because sample sizes are relatively large, it was decided that analytic batch definition should maximize the potential for stratigraphic analysis of the site which seemed to reflect a several hundred year period of village activity (chronometric dates confirm this amount of time depth; see Chapter 8). On this basis, five analytic batches are identified based on superposition of arbitrary excavation levels in tests 2 and 3; test 4 samples are assigned to certain of these five time period batches based on general similarities with test 2 and 3 samples. Batch 29 incorporates all data from the uppermost excavation level in test 2 and test 3. Batch 30 includes all material from levels 2 and 3 of tests 2 and 3. Batch 31, reflecting the third in the series of relative time blocks, includes level 4 and Feature 4 in test 2 and levels 4 and 5 and Features 5 and 6 in test 3. Batch 32 includes the next two lower levels in tests 2 and 3, respectively, and the upper two levels in test 4. Batch 33 includes the lowermost two levels (7, 8) in test 2, the lowest two levels (8, 9) and Feature 8 in test 3, and the third level and Features 9 and 10 in test 4. All body sherds from all the defined batch contexts were used in the surface treatment analysis, while systematic samples of grade 2 sherds were used for thickness measurements.

34. Clark's Creek (32ME1).

The ceramic data from the Clark's Creek site derive from the 1968 Wood-Lehmer testing program (Wood 1986c; Calabrese 1972:34). Two tests were dug in that year at the site, one a 5 x 5 ft square reaching a depth of 0.8 ft and the second a 5 x 10 ft unit reaching a depth of 1.8 ft. Vertical stratification is negligible, and there is no indication that the contents of the two tests differ to any degree. On that basis, the 1968 materials from the site are treated in a single analytic batch. Body sherd surface treatment data derive from the entire body sherd sample, while a selective sample of grade 2 body sherds was used for thickness measurements.

35. *Fort Clark (32ME2).*

The ceramic data from the Fort Clark site used in the analysis derive entirely from the 1968 Wood-Lehmer testing program. Four test pits were dug there, with tests 1, 3, and 4 being 5 x 5 ft squares which penetrated midden from about 1.0 to 1.5 ft deep. Test 2 is a trench measuring 3 x 11.5 ft dug inside a house depression. The ceramic sample from all tests is rather small. Although it is recognized that the Fort Clark site was occupied sequentially by first the Mandans and then the Arikaras, it is not possible to analyze the excavated sample accordingly, due to the small sample size and shallow stratification. Therefore, all materials from all four 1968 tests are combined here into a single analytic batch for purposes of comparative analysis. All available body sherds from the tests were also used for both surface treatment and thickness measurement analyses.

36. *Lyman Aldren (32ME3).*

To the author's knowledge, this site has not been test excavated since W. D. Strong's unreported work there in 1938, and the ceramic data used here derive entirely from an extensive surface collection made at the site during the 1968 Wood-Lehmer testing program. Examination of the rim sherds indicates an odd combination of Fort Yates ware attributes and Le Beau ware attributes on S-rim vessels, such as angular zone 3 junctures in combination with small diameter cords and narrow cord spacings. All such vessels were coded as Unnamed S-Rim ware. Multiple components are clearly a possibility in this sample. All body sherds in the surface collection were used for surface treatment data, while a systematic sample of G2 body sherds was used for thickness measurement.

37. *Alderin Creek (32ME4).*

The ceramic data from the Alderin Creek site used in this study derive primarily from collections obtained in an unreported highway salvage excavation conducted there by the State Historical Society of North Dakota in 1968. That excavation was quite extensive, covering all of an earthlodge feature and a large surrounding area, and only part of the available artifact sample could be included in the present study. Study focused on the pottery in cache pits and large basin-shaped pits in the floor of the house and presumably related to the house occupation. All pottery in the following pits was studied: Features 129, 132, 133, 137, 138, 149, 157, 162, 190, and 193. Radiocarbon dates were also obtained on charcoal and wood in Features 132 and 137 (Chapter 8). In addition, a small sample of ceramic vessels was studied which was obtained in the 1968 Wood-Lehmer testing program, occurring in a surface collection made at the site and in the contents of a cache pit they salvaged from a cutbank. A general observation on the collection is that the sample from the excavated house features is extremely internally homogeneous, consisting almost entirely of Le Beau ware, while the surface collection and cutbank sample is somewhat more heterogeneous. All of the body sherds from the SHSND excavation sample were used for surface treatment observations, and a selected sample of body sherds from both the SHSND and 1968 Wood-Lehmer samples was used for thickness measurements.

38. *Deapolis (32ME5).*

The ceramic sample from the Deapolis site derives primarily from the Ralph Thompson (1961) collection and secondarily from a much smaller sample collected from near the former site location during the 1968 Wood-Lehmer testing program. The Thompson collection, previously studied by Lehmer et al. (1978), is an aggregate of material from a village occupied for at least 30 years and for perhaps as much as 60 years during a time of rapid cultural change in the AD 1800s. The nature of the sample, salvaged from a bulldozing operation, precludes any type of subdivision of the sample for analytical purposes. The body sherd sample from the site is quite small. All available body sherds in both the Thompson collection and the 1968 Wood-Lehmer surface collection were studied for both surface treatment and thickness measurements.

39, 40. *White Buffalo Robe (32ME7).*

The ceramic data from the White Buffalo Robe site derive from a portion of the artifact sample salvaged from the site by the University of North Dakota in the path of pipeline construction (Lee, ed. 1980). Because the excavated pottery collection is quite large and because a portion of it is from mixed component contexts within the site, only a part of the collection having clearest component association is studied here. Study here is restricted to materials from cultural features given definite assignments to either the Heart River phase or the Nailati phase. These two phase designations constitute the basis for the two analytic batches, 39 and 40, respectively, assigned to the site in the present study. The chronological separation of these two phases is well documented by radiocarbon dates from the site (Chapter 8). Materials designated as being from the Knife River phase in the site report (Lee 1980) are not included in the present study. The original Heart River phase and Nailati phase designations were based primarily on the ceramic content exhibited by individual features. The phase associations for individual features listed in Table 6.2 in Lee and Hetland (1980) were used for batch sample definition in this study. Body sherd surface treatment data used in this study were taken from the data tabulations compiled by C. H. Lee for the respective Heart River phase and Nailati phase feature samples (data on file at UND). Body sherd thickness measurements were made on a systematic sample of approximately 200 grade 2 sherds from each of the feature batch samples.

41, 42. Amahami (32ME8).

The data from the Amahami site derive from a test conducted as part of the Wood-Lehmer program in 1968 (Wood 1986c) and from collections recovered in salvage excavations conducted there in the years 1970-1972 by the State Historical Society of North Dakota and Dana College (Lehmer et al. 1978:144-179). Ceramics and other artifacts and features in the excavations clearly indicate two occupational components widely separated in time. An historically documented post-contact period, Knife River phase component overlies a much earlier but undated prehistoric period component. Ceramic materials from the site were separated into respective late and early period batches (41 and 42, respectively) based on their association with these two occupation periods. Ceramic vessels were assigned directly to respective late and early period batches based on typology, form, and paste characteristics. The late period sample consists almost entirely of Knife River ware and Deapolis Collared ware. All Fort Yates ware, Riggs ware, and Unnamed Straight Rim and Unnamed S-Rim ware vessels were assigned to the early analytic batch. Because the late period sample from the site consists of more than 400 rims, a systematic sample of approximately 200 rims from the late period component was subjected to analysis to conserve lab time. All ceramic vessels assigned to the early period batch were coded and included in the analysis.

Body sherds used in the study were confined to feature samples only, because those are the only contextual units which could confidently be assigned a period association. Batch association for individual features was based on combined examination of the rim sherd types found in the feature and on the characteristics of the body sherds themselves. Early body sherds are characteristically dull in luster, brown or buff in color, porous and crumbly, and exhibit narrow simple-stamping, some check-stamping, and heavy smoothing as surface treatments. Late body sherds are characteristically dark brown to black in color, burnished and reflective in luster, and marked by very broad undulating simple-stamping. On this basis, features were assigned to early, late, or mixed early/late time periods. Mixed feature samples were not included in the analysis. The body sherds in all features assigned to a definite unmixed period association were used for surface treatment observations, while a systematic sample of approximately 150 sherds was taken from each period sample for thickness measurement. Period assignments for individual features in the site, and the data giving the basis for those assignments (rim sherds, body sherds, or both) are on file at UND.

43. Buchfink (32ME9).

The ceramic data for this site derive from the UND/NPS controlled surface collection conducted in 1979 (Lovick and Ahler 1982:169-182) and from test excavations conducted there in 1979 and 1981 (Ahler and Mehrer 1984:103-132). It is clear that the southern part of the Buchfink site contains a mixture of prehistoric village artifacts and late historic period artifacts, the latter deriving from activities at the adjoining Amahami site (32ME8). For this reason, vessels which are clearly post-contact period in age have been excluded from the vessel coding, and the analysis focuses on only the prehistoric age materials. All vessels classified as Knife River ware or Deapolis Collared ware have been excluded from this batch sample. These occurred primarily in the surface collection. Excavations in the northern end of the site revealed no clear cultural stratification and no basis for separation of excavated samples into more than one cultural component, and also little evidence for post-contact period cultural activities. Body sherd surface treatment data are derived from the excavated sample only, thought to be devoid of significant late period content, as reported in Ahler and Mehrer (1984:117, Table 36). Body sherd thickness measurements were also taken on excavated artifacts only, as reported in Ahler and Mehrer (1984:117, Table 37).

44, 45, 46, 47, 48, 49, 50. Lower Hidatsa (32ME10).

The ceramic data in the first six of the seven designated batches derive entirely from the stratified artifact samples and contexts exposed in the 1978 UND/NPS excavations at the site reported in Ahler and Weston (1981). The last batch (50) contains data on pottery derived from unprovenienced or mixed contexts (surface, unstratified excavations) in both the 1978 UND/NPS excavations and in the earlier 1965 excavations by D. J. Lehmer. Batch 50 is intended to be a residual group with little analytic value. Batches 44 through 49, on the other hand, are designed to capture the full range of chronological variation evident in the site deposits. When the 1981 report was written, it was assumed that the deposits at the site represented about 100 years of intensive occupation (circa AD 1680-1780), and the stratified deposits were separated into three time periods and two intervening transitional or mixed temporal units. Since then, many additional chronometric dates have become available for the site, and it is clear that the temporal span of occupation there is much greater than originally thought. Presently, we estimate the site to have been established at least as early ad AD 1525 and perhaps as early as AD 1450, with occupation continuing until circa AD 1780 (see Chapter 8 on chronometric dates). Because of the extended period of occupation, the excavated stratified site deposits have been reorganized according to six rather than three sequential time periods, each thought to reflect circa 40-50 year blocks of time. The original organization of the site deposits into a time period sequence and correlation of deposits between excavations according to these units were accomplished by examining body sherd thickness data and vessel ware classifications as well as physical stratification of the deposits. The same procedures were used in reorganizing the site deposits into the six periods of relative chronology.

The original time period 1 deposits and the underlying transitional period 1/2 deposits have been largely reidentified as period 1 and 2 (batches 44 and 45); the original time period 2 and period 2/3 transitional deposits have largely been reassigned to periods 3 and 4 (batches 46 and 47). The original time period 3 deposits have been subdivided based on stratigraphy and chronometric dates into periods 5 and 6 (batches 48 and 49). Actual assignment of individual vertical excavation horizons from individual excavation (archeological context, AC) units is spelled out in Table 17.1. Body sherd surface treatment data collected for the 1981 report are used in this study, reorganized according to the six rather than three time periods or batch units following the explanation in Table 17.1. Body sherd thickness measurements used here are also those collected for the 1981 study, appropriately reorganized and recompiled by the six batch units; thickness was measured for only a systematic sample of grade 2 body sherds.

53, 54, 55, 56, 57. Lower Hidatsa (32ME10).

The ceramic data included in this series of five batches derive from stratified samples occurring in the excavations conducted at Lower Hidatsa site in 1965 by D. J. Lehmer, reported by Lehmer et al. (1978:132-137) and Ahler and Weston (1981). Lehmer dug two test units extending roughly 6.0 ft and 4.0 ft, respectively, into midden deposits. In the 1981 report his test 1 (AC Unit 6) was separated into three major stratigraphic horizons assigned to time periods 1, 2, and 3, respectively, in the original temporal framework for the site. Lehmer's test 2 (AC Unit 7) deposits were separated into two horizons assigned to mixed time periods 2/3 and period 3 in the original temporal framework. Due to the poor excavation control in those tests, no attempt is made here to reorganize the materials from the 1965 tests according to the new six-period temporal framework for the site, although it is likely that most of the full time duration for the site is encompassed in the Lehmer tests. Rather, each horizon of each AC Unit (test) is maintained as a separate analytic batch (batches 53 through 57) as identified in Table 17.1, and these batch samples will be subjected to comparative analysis as a check, more or less, on their relationship to the more finely controlled samples from the 1978 excavations. No body sherd data exist for the Lehmer tests. To facilitate certain analyses, surface treatment values and thickness values derived from the entire 1978 sample treated as a unit (batches 44-49 combined) will be used with each of the Lehmer batches.

59, 60, 61, 62, 63. Sakakawea (32ME11).

The ceramic data used in the analysis of the Sakakawea site derive both from test excavations conducted by D. J. Lehmer in 1965 (reported in Lehmer et al.

1978:38-43) and from excavations conducted in the UND/NPS program in 1976 and 1977 (reported in Ahler et al. 1980). Lehmer dug two test pits which penetrated up to 4.0 ft of midden deposits, and the UND/NPS excavations consisted of salvage of linear sections along the eroding Knife River cutbank and four isolated tests in inside- and outside-house contexts at scattered locations in the site. The various isolated excavations or contiguous excavation areas are designated as archeological context (AC) units, and 15 such units, including Lehmer's tests (AC Unit 13) and uncontrolled collections from the site, are identified in the 1980 report. Emphasis in the ceramic analysis is on temporal variation, and site stratigraphy in outside-house middens is used to identify three analytic batches which reflect three successive time periods of site occupation.

The first of these is batch 59 which encompasses roughly the upper one-half of the midden sequence in each test or series of tests dug in outside house locations (dug between the presently visible house depressions). Batch 60 is comprised of roughly the lower one-half of midden deposits in the same locations, exclusive of distinctive materials included in batch 61. Batch 61 is comprised of a relatively thin layer of heavily burned house roof and floor debris which occurs at the extreme base of the midden deposits in four AC units. This material is thought to represent the remains of a briefly occupied village on the site location which was destroyed by fire early in the period of site use, followed immediately by a much longer period of site use. Historic documentation indicates that a combined Mandan/Hidatsa village stood at this location in 1797/1798 (Wood 1977:338), while by the time Lewis and Clark arrived in 1804, the village at this location was comprised entirely of Awatixa Hidatsas. The Awitaxas remained there until circa 1834/1837 and possibly into the early 1840s, by which time the village was abandoned. Thus, batches 59, 60, and 61 reflect occupation from the 1790s until possibly as late as 1845.[1]

Batch 62 consists of all materials from test excavations within the floors and perimeters of the lodge depressions presently visible on the site surface. These materials cannot be stratigraphically separated, and they represent a composite of the main period of occupation from circa 1800 to circa 1845, roughly equivalent to combined batches 59 and 60 from outside house contexts. Batch 63 consists of all other excavated or other samples from the site which cannot readily be associated with any of the preceding batches having better locational and chronological control. Body sherd surface treatment data for all batches derive from information collected for the 1980 report, exclusive of data for Lehmer's test where body sherds were not collected. Body sherd thickness data were collected only for systematic samples of body sherds from batches 59, 60, and 61. Mean thickness values for batches 59 and 60 combined are used as necessary to facilitate the inclusion of batch 62 in the analysis.

64, 65, 66, 67, 68, 69, 70, 71. Big Hidatsa (32ME12).

The ceramic sample from the Big Hidatsa site derives entirely from the UND/NPS excavations conducted there in 1980 and reported in Ahler and Swenson (1985a). The first seven of the eight batch samples defined for the site equate directly with time period analytic units 1-7, respectively, developed in the 1985 report. The time period units correlate and combine artifacts from across several excavation units on the basis of multivariate analysis of sherd thickness data and artifact class ratios considered along with site stratigraphy. The time period sequence is generally confirmed by chronometric analysis (Chapter 8). Period 7 (batch 70) is prehistoric in age, dating perhaps in the AD 1400s, while periods 1-6 (batches 64-69) are all post-contact period in age, seeming to reflect continuous occupation during the period circa AD 1600 to 1845 when the site was abandoned. The time period or batch units each are thought to reflect time increments ranging from roughly 30 to 50 years in duration. Body sherd data used here consist of surface treatment and thickness measurements reported by Ahler and Swenson for each of the time period/batch units. Batch 71 is identified here as a residual class comprised of all mixed contexts identified in the 1985 report (time periods 0, 8, 9, 10, 99 in Ahler and Swenson 1985a).

72. Stanton Ferry (32ML6).

The ceramic sample from this site derives from an intensive surface collection made at that location in 1977 as part of the UND/NPS program, subsequent to the site's total destruction during gravel mining (Ahler and Swenson 1980:33-62). While the collection might represent a

[1] Subsequent interpretation of data from salvage excavations at the Taylor Bluff Village (Ahler 1988) has bearing on these dates. See footnote 2, this chapter.

mixture from more than one component, it appears to be relatively homogeneous from a typological perspective. On that basis, no individual vessels were excluded from analysis. Body sherd surface treatment data used here were developed from a second examination of the sherds, separate from the data presented in Ahler and Swenson (1980:52, Table 16). All available body sherds were also used for thickness measurements.

73. Poly (32ME407).

Ceramic data for this site derive from both the controlled surface collection conducted in 1977 as part of the UND/NPS program (Ahler and Swenson 1980:5-32) and from test excavations conducted there in 1978 and reported in Ahler and Mehrer (1984:131-161). All vessels from both the surface collection and from excavation were coded and included in the analysis. Detailed study of stratigraphy in the test excavations indicates that only a single period of site occupation is represented, and on that basis, all materials from the site are combined into a single analytic batch. Body sherd surface treatment data and thickness measurements are taken from the excavated sample only. Thickness measurements were taken twice, once by E. L. Mehrer (Ahler and Mehrer 1984:148-149) and a second time by Swenson.

74. Elbee (32ME408).

Data from this site derive from the testing and salvage excavations conducted there in 1978 as part of the UND/NPS program (Ahler, ed. 1984). The ceramic sample from the site was subjected to an intensive study in the 1984 report, with the conclusion that the pottery is more like collections from Extended Coalescent sites in South Dakota than samples from nearby villages in the Knife-Heart region (Ahler 1984b:208-210). It is also apparent that more than one component is present at the site, but that the majority of the pottery collection derives from a single brief period of occupation. Because of the small sample size available, it was decided that the Elbee pottery would be analyzed as a single batch unit, rather than separated according to intrasite context. The first detailed study of the sample (Ahler 1984a) was conducted for all vessels of size grade 3 and larger, while the present study is restricted to grade 2 and larger vessel fragments, consistent with general procedure for the comparative program. Body sherd surface treatment data derive from the total excavated collection, while thickness measurements used in this study derive from body sherds from feature contexts only, as reported in Ahler (1984a:68).

75. Scovill (32ME409).

The ceramic data from the Scovill site derive from test excavations conducted there in 1978 as part of the UND/NPS program (Ahler and Mehrer 1984:162-191); also included are a few vessels from an intensive unreported surface collection taken in 1978. The pottery from the site is somewhat heterogeneous from a typological or stylistic perspective, suggesting that more than one village component may be represented. Analysis has failed to reveal any way of segregating the components, so the ceramic sample is treated here as a unit in a single analytic batch. Body sherd surface treatment data derive from the excavated collection only. Body sherd thickness measurements derive from the excavated collection also, and they were taken twice, once by Mehrer (Ahler and Mehrer 1984:179) and a second time by Swenson.

76. Hotrok (32ME412).

The ceramic sample from the Hotrok site derives from excavations conducted in 1979 as part of the UND/NPS program (Ahler and Mehrer 1984:45-72). The ceramic sample from the site is thought to derive primarily from a temporally restricted period of time during which the site was used as a dump for fire-cracked rock and other refuse. Minor parts of the ceramic sample may derive from earlier village period activities. The site sample, even when considered as a unit, is too small (seven vessels) for systematic quantitative comparison with other regional samples, although the general characteristics of the sample bear consideration relative to the question of correlation between ceramic content and site function.

77, 78. Forkorner (32ME413).

The ceramic sample from the Forkorner site derives from a controlled surface collection made at the site in 1979 and test excavations in three parts of the site in 1979 and 1981 which were conducted as part of the UND/NPS program (cf. Lovick and Ahler 1982:161-182; Ahler and Mehrer 1984:192-249). Previous study of the ceramics and other artifacts indicates that the two main areas of occupation in the eastern and western parts of the site differ somewhat in content and deserve separate analysis (Ahler and Mehrer 1984:206-209), although both areas are generally classifiable as components of the Scattered Village complex. No vertical stratification is apparent in either site area, and the materials in each site area seem to represent a relatively short single component occupation. On this basis, the site ceramic sample is studied under two batch designations. Batch 77 is comprised of artifacts in the east and central parts of the site which were intensively surface collected in 1979 and test excavated in 1981. Batch 78 is comprised of materials in the western site subarea, test excavated in 1979. Body sherd data derive from excavated samples only. Thickness measurements for batch 77 (east and central areas) were recorded by Mehrer (Ahler and Mehrer 1984:228,244), while measurements for the batch 78 (west area) sample were recorded both by Mehrer (Ahler and Mehrer 1984:214) and by Swenson.

79. Hump (32ME414).

The ceramic data for this site derive from a controlled surface collection made in 1979 (Lovick and Ahler 1982:161-182) and from test excavations conducted there in 1981 as part of the UND/NPS program (Ahler and Mehrer 1984:250-269). There is no evidence in the small ceramic sample for multiple periods of occupation or for mixed components. The entire site pottery sample is therefore treated as a single batch unit. Both the surface collection and the excavated materials are included in the vessel analysis. Only excavated body sherds are used in the surface treatment analysis and in thickness measurements. Thickness measurements were recorded on the sample both by Mehrer (Ahler and Mehrer 1984:260) and by Swenson.

80. Youess (32ME415).

The ceramic data set for the Youess site derives from a controlled surface collection made at the site in 1979 (Lovick and Ahler 1982:161-182) and from test excavations in 1981 (Ahler and Mehrer 1984:270-299) conducted as part of the UND/NPS program. Intensive study of intrasite variation in ceramics and other data gives no reason to suspect that the pottery sample derives from more than one period of occupation. On that basis, it is treated here as a single analytic batch. Body sherd data derive from the excavated sample only. Body sherd thickness measurements were recorded twice, once by Mehrer (Ahler and Mehrer 1984:282) and a second time by Swenson.

81. Stiefel (32ME202).

The ceramic data for the Stiefel site derive largely from an intensive surface collection conducted there in 1977 as part of the UND/NPS program (Ahler and Swenson 1980:63-84) and also from a small surface collection made there in 1968 as part of the Wood-Lehmer testing program. The 1977 UND/NPS surface collection is relatively homogeneous, consisting primarily of Riggs ware and small amounts of Fort Yates ware, both clearly prehistoric in age. The 1968 Wood-Lehmer surface collection is much more heterogeneous, containing Riggs and Fort Yates wares and also Knife River ware and a few other vessels which are clearly post- contact period in age. To focus the analysis on the predominant prehistoric period component, all vessels judged to be post-contact period in age on typological and stylistic grounds (mostly Knife River ware vessels) were excluded from this batch and from analysis. To avoid further confusion of mixed components, the body sherd data were derived exclusively from the 1977 surface collection. Body sherd surface treatment data were rerecorded and differ from those reported in Ahler and Swenson (1980:77). Thickness measurements were recorded for all available sherds in the 1977 collection.

82. Rock Village (32ME15).

The ceramic data from this site derive from a portion of the collection excavated there in 1947-1951 in a salvage operation conducted as part of the SIRBS program (Hartle 1960; Lehmer et al. 1978:11-63). Physical evidence at the site indicates that it contains two village components; the earlier one is bounded by a fortification ditch which was subsequently refilled and abandoned when a later ditch and several additional houses were built in an area to the southeast farther away from the river bank. Superimposed houses occur inside the inner ditch but not between the inner and outer ditch. Archeological feature data indicate that it is clearly possible that the site was settled at an early time, briefly occupied and then abandoned, then was resettled at a later time with the village fortification constructed in a new location to the southeast. Some of the later houses were built on earlier house locations, others were built on new ground to the southeast. Such a reoccupation suggests ethnic continuity in the peoples who lived at the site at different times. Various evidence indicates that the two components were of different durations, with the earlier one being more lengthy than the second one.

Various ethnohistoric and traditional data agree with the archeological data suggesting two occupations at different times by the same people. Bowers (1965:17-18, 21, 24, 27) cites evidence from Curtis (1907:131) and Maximillian (Thwaites 1966, 23:230-231) and data from his Hidatsa informant Bears Arm that Rock Village was settled by the Awatixas very shortly after the devastating 1780-1781 smallpox epidemic and that they abandoned the site in the 1790s to settle at Sakakawea Village where they were found by Lewis and Clark in 1804. Hartle (1960:33-34), citing Libby (1908:465 and Libby's personal notes), provides evidence that Rock village was settled, perhaps for the second time, in 1838 by a remnant of Mandans and Hidatsas who had survived the 1837 epidemic. The site was used only for a short time, perhaps a year or so, before the inhabitants moved to Like-a-Fishhook Village. Thus it seems that the site may contain evidence of two Hidatsa occupations, one in the 1780/1790s, and the second circa 1838.

Hartle (1960) and Lehmer et al. (1978) treat the ceramic artifacts from Rock Village as if they were essentially from a single component. The implications of the above ethnohistoric and traditional data were not clear to the present authors at the time that the Rock Village ceramic sample was coded at the Smithsonian Institution. If they had been, we might have attempted a more rigorous investigation of the two potentially separate components at the site. Rather, we coded a relatively small sample of 63 vessels and less than 200 body sherds, with these coming primarily from house 6, inside the inner ditch, and house 7, between the ditches. Smaller samples were also coded from houses 2 and 10 (inside the inner ditch) and houses 1 and 13 (between the ditches). A rigorous comparison of ceramic data from the innner ditch and between-ditch loci has not been attempted here, although a cursory study of body sherd thickness indicates that the between-ditch sample is significantly thicker and presumably more recent in age. For the present purposes, all ceramic materials from Rock Village are combined into a single analytic batch, 82. Judging from ethnohistoric data, this sample probably combines artifacts dating from circa 1780 through the late 1830s. A fuller exploration of the ethnohistoric data pertaining to the site and the possiblity of two separable components at the site remain topics for future study.

83. *Star Village (32ME16)*.

The ceramic data from Star Village derive from the 1951 SIRBS salvage excavations at the site (Metcalf 1963). All available vessels and body sherds in the Smithsonian Institution collections were analyzed, excepting a small number of cord- roughened sherds which probably reflect a Woodland period component at the site. The total sample is too small (10 vessels) for detailed quantitiative comparision with other regional ceramic data sets.

84. *Grandmother's Lodge (32ME59)*.

The ceramic material in this batch unit derive from excavations at the Grandmother's Lodge site by the SIRBS in 1952 and the SHSND in 1953 and 1954 (Woolworth 1956). No artifacts from this site could be located at the Smithsonian Institution, and only part of the reported ceramic collection could be found at the SHSND. The sample of five vessels and two body sherds is too small for detailed quantitative comparison with other study collections.

85. *Like-a-Fishhook (32ML2)*.

The ceramic sample for this analytic batch derives from the SHSND and SIRBS salvage excavations conducted at Like-a-Fishhook in the period 1950-1954, as reported in Smith (1972). A small number of vessels were found in the Smithsonian Institution collections, while the majority are in the SHSND collections. Although the village is known to have been occupied by Mandan, Hidatsa, and Arikara tribal groups, the small sample size precludes meaningful separation of the collection into ethnically associated subgroups useful for quantitative analysis. Thus, a single batch is defined for the site as a whole. All available body sherds were studied for both surface treatment and thickness measurements. The coded vessels in the SHSND collection include a small complete pot which, by its appearance, may be an ethnographically collected specimen made by a resident of the village; this vessel (number 4) is not illustrated in Smith (1972).

86. *Nightwalker's Butte (32ML39)*.

Ceramic data from this site derive from the 1952 salvage excavations conducted there by the SIRBS and reported in Lehmer et al. (1978:64-131). The site contains a main Plains Village component and a second very minor Woodland component. Only the Plains Village materials, assumed to be from a single occupation, are studied here under this batch number. A systematic sample of approximately one-fourth of the total Plains Village vessel collection from the site was studied, taking the sample from widespread parts of the village. A similarly dispersed sample of body sherds was studied for surface treatment and thickness measurements.

87. *Mondrian Tree (32MZ58).*

The ceramic data for the Mondrian Tree site derive from the pottery collection recovered in salvage excavations conducted there in 1980 by the University of North Dakota (Toom and Gregg 1983). The entire pottery sample previously studied by C. Johnson (1983) was reexamined for this study, excepting a single vessel with cord-roughened surface treatment. The latter vessel apparently predates the other pottery from the site. It is likely that the ceramic sample from Mondrian Tree represents an accumulation over a long period of time, reflecting several brief occupational components. Even so, there is no reliable way to subdivide the small sample into meaningful subunits for analysis, and the entire site collection exclusive of the cord-roughened vessel is analyzed here as a single analytic batch. Body sherd thickness data and surface treatment data reported for grade 2 sherds in Johnson (1983:9.24-9.26) are used in the present analysis.

88. *Hagen (24DW1).*

The ceramic data from the Hagen site derive from the 1938 excavations there by Montana State University as reported in Mulloy (1942). Although the collection is quite large and the site is quite extensive, for the present purposes we decided not to spatially subdivide the collection into more than a single unit of analysis. Thus, a systematic sample of approximately 300 vessels was coded, reflecting the entire site collection and all excavated parts of the site. A small sample of body sherds from a general site collection was used for surface treatment and thickness analysis.

89, 90. *Hintz (32SN3).*

The ceramic data from the Hintz site derive from salvage excavations conducted there in 1952-1954 by the SIRBS as reported by Wheeler (1963). To conserve analysis time, only a portion of the excavated collection was studied, that being the samples derived from the excavated houses 3 and 4. These two house units were randomly selected from among a total of five major spatial units in the excavated part of the site. This site is thought to be a key location relative to the question of Hidatsa origins and relationships outside the Missouri valley, and to further the comparative study, the ceramic samples from houses 3 and 4 were maintained as separate analytic batches (89 and 90, respectively). All available body sherds from these two house units were studied for surface treatment and thickness.

91. *Arzberger (39HU6).*

The ceramic data from the Arzberger site used in this study derive from a portion of the collection from the 1939 Columbia University excavations reported by Spaulding (1956). To conserve analysis time, only a portion of the full excavated collection was studied, this being the samples from houses 2, 3, and 4. Spaulding determined that the ceramic samples were essentially similar among all excavated house areas (1956:120-121), and on that basis, the vessels from these three houses were combined into a single analytic batch. It is apparent from examination of the collection and the catalog that some portion of the rim sherd sample from this site was not included in the study sample, probably due to highgrading of sherds for display purposes and for exchanges. Even so, it is thought likely that the studied sample is probably representive of the site as a whole. Body sherd data derive from the house 3 sample only, and a systematic sample of grade 2 sherds from that locus was subjected to thickness measurement.

92. *Flaming Arrow (32ML4).*

The ceramic sample from the Flaming Arrow site derives from the 1983 test excavation and surface collection program conducted there by UND (Toom and Root 1983; Toom 1988). The sample appears to be internally homogeneous, and it is treated here as a unit. A collection at the SHSND which is reportedly from the Flaming Arrow site clearly contains artifacts from multiple time periods and multiple components, and for that reason it was not used in the present analysis. The coded UND ceramic sample from Flaming Arrow is too small for detailed quantitative analysis and comparison to other larger regional samples.

93. *Sharbono (32BE419).*

The ceramic sample used here derives from a selective surface collection made at the site by UND in 1976 (Schneider 1983). There is no certainty that the sample derives from only a single component, but due to its small size, it is included in its entirety as a single analytic batch. All available body sherds were also included in the surface treatment and thickness measurement aspects of analysis, with such data recorded by Swenson.

94, 95. *Taylor Bluff (32ME366).*

When the coding was being conducted, the only available data from Taylor Bluff consisted of extremely small samples from several components collected in minor salvage excavations at the site in 1982 (Ahler et al. 1983). In 1983 a large salvage excavation took place there, and a substantial collection of artifacts from the main post-contact period component was obtained. Analysis of the latter material was ongoing at the time the present study was performed, and data from the 1983 salvage work were not available for inclusion here. The available ceramic sample from the site is separable into two major time periods, one being late post-contact in age (batch 94) which comprises the majority of the collection, and the other being prehistoric in age (batch 95) which consists of materials from several intermittent and poorly defined occupations. These batch numbers are defined in anticipation of eventual comparative studies of Taylor Bluff and other late period ceramic samples from the KNRI.[2]

96. *Angus (32OL144).*

The Angus site ceramic sample was collected in test excavations conducted there in 1982 by UND, presently unreported. The ceramic vessels have not yet been formally coded under the current analysis system, largely because the sample is too small for detailed quantitative analysis. Even so, radiocarbon dates do exist from the site; a culture-historic classification of the main village component can be made; and data from parts of the lithic tool sample will be used in the comparative study. For that reason, a single batch number is defined for the main Nailati phase component collection from the site.

97. *PG (32OL148).*

The PG site ceramic sample was collected in test excavations conducted there in 1982 by UND, presently unreported. The ceramic vessels have not yet been formally coded under the current analysis system, largely because the sample is too small for detailed quantitative analysis. Even so, radiocarbon dates do exist from the site; a culture-historic classification of the main village component can be made; and data from parts of the lithic tool sample will be used in the comparative study. For that reason, a single batch number is defined for the main Clark's Creek phase component collection from the site.

98. *Running Deer (32ME383).*

The ceramic sample from this site derives from limited test excavation conducted there in 1980 as part of the UND/NPS program (Ahler and Mehrer 1984:73-102). A long period of site occupation is reflected in data on stratigraphy, historic artifacts, and ceramic typology. Because of this and the extremely small sample size, the site collection cannot be meaningfully subdivided into discrete and useful analytic batches. The ceramic content at this location is therefore excluded from detailed analysis, although a batch number is assigned to this site to facilitate possible future comparative studies.

99. *Cross Ranch, Late Woodland.*

This batch number is identified to accomodate the analysis of lithic artifacts from several Late Woodland period sites on the Cross Ranch which were tested in 1980 and 1981 in joint UND and SHSND site evaluation programs (Ahler, Lee, and Falk 1981; Ahler et al. 1982). The ceramic sample from these sites has not been formally coded in the Ahler and Swenson (1985b) system, and therefore will not be included in the present comparative analysis except in a summary way as described in Ahler et al. (1982:241-247). Selected lithic artifacts (arrowpoints

[2] Subsequent to this writing a full report on the 1983 salvage work at Taylor Bluff has been produced (Ahler 1988). A significant conclusion in that report is that the late component at Taylor Bluff is attributable to the Awatixa Hidatsas in the period AD 1835 to 1845. By implication, this changes slightly the dates used herein for Sakakawea Village batch samples 59 and 60, from circa AD 1800 to 1845, to circa AD 1800 to 1834. On this basis, batch 60 would have a revised date range of circa AD 1800 to 1817 with a mid-point of AD 1809, while batch 59 would have a date range of circa AD 1817 to 1834 with a mid-point of AD 1826. Such revisions have not been incorporated into the present study, as the changes would have only very minor effect on the overall results presented here. (S.A.A.)

in particular) from sites 32OL159, 32OL252, 32OL161, 32OL162, and 32OL177 will be included in the comparative study of projectile dimensions to provide a chronological extension of the study into the Late Woodland period.

100. Sagehorn (32ME101).

The ceramic data from this site derive from a single cultural feature at the site which was eroding from a cutbank and which was salvaged during the 1968 Wood-Lehmer testing program (Wood 1986c). Materials from the feature are studied as a unit. The sample size is far too small, however (vessel n = 9), to permit detailed quantitative analysis of the ceramic data.

BATCH CHRONOLOGY

The ordering of the analytic batches into a chronological and culture-historic framework was a complex task which required simultaneous examination of data on many ceramic variables. A straightforward ordering or seriation based on changing ware frequencies was not attempted due to the incomplete definition of wares and ware-like groups applied to the regional collections. In addition, it was felt that forces acting upon the cultures in the study area were complex, with multiple cultural traditions possibly involved, potentially leading to a very complex sequence of ceramic change not easily portrayed in a simple seriation applied to a small set of ceramic variables. For all these reasons, a complex multistage approach involving multivariate analysis was used, having roughly the following steps:

1. Generation of summary data on a large number of coded ceramic variables for each analytic batch.

2. Screening of these data to select a somewhat smaller number of potentially meaningful variables, and screening of the batches.

3. Application of principal components analysis to isolate major underlying variables or factors accounting for most of the chronological and culture-historic structure in the data set.

4. Application of cluster analysis to principal component scores for each batch to organize batches into chronologically and culture-historically similar groups.

5. Application of a cluster analysis to selected raw ceramic data for temporally restricted subsets of batches (early and late) to yield more detailed chronological/culture-historic groups.

6. Development of a working chronological ordering and grouping for most regional batch samples, based on combined information from stratigraphy, chronometric dating, and cluster analysis.

Each of these steps will be discussed in greater detail in the following subsections.

Batch Summary Data and Variable Selection

As indicated in Table 17.1, the basic data set available for study consists of coded information on a total of 7,004 pottery vessels and more than 36,000 body sherds organized according to a total of 92 analytic batches. For various reasons noted in the preceding section on analytic batch defintions, some 14 of these batches were excluded from the detailed quantitative analysis, although several of these 14 were later reincorporated into the chronological ordering process. Reasons for batch exclusion usually involved small sample sizes, or more commonly, possible mixed origin from sites having potential for multiple components or occupation periods. The data set on the 78 batches selected for quantitative analysis was developed for a total of 6,527 coded vessels, 35,136 body sherds examined for surface treatment, and 21,905 body sherds measured for maximum thickness (Table 17.1).

The next step in the analysis was to display summary information for virtually all the coded ceramic vessel variables by analytic batch. For nominal-scaled variables this was accomplished by generating cross-tabulation of variable code frequencies according to batch (e.g., rim form class frequencies by batch, individual zone condition/shape code frequencies by batch, decorative type frequencies for each zone by batch, etc.). This process was conducted using the program CROSSTABS in SPSS-X (SPSS, Inc. 1983:287-301). Percentage data across the code values for each variable were also computed for each batch. Coded interval-scaled variables for vessels (various zone thicknesses, cord and incised decoration spacing, etc.) were summarized by batch by using the program BREAKDOWN (SPSS, Inc. 1983:320-331) to compute means and standard deviations for each such variable according to each batch. Summary data for body sherds were developed by computing frequency totals and percentages for the various surface treatment classes for each batch and by using BREAKDOWN to compute a mean size grade 2 body sherd thickness value for each batch.

Variation in each of these data sets was then examined in some detail in order to select a smaller number of variables thought to be useful for quantitative analysis and chronological ordering. Knowledge of the relative chronological placement of many of the batches already dated by chronometric means allowed us to identify by inspection some of the variables which would be useful for chronological ordering. The desirability of selecting certain variables such as general rim form class, ware class, decorative type, body sherd surface treatment, body sherd thickness, and cord spacing was evident from previous studies with samples from individual or multiple sites which had demonstrated such variables to be culture-historically sensitive (e.g., Lee 1980; Ahler and Weston 1981:104-109; Ahler and Swenson 1985a:131-143). A total of 88 variables was selected from the cross-tabulation and BREAKDOWN outputs as being potentially useful for chronological ordering. A separate data file was then developed which consisted of percentage data for each of the nominally-scaled variables (usually rounded to the nearest whole percent) and mean values for interval-scaled variable listed for each of the selected 78 batches. The raw summary data on these selected variables, involving both vessel and body sherd information, are listed by batch in Table 17.2.

Table 17.2(a). Summary of data for selected ceramic variables by analytic batch.

BATCH	FORM3	FORM4	FORM5	FORM6	FORM7	FORM8	FORM9	FORM10	FORM11	FORM12	FORM15	FORM16	FORM19	FORM20	FORM22	RDLIP	FLTLIP	INLIP	OUTLIP	LTLIP	POILIP	BDLIP
0	4	4	0	0	30	0	0	0	26	13	22	0	0	0	0	61	6	6	0	0	11	17
1	10	24	0	0	14	29	0	0	0	10	10	0	0	5	0	83	11	0	0	0	6	0
4	19	57	0	0	13	1	0	0	1	1	1	0	6	0	1	75	11	4	5	3	3	0
5	50	6	2	0	28	0	0	0	0	0	7	0	2	5	0	35	20	7	5	32	1	0
6	5	21	0	0	26	0	0	0	11	0	16	0	0	21	0	50	16	25	0	0	8	0
7	13	12	0	0	37	2	0	0	5	1	24	0	0	5	0	62	8	17	0	10	3	0
8	55	7	0	0	31	3	0	0	0	0	3	0	0	0	0	37	37	0	10	17	0	0
9	38	7	0	0	40	0	2	0	0	0	9	0	0	2	0	20	48	2	0	30	0	0
10	25	11	5	0	41	0	2	0	0	0	16	0	0	0	0	30	37	2	4	15	13	0
11	18	5	5	0	55	0	0	0	0	0	14	5	0	0	0	62	24	5	0	0	10	0
13	52	1	3	0	28	0	2	0	0	0	7	1	0	6	0	81	20	0	0	0	0	0
14	47	0	9	0	28	0	0	0	4	0	4	0	0	9	0	55	31	6	0	8	0	0
15	61	0	0	0	38	0	0	0	0	0	1	0	0	0	0	62	28	3	1	6	0	0
16	59	0	1	0	37	0	0	0	0	0	2	0	0	1	0	49	44	1	0	6	1	0
19	6	67	0	1	2	14	0	1	2	1	0	0	5	0	0	82	12	1	0	0	5	0
20	8	20	0	0	31	11	0	0	0	0	20	0	3	8	0	71	8	18	2	0	0	0
21	5	8	0	0	21	24	0	0	0	0	26	0	1	15	0	82	6	7	0	4	2	0
23	9	9	0	0	25	16	3	0	0	0	19	3	0	16	0	60	32	5	0	0	5	0
24	15	5	0	0	27	19	1	0	0	0	22	0	1	9	1	52	29	7	1	4	3	5
25	13	21	0	0	19	14	0	0	1	0	13	0	0	17	0	63	21	6	3	1	5	1
26	16	14	4	0	38	12	0	0	0	2	8	0	0	6	0	39	41	4	2	7	2	4
27	5	21	3	0	23	13	0	0	0	0	31	0	0	5	0	43	46	4	0	0	7	0
28	6	7	0	0	33	11	0	0	2	0	26	0	2	15	0	64	18	15	0	0	0	3
29	19	40	0	0	26	7	2	0	0	0	0	0	4	2	0	70	22	4	2	0	0	2
30	18	30	0	0	19	13	1	0	0	0	9	0	7	3	0	56	21	8	1	2	3	10
31	22	26	0	0	29	7	1	0	0	0	7	0	0	8	0	52	19	9	2	6	3	9
32	21	23	0	0	31	3	3	0	1	1	14	0	0	4	0	35	33	10	3	2	9	8
33	27	12	0	0	40	5	0	0	0	0	10	0	2	5	0	31	57	3	0	0	2	7
34	66	0	0	0	24	0	0	0	0	0	3	0	0	7	0	65	29	1	1	4	0	0

Table 17.2(a). Continued.

BATCH	FORM3	FORM4	FORM5	FORM6	FORM7	FORM8	FORM9	FORM10	FORM11	FORM12	FORM15	FORM16	FORM19	FORM20	FORM22	RDLIP	FLTLIP	INLIP	OUTLIP	LTLIP	POILIP	BDLIP
35	8	75	0	0	0	0	0	0	0	0	0	0	17	0	0	85	11	0	0	0	4	0
36	29	9	1	0	43	1	0	0	0	0	12	0	0	3	0	35	28	9	0	28	1	0
37	1	0	0	0	40	4	0	0	3	2	35	0	0	15	0	19	48	16	0	16	2	0
38	10	84	0	0	0	1	0	0	0	1	0	0	1	0	0	79	20	0	0	0	0	0
39	6	4	0	0	76	2	0	0	2	0	6	0	4	0	0	47	20	22	2	8	2	0
40	28	0	2	0	54	0	0	0	2	0	7	0	0	0	0	36	60	0	2	0	2	0
41	7	87	0	0	1	2	0	0	0	0	0	0	4	0	0	90	8	0	0	0	3	0
42	18	0	1	0	54	1	4	0	4	0	10	0	0	9	0	18	71	6	3	0	0	3
43	21	5	0	0	57	0	0	0	0	0	7	0	7	2	0	22	62	8	0	6	2	0
44	13	41	0	0	21	9	0	0	1	0	4	0	9	0	0	74	10	4	1	8	3	0
45	12	35	0	0	26	4	0	0	0	1	10	0	5	7	0	65	11	11	0	10	4	0
46	7	17	0	0	37	12	0	0	1	1	17	0	5	5	0	66	7	16	2	7	2	0
47	10	16	1	0	48	3	0	0	3	1	11	0	2	5	0	56	10	15	1	14	5	0
48	8	6	2	0	60	0	0	0	2	0	18	0	0	6	0	43	11	24	0	19	4	0
49	10	4	0	0	60	1	0	0	4	0	19	0	0	1	0	62	5	26	0	5	2	0
53	22	44	0	0	11	11	0	0	0	0	0	0	3	8	0	81	7	0	0	3	10	0
54	14	29	0	0	22	16	0	0	0	0	6	0	4	4	2	77	7	9	0	7	0	0
55	4	23	0	0	35	12	0	0	0	4	12	0	4	8	0	57	5	19	0	19	0	0
56	19	22	0	0	35	5	0	0	0	0	8	0	8	3	0	55	15	21	0	6	3	0
57	15	20	5	0	35	0	0	0	0	0	20	0	5	0	0	47	12	18	6	12	6	0
59	15	57	1	2	5	2	0	0	0	0	0	0	18	0	0	82	10	0	2	0	7	0
60	10	58	0	1	2	5	0	0	0	0	1	0	22	0	1	86	5	1	0	3	5	0
61	0	68	0	5	5	0	5	0	0	5	0	0	11	0	0	86	5	10	0	0	0	0
62	12	56	0	0	4	6	0	0	0	0	0	0	22	0	0	89	2	0	0	4	4	0
64	13	44	0	0	0	0	0	0	0	0	0	0	44	0	0	86	5	0	0	5	5	0
65	23	42	0	0	7	6	0	0	0	0	2	0	18	1	1	83	7	1	0	1	8	0
66	10	49	0	0	10	8	0	0	1	0	6	0	11	3	1	81	11	3	0	2	3	0
67	14	47	0	0	13	5	0	0	0	1	2	1	14	3	1	83	5	3	0	7	3	0
68	12	28	0	0	12	17	0	0	0	0	6	0	15	5	5	82	9	1	0	0	9	0
69	5	27	0	0	23	0	0	0	0	0	14	0	14	14	5	71	21	0	0	0	7	0
70	17	0	0	0	33	0	0	0	0	0	33	0	0	17	0	25	75	0	0	0	0	0
72	22	10	0	0	49	2	0	0	0	0	18	0	0	0	0	20	52	7	0	2	0	20
73	16	1	0	0	48	0	6	0	0	0	16	4	0	10	0	21	41	10	0	27	2	0
74	28	50	0	0	9	6	0	0	0	0	3	0	3	0	0	58	13	7	0	0	10	13
75	46	4	0	0	23	0	0	0	0	0	12	0	4	12	0	43	33	3	13	0	3	3
77	23	6	0	0	39	0	0	0	0	0	15	0	3	15	0	18	49	8	2	19	0	5
78	10	2	0	0	40	0	0	0	0	0	12	0	5	32	0	25	57	0	2	16	0	0
79	11	7	2	0	38	2	0	0	0	0	27	0	0	13	0	26	51	9	0	6	6	3
80	23	7	0	0	42	1	0	0	0	0	14	0	0	11	1	23	46	8	3	17	2	2
81	85	0	0	0	9	0	0	0	0	0	7	0	0	0	0	51	33	2	0	0	4	11
82	24	73	0	0	0	0	0	0	0	3	0	0	0	0	0	83	9	0	0	0	9	0
85	9	70	0	0	9	0	0	0	0	0	0	0	13	0	0	91	9	0	0	0	0	0
86	21	64	0	0	3	0	0	0	1	1	1	0	8	0	0	82	4	0	1	0	9	4
87	43	33	0	0	5	0	0	0	0	0	0	0	19	0	0	61	22	4	4	0	4	4
88	20	4	0	0	44	1	0	0	4	0	19	0	4	3	1	65	23	2	1	6	3	0
89	25	18	0	0	26	3	0	0	1	0	11	0	11	4	0	69	11	1	0	1	0	17
90	23	14	0	0	35	0	0	0	0	0	21	0	3	5	0	67	3	10	3	0	0	18
91	87	0	1	0	8	2	0	0	0	0	2	0	0	0	0	88	10	0	0	0	1	2
93	6	29	0	0	29	18	0	0	0	0	7	0	0	6	0	67	13	13	0	0	0	7

Table 17.2(b).Continued.

BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWTI	FINGER	DENTATE
0	0	96	0	0	0	0	4	0	0
1	14	43	10	0	14	0	0	19	0
4	25	46	3	2	22	0	0	2	0
5	7	38	35	8	0	0	0	12	0
6	0	90	5	5	0	0	0	0	0
7	2	77	10	2	0	0	7	1	0
8	10	31	21	10	0	0	0	28	0
9	7	34	17	13	0	4	0	25	0
10	8	48	24	5	0	0	0	15	0
11	5	57	10	10	14	0	0	5	0
13	17	40	17	1	3	0	0	21	0
14	11	40	12	4	5	0	0	28	0
15	16	30	3	10	10	0	0	31	0
16	22	35	8	4	10	0	0	22	0
19	26	57	3	12	1	0	0	0	0
20	3	89	0	0	0	0	0	8	0
21	5	87	0	1	0	0	1	5	0
23	3	73	18	0	0	0	0	6	0
24	9	73	8	1	1	1	1	7	0
25	7	67	14	9	0	1	0	3	0
26	2	63	25	2	0	0	2	6	0
27	0	69	15	10	3	0	0	3	0
28	2	85	10	2	0	0	0	2	0
29	27	44	7	7	5	2	0	7	0
30	23	47	7	2	4	3	3	8	4
31	11	45	23	9	0	0	1	11	0
32	12	42	20	7	0	3	5	11	0
33	17	41	15	8	2	6	2	11	0
34	12	32	46	1	1	0	0	8	0
35	54	42	0	0	4	0	0	0	0
36	7	33	21	13	2	4	1	17	1
37	0	98	1	0	2	0	0	0	0
38	62	33	2	0	1	0	0	3	0
39	2	94	2	0	0	0	0	2	0
40	8	52	15	8	12	2	0	4	0
41	50	35	2	3	6	0	0	5	1
42	4	53	3	15	11	8	0	2	0
43	16	41	22	8	0	8	0	5	0
44	23	55	3	3	10	0	1	4	1
45	20	61	1	1	5	0	1	5	3
46	8	87	1	0	1	0	2	0	1
47	8	79	2	3	1	0	4	2	0
48	2	87	2	4	2	0	2	2	0
49	4	93	0	0	0	0	1	1	0
53	30	54	5	3	8	0	0	0	0
54	16	66	4	2	6	0	0	6	0
55	4	81	8	4	4	0	0	0	0
56	8	85	0	0	0	0	5	3	0
57	9	68	0	5	5	0	14	0	0
59	41	51	4	3	0	0	0	0	1
60	15	75	0	1	4	0	0	1	3

Table 17.2(b). Continued.

BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWTI	FINGER	DENTATE
61	0	74	0	11	5	0	0	5	5
62	12	72	2	6	2	0	0	4	2
64	22	67	6	6	0	0	0	0	0
65	13	59	5	3	11	0	0	5	3
66	12	66	4	1	10	0	0	3	3
67	13	69	3	0	8	0	1	3	3
68	15	68	4	0	13	0	0	0	0
69	0	86	0	0	14	0	0	0	0
70	0	43	0	14	14	0	0	0	0
72	19	48	17	2	0	4	0	10	0
73	10	47	5	12	7	4	0	16	0
74	6	16	13	63	0	0	0	3	0
75	8	42	21	21	0	4	0	4	0
77	8	30	14	27	0	11	4	6	0
78	2	25	3	51	2	8	0	10	0
79	17	52	7	12	0	7	5	7	0
80	14	42	11	18	1	8	0	8	0
81	22	14	53	0	0	0	0	12	0
82	11	57	3	0	22	0	0	8	0
85	36	55	9	0	0	0	0	0	0
86	15	48	13	0	14	0	0	8	4
87	10	48	10	19	5	5	0	5	0
88	4	21	11	8	1	0	53	1	3
89	3	73	11	0	2	0	12	0	0
90	3	66	17	0	0	0	15	0	0
91	4	0	76	18	0	1	0	1	0
93	6	47	6	0	0	0	42	0	0

Table 17.2(c). Continued.

BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	CDSPACE	CDDIAM	Z2THICK
0	100	44	0	94	0	0	78	100	0	3.16	2.03	5.80
1	100	47	0	81	57	33	78	94	0	3.17	2.01	6.22
4	75	64	0	99	71	38	85	80	15	4.00	2.29	5.77
5	13	61	5	94	0	13	51	99	7	5.21	2.40	6.65
6	100	36	0	80	0	0	100	92	6	3.96	2.36	5.60
7	97	54	0	92	0	15	72	100	2	3.90	2.22	5.85
8	100	24	3	92	0	0	63	100	0	5.13	2.16	6.19
9	6	33	8	92	21	0	50	100	11	5.69	2.54	6.21
10	11	30	6	94	14	0	70	100	4	6.31	2.48	6.52

Table 17.2(c). Continued.

BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	CDSPACE	CDDIAM	Z2THICK
11	43	39	0	96	7	0	91	100	0	6.28	2.68	7.06
13	40	63	0	100	8	99	58	100	0	6.57	3.08	6.32
14	25	63	0	95	4	.	61	100	13	7.33	3.40	6.49
15	0	63	4	100	0	.	63	100	8	6.58	2.87	6.51
16	16	55	0	99	2	.	71	100	11	7.15	3.03	6.44
19	70	49	1	93	80	30	91	82	27	3.66	2.12	6.37
20	89	46	3	94	0	33	78	88	2	3.85	2.22	5.38
21	90	41	3	87	4	59	83	94	6	4.30	2.33	5.59
23	89	26	16	93	19	43	76	95	17	4.36	2.55	6.52
24	91	39	6	94	3	36	84	97	7	4.59	2.41	5.85
25	92	36	10	84	3	43	81	99	7	4.13	2.42	6.01
26	64	44	11	93	3	64	72	100	7	4.68	2.44	5.66
27	58	57	0	100	0	46	82	100	0	5.91	2.65	5.94
28	83	36	0	100	9	20	77	100	14	5.73	2.68	5.83
29	25	21	0	100	27	41	93	84	6	4.40	2.66	6.51
30	57	27	3	89	26	67	76	86	6	4.26	2.44	6.23
31	70	42	0	91	11	32	76	97	9	4.93	2.61	6.31
32	57	31	6	92	12	27	82	99	10	4.96	2.63	6.18
33	16	39	2	98	3	42	77	100	26	6.32	2.99	6.30
34	0	44	0	94	0	.	43	100	13	6.09	2.99	7.26
35	68p	30	0	94	10o	59	100	86	10	4.03	2.15	6.41
36	24	46	4	96	9	20	60	100	16	5.34	2.47	6.35
37	76	66	5	98	2	57	52	100	3	4.34	2.45	5.74
38	60	15	0	98	71	64	93	97	20	4.10	2.27	6.80
39	70	54	0	80	0	20	71	92	10	4.11	2.25	6.33
40	14	55	0	92	6	.	88	100	0	6.91	3.36	7.41
41	100	13	0	99	25	64	92	88	18	4.24	2.38	6.39
42	33	21	7	98	8	99	77	100	12	8.22	2.73	7.72
43	25	33	0	93	19	99	78	100	7	8.85	2.85	5.90
44	60	67	0	80	26	61	69	92	8	4.24	2.21	6.64
45	82	70	0	91	22	53	68	87	9	3.80	2.26	6.51
46	76	46	0	81	13	12	72	92	7	3.78	2.25	6.26
47	89	72	0	82	8	14	64	90	9	3.80	2.22	6.15
48	89	64	5	82	2	0	69	100	8	4.13	2.11	6.35
49	94	67	0	92	2	50	57	95	22	4.16	2.08	6.03
53	100	58	0	96	14	57	73	73	14	4.22	2.11	6.65
54	73	44	0	75	13	29	84	95	0	3.92	2.36	6.15
55	78	50	0	75	13	18	52	95	5	3.77	2.36	6.55
56	100	60	0	70	0	31	69	94	16	3.75	2.19	6.84
57	60	60	0	75	9	20	78	87	20	3.87	2.13	6.26
59	100	30	0	99	67	41	91	92	15	3.95	1.92	6.41
60	100	20	0	92	80	25	85	80	13	3.92	2.26	6.43
61	100	21	0	79	67	6	95	70	20	3.88	2.11	6.13
62	0	39	0	92	50	14	82	84	8	4.19	2.11	6.57
64	68p	38	0	100	10o	17	76	64	9	3.74	2.04	7.46
65	33	26	2	89	46	25	77	77	12	4.03	2.20	6.69
66	69	33	0	88	32	30	76	81	11	4.14	2.20	6.45
67	15	27	5	93	30	26	75	73	11	4.36	2.36	6.94
68	45	42	0	94	32	25	89	93	7	3.98	2.09	6.02

Table 17.2(c). Continued.

BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	CDSPACE	CDDIAM	Z2THICK
69	25	31	0	85	9	11	86	92	0	3.75	2.16	5.67
70	33	25	0	50	0	.	100	100	0	7.50	2.85	7.78
72	25	33	13	100	3	83	80	100	12	6.90	3.10	6.32
73	44	32	0	100	21	0	82	100	22	7.20	2.40	6.48
74	100	24	0	58	0	11	81	100	17	4.13	2.02	5.90
75	25	18	9	75	0	0	47	100	10	4.24	2.06	6.48
77	50	42	3	84	15	43	59	98	8	5.22	2.23	6.72
78	55	50	0	100	4	25	48	98	20	5.47	2.36	6.59
79	41	15	20	88	19	25	74	100	5	5.55	2.45	5.55
80	41	34	12	91	12	33	65	99	15	5.23	2.29	6.40
81	20	11	0	98	11	.	34	100	38	6.11	3.09	7.02
82	68p	7	0	92	0	25	100	86	10	4.21	1.99	7.18
85	0	14	0	96	0	53	77	91	33	5.45	2.16	6.89
86	100	9	0	96	20	40	79	89	5	4.39	2.07	6.24
87	61o	29	0	60	0	9	78	95	20	3.93	2.24	5.02
88	52	35	1	78	7	23	59	95	40	4.41	2.30	6.31
89	100	9	0	91	9	5	80	93	12	3.78	1.91	6.44
90	100	13	0	84	8	0	69	100	22	3.25	1.49	6.04
91	21	5	0	93	17	25	38	71	11o	4.55o	2.34o	6.47
93	100	63	0	88	20	44	60	100	22	3.99	2.44	5.69

Table 17.2(d). Continued.

BATCH	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH	STPLAIN	STSS	STCHECK	STCORD	STDEC
0	6.19	7.70	6.87	12.3	4.74	11	79	0	1	4.9
1	6.11	12.04	8.32	17.1	4.88	13	83	1	0	3.0
4	6.75	9.44	7.79	21.9	5.28	14	81	2	0	.1
5	6.34	8.90	7.67	12.5	5.14	9	64	12	0	5.6
6	6.00	7.95	6.88	12.7	5.00	7	87	5	0	1.7
7	5.96	8.01	7.56	13.2	4.60	8	79	1	0	8.6
8	6.31	9.17	7.91	15.0	5.32	13	72	12	0	2.9
9	6.66	8.97	8.48	13.7	5.38	17	77	3	1	1.5
10	6.70	8.16	7.31	13.4	5.17	13	75	9	0	2.9
11	6.64	8.40	6.67	12.0	5.58	22	26	5	1	.7
13	6.51	5.60	6.18	10.0	5.26	12	8	75	0	.4
14	6.62	.	6.60	.	5.82	20	23	49	0	.5
15	6.26	.	6.63	.	5.82b	20b	23b	49b	0b	.5b
16	6.70	.	6.54	.	5.82b	20b	23b	49b	0b	.5b
19	6.84	10.55	8.52	19.2	6.00	10	87	0	0	.0
20	5.92	8.01	7.25	12.9	5.04	3	90	1	0	5.1

Table 17.2(d). Continued.

BATCH	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH	STPLAIN	STSS	STCHECK	STCORD	STDEC
21	5.94	8.69	7.62	15.2	4.91	6	88	2	1	1.7
23	6.53	10.25	8.73	15.1	4.74	22	63	13	0	2.2
24	5.96	8.38	7.53	16.6	4.65	13	71	9	0	3.5
25	5.96	7.98	7.29	13.4	4.95	12	80	4	1	1.9
26	6.09	8.29	7.60	14.2	4.95	20	63	13	0	2.5
27	6.11	8.38	7.25	14.2	5.27	9	66	21	0	3.0
28	6.01	7.66	7.20	14.6	5.30	8	53	32	0	1.6
29	6.95	9.24	7.62	19.3	5.54	11	83	2	0	1.7
30	6.49	9.25	7.79	21.4	5.72	7	88	1	0	.4
31	6.57	8.77	8.04	15.3	5.07	10	78	4	0	5.6
32	6.76	8.68	7.51	13.8	5.18	16	70	9	0	1.7
33	6.58	8.34	7.63	13.5	5.19	10	21	67	0	1.3
34	7.72	.	7.40	.	6.13	24	61	4	0	6.8
35	6.56o	9.86	7.88	19.2	6.89	22	77	0	0	.0
36	6.92	9.26	8.39	14.3	5.57	12	66	1	3	10.9
37	5.98	9.04	8.53	18.1	4.87	3	88	0	0	8.4
38	5.63	10.65	8.43	22.7	6.10	7	94	0	0	.0
39	6.90	9.66	7.67	13.0	5.45	47	42	3	0	6.9
40	7.56	.	6.91	.	6.07	68	16	15	0	1.1
41	6.00	9.90	7.84	23.1	6.41	24	71	1	1	.0
42	7.47	9.40	7.76	31.0	5.57	15	24	60	0	.3
43	6.60	9.92	7.96	16.0	5.64	21	31	42	0	3.2
44	6.97	9.76	8.28	22.9	5.58	33	61	0	0	1.9
45	6.85	10.23	8.03	21.4	5.50	32	67	0	0	.4
46	6.85	9.55	7.89	20.1	5.27	38	60	0	0	1.2
47	6.45	8.71	7.63	19.2	5.13	30	64	0	0	1.6
48	6.60	9.63	7.99	17.0	5.19	28	63	0	1	4.0
49	6.39	9.65	7.46	17.0	5.00	25	65	4	1	4.7
53	6.59	10.45	7.60	26.2	5.29s	31s	63s	1s	0s	2.3s
54	7.01	9.61	7.72	24.7	5.29s	31s	63s	1s	0s	2.3s
55	6.75	10.38	8.40	21.7	5.29s	31s	63s	1s	0s	2.3s
56	6.88	9.96	8.03	19.6	5.29s	31s	63s	1s	0s	2.3s
57	6.61	9.07	7.36	17.6	5.29s	31s	63s	1s	0s	2.3s
59	7.86	9.90	7.69	19.2	6.43	31	66	0	0	.0
60	7.04	10.24	7.87	21.9	5.98	23	74	0	0	.6
61	5.90	10.56	7.97	20.0	5.41	41	56	0	0	.0
62	7.15	10.21	7.69	22.1	6.03s	34	64	0	0	.5
64	6.56	9.36	8.62	18.2	6.30	40	59	0	0	.0
65	7.10	10.64	7.96	20.4	6.17	30	68	0	0	.0
66	7.50	10.27	8.20	22.8	5.79	25	72	1	0	.3
67	6.66	10.42	8.19	23.3	5.75	31	67	1	0	.1
68	6.78	9.11	7.48	22.1	5.40	33	62	2	0	1.1
69	6.39	10.05	7.32	20.3	5.14	25	57	7	0	5.8
70	7.10	.	7.98	.	5.80	0	94	6	0	.0
72	7.11	8.82	8.28	10.6	5.26	22	17	56	2	.3
73	6.66	11.40	8.67	18.0	5.19	21	35	42	0	2.0
74	5.83	7.97	6.97	12.3	4.81	32	54	4	0	8.2
75	7.19	7.30	7.21	13.0	5.07	21	65	8	2	2.4
77	6.94	8.90	9.29	12.0	5.44	15	76	3	0	.9
78	7.02	9.90	8.73	12.0	5.57	24	70	2	0	4.1
79	6.50	9.90	7.61	16.0	5.56	4	64	31	0	1.9

Table 17.2(d). Continued.

BATCH	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH	STPLAIN	STSS	STCHECK	STCORD	STDEC
80	6.80	8.92	8.47	13.3	5.50	15	77	3	0	3.8
81	7.79	.	7.15	.	5.63	42	44	4	0	8.7
82	7.70	10.36	8.14	20.2	6.71	17	75	4	0	.0
85	10.30	10.49	8.41	23.3	7.64	53	47	0	0	.0
86	6.64	9.93	7.94	21.7	5.83	20	78	1	0	.0
87	6.70	7.51	6.61	14.7	4.84	22	47	0	0	25.0
88	6.31	8.57	7.10	11.9	4.95	20	68	6	3	1.7
89	5.66	10.06	7.51	15.6	4.93	32	63	2	1	2.6
90	5.70	9.54	7.25	15.3	5.16	53	34	5	2	3.4
91	6.92	12.88	6.16	33.5	5.30	33	59	2	3	2.1
93	6.70	9.16	7.77	18.5	5.25	30	36	3	12	.0

Table 17.2(e). Continued.

BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO	NODE	TAB	HANDLE	SPOUT	CASTL	PINCHING
0	100	0	0	0	0	48	0	5	43	5	0	0	25	75	0	0	26	0	0	0	0	0
1	67	25	8	0	0	33	0	0	17	17	33	38	0	53	0	0	5	0	0	0	10	10
4	47	11	20	22	0	25	0	25	0	0	0	2	5	71	19	2	1	0	1	4	4	23
5	13	0	0	88	0	68	3	16	5	3	0	14	0	71	0	14	1	2	0	0	0	0
6	100	0	0	0	0	15	0	8	8	61	0	25	0	75	0	0	6	0	0	0	0	0
7	62	8	8	23	0	46	0	9	15	27	0	0	0	99	0	0	1	0	0	0	0	0
8	33	0	0	67	0	67	0	33	0	0	0	67	0	33	0	0	3	0	0	0	0	0
9	50	0	0	50	0	57	10	33	0	0	0	99	0	0	0	0	8	2	0	0	0	2
10	0	0	0	100	0	67	7	11	0	0	15	14	57	29	0	0	5	2	0	0	0	0
11	0	0	0	100	0	50	14	14	0	14	7	0	0	0	99	0	0	0	0	0	0	18
13	100	0	0	0	0	97	0	3	0	0	0	.	.	.	.	.	0	0	0	0	0	3
14	.	.	.	.	.	86	0	14	0	0	0	.	.	.	.	.	2	0	0	0	0	5
15	.	.	.	.	.	83	3	7	0	3	0	.	.	.	.	.	1	0	0	0	0	10
16	.	.	.	.	.	92	0	5	0	0	1	.	.	.	.	.	2	0	0	0	0	10
19	57	2	15	25	0	67	0	0	0	33	0	0	3	62	33	2	1	8	9	3	3	3
20	68	26	5	0	0	37	3	11	3	40	3	39	0	54	8	0	2	0	0	0	0	0
21	29	71	0	0	0	48	3	13	7	26	0	17	0	58	16	8	0	0	0	0	0	0
23	13	50	0	13	25	40	0	20	25	15	0	25	25	25	25	0	0	0	0	0	0	3
24	23	77	0	0	0	63	4	19	3	6	3	38	0	19	38	6	4	1	0	0	0	1
25	43	45	8	3	3	51	2	19	9	15	0	22	9	48	17	4	3	2	0	0	0	0
26	21	64	0	0	14	61	7	13	3	6	3	20	0	80	0	0	0	0	0	0	0	0
27	31	46	0	0	23	52	10	14	10	10	0	43	0	43	14	0	3	0	0	0	0	3
28	45	55	0	0	0	55	3	13	10	13	3	17	0	67	17	0	4	0	0	0	0	4

Table 17.2(e). Continued.

BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO	NODE	TAB	HANDLE	SPOUT	CASTL	PINCHING
29	57	14	19	10	0	60	0	0	0	40	0	8	0	93	0	0	0	0	0	2	2	5
30	40	25	25	7	2	63	9	6	0	17	3	20	10	65	5	0	0	0	0	4	1	5
31	68	20	0	8	0	55	0	16	3	16	7	29	6	65	0	0	6	0	0	0	0	0
32	55	12	6	15	9	75	4	14	2	6	0	50	8	33	4	4	1	0	0	0	0	0
33	58	8	8	16	8	50	25	3	6	6	11	86	0	14	0	0	6	0	0	0	0	1
34	.	.	.	.	.	29	0	48	14	0	0	.	.	.	.	.	11	0	0	0	0	1
35	33	5	5	57	0	0	0	0	0	0	0	0	11	78	0	11	0	0	0	0	5	5
36	30	20	0	40	10	69	4	14	2	6	6	38	0	50	0	13	3	0	0	0	0	2
37	43	57	0	0	0	34	0	19	16	26	0	0	0	99	0	0	10	0	0	0	0	3
38	65	1	26	7	0	0	0	0	0	99	0	1	6	71	18	4	1	3	0	1	2	1
39	25	25	0	25	25	51	4	9	13	22	0	0	0	75	0	25	6	0	0	0	0	2
40	.	.	.	.	.	53	0	33	7	0	7	.	.	.	.	.	13	0	0	0	0	11
41	82	1	10	5	2	33	0	0	0	67	0	0	5	86	8	2	0	2	1	2	3	6
42	0	0	100	0	0	74	13	10	1	0	0	.	.	.	.	.	7	0	0	0	0	3
43	25	50	0	0	25	90	0	5	0	0	5	.	.	.	.	.	0	0	0	0	0	0
44	32	6	35	26	0	39	0	8	8	46	0	0	0	94	6	0	2	0	0	2	0	13
45	48	0	22	30	0	44	0	13	4	39	0	0	0	87	13	0	0	0	0	0	0	9
46	36	0	6	55	2	60	1	10	5	20	0	0	0	99	0	0	1	0	0	0	2	9
47	42	0	21	37	0	47	3	19	9	21	0	0	6	94	0	0	0	0	0	0	0	3
48	0	0	0	100	0	39	2	13	5	32	2	25	0	75	0	0	2	0	0	0	0	5
49	50	0	0	50	0	20	0	13	10	55	0	0	0	99	0	0	3	0	1	0	0	4
53	30	10	20	40	0	60	0	20	0	20	0	0	11	67	11	11	0	0	0	0	3	9
54	14	5	43	38	0	36	0	35	14	7	7	6	0	82	12	0	0	0	0	0	0	18
55	40	0	10	50	0	33	0	33	0	33	0	0	0	89	0	11	0	0	0	0	0	4
56	17	8	25	50	0	57	0	6	0	22	0	0	0	99	0	0	0	0	0	0	0	10
57	33	0	33	33	0	30	20	10	20	20	0	0	0	75	25	0	5	0	0	0	0	5
59	54	0	22	22	1	99	0	0	0	0	0	0	2	59	33	6	0	2	0	0	2	2
60	52	0	22	23	2	99	0	0	0	0	0	0	0	77	23	0	0	4	1	4	10	13
61	71	0	12	18	0	0	0	0	0	0	99	0	6	62	31	0	0	0	0	0	0	12
62	65	0	11	24	0	50	0	0	0	50	0	3	0	64	31	3	3	5	0	3	5	10
64	50	0	17	33	0	0	0	0	0	0	0	0	0	90	10	0	0	0	0	0	0	0
65	47	4	2	47	0	40	0	0	0	60	0	0	2	78	20	0	0	1	6	6	4	26
66	44	0	13	42	0	30	20	10	0	40	0	4	4	81	9	1	1	0	0	4	5	21
67	52	2	18	28	0	29	7	0	0	64	0	0	6	78	15	2	3	0	0	3	7	19
68	53	0	18	30	0	46	0	0	0	54	0	3	0	90	8	0	0	0	3	2	2	25
69	43	0	0	57	0	67	0	0	0	33	0	0	0	99	0	0	0	0	0	0	0	30
70	.	.	.	.	.	99	0	0	0	0	0	.	.	.	.	.	14	0	0	0	0	14
72	17	83	0	0	0	62	17	3	0	3	7	99	0	0	0	0	2	0	0	0	0	0
73	0	0	0	100	0	82	5	0	0	3	10	0	0	0	99	0	0	0	0	0	0	6
74	72	6	0	17	6	80	0	20	0	0	0	12	12	53	23	0	6	0	6	0	0	3
75	100	0	0	0	0	46	0	9	9	18	18	0	0	99	0	0	8	0	0	0	0	4
77	14	28	0	28	28	58	3	16	3	8	5	0	0	75	25	0	1	0	0	0	0	0
78	0	0	0	100	0	67	2	11	4	7	4	33	0	33	33	0	4	0	0	0	0	2
79	50	25	0	25	0	65	0	7	4	4	15	33	0	67	0	0	0	0	0	0	0	4
80	57	14	0	29	0	69	2	16	1	5	6	22	22	22	22	11	0	2	0	0	0	1
81	.	.	.	.	.	86	0	0	0	14	0	.	.	.	.	.	2	0	1	0	9	0
82	82	0	4	14	0	0	0	0	0	99	0	0	0	99	0	0	0	5	0	0	8	22
85	69	0	6	19	6	0	0	0	0	50	0	0	0	89	11	0	0	5	5	0	15	0
86	68	3	23	6	0	0	25	0	0	25	0	0	5	68	24	3	0	6	4	1	7	17
87	88	0	0	13	0	99	0	0	0	0	0	0	0	80	10	10	0	0	0	0	0	5

Table 17.2(e). Continued.

BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO	NODE	TAB	HANDLE	SPOUT	CASTL	PINCHING
88	41	12	0	41	6	41	6	6	4	39	1	12	0	59	18	12	2	0	0	0	0	2
89	87	0	0	13	0	48	0	7	0	45	0	0	0	76	5	19	1	0	1	0	0	4
90	71	0	0	29	0	42	13	13	0	33	0	0	0	71	14	14	0	0	2	0	5	0
91	0	0	0	100	0	16	32	5	0	26	0	0	0	33	67	0	2	3	5	0	0	0
93	33	44	0	11	11	43	0	0	29	28	0	0	0	99	0	0	0	0	0	0	0	0

Table 17.2(f). Continued.

BATCH	WARE0	WARE1	WARE2	WARE3	WARE4	WARE5	WARE6	WARE7	WARE8	WARE9	WARE12	WARE17	WARE21	STRAIGHT	SSHAPED	RECURVED	BRACED	FILLETED	CHKRATIO	LOGCHECK
0	4	4	0	0	0	87	0	0	4	0	0	0	0	8	91	39	17	0	.00	.00
1	0	5	0	0	0	57	19	0	14	5	0	0	0	34	68	10	63	0	.01	.01
4	1	15	0	0	0	2	71	12	0	0	0	0	0	76	18	2	65	0	.02	.01
5	59	41	0	0	0	0	0	0	0	0	0	0	0	58	40	0	8	2	.19	.07
6	6	12	0	0	0	71	0	0	12	0	0	0	0	26	74	11	21	0	.06	.02
7	14	10	0	0	0	67	1	0	9	0	0	0	0	25	74	6	15	0	.01	.01
8	59	10	0	17	0	14	0	0	0	0	0	0	0	62	37	0	10	0	.17	.07
9	47	6	0	43	0	4	0	0	0	0	0	0	0	45	53	0	7	2	.04	.02
10	38	14	0	41	0	3	0	0	3	0	0	0	0	41	59	0	11	7	.12	.05
11	27	27	0	46	0	0	0	0	0	0	0	0	0	28	74	0	5	10	1.96	.47
13	12	2	44	42	0	0	0	0	0	0	0	0	0	56	44	0	1	6	9.38	1.02
14	2	4	54	40	0	0	0	0	0	0	0	0	0	56	45	4	0	9	2.13	.50
15	7	2	54	37	0	0	0	0	0	0	0	0	0	61	39	0	0	0	2.13	.50
16	3	1	57	39	0	0	0	0	0	0	0	0	0	60	40	0	0	1	2.13	.50
19	0	13	0	0	0	2	74	3	1	3	0	2	0	74	20	3	89	2	.00	.00
20	17	2	0	0	0	69	2	0	10	0	0	0	0	28	70	0	34	0	.01	.00
21	7	5	0	0	0	84	1	0	4	0	0	0	0	13	86	0	33	0	.02	.01
23	19	19	0	6	0	56	0	0	0	0	0	0	0	18	82	0	25	6	.21	.08
24	19	31	0	8	0	40	1	0	0	0	0	0	0	20	79	0	25	1	.13	.05
25	32	34	0	3	0	30	1	0	1	0	0	0	0	34	64	1	35	0	.05	.02
26	32	20	0	22	0	24	0	0	2	0	0	0	0	34	66	2	28	4	.21	.08
27	28	31	0	28	0	13	0	0	0	0	0	0	0	29	72	0	34	3	.32	.12
28	4	39	4	20	0	28	2	0	4	0	0	0	0	13	87	2	20	0	.60	.21
29	19	31	0	2	0	5	33	10	0	0	0	0	0	59	37	0	51	2	.02	.01
30	20	26	0	4	0	19	18	14	1	0	0	0	0	48	45	0	50	1	.01	.00
31	34	29	0	1	0	21	15	0	0	0	0	0	0	48	52	0	33	1	.05	.02
32	43	37	0	7	0	14	0	0	0	0	0	0	0	44	57	2	27	3	.13	.05
33	39	30	0	28	0	2	2	0	0	0	0	0	0	39	60	0	19	0	3.19	.62

Table 17.2(f). Continued.

BATCH	WARE 0	WARE 1	WARE 2	WARE 3	WARE 4	WARE 5	WARE 6	WARE 7	WARE 8	WARE 9	WARE 12	WARE 17	WARE 21	STRAIGHT	SSHAPED	RECURVED	BRACED	FILLETED	CHKRATIO	LOGCHECK
34	7	21	55	13	4	0	0	0	0	0	0	0	0	66	34	0	0	0	.07	.03
35	0	0	0	0	0	0	95	5	0	0	0	0	0	83	0	0	92	0	.00	.00
36	38	60	2	0	0	0	0	0	0	0	0	0	0	39	59	0	10	1	.02	.01
37	1	5	0	2	0	92	0	0	0	0	0	0	0	1	99	5	6	0	.00	.00
38	1	0	0	0	0	0	78	21	1	0	0	0	0	94	2	1	87	0	.00	.00
39	0	24	4	6	0	60	0	0	6	0	0	0	0	10	86	2	10	0	.07	.03
40	0	28	28	44	0	0	0	0	0	0	0	0	0	30	63	2	0	2	.94	.29
41	0	0	0	0	0	1	92	7	0	0	0	0	0	94	3	0	93	0	.01	.01
42	6	27	14	52	0	2	0	0	0	0	0	0	0	19	82	4	1	5	2.50	.54
43	26	44	3	28	0	0	0	0	0	0	0	0	0	26	66	0	12	0	1.35	.37
44	3	2	0	0	0	30	37	22	3	3	0	0	0	54	35	1	59	0	.00	.00
45	1	4	0	0	0	40	41	7	0	6	0	0	0	47	48	1	45	0	.00	.00
46	1	1	0	1	0	59	20	1	4	13	0	0	0	24	73	2	35	0	.00	.00
47	0	7	0	0	0	70	14	0	5	4	0	0	0	27	71	4	22	1	.00	.00
48	3	2	0	0	0	92	0	0	1	1	0	0	0	16	86	2	6	2	.00	.00
49	6	4	0	0	0	83	4	0	3	0	0	0	0	14	85	4	5	0	.06	.03
53	0	3	0	0	0	29	63	6	0	0	0	0	0	66	30	0	58	0	.02	.01
54	0	5	0	0	0	30	39	7	2	18	0	0	0	43	50	0	49	0	.02	.01
55	0	0	0	0	0	64	28	0	0	8	0	0	0	27	71	4	43	0	.02	.01
56	3	0	0	0	0	56	35	6	0	0	0	0	0	41	51	0	35	0	.02	.01
57	5	5	0	0	0	63	21	5	0	0	0	0	0	40	55	0	25	5	.02	.01
59	1	4	0	0	0	5	87	2	0	1	0	0	0	75	7	0	79	3	.00	.00
60	0	0	0	0	0	5	82	5	3	5	0	0	0	69	9	0	86	1	.00	.00
61	0	0	0	0	0	18	82	0	0	0	0	0	0	73	15	5	89	10	.00	.00
62	0	0	0	0	0	5	85	3	3	5	0	0	0	68	10	0	84	0	.00	.00
64	0	0	0	0	0	0	78	11	11	0	0	0	0	57	0	0	88	0	.00	.00
65	0	0	0	0	0	10	75	4	4	6	0	0	0	65	17	0	66	0	.00	.00
66	0	5	0	1	0	14	62	9	0	10	0	0	0	59	29	1	68	0	.01	.01
67	1	5	0	1	0	13	63	7	0	11	0	0	0	61	26	1	67	1	.01	.01
68	0	3	0	0	0	20	45	2	3	27	0	0	0	40	45	0	60	0	.03	.01
69	0	0	0	5	0	40	20	0	10	25	0	0	0	32	56	0	41	0	.12	.05
70	14	29	0	43	0	14	0	0	0	0	0	0	0	17	83	0	0	0	.06	.03
72	22	10	10	55	0	4	0	0	0	0	0	0	0	32	69	0	12	0	3.29	.63
73	17	83	0	0	0	0	0	0	0	0	0	0	0	17	84	0	1	10	1.20	.34
74	81	19	0	0	0	0	0	0	0	0	0	0	0	78	18	0	59	0	.07	.03
75	52	48	0	0	0	0	0	0	0	0	0	0	0	50	47	0	8	0	.12	.05
77	30	68	0	0	0	3	0	0	0	0	0	0	0	29	69	0	9	0	.04	.02
78	12	86	0	0	0	2	0	0	0	0	0	0	0	12	84	0	7	0	.03	.01
79	11	73	2	0	0	7	7	0	0	0	0	0	0	20	80	0	9	2	.48	.17
80	31	69	0	0	0	0	0	0	1	0	0	0	0	30	69	0	8	0	.04	.02
81	0	5	85	9	0	2	0	0	0	0	0	0	0	85	16	0	0	0	.09	.04
82	3	3	0	0	0	0	95	0	0	0	0	0	0	97	3	3	76	0	.05	.02
85	0	10	0	0	0	0	90	0	0	0	0	0	0	79	9	0	83	0	.00	.00
86	3	6	0	0	0	0	78	11	3	0	0	0	0	85	6	2	73	0	.01	.01
87	72	6	0	0	0	0	22	0	0	0	0	0	0	76	5	0	52	0	.00	.00
88	25	72	0	0	0	3	0	0	0	0	0	0	0	24	72	4	9	0	.09	.04
89	16	30	0	0	0	19	33	0	2	0	0	0	0	43	45	1	32	0	.03	.01
90	21	29	0	0	0	33	14	0	2	0	0	0	0	37	61	0	17	0	.15	.06
91	0	0	0	0	0	0	0	0	0	0	13	0	87	88	12	0	2	1	.03	.01
93	25	38	0	0	0	25	13	0	0	0	0	0	0	35	60	0	47	0	.08	.03

Table 17.2. Continued.

Variable identifications:

BATCH	Analytic Batch Number (see Table 1 for identification)
FORM3	percentage straight or outcurved rim form
FORM4	percentage straight/outcurved rim form with brace
FORM5	percentage straight/outcurved rim form with fillet
FORM6	percentage straight/outcurved rim form with brace and fillet
FORM7	percentage S-rim form
FORM8	percentage S-rim form with brace
FORM9	percentage S-rim form with fillet
FORM10	percentage S-rim form with brace and fillet
FORM11	percentage recurved S-rim form
FORM12	percentage recurved S-rim form with brace
FORM15	percentage zone 2 and 3 rim fragment
FORM16	percentage zone 2 and 3 rim fragment with fillet
FORM19	percentage zone 5 brace fragment
FORM20	percentage zone 3 rim fragment
FORM22	percentage zone 2 and 3 rim fragment with brace
	rim form class percentages are computed exclusive of bowl forms, zone 2 fragments, zone 1-2 fragments, and appendage fragments
*RDLIP	percentage round lip form
*FLTLIP	percentage flat lip form
*INLIP	percentage inslanted lip form
*OUTLIP	percentage outslanted lip form
*LTLIP	percentage L- and T-shaped lip form combined
*POILIP	percentage pointed lip form
*BDLIP	percentage beaded lip form, all variations
*PLAIN	percentage new type plain, undecorated
*CORDIMPR	percentage new type cord impressed
*TOOLIMP	percentage new type tool impressed
*TRAILIN	percentage new type trailed or incised
*PINCHED	percentage new type pinched
*STABDRAG	percentage new type stab-and-drag
*CWTI	percentage new type cord-wrapped-tool impressed
*FINGER	percentage new type finger impressed
*DENTATE	percentage new type dentate stamped
*Z3CURVED	percentage of vessels with curved rather than angular zone 3 juncture exclusive of those with indeterminate shape
*Z2BRUSH	percentage of vessels with brushed zone 2 surface treatment
*Z2COB	percentage of vessels with cob-impressed zone 2 surface treatment
*Z2PLAIN	percentage of vessels lacking decoration in zone 2
*Z3PLAIN	percentage of vessels lacking decoration in zone 3
Z5PLAIN	percentage of vessels lacking decoration in zone 5
*Z7PLAIN	percentage of vessels lacking decoration in zone 7

Table 17.2. Continued.

*INTPLAIN	percentage of vessels lacking decoration on the rim interior
*STWIST	percentage of cord-impressed vessels with S-twist cord direction
*CDSPACE	mean distance between individual parallel cord decorations, mm
*CDDIAM	mean diameter or width of individual cord impressions
*Z2THICK	mean vessel wall thickness in zone 2
*Z3THICK	mean vessel wall tkickness in zone 3
Z5THICK	mean vessel wall maximum thickness in zone 5
*Z7THICK	mean vessel wall thickness at zone 7
Z5WIDTH	mean width (height) of zone 5 brace
*BODYTH	mean maximum thickness in size grade 2 body sherds
STPLAIN	percentage plain or smoothed body sherd surface treatment
STSS	percentage simple-stamped body sherd surface treatment
STCHECK	percentage check-stamped body sherd surface treatment
STCORD	percentage cord-roughened body sherd surface treatment
STDEC	percentage of body sherds which are decorated by any technique
Z5EXT	percentage of braces (zone 5) with curved, exterior form
Z5INT	percentage of braces (zone 5) with curved, interior form
Z5COLLAR	percentage of braces (zone 5) with collared, exterior form
Z5WEDGE	percentage of braces (zone 5) with wedge-shaped, exterior form
Z5INVWE	percentage of braces (zone 5) with inverted wedge, exterior form
Z3PATH	percentage of zone 3 with horizontally continuous decorative pattern only
Z3PATHOU	percentage of zone 3 with horizontally continuous decoration over or under a pattern with no orientation
Z3PATAR	percentage of zone 3 with angular or indeterminate rainbow decorative pattern in any combination
Z3PATCR	percentage of zone 3 with curved rainbow decorative pattern in any combination
Z3PATD	percentage of zone 3 with diagonal decorative pattern in any combination
Z3PATNO	percentage of zone 3 having only decoration with no orientation
Z5PATNO	percentage of zone 5 having only decoration with no orientation
Z5PATV	percentage of zone 5 with vertically oriented decorative pattern in any combination
Z5PATD	percentage of zone 5 with diagonally oriented decorative pattern in any combination
Z5PATH	percentage of zone 5 with horizontally continuous decoration in any combination
Z5PATO	percentage of zone 5 with other decorative patterns
*NODE	percentage of ware classifiable vessels exhibiting nodes
*TAB	percentage of ware classifiable vessels exhibiting tabs
*HANDLE	percentage of ware classifiable vessels exhibiting loop/strap handles
*SPOUT	percentage of ware classifiable vessels exhibiting spouts

Table 17.2. Concluded.

*CASTL	percentage of ware classifiable vessels exhibiting castellation
*PINCHING	percentage of ware classifiable vessels exhibiting pinching/wavy rim
WARE0	percentage of vessels classified as Unclassified Straight Rim ware
WARE1	percentage of vessels classified as Unclassified S-Rim ware
WARE2	percentage of vessels classified as Riggs ware
WARE3	percentage of vessels classified as Fort Yates ware
WARE4	percentage of vessels classified as Anderson Low Rim ware
WARE5	percentage of vessels classified as Le Beau ware
WARE6	percentage of vessels classified as Knife River ware
WARE7	percentage of vessels classified as Deapolis Collared ware
WARE8	percentage of vessels classified as Knife River Fine ware
WARE9	percentage of vessels classified as Transitional S-Rim ware
WARE12	percentage of vessels classified as Arzberger ware
WARE17	percentage of vessels classified as Colombe Collared ware
WARE21	percentage of vessels classified as Hughes ware
*STRAIGHT	percentage of vessels having some form of straight rim (rim form 3, 4, 5 or 6)
*SSHAPED	percentage of vessels having some form of S-shaped rim (rim form 7, 8, 9, 10, 11, 12, 15, 16, 20 or 22)
*RECURVED	percentage of vessels having some form of recurved S-shaped rim (rim form 11 or 12)
*BRACED	percentage of vessels having some form of braced rim (rim form 4, 6, 8, 10, 12 or 19)
*FILLETED	percentage of vessels having some form of filleted rim (rim form 5, 6, 9, 10 or 16)
CHKRATIO	ratio of the percentage of body sherds with check-stamped surface treatment to the percentage of body sherds with simple-stamped surface treatment
*LOGCHECK	log to the base 10 of (CHKRATIO + 1.0)

Notes: * indicates variables used in the principal components analysis.
p = missing data; Knife River phase mean data used for factor analysis
o = missing data; overall sample mean data used for factor analysis
b = missing data; batch 14 data used for factor analysis
s = missing data; site mean data used for factor analysis

Because some of these selected variables are not directly useful for quantitative analysis, several new variables were computed from existing information on other variables. For example, the raw summary data on rim form classes include data on various kinds and degrees of fragmentation. Percentages for variables reflecting various fragments of common rim form types were summed to produce a simpler representation of alternative rim form percentages in each batch sample. For example, percentages for specific rim form classes 3, 4, 5, and 6 were summed to yield a total percentage value for vessels exhibiting some type of straight rim form (regardless of bracing, filleting, etc.). Another newly computed variable deals with the relative frequency of check-stamped surface treatment in body sherds. Check-stamping, occurring as an alternative to simple-stamping, is thought to be a culture-historically sensitive variable. Because it was thought that some of the data on the alternative smoothed, simple-stamped, and check-stamped classes might not have been recorded similarly by all investigators, the surface treatment analysis was narrowed to focus on the relative proportions of simple- and check-stamping, exclusive of sherds classified as smoothed. A ratio of check-to-simple stamp percentages was computed, with values above 1.0 indicating a predominant use of check-stamping, and values near 0.0 indicating predominant use of simple-stamping. Because such a ratio has a decidedly skewed distribution (clustering near zero) this variable was rescaled or transformed by taking the logarithm to the base 10 of the check-ratio value + 1.0.

Table 17.2 then illustrates the raw summary data for the total of 95 existing and computed ceramic variables for each batch based on body sherd and coded vessel information. To briefly summarize, these variables include data on ware class percentages; new type (decorative class) percentages; individual and general rim form class percentages; individual zone shape class percentages for zone 3 (upper S-rim), zone 5 (brace), and zone 7 (lip); percentage of vessels with appendages or rim/lip modifications; zone 2 and body sherd surface treatment percentages; percentage of plain decoration in zones 2, 3, 5, and 7; percentage of cord impressions with S-twist direction; decorative pattern class (much collapsed) percentages for zones 3 and 5; means for spacing and diameter of cord impressions; mean vessel wall thickness in zones 2, 3, 5, 7, and body sherds; and mean width of zone 5. The full list of variables coded for each batch is given at the end of Table 17.2, showing both the abbreviated variable code used in the computer analysis and listed there in subsequent tables as well as a more complete description of each variable.

Principal Components and Initial Cluster Analysis

Principal components analysis was used to investigate the underlying structure in the ceramic data for the selected 78 batch samples. Principal components analysis was used primarily to collapse information on a large number of variables into a summary form of data on a much smaller number of new variables or factors, thereby hopefully simplifying interpretation of ceramic variability in the total data set. In the sense used here, principal components analysis is used as an exploratory, data-reducing, and pattern-searching technique rather than as a hypothesis testing technique (Rummel 1970:29-30). The intent is to produce a simplified picture of the patterned relationships among the original data variables. The influence of each of these simplified patterns on each analytic batch can be expressed as a factor score on each factor for each batch. The relationships of batches among themselves can then be determined by examining a graphic display of factor scores and by applying cluster analysis to the array of factor scores for all batches. Of the many forms of factor analysis which are available today, principal components analysis was chosen because it is mathematically more elegant, producing a linear reproduction of relationships among the original variables as expressed in the data correlation matrix, while requiring fewer assumptions about normal distribution in the original variable data sets (Rummel 1970:159). Our use of factor analysis here as a pattern-searching, data-reduction technique generally parallels several examples of similar application in the anthropological literature (e.g., Benfer 1972; Binford and Binford 1966; Ahler 1973; McMillan 1976), several of which are also intended to develop chronological arrangements of archeological data sets (cf. Marquardt 1978:287-292; 1979; C. Johnson 1977a; Le Blanc 1975).

The data entered into the principal components analysis consist of a correlation matrix developed for a total of 42 variables identified in Table 17.2 and for a total of 78 analytic batches listed in that table. This is an R-mode analysis, involving 78 cases (batches) and 42 variables. The principal components factoring procedure identified as PC or PA1 in the SPSS-X library (SPSS, Inc. 1983:647-661) was used for the analysis. The 42 variables entered into the analysis include the following:

- general rim form class percentages (5 classes)
- new type (dominant decorative technique) class percentages (9 classes)
- lip shape class percentages (7 classes)
- zone 3 shape class percentage
- vessel appendage or modelling percentage data (6 variables)
- zone 2 surface treatment class percent ages (2 classes)
- percentage of vessels undecorated in zones 2, 3, 7 and interior
- cord twist direction percentage
- all metric data except for zone 5 data (5 variables)
- body sherd thickness and log of check-ratio data

Data concerning vessel zone 5 (the brace) were specifically excluded from this analysis because such information was lacking for a significant number of batches. The missing data for zone 5 would have eliminated these batches from the factor analysis; it was thought more desirable to include the batches and exclude the zone 5 variables at this point in the analysis. In a few instances where zone 3 data were missing, appropriate means developed from entire site or phase samples were inserted to facilitate inclusion of those batches in the analysis (see notes in Table 17.2). Decorative pattern data for zone 3 were also excluded from this analysis because such variables were thought to be too fine-grained to be relevant to recognition and extraction of region-wide culture-historic patterns. Ware classification data were also specifically excluded from the analysis, due primarily to the potentially inconsistent usage of the unclassified ware-like groups relative to ceramic batches which are thought to lie at opposite ends of the regional chronological scale. It was thought desirable to temporarily exclude ware classification from consideration and see if a meaningful culture-historic arrangement could be developed exclusive of such data.

The principal components analysis resulted in extraction of a total of 12 factors with eigenvalues greater than 1.0, with these factors accounting for a total of 78.7 percent of the total variance in the variable correlation matrix. All of the ouput from the factor analysis is summarized in Table 17.3. The large number of factors extracted indicates that a large number of relatively weak patterns exist in the data set. That this is so, and that several of these patterns are probably due to relatively obscure relationships or even to random variation, can be seen from inspection of the factor loading matrix. Quartimax rotation was applied to the factor loading matrix, and the rotated matrix is presented in Table 17.3. Even though only the first three factors in this rotated loading matrix are thought to be of interest here, the full matrix for all 12 rotated factors is reproduced in the table for purposes of general information. Also reproduced in that table are the factor scores for all 78 cases or batches on the first six of the rotated factors.

The composition of the first three factors, which together account for a combined total of 43.0 percent of the total variance in the variable correlation matrix, can be discussed in somewhat greater detail. Factor 1, which accounts for nearly 22 percent of the total variance, is dominated by variables concerning rim form, to a lesser degree by variables concerning decoration, and to an even lesser degree by variables concerning rim/lip modifications. Straight and to a lesser degree braced rim form load highly positive on this factor, opposed by S-shaped rim form with a high negative loading. The bipolarization of straight and S-shaped rim forms is due primarily to measurement redundancy (Benfer 1972:535) because all vessels except brace fragments will necessarily be classified as either straight or S-shaped in form. Percentage data for these two variables can be predicted to load in opposite directions on some factor. Decoration type variables with high loadings on factor 1 include plain and plain in zone 3 which are positive, opposed to cord- impressed which is negative. Body sherd thickness has a high positive loading; inslanted lip form has a high negative loading; and tabs and castellations have moderately high positive loadings. In sum, factor 1 extracts a pattern in which somewhat thicker braced and unbraced straight rims with plain decoration and with common occurrences of tabs and castellations exhibit contrastive distributions with somewhat thinner vessels with S-shaped rims, cord decoration, and inslanted lip form. The former rim classes are most reflective of Knife River ware which is most common in the most recent pottery samples in the region, while the latter pattern collectively describes Le Beau ware, Fort Yares ware, and unnamed intermediate S-shaped vessel forms which together are most common in sites of intermediate or early age in the region. In general terms, this factor extracts a pattern which agrees with the present understanding of pottery trends in the region and existing data on chronology.

Unlike factor 1, factor 2 does not involve any general rim form characteristics. Rather, it extracts a pattern dominated by minor aspects of vessel form, decorative detail, and body surface treatment. Several variables have high positive loadings: cord spacing and cord impression diameter (it is not surprising that these two are correlated, for mechanical reasons), check-stamp ratio, flattened lip form, finger impressions, and plain vessel interior. High negative loadings occur for curved zone 3 percentage and for round lip form. The former suggests that the complement of curved zone 3 percentage, angular zone 3 percentage, would have had a high positive loading had it been entered in the analysis. Collectively, nearly all of the variables with high loadings on factor 2 serve to define Fort Yates Cord Impressed pottery, particularly as it is identified and described in Nailati phase sites in the region: vessels with widely spaced, large diameter cord impressions; dominant use of check-stamped as opposed to simple-stamped body surface treatment; flattened rather than rounded lips; angular zone 3 lower juncture; and frequent use of finger impression for decoration. All of these features contrast strongly with Le Beau ware as it is presently identified at Heart River phase sites in the region, characterized by small diameter, closely spaced cord-impressed decoration; high occurrence of simple-stamped rather than check-stamped body surface treatment; round-

Table 17.3(a). Output data from the principal components analysis of 78 ceramic batches and 42 summary ceramic data variables. See the end of Table 17.2 for variable identifications.

VARIABLE MEANS AND STANDARD DEVIATIONS ACROSS ALL BATCHES:

VARIABLE	MEAN	STD DEV
RDLIP	58.37179	21.85496
FLTLIP	23.03846	18.09387
INLIP	6.50000	6.87504
OUTLIP	1.15385	2.21023
LTLIP	5.65385	7.79748
POILIP	3.34615	3.27457
BDLIP	2.28205	4.66514
PLAIN	12.55128	12.21947
CORDIMPR	56.11538	21.48692
TOOLIMP	10.35897	12.55634
TRAILIN	6.57692	10.17192
PINCHED	3.97436	5.33056
STABDRAG	1.20513	2.50381
CWTI	2.42308	7.96505
FINGER	6.23077	7.26479
DENTATE	.48718	1.14805
Z3CURVED	59.46154	32.54675
Z2BRUSH	38.71795	17.38181
Z2COB	2.21795	4.10146
Z2PLAIN	89.61538	10.06115
Z3PLAIN	15.96154	20.32300
Z7PLAIN	73.97436	14.52984
INTPLAIN	93.20513	8.61494
STWIST	11.23077	8.48516
CDSPACE	4.81590	1.24003
CDDIAM	2.38615	.34661
Z2THICK	6.35000	.50518
Z3THICK	6.67000	.65513
Z7THICK	7.69731	.61949
BODYTH	5.46128	.53466
NODE	2.61538	4.13798
TAB	.70513	1.61252
HANDLE	.58974	1.65487
SPOUT	.52564	1.26619
CASTEL	1.34615	2.85050
PINCHING	6.03846	7.29248
STRAIGHT	45.73077	23.85926
SSHAPED	49.84615	27.49549
RECURVED	1.67949	4.78768
BRACED	34.44872	29.35039
FILLETED	1.33333	2.53119
LOGCHECK	.09552	.19204

Table 17.3(b). Continued.

FINAL STATISTICS:

VARIABLE	COMMUNALITY	*	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
		*				
RDLIP	.90841	*	1	9.15039	21.8	21.8
FLTLIP	.90059	*	2	5.75347	13.7	35.5
INLIP	.74501	*	3	3.17117	7.6	43.0
OUTLIP	.59429	*	4	2.54365	6.1	49.1
LTLIP	.83113	*	5	2.19226	5.2	54.3
POILIP	.57909	*	6	1.87552	4.5	58.8
BDLIP	.68216	*	7	1.82437	4.3	63.1
PLAIN	.84295	*	8	1.57388	3.7	66.9
CORDIMPR	.91761	*	9	1.42468	3.4	70.3
TOOLIMP	.81083	*	10	1.26092	3.0	73.3
TRAILIN	.84953	*	11	1.19421	2.8	76.1
PINCHED	.77706	*	12	1.07399	2.6	78.7
STABDRAG	.75541	*				
CWTI	.68333	*				
FINGER	.70950	*				
DENTATE	.71864	*				
Z3CURVED	.73399	*				
Z2BRUSH	.75896	*				
Z2COB	.71786	*				
Z2PLAIN	.69839	*				
Z3PLAIN	.71904	*				
Z7PLAIN	.86149	*				
INTPLAIN	.62734	*				
STWIST	.74162	*				
CDSPACE	.90919	*				
CDDIAM	.81877	*				
Z2THICK	.68551	*				
Z3THICK	.76909	*				
Z7THICK	.83167	*				
BODYTH	.86047	*				
NODE	.86711	*				
TAB	.69883	*				
HANDLE	.84581	*				
SPOUT	.77923	*				
CASTEL	.64688	*				
PINCHING	.87482	*				
STRAIGHT	.92992	*				
SSHAPED	.90756	*				
RECURVED	.86051	*				
BRACED	.92143	*				
FILLETED	.88292	*				
LOGCHECK	.78456	*				

Table 17.3(c). Continued.

QUARTIMAX ROTATED FACTOR LOADING MATRIX WITH KAISER NORMALIZATION:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
STRAIGHT	.89196	-.12641	.11304	-.15977	.08745	-.20273
SSHAPED	-.87823	.20375	-.15686	.08369	-.11489	.15047
PLAIN	.80284	.03551	-.14381	.26283	.03653	.15616
INLIP	-.69917	-.27720	-.22031	.04795	-.12488	.08937
BODYTH	.62668	.07597	.04933	.18235	.60482	.11233
BRACED	.62236	-.55652	.24990	.35949	.00289	.07794
CORDIMPR	-.56275	-.49429	.06684	.34547	-.01117	-.00846
Z3PLAIN	.50952	-.21259	.43533	.14839	-.14803	.31425
TAB	.50163	-.23818	-.01654	-.07307	.25226	.15071
CASTEL	.48874	-.31747	.23177	.13382	.35932	.06841
CDSPACE	-.06985	.90599	-.08115	.00220	.23578	.01128
CDDIAM	-.08398	.86299	-.01472	-.05817	.08736	-.15291
LOGCHECK	-.04489	.80922	-.03259	.12534	-.09620	-.22387
FLTLIP	-.25196	.76717	-.11861	.04960	.13513	.25387
Z3CURVED	-.11639	-.62936	-.13289	.32661	-.42172	-.00749
FINGER	.18352	.58967	-.02083	-.35507	-.22407	.09043
RDLIP	.52167	-.53096	.23621	.11155	-.00602	-.38489
INTPLAIN	-.38654	.47601	-.43146	-.02212	-.09456	.00742
PINCHING	.09358	-.11450	.79060	.24387	.17947	-.20222
SPOUT	.32920	-.16921	.72342	-.00006	-.03788	.15831
DENTATE	.20311	-.23098	.66975	-.04612	-.02123	.12724
PINCHED	.17991	.11119	.64418	.31261	.21084	-.20479
Z7PLAIN	.20537	-.15585	.14456	.82771	-.03985	-.09300
TOOLIMP	.12594	.26697	-.22658	-.72013	.05618	-.25732
Z3THICK	.21996	.10688	.02874	-.09237	.81537	.06453
Z2THICK	.23612	.25359	.10229	-.00447	.71360	.06632
Z7THICK	.03763	-.19159	.06701	.14467	.20928	.84149
LTLIP	-.26839	.08280	-.10579	-.43789	.00654	.60851
STABDRAG	-.13408	.45605	-.07632	.02562	-.00393	.50785
TRAILIN	.01282	.17450	-.11578	-.10053	-.09589	.15638
Z2PLAIN	.31196	.36800	-.06625	-.10257	-.09157	.19201
Z2BRUSH	-.39698	.06177	-.01792	-.04442	-.14375	.07695
Z2COB	-.25654	.19849	-.10175	-.13790	-.12327	.32825
BDLIP	-.04034	.06700	-.16030	-.01515	-.28763	-.16126
RECURVED	-.17163	-.18514	-.03706	.08650	-.13693	-.04803
NODE	-.25852	.13071	-.08145	-.05187	.15442	-.06688
CWTI	-.14071	-.13469	-.00667	-.04168	-.07731	-.10172
STWIST	.27516	-.04086	-.15982	-.09358	.15468	.11231
HANDLE	.31702	-.22365	.08988	-.13889	.07136	-.12458
OUTLIP	-.00173	-.08932	-.12533	-.33752	-.00231	.03393
FILLETED	-.07677	.31487	.03789	.06411	-.02066	-.03146
POILIP	.06876	-.32213	.10948	.17358	-.04878	-.23351

Table 17.3(c). Continued.

QUARTIMAX ROTATED FACTOR LOADING MATRIX WITH KAISER NORMALIZATION: (CONTINUED)

	FACTOR 7	FACTOR 8	FACTOR 9	FACTOR 10	FACTOR 11	FACTOR 12
STRAIGHT	-.08516	-.00853	-.12712	.08189	.00500	.03283
SSHAPED	.05481	.00923	.15334	.00518	-.02434	.00914
PLAIN	.18686	-.06904	-.12726	-.00520	-.04683	-.15348
INLIP	.11379	-.23608	-.13143	.11212	.07929	.01018
BODYTH	.13718	-.07268	-.09584	-.03460	.10387	-.05087
BRACED	.07385	-.00571	-.08949	.06390	.09450	-.01044
CORDIMPR	.42788	-.07324	.04717	-.18381	.08549	.02883
Z3PLAIN	.09862	-.00448	-.00831	.05949	.19575	.17426
TAB	.03693	.14364	.01877	-.17656	.46356	.17348
CASTEL	.20237	.10776	.03178	-.08183	.18960	-.07480
CDSPACE	-.05983	.03270	-.03534	-.03108	.03042	.11569
CDDIAM	.15562	-.08893	-.00454	.00725	.01205	.00011
LOGCHECK	.14846	-.04673	-.06610	.00315	.07474	.13186
FLTLIP	-.26302	.24230	.05879	-.05121	-.11954	-.03251
Z3CURVED	.02779	-.06754	.06974	.09819	-.02925	.03747
FINGER	.02799	-.17375	-.00827	-.19366	-.20563	.17999
RDLIP	.28054	-.16882	-.08933	.04090	.14258	-.02736
INTPLAIN	-.12363	.04930	.14415	-.02585	-.10473	-.07455
PINCHING	-.05145	-.12810	-.10563	-.25192	-.03778	-.01526
SPOUT	.11019	.05483	-.02785	-.04445	.23667	-.13591
DENTATE	.11360	.08627	-.00307	.31929	.00803	.18530
PINCHED	-.11012	-.16705	.03216	-.26541	-.14614	.01915
Z7PLAIN	.01259	.13922	.01964	-.18799	.01719	.15238
TOOLIMP	-.05245	.27276	-.02035	.02047	.07956	.00914
Z3THICK	.02565	.05054	-.04733	.00448	.13485	-.08534
Z2THICK	-.04036	-.06990	.09481	.05583	-.11220	.10064
Z7THICK	.00870	.03628	-.08219	.01386	.01036	-.08821
LTLIP	-.10661	-.32073	-.07123	-.09768	-.14892	.16717
STABDRAG	-.35624	.33250	-.07040	.03763	-.00825	-.14539
TRAILIN	-.86006	.04673	.01656	.00747	.13745	.02539
Z2PLAIN	.59191	.01964	.04400	-.13082	.16533	.09146
Z2BRUSH	.12560	-.73858	.01657	-.07101	-.02154	-.04034
Z2COB	.09227	.61218	-.15416	-.17699	-.09854	.11072
BDLIP	-.03513	.50127	.33288	.30246	.11339	-.27152
RECURVED	.14469	-.05086	.85870	-.00283	.05585	.05341
NODE	-.12729	.01475	.83963	-.08552	-.07371	-.10681
CWTI	-.02291	.00698	.02307	.78004	-.13286	-.00855
STWIST	-.09839	.03707	-.14158	.70088	.26437	.03429
HANDLE	-.27485	.10615	-.02096	-.03639	.74728	-.01781
OUTLIP	-.28351	.23583	-.03569	-.16035	-.53985	.03327
FILLETED	.04716	-.01191	-.07515	.03369	-.01022	.87274
POILIP	-.14575	.17220	.27661	-.30688	.11827	.36878

Table 17.3(d). Continued.

ROTATED FACTOR SCORES:

BATCH	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
0	-.69229	-.91590	-.53953	.27203	-.96119	-.45825
1	.74589	-.60539	.72367	.37005	-.98837	.39220
4	1.09049	-.18945	2.35044	.13861	-1.11971	.24238
5	.05076	-.04196	-.61650	-2.83359	.07155	.73217
6	-1.26117	-.94016	-.89009	1.10967	-.55472	-.95811
7	-1.09297	-.78459	-.65604	-.20927	-.89475	-.17850
8	.96364	-.12254	-.84599	-1.82208	-.93800	.56591
9	.12874	.94703	-.05943	-1.85917	-.20459	2.29189
10	-.05035	.24281	-.63809	-1.20112	.39052	-.05699
11	-.69239	1.15509	.58974	1.29181	.66084	-1.95580
13	.57069	2.35571	-.17917	-.38626	-1.28407	-1.97550
14	.34881	2.25628	-.11007	-.50112	-.32557	-.97594
15	.73322	2.07171	.36046	-.62285	-.85085	-.85920
16	.65165	2.23816	.15475	.05272	-.30802	-1.06253
19	1.56507	-.88310	-.32802	.27838	-.27830	1.29784
20	-.85408	-.78293	-.61967	.10155	-1.13351	-.46271
21	-.87818	-.61143	-.56259	.57635	-.98227	-.30171
23	-1.02219	-.17666	-.29236	.18288	-.01541	.51450
24	-.65848	-.05635	-.55955	.38887	-1.07007	-.01821
25	-.40912	-.61407	-.85096	.05088	-.68789	-.39691
26	-.66038	.10983	-.45355	-.58568	-.92576	-.01695
27	-.63870	.61815	-.33823	.60123	-.47141	-.72906
28	-1.03298	.34772	-.50556	.57109	-.55518	-.66270
29	.92572	.40210	.24829	.50711	-.18174	.02678
30	.28205	.19950	1.98903	-.21031	-1.02472	.71324
31	.19216	.09371	-.69406	-.42022	-.52172	-.08760
32	-.02801	.27931	-.70867	.04761	-.50300	-.17571
33	.12059	2.20868	-.31347	.78180	-.50865	.06950
34	.36737	.84188	-.50690	-2.16725	2.00338	-.95808
35	2.24892	-.46945	-1.51533	1.90787	.26962	-.05988
36	-.17570	.58139	-.01928	-1.46227	.06786	1.75229
37	-1.93005	-.17515	-.07290	-.36123	-.26338	1.46544
38	2.95678	.03233	-1.38649	1.53864	-.95651	1.31907
39	-1.65718	-.83787	-.59154	.06684	.97198	-.00323
40	-.46278	1.89186	.54269	.76943	1.94232	-1.02789
41	2.50034	-.19610	-.55626	1.24877	-.81723	.24104
42	-.91847	2.10933	.25672	1.43760	1.71049	.58369
43	-.29037	1.98263	-.40680	.88091	-.25894	.76029
44	.28912	-.38099	.99558	.02300	.17605	.38319
45	-.08207	-.55113	.62651	-.14211	-.08757	.59515
46	-1.08868	-1.05200	.03600	.13221	.54345	-.01595
47	-.98118	-.94258	-.48539	-.20172	-.15165	.15891
48	-1.80082	-.92602	-.49589	-.06459	.40969	.63050
49	-1.63090	-.87281	-.65303	-.18158	-.02396	-.09465
53	.89165	-.78380	-.27490	.48699	-.08512	-.45522
54	-.33550	-.50066	.24034	.57479	.07603	-.57578
55	-1.20878	-.98468	-.19123	-.50310	.60142	.63173
56	-1.12833	-1.07032	-.50561	.47515	.92099	-.17046
57	-.78774	-1.12691	-.36143	.04379	.71563	-.36065
59	1.97990	-.87623	-1.36761	1.14860	.34886	.45428
60	1.07472	-.97385	1.80686	.20823	.08274	.87433
61	.38945	-.93943	1.74287	.80012	-.91453	.29684

Table 17.3(d). Concluded.

ROTATED FACTOR SCORES: (CONTINUED)

BATCH	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
62	.93663	-.67849	1.13806	-.41054	.64347	.47250
64	1.16371	-1.06242	-.88686	.37432	.83068	.45666
65	.35130	-.42611	3.53473	-.71836	.30670	-.01386
66	.14100	-.51850	2.61837	-.08797	.55882	.26063
67	.20548	-.43502	2.54818	-.50449	.79281	.48051
68	-.06967	-.39624	1.43483	.67397	-.18934	-.91605
69	-.94314	-.36467	1.54999	.83013	.01082	-1.52970
70	-1.27110	1.08543	.92412	1.99757	2.79224	-.71159
72	-.35781	2.22864	-.34144	.67753	-.59050	.48287
73	-.53791	1.39041	-.07973	.62948	-.01207	1.83139
74	.64174	-.66798	-.90105	.42996	-1.73308	-1.56249
75	-.18169	-.69830	-.36776	-1.79796	.83421	-.51276
77	-.44676	.51589	-.25101	-.19765	.17160	2.65754
78	-.25015	.96860	-.20344	-.28080	.08129	2.43797
79	-.85264	.78620	-.18458	.64141	-.77466	1.02767
80	-.37531	.34923	-.55315	-.37471	.09878	2.17081
81	1.05664	1.11339	-.82198	-2.26252	1.00978	-1.32295
82	1.29483	-.88483	.21981	1.21077	2.36664	-.80869
85	1.55941	-.76521	-2.05472	.21221	4.55470	.22980
86	1.26558	-.91163	1.33088	-.42401	-.01501	-.38577
87	.39192	-.53789	-.36773	.22802	-1.00442	-1.35213
88	-.62543	-.21220	.89612	-.69190	.09610	-.63212
89	-.12150	-.60050	-.24264	.35227	-.93518	-.92111
90	-.38815	-1.18811	-.74283	-.26813	-.68920	-1.05417
91	.90159	-.24575	-.22991	-3.76562	.23855	-2.37300
93	-.52105	-.34405	-.39627	.19693	-.55880	-.35098

ed rather than flattened lip form; and predominantly curved lower zone 3 junctures. That these ceramic characteristics are most indicative of Nailati phase versus Heart River phase components in the region indicates that factor 2, like factor 1, encapsulates a significant amount of chronological information in the data set.

Factor 3 involves yet a smaller set of variables, accounting for only 7.6 percent of the total variation in the correlation matrix. Most heavily involved here are variables dealing primarily with decoration and upper rim/lip modification, including pinching, the presence of spouts, dentate stamped decorative technique, and pinched decorative type classification. The correlation between pinching or wavy rim modification and pinched type classification involves some degree of measurement redundancy, with the two variables often recording the same thing in vessels lacking decorative modification other than pinching. Generally, all the variables involved and the characteristics noted are commonly associated with Knife River ware as it is currently identified in the region. This is particularly true for spouts and wavy rims, but less true for dentate stamping. Dentate stamping often occurs on S-rims as well as braced rims, with the S-rim vessels usually classified as something other than Knife River ware. Factor 3 is orthogonal to and independent of the other two factors; this indicates that the pattern extracted here, while perhaps linked to Knife River ware, is independent of the more general pattern also thought to be linked to Knife River ware in factor 1, as discussed above. Factor 3 exhibits an unexpected pattern in the data set.

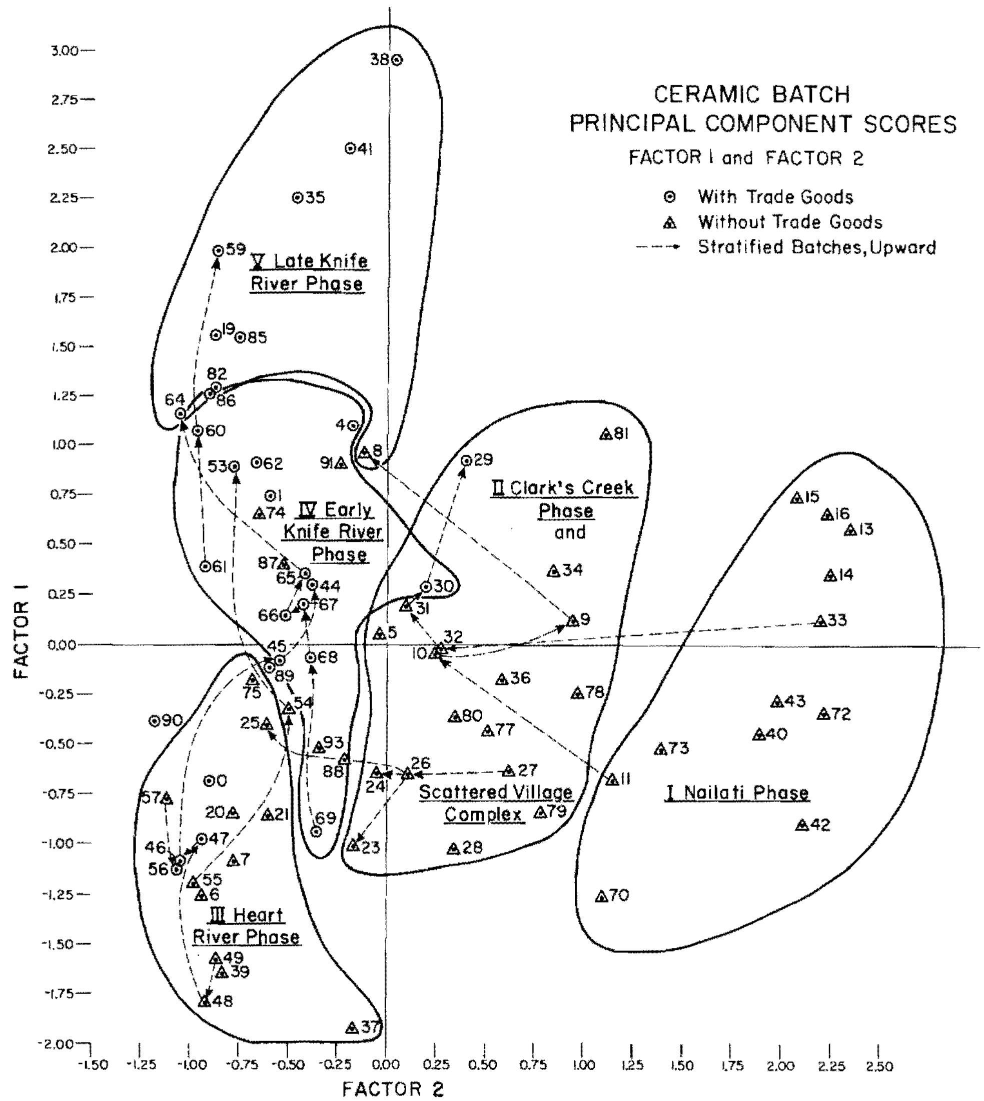
The remaining nine factors with eigenvalues greater than 1.0 are relatively trivial in significance and will not be discussed in detail or used in the overall chronological interpretation of the data set based on cluster analysis. All of these factors involve either two or three variables, and the correlations extracted are in each case either due to measurement redundancy, error variation, or relatively isolated patterns of variable correlation which occur in only a few analytic batches. While some of these factors may extract patterns which are of value for interpreting detailed culture-historic relationships within one or two taxonomic units, they are generally of little value for reconstructing the broad chronological scheme for the study area. Attempts to incorporate these factors into the quantitative ordering of batches through cluster analysis generally proved unsatisfactory. When scores on these factors were included in the clustering process, spurious and illogical results were obtained, apparently due to the overweighting of the patterns extracted by these factors.

A factor score is computed for each batch on each factor. This score provides a direct measure of how strongly the raw data for a particular batch reflect the pattern of variable correlations extracted by each factor. Scores can be either positive or negative in sign, and the farther the score deviates from zero, the more strongly the factor pattern is reflected in the raw data for any given batch. Scores for the first six rotated principal component factors are listed for the 78 batches at the end of Table 17.3. As noted previously, only data for the first three factors will be interpreted in detail, and the information on the remaining three factors is provided only for the general interest of the reader.

Factor scores provide the basis for both graphic and quantitative interpretation of the relationships among batches. Figure 17.1 contains a graphic plot of scores for each batch on factors 1 and 2, and Figure 17.3 provides a similar plot of scores on factors 1 and 3. The proximity of factor scores for any two batches gives an indication of similarities in raw data for the batches; insofar as the factors reflect major chronological or culture-historic patterns, the similarity of scores for any two batches provides a measure of how culturally or chronologically similar two batch data sets might be. To further illustrate the relationship between the factor patterns and regional chronology, as presently understood from chronometric and historic dating, Figure 17.2 shows the location of all batch scores on factors on 1 and 2 for which we have chronometric or historic dates. Such dates are plotted at the appropriate batch score locations. Batches not presently dated by those techniques are not plotted. Broad enclosures are drawn in Figure 17.2 to encompass all or most batch locations within a particular time range, and the arrows illustrate progression through time from the oldest to the youngest batches.

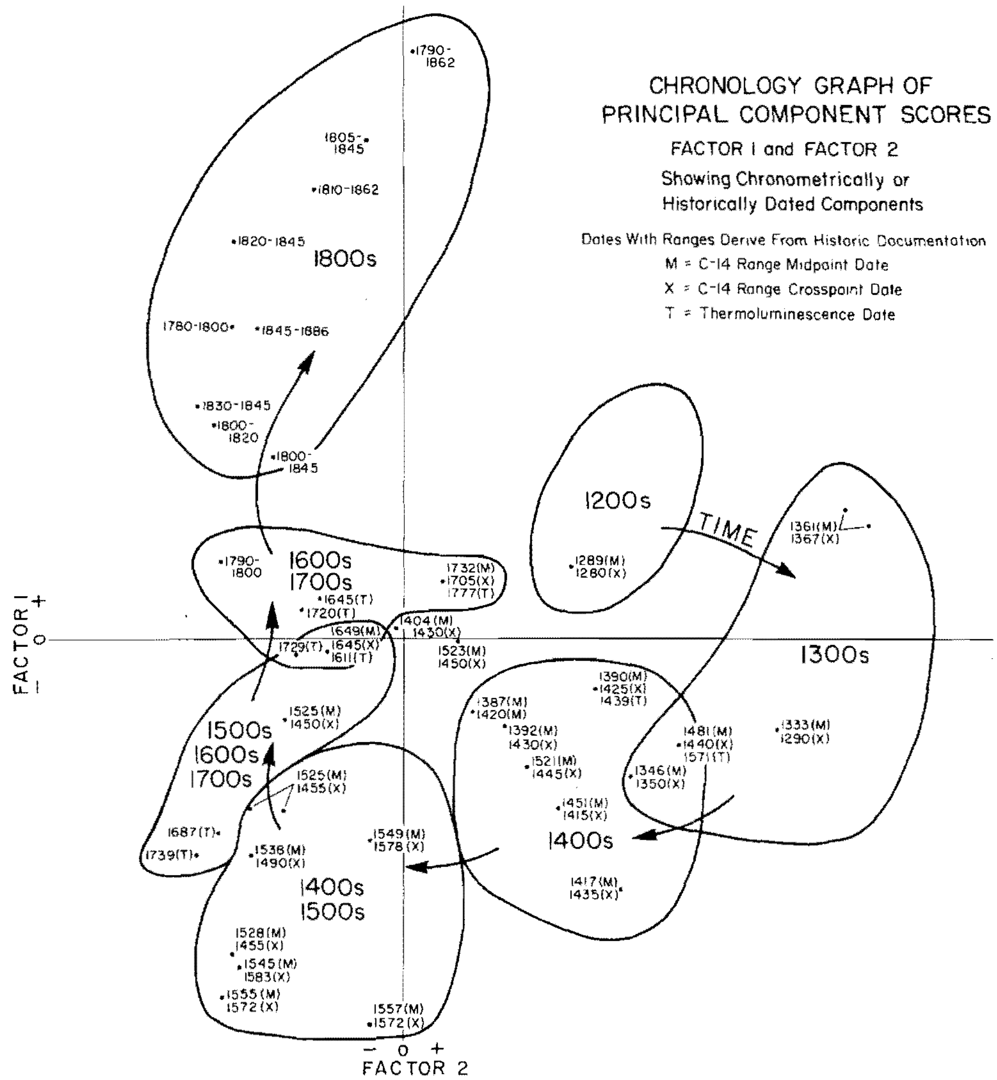
From this figure it can be noted that both factor 1 and factor 2 incorporate a great deal of chronological information, yet neither factor alone accounts for the majority of chronological variation in the data set. Factor 1 best separates batch samples which date in the AD 1500s or earlier (high negative scores) from those that date in the AD 1700s and 1800s (high positive scores on factor 1); it therefore reflects chronological patterns occurring during approximately the last half of the 600-year occupation period under study. Factor 2, on the other hand, most clearly segregates components dated in the AD 1300s (high positive scores) from those dated in the AD 1400s (neutral scores) and 1500s/1600s (high negative scores). It can be noted that the single batch dated to the AD 1200s (Clark's Creek site, batch 81) is not particularly well segregated along either factor score axis, and therefore the earliest end of the regional time scale is not fully accounted for by the factor analysis.

This factor score plot of dated components in Figure 17.1 adequately illustrates that chronological change in the regional ceramic sequence is not a unidimensional phenomenon. Rather, it is much more complex, requiring at least two and possibly three independent axes of variation for adequate representation. Changes in ceramic attributes in regional samples move in one direction represented by factor 2 early in time, until the AD 1500s or so; from that time on, a completely different pattern or direction of change emerges along factor 1 for the period from the 1500s through the 1800s. Mathematically, the two patterns expressed by factors 1 and 2 are orthogonal or independent of each other. This can be interpreted in more than one way. One interpretation is that two distinct ceramic traditions are reflected in the regional data sets; one tradition continues through the 1500s, after which time the second tradition emerges and moves the ceramic composition of the regional components into a completely different tradition in the subsequent three centuries. Another interpretation is that perhaps a single ceramic tradition is involved, but that a significant, new, and irreversible transformation of this tradition was introduced in the 1500s or 1600s. This tranformation led to changes in a completely different direction from those seen up until that time. These two interpretations can be likened to explanations based on migration on the one hand, versus diffusion on the other. In either case, it is evident that a major alteration in pottery manufacturing practices was introduced in the 1500s or 1600s, and that the course of



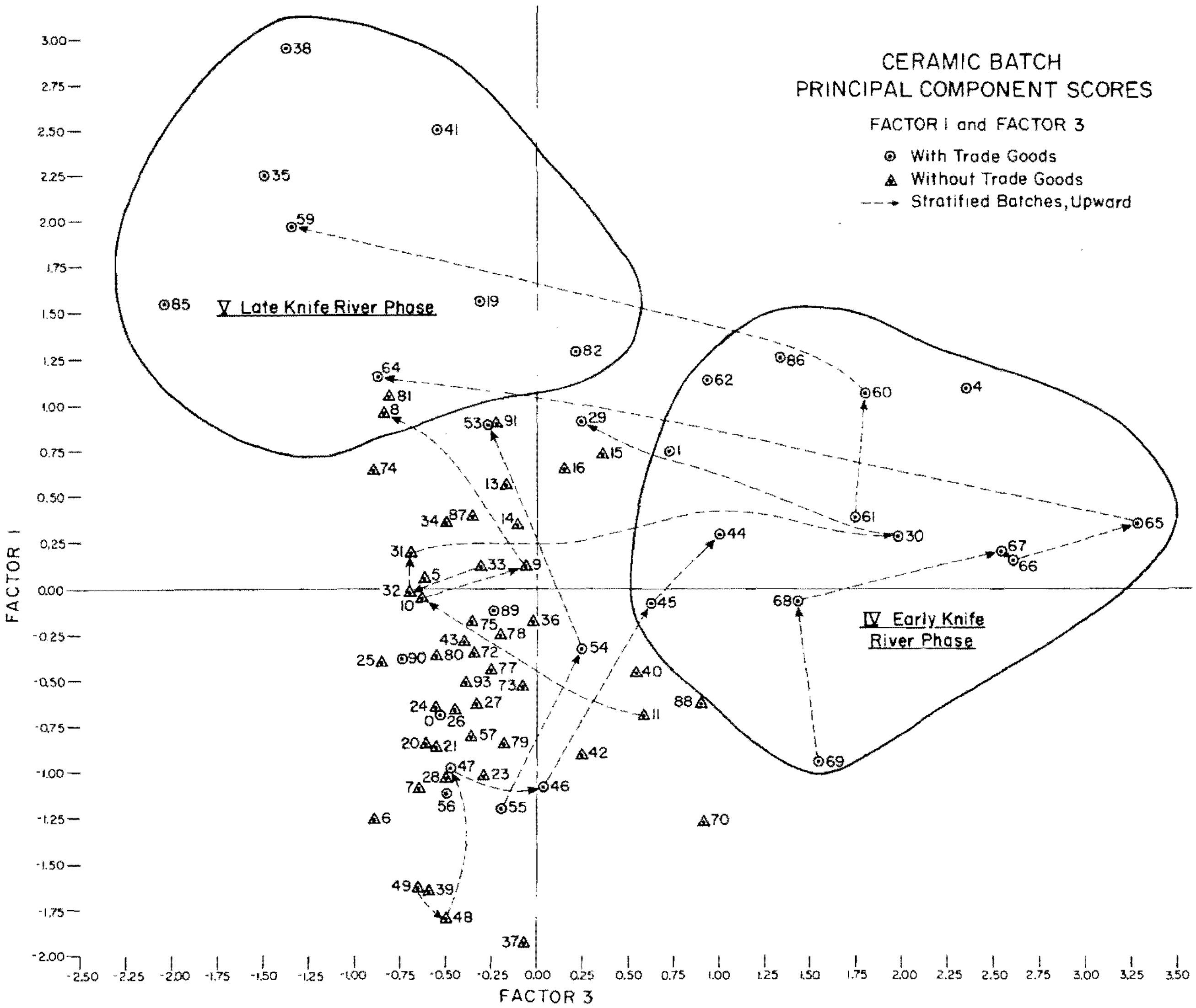
0 Slant E Large	20 Hensler T1	37 Alderin Creek	55 Low Hidatsa 63	74 Elbee
1 Slant L Large	21 Hensler T2	38 Deapolis	56 Low Hidatsa 71	75 Scovill
4 Molander	23 Mand Lake T1P1	39 W Buff Robe L	57 Low Hidatsa 72	77 Forkorner E
5 Pretty Point	24 Mand Lake T3P1	40 W Buff Robe E	59 Sakakawea 1	78 Forkorner W
6 Smith Farm	25 Mand Lake T4P1	41 Amahami Late	60 Sakakawea 2	79 Hump
7 Lower Sanger	26 Mandan Lake P2	42 Amahami Early	61 Sakakawea 3	80 Youess
8 Upper Sanger 1	27 Mandan Lake P3	43 Buchfink	62 Sakakawea In	81 Stiefel
9 Upper Sanger 2	28 Shoreline	44 Low Hidatsa 1	64 Big Hidatsa 1	82 Rock
10 Upper Sanger 3	29 Mahhaha 1	45 Low Hidatsa 2	65 Big Hidatsa 2	85 Fishhook
11 Upper Sanger 4	30 Mahhaha 2	46 Low Hidatsa 3	66 Big Hidatsa 3	86 Nightwalker's
13 Mile Post 28	31 Mahhaha 3	47 Low Hidatsa 4	67 Big Hidatsa 4	87 Mondrian Tree
14 Cross Ranch T1	32 Mahhaha 4	48 Low Hidatsa 5	68 Big Hidatsa 5	88 Hagen
15 Cross Ranch H3	33 Mahhaha 5	49 Low Hidatsa 6	69 Big Hidatsa 6	89 Hintz H3
16 Cross Ranch H7	34 Clark's Creek	53 Low Hidatsa 61	70 Big Hidatsa 7	90 Hintz H4
19 Greenshield	35 Fort Clark	54 Low Hidatsa 62	72 Stanton Ferry	91 Arzberger
	36 Lyman Aldren		73 Poly	93 Sharbono

Figure 17.1. Principal component scores for 78 pottery batches on factor 1 (vertical axis) and factor 2 (horizontal axis). The five groups of batches defined in the cluster analysis of factor scores are identified.



0 Slant E Large
1 Slant L Large
4 Molander
5 Pretty Point
6 Smith Farm
7 Lower Sanger
8 Upper Sanger 1
9 Upper Sanger 2
10 Upper Sanger 3
11 Upper Sanger 4
13 Mile Post 28
14 Cross Ranch T1
15 Cross Ranch H3
16 Cross Ranch H7
19 Greenshield
20 Hensler T1
21 Hensler T2
23 Mand Lake T1P1
24 Mand Lake T3P1
25 Mand Lake T4P1
26 Mandan Lake P2
27 Mandan Lake P3
28 Shoreline
29 Mahhaha 1
30 Mahhaha 2
31 Mahhaha 3
32 Mahhaha 4
33 Mahhaha 5
34 Clark's Creek
35 Fort Clark
36 Lyman Aldren
37 Alderin Creek
38 Deapolis
39 W Buff Robe L
40 W Buff Robe E
41 Amahami Late
42 Amahami Early
43 Buchfink
44 Low Hidatsa 1
45 Low Hidatsa 2
46 Low Hidatsa 3
47 Low Hidatsa 4
48 Low Hidatsa 5
49 Low Hidatsa 6
53 Low Hidatsa 61
54 Low Hidatsa 62
55 Low Hidatsa 63
56 Low Hidatsa 71
57 Low Hidatsa 72
59 Sakakawea 1
60 Sakakawea 2
61 Sakakawea 3
62 Sakakawea In
64 Big Hidatsa 1
65 Big Hidatsa 2
66 Big Hidatsa 3
67 Big Hidatsa 4
68 Big Hidatsa 5
69 Big Hidatsa 6
70 Big Hidatsa 7
72 Stanton Ferry
73 Poly
74 Elbee
75 Scovill
77 Forkorner E
78 Forkorner W
79 Hump
80 Youess
81 Stiefel
82 Rock
85 Fishhook
86 Nightwalker's
87 Mondrian Tree
88 Hagen
89 Hintz H3
90 Hintz H4
91 Arzberger
93 Sharbono

Figure 17.2. Display of chronometric dates for pottery batches included in the principal components analysis, with dates plotted at the factor 1 and factor 2 score locations for the appropriate batches. Dates are corrected, AD.



0 Slant E Large	20 Hensler T1	37 Alderin Creek	55 Low Hidatsa 63	74 Elbee
1 Slant L Large	21 Hensler T2	38 Deapolis	56 Low Hidatsa 71	75 Scovill
4 Molander	23 Mand Lake T1P1	39 W Buff Robe L	57 Low Hidatsa 72	77 Forkorner E
5 Pretty Point	24 Mand Lake T3P1	40 W Buff Robe E	59 Sakakawea 1	78 Forkorner W
6 Smith Farm	25 Mand Lake T4P1	41 Amahami Late	60 Sakakawea 2	79 Hump
7 Lower Sanger	26 Mandan Lake P2	42 Amahami Early	61 Sakakawea 3	80 Youess
8 Upper Sanger 1	27 Mandan Lake P3	43 Buchfink	62 Sakakawea In	81 Stiefel
9 Upper Sanger 2	28 Shoreline	44 Low Hidatsa 1	64 Big Hidatsa 1	82 Rock
10 Upper Sanger 3	29 Mahhaha 1	45 Low Hidatsa 2	65 Big Hidatsa 2	85 Fishhook
11 Upper Sanger 4	30 Mahhaha 2	46 Low Hidatsa 3	66 Big Hidatsa 3	86 Nightwalker's
13 Mile Post 28	31 Mahhaha 3	47 Low Hidatsa 4	67 Big Hidatsa 4	87 Mondrian Tree
14 Cross Ranch T1	32 Mahhaha 4	48 Low Hidatsa 5	68 Big Hidatsa 5	88 Hagen
15 Cross Ranch H3	33 Mahhaha 5	49 Low Hidatsa 6	69 Big Hidatsa 6	89 Hintz H3
16 Cross Ranch H7	34 Clark's Creek	53 Low Hidatsa 61	70 Big Hidatsa 7	90 Hintz H4
19 Greenshield	35 Fort Clark	54 Low Hidatsa 62	72 Stanton Ferry	91 Arzberger
	36 Lyman Aldren		73 Poly	93 Sharbono

Figure 17.3. Principal component scores for 78 pottery batches on factor 1 (vertical axis) and factor 3 (horizontal axis). Groups IV and V defined by cluster analysis of factor scores are identified.

pottery development was significantly altered from that time onward.

The factor loading patterns, previously discussed, provide the best interpretation for the exact nature of these differing and contrastive trends in pottery change in the region. Factor 2 expresses a change from vessels with coarse, widely spaced cord decoration, flattened lips, and checked-stamped surface treatment in the AD 1300s to much more finely decorated vessels with rounded lips and simple-stamped surface treatment in the 1400s and 1500s. After AD 1500 or so, a much more dramatic pattern of change occurs, one having more to do with basic rim form than with decorative finesse, decorative type, or surface treatment. The second trend is for vessels with S-shaped rim form to be increasingly supplanted by vessels with straight and straight braced rim forms, for the vessel bodies to become progressively thicker, and for plain decoration with use of tabs and castellations to increasingly supplant the use of cord-impressed decoration.

Stratigraphic relationships among batches, evident at a few sites, also provide another means for assessing the relationships between the factors and chronological change in the study area. Scores for physically stratified batches from single sites are connected by arrows in Figures 17.1 and 17.3, with the arrows indicating upward movement through the stratigraphy and through time. In Figure 17.1 it is evident that both factors 1 and 2 involve chronological change. This pattern is particualrly evident for factor 2 in the lowermost stratified batches from the Mahhaha site (batches 31-33), the lowermost batches from the Upper Sanger site (batches 10 and 11), and in all batches from the Mandan Lake site (batches 23-27). Upward movement through the stratigraphy is evident as increasingly negative scores on factor 2. Strong stratigraphic correlations also emerge for factor 1, most evident in batches 53-55 and 44-48 for the Lower Hidatsa site, batches 64-69 for Big Hidatsa Village, and batches 59-61 at Sakakawea Village. In all cases, upward movement through the stratigraphy is reflected in increasingly higher positive scores on factor 1.

Stratigraphic data also indicate that factor 3 reflects a significant chronological component, as shown in Figure 17.3. This pattern is most evident in the uppermost two stratified batch samples from the Mahhaha site (batches 29 and 30), from Sakakawea Village (batches 59 and 60), and from Big Hidatsa Village (64 and 65). In each case upward movement in the stratigraphy is reflected by strong shifts from high positive to neutral or high negative scores on factor 3.

A step toward grouping or ordering the batch samples into a culture-historic framework or chronological sequence is made by applying cluster analysis to the scores on the first three factors. Each factor is given equal weight in the clustering process, even though factor 1 accounts for a much larger proportion of the total variation in the variable correlation matrix. In effect, the clustering process tends to group together batches with the most similar scores on all three factors, a process which is somewhat difficult to do graphically when only two scores are readily portrayed in the bivariate plots in Figures 17.1 and 17.3. The cluster analysis was conducted using Veldman's (1967:308-317) program HGROUP. This program uses Ward's (1963) hierarchical clustering method in which cases are selected for combination into clusters based on a minimum increase in total within-group variance. A wide number of alternative clustering methods are in use today in multivariate analysis; program HGROUP and Ward's method were used because they were readily available and familiar to the author.

Two different clusterings of batch factor scores were conducted, only one of which is presented here. The first involved clustering all 78 batch samples which were included in the principal component analysis, the scores for which are listed in Table 17.3. The second analysis, discussed here, involved clustering a more restricted set of 66 batches. This analysis focused specifically on the least mixed batch samples from directly within the upper Knife-Heart region or from the Garrison region, restricting the study to components which are thought to be directly involved in regional Mandan and particularly Hidatsa cultural traditions. Various batches were excluded because it was thought that their inclusion might unnecessarily bias the final form of the cluster output, thereby making it doubly difficult to reach an interpretable chronological and culture-historical sequence for the region. After a regional sequence is developed, then data from the extra-regional or extra-tradition samples can be reexamined for assessment of their place in the scheme of things. Excluded batches are those from Lehmer's excavation at Lower Hidatsa (53-57), Elbee (74), Mondrian Tree (87), Hagen (88), Hintz (89, 90), Arzberger (91), and Sharbono (93). The Lehmer materials were excluded because a much better dated and stratified series exists in other batches from the site (44-49). Elbee was excluded because the ceramics from the site have been shown to be basically dissimilar to any other regional samples (Ahler 1984a). The remaining six batches were excluded due to the extraregional location of the sites involved.

Output from the cluster analysis of the selected 66 batches using data on the first three factor scores is shown both as a hierarchical tree diagram in Figure 17.4 and graphically on the factor score plots in Figures 17.1 and 17.3. The tree diagram in Figure 17.4 shows the clustering results from the nine-group level down to the one-group level. The large increase in total within-group variance that occurs in the move from five groups to four groups, and which continues in subsequent groupings, indicates that the five-group level is probably a particularly meaningful subdivision of the sample. As labeled in Figures 17.1, 17.3, and 17.4, these five groups correspond closely with recognized culture-historic units in the region; they are named accordingly and are numbered from I through V, from earliest to latest. In each group there exist anomalous inclusions which contradict known chronometric, historic, or stratigraphic information. Some of these inconsistencies prohibit direct use of the cluster analysis results for a final chronological ordering of batch components. The composition of each group will be discussed in turn, and anomalous batch inclusions will be identified where possible.

Group I has been labeled the Nailati phase group because it contains virtually all previously identified Nailati phase components in the region. Group I is clearly identified by high positive principal component scores on factor 2 (Figure 17.1). This group includes Nailati phase type site samples from Cross Ranch and Milepost 28 (batches 13-16) (Calabrese 1972) and previously studied materials from the early component at White Buffalo Robe (batch 40) (Lee, ed. 1980), all of which are radiocarbon dated in the AD 1300s. Most of the remaining components assigned to this group are undated, but there is little reason to question their group assignment on stratigraphic or other grounds. Included are the stratigraphically earliest materials from deep deposits at Upper Sanger (batch 11) and Mahhaha (batch 33). Potentially anomalous assignments include the Big Hidatsa period 7 (batch 70) and Poly site (batch 73) components, both of which are chronometrically dated somewhat later than the period presently recognized for the Nailati phase in the region. The taxonomic placement of the Poly site materials has always been somewhat uncertain (Nailati phase versus Scattered Village complex) (Ahler and Mehrer 1984:161, 315-316), and the Big Hidatsa period 7 batch may cluster incorrectly due to the extremely small sample size for that batch (n = 7 vessels).

Group II contains 18 batch components. Inspection of Figure 17.1 indicates that this group is characterized by moderately high positive scores on factor 2 and a broader scatter of scores on factor 1 centered on zero but ranging in both positive and negative directions. All of the included batches from within the KNRI (Forkorner east and west, Hump, and Youess sites) have been previously studied and have been identified as type sites for the Scattered Village complex (Ahler and Mehrer 1984:316). In addition, this group includes one previously studied component from the Clark's Creek site which has been named as the type site for the Clark's Creek phase (Wood 1986c). On this basis, this group is named the Scattered Village Complex/Clark's Creek phase group. Familiarity with the ceramic data content for the remaining batches in this group indicates that the majority of them can probably be associated with the Scattered Village complex. Batches which seem anomalous in this pattern, in addition to Clark's Creek (34), include Stiefel (81) which is highly similar to the Clark's Creek sample in ceramic content, and the uppermost stratified batch from the Mahhaha site (29). The latter batch sample is almost certainly included here by error, given that it contains predominantly Knife River phase materials in association with Euroamerican trade artifacts. The chronometric dates available for group II batches indicate that most of the samples included here date in the AD 1400s (compare Figures 17.1 and 17.2).

Group III contains a total of 13 batch samples. Several of these including Slant Village early (0), White Buffalo Robe late (39), and Lower Hidatsa periods 5 and 6 (48, 49) have been formally studied previously and categorized as Heart River phase in culture-historic placement (cf. Breakey and Ahler 1985; Lee, ed. 1980; Ahler and Weston 1981, respectively). On this basis, group III is designated as the Heart River phase group. Inspection of Figure 17.1 indicates that this group is characterized by batches with slightly to highly negative scores on factor 1 and scores in a similarly high negative range on factor 2. Comparison of Figures 17.1 and 17.2 indicates that this group contains primarily batches which have been chronometrically dated in the AD 1500s and 1600s. Two possible anomalies occur in this grouping. One involves

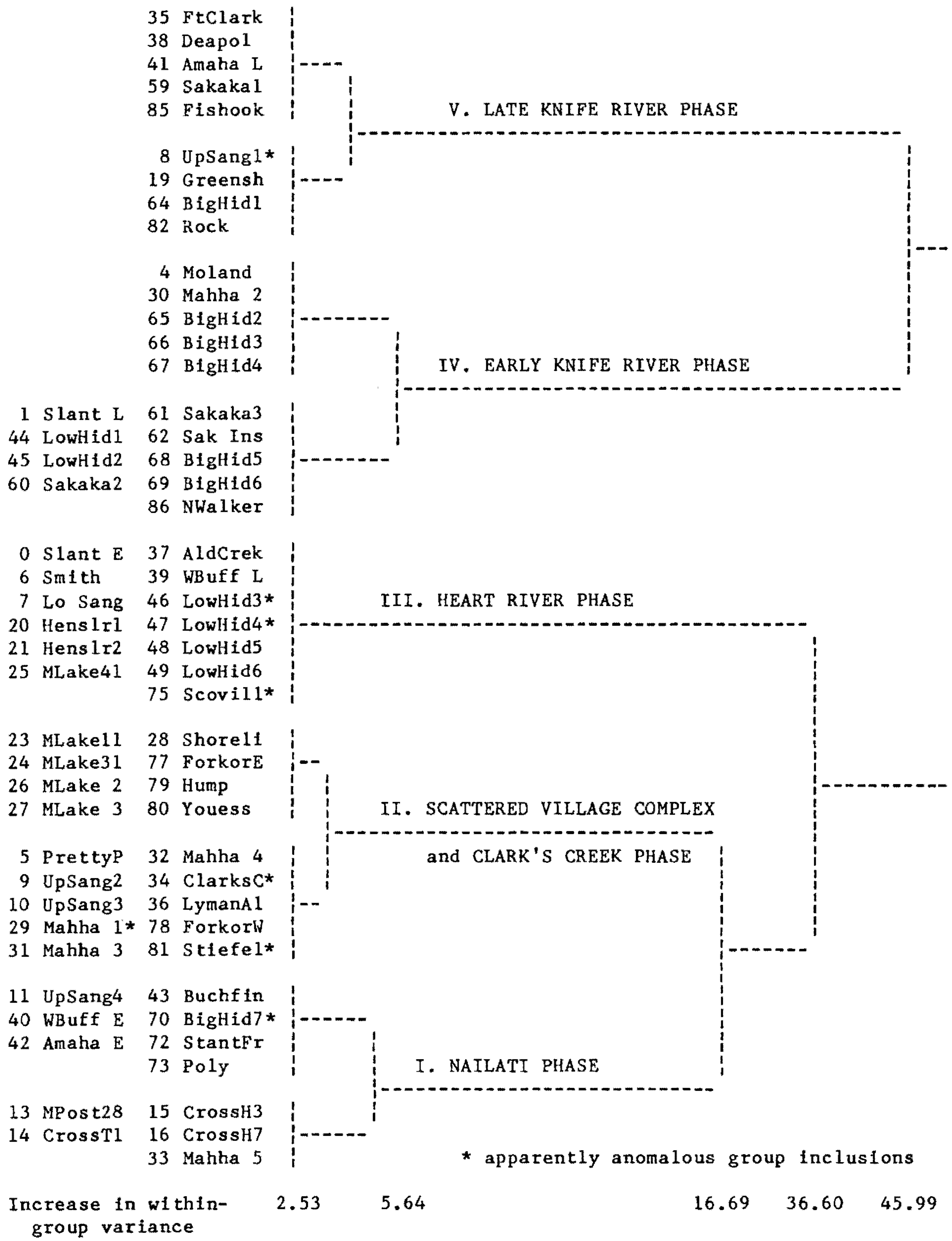


Figure 17.4. Hierarchical tree diagram for 66 regional batches on factor scores.

the inclusion of Lower Hidatsa period 3 and 4 samples (batches 46 and 47) which, being equivalent to time period 2 samples at the site as designated in the 1981 report (Ahler and Weston 1981), have previously been associated with a modified form of Heart River phase culture thought to reflect transition between that phase and the subsequent Knife River phase. Thus, the analytical and clustering procedure used here may not be sufficiently detailed to extract such subtleties from the ceramic data base. Lastly, the Scovill site batch (75) has previously been designated as primarily Scattered Village complex in association, while recognizing that the sample from there probably contains a mixed deposit from multiple cultural periods (Ahler and Mehrer 1984:316).

Group IV contains a total of 14 batch samples (Figures 17.1, 17.3, and 17.4). Many of the batch samples included here have been formally studied (virtually all except the Molander and Mahhaha period 2 samples), and all of these have been previously classified as representative of the Knife River phase. By comparing Figures 17.1 and 17.2 it can be seen that the dates associated with this group range from the 1600s through the early 1800s. Because the majority of the samples predate AD 1800, and because of the distinct contrast between this group and the decidedly later Group V, this group is named the Early Knife River phase group. Inspection of Figure 17.3 indicates that this group is clearly distinguished by high positive scores on factor 3; of lesser significance are slightly to moderately negative scores on factor 2 (Figure 17.1). Although a relatively long time sequence is apparently represented in the batch samples included here (including those from the AD 1600s at Big Hidatsa to those in the AD 1800s at Sakakawea), there are no distinctly anomalous inclusions in this group. All samples have in common a clear characterization as belonging to the Knife River phase.

Group V contains a total of nine batch samples (Figures 17.1, 17.3, and 17.4). These batches are characterized by highest positive loadings on factor 1 in combination with neutral to negative loadings on factors 2 and 3. Most of the samples included here are from historically documented sites of known ethnic group origin. With a couple of exceptions, all batches are documented to date in the period after AD 1780, and predominantly after the early 1800s. Clearly this is the chronologically latest group in the sequence, and accordingly it is named the Late Knife River phase group. One anomaly occurs. This is the inclusion here of the uppermost stratified sample from the Upper Sanger site (batch 8). A coding error was the suspected cause for inclusion of this sample in this group, but repeated inspections of the raw and batch summary ceramic data have yielded no evidence of errors. Intuitive assessment of the ceramic sample from that batch suggests that it is little different from the next two stratigraphically lower batches from Upper Sanger, both comfortably included in the Scattered Village complex group (II); batch 8 should also fall there.

In summary, the principal components analysis and subsequent cluster analysis of factor scores have yielded results which are generally compatible with present understanding of the chronology and cultural taxonomy in the Knife-Heart region. Five major groups of batches have been recognized. New information developed in this analysis is the clear separation of Knife River phase components into two distinct early and late groups, reflected primarily in different scores on the third principal component factor. It appears that a strong developmental trend has been isolated for the Knife River phase along factor 1, and that factor 3 further separates this developmental sequence into two distinct parts. While the results achieved here are generally satisfactory and allow placement of many previously undated components according to general culture-historical groupings, there are several shortcomings in the analysis. One is that components belonging to the Clark's Creek phase, dated by radiocarbon as the earliest in the region, are not clearly separated from considerably later Scattered Village complex components. A second difficulty lies in the two or more centuries of time apparently represented in the batches making up group IV. A more discrete chronological breakdown of batches spanning this critical period from AD 1600 to AD 1800 is clearly desired, given the overall goals of the KNRI program. Third, a number of batch samples appear simply to be misclassified and misgrouped, based on all considerations of chronology, stratigraphy, and general knowledge of batch ceramic content. Included among these are the period 7 sample from Big Hidatsa Village (70), the uppermost stratified sample from Mahhaha (29), the Scovill sample (75), possibly the intermediate level samples from Lower Hidatsa (46 and 47), and the uppermost sample from Upper Sanger (8).

Taken together, these considerations and limitations indicate that the chronological arrangement expressed in the factor scores and their groupings in Figures

17.1, 17.3, and 17.4 can be improved upon in several details. The following subsection presents details of further cluster analysis aimed at a more refined understanding of chronology and cultural taxonomy in the regional samples, while the subsequent section discusses the final most detailed working chronology for the regional samples based on all considerations of chronometrics, historic documentation, and ceramic data combined.

Additional Batch Cluster Analyses

The principal components analysis clearly indicates that ceramic variability in the regional pottery samples relates to chronology in a very complex manner. Figures 17.1 and 17.2 in particular indicate that extraction of a single factor or underlying dimension representing chronological change probably is not possible when all regional batch samples are considered together. As noted previously, these figures also illustrate that each of the first two principal components does express chronological variation for a certain, restricted part of the regional sequence, each in different and apparently independent ways. One explanation for this could be that two basically different pottery traditions affecting ceramic change and sequences are represented in the full array of batch samples. One tradition, represented by factor 2, seems to account for variation encompassing Nailati phase, Scattered Village complex, and Heart River phase batch components (progressing chronologically from positive to negative along factor 2 in Figure 17.1). On the other hand, a second tradition, reflected by factor 1, captures chronological changes commencing with Heart River phase batches and progressing through late historic period Knife River phase samples (expressed as scores moving from negative to positive on factor 1 in Figure 17.1).

If in fact two distinct traditions or independent complexes of forces motivating ceramic change are in operation in the region, it is likely that attempts to seriate all samples simultaneously along a single dimension representing chronology will be unsuccessful. A more useful approach would seem to be to partition the full regional sample into two parts for purposes of chronological analysis, these being those batches showing influence from the two independent ceramic traditions, respectively. The factor patterns shown in Figure 17.1 and the results of the cluster analysis shown in Figure 17.4 for 66 regional batch samples fairly clearly identify which batch samples should be considered in each independent, partitioned analysis. Early tradition samples should definitely include demonstrable and potential Clark's Creek phase, Nailati phase, and Scattered Village complex batches (groups I and II). Late tradition samples should definitely include demonstrable and potential early and late Knife River phase samples (groups IV and V). Heart River phase samples (group III), lying potentially at the end point of one tradition and at the beginning point of the second, should be included in the analysis of both the early and late period batch groupings. The batch samples were partitioned in approximately this fashion, with exceptions having to do with anomalies in the cluster analysis shown in Figure 17.4, for purposes of further analysis.

Chronometric dates and historically determined dates of occupation clearly provide some basis for chronological ordering of the regional batch samples, if not the basis for a taxonomic framework. A limitation here which must be overcome, however, is the fact that about 38 percent of the regional samples have not been dated chronometrically or by historic documentation. In addition, some of the chronometric dates may themselves be unreliable, and the chronological data alone will not necessarily provide the basis for a regional cultural taxonomy which may involve multiple overlapping cultural traditions in the region. We need to make maximum use of the available data on chronology, which is significant, while at the same time using all available ceramic data to develop a picture of regional culture-history and to place the presently undated components accurately within that framework.

Cluster analysis or any other multivariate procedure can produce a spurious or uninterpretable chronological ordering if a significant number of variables having little to do with chronology are included in the analysis. This statement echoes Marquardt's (1979:309) recommended first step in the chronological seriation process, that of isolating variables which are known to be sensitive to trends in chronology. That goal was achieved in this second phase of the analysis by computing the Pearson product moment correlation coefficient and its associated probability between each potential ceramic data variable and the variable "chronometric/historic date" for the respective early and late series of batch samples. This computation was possible for only a series of 41 of the 66 regional batches which had been dated by radiocarbon, thermoluminescence, or historic documentation. The dated batches and the specific dates used in the correlation analysis are listed in Table 17.4. Historic dates are suggested only for batch components representing occupations after about AD 1790, the time when good historic documentation begins for the region. For historic dates, a date range is estimated and the midpoint of this date range is entered in the analysis. If both historic and chronometric dates exist for a batch, historically documented dates were given first priority. Radiocarbon dates constitute the second priority dates used in the analysis. In nearly all cases, both a correction curve cross-point date as well as a two sigma range midpoint date are available for each radiocarbon date or averaged group of dates for a batch sample (see Table 8.9). Somewhat arbitrarily, the radiocarbon corrected range midpoint date is used in this analysis. Finally, the TL date midpoint is used where available and if neither historic dates nor radiocarbon dates occur (Tables 8.3 and 8.9).

Twenty-three batch components having associated calendar dates are included in the early group correlation analysis, while a total of 27 batch components with calendar dates are included in the late group analysis (Table 17.4). Results of the respective correlation analyses are presented in Table 17.5 for the group of early batches and in Table 17.6 for the group of late batches. In each table all ceramic variables having a statistically significant ($p = \leq .05$) correlation with the chronometric/historic date variable are listed. In each case a distinction is made between variables which are only moderately correlated with chronology ($.010 > p < .05$) and those variables which are highly correlated with chronology ($p \leq .010$). The data in these tables are quite significant, effectively isolating the variables which are of greatest interest for studying chronological change in the dated early and late batch groups in the region.

Inspection indicates some strong contrasts between the chronologically significant variables in the early and late sample groups. It is apparent that there are many more chronologically significant variables in the late period than in the early period; rougly twice as many variables have highly significant correlation coefficents in the late period analysis. Further, it is clear, as anticipated from previous factor analysis, that distinctly different suites of variables are of chronological importance in each general time period. Altogether, six variables are highly significant in the early period samples only, while 22 variables are highly significant in the late period samples only.

Table 17.4. List of chronometrically or historically dated analytic batches in the Knife-Heart region, their designation as early or late, and dates entered into the correlation analysis with other variables.

Batch		AD Date Used In Correlation	Date Basis	Period
34	Clark's Creek	1289	M	early
40	White Buffalo Robe, early	1333	M	early
11	Upper Sanger, time period 4	1346	M	early
16	Cross Ranch, house 7	1355	M	early
80	Youess	1387	M	early
78	Forkorner, west	1390	M	early
77	Forkorner, east and central	1392	M	early
5	Pretty Point	1404	M	early
70	Big Hidatsa, time period 7	1417	M	early
79	Hump	1451	M	early
15	Cross Ranch, house 3	1457	M	early
73	Poly	1481	M	early
20	Hensler, test 1	1481	M	early, late
27	Mandan Lake, time period 3	1521	M	early
32	Mahhaha, time period 4	1523	M	early
25	Mandan Lake, test 4, time period 1	1525	M	early, late
49	Lower Hidatsa, time period 6	1528	M	early, late
21	Hensler, test 2	1535	M	early, late
7	Lower Sanger	1538	M	early, late
39	White Buffalo Robe, late	1545	M	early, late
23	Mandan Lake, test 1, time period 1	1549	M	early, late

Table 17.4. Concluded.

Batch		AD Date Used In Correlation	Date Basis	Period
48	Lower Hidatsa, time period 5	1555	M	early, late
37	Alderin Creek	1557	M	early, late
67	Big Hidatsa, time period 4	1645	TL	late
68	Big Hidatsa, time period 5	1649	M	late
47	Lower Hidatsa, time period 4	1687	TL	late
66	Big Hidatsa, time period 3	1720	TL	late
45	Lower Hidatsa, time period 2	1729	TL	late
30	Mahhaha, time period 2	1732	M	late
46	Lower Hidatsa, time period 3	1739	TL	late
61	Sakakawea, time period 3	1795	H	late
19	Greenshield	1798	H	late
65	Big Hidatsa, time period 2	1810	H	late
60	Sakakawea, time period 2	1810	H	late
62	Sakakawea, inside later houses	1820	H	late
41	Amahami, late	1822	H	late
38	Deapolis	1826	H	late
59	Sakakawea, time period 1	1832	H	late
35	Fort Clark	1836	H	late
64	Big Hidatsa, time period 1	1837	H	late
85	Like-a-Fishhook	1865	H	late

Note: M = C-14 date range midpoint; TL = thermoluminescence date; H = historic documentation, midpoint of range

Table 17.5. Pearson product moment correlation coefficients between the variable chronometric/historic date and other ceramic variables, computed for 23 dated early batches in the Knife-Heart region.

Correlations with p = < .010			Correlations with p = > .010, < .050		
Variable	Correlation	p	Variable	Correlation	p
*INLIP	.650	.001	*FLTLIP	-.448	.032
*CORDIMPR	.746	.000	*PLAIN	-.467	.025
*Z3CURVED	.798	.000	*TOOLIMP	-.452	.030
*CDSPACE	-.669	.000	*PINCHED	-.484	.019
*CDDIAM	-.593	.003	Z5WIDTH	.571	.013
*Z2THICK	-.666	.001	STCORD	.433	.039
*Z3THICK	-.692	.000	Z5WEDGE	-.485	.042
*BODYTH	-.811	.000	*Z3PATCR	.427	.042
*Z3PATD	.618	.002	Z5PATH	-.483	.043
*WARE2	-.525	.010	*WARE3	-.482	.020
*WARE5	.762	.000	WARE4	-.446	.033
STRAIGHT	-.541	.008	RECURVED	.477	.021
SSHAPED	.569	.005			
BRACED	.546	.007			

Notes: Variables dealing with zone 5 involve a sample of n = 18; n = 23 for all other variables. See Table 17.2 for variable identifications.
* Indicates variables used in the early period cluster analysis.

Table 17.6. Pearson product moment correlation coefficients between the variable chronometric/historic date and other ceramic variables, computed for 27 dated late batches in the Knife-Heart region.

Correlations with p = < .010			Correlations with p = > .010, < .050		
Variable	Correlation	p	Variable	Correlation	p
*RDLIP	.650	.000	LTLIP	-.405	.036
*INLIP	-.713	.000	DENTATE	.378	.052
*PLAIN	.696	.000	STWIST	.482	.011
*CORDIMPR	-.713	.000	Z3THICK	.431	.025
*Z2BRUSHED	-.553	.003	STPLAIN	.393	.043
*Z2COB	-.512	.006	STCORD	-.386	.047
*Z3PLAIN	.618	.001	Z5EXT	.443	.021
*Z7PLAIN	.545	.003	Z5PATH	.407	.035
*INTPLAIN	.542	.003	NODE	-.477	.012
*Z2THICK	.655	.000	SPOUT	.382	.049
*Z5THICK	.664	.000	WARE1	-.404	.037
*Z5WIDTH	.763	.000	WARE3	-.402	.038
*BODYTH	.839	.000	CHKRATIO	-.477	.012
*STCHECK	-.493	.009			
*STDEC	-.764	.000			
*Z5INT	-.616	.001			
*Z5COLLAR	.524	.005			
Z3PATAR	-.758	.000			
Z3PATCR	-.710	.000			
*Z5PATNO	-.575	.002			
*TAB	.498	.008			
*CASTEL	.548	.003			
*WARE0	-.566	.002			
*WARE5	-.836	.000			
*WARE6	.917	.000			
*WARE7	.490	.010			
STRAIGHT	.871	.000			
SSHAPED	-.897	.000			
BRACED	.873	.000			
LOGCHECK	-.490	.009			

Note: See Table 17.2 for variable identifications.
* Indicates variables used in the late period cluster analysis.

Eight of the 14 highly significant variables in the early group analysis are also highly significant in the late group analysis: inslant lip form, cord-impressed type, mean zone 2 thickness, mean body sherd thickness, Le Beau ware, and straight, S-shaped, and braced rim form. In all cases, the direction of correlation between these variables and chronology is reversed between the two group analyses, indicating that all trends evident in the early period for these variables are reversed in the late period. While this might be expected for "stylistic" variables, such as Le Beau ware percentages and rim form percentages which can be expected to exibit a boat-shaped relative frequency curve (gradually increasing, then decreasing in popularity), it is an unexpected pattern for the variables measuring vessel wall thickness.

Interestingly, check-stamped surface treatment, which exhibits widely varying frequencies in the early period samples, is not significant in that period. Perhaps during the course of that period check-stamping gradually increased and then decreased in frequency through time, yielding an overall low correlation with chronology across the full time span. This example illustrates a limitation in the use of linear correlation to explore chronological variations which may not behave in a monotonic fashion, suggesting that the correlation analysis may isolate most but not necessarily all of the ceramic variables exhibiting chronological change in the regional samples.

The next step in the analysis was to conduct a hierarchical cluster analysis of the respective early and late group batches using variables isolated in Tables 17.5 and 17.6 which are demonstrably time-sensitive in each of the periods. The first cluster analysis involved a total of 42 early batch components. These include all batches placed in groups I, II, and III in the overall cluster analysis (Figure 17.4) excepting batches 46 and 47 from Lower Hidatsa and 29 from Mahhaha which each have associated trade artifacts and presumably date after circa AD 1600, after the end of the Heart River phase. Other batches included in the early group include batch 8 from Upper Sanger, considered to have been misclassified as part of group V in Figure 17.4, and batch 69, Big Hidatsa period 6, which is thought to date immediately post-AD 1600 and which contains small amounts of trade artifacts. The latter batch exhibits distinct affinities with the Heart River phase, but it is also relatively unlike nearly all other samples; it was included to see if it would stand apart from the other early period samples. Variables included in this analysis include all those listed in Table 17.5 as highly significant from INLIP through WARE5, and the moderately significant variables FLTLIP, PLAIN, TOOLIMP, PINCHED, Z3PATCR, and WARE3. An additional variable, the percentage of check-stamped surface treatment, computed over the sum of check- and simple-stamped sherds alone, was included because of the assumed significance of check-stamping in recognition of certain early culture-historic units in the region. Variables listed in Table 17.5 but excluded from the analysis include all the rim form class variables which could not be internally computed within the HGROUP cluster program, the zone 5 variables which have missing data for several early batches, and the cord-impressed surface treatment and the Anderson ware variables which generally have values near zero throughout the full series of early batches. Data on the 18 variables were standardized or converted to Z-scores to give each variable equal weighting in the cluster analysis which was conducted with Veldman's (1967) program HGROUP.

Results of the early period cluster analysis are displayed in Figure 17.5. A relatively large difference in the increase in within-group variance shown for the six- group and the five-group arrangements indicates that the six-group level is a meaningful structure for the particular set of batches being clustered. These are numbered as groups 1E through 6E in Figure 17.5, from earliest to latest. Clustering results, while not fully explainable, are highly consistent with intuitive assessments of the ceramic content in the various batches and the known chronometric dates for many of the components. Group 1E, for example, clearly isolates the Clark's Creek site type component for the Clark's Creek phase and groups it with the Stiefel sample, a procedure fully compatible with the authors' intuitive assessment of these two samples. Groups 2E and 3E each contain one or more components or batch samples which have been formally studied and previously classified as representative of the Nailati phase (White Buffalo Robe early - Lee, ed. 1980; the Cross Ranch and Mile Post 28 samples - Calabrese 1972). For this reason, both groups 2E and 3E are identified as Nailati phase. There is a slight suggestion in the chronometrtic data that the group 2E samples may date slightly earlier than the group 3E samples (dates for Upper Sanger period 4 and White Buffalo Robe early are slightly earlier than dates for Cross Ranch samples; see Table 8.3). The basis for the separation of groups 2E and 3E, in terms of the ceramic data (Table 17.2), seems to be very subtle.

Group 4E is a large composite of 13 batch samples which is collectively labeled here the Scattered Village complex group. Many of the group 4E batches from within the KNRI have been formally studied and classified in that taxon, and nearly all the previously unclassified component samples can be intuitively classified here as well. Chronometric dates indicate that these samples as a whole date later than the Nailati phase groups 2E and 3E. The only quibble with group 4E composition has to do with period 3 at Mahhaha (batch 31). Several characteristics of this sample suggest that it may reflect a mixture of several components; the relatively high frequency of Le Beau ware in that batch (Table 17.2) is uncharacteristic of Scattered Village complex components in general, and suggests that it may fall later in time than most batches in this group.

The group 5E sample contains all five Mandan Lake batches, the nearby Shoreline site batch, and the potentially anomalous single sample from Big Hidatsa Village. The Mandan Lake and Shoreline samples seem to lie midway between the group 4E Scattered Village complex batches and the group 6E Heart River phase samples, in terms of ceramic composition (Table 17.2). This suggests an intermediate temporal placement for group 5E; such is suggested by the term "Late" Scattered Village complex used for this group. The inclusion here of the Big

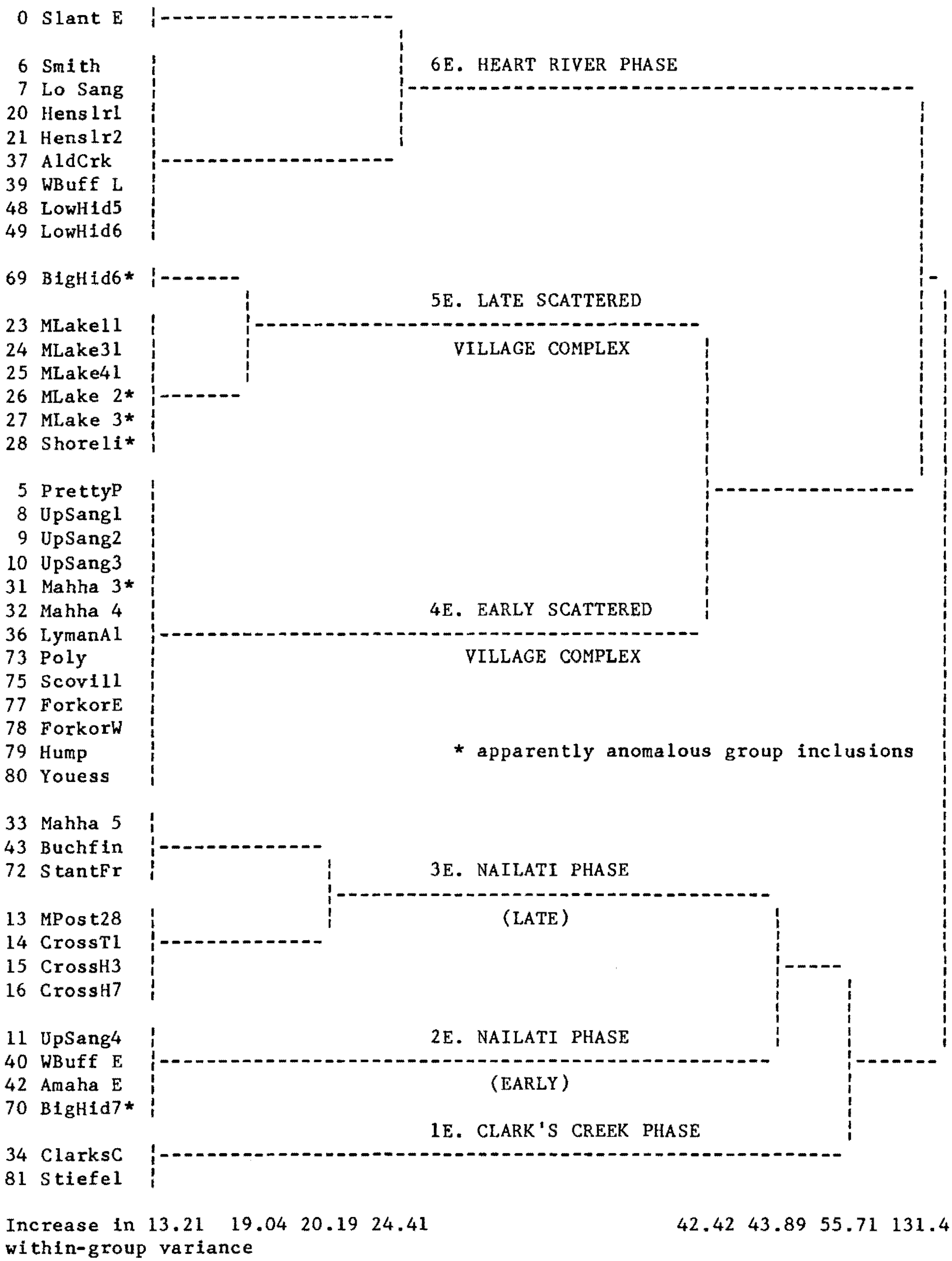


Figure 17.5. Hierarchical tree diagram for 42 early batches on selected raw data.

Hidatsa sample is anomalous and probably erroneous. Based on stratigraphy, relatively high frequencies of check-stamping, and Fort Yates ware, the early Mandan Lake and Shoreline samples (batches 26-28) might more correctly be classified as "Early" Scattered Village complex, as well.

Finally, group 6E contains nine samples readily identifiable as representative of the Heart River phase; this includes materials from On-a-Slant, White Buffalo Robe, and Lower Hidatsa Village which have previously been studied and so classified. The relatively distinctive nature of the early Slant Village sample (batch 0) is indicated by its isolation and relatively late inclusion in this group.

The final working chronological arrangement of the early batch samples studied here will be discussed in the following section, in conjunction with available chronometric data. It suffices at this point to note that the clustering results appear free of major anomalies and seem to reflect the authors' current intuitive assessment of the early chronology and cultural taxonomy for the region.

Cluster analysis of the late period, Heart River phase through Knife River phase batches involved a total of 43 batch samples. These include all of the batches identified in Figure 17.4 as belonging to groups III, IV, and V, excepting the Upper Sanger period 1 batch (8) and the Scovill batch (75) which have previously been identified as misclassified. Also included are the stratigraphically upper three batches (23-25) from Mandan Lake, possibly chronologically not far removed from Heart River phase, the Mahhaha period 3 batch (31) (included for the same reason), and the Mahhaha period 1 batch (29) which was misclassified in group II in Figure 17.4. Also included were the five batch samples from Lehmer's two test pits at Lower Hidatsa Village (53-57) which had been excluded from the general cluster analyses. These are thought to range from Heart River phase to later in age, but also to contain mixed deposits. These 43 batches were clustered using the HGROUP hierarchical clustering program (Veldman 1967:308-317). Variables used in the analysis include all of the highly significant variables listed in the left-hand column in Table 17.6 except for the two zone 3 decorative pattern variables, the three rim form class variables, and the logcheck variable. The latter four were excluded because they could not easily be internally computed in the HGROUP program. Z3PATAR and Z3PATCR were excluded because decorative pattern data in zone 3 were missing for several of the latest batch components. Data on the 24 variables were standardized or converted to Z-scores to give each variable equal weighting in the cluster analysis.

Results of the hierarchical clustering of the 43 late period batches are presented in Figure 17.6. A relatively large difference in the increase in within-group variance between the nine- and the eight-group level indicates that the nine-group level deserves examination. These groups are numbered from 1L through 9L from earliest to latest and are given working names reflecting their general content based on cultural taxonomy and ethnohistorical data. The data on increase in within-group variance indicate that the five-group level (labeled A through E) may also warrant discussion. Interpretation of the five-group arrangement is relatively straightforward, yielding in effect a relatively clear temporal sequence moving from Late Scattered Village complex (A) through Heart River phase (B), Heart River/Knife River phase transition (C), Early Knife River phase (D), and Late Knife River phase (E). In contrast, the nine-group arrangement provides a framework which is quite complex, not indicative of chronology alone, but which probably reflects meaningful cultural taxonomic subdivisions in the region.

In the nine-group arrangement, group 1L clearly represents a small but highly distinctive set of batches which are quite different from most of the others studied in this partition of the batch samples. Based primarily on the results of the early batch cluster analysis shown in Figure 17.5, these batches from period 3 at Mahhaha and from the upper levels in the Mandan Lake site are recognized as Late Scattered Village complex in association. The distinction between these batches and the temporally subsequent Heart River phase groups is quite evident in Figure 17.5.

Groups 2L and 3L are both labelled Heart River phase. One distinction between these two groups is their respective geographic placement on the Missouri River, and on that basis group 2L is labelled as the downriver branch of the Heart River phase, while group 3L is labeled as the upriver branch of the same. The only anomaly in this arrangement, the inclusion of Big Hidatsa period 6 (batch 69) in the downriver group, may reflect the close association between the Hidatsa-proper subgroup and the Mandans immediately prior to the establishment of Big Hidatsa Village, as documented in Hidatsa oral traditions (cf. Wood 1986b). The group 2L/3L separation leads one to

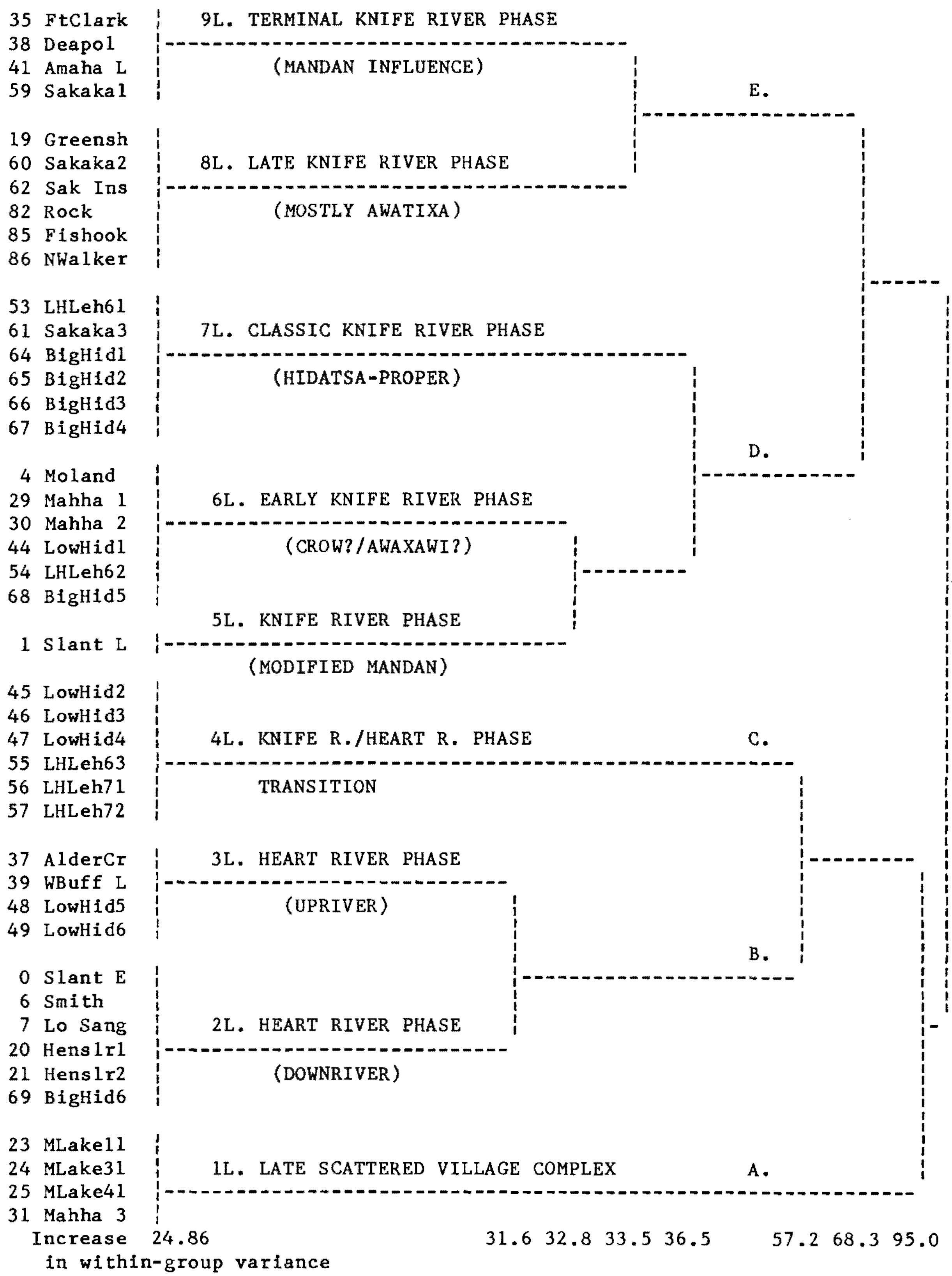


Figure 17.6. Hierarchical tree diagram for 43 late batches on selected raw data.

anticipate that significant distinctions might be drawn between Heart River phase sites linked by traditions to respective Mandan and Hidatsa tribal groups.

Group 4L contains six batches, all from Lower Hidatsa Village. It is labelled as a group representing transition from the earlier Heart River phase to the subsequent Knife River phase at the site. This is based primarily on the inclusion here of batches 46 and 47 which were originally designated as being from the intermediate time period 2 in the original Lower Hidatsa site report (Ahler and Weston 1981:188) and which were interpreted as reflecting transition in ceramic manufacture from a dominant interest in Le Beau ware to an equally dominant interest in Knife River ware. The present understanding is that the batch samples included here date primarily in the AD 1600s with some possible inclusion of slightly earlier and later materials.

Group 5L is the first of several subsequent groups which are all classified as representing some form or part of the Knife River phase. This particular group consists of a single batch, the late component at On-a-Slant Village. Present understanding is that this sample probably dates in the later half of the AD 1700s; it is thought to reflect a basic Mandan ceramic tradition strongly modified by the forces presently recognized as characteristic of the Knife River phase. Whether this means influence from the Hidatsas or simply ceramic degradation due to depopulation is not clear at this time. What is clear is that this sample is quite distinct from several upriver batches more firmly associated with occupation by various subgroups of Hidatsas; its separation as a single group may again provide support for the concept of clear separation of Mandan and Hidatsa archeological traditions in the AD 1700s.

Group 6L is characterized as Early Knife River phase, indicating both that batches included here are thought to date from late in the 1600s through the 1700s, and also that the Knife River phase designation for all batches found here is fairly unequivocal. A specific ethnic or Hidatsa subgroup identification may also be involved in the make-up of this group. This is suggested because the group contains both the Molander sample (batch 4) and the two latest batch samples from Mahhaha village (29, 30). Wood (Chapter 12, this volume) argues that according to oral traditions and ethnohistoric information, both of these sites represent occupations by the Awaxawis prior to their settling at Amahami Village in historic times. The inclusion here of the Lower Hidatsa and early Big Hidatsa samples is not entirely compatible with this interpretation for this group. Regardless, this group seems to reflect a protohistoric period subpart of the Hidatsa phase readily distinguished from another branch of the phase dating in the same period and identified as group 7L.

Group 7L contains seven batch samples, five of which reflect the latter two thirds or so of the occupation sequence at Big Hidatsa Village extending from roughly AD 1700 through 1845. Also included is one of the late batches from Lehmer's excavations at Lower Hidatsa Village, which probably dates in the 1700s, and the earliest batch component from Sakakawea Village (late 1700s, possibly mixed Awaxawi/Mandan in origin). Thus this group is dominated by batches in the apparently continuous sequence at Big Hidatsa Village attributable to the Hidatsa-proper subgroup of the Hidatsas. These peoples, historically the most numerous of the Hidatsa subgroups, can be characterized as some of the least influenced by resident Mandans in the valley and potentially the most exemplary of a distinct cultural traditon reflective of late Hidatsa migrations from the east.

Group 8L contains six batch samples, four of which are documented historically as dating after circa AD 1780 (batches from Greenshield, Sakakawea, and Like-a-Fishhook). All batches included here are readily classifiable as Knife River phase in the sense of the original phase definition (Lehmer 1971:205-206) and more recent reevaluation of the phase (Lehmer et al. 1978). Chronologically, this group exhibits more heterogeneity than we might desire, including Nightwalker's Butte which was probably occupied in the mid to late 1700s, Greenshield occupied in the 1790s, Sakakawea batches representing occupation in the early 1800s, and the Like-a-Fishhook sample which is post-1845 in age. An element more central to this group than chronology, however, might be the presence of substantial representation by the Awatixa subgroup of the Hidatsas. This is clearly evident in the Sakakawea samples, probably in the Rock Village sample, possible at Nightwalker's Butte, and definitely present to some degree at Fishhook. Greenshield is the only sample not fitting this pattern, it being attributable to a subgroup of Arikaras and possibly to Mandan occupation as well.

The final group, 9L ,contains four batch samples. All of these are historically documented occupations postdating circa AD 1800, in each case reflecting the terminal occupation for four of the five subgroups of Mandans (at Deapolis and Fort Clark) and Hidatsas (at Sakakawea and Amahami) in residence at the mouth of the Knife River. Of the five late villages at Knife River, only the terminal occupation at the Big Hidatsa is not included here. This group not only reflects a strong chronological element but also a strong element of influence from the Mandans or, perhaps more correctly, a strong element of intertribal mixture among four of the five subgroups of the two tribes in residence at the mouth of the Knife River in this period. The fact that demonstrably contemporaneous Big Hidatsa samples are not included in this group offers the strong suggestion that the Hidatsas-proper maintained their independence as a separate cultural unit throughout this period of rapid cultural change and strong cultural interaction in the 1800s.

The late period cluster analysis, while extremely complex and difficult to interpret, does provide some basis for suggesting that discernible tribal and subtribal cultural traditions were maintained throughout the late prehistoric and post-contact period. The structure of the cluster output presented here provides some basis for several hypotheses to be studied in more detail in a subsequent section in this chapter dealing with Mandan-Hidatsa distinctions in the archeological record.

A Working Chronology for the Knife-Heart Region

The foregoing factor and cluster analyses, when combined with available information on regional chronology from stratigraphic, chronometric, and ethnohistoric studies, provide the basis for developing a fairly rigorous cultural chronology for the Plains village components in the regional study sample. The ceramic data, summarized for each batch, play a key role in developing this chronology, and such data are listed by batch and by the recognized chronological periods in Table 17.7. The organization of the batches themselves into 16 different temporal "periods" is presented in Table 17.8 along with all available chronometric data and estimates of the actual encompassing calendar dates of site occupation for each batch. Chronometric data are taken directly from Table 8.9 in Chapter 8 dealing with the chronometric program.

As noted, 16 individual time period units are recognized for the regional samples. Such a period designation is assigned to 85 of the 98 analytic batches identified in the study sample; 13 batches remain unassigned to time period due to small sample size, lack of rigorous study, chronologically mixed composition, or associations with regions or cultural traditions outside of the present focus on the Knife-Heart and Garrison regions. The periods are designated by numbers such as 10, 20, 30, 41, and 42 which in themselves have some analytical meaning. Major temporal periods, usually a century or more in duration, which also coincide with what can be thought of as recognizable taxonomic units in the region (e.g., Heart River phase, Scattered Village complex), are assigned period numbers divisible by ten (10, 20, 30, 50, etc.). When such a "major period" is divisible into yet shorter chronological units, then these "subperiods" are designated by numbers not evenly divisible by ten, such as 41, 42, 61, 62, etc. A total of eight "major periods" are recognized in the region, designated 10 through 80. Within four of these (40, 60, 70 and 80), a total of nine "subperiod" designations are recognized (41, 42, 61, 62, 71, 72, 81, 82, and 83). This arrangement allows grouping of the samples and data by major period if necessary (some batches cannot be accurately assigned to subperiods but can be assigned to major periods), and yet allows detailed subperiod designations for samples where the chronology can be more finely controlled. The discussion that follows focuses on the batch assignments for each of the major periods and the subperiods. The basis for period designations will be discussed along with the available chronological information. Highlights of the ceramic content most distinctive of each period will be discussed on a period-by-period basis. A detailed overview of ceramic content and ceramic variable changes across time periods will be presented in the following major sections of this chapter.

Period 10. Before AD 1200. Late Woodland or Formative Village.

Two batches are included in this period (Table 17.8), although neither was represented in the quantitative ceramic data analysis due to sample limitations. One is from the Flaming Arrow site (Toom and Root 1983; Toom 1988); its inclusion here is based on radiocarbon dates, compatible Awatixa oral traditions which establish this as the earliest Awatixa Hidatsa subgroup settlement in the region, and limited ceramic data compatible with this temporal assessment. Flaming Arrow ceramics (Table 17.7) are characterized by low straight rims with simple decoration, frequent use of cord-wrapped-tool-impressed decoration, and predominantly cord-roughened body surface treatment. The combined Late Woodland components (batch 99) from the Cross Ranch test excavation program (Ahler, Lee, and Falk 1981; Ahler et al. 1982) are included here as a unit due to their suspected chronological age and general ceramic content. Pottery from these sites has not been included in the quantitative analysis, but it is discussed in some detail by Ahler et al. (1982:241-247). It is similar to that from Flaming Arrow, characterized by straight rims with simple cord-wrapped-tool-impressed decoration and cord-roughened body surface treatment.

The use of nodes is closely linked with the use of rainbow decorative motifs on S-rim vessels (Fort Yates, Unnamed, and Le Beau wares), with the rainbow decorative element usually centered beneath a node. Two other modifications are used primarily late in time. Pinching exhibits a brief episode of popularity in period 30 (Nailati phase) followed by a period of disuse. Then it becomes progressively more popular following AD 1600, occurring on nearly 20 percent of the vessels in the early 1800s. Data for castellations and spouts (Table 17.7), features often difficult to distinguish from each other, are combined in the graphic plots (Figure 17.15a). These features also show a progressively more common occurrence after the late 1600s, peaking in frequency in the early 1800s. The pattern for castellations and spouts is closely correlated with the general increase in frequency of Knife River ware in this same period (Figure 17.7b); such modifications are a characteristic feature of Knife River ware but do not occur on other wares recognized in the study sample.

Vessel Wall Thickness Change

Sufficient data exist to examine vessel wall thickness measured in three locations: in body sherds (zone 1), in the neck area (zone 2), and in the upper area on S-rim vessels (zone 3). Measurements in all three locations exhibit very regular patterns of change through time, patterns which are generally consistent across all three variables as illustrated in Figure 17.15b. In all cases analysis of variance confirms statistically significant differences according to time period. In all three variables vessel wall thickness is relatively thick in the earliest time period for which it can be measured, then it diminishes steadily through time to a minimum mean value either in period 41 (Late Scattered Village complex) (body and zone 3 thickness) or in period 50 (Heart River phase) (neck thickness). Then, each thickness measurement shows an immediate reversal in the previous trend toward thinner pottery, and thickness increases progressively to a new peak value in the latest time period (83). The trend toward increasing thickness is most erratic for the zone 3 measurements late in time, and this is probably a function of the increasingly smaller samples for which zone 3 could be measured in the later periods. The patterns exhibited by all three variables are strikingly similar when considered across the full time span in the study samples.

Other Variables

Temporal variation, or lack thereof, can be noted for a few other variables recorded in the ceramic analysis. As noted previously, decorative techniques are captured in part by the general variable decorative type, plotted in Figure 17.10. There are many aspects of decorative technique which are not expressed in this summary variable, however, which show significant changes through time. Such information is difficult to summarize graphically by time period, being best dealt with by controlling for both the location of the decoration on the vessel and the vessel form. Such detailed data on decorative technique and its location is most easily presented in the context of decoration according to individual ceramic wares. Such a breakdown of ceramic data is not attempted here.

Vessel thickness measured at zone 7, the lip, is shown by analysis of variance to change significantly through time. This variable is not plotted graphically or discussed in detail, however, because such a measurement is thought to be highly correlated with variation in lip form and particularly the use of bracing on the vessel rim. Thus, for lip thickness data to be meaningful, they should be presented while controlling for presence or absence of bracing. Such a presentation is better handled as part of a detailed ware description.

It is worth noting that several other vessel measurements do not show significant variation through time, according to analysis of variance over time period groups. Among these are total rim height, the height of zone 2, zone 2 inflection, and vessel orifice diameter. For the record, we can note that the overall mean for vessel orifice diameter is 19.1 cm based on a sample of 210 vessels. Some of these measurements probably do differ significantly among vessel ware groupings, and such comparisons should be part of detailed ware descriptions based on the overall study sample.

Table 17.7(a). Summary data for selected ceramic variables according to analytic batches grouped according to chronological periods. See Table 17.2 for variable identifications.

PERIOD	BATCH	STRAIGHT	SSHAPED	RECURVED	BRACED	FILLETED	WARE0	WARE1	WARE2	WARE3	WARE4	WARE5	WARE6	WARE7	WARE8	WARE9	WARE12	WARE17	WARE21
Before 1200																			
10	92	99	0	0	0	0	99	0	0	0	0	0	0	0	0	0	0	0	0
1200-1300																			
20	34	66	34	0	0	0	7	21	55	13	4	0	0	0	0	0	0	0	0
20	81	85	16	0	0	0	0	5	85	9	0	2	0	0	0	0	0	0	0
Overall		74	26	0	0	0	4	14	68	11	2	1	0	0	0	0	0	0	0
1300-1400																			
30	11	28	74	0	5	10	27	27	0	46	0	0	0	0	0	0	0	0	0
30	13	56	44	0	1	6	12	2	44	42	0	0	0	0	0	0	0	0	0
30	14	56	45	4	0	9	2	4	54	40	0	0	0	0	0	0	0	0	0
30	15	61	39	0	0	0	7	2	54	37	0	0	0	0	0	0	0	0	0
30	16	60	40	0	0	1	3	1	57	39	0	0	0	0	0	0	0	0	0
30	33	39	60	0	19	0	39	30	0	28	0	2	2	0	0	0	0	0	0
30	40	30	63	2	0	2	0	28	28	44	0	0	0	0	0	0	0	0	0
30	42	19	82	4	1	5	6	27	14	52	0	2	0	0	0	0	0	0	0
30	43	26	66	0	12	0	26	44	3	28	0	0	0	0	0	0	0	0	0
30	72	32	69	0	12	0	22	10	10	55	0	4	0	0	0	0	0	0	0
Overall		45	55	1	3	3	10	13	35	41	0	1	0	0	0	0	0	0	0
1400-1450																			
41	5	58	40	0	8	2	59	41	0	0	0	0	0	0	0	0	0	0	0
41	8	62	37	0	10	0	59	10	0	17	0	14	0	0	0	0	0	0	0
41	9	45	53	0	7	2	47	6	0	43	0	4	0	0	0	0	0	0	0
41	10	41	59	0	11	7	38	14	0	41	0	3	0	0	3	0	0	0	0
41	26	34	66	2	28	4	32	20	0	22	0	24	0	0	2	0	0	0	0
41	27	29	72	0	34	3	28	31	0	28	0	13	0	0	0	0	0	0	0
41	28	13	87	2	20	0	4	39	4	20	0	28	2	0	4	0	0	0	0
41	32	44	57	2	27	3	43	37	0	7	0	14	0	0	0	0	0	0	0
41	36	39	59	0	10	1	38	60	2	0	0	0	0	0	0	0	0	0	0
41	70	17	83	0	0	0	14	29	0	43	0	14	0	0	0	0	0	0	0
41	73	17	84	0	1	10	17	83	0	0	0	0	0	0	0	0	0	0	0
41	75	50	47	0	8	0	52	48	0	0	0	0	0	0	0	0	0	0	0
41	77	29	69	0	9	0	30	68	0	0	0	3	0	0	0	0	0	0	0
41	78	12	84	0	7	0	12	86	0	0	0	2	0	0	0	0	0	0	0
41	79	20	80	0	9	2	11	73	2	0	0	7	7	0	0	0	0	0	0
41	80	30	69	0	8	0	31	69	0	0	0	0	0	0	1	0	0	0	0
Overall		35	65	0	12	2	33	50	1	9	0	6	0	0	1	0	0	0	0
1450-1525																			
42	23	18	82	0	25	6	19	19	0	6	0	56	0	0	0	0	0	0	0
42	24	20	79	0	25	1	19	31	0	8	0	40	1	0	0	0	0	0	0
42	25	34	64	1	35	0	32	34	0	3	0	30	1	0	1	0	0	0	0

Table 17.7(a). Continued.

PERIOD	BATCH	STRAIGHT	SSHAPED	RECURVED	BRACED	FILLETED	WARE 0	WARE 1	WARE 2	WARE 3	WARE 4	WARE 5	WARE 6	WARE 7	WARE 8	WARE 9	WARE 12	WARE 17	WARE 21
1450-1525 continued																			
42	31	48	52	0	33	1	34	29	0	1	0	21	15	0	0	0	0	0	0
Overall		32	68	0	31	1	27	30	0	4	0	34	4	0	0	0	0	0	0
1525-1600																			
50	6	26	74	11	21	0	6	12	0	0	0	71	0	0	12	0	0	0	0
50	7	25	74	6	15	0	14	10	0	0	0	67	1	0	9	0	0	0	0
50	20	28	70	0	34	0	17	2	0	0	0	69	2	0	10	0	0	0	0
50	21	13	86	0	33	0	7	5	0	0	0	84	1	0	4	0	0	0	0
50	37	1	99	5	6	0	1	5	0	2	0	92	0	0	0	0	0	0	0
50	39	10	86	2	10	0	0	24	4	6	0	60	0	0	6	0	0	0	0
50	48	16	86	2	6	2	3	2	0	0	0	92	0	0	1	1	0	0	0
50	49	14	85	4	5	0	6	4	0	0	0	83	4	0	3	0	0	0	0
50	55	27	71	4	43	0	0	0	0	0	0	64	28	0	0	8	0	0	0
50	57	40	55	0	25	5	5	5	0	0	0	63	21	5	0	0	0	0	0
Overall		15	84	3	16		0	6	6	0	1	79	3	0	4	1	0	0	0
Circa 1600-1700																			
60	30	48	45	0	50	1	20	26	0	4	0	19	18	14	1	0	0	0	0
60	54	43	50	0	49	0	0	5	0	0	0	30	39	7	2	18	0	0	0
60	56	41	51	0	35	0	3	0	0	0	0	56	35	6	0	0	0	0	0
Overall		46	48	0	47	1	12	16	0	2	0	28	26	11	1	4	0	0	0
1600-1650																			
61	47	27	71	4	22	1	0	7	0	0	0	70	14	0	5	4	0	0	0
61	69	32	56	0	41	0	0	0	0	5	0	40	20	0	10	25	0	0	0
Overall		27	68	4	27	1	0	5	0	1	0	64	15	0	6	8	0	0	0
1650-1700																			
62	46	24	73	2	35	0	1	1	0	1	0	59	20	1	4	13	0	0	0
62	68	40	45	0	60	0	0	3	0	0	0	20	45	2	3	27	0	0	0
Overall		29	63	1	45	0	1	2	0	1	0	47	28	1	4	17	0	0	0
Circa 1700-1780																			
70	4	76	18	2	65	0	1	15	0	0	0	2	71	12	0	0	0	0	0
70	29	59	37	0	51	2	19	31	0	2	0	5	33	10	0	0	0	0	0
70	53	66	30	0	58	0	0	3	0	0	0	29	63	6	0	0	0	0	0
70	86	85	6	2	73	0	3	6	0	0	0	0	78	11	3	0	0	0	0
Overall		75	19	2	65	0	4	13	0	0	0	6	66	10	1	0	0	0	0
1700-1740/45																			
71	0	8	91	39	17	0	4	4	0	0	0	87	0	0	4	0	0	0	0
71	2	5	84	14	19	0	0	4	0	0	0	87	4	0	6	0	0	0	0
71	45	47	48	1	45	0	1	4	0	0	0	40	41	7	0	6	0	0	0

Table 17.7(a). Continued.

PERIOD	BATCH	STRAIGHT	SSHAPED	RECURVED	BRACED	FILLETED	WARE 0	WARE 1	WARE 2	WARE 3	WARE 4	WARE 5	WARE 6	WARE 7	WARE 8	WARE 9	WARE 12	WARE 17	WARE 21
1700-1740/45 continued																			
71	67	61	26	1	67	1	1	5	0	1	0	13	63	7	0	11	0	0	0
Overall		40	51	9	46	0	1	4	0	0	0	46	37	5	2	6	0	0	0
<u>1740/45-1790</u>																			
72	1	34	68	10	63	0	0	5	0	0	0	57	19	0	14	5	0	0	0
72	3	9	80	19	38	0	0	3	0	3	0	82	5	0	8	0	0	0	0
72	44	54	35	1	59	0	3	2	0	0	0	30	37	22	3	3	0	0	0
72	66	59	29	1	68	0	0	5	0	1	0	14	62	9	0	10	0	0	0
Overall		48	42	5	62	0	1	4	0	1	0	32	43	10	3	6	0	0	0
<u>Circa 1780-1845</u>																			
80	41	94	3	0	93	0	0	0	0	0	0	1	92	7	0	0	0	0	0
80	62	68	10	0	84	0	0	0	0	0	0	5	85	3	3	5	0	0	0
80	82	97	3	3	76	0	3	3	0	0	0	95	0	0	0	0	0	0	0
Overall		90	4	0	87	0	0	1	0	0	0	1	92	5	1	1	0	0	0
<u>1780-1800</u>																			
81	19	74	20	3	89	2	0	13	0	0	0	2	74	3	1	3	0	2	0
81	61	73	15	5	89	10	0	0	0	0	0	18	82	0	0	0	0	0	0
Overall		75	19	4	89	4	0	11	0	0	0	5	76	3	1	3	0	2	0
<u>1800-1820/30</u>																			
82	60	69	9	0	86	1	0	0	0	0	0	5	82	5	3	5	0	0	0
82	65	65	17	0	66	0	0	0	0	0	0	10	75	4	4	6	0	0	0
Overall		67	13	0	76	1	0	0	0	0	0	8	79	5	3	6	0	0	0
<u>After 1820/30</u>																			
83	35	83	0	0	92	0	0	0	0	0	0	0	95	5	0	0	0	0	0
83	38	94	2	1	87	0	1	0	0	0	0	0	78	21	1	0	0	0	0
83	59	75	7	0	79	3	1	4	0	0	0	5	87	2	0	1	0	0	0
83	64	57	0	0	88	0	0	0	0	0	0	0	78	11	11	0	0	0	0
83	85	79	9	0	83	0	0	10	0	0	0	0	90	0	0	0	0	0	0
Overall		88	4	1	87	1	1	1	0	0	0	1	81	10	1	0	0	0	0
<u>Unassigned</u>																			
99	74	78	18	0	59	0	81	19	0	0	0	0	0	0	0	0	0	0	0
99	87	76	5	0	52	0	72	6	0	0	0	0	22	0	0	0	0	0	0
99	88	24	72	4	9	0	25	72	0	0	0	3	0	0	0	0	0	0	0
99	89	43	45	1	32	0	16	30	0	0	0	19	33	0	2	0	0	0	0
99	90	37	61	0	17	0	21	29	0	0	0	33	14	0	2	0	0	0	0
99	91	88	12	0	2	1	0	0	0	0	0	0	0	0	0	0	13	0	87
99	93	35	60	0	47	0	25	38	0	0	0	25	13	0	0	0	0	0	0

Table 17.7(b). Continued.

PERIOD	BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWI	FINGER	DENTATE	RDLIP	FLTLIP	INLLIP	OUTLIP	LTLIP	POLLIP	BDLIP	NODE	TAB	HANDLE	SPOUT	CASTEL	PINCHING
Before 1200																							
10	92	44	0	11	11	0	0	33	0	0	11	67	0	0	11	0	11	0	0	0	0	0	0
1200-1300																							
20	34	12	32	46	1	1	0	0	8	0	65	29	1	1	4	0	0	11	0	0	0	0	1
20	81	22	14	53	0	0	0	0	12	0	51	33	2	0	0	4	11	2	0	1	0	9	0
Ov'all		16	24	49	1	1	0	0	10	0	60	31	1	1	2	2	5	8	0	1	0	4	1
1300-1400																							
30	11	5	57	10	10	14	0	0	5	0	62	24	5	0	0	10	0	0	0	0	0	0	18
30	13	17	40	17	1	3	0	0	21	0	81	20	0	0	0	0	0	0	0	0	0	0	3
30	14	11	40	12	4	5	0	0	28	0	55	31	6	0	8	0	0	2	0	0	0	0	5
30	15	16	30	3	10	10	0	0	31	0	62	28	3	1	6	0	0	1	0	0	0	0	10
30	16	22	35	8	4	10	0	0	22	0	49	44	1	0	6	1	0	2	0	0	0	0	10
30	33	17	41	15	8	2	6	2	11	0	31	57	3	0	0	2	7	6	0	0	0	0	1
30	40	8	52	15	8	12	2	0	4	0	36	60	0	2	0	2	0	13	0	0	0	0	11
30	42	4	53	3	15	11	8	0	2	0	18	71	6	3	0	0	3	7	0	0	0	0	3
30	43	16	41	22	8	0	8	0	5	0	22	62	8	0	6	2	0	0	0	0	0	0	0
30	72	19	48	17	2	0	4	0	10	0	20	52	7	0	2	0	20	2	0	0	0	0	0
Ov'all		15	41	11	7	7	2	0	16	0	46	44	3	0	4	1	2	3	0	0	0	0	6
1400-1450																							
41	5	7	38	35	8	0	0	0	12	0	35	20	7	5	32	1	0	1	2	0	0	0	0
41	8	10	31	21	10	0	0	0	28	0	37	37	0	10	17	0	0	3	0	0	0	0	0
41	9	7	34	17	13	0	4	0	25	0	20	48	2	0	30	0	0	8	2	0	0	0	2
41	10	8	48	24	5	0	0	0	15	0	30	37	2	4	15	13	0	5	2	0	0	0	0
41	26	2	63	25	2	0	0	2	6	0	39	41	4	2	7	2	4	0	0	0	0	0	0
41	27	0	69	15	10	3	0	0	3	0	43	46	4	0	0	7	0	3	0	0	0	0	3
41	28	2	85	10	2	0	0	0	2	0	64	18	15	0	0	0	3	4	0	0	0	0	4
41	32	12	42	20	7	0	3	5	11	0	35	33	10	3	2	9	8	1	0	0	0	0	0
41	36	7	33	21	13	2	4	1	17	1	35	28	9	0	28	1	0	3	0	0	0	0	2
41	70	0	43	0	14	14	0	0	0	0	25	75	0	0	0	0	0	14	0	0	0	0	14
41	73	10	47	5	12	7	4	0	16	0	21	41	10	0	27	2	0	0	0	0	0	0	6
41	75	8	42	21	21	0	4	0	4	0	43	33	3	13	0	3	3	8	0	0	0	0	4
41	77	8	30	14	27	0	11	4	6	0	18	49	8	2	19	0	5	1	0	0	0	0	0
41	78	2	25	3	51	2	8	0	10	0	25	57	0	2	16	0	0	4	0	0	0	0	2
41	79	17	52	7	12	0	7	5	7	0	26	51	9	0	6	6	3	0	0	0	0	0	4
41	80	14	42	11	18	1	8	0	8	0	23	46	8	3	17	2	2	0	2	0	0	0	1
Ov'all		9	43	17	14	1	4	1	11	0	31	38	7	3	16	3	2	2	1	0	0	0	2
1450-1525																							
42	23	3	73	18	0	0	0	0	6	0	60	32	5	0	0	5	0	0	0	0	0	0	3
42	24	9	73	8	1	1	1	1	7	0	52	29	7	1	4	3	5	4	1	0	0	0	1

Table 17.7(b). Continued.

PERIOD	BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWTI	FINGER	DENTATE	RDLIP	FLTLIP	INLIP	OUTLIP	LTLIP	POLIP	BDLIP	NODE	TAB	HANDLE	SPOUT	CASTEL	PINCHING
1450-1525 continued																							
42	25	7	67	14	9	0	1	0	3	0	63	21	6	3	1	5	1	3	2	0	0	0	0
42	31	11	45	23	9	0	0	1	11	0	52	19	9	2	6	3	9	6	0	0	0	0	0
Ov'all		8	64	15	6	0	1	1	6	0	56	24	7	2	3	4	5	3	1	0	0	0	1
1525-1600																							
50	6	0	90	5	5	0	0	0	0	0	50	16	25	0	0	8	0	6	0	0	0	0	0
50	7	2	77	10	2	0	0	7	1	0	62	8	17	0	10	3	0	1	0	0	0	0	0
50	20	3	89	0	0	0	0	0	8	0	71	8	18	2	0	0	0	2	0	0	0	0	0
50	21	5	87	0	1	0	0	1	5	0	82	6	7	0	4	2	0	0	0	0	0	0	0
50	37	0	98	1	0	2	0	0	0	0	19	48	16	0	16	2	0	10	0	0	0	0	3
50	39	2	94	2	0	0	0	0	2	0	47	20	22	2	8	2	0	6	0	0	0	0	2
50	48	2	87	2	4	2	0	2	2	0	43	11	24	0	19	4	0	2	0	0	0	0	5
50	49	4	93	0	0	0	0	1	1	0	62	5	26	0	5	2	0	3	0	1	0	0	4
50	55	4	81	8	4	4	0	0	0	0	57	5	19	0	19	0	0	0	0	0	0	0	4
50	57	9	68	0	5	5	0	14	0	0	47	12	18	6	12	6	0	5	0	0	0	0	5
Ov'all		3	89	2	1	1	0	2	2	0	55	15	19	1	9	2	0	4	0	0	0	0	2
Circa 1600-1700																							
60	30	23	47	7	2	4	3	3	8	4	56	21	8	1	2	3	10	0	0	0	4	1	5
60	54	16	66	4	2	6	0	0	6	0	77	7	9	0	7	0	0	0	0	0	0	0	18
60	56	8	85	0	0	0	0	5	3	0	55	15	21	0	6	3	0	0	0	0	0	0	10
Ov'all		18	59	5	2	3	2	3	6	3	61	16	11	1	4	2	6	0	0	0	2	1	8
1600-1650																							
61	47	8	79	2	3	1	0	4	2	0	56	10	15	1	14	5	0	0	0	0	0	0	3
61	69	0	86	0	0	14	0	0	0	0	71	21	0	0	0	7	0	0	0	0	0	0	30
Ov'all		7	80	2	3	3	0	3	2	0	58	12	13	1	12	5	0	0	0	0	0	0	9
1650-1700																							
62	46	8	87	1	0	1	0	2	0	1	66	7	16	2	7	2	0	1	0	0	0	2	9
62	68	15	68	4	0	13	0	0	0	0	82	9	1	0	0	9	0	0	0	3	2	2	25
Ov'all		11	80	2	0	5	0	1	0	0	72	8	11	1	5	4	0	1	0	1	1	2	14
Circa 1700-1780																							
70	4	25	46	3	2	22	0	0	2	0	75	11	4	5	3	3	0	1	0	1	4	4	23
70	29	27	44	7	7	5	2	0	7	0	70	22	4	2	0	0	2	0	0	0	2	2	5
70	53	30	54	5	3	8	0	0	0	0	81	7	0	0	3	10	0	0	0	0	0	3	9
70	86	15	48	13	0	14	0	0	8	4	82	4	0	1	0	9	4	0	6	4	1	7	17
Ov'all		23	47	7	2	15	0	0	4	1	77	10	2	2	2	5	2	0	2	2	2	5	16

Table 17.7(b). Continued.

PERIOD	BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWTI	FINGER	DENTATE	RDLIP	FLTLIP	INLIP	OUTLIP	LTLIP	POLIP	BDLIP	NODE	TAB	HANDLE	SPOUT	CASTEL	PINCHING
1700-1740/45																							
71	0	0	96	0	0	0	0	4	0	0	61	6	6	0	0	11	17	26	0	0	0	0	0
71	2	2	92	0	2	4	0	0	2	0	66	10	5	0	0	5	15	0	0	0	0	0	0
71	45	20	61	1	1	5	0	1	5	3	65	11	11	0	10	4	0	0	0	0	0	0	9
71	67	13	69	3	0	8	0	1	3	3	83	5	3	0	7	3	0	3	0	0	3	7	19
Ov'all		11	74	2	1	6	0	1	3	2	73	8	6	0	6	4	4	4	0	0	1	3	9
1740/45-1790																							
72	1	14	43	10	0	14	0	0	19	0	83	11	0	0	0	6	0	5	0	0	0	10	10
72	3	7	81	2	0	0	0	2	7	0	68	5	8	3	0	11	5	2	2	0	0	0	2
72	44	23	55	3	3	10	0	1	4	1	74	10	4	1	8	3	0	2	0	0	2	0	13
72	66	12	66	4	1	10	0	0	3	3	81	11	3	0	2	3	0	1	0	0	4	5	21
Ov'all		14	64	4	1	9	0	1	5	2	78	10	4	1	3	4	1	2	0	0	2	4	15
Circa 1780-1845																							
80	41	50	35	2	3	6	0	0	5	1	90	8	0	0	0	3	0	0	2	1	2	3	6
80	62	12	72	2	6	2	0	0	4	2	89	2	0	0	4	4	0	3	5	0	3	5	10
80	82	11	57	3	0	22	0	0	8	0	83	9	0	0	0	9	0	0	5	0	0	8	22
Ov'all		35	48	2	3	7	0	0	3	2	87	8	0	0	1	4	0	1	3	1	2	5	9
1780-1800																							
81	19	26	57	3	12	1	0	0	0	0	82	12	1	0	0	5	0	1	8	9	3	3	3
81	61	0	74	0	11	5	0	0	5	5	86	5	10	0	0	0	0	0	0	0	0	0	12
Ov'al		22	60	3	12	2	0	0	1	1	83	10	3	0	0	4	0	1	7	7	3	3	5
1800-1820/30																							
82	60	15	75	0	1	4	0	0	1	3	86	5	1	0	3	5	0	0	4	1	4	10	13
82	65	13	59	5	3	11	0	0	5	3	83	7	1	0	1	8	0	0	1	6	6	4	26
Ov'all		14	67	3	2	8	0	0	3	3	84	6	1	0	2	7	0	0	3	3	5	8	19
After 1820/30																							
83	35	54	42	0	0	4	0	0	0	0	85	11	0	0	0	4	0	0	0	0	0	5	5
83	38	62	33	2	0	1	0	0	3	0	79	20	0	0	0	0	0	1	3	0	1	2	1
83	59	41	51	4	3	0	0	0	0	1	82	10	0	2	0	7	0	0	2	0	0	2	2
83	64	22	67	6	6	0	0	0	0	0	86	5	0	0	5	5	0	0	0	0	0	0	0
83	85	36	55	9	0	0	0	0	0	0	91	9	0	0	0	0	0	0	5	5	0	15	0
Ov'all		54	39	3	1	1	0	0	2	0	81	16	0	0	0	2	0	1	3	0	0	3	1
Unassigned																							
99	74	6	16	13	63	0	0	0	3	0	58	13	7	0	0	10	13	6	0	6	0	0	3
99	87	10	48	10	19	5	5	0	5	0	61	22	4	4	0	4	4	0	0	0	0	0	5

Table 17.7(b). Continued.

PERIOD	BATCH	PLAIN	CORDIMPR	TOOLIMP	TRAILIN	PINCHED	STABDRAG	CWTI	FINGER	DENTATE	RDLIP	FLTLIP	INLIP	OUTLIP	LTLIP	POLIP	BDLIP	NODE	TAB	HANDLE	SPOUT	CASTEL	PINCHING
Unassigned continued																							
99	88	4	21	11	8	1	0	53	1	3	65	23	2	1	6	3	0	2	0	0	0	0	2
99	89	3	73	11	0	2	0	12	0	0	69	11	1	0	1	0	17	1	0	1	0	0	4
99	90	3	66	17	0	0	0	15	0	0	67	3	10	3	0	0	18	0	0	2	0	5	0
99	91	4	0	76	18	0	1	0	1	0	88	10	0	0	0	1	2	2	3	5	0	0	0
99	93	6	47	6	0	0	0	42	0	0	67	13	13	0	0	0	7	0	0	0	0	0	0

Table 17.7(c). Continued.

PERIOD	BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	STPLAIN	STSS	STCHECK	STCORD	STDEC	CHKRATIO
Before 1200																
10	92	.	0	0	89	.	.	44	100	.	5	2	0	93	.0	.00
1200-1300																
20	34	0	44	0	94	0	.	43	100	13	24	61	4	0	6.8	.07
20	81	20	11	0	98	11	.	34	100	38	42	44	4	0	8.7	.09
Overall		8	27	0	96	3	.	39	100	19	28	57	4	0	7.2	.07
1300-1400																
30	11	43	39	0	96	7	0	91	100	0	22	26	51	0	.7	1.96
30	13	40	63	0	100	8	99	58	100	0	12	8	75	0	.4	9.38
30	14	25	63	0	95	4	.	61	100	13	.	.	.	.	.	.
30	15	0	63	4	100	0	.	63	100	8	.	.	.	.	.	.
30	16	16	55	0	99	2	.	71	100	11	20	23	49	0	.5	2.13
30	33	16	39	2	98	3	42	77	100	26	10	21	67	0	1.3	3.19
30	40	14	55	0	92	6	.	88	100	0	68	16	15	0	1.1	.94
30	42	33	21	7	98	8	99	77	100	12	15	24	60	0	.3	2.50
30	43	25	33	0	93	19	99	78	100	7	21	31	42	0	3.2	1.35
30	72	25	33	13	100	3	83	80	100	12	22	17	56	2	.3	3.29
Overall		23	50	2	98	6	65	72	100	10	34	19	44	0	0.9	2.35

Table 17.7(c). Continued.

PERIOD	BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	STPLAIN	STSS	STCHECK	STCORD	STDEC	CHKRATIO
1400-1450																
41	5	13	61	5	94	0	13	51	99	7	9	64	12	0	5.6	.19
41	8	100	24	3	92	0	0	63	100	0	13	72	12	0	2.9	.17
41	9	6	33	8	92	21	0	50	100	11	17	77	3	1	1.5	.04
41	10	11	30	6	94	14	0	70	100	4	13	75	9	0	2.9	.12
41	26	64	44	11	93	3	64	72	100	7	20	63	13	0	2.5	.21
41	27	58	57	0	100	0	46	82	100	0	9	66	21	0	3.0	.32
41	28	83	36	0	100	9	20	77	100	14	8	53	32	0	1.6	.60
41	32	57	31	6	92	12	27	82	99	10	16	70	9	0	1.7	.13
41	36	24	46	4	96	9	20	60	100	16	12	66	1	3	10.9	.02
41	70	33	25	0	50	0	.	100	100	0	0	94	6	0	.0	.06
41	73	44	32	0	100	21	0	82	100	22	21	35	42	0	2.0	1.20
41	75	25	18	9	75	0	0	47	100	10	21	65	8	2	2.4	.12
41	77	50	42	3	84	15	43	59	98	8	15	76	3	0	.9	.04
41	78	55	50	0	100	4	25	48	98	20	24	70	2	0	4.1	.03
41	79	41	15	20	88	19	25	74	100	5	4	64	31	0	1.9	.48
41	80	41	34	12	91	12	33	65	99	15	15	77	3	0	3.8	.04
Overall		42	38	6	93	11	30	66	99	11	14	68	12	0	3.1	.17
1450-1525																
42	23	89	26	16	93	19	43	76	95	17	22	63	13	0	2.2	.21
42	24	91	39	6	94	3	36	84	97	7	13	71	9	0	3.5	.13
42	25	92	36	10	84	3	43	81	99	7	12	80	4	1	1.9	.05
42	31	70	42	0	91	11	32	76	97	9	10	78	4	0	5.6	.05
Overall		88	36	4	90	6	38	80	98	8	13	76	6	0	2.9	.08
1525-1600																
50	6	100	36	0	80	0	0	100	92	6	7	87	5	0	1.7	.06
50	7	97	54	0	92	0	15	72	100	2	8	79	1	0	8.6	.01
50	20	89	46	3	94	0	33	78	88	2	3	90	1	0	5.1	.01
50	21	90	41	3	87	4	59	83	94	6	6	88	2	1	1.7	.02
50	37	76	66	5	98	2	57	52	100	3	3	88	0	0	8.4	.00
50	39	70	54	0	80	0	20	71	92	10	47	42	3	0	6.9	.07
50	48	89	64	5	82	2	0	69	100	8	28	63	0	1	4.0	.00
50	49	94	67	0	92	2	50	57	95	22	25	65	4	1	4.7	.06
50	55	78	50	0	75	13	18	52	95	5	.	.	.	.	.	.
50	57	60	60	0	75	9	20	78	87	20	.	.	.	.	.	.
Overall		88	55	2	89	2	37	69	95	7	19	72	2	1	5.4	.03
Circa 1600-1700																
60	30	57	27	3	89	26	67	76	86	6	7	88	1	0	.4	.01
60	54	73	44	0	75	13	29	84	95	0	.	.	.	.	.	.
60	56	100	60	0	70	0	31	69	94	16	.	.	.	.	.	.
Overall		68	36	2	82	18	52	76	89	7	7	88	1	0	.4	.01

Table 17.7(c). Continued.

PERIOD	BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	STPLAIN	STSS	STCHECK	STCORD	STDEC	CHKRATIO
1600-1650																
61	47	89	72	0	82	8	14	64	90	9	30	64	0	0	1.6	.00
61	69	25	31	0	85	9	11	86	92	0	25	57	7	0	5.8	.12
Overall		81	63	0	83	8	13	67	90	7	29	62	2	0	2.8	.03
1650-1700																
62	46	76	46	0	81	13	12	72	92	7	38	60	0	0	1.2	.00
62	68	45	42	0	94	32	25	89	93	7	33	62	2	0	1.1	.03
Overall		66	44	0	86	16	18	78	93	7	36	61	1	0	1.2	.01
Circa 1700-1780																
70	4	75	64	0	99	71	38	85	80	15	14	81	2	0	.1	.02
70	29	25	21	0	100	27	41	93	84	6	11	83	2	0	1.7	.02
70	53	100	58	0	96	14	57	73	73	14	.	.	.	.	.	.
70	86	100	9	0	96	20	40	79	89	5	20	78	1	0	.0	.01
Overall		76	37	0	98	41	41	83	83	10	17	80	1	0	.3	.02
1700-1740/45																
71	0	100	44	0	94	0	0	78	100	0	11	79	0	1	4.9	.00
71	2	100	22	0	90	4	22	83	95	2	11	79	0	1	4.9	.00
71	45	82	70	0	91	22	53	68	87	9	32	67	0	0	.4	.00
71	67	15	27	5	93	30	26	75	73	11	31	67	1	0	.1	.01
Overall		71	42	2	92	12	33	74	84	7	29	70	0	0	1.5	.01
1740/45-1790																
72	1	100	47	0	81	57	33	78	94	0	13	83	1	0	3.0	.01
72	3	100	20	0	78	12	40	81	97	9	13	83	1	0	3.0	.01
72	44	60	67	0	80	26	61	69	92	8	33	61	0	0	1.9	.00
72	66	69	33	0	88	32	30	76	81	11	25	72	1	0	.3	.01
Overall		77	43	0	85	27	39	75	87	9	24	73	1	0	1.3	.01
Circa 1780-1845																
80	41	100	13	0	99	25	64	92	88	18	24	71	1	1	.0	.01
80	62	0	39	0	92	50	14	82	84	8	34	64	0	0	.5	.00
80	82	.	7	0	92	0	25	100	86	10	17	75	4	0	.0	.05
Overall		80	17	0	96	42	46	90	85	13	31	65	1	0	.3	.01
1780-1800																
81	19	70	49	1	93	80	30	91	82	27	10	87	0	0	.0	.00
81	61	100	21	0	79	67	6	95	70	20	41	56	0	0	.0	.00
Overall		75	45	1	91	78	26	92	80	25	14	82	0	0	.0	.00

Table 17.7(c). Continued.

PERIOD	BATCH	Z3CURVED	Z2BRUSH	Z2COB	Z2PLAIN	Z3PLAIN	Z5PLAIN	Z7PLAIN	INTPLAIN	STWIST	STPLAIN	STSS	STCHECK	STCORD	STDEC	CHKRATIO
<u>1800-1820/30</u>																
82	60	100	20	0	92	80	25	85	80	13	23	74	0	0	.6	.00
82	65	33	26	2	89	46	25	77	77	12	30	68	0	0	.0	.00
Overall64		23	1	91	56	25	81	79	13	27	71	0	0	.3	.00	
<u>After 1820/30</u>																
83	35	.	30	0	94	.	59	100	86	10	22	77	0	0	.0	.00
83	38	60	15	0	98	71	64	93	97	20	7	94	0	0	.0	.00
83	59	100	30	0	99	67	41	91	92	15	31	66	0	0	.0	.00
83	64	.	38	0	100	.	17	76	64	9	40	59	0	0	.0	.00
83	85	0	14	0	96	0	53	77	91	33	53	47	0	0	.0	.00
Overall63		18	0	98	56	57	91	94	19	32	65	0	0	.0	.00	
<u>Unassigned</u>																
99	74	100	24	0	58	0	11	81	100	17	32	54	4	0	8.2	.07
99	87	.	29	0	60	0	9	78	95	20	22	47	0	0	25.0	.00
99	88	52	35	1	78	7	23	59	95	40	20	68	6	3	1.7	.09
99	89	100	9	0	91	9	5	80	93	12	32	63	2	1	2.6	.03
99	90	100	13	0	84	8	0	69	100	22	53	34	5	2	3.4	.15
99	91	21	5	0	93	17	25	38	71	.	33	59	2	3	2.1	.03
99	93	100	63	0	88	20	44	60	100	22	30	36	3	12	.0	.08

Table 17.7(d). Continued.

PERIOD	BATCH	CDSPACE	CDDIAM	Z2THICK	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH
<u>Before 1200</u>									
10	92	.	.	7.63	.	.	8.50	.	6.09
<u>1200-1300</u>									
20	34	6.09	2.99	7.26	7.72	.	7.40	.	6.13
20	81	6.11	3.09	7.02	7.79	.	7.15	.	5.63
Overall		6.10	3.01	7.14	7.74	.	7.29	.	5.80
<u>1300-1400</u>									
30	11	6.28	2.68	7.06	6.64	8.40	6.67	12.0	5.58
30	13	6.57	3.08	6.32	6.51	5.60	6.18	10.0	5.26
30	14	7.33	3.40	6.49	6.62	.	6.60	.	5.82
30	15	6.58	2.87	6.51	6.26	.	6.63	.	.

Table 17.7(d). Continued.

PERIOD	BATCH	CDSPACE	CDDIAM	Z2THICK	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH
1300-1400 continued									
30	16	7.15	3.03	6.44	6.70	.	6.54	.	.
30	33	6.32	2.99	6.30	6.58	8.34	7.63	13.5	5.19
30	40	6.91	3.36	7.41	7.56	.	6.91	.	6.07
30	42	8.22	2.73	7.72	7.47	9.40	7.76	31.0	5.57
30	43	8.85	2.85	5.90	6.60	9.92	7.96	16.0	5.64
30	72	6.90	3.10	6.32	7.11	8.82	8.28	10.6	5.26
Overall		7.22	2.99	6.65	6.89	8.69	6.96	13.6	5.51
1400-1450									
41	5	5.21	2.40	6.65	6.34	8.90	7.67	12.5	5.14
41	8	5.13	2.16	6.19	6.31	9.17	7.91	15.0	5.32
41	9	5.69	2.54	6.21	6.66	8.97	8.48	13.7	5.38
41	10	6.31	2.48	6.52	6.70	8.16	7.31	13.4	5.17
41	26	4.68	2.44	5.66	6.09	8.29	7.60	14.2	4.95
41	27	5.91	2.65	5.94	6.11	8.38	7.25	14.2	5.27
41	28	5.73	2.68	5.83	6.01	7.66	7.20	14.6	5.30
41	32	4.96	2.63	6.18	6.76	8.68	7.51	13.8	5.18
41	36	5.34	2.47	6.35	6.92	9.26	8.39	14.3	5.57
41	70	7.50	2.85	7.78	7.10	.	7.98	.	5.80
41	73	7.20	2.40	6.48	6.66	11.40	8.67	18.0	5.19
41	75	4.24	2.06	6.48	7.19	7.30	7.21	13.0	5.07
41	77	5.22	2.23	6.72	6.94	8.90	9.29	12.0	5.44
41	78	5.47	2.36	6.59	7.02	9.90	8.73	12.0	5.57
41	79	5.55	2.45	5.55	6.50	9.90	7.61	16.0	5.56
41	80	5.23	2.29	6.40	6.80	8.92	8.47	13.3	5.50
Overall		5.48	2.45	6.31	6.66	8.66	8.06	13.9	5.34
1450-1525									
42	23	4.36	2.55	6.52	6.53	10.25	8.73	15.1	4.74
42	24	4.59	2.41	5.85	5.96	8.38	7.53	16.6	4.65
42	25	4.13	2.42	6.01	5.96	7.98	7.29	13.4	4.95
42	31	4.93	2.61	6.31	6.57	8.77	8.04	15.3	5.07
Overall		4.45	2.42	6.07	6.13	8.46	7.70	14.8	4.84
1525-1600									
50	6	3.96	2.36	5.60	6.00	7.95	6.88	12.7	5.00
50	7	3.90	2.22	5.85	5.96	8.01	7.56	13.2	4.60
50	20	3.85	2.22	5.38	5.92	8.01	7.25	12.9	5.04
50	21	4.30	2.33	5.59	5.94	8.69	7.62	15.2	4.91
50	37	4.34	2.45	5.74	5.98	9.04	8.53	18.1	4.87
50	39	4.11	2.25	6.33	6.90	9.66	7.67	13.0	5.45
50	48	4.13	2.11	6.35	6.60	9.63	7.99	17.0	5.19
50	49	4.16	2.08	6.03	6.39	9.65	7.46	17.0	5.00
50	55	3.77	2.36	6.55	6.75	10.38	8.40	21.7	.
50	57	3.87	2.13	6.26	6.61	9.07	7.36	17.6	.
Overall		4.12	2.28	5.87	6.25	8.70	7.73	15.3	4.97
Circa 1600-1700									
60	30	4.26	2.44	6.23	6.49	9.25	7.79	21.4	5.72
60	54	3.92	2.36	6.15	7.01	9.61	7.72	24.7	.

Table 17.7(d). Continued.

PERIOD	BATCH	CDSPACE	CDDIAM	Z2THICK	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH
Circa 1600-1700 continued									
60	56	3.75	2.19	6.84	6.88	9.96	8.03	19.6	.
Overall		4.02	2.35	6.31	6.68	9.44	7.82	22.0	5.72
1600-1650									
61	47	3.80	2.22	6.15	6.45	8.71	7.63	19.2	5.13
61	69	3.75	2.16	5.67	6.39	10.05	7.32	20.3	5.14
Overall		3.79	2.21	6.05	6.44	9.11	7.59	19.4	5.13
1650-1700									
62	46	3.78	2.25	6.26	6.85	9.55	7.89	20.1	5.27
62	68	3.98	2.09	6.02	6.78	9.11	7.48	22.1	5.40
Overall		3.83	2.21	6.16	6.84	9.36	7.74	21.0	5.32
Circa 1700-1780									
70	4	4.00	2.29	5.77	6.75	9.44	7.79	21.9	5.28
70	29	4.40	2.66	6.51	6.95	9.24	7.62	19.3	5.54
70	53	4.22	2.11	6.65	6.59	10.45	7.60	26.2	.
70	86	4.39	2.07	6.24	6.64	9.93	7.94	21.7	5.83
Overall		4.23	2.24	6.15	6.77	9.71	7.79	22.0	5.68
1700-1740/45									
71	0	3.16	2.03	5.80	6.19	7.70	6.87	12.3	4.74
71	2	3.44	2.16	5.19	6.00	8.60	7.59	13.3	4.74
71	45	3.80	2.26	6.51	6.85	10.23	8.03	21.4	5.50
71	67	4.36	2.36	6.94	6.66	10.42	8.19	23.3	5.75
Overall		3.84	2.25	6.55	6.36	10.09	7.94	21.2	5.51
1740/45-1790									
72	1	3.17	2.01	6.22	6.11	12.04	8.32	17.1	4.88
72	3	3.58	2.10	5.71	6.08	8.90	7.83	11.9	4.88
72	44	4.24	2.21	6.64	6.97	9.76	8.28	22.9	5.58
72	66	4.14	2.20	6.45	7.50	10.27	8.20	22.8	5.79
Overall		4.00	2.17	6.44	6.72	10.16	8.18	21.2	5.64
Circa 1780-1845									
80	41	4.24	2.38	6.39	6.00	9.90	7.84	23.1	6.41
80	62	4.19	2.11	6.57	7.15	10.21	7.69	22.1	.
80	82	4.21	1.99	7.18	7.70	10.36	8.14	20.2	6.71
Overall		4.14	2.20	6.57	6.63	10.10	7.82	22.2	6.53
1780-1800									
81	19	3.66	2.12	6.37	6.84	10.55	8.52	19.2	6.00
81	61	3.88	2.11	6.13	5.90	10.56	7.97	20.0	5.41
Overall		3.70	2.11	6.32	6.67	10.55	8.42	19.3	5.86

Table 17.7(d). Continued.

PERIOD	BATCH	CDSPACE	CDDIAM	Z2THICK	Z3THICK	Z5THICK	Z7THICK	Z5WIDTH	BODYTH
1800-1820/30									
82	60	3.92	2.26	6.43	7.04	10.24	7.87	21.9	5.98
82	65	4.03	2.20	6.69	7.10	10.64	7.96	20.4	6.17
Overall		3.96	2.23	6.55	7.08	10.41	7.91	21.3	6.10
After 1820/30									
83	35	4.03	2.15	6.41	.	9.86	7.88	19.2	6.89
83	38	4.10	2.27	6.80	5.63	10.65	8.43	22.7	6.10
83	59	3.95	1.92	6.41	7.86	9.90	7.69	19.2	6.43
83	64	3.74	2.04	7.46	6.56	9.36	8.62	18.2	6.30
83	85	5.45	2.16	6.89	10.30	10.49	8.41	23.3	7.64
Overall		4.12	2.15	6.76	7.55	10.44	8.25	21.9	6.55
Unassigned									
99	74	4.13	2.02	5.90	5.83	7.97	6.97	12.3	4.81
99	87	3.93	2.24	5.02	6.70	7.51	6.61	14.7	4.84
99	88	4.41	2.30	6.31	6.31	8.57	7.10	11.9	4.95
99	89	3.78	1.91	6.44	5.66	10.06	7.51	15.6	4.93
99	90	3.25	1.49	6.04	5.70	9.54	7.25	15.3	5.16
99	91	.	.	6.47	6.92	12.88	6.16	33.5	5.30
99	93	3.99	2.44	5.69	6.70	9.16	7.77	18.5	5.25

Table 17.7(e). Continued.

PERIOD	BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO
Before 1200																	
10	92	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1200-1300																	
20	34	.	.	.	.	.	29	0	48	14	0	0	.	.	.	.	.
20	81	.	.	.	.	.	86	0	0	0	14	0	.	.	.	.	.
Overall		.	.	.	.	.	43	0	36	11	4	0	.	.	.	.	
1300-1400																	
30	11	0	0	0	100	0	50	14	14	0	14	7	0	0	0	99	0
30	13	100	0	0	0	0	97	0	3	0	0	0	.	.	.	.	.
30	14	.	.	.	.	.	86	0	14	0	0	0	.	.	.	.	.
30	15	.	.	.	.	.	83	3	7	0	3	0	.	.	.	.	.

Table 17.7(e). Continued.

PERIOD	BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATACR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO
1300-1400 continued																	
30	16	.	.	.	.	.	92	0	5	0	0	1	.	.	.	.	.
30	33	58	8	8	16	8	50	25	3	6	6	11	86	0	14	0	0
30	40	.	.	.	.	.	53	0	33	7	0	7	.	.	.	.	.
30	42	0	0	100	0	0	74	13	10	1	0	0	.	.	.	.	.
30	43	25	50	0	0	25	90	0	5	0	0	5	.	.	.	.	.
30	72	17	83	0	0	0	62	17	3	0	3	7	99	0	0	0	0
Overall		40	32	8	12	8	76	7	8	1	2	3	78	0	11	11	0
1400-1450																	
41	5	13	0	0	88	0	68	3	16	5	3	0	14	0	71	0	14
41	8	33	0	0	67	0	67	0	33	0	0	0	67	0	33	0	0
41	9	50	0	0	50	0	57	10	33	0	0	0	99	0	0	0	0
41	10	0	0	0	100	0	67	7	11	0	0	15	14	57	29	0	0
41	26	21	64	0	0	14	61	7	13	3	6	3	20	0	80	0	0
41	27	31	46	0	0	23	52	10	14	10	10	0	43	0	43	14	0
41	28	45	55	0	0	0	55	3	13	10	13	3	17	0	67	17	0
41	32	55	12	6	15	9	75	4	14	2	6	0	50	8	33	4	4
41	36	30	20	0	40	10	69	4	14	2	6	6	38	0	50	0	13
41	70	.	.	.	.	.	99	0	0	0	0	0	.	.	.	.	.
41	73	0	0	0	100	0	82	5	0	0	3	10	0	0	0	99	0
41	75	100	0	0	0	0	46	0	9	9	18	18	0	0	99	0	0
41	77	14	28	0	28	28	58	3	16	3	8	5	0	0	75	25	0
41	78	0	0	0	100	0	67	2	11	4	7	4	33	0	33	33	0
41	79	50	25	0	25	0	65	0	7	4	4	15	33	0	67	0	0
41	80	57	14	0	29	0	69	2	16	1	5	6	22	22	22	22	11
Overall		37	24	2	28	8	66	4	15	3	6	5	34	9	44	9	4
1450-1525																	
42	23	13	50	0	13	25	40	0	20	25	15	0	25	25	25	25	0
42	24	23	77	0	0	0	63	4	19	3	6	3	38	0	19	38	6
42	25	43	45	8	3	3	51	2	19	9	15	0	22	9	48	17	4
42	31	68	20	0	8	0	55	0	16	3	16	7	29	6	65	0	0
Overall		41	48	3	4	3	55	2	19	8	12	2	28	7	43	18	4
1525-1600																	
50	6	100	0	0	0	0	15	0	8	8	61	0	25	0	75	0	0
50	7	62	8	8	23	0	46	0	9	15	27	0	0	0	99	0	0
50	20	68	26	5	0	0	37	3	11	3	40	3	39	0	54	8	0
50	21	29	71	0	0	0	48	3	13	7	26	0	17	0	58	16	8
50	37	43	57	0	0	0	34	0	19	16	26	0	0	0	99	0	0
50	39	25	25	0	25	25	51	4	9	13	22	0	0	0	75	0	25
50	48	0	0	0	100	0	39	2	13	5	32	2	25	0	75	0	0
50	49	50	0	0	50	0	20	0	13	10	55	0	0	0	99	0	0
50	55	40	0	10	50	0	33	0	33	0	33	0	0	0	89	0	11
50	57	33	0	33	33	0	30	20	10	20	20	0	0	0	75	25	0
Overall		44	34	4	16	1	38	2	14	10	32	0	14	0	76	6	4

Table 17.7(e). Continued.

PERIOD	BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO
Circa 1600-1700																	
60	30	40	25	25	7	2	63	9	6	0	17	3	20	10	65	5	0
60	54	14	5	43	38	0	36	0	35	14	7	7	6	0	82	12	0
60	56	17	8	25	50	0	57	0	6	0	22	0	0	0	99	0	0
Overall		31	18	29	20	1	55	5	12	3	15	3	11	4	79	7	0
1600-1650																	
61	47	42	0	21	37	0	47	3	19	9	21	0	0	6	94	0	0
61	69	43	0	0	57	0	67	0	0	0	33	0	0	0	99	0	0
Overall		42	0	15	42	0	49	3	15	8	22	0	0	4	96	0	0
1650-1700																	
62	46	36	0	6	55	2	60	1	10	5	20	0	0	0	99	0	0
62	68	53	0	18	30	0	46	0	0	0	54	0	3	0	90	8	0
Overall		44	0	12	44	1	50	1	9	4	25	0	1	0	95	4	0
Circa 1700-1780																	
70	4	47	11	20	22	0	25	0	25	0	0	0	2	5	71	19	2
70	29	57	14	19	10	0	60	0	0	0	40	0	8	0	93	0	0
70	53	30	10	20	40	0	60	0	20	0	20	0	0	11	67	11	11
70	86	68	3	23	6	0	0	25	0	0	25	0	0	5	68	24	3
Overall		54	8	21	17	0	44	4	8	0	26	0	2	5	72	18	3
1700-1740/45																	
71	0	100	0	0	0	0	48	0	5	43	5	0	0	25	75	0	0
71	2	75	25	0	0	0	57	2	7	5	30	0	14	14	57	14	0
71	45	48	0	22	30	0	44	0	13	4	39	0	0	0	87	13	0
71	67	52	2	18	28	0	29	7	0	0	64	0	0	6	78	15	2
Overall		55	3	17	25	0	48	2	7	12	31	0	1	6	78	14	1
1740/45-1790																	
72	1	67	25	8	0	0	33	0	0	17	17	33	38	0	53	0	0
72	3	53	13	0	33	0	60	0	8	8	20	4	11	.	8	90	0
72	44	32	6	35	26	0	39	0	8	8	46	0	0	0	94	6	0
72	66	44	0	13	42	0	30	20	10	0	40	0	4	4	81	9	1
Overall		44	5	17	34	0	44	6	8	6	31	5	7	3	83	7	1
Circa 1780-1845																	
80	41	82	1	10	5	2	33	0	0	0	67	0	0	5	86	8	2
80	62	65	0	11	24	0	50	0	0	0	50	0	3	0	64	31	3
80	82	82	0	4	14	0	0	0	0	0	99	0	0	0	99	0	0
Overall		74	1	11	13	1	29	0	0	0	71	0	1	2	79	17	2

Table 17.7(e). Concluded.

PERIOD	BATCH	Z5EXT	Z5INT	Z5COLLAR	Z5WEDGE	Z5INVWE	Z3PATH	Z3PATHOU	Z3PATAR	Z3PATCR	Z3PATD	Z3PATNO	Z5PATNO	Z5PATV	Z5PATD	Z5PATH	Z5PATO
1780-1800																	
81	19	57	2	15	25	0	67	0	0	0	33	0	0	3	62	33	2
81	61	71	0	12	18	0	0	0	0	0	0	99	0	6	62	31	0
Overall		59	2	15	24	0	50	0	0	0	25	25	0	4	62	33	1
1800-1820/30																	
82	60	52	0	22	23	2	99	0	0	0	0	0	0	0	77	23	0
82	65	47	4	2	47	0	40	0	0	0	60	0	0	2	78	20	0
Overall		50	2	13	33	1	50	0	0	0	50	0	0	1	77	22	1
After 1820/30																	
83	35	33	5	5	57	0	.	.	.	.	.	.	0	11	78	0	11
83	38	65	1	26	7	0	0	0	0	0	99	0	1	6	71	18	4
83	59	54	0	22	22	1	99	0	0	0	0	0	0	2	59	33	6
83	64	50	0	17	33	0	.	.	.	.	.	.	0	0	90	10	0
83	85	69	0	6	19	6	0	0	0	0	50	0	0	0	89	11	0
Overall		61	1	23	14	1	33	0	0	0	50	0	1	5	71	20	3
Unassigned																	
99	74	72	6	0	17	6	80	0	20	0	0	0	12	12	53	23	0
99	87	88	0	0	13	0	99	0	0	0	0	0	0	0	80	10	10
99	88	41	12	0	41	6	41	6	6	4	39	1	12	0	59	18	12
99	89	87	0	0	13	0	48	0	7	0	45	0	0	0	76	5	19
99	90	71	0	0	29	0	42	13	13	0	33	0	0	0	71	14	14
99	91	0	0	0	100	0	16	32	5	0	26	0	0	0	33	67	0
99	93	33	44	0	11	11	43	0	0	29	28	0	0	0	99	0	0

Period 20. AD 1200-1300. Clark's Creek Phase.

This is a chronological period associated with the Clark's Creek phase as defined in Wood (1986c). The Clark's Creek site archeological sample provided the basis for the phase definition, and the early period cluster analysis confirms the identity of the Clark's Creek phase taxonomic unit and the assignment of both the type site sample and the Stiefel site batch to this unit and period. Chronological limits for the unit are defined primarily on the basis of the radiocarbon dates available for the Clark's Creek site; Stiefel remains undated by chronometric means. A third batch sample from the PG site on the Cross Ranch (Ahler and Picha 1985) is included in this period and taxonomic group, based both on radiocarbon dates in the late AD 1200s and on ceramic content from the site. The PG ceramic sample has not been coded and was too small for inclusion in the quantitative analyses conducted here. Ceramic attributes distinctive of this period and of the Clark's Creek phase center on high frequencies of Riggs ware and Fort Yates ware, low frequencies of all other defined wares or ware-like groups, predominance of simple-stamping in body surface treatment, and high vessel wall thickness measurements.

Period 30. AD 1300-1400. Nailati Phase.

Twelve batch samples from a total of nine sites have been assigned to this time period and to the Nailati phase. These samples hang together well as a group in both the general cluster analysis and in the early period cluster analysis. The only batch sample falling in the Nailati phase group in the early period cluster analysis but removed now is the Big Hidatsa Village period 7 batch (70) which is here reclassified into the subsequent period based on its associated radiocarbon dates. That sample is also extremely small, possibly accounting for its misclassification in the cluster analysis. The Angus site on the Cross Ranch (batch 95) (Ahler and Picha 1985) is also assigned to this group on the basis of radiocarbon dates and ceramic information, although that pottery sample was not coded nor included in the present quantitative analysis.

Four independent sets of radiocarbon dates occur with the batches assigned to this period, and seven of the eight midpoints and crossing points fall in the AD 1300s, leading to the designated span of 1300-1400 for this period and batch group. Three sites accounting for six of the 12 batches in this period have been previously studied (cf. Lee, ed. 1980; Calabrese 1972) and determined to be representative of the Nailati phase as defined by Calabrese. The Milepost 28 and various Cross Ranch batches form an internally consistent, tight cluster in all analyses performed here, and these results confirm Calabrese's (1972:6) decision to treat the Milepost 28 sample as a spatial continuation of the adjacent Cross Ranch Village site.

The early period cluster analysis drew a distinction between the Upper Sanger 4, White Buffalo Robe early, and Amahami early batches as group 2E and the remaining batches in this period as group 3E. Inspection of the data in Table 17.7 indicates that this distinction is apparently based on lower percentages of straight rim forms, higher percentages of cord-impressed type, slightly lower proportions of check-stamped surface treatment, and decidedly greater thickness measurements in zones 2 and 3 in the group 2E batches. The latter two characteristics are shared with the earlier period 20, Clark's Creek phase samples, and this may suggest that the three named batches occurring in group 2E might be slightly earlier than the other batches assigned to this period. Regardless, these differences are rather subtle, and a formal subdivision of the Nailati phase group into those in early and late subperiods seems unjustified at this time. For the time being, all twelve batches will be assigned to a single century-long period and a single taxonomic unit. Distinctive ceramic characteristics for this period (Table 17.7) include approximately equal frequencies of Riggs and Fort Yates wares, lesser but significant amounts of Unclassified S-Rim and Straight Rim ware groups, relatively coarse, widely spaced cord impressions, a high proportion of angular shape in zone 3, relatively equal proportions of round and flattened lip shapes, and above all else, high proportions of check-stamped surface treatment as opposed to low frequencies of simple-stamped treatment.

Period 41. AD 1400-1450. Early Scattered Village Complex.

Batches assigned to this subperiod are thought to be generally representative of the Scattered Village complex, and they fall roughly in the first third to half of the 125 year period assigned to that taxonomic unit. Sixteen batch samples representing occupations at a total of 13 sites are assigned to this time period. This subperiod grouping is defined primarily by the content of group 4E in the early cluster analysis. Exceptions are the removal of the Mahhaha period 3 batch (31), which was in group 4E, to the following time period (42), and inclusion here of the Big Hidatsa period 7 batch (70) which was originally placed in group 2E in the early period cluster analysis. The latter Big Hidatsa sample is placed here on the basis of its associated radiocarbon dates. Nine of the 16 batch components included in this period have associated radiocarbon dates. In all cases, either the corrected C-14 midpoint or the curve cross-point falls within the suggested time range of AD 1400-1450 for this period. Most questionable, perhaps, are the AD 1521 and AD 1523 C-14 midpoints for the Mandan Lake period 3 and Mahhaha period 4 samples, respectively. It is conceivable that the Mandan Lake (and Shoreline) samples should be included in the next later period, as suggested by the cluster analysis. They are included here, however, because characteristics of the pottery such as a substantial frequency of check-stamping and a significant amount of Fort Yates ware pottery suggest an early rather than later time frame.

Pottery and other artifacts from several sites included here (Forkorner East and West, Hump, Youess, and Poly) have been studied in some detail as part of the KNRI program (Ahler and Mehrer 1984) and have been used as type examples for the Scattered Village complex. Virtually none of the other components included here, however, have been formally studied, and their inclusion is based primarily on the ceramic analysis results. Distinctive ceramic characteristics for this period include relatively high frequencies of both Unclassified S-Rim and Straight Rim pottery wares, relatively low frequencies of Riggs and Fort Yate wares, considerable diversity in decorative technique (type) and lip form, and a low but consistent occurrence of check-stamping in body surface treatment.

Period 42. AD 1450-1525. Late Scattered Village Complex.

The presence of the group comprising this subperiod is indicated particularly in the results of the early period cluster analysis (group 5E). That the batch samples assigned to this subperiod should be considered as part of the Scattered Village complex is indicated by the results of both the early and later period cluster analyses, which show stronger affinities between this group and the Early Scattered Village sample than with the subsequent Heart River phase samples. The earlier Mandan Lake batches (26 and 27) and the Shoreline batch (28) included in group 5E in the cluster analysis have been removed from this period and placed in the next earliest one (period 41). As noted above, this decision is based on relatively high percentages of check-stamping and Fort Yates ware, presumably early characteristics, in those batch samples. The Mahhaha period 3 batch (31) has been included in this group, largely because of relatively high occurrences of Le Beau ware in that sample (Table 17.7). The Bagnell sample is very tentatively included in this group, based primarily on the available radiocarbon dates from the site and the authors' very general understanding of the site's ceramic characteristics. Lehmer et al. (1973) indicate that Bagnell has multiple components; full analysis of the huge artifact collections from the site could easily result in period 41, 42, and 50 associations for the lengthy Bagnell site occupation sequence.

Three of the five batch components assigned to this subperiod have associated radiocarbon dates. Midpoint and crosspoint determinations for Bagnell and Mandan Lake batch 23 fall somewhat later than the suggested range for this period, within what is designated as period 50, the Heart River phase. The quantitatively studied samples included here are definitely not part of the Heart River phase, however, based on ceramic data, and for that reason they are included here regardless of C-14 age determinations. The Mandan Lake batch 25 sample has date midpoint and crosspoints which bracket the suggested limits for this period. The ceramic characteristics of the studied samples included here are generally similar to those enumerated above for the Early Scattered Village complex period, with minor distinctions. The distinctions include a higher frequency of Le Beau ware, greater use of cord-impressed decoration and round lip forms, higher frequencies for curved zone 3 shape, and less check-stamping. All these characteristics foreshadow the ceramic patterns most evident in the succeeding Heart River phase.

Period 50. AD 1525-1600. Heart River Phase.

Eleven batch samples representing six sites are assigned to the period AD 1525-1600 which is identified with the Heart River phase. The Heart River phase identification is based largely on previous detailed study of both the White Buffalo Robe late sample (Lee, ed. 1980) and the various Lower Hidatsa Village batches (Ahler and Weston 1981) assigned to this period. Batches in this period include all of those placed in group 6E in the early period cluster analysis (Figure 17.5) and group B in the late period analysis, with the exception of On-a-Slant early (batch 0) and Big Hidatsa period 6 (batch 69). Both of these are thought on the basis of chronometric/stratigraphic and other data to belong to later time periods, regardless of taxonomic associations. The inclusion of particularly the Slant early sample in the Heart River phase clusters indicates that the Heart River phase may in some parts of the Knife-Heart region have a temporal duration far longer than the period suggested here. This topic will be explored more fully in the assessment of Mandan/ Hidatsa archeological differences. The lowermost stratified deposits from Lehmer's 1965 tests at Lower Hidatsa Village (batches 55 and 57) are included in period 50, this being based on inclusion here of what are thought to be chronologically and stratigraphically similar deposits from the 1978 excavations at the same site (batches 48 and 49).

Six sets of radiocarbon dates exist for components assigned to this period (Table 17.8). Several of these have crosspoints in the mid-AD 1400s and range midpoints in the 1500s. Due in part to the extreme fluctuation in the radiocarbon correction curve in this period, all of the C-14 dates exhibit extremely wide ranges extending from in the AD 1400s well into the AD 1600s, generally bracketing the narrower time frame (1525-1600) suggested for this period. Ceramic characteristics which are distinctive in this period (Table 17.7) include a high frequency of Le Beau ware and low frequencies of all other wares, high frequencies of S-shaped rim forms, predominance of cord-impressed decoration, relatively high frequencies of inslanted lip forms, very low frequencies of angular shape in zone 3, low frequencies of check-stamped surface treatment, very low thickness measurements at several places on the vessel, and relatively high frequencies of diagonally oriented decorative patterns.

Period 60. Circa AD 1600-1700. Heart River/Knife River Phase Transition.

Three batch components are placed in major period 60 (Table 17.8) which designates roughly a century-long span characterized by evidence in the ceramic data of elements of both the Knife River phase and the preceding Heart River phase. Batches placed in period 60 are poorly dated and are placed here primarily on the basis of ceramic content. This same time span, the seventeenth century, has also been subdivided in more detail into two subperiods (61 and 62) to which are assigned a small number of batch components thought to be more precisely datable. The Mahhaha period 2 sample (batch 30) is included in period 60, although the radiocarbon and TL dates available from this sample fall in the AD 1700s (Table 17.8). This placement is made largely because of the ceramic content of batch 30 which includes roughly equal frequencies of Unnamed wares, Le Beau ware, Knife River ware, and Transitional ware, suggesting a date earlier than AD 1700 for this batch. This ceramic composite also strongly indicates substantial mixture of several components in this batch sample. The two batches from intermediate and higher stratigraphic positions in Lehmer's tests at Lower Hidatsa Village are also included here based on general

Table 17.8. Working organization of analytic batches in the Knife-Heart and Garrison regions according to time periods and tentative culture-historic units.

Period	Batch and Description	Chronometric Dates C-14 Midpt	C-14 Crosspt	TL Mean	Best Estimated Period
PERIOD 10.	BEFORE AD 1200. LATE WOODLAND OR FORMATIVE VILLAGE.				
	92. Flaming Arrow (32ML4)	1109	1100	-	1050-1200
	99. Combined Late Woodland Components on the Cross Ranch	-	-	-	500-1200
PERIOD 20.	AD 1200-1300. CLARK'S CREEK PHASE.				
	34. Clark's Creek (32ME1)	1289	1280	-	1250-1300
	81. Stiefel (32ME202)	-	-	-	1200-1300
	97. PG (32OL148)	1303	1285	-	1250-1300
PERIOD 30.	AD 1300-1400. NAILATI PHASE.				
	11. Upper Sanger (32OL12), time period 4	1346	1350	-	1300-1400
	13. Mile Post 28 (32OL13)	-	-	-	1300-1400
	14. Cross Ranch (32OL14), test 1	-	-	-	1300-1400
	15. Cross Ranch (32OL14), house 3	1361	1367	-	1300-1400
	16. Cross Ranch (32OL14), house 7	1361	1367	-	1300-1400
	17. Cross Ranch (32OL14), other	1361	1367	-	1300-1400
	33. Mahhaha (32OL22), time period 5	-	-	-	1300-1400
	40. White Buffalo Robe (32ME7), early	1333	1290	-	1300-1350
	42. Amahami (32ME8), early	-	-	-	1300-1400
	43. Buchfink (32ME9)	-	-	-	1300-1400
	72. Stanton Ferry (32ML6)	-	-	-	1300-1400
	96. Angus (32OL144)	1351	1348	-	1300-1400

Table 17.8. Continued.

Period	Batch and Description	Chronometric Dates C-14 Midpt	C-14 Crosspt	TL Mean	Best Estimated Period
PERIOD 41.	AD 1400-1450. EARLY SCATTERED VILLAGE COMPLEX.				
	5. Pretty Point (32OL10)	1404	1430	-	1400-1450
	8. Upper Sanger (32OL12), time period 1	-	-	-	1400-1450
	9. Upper Sanger (32OL12), time period 2	-	-	-	1400-1450
	10. Upper Sanger (32OL12), time period 3	-	-	-	1400-1450
	26. Mandan Lake (32OL21), time period 2	-	-	-	1400-1450
	27. Mandan Lake (32OL21), time period 3	1521	1445	-	1400-1450
	28. Shoreline (32OL103)	-	-	-	1400-1450
	32. Mahhaha (32OL22), time period 4	1523	1450	-	1400-1450
	36. Lyman Aldren (32ME3)	-	-	-	1400-1450
	70. Big Hidatsa (32ME12), time period 7	1417	1435	-	1400-1450
	73. Poly (32ME407)	1481	1440	1571	1400-1450
	75. Scovill (32ME409)	-	-	-	1400-1450
	77. Forkorner (32ME413), east	1392	1430	-	1400-1450
	78. Forkorner (32ME413), west	1390	1425	1439	1400-1450
	79. Hump (32ME414)	1451	1415	-	1400-1450
	80. Youess (32ME415)	1387	1420	-	1400-1450
PERIOD 42.	AD 1450-1525. LATE SCATTERED VILLAGE COMPLEX.				
	?? 18. Bagnell (32OL16), late (?) component	1545	1582	-	1450-1525
	23. Mandan Lake (32OL21), T.1, time per. 1	1549	1578	-	1450-1525
	24. Mandan lake (32OL21), T.3, time per. 1	-	-	-	1450-1525
	25. Mandan Lake (32OL21), T.4, time per. 1	1525	1450	-	1450-1525
	31. Mahhaha (32OL22), time period 3	-	-	-	1450-1525
PERIOD 50.	AD 1525-1600. HEART RIVER PHASE.				
	6. Smith Farm (32OL9)	-	-	-	1525-1600
	7. Lower Sanger (32OL11)	1538	1490	-	1525-1600
	20. Hensler (32OL18), test 1	1525	1455	-	1525-1600
	21. Hensler (32OL18), test 2	1525	1455	-	1525-1600
	22. Hensler (32OL18), other	1525	1455	-	1525-1600
	37. Alderin Creek (32ME4)	1557	1572	-	1525-1600
	39. White Buffalo Robe (32ME7), late	1545	1583	-	1525-1600
	48. Lower Hidatsa (32ME10), time period 5	1555	1572	1634	1560?-1600
	49. Lower Hidatsa (32ME10), time period 6	1528	1455	-	1525-1560?
	55. Lower Hidatsa (32ME10), ACU6, hor. 3	-	-	-	1525-1600
	57. Lower Hidatsa (32ME10), ACU7, hor. 2	-	-	-	1525-1600
PERIOD 60.	CIRCA AD 1600-1700. HEART RIVER/KNIFE RIVER PHASE TRANSITION.				
	30. Mahhaha (32OL22), time period 2	1732	1705	1777	1600-1700
	54. Lower Hidatsa (32ME10), ACU6, hor. 2	-	-	-	1600-1700
	56. Lower Hidatsa (32ME10), ACU7, hor. 1	-	-	-	1600-1780
PERIOD 61.	AD 1600-1650. EARLY HEART R./KNIFE R. PHASE TRANSITION.				
	47. Lower Hidatsa (32ME10), time period 4	-	-	1687	1600-1650
	69. Big Hidatsa (32ME12), time period 6	1736	1736	-	1600-1650

Table 17.8. Continued.

Period	Batch and Description	Chronometric Dates C-14 Midpt	C-14 Crosspt	TL Mean	Best Estimated Period
PERIOR 62.	AD 1650-1700. LATE HEART R./KNIFE R. PHASE TRANSITION.				
	46. Lower Hidatsa (32ME10), time period 3	-	-	1739	1650-1700
	68. Big Hidatsa (32ME12), time period 5	1649	1645	1611	1650-1700
PERIOD 70.	CIRCA AD 1700-1780. EARLY KNIFE RIVER PHASE.				
	4. Molander (32OL7)	-	-	-	1700-1780
	29. Mahhaha (32OL22), time period 1	-	-	-	1700-1780
	53. Lower Hidatsa (32ME10), ACU6, hor. 1	-	-	-	1700-1780
	86. Nightwalker's Butte (32ML39)	-	-	-	1700-1780
PERIOD 71.	AD 1700-1740/45. EARLY KNIFE RIVER PHASE (WITH EXCEPTIONS)				
	0. On-a-Slant (32MO26), early, large	-	-	-	1700-1745
	2. On-a-Slant (32MO26), early, small	-	-	-	1700-1745
	45. Lower Hidatsa (32ME10), time period 2	-	-	1729	1700-1740
	67. Big Hidatsa (32ME12), time period 4	-	-	1645	1700-1745
PERIOD 72.	AD 1740/45-1780. EARLY KNIFE RIVER PHASE (WITH EXCEPTIONS).				
	1. On-a-Slant (32MO26), late, large	-	-	-	1745-1785
	3. On-a-Slant (32MO26), late, small	-	-	-	1745-1785
	44. Lower Hidatsa (32ME10), time period 1	-	-	-	1740-1780
	66. Big Hidatsa (32ME12), time period 3	-	-	1720	1745-1790
PERIOD 80.	CIRCA 1780-1845. LATE KNIFE RIVER PHASE.				
	41. Amahami (32ME8), late	-	-	-	1800-1845
	62. Sakakawea (32ME11), inside, mixed	-	-	-	1800-1845
	63. Sakakawea (32ME11), all other	-	-	-	1790-1845
	82. Rock (32ME15)	-	-	-	1780-1845
PERIOD 81.	AD 1780-1800. (EARLY) LATE KNIFE RIVER PHASE.				
	19. Greenshield (32OL17)	-	-	-	1790-1800
	61. Sakakawea (32ME11), time period 3	-	-	1797	1790-1800
PERIOD 82.	AD 1800-1820/30. (MID) LATE KNIFE RIVER PHASE.				
	60. Sakakawea (32ME11), time period 2	-	-	1800	1800-1820*
	65. Big Hidatsa (32ME12), time period 2	-	-	1725	1790-1830
PERIOD 83.	AD 1820/30-1886. (LATE) LATE KNIFE RIVER PHASE.				
	35. Fort Clark (32ME2)	-	-	-	1810-1862
	38. Deapolis (32ME5)	-	-	-	1790-1862
	59. Sakakawea (32ME11), time period 1	-	-	1833	1820-1845*
	64. Big Hidatsa (32ME12), time period 1	-	-	-	1830-1845
	83. Star (32ME16)	-	-	-	1861-1862
	85. Like-a-Fishhook (32ML2)	-	-	-	1845-1886
	94. Taylor Bluff (32ME366), late	-	-	-	?1830-1862

Table 17.8. Concluded.

Period	Batch and Description	Chronometric Dates C-14 Midpt	C-14 Crosspt	TL Mean	Best Estimated Period
UNASSIGNED.					
	12. Upper Sanger (32OL12), other	-	-	-	1300-1450
	50. Lower Hidatsa (32ME10), misc.	-	-	-	1525-1780
	71. Big Hidatsa (32ME12), other	-	-	-	1400-1845
	74. Elbee (32ME408)	1542	1555	1629	1520-1630
	76. Hotrok (32ME412)	-	-	-	1525-1780
	84. Grandmother's Lodge (32ME59)	-	-	-	1200-1525
	87. Mondrian Tree (32MZ58)	1552	1583	-	1500-1650
	88. Hagen (24DW1)	1460	1425	-	1450-1700
	89. Hintz (32SN3), house 3	-	-	-	1600-1700
	90. Hintz (32SN3), house 4	-	-	-	1600-1700
	91. Arzberger (39HU6)	1469	1430	-	1350-1500
	93. Sharbono (32BE419)	-	-	-	1525-1700
	95. Taylor Bluff (32ME366), early	-	-	-	1400-1600
	98. Running Deer (32ME383)	-	-	-	1400-1845
	100. Sagehorn (32ME101)	-	-	-	1200-1525

*See footnote 2, this chapter.

ceramic content and stratigraphic position in the site deposits. These samples are also probably highly mixed, and a more precise chronologic placement is not possible, although other batch samples from the same site can be more precisely dated. Ceramic characteristics distinctive of period 60 samples include foremost relatively high and equal frequencies of Le Beau ware, thought to signify the Heart River phase, and Knife River ware, thought to signify the Knife River phase. Transitional ware also occurs in higher frequency here than in other time periods.

Period 61. AD 1600-1650. Early Heart River/Knife River Phase Transition.

Two batch samples are placed in this relatively restricted time period, these being the period 6 sample from Big Hidatsa Village (batch 69) and the period 4 sample from Lower Hidatsa Village (batch 47). The relatively precise chronological placement of these two samples is based on detailed studies of the internal stratigraphy in each of these deeply stratified villages, together with considerations of C-14 and TL dating, ceramic content, trade artifact content and densities, sherd thickness characteristics, etc., worked out independently for each site sequence. In both sites, the batches included here are the earliest known to produce Euroamerican trade artifacts, estimated to have entered the region by the indirect trading process shortly after AD 1600. The derivation of the internal site chronology is spelled out for Big Hidatsa in Ahler and Swenson (1985a:86-113). The Lower Hidatsa batch sample consists in essence of the lower stratigraphic half of samples from that site previously assigned to time period 3 in the report on 1978 excavations (Ahler and Weston 1981:60-72). These two batches share certain ceramic characteristics such as occurrences of both Le Beau ware and Knife River ware (Le Beau being more common), and some occurrence of Transitional ware. Overall, both samples are more like Heart River phase and period samples (period 50) than later period samples.

Period 62. AD 1650-1700. Late Heart River/Knife River Phase Transition.

From a culture-historic or taxonomic perspective the two samples included in this subperiod differ little from those in the preceding period. The Lower Hidatsa period 3 batch (46) and Big Hidatsa period 5 batch (68) are included here on the basis of detailed studies of intra-site stratigraphy and chronology as discussed in the preceding paragraph. Chronometric dates exist for both batches included here; the central indicator for each date series falls outside the suggested range for period 62, but the two sigma range for each date series does overlap with the suggested period span, AD 1650-1700. Ceramic characteristics for this period and for these batches differ little from the attributes noted for the previous subperiod except that Knife River ware is somewhat more common, Le Beau ware is less common, and Transitional ware exhibits a peak in relative frequency.

Period 70. Circa AD 1700-1780. Early Knife River Phase.

This is a major period encompassing most of the eighteenth century AD and including a total of four batch samples which can be dated to roughly this time frame. Batches in this period include Molander, Mahhaha period 1, the uppermost stratified part of Lehmer's AC Unit 6 at Lower Hidatsa Village, and Nightwalker's Butte. All of the batch samples included here have been previously classified as being in the Knife River phase (cf. especially Lehmer et al. 1978 for discussion of Nightwalker's Butte and Lower Hidatsa), and all contain associated Euroamerican trade artifacts. None have been dated chronometrically or by direct historic observation, all apparently pre-dating the time of detailed direct historic documentation for village locations in the region (such records commence with Thompson's visit in 1797-1798). Various ethnohistoric evidence and oral traditions place occupation at all of the sites prior to the AD 1780-1781 epidemic. Wood (Chapter 12, this volume) concludes that traditions link the Awaxawi subgroup of the Hidatsas to occupation at Molander and possibly Mahhaha. Nightwalker's Butte is attributed to the Hidatsas, based on its location in the Garrison region, but a particular subgroup association is not offered.

The ceramic content of the batches in this period can be characterized as typical of a generalized Knife River phase composite (Table 17.7). Knife River ware dominates and Deapolis ware occurs in some frequency. Le Beau ware is uncommon, although frequencies of Le Beau ware vary widely among the components included here, probably reflecting different ethnic origins and subtraditions for the various components. Straight and straight braced rim forms are quite common, and cord-impressed, plain, and pinched decoration are common. Round lip forms are most common, and spouts and castellations occur frequently. Check-stamped surface treatment is rare, and few vessel bodies are decorated in shoulder areas. In general, the ceramic characteristics noted for this major period hold true for the temporally more restricted subperiods discussed in the following two sections (periods 71 and 72).

Period 71. AD 1700-1740/45. Early Knife River Phase (with exceptions).

Four batch samples are assigned to this relatively restricted chronological period in the first part of the eighteenth century AD. These include Lower Hidatsa period 2 (batch 45), Big Hidatsa period 4 (batch 67), and the two early batches from On-a-Slant (0 and 2). The Big Hidatsa and Lower Hidatsa samples are placed here on the basis of detailed studies of internal stratigraphy, trade artifact densities, and chronometrtic dates from deep excavations at each site, as detailed in the testing reports (Ahler and Swenson 1985a:86-113, and Ahler and Weston 1981:61-72). Lower Hidatsa batch 45 is essentially the stratigraphically lower half of deposits in the 1978 excavations originally assigned to period 1 in the 1981 report, subsequently subdivided and redated according to six time periods rather than three.

The Slant Village samples are included in this time period on the basis of trade artifact densities (Breakey and Ahler 1985) and data from Mandan traditions which place the entire occupation sequence at Slant in the period after about AD 1700 and before about 1780/1785. For example, in a brief biography of a Mandan named Bad Gun who was born in 1829, Libby (1908:465) reports that Bad Gun's grandfather, Good-Boy, was born at Slant Village and, while still young, became its chief a few years after the founder of Slant Village, Good Fur Blanket, died. Thus Slant was founded by Mandans in the third or fourth generation before Bad Gun who was born in 1829. This would indicate a founding date for Slant in the early 1700s. The village is thought to have been abandoned shortly after the devastating 1780-1781 smallpox epidemic and an attack by the Sioux. The cluster analyses clearly place the early batch sample from Slant (batch 0) in the Heart River phase group. There is no reason to question this taxonomic placement based on ceramic data, and the term Heart River phase seems appropriate for describing the content of the early Slant Village batch samples (0 and 2). However, the chronological placement of this batch sample, if correct, indicates that the Heart River phase persisted in the Heart River area, and perhaps at all Mandan sites, long after the transition to the Knife River phase at sites in the upper Knife-Heart region. Batch 2, comprised of physically smaller vessel parts from early contexts at Slant Village, is also included in this time period for purposes of further analysis.

The pottery samples in this period contrast greatly between sites (Table 17.7). The Big Hidatsa and Lower Hidatsa samples generally conform to the Early Knife River phase patterns noted in the preceding section for period 70. The Slant Village samples contrast markedly with the samples from Knife River sites. Le Beau ware with finely executed cord-impressed decoration dominates the Slant samples; Knife River ware and the companion wares characteristic of the Knife River phase are virtually absent. These contrasts will be examined in more detail in a subsequent section on Mandan-Hidatsa comparisons.

Period 72. AD 1740/1745-1780. Early Knife River Phase (with exceptions).

This is a temporally restricted time period containing samples which can be dated with some certainty to the 35-40 year period immediately preceding the AD 1780-1781 smallpox epidemic. Four batch samples analogous to the four included in the preceding subperiod 71 are included here: Lower Hidatsa period 1 (44), Big Hidatsa period 3 (66), and the two batch samples from the late period at On-a-Slant Village (batches 1 and 3, containing large and small vessel fragments from the same contexts). The rationale for inclusion of the samples in this subperiod follows the reasoning and explanation given for samples in subperiod 71. The Lower Hidatsa and Big Hidatsa samples are so grouped based on detailed intrasite and chronometric studies, while the Slant samples are included based on dates provided by ethnohistoric documentation. The pottery samples included here have widely varying characteristics according to site (Table 17.7), with the Big Hidatsa and Lower Hidatsa samples conforming generally to the Early Knife River phase characteristics enumerated above for this general time period (period 70). The Slant Village samples exhibit a predominantly Heart River phase character modified by forces originating in part in the Knife River phase. Slant pottery is dominated by Le Beau ware, with plain, tool-impressed, and pinched decoration being common. Alongside Le Beau ware occurs Knife River ware and Transitional ware pottery similar or identical to that which dominates sites in this subperiod at the Knife River. These intraregional differences will be explored more fully in subsequent sections on Mandan-Hidatsa comparisons.

Period 80. AD 1780-1845. Late Knife River Phase.

This is a major time period which includes a series of four batch samples from three sites which can be dated by historic or ethnohistoric documentation to a period after the AD 1780-1781 epidemic but prior to establishment of Like-a-Fishhook Village in 1845. This includes the late component at Amahami (batch 41) attributed to the Awaxawis. This village was settled sometime between Thompson's visit in 1797-1798 and Lewis and Clark's visit in 1804; the date of abandonment can be argued as possibly occurring as early as the Sioux burnout in 1834 (Stewart 1974:296) or as late as general abandonment of the region by all Hidatas in 1845. Also included here are the Sakakawea inside-house batch (62) and the Sakakawea other batch (63). These contain a mixed composite of Sakakawea artifacts dating from the time of initial settlement by Mandans and Awaxawis in the 1780s/1790s through the major period of Awatixa occupancy which ended by no later than 1845 (cf. Stewart 1974:296).[3] Finally, this period has assigned to it the Rock Village sample (82). According to ethnohistoric data (see the discussion in the section of batch definitions), this site was settled in the 1780s/1790s by the Awatixas, was soon abandoned for their move to Sakakawea Village, and then was resettled for a brief period after the 1837 epidemic by a mixed Mandan/Hidatsa group. Thus the artifacts in batch 82 probably reflect a composite sample of two components spanning most of period 80.

Pottery characteristics for this major period are typical of the Knife River phase with added features indicating a degeneration of pottery technology and decreasing general interest in ceramic manufacture (Table 17.7). Knife River ware dominates, Deapolis ware occurs, and virtually no other wares exist. Nearly all rims are straight and braced in form. Cord-impressed and plain decoration occur in nearly equal frequency, with the increase in plain from previous periods suggesting a grow-

[3] See footnote 2, this chapter.

ing disinterest in the time-consuming aspects of pottery manufacture and decoration. Shoulder decoration is virtually absent, and check-stamping occurs rarely. Most thickness measurements on the vessel rim and on body sherds show a marked increase from values in all previous periods, reflecting more crudely made vessels. Virtually all of the general characteristics noted for period 80 prevail in the three subperiods, 81, 82, and 83, which are discussed below (see Table 17.7). Many of the patterns interpreted here to reflect declining interest and skill in pottery making show progressive development through the subperiod sequence. Details of those changes and developmental sequences will be explained more fully in the following major section on chronological change in regional ceramics.

Period 81. AD 1780-1800. (Early) Late Knife River Phase.

Two batch samples which can be dated fairly certainly by historic records to the restricted period in question are assigned to this subperiod. These are the Greenshield site batch (19) and the earliest period batch (61) from Sakakawea Village. The Greenshield site occupation is dated to a span of a few years in the late 1790s on the basis of direct observations by Thompson on his trip in the region in 1797-1798 and by ethnohistoric data collected by several travelers in the immediately following period (cf. Chomko 1986). Greenshield was occupied by one subgroup of the Arikaras and also apparently by one subgroup of the Mandans who subsequently settled at one of the two Mandan villages observed by Lewis and Clark in 1804. Occupation of Sakakawea Village in 1797-1798 by a mixed group of Mandans and an unidentified Hidatsa subgroup is documented by Thompson (Wood 1977). Bowers (1965:11) identifies the Hidatsas there at that time as the Awaxawis. By the time Lewis and Clark visited the site in 1804, it was occupied by the Awatixas. Here we attribute the earliest burned series of houses at Sakakawea Village (identified as batch 61) to the mixed Mandan/Awaxawi settlement, and attribute subsequent overlying archeological deposits (batches 59 and 60) to the following Awatixa settlement. Thus, neither of the two batch samples assigned to this group is attributable to predominantly Hidatsa occupation, and this fact will be considered in subsequent studies of ceramic change and Mandan/Hidatsa relationships. General pottery characteristics for this period have been described in the preceding section.

Period 82. AD 1800-1820/1830. (Mid) Late Knife River Phase.

Two batch samples are assigned to this restricted time period. These are the early outside-house sample from Sakakawea village (60) and the period 2 sample from Big Hidatsa Village. The Big Hidatsa sample reflects Hidatsa-proper occupation of that site during the approximate period from 1790-1830. These dates and the composition of this batch were developed by detailed study of the intrasite chronology, stratigraphy, and trade artifact content, as documented in the 1985 report (Ahler and Swenson 1985a:86-113). The Sakakawea sample relates to the primary occupancy of that site by the Awatixas after about 1800, and it reflects a stratigraphic separation of the outside-house midden into upper and lower parts thought to date roughly AD 1800-1820 and AD 1820-1834/1845.[4] Ceramic characteristics for this period are generally those enumerated for the general Late Knife River phase period 80, discussed above.

Period 83. After AD 1820. (Late) Late Knife River Phase.

This period sample includes seven batches from as many sites differing greatly in the precision by which they can be dated. All have in common occupation spans which occurred predominantly after AD 1820. The two most precisely dated samples include the uppermost stratified deposits from Sakakawea Village (batch 59), thought to date circa AD 1820-1834/1845,[5] and similarly positioned deposits from Big Hidatsa (batch 64) which are thought to date circa AD 1830-1845. Also fairly precisely dated are the batch 83 sample deriving from the Arikara occupation of Star Village in 1862 (Metcalf 1963:67) and the Like-a-Fishhook sample (85) spanning the period from 1845 to allotment in 1886.

More loosely dated samples derive from Fort Clark and Deapolis. The precise date of Mandan settlement at Fort Clark Village is uncertain, but it probably occurred around 1822 (Wood 1986c:20). The village was occupied by the Mandans until 1837 and by the Arikaras from 1838 to abandonment in 1861.

[4] See footnote 2, this chapter.

[5] See footnote 2, this chapter.

The date of settlement at Deapolis is also uncertain. The Deapolis site as it has been defined is actually fairly imprecisely located. Post-contact age village debris which can be attributed to the Mandans extends over a broad area in the vicinity of the Deapolis site, from the Boller site (32ME6) upstream, to the Big White site (32ME203) more than two miles (3 km) downstream. Many different Mandan settlements probably existed along this portion of the river, and it is presently nearly impossible to assign specific dates to artifacts from any one small part of this area. A Mandan village existed in the vicinity of the Deapolis site at the time of Thompson's visit in 1797-1798, but it is unclear if this village was directly on the Deapolis site location from which our artifact sample derives (Thompson 1961). Shifts in Mandan village locations took place between Lewis and Clark's first and second visits to the area in 1804 and 1806. One village existed in the Deapolis site vicinity in 1804, and two existed there in 1806. It is likely that one of these two Mandan villages was located precisely on the Deapolis site by 1806. The village in the vicinity of Deapolis was not abandoned by the Mandans after the 1837 epidemic, and it is known that a small remnant of Mandans held on there as a separate group at least as late as 1855 (Wood 1986a:47) and perhaps until Fort Clark trading post was abandoned circa 1860. It is likely that the majority of occupational debris in our Deapolis Village sample derives from the post-1820 period, justifying inclusion in this time period group.

The late component at Taylor Bluff site in the KNRI (batch 94) is also included in this period, although ceramic materials from that component have not been included in this study. Occupation there is clearly late historic in time, based on artifact content, and a post-1820 date is almost certain.[6]

As can be noted from the present discussion, the tribal or ethnic group content of the components assigned to this period is quite varied. Awatixa Hidatsas are represented at Sakakawea Village, Hidatsas-proper at Big Hidatsa Village, and predominantly Hidatsas of various subgroups in the Like-a-Fishhook sample. Deapolis is presumably pure Mandan, while Fort Clark contains a mixture of Mandan and Arikara artifacts. Star Village is Arikara alone, and Taylor Bluff was of undetermined tribal or subgroup identification at the time of this writing, but has later been proposed to be Awatixa Hidatsa in association (cf. Ahler 1988).[7] These differences will be noted where appropriate in the following discussions of ceramic change and Mandan-Hidatsa comparisons. The general ceramic characteristics for all batches in this period are somewhat similar, reflecting the patterns noted previously for the general Late Knife River phase period (period 80), with the decline in ceramic quality and technology being accentuated in most samples.

CHRONOLOGICAL CHANGE IN POTTERY ASSEMBLAGES

In this section we examine the subject of chronological change in pottery assemblages in the study samples from the Knife-Heart and Garrison regions. There are two parts to this examination, one being the description of variation in several pottery variables according to the chronological dimension, and the second being pursuit of possible explanations for those observed patterns.

Patterns of Change

The basic approach here is to summarize data for several ceramic variables in graphic form to illustrate what are thought to be the most significant changes through time in the study samples. In this presentation, we deal specifically with data summarized by time periods, as listed in Tables 17.7 and 17.8 and as previously discussed. Many individual ceramic variables exhibit significant change through time in the regional samples, as illustrated by the particular variables listed in Tables 17.5 and 17.6. Here we examine those variables as classes of variables, looking first at what are usually considered to be the most fundamental of expressions of stylistic differences (rim form and ware classes) and then moving to those variables which presumably express more detailed stylistic variation such as decorative techniques and minor shape changes in specific vessel zones. Finally, we focus on a small number of variables such as vessel thickness and measurements which might express changes in basic technological parameters of the pottery assemblages.

[6] See footnote 2, this chapter.

[7] See footnote 2, this chapter.

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The data used here consist primarily of variable attribute state frequencies and percentages computed for all pottery in all batches assigned to a time period. These summary percentage figures are plotted across time periods to give a graphic presentation of chronological change. Mean data values for several metric variables are also presented graphically by time period. These data values were computed by the SPSS-X (SPSS, Inc. 1983:287-301, 321-332) programs CROSSTABS and BREAKDOWN. Differences in relative frequencies for nominal variables were tested for significance by means of chi-square analysis applied to frequency tabulations by time period, and analysis of variance was used to test for significant differences in metric variable means by time period. The detailed data involved in the chi-square and ANOVA tests will not be presented here, although the results of the significance tests will be noted where thought to be important.

The data presented here are compiled across all batches assigned to a time period without regard to ware, rim form, or typological classification of the pottery involved. For example, the graphic data on changing lip shape through time is compiled irrespective of vessel classification by rim form or ware. With some notable exceptions, then, the data presented here consist of the "overall" period summary data listed for each time period in Table 17.7. The exceptions involve the exclusion of certain batches from general consideration at this time.

Two principles guided further selection of the data to be compiled by time period. First, we wished for the study of chronological change to focus as directly as possible on the upper Knife-Heart Region and particularly on sites thought to lie in the "Hidatsa" cultural tradition. This focus was followed in order to temporarily exclude from consideration potentially confusing variation which might derive from tribal or cultural tradition differences rather than from chronological differences. On this basis, site or batch samples included in the study are generally those lying within the upper Knife-Heart region and Garrison region, with the exception of particular sites known to be primarily non-Hidatsa in tribal association. Sites used for the period summaries in Table 17.7 but excluded from the present chronological study are the four On-a-Slant batches (0-3, known to be Mandan in origin and occurring in the lower Knife-Heart Region), Greenshield (batch 19, known to be Arikara and possibly Mandan in origin), Sakakawea period 3 (batch 61, thought to be primarily Mandan in origin), Fort Clark (batch 35, known to be Mandan and Arikara in origin), Deapolis (batch 38, known to be Mandan in origin), and Star (batch 83, known to be Arikara in origin). Even though it is a mixed sample, Like-a-Fishhook was included because it is thought to be primarily Hidatsa in origin, based on survivor rates for Mandans and Hidatsas following the 1837 epidemic.

The second principle was that the chronological comparison is to be as detailed and fine-grained as possible. This means that several post-AD 1600 samples assigned to major time periods and having less precise chronological placement (periods 60, 70, and 80) were given less consideration as opposed to more precisely dated samples spanning the same general time frame (periods 61, 62, 71, 72, 82, and 83). Data are occasionally presented for the more general period samples (60, 70, and 80). It will be apparent that most of these are mixed samples which probably contain considerable amounts of pottery which are chronologically misclassified, further justifying their exclusion from chronological pattern studies.

Thus, we focus here as specifically as possible on chronological change in the "Hidatsa ceramic tradition," presenting the results in the most fine-grained temporal increments that can be obtained from the available data sets. The reliability of the patterns of change observed in these samples depends of course on adequate sample sizes. The number of observations that can be recorded on the vessels depends in turn on the degree of fragmentation of the vessels and on the frequency with which a given vessel zone was used in vessel construction during each time period. Thus the number of observable vessel zone occurrences constitutes the effective maximum possible sample size for the variables studied here. Such data are reproduced in Table 17.9 for the "Hidatsa tradition" pottery sample, giving the reader an indication of when and for which zones the data might become less reliable due to small sample sizes. Note that the numbers plotted in Table 17.9 for individual zones constitute the maximum possible sample size, and that certain complex variables such as decorative patterns cannot be observed on nearly that many vessels due to fragmentation and incomplete zone occurrences.

Table 17.9. Data on sample size expressed as the maximum number of observable occurrences of each vessel zone according to time period for the Hidatsa tradition ceramic samples from the upper Knife-Heart and Garrison regions.

Time Period	Zone Occurrences in Coded Vessels							N Body Sherds	
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Sur.Tret.	Thick.
10	1	9	0	0	0	0	9	99	96
20	2	106	33	0	0	0	131	959	310
30	22	536	452	8	26	24	823	3374	1369
41	35	653	680	4	135	24	915	3841	2744
42	10	166	215	1	99	4	243	1323	706
50	22	321	527	20	106	2	453	3896	2302
60	4	130	85	0	94	1	189	1122	168
61	4	64	76	4	30	2	95	1281	1189
62	7	129	115	3	104	0	196	2789	2502
70	25	203	44	4	169	1	265	2263	865
71	7	110	52	2	107	1	182	2498	2209
72	8	137	53	3	141	0	220	2767	2473
80	35	355	12	1	343	1	394	1452	317
82	11	118	16	0	143	1	186	2243	1595
83	12	95	8	0	111	3	151	1260	621
Total	205	3132	2368	50	1608	64	4452	31167	19466

Ware Class Change

Ceramic wares and ware-like groups capture primarily data on rim form preferences and secondarily information on decorative details associated with particular rim form variants. These are somewhat subjectively defined groups, but they are thought to capture fundamental aspects of ceramic variation among phases or other taxonomic groups and through time.

Temporal variation in ware class percentages is illustrated in Figure 17.7. As might be surmised from the graphs, ware class frequencies show statistically significant variation according to chronology. For clarity, the ware class percentages are graphed in two parts, involving primarily early wares (Figure 17.7a) and late wares (Figure 17.7b). It can be seen that each of the major periods and potential taxonomic units in each period prior to AD 1525 is characterized by a relatively unique combination of dominant ware classes. The Formative Village period (10) contains only Unnamed Straight Rim ware (admittedly a small sample of nine vessels from the Flaming Arrow site). In period 20 associated with the Clark's Creek phase, straight-rim Riggs ware is dominant, with minor amounts of Fort Yates and Unnamed S-Rim ware occurring. Anderson ware (not graphed) makes its only appearance in period 20, comprising a small fraction of the total pottery sample (Table 17.7). In the Nailati phase and period 30, Riggs ware and Fort Yates ware occur in highest and relatively equal frequency, with Unnamed wares of various forms comprising smaller and about equal frequencies. The Unnamed Straight Rim and Unnamed S-Rim ware classes are dominant in periods 41 and 42, both assigned to the Scattered Village complex. One of the distinctions between the early and late parts of this period is the diminishing relative frequency of both of these ware groups, associated with increasing frequency of Le Beau ware.

The relatively high percentages of Unnamed Straight and S-Rim wares in the major period 60 and 70 samples (indicated by solid symbols in Figure 17.7a) strongly indicate that some of the batches making up those major period samples contain chronologically mixed deposits. This is particularly true for the Mahhaha batches (29 and 30) which account for a large portion of the Unnamed ware examples in periods 60 and 70. This pattern in which the composition for periods 60 and 70 is basically incongruous with samples for period 61/62 and 71/72 will be noted again for several other variables. This indicates that those batch samples are mixed and not easily chronologically classified according to a single time period.

Le Beau ware (Figure 17.7b) first begins to appear in period 41 (AD 1400-1450) and rapidly becomes the dominant ware class in the Heart River phase shortly thereafter (period 50, AD 1525-1600). After AD 1600 there is a gradual and very steady decline in the relative frequency of Le Beau S-Rim ware and a corresponding, mirror image increase in the highly contrastive and distinctive straight rimmed Knife River ware. Minor wares also come and go during this post-AD 1600 period. Transitional ware, reflecting a mixture of attributes associated with both Le Beau ware and Knife River ware, becomes most frequent in period 62, in the late AD 1600s, at a time when the shift from Le Beau to Knife River ware is occurring at a maximal rate in regional samples. Deapolis ware, which may rightly be considered as simply a variant of Knife River ware having a particular collared form of brace, peaks in frequency in period 72 in the later 1700s and gradually diminishes in relative frequency thereafter.

Note that the content of the major period samples (60, 70, and 80) represented by solid symbols in Figure 17.7b does not agree well with the content of the presumably contemporaneous samples in finer-grained subperiods. It appears that each of these major period samples has been placed too early in time. This is the opposite appearance from that given by early ware data (Figure 17.7a), illustrating the chronologically mixed composition of some of the batch samples assigned to the major period groups (particularly batches 29 and 30 from Mahhaha and possibly 53, 54 and 56 from Lower Hidatsa).

Rim Form Change

Changes in general rim form class or rim form attribute frequencies are examined through time, independent of ware classification. This may give a more objective picture of temporal changes in vessel shape, independent of subjective classification of individual vessels according to ware groups which are based in part on considerations other than rim form characteristics. Such an examination is presented graphically in Figure 17.8a. Two basic rim form types occur in the regional samples, straight/outflared rims and S-shaped rims. For this reason, one can expect the relative proportions of such classes to vary inversely through time; i.e., the pattern shown in Figure 17.8a. The other rim form classes plotted in the figure are variants or additive features which may be applied to one or the other or both of these basic rim forms. For example, percentages are computed for the frequency of bracing in the regional samples, with the bracing potentially occurring as an added feature on either straight or S-shaped rims. Similarly, filleting can occur on either basic rim form. Recurved rims are those with a zone 4, recurved area, and thus constitute a special type of S-shaped rim.

S-shaped rims as a general group (encompassing several ware variants) show a very strong pattern of temporal change. Such rims are absent in the period 10 sample, gradually increase to a peak of more than 80 percent in the period 50, Heart River phase samples, and then rapidly decrease to less than 10 percent in the latest historic period samples. Straight rims exhibit a pattern which is the mirror image of that for S-rims, dominating earliest and latest period samples, and being least common in the period 50 samples.

Bracing, as a special rim form feature, exhibits quite a different pattern which, through the entire temporal sequence, is not especially similar to the pattern for either straight or S-rims. The braced form first becomes noticeably common in the period 41 and 42 samples (Scattered Village complex), diminishes slightly in the period 50 sample, and then increases in frequency even more rapidly than straight rim wares in the period from AD

1600 onward. The temporary decrease in braced form occurrence in the period 50 samples is interesting, suggesting that the period 50 materials reflect a disruption of a pattern of increasing use of bracing that began in the previous periods. Bracing is most commonly associated with Knife River ware which increasingly dominates the later period samples. It also is characteristic of both Transitional ware and Deapolis ware, and it does occur in the earlier Le Beau ware and Unnamed wares, as well.

The use of fillets, usually applied to straight rim vessels, while generally rare, is most common in the period 30 and 41 samples (Nailati phase and Early Scattered Village complex). This rim form variant shows a brief resurgence late in time; in that context, filleting is usually associated with Deapolis ware vessels. Recurved S-rims are also rare, but this rim form variant is most common in the period 50 and period 61 samples. This variant of the S-rim form becomes less common later in time, and eventually disappears as S-rims in general become a minor part of the ceramic samples in the latest time periods.

Additional details can be provided concerning more subtle aspects of rim form change, in particular, changes in the shape and dimensions of zone 3. This is of relevance because the distinctions among some of the S-rim wares (Fort Yates, Unnamed S-Rim, and Le Beau) are based on more subtle characteristics of S-rim shape and dimensions. Data for selected variables over time are graphed in Figure 17.8b. The angularity of the lower juncture boundary is one of the features distinguishing Fort Yates ware (predominantly angular) from Le Beau ware (typically curved). The proportion of classifiable zone 3 occurrences which are curved is plotted in the figure. The data indicate that curved zone 3 shape is rare in period 20, increases in periods 30 and 41, and increases dramatically in period 42. From period 50 on, curved shape in zone 3 diminishes gradually and somewhat erratically. This pattern corresponds fairly well with the ebb and flow of Fort Yates and Le Beau ware, except that the sudden increase in curved zone 3 occurrences in period 42 slightly precedes the major increase in Le Beau ware in period 50 (Figures 17.7a and 17.7b). It seems that a curved shape in zone 3 is particularly characteristic of Unnamed S-Rim ware assigned to period 42 as well as of Le Beau ware.

Metric dimensions measured for zone 3 also vary significantly through time. Analysis of variance indicates that both zone 3 height and zone 3 inflection measurements vary significantly by time period. The zone 3 height exhibits an interesting pattern in which it diminishes greatly during periods 41 and 42 (Scattered Village complex), then peaks in period 50 (Heart River phase), and then decreases somewhat erratically in the later periods. Zone 3 inflection measurements, documenting the amount of vertical curvature in that part of the vessel, show a similar but even more regular pattern. Mean inflection values are low in periods 41 and 42 (Scattered Village complex), increase dramatically in period 50 (Heart River phase), and then steadily decrease afterwards through the late historic period.

The shape of the juncture between zone 2, the neck, and zone 1, the body, also changes significantly through time, as illustrated in Figure 17.9a. In that figure percentages for curved junctures are plotted, these data being the complement of percentages for angular juncture shape. Data from period 10 are limited to a single vessel and therefore carry little weight. Minimum occurrence of curved zone 2 juncture and maximum occurrence of angular juncture is indicated for period 20, Clark's Creek phase. This vessel form occurs primarily in this period in Riggs ware, in which the upper straight rim joins the vessel body in a relatively abrupt, angular juncture. After period 20, angular juncture shape decreases markedly in relative importance and curved junctures become much more common. In period 50, Heart River phase, 80 percent of the classifiable zone 2 juncture shapes are curved. Thereafter, the proportions between curved and angular juncture shapes vary somewhat erratically, but with curved forms comprising 50 percent or more of the samples in all periods.

Decoration Location Change

The choice of alternative zone areas as locations for application of decoration varies significantly through time in the study samples. Figure 17.9b provides a graphic plot of the percentages of available zone surfaces in each time period which exhibit decoration of any kind. The type of decoration used in any zone is not considered here. Several temporal patterns can be noted. Zone 3, the upper part of the S-rim, was heavily decorated in periods ranging in time from the 1200s through the early 1600s, during which time 89 percent or more of the zone 3 occurrences were used as a locus for decoration. Subsequent to AD 1650, zone 3 was used less and less commonly as a locus for

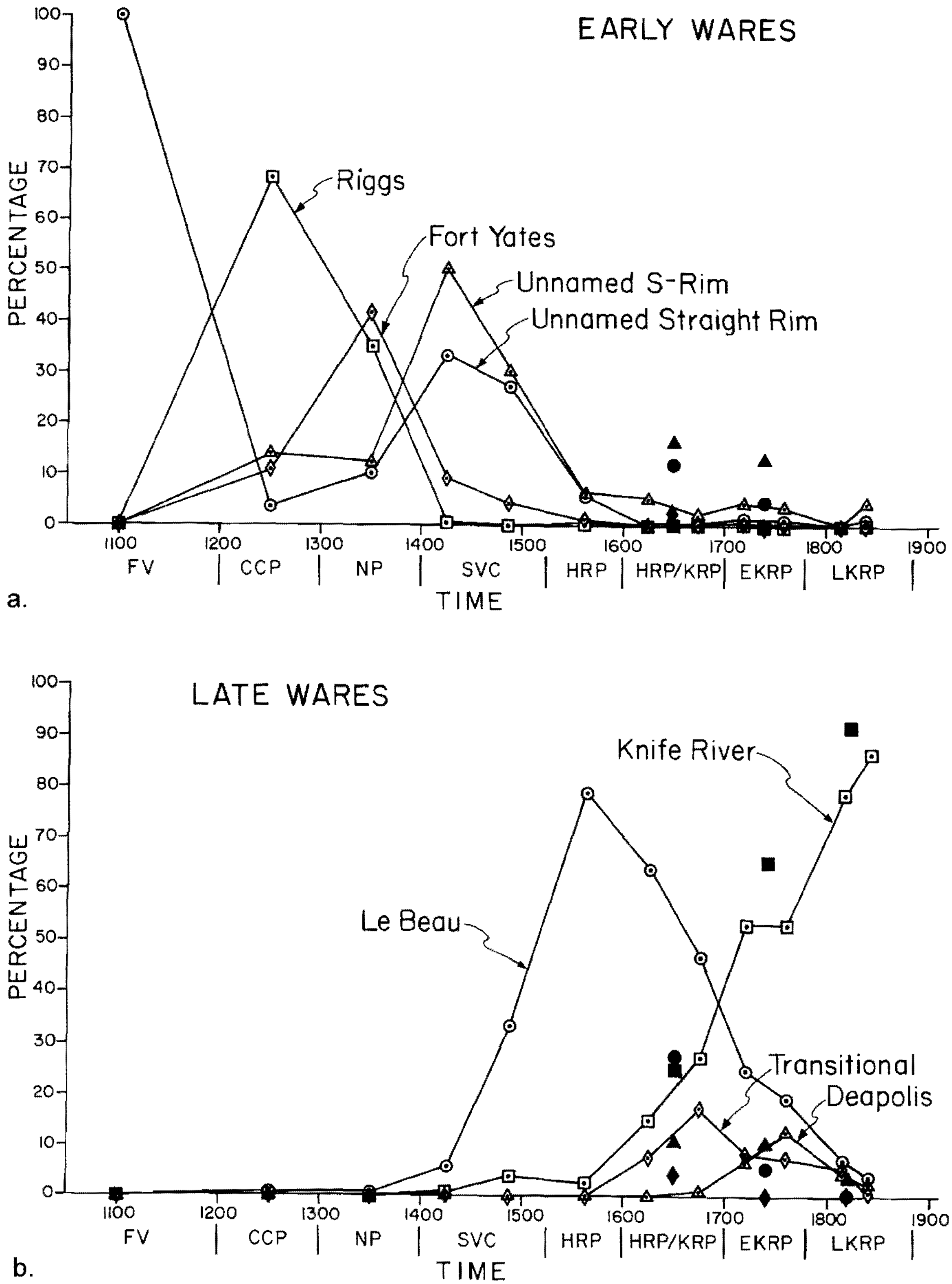


Figure 17.7. Data distributions by time period for Hidatsa tradition ceramic batches. Solid symbols indicate data for major periods 60, 70, and 80. a: percentages of early wares; b: percentages of late wares.

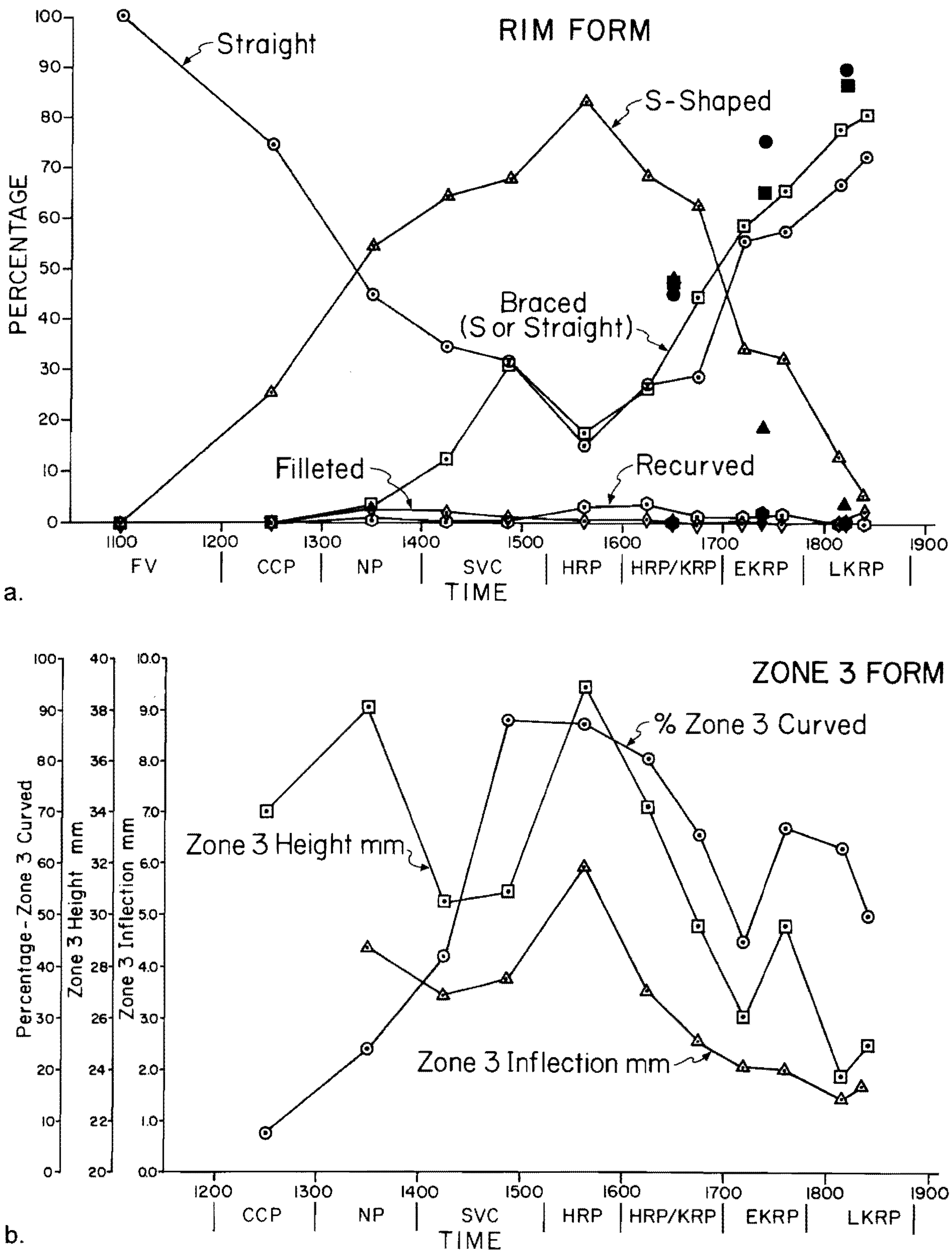
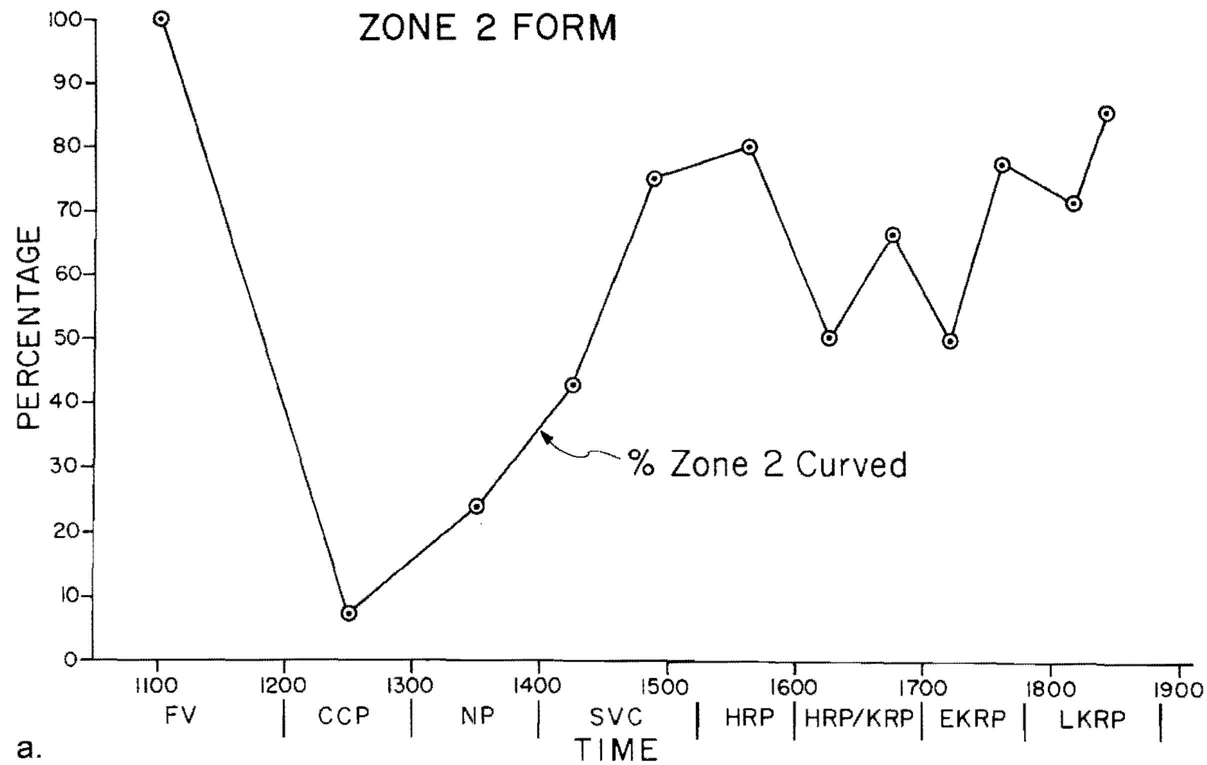


Figure 17.8. Data distributions by time period for Hidatsa tradition ceramic batches. Solid symbols indicate data for major periods 60, 70, and 80. a: rim form class percentages; b: zone 3 curvature and measurement data.



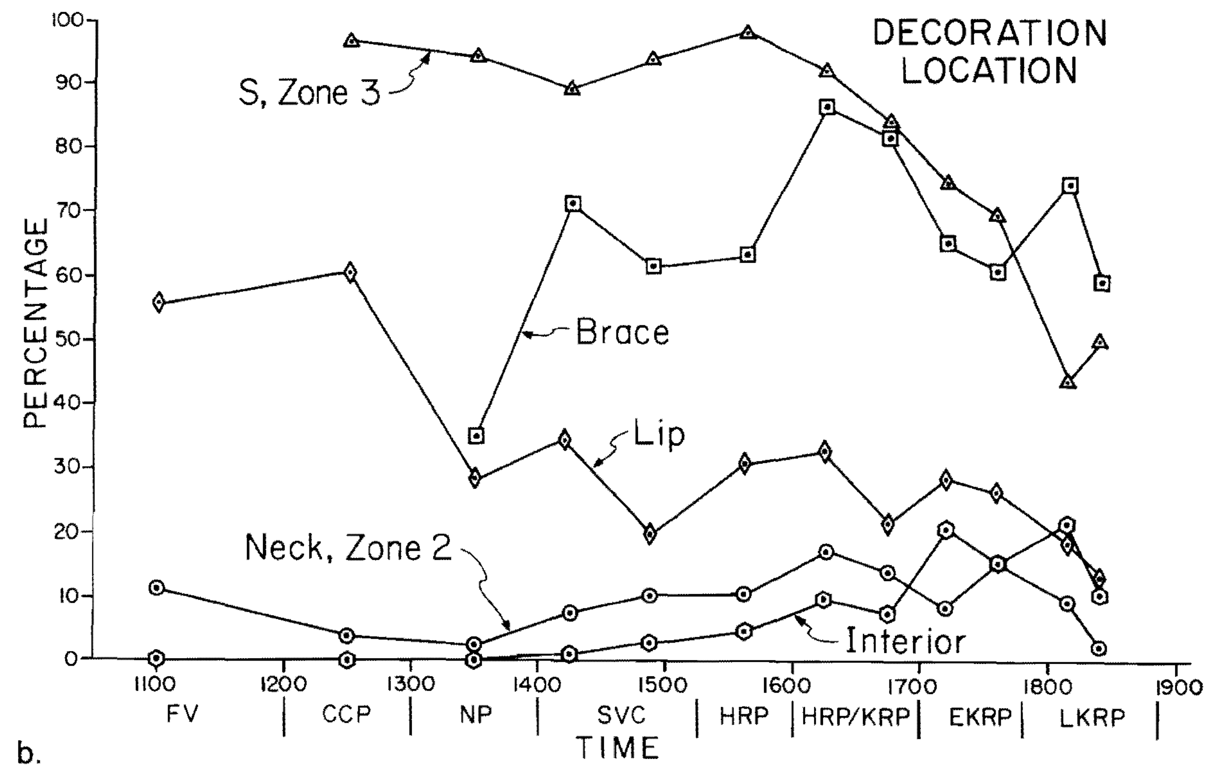


Figure 17.9. Data distributions by time period for Hidatsa tradition ceramic batches. a: percentage of zone 2 occurrences with curved shape; b: percentages of vessel zone occurrences which exhibit some form of decoration.

decoration. This pattern corresponds with a decreasing occurrence of zone 3 (S-rims) in vessels in general, and also with a general pattern of less decoration later in time, regardless of vessel form (see the following discussion). The frequency of decoration on the brace also changes through time. In the earlier periods (Nailati through Heart River phase) when braces are less commonly used as an element of vessel form, braces are also less frequently decorated. In the early 1600s, when braces have become a common element of vessel form in the study sample, decoration also is most commonly applied wherever braces occur. Thereafter, the relative frequency of decoration on braces tends to gradually decrease through time, corresponding perhaps to the general tendency for more completely plain vessels to occur in the latest time periods.

Lip decoration shows a somewhat erratic but strong general temporal pattern (Figure 17.9b); through time there is progressively less frequent use of the lip as a decorative locus. In the earliest two periods, more than 50 percent of the lips exhibit decoration of some type; by the latest two periods, the figure has dropped to less than 20 percent. Decoration on zone 2 or the lower rim face or neck area shows a gradual increase through time, reaching peaks above 15 percent in the 1600s and 1700s, with a substantial decline in the 1800s. Decoration on the vessel interior is never particularly common, but this variable shows a distinct and fairly regular temporal pattern. This feature is nonexistent in the earliest period, begins to occur in the 1400s, and gradually becomes more common and peaks in frequency at greater than 20 percent in the 1700s. This decoration usually occurs in the form of multiple parallel cord impressions placed just below the lip on the vessel interior.

Decorative Type Change

The decorative types used to classify the regional samples capture information on the "dominant" decorative techniques used to decorate the ceramic vessels. Thus, the decorative type classification ("new type") illustrates general patterns in decorative techniques, while glossing over information on decorative information controlled according to ware, according to location on the vessel, or according to possible combinations with other decorative techniques also used on the same vessel.

Several significant and patterned changes in decorative type occur in the study samples. These patterns are illustrated in Figure 17.10a for the three most common decorative types and in Figure 17.10b for several other less common decorative types. The three most common decorative types are cord-impressed, plain, and tool-impressed. Cord-impressed type exhibits major temporal changes, being absent in the small period 10 sample, and gradually increasing to a peak of nearly 90 percent in the period 50, Heart River phase sample. Thereafter, cord-impressed type gradually decreases to less than 60 percent in the latest period 83 sample. Plain type pottery percentages exhibit a pattern which is somewhat the inverse of that for cord-impressed. Plain pottery is relatively common in period 10, diminishes to a low of less than 5 percent in the period 50, Heart River phase sample, then increases to a peak of nearly 40 percent in the latest period 83 sample. Tool-impressed is a predominantly early decorative technique. It is most common in the period 20, Clark's Creek phase sample (occuring in the type Riggs Decorated Lip). It diminishes greatly in importance in period 30, then becomes somewhat more common again in the period 41 and 42 samples (Scattered Village complex). Indeed, tool-decorated pottery is one of the characteristics of the Scattered Village complex assemblages. From period 50 (Heart River phase) onward, tool-impression is a minor decorative technique.

Minor decorative types, generally constituting less than 20 percent of the sample in any time period, are graphed in Figure 17.10b. While the raw frequencies of these minor types are small in comparison with the major types discussed above, several chronologically clear and potentially significant patterns emerge for these types. For example, certain minor types are associated primarily with the early part of the regional cultural sequence. Finger-impressed pottery is most common in the Nailati phase (AD 1300-1400) and diminishes rapidly to a minimum in the early 1600s. Trailing/incising shows a somewhat similar pattern, except that it peaks in frequency somewhat later in time (in period 41, Early Scattered Village complex), drops to a minimum value in the early contact period, and then increases slightly in the terminal periods. Stab-and-drag occurs almost exclusively in the period 30 and 41 samples (Nailati phase and Early Scattered Village complex).

Cord-wrapped-tool-impressed (CWTI) decoration exhibits an interesting temporal pattern (Figure 17.10b). It is most common in the period 10 sample, occurring in five of nine or 55 percent of the vessels in that period. Immediately thereafter, it becomes a nearly unused decorative technique in the study samples until a minor resurgence around AD 1600 (period 61). Thereafter, it gradually diminishes in significance to a frequency of zero in the late historic samples. Dentate stamping is a decidedly late although very minor decorative technique. It first occurs in measurable frequency in the period 71 samples (early 1700s), continues to occur into the early 1800s, then virtually disappears in the latest period samples.

Brace Shape Change

The shape of the brace, a relatively minor aspect of overall vessel form, changes significantly through time. Relative frequencies for selected brace shape classes are illustrated through time in Figure 17.11a. Curved, exterior braces are the most common form throughout all periods (with one minor exception). The percentage graph indicates that this form of brace gradually increases in relative frequency through time from about 40 percent in the pre-Heart River phase periods to about 55 percent in the latest historic periods. More dramatic changes in other brace variants occur, however. Interior bracing is a common variant in periods 30, 41, 42, and 50 (Nailati through Heart River phases), and then this brace type virtually disappears from the samples post-dating 1600. An inverse pattern, somewhat less regular, occurs in both collared exterior braces and wedge-shaped exterior braces. Both forms are relatively uncommon in the first four time periods, then increase dramatically in relatively frequency after AD 1600. These patterns, though confined to relatively minor aspects of rim form, suggest that a significant transformation in ceramic manufacturing patterns occurred at about AD 1600, and that a different pattern was maintained from that time on.

Metric data on brace (zone 5) dimensions show a corresponding, statistically significant temporal pattern, illustrated in Figure 17.11b. Mean brace height is less than 16 mm before AD 1600, then jumps into the range from 19 to 23 mm from that time onward. Mean thickness at the brace also exhibits a similar pattern, changing from less than 9.0 mm to more than 9.0 mm at around AD 1600.

Lip Shape Change

Lip form exhibits statistically significant change through time, and the major patterns of change are illustrated in Figure 17.12a. The most common forms are round and flat, and these two variants exhibit somewhat inversely proportional relative frequencies, as might be expected. Round lip form exhibits a bimodal frequency, showing a peak in period 20 (Clark's Creek phase, in Riggs ware), then diminishing, and then gradually continuing to increase to a second peak in the post-AD 1780 period. The high frequency of flat lip form in period 10 is of somewhat questionable significance due to the small sample size in that period. More meaningful is the second peak occurrence of flat lip form in the Nailati phase. Subsequent to the Nailati phase (period 30), flat lip form gradually diminishes in relative frequency through time. L- and T-shaped lips generally co-occur through time and are plotted together in the time graph. L/T-shaped lip forms are most common in period 41 (Early Scattered Village complex) and indeed are one of the characteristics of the Unnamed wares of that period. Inslanted lip forms are closely associated with Le Beau ware pottery, and the pattern for this lip form parallels that for Le Beau ware in general (Figure 17.7b), peaking in period 50 (Heart River phase). Beaded lip forms (not plotted) show no temporally consistent pattern, occurring in minor frequency through most of the time sequence (see data in Table 17.7).

Vessel Surface Treatment Change

Vessel surface treatment has been compiled separately by vessel area or zone, with temporally significant but independent patterns existing for zone 1 (the vessel body), and zone 2 (the vessel neck area). Data by batches and by time period are contained for most alternative attribute states in Table 17.7, and the most distinctive patterns are graphically summarized in Figure 17.12b.

Considering first body surface treatment, several patterns can be noted. Cord-roughened surface treatment occurs in more than 90 percent of the period 10 sample from Flaming Arrow, but in periods thereafter cord-roughened treatment shows no significant use nor meaningful pattern, accounting for less than 1 percent of all surface treatment occurrences in all periods. The main body sherd surface treatment variation in periods 20 (Clark's Creek phase) and after involves the relative proportions of two major alternatives, simple-stamping and check-stamping. Percentages of each of these treatments computed across the entire body sherd samples are listed by batch in Table 17.7. Figure 17.12b graphs the percentage of check-stamping computed over the sum of only simple- and check-stamped sherds (excluding plain, brushed, and decorated sherds). This graph illustrates a strong preference for check-stamped body treatment only in period 30, the Nailati phase, and indeed, check-stamping is considered to be a distinguishing feature of components assigned to the Nailati phase and this period. Check-stamping shows measurable but relatively minor occurrences before and particularly following period 20, but in all other periods simple-stamping is the preferred surface treatment.

Decoration on body sherds exhibits a low overall relative frequency but an interesting and significant temporal pattern. Decoration is relatively common in period 20 (Clark's Creek phase, 7.22 percent), diminishes immediately thereafter to near zero, then gradually increases to another peak in period 50 (Heart River phase, 5.4 percent), and decreases again to near zero occurrences in the historic period.

Data from the Elbee site derived from both reconstructed vessels and from body sherds provide some basis for interpreting these patterns in terms of actual proportions of vessels in any period having plain versus decorated shoulder areas. Those data (Ahler 1984a) indicate that a body sherd decoration rate of 9.3 percent is associated with a reconstructed vessel sample in which 6 of 11 pots (55 percent) exhibit shoulder decoration. From this we might surmise that if one quarter of the vessels are decorated, then about 5 percent of the body sherds might exhibit decoration; if half of the vessels are decorated, then 9-10 percent of the body sherds would exhibit decoration, and so on. From this, it would seem that perhaps 40 percent or more of the vessels in period 20 would have had shoulder decoration, while about one fourth of the vessels in period 50 would have had shoulder decorations.

Extremely small numbers of vessels with zone 1 intact preclude the collection of reliable shoulder or zone decoration data from the coded vessels themselves. Samples of 20 or more zone 1 occurrences are found only in period 30, 41, and 50 pottery samples studied here (Table 17.9). The percentages of decorated zone 1 occurrences in each period are as follow: period 30 — 4 percent decorated; period 41 — 16 percent decorated; and period 50 — 50 percent decorated. Thus, the temporal pattern in body sherd decoration is supported to a limited degree in the data on more complete coded vessels.

Two alternate surface treatments on zone 2 or the neck area are graphed in Figure 17.12b, brushed and cob-impressed. These data include both unsmoothed and smoothed-over versions of each of these treatments. The other major neck treatment not graphed here is plain or rough which varies inversely with the sum of the two graphed treatment types. Neck area brushing varies significantly through time, becoming increasingly more common in periods 10, 20, and 30 (Formative Village through Nailati phase), diminishing in use in the Scattered Village complex (periods 41 and 42), and then peaking in occurrence in the early seventeenth century (period 61). Late in time, neck brushing becomes less and less frequently used, occurring on less than 30 percent of the late historic period vessels. Cob-impressed neck decoration is always a rare treatment but is most common in the Scattered Village complex samples (periods 41 and 42). This treatment is absent in the eariest samples (period 10) and is absent or extremely rare in the samples dating after AD 1600 (periods 61- 83).

Decorative Pattern Change

Decorative patterns change in many significant ways through time in the study collections. These changes are difficult to summarize, however, because they are linked in varying degrees to location on the vessel and to rim form, and the patterns themselves are often quite complex and difficult to classify in simple terms. Here we can attempt to sumarize data on decorative patterns on zone 3 (the S-rim surface) and zone 5 (the brace), the two most frequently decorated parts of the vessel in the study samples. Data on decorative patterns are summarized without regard to decoration technique; for example, diagonal patterns could be executed in either incised lines or in cord impressions. In addition, several slightly different patterns which share a common dominant theme are combined into single patterns for purposes of data presentation. For example, unbounded repetitive diagonal lines, repetitive diagonal lines bounded by horizontal lines, repetitive diagonal lines above punctations, and diagonal lines beneath punctations are combined into a single pattern, "repetitive diagonal."

Figure 17.13a gives a graphic presentation of percentages for selected decorative patterns on zone 3 according to time period. Repetitive diagonals exhibit the strongest and most noticeable temporal change, changing from less than 5 percent in period 20 (Clark's Creek phase) to values of greater than 40 percent in the latest two time periods. Repetitive diagonal decorative patterns first become particularly common in the Heart River phase (period 50), this being a pattern commonly used on Le Beau ware. Two other zone 3 patterns occur throughout the sequence, with some temporal variation, these being alternative angular and curved forms of the rainbow and horizontal line motif. Vessels which exhibit a fragmentary, indeterminate rainbow pattern are coded as angular in form. The angular rainbow pattern is most common earliest in time, in the Clark's Creek phase samples. After that time, the angular rainbow pattern varies somewhat erratically through time, reaching lowest values in the late 1600s and 1700s. The curved rainbow pattern occurs throughout the temporal sequence, but this motif is most commonly used in the period 50, Heart River phase samples where it comprises 10 percent of all recognizable decorative patterns. Single and multiple horizontal line patterns also occur throughout the sequence (Table 17.7). These are not graphed because on zone 3 they generally reflect some fragmentary and incomplete portion of vessels decorated in the rainbow motif, which is graphed.

Selected data on decorative patterns found on zone 5, or on the brace, are shown graphically in Figure 17.13b. Strong chronological changes are indicated in several patterns. Repetitive diagonal lines, occurring in several minor variants, are undoubtedly the most common decorative pattern used for brace decoration in all except the earliest, Nailati phase samples. Diagonal patterns grow in relative frequency early in time, reaching highest values in the AD 1600s, (periods 61 and 62), and then they diminish slightly in relative frequency thereafter. Repetitive decorations with no orientation, generally tool punctations or finger end impressions, are quite common on zone 5 in the earliest period 30, Nailati phase samples. This pattern gradually disappears and virtually ceases to be used after AD 1600. This pattern is in part linked to the dominant use of cord decoration in the later periods which lends itself to line patterns but not to punctation or individual unoriented impressions. Finally, horizontal line patterns show a distinct temporal trend, having appreciable frequency early in time in periods 30, 41, and 42 (Nailati phase through Scattered Village complex) and diminishing to zero occurrences in period 61 (early 1600s). Thereafter, horizontal line patterns become increasingly popular again, reaching a peak value of more than 25 percent in the latest time period.

Trailing/Incising Change

Analysis of variance indicates that both the spacing between and the average width of trailed/incised decoration lines on the rim above zone 1 vary significantly according to time period. Mean values for these two variables are graphed by period in Figure 17.14a. The spacing data indicate a very strong pattern for progressively closer line spacing through the period from AD 1200 to 1600. The data from period 61 and afterward (post-1600) are probably less reliable than those for the earlier periods, being based on very small sample sizes. The data for mean trailed/incised line width vary in a pattern somewhat different from that for element spacing. One might predict that element width would decrease as spacing decreases through the early periods; this is not the case. Line elements are relatively wide in periods 20 and 30, decrease in width by nearly 30 percent in the Scattered Village complex periods (41 and 42), and then increase in mean width again in the subsequent Heart River phase (period 50). Overall, the patterns of temporal change in trailed/incised line width and spacing indicate that these variables are responding to a complex series of stimuli which are changing through time; a unidirectional force for change is not necessarily reflected in the data set (compare the pattern in cord decoration, discussed below).

Cord Decoration Change

Several aspects of cord decoration vary significantly and in patterned ways through time, as illustrated graphically in Figure 17.14b. Cord twist direction exhibits an interesting pattern of change in which the percentage of S-twist cordage gradually diminishes through time from values near 19 percent in the Clark's Creek phase (1200-1300) to values of less than 8 percent in periods from 1525 to 1700, then increases rapidly to a peak of more than 17 percent in the final time period. The reasons for a potter having used S-twist rather than Z-twist cordage remain unclear, and the reasons for manufacturing one twist variety rather than the other also remain unclear. Therefore, this fairly systematic chronological change in cord twist direction remains difficult to understand. Mere stylistic preference seems an unlikely explanation unless we suggest that the early potter was tuned in to decorative details that escape all but the closest inspection by the modern analyst.

Variation in spacing between cord impressions has already been noted as one feature distinguishing Fort

Yates ware from Le Beau ware. Such variation, expressed along a chronological scale rather than according to pottery wares, is graphically illustrated in Figure 17.14b. Mean cord impression spacing has a maximum value of more than 7 mm in period 30, the Nailati phase. Mean spacing distance gradually diminishes through time, reaching a minimum value of less than 4.0 mm in period 61, in the early 1600s. From that time on spacing distance remains relatively stable, increasing by only a slight and insignificant amount in the subsequent periods. Mean diameter of cord impressions exhibits a similar pattern, also determined to be statistically significant based on analysis of variance. Maximum cord diameter values of circa 3.0 mm occur in the Clark's Creek phase and Nailati phase samples, after which time the mean diameter decreases to circa 2.2 mm by the early 1600s and in subsequent periods. These patterns suggest an evolving and increasingly refined cordage technology which reaches a plateau of refinement, as expressed in cord diameters and spacing, by circa AD 1600.

Change in Upper Rim-Lip Modification

The type and frequency of modifications to the upper rim or lip area, such as pinching and addition of various appendages, vary significantly through time. Figure 17.15a illustrates these patterns graphically, with the data consisting of the percentage of vessels classifiable by ware in each period which exhibit the particular modification type. The use of nodes is a chronologically early attribute, being most common in the period 20, Clark's Creek phase sample and continuing to be used in some frequency through period 50, Heart River phase. The use of nodes is closely linked with the use of rainbow decorative motifs on S-rim vessels (Fort Yates, Unnamed, and Le Beau wares), with the rainbow decorative element usually centered beneath a node. Two other modifications are used primarily late in time. Pinching exhibits a brief episode of popularity in period 30 (Nailati phase) followed by a period of disuse. Then it becomes progressively more popular following AD 1600, occurring on nearly 20 percent of the vessels in the early 1800s. Data for castellations and spouts (Table 17.7), features often difficult to distinguish from each other, are combined in the graphic plots (Figure 17.15a). These features also show a progressively more common occurrence after the late 1600s, peaking in frequency in the early 1800s. The pattern for castellations and spouts is closely correlated with the general increase in frequency of Knife River ware in this same period (Figure 17.7b); such modifications are a characteristic feature of Knife River ware but do not occur on other wares recognized in the study sample.

Vessel Wall Thickness Change

Sufficient data exist to examine vessel wall thickness measured in three locations: in body sherds (zone 1), in the neck area (zone 2), and in the upper area on S-rim vessels (zone 3). Measurements in all three locations exhibit very regular patterns of change through time, patterns which are generally consistent across all three variables as illustrated in Figure 17.15b. In all cases analysis of variance confirms statistically significant differences according to time period. In all three variables vessel wall thickness is relatively thick in the earliest time period for which it can be measured, then it diminishes steadily through time to a minimum mean value either in period 42 (Late Scattered Village complex) (body and zone 3 thickness) or in period 50 (Heart River phase) (neck thickness). Then, each thickness measurement shows an immediate reversal in the previous trend toward thinner pottery, and thickness increases progressively to a new peak value in the latest time period (83). The trend toward increasing thickness is most erratic for the zone 3 measurements late in time, and this is probably a function of the increasingly smaller samples for which zone 3 could be measured in the later periods. The patterns exhibited by all three variables are strikingly similar when considered across the full time span in the study samples.

Other Variables

Temporal variation, or lack thereof, can be noted for a few other variables recorded in the ceramic analysis. As noted previously, decorative techniques are captured in part by the general variable decorative type, plotted in Figure 17.10. There are many aspects of decorative technique which are not expressed in this summary variable, however, which show significant changes through time. Such information is difficult to summarize graphically by time period, being best dealt with by controlling for both the location of the decoration on the vessel and the vessel form. Such detailed data on decorative technique and its location is most easily presented in the context of decoration according to individual ceramic wares. Such a breakdown of ceramic data is not attempted here.

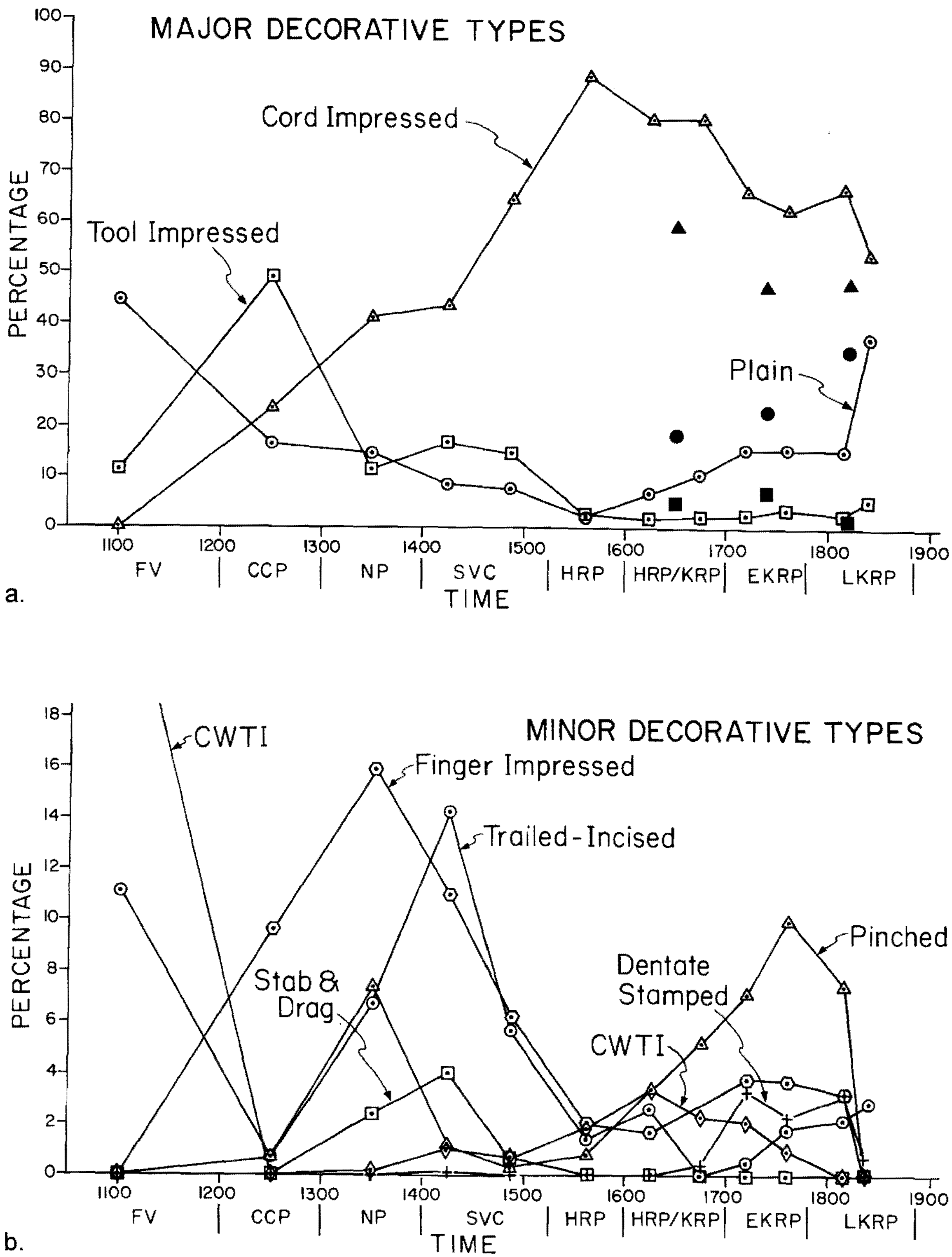


Figure 17.10. Data distributions by time period for Hidatsa tradition ceramic batches. Solid symbols indicate data for major periods 60, 70, and 80. a: percentages of major decorative types; b: percentages of minor decorative types.

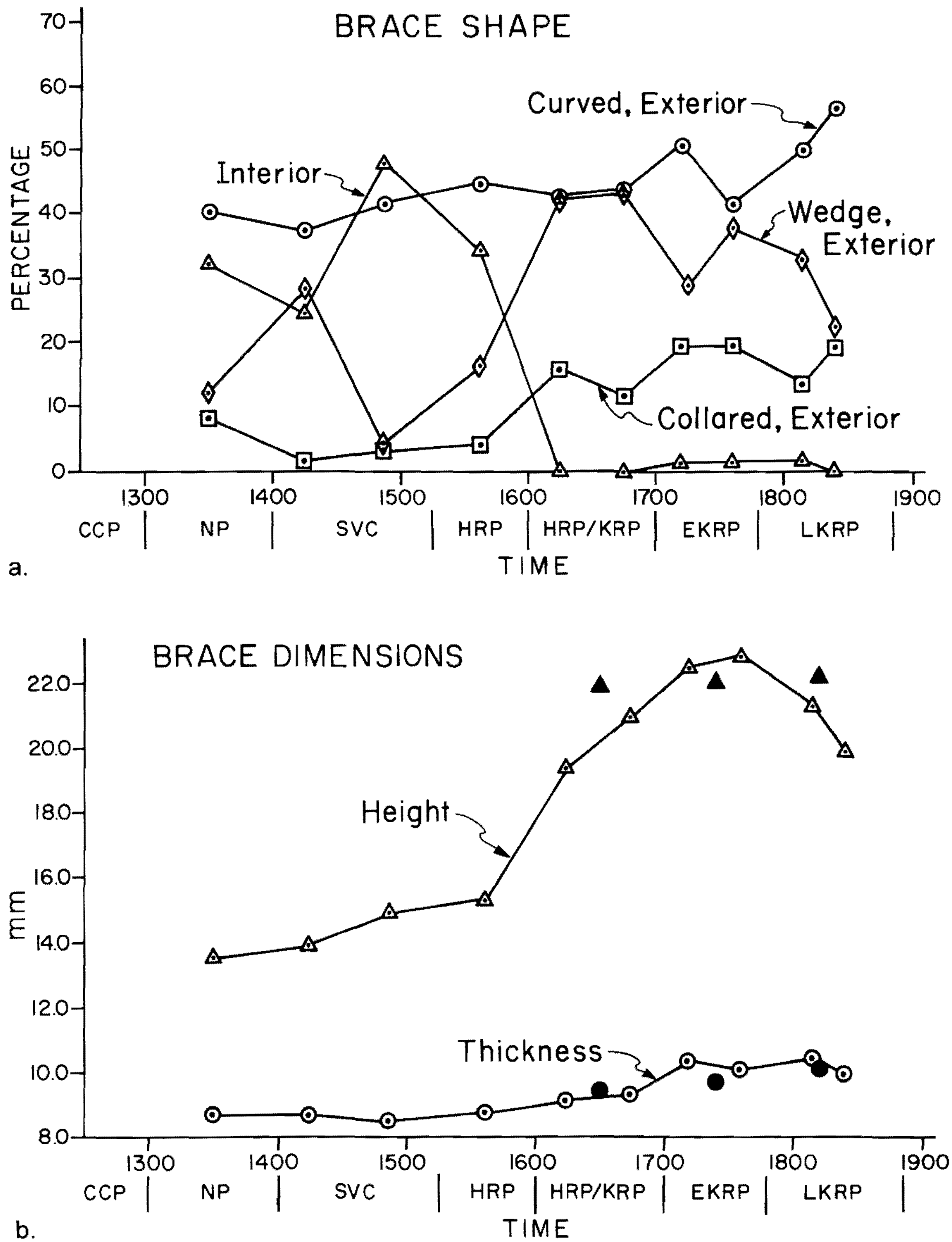


Figure 17.11. Data distributions by time period for Hidatsa tradition ceramic batches. Solid symbols indicate data for major periods 60, 70, and 80. a: brace shape class percentages; b: mean brace measurements.

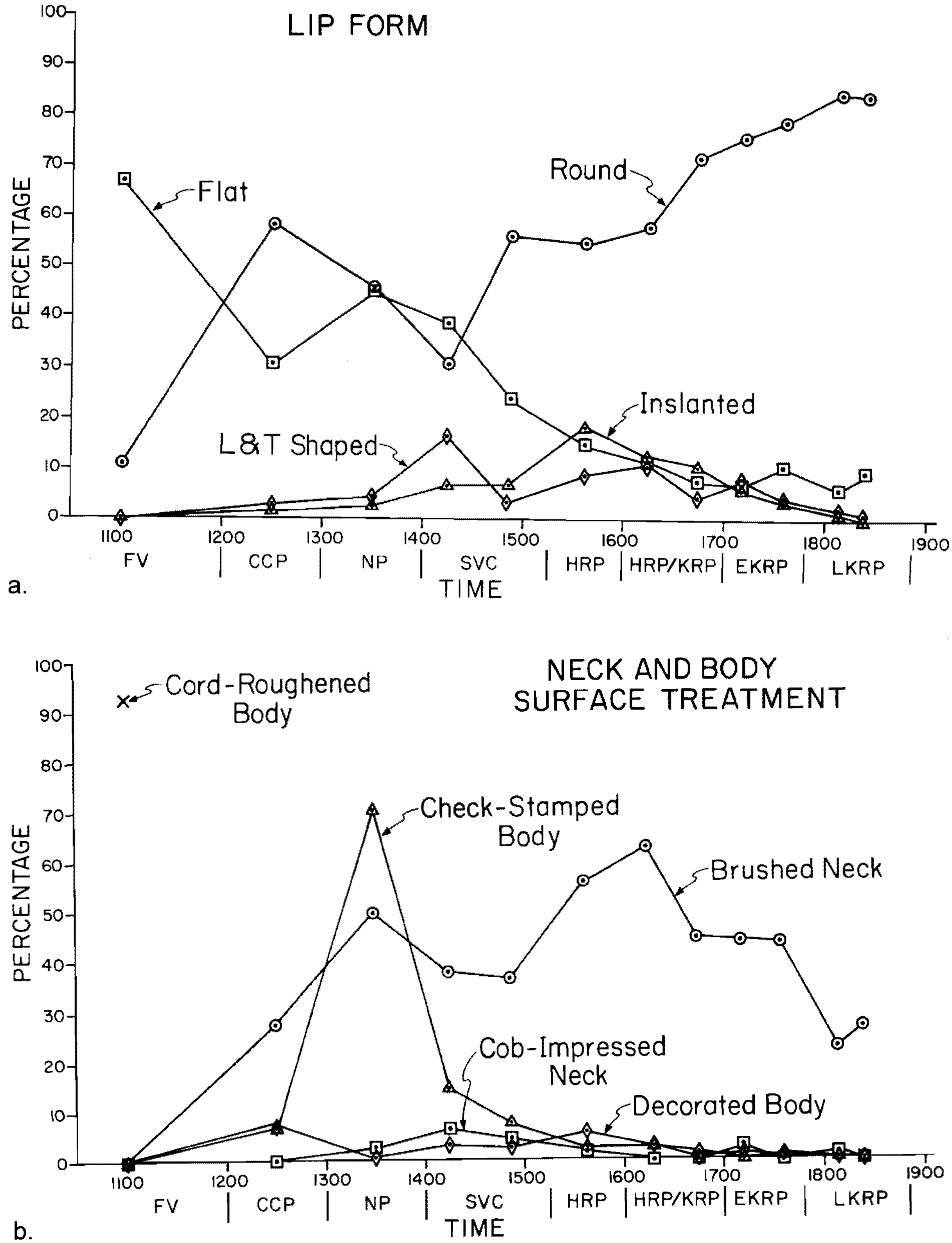
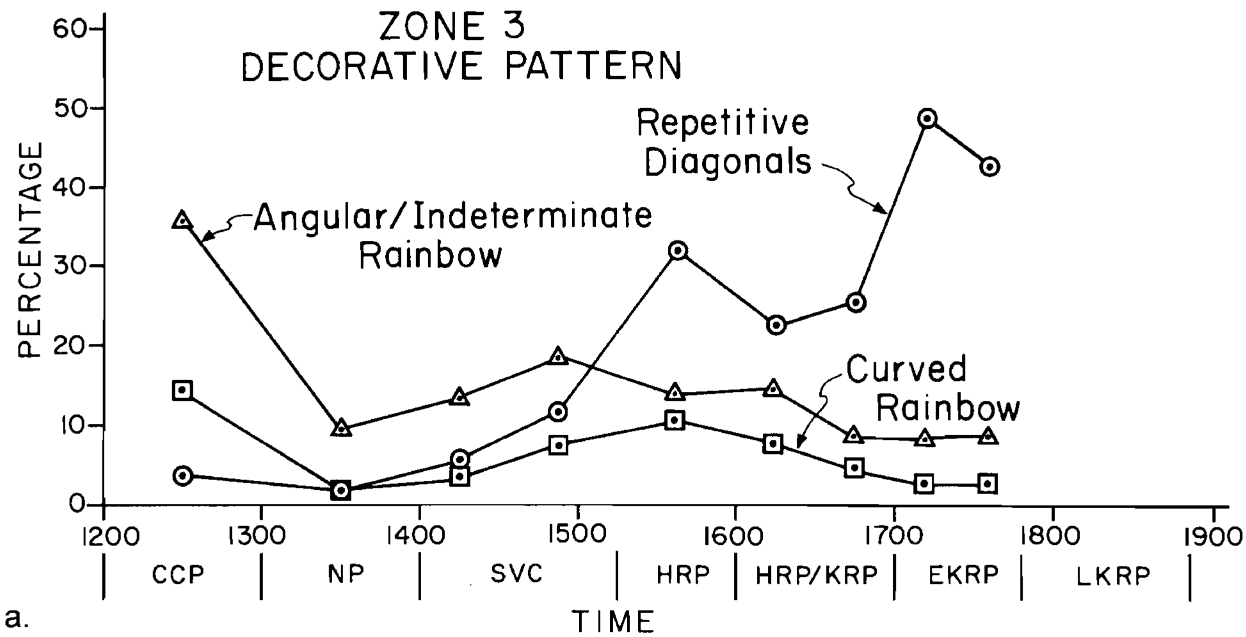


Figure 17.12. Data distributions by time period for Hidatsa tradition ceramic batches. a: selected lip shape class percentages; b: selected neck and body sherd surface treatment class percentages.



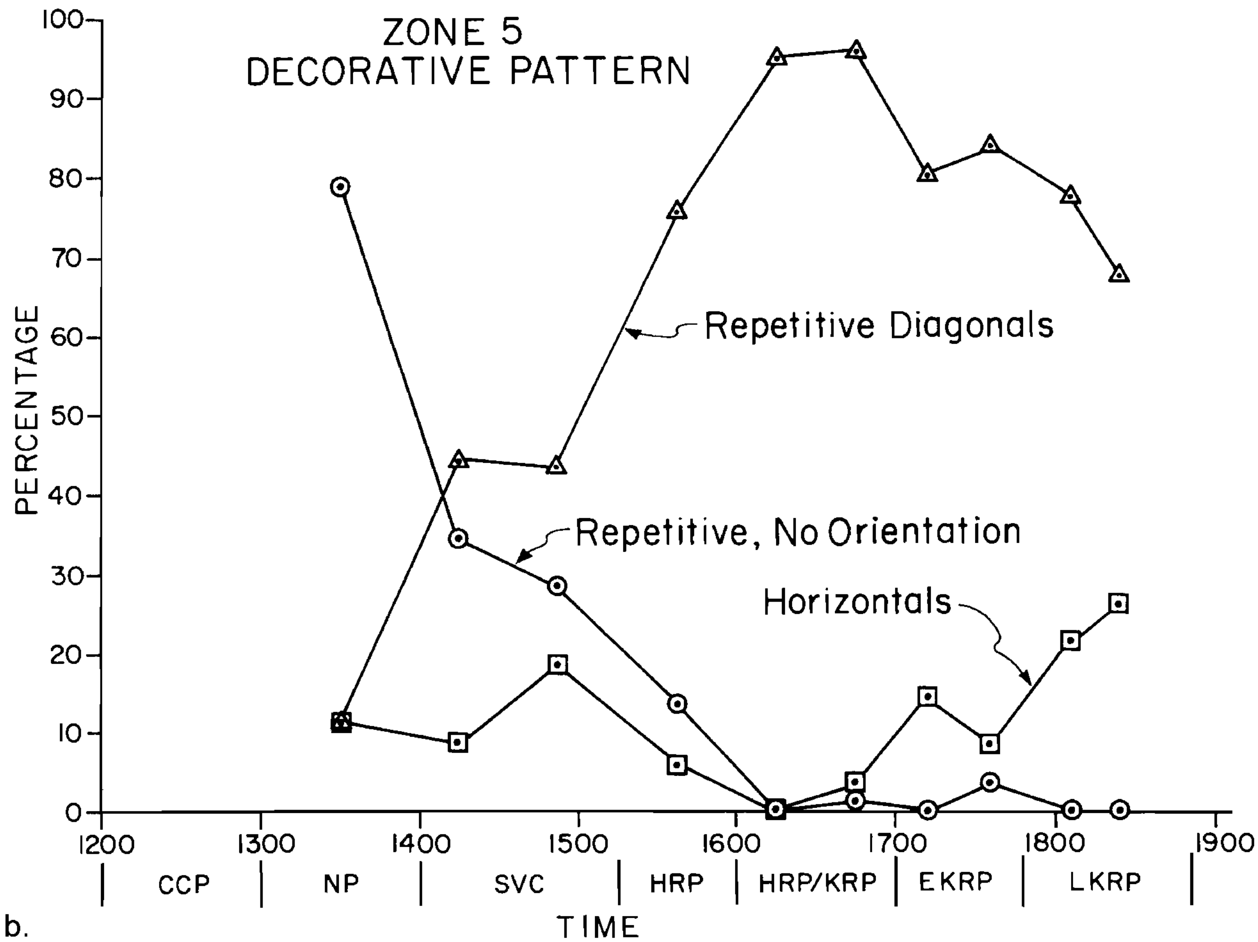
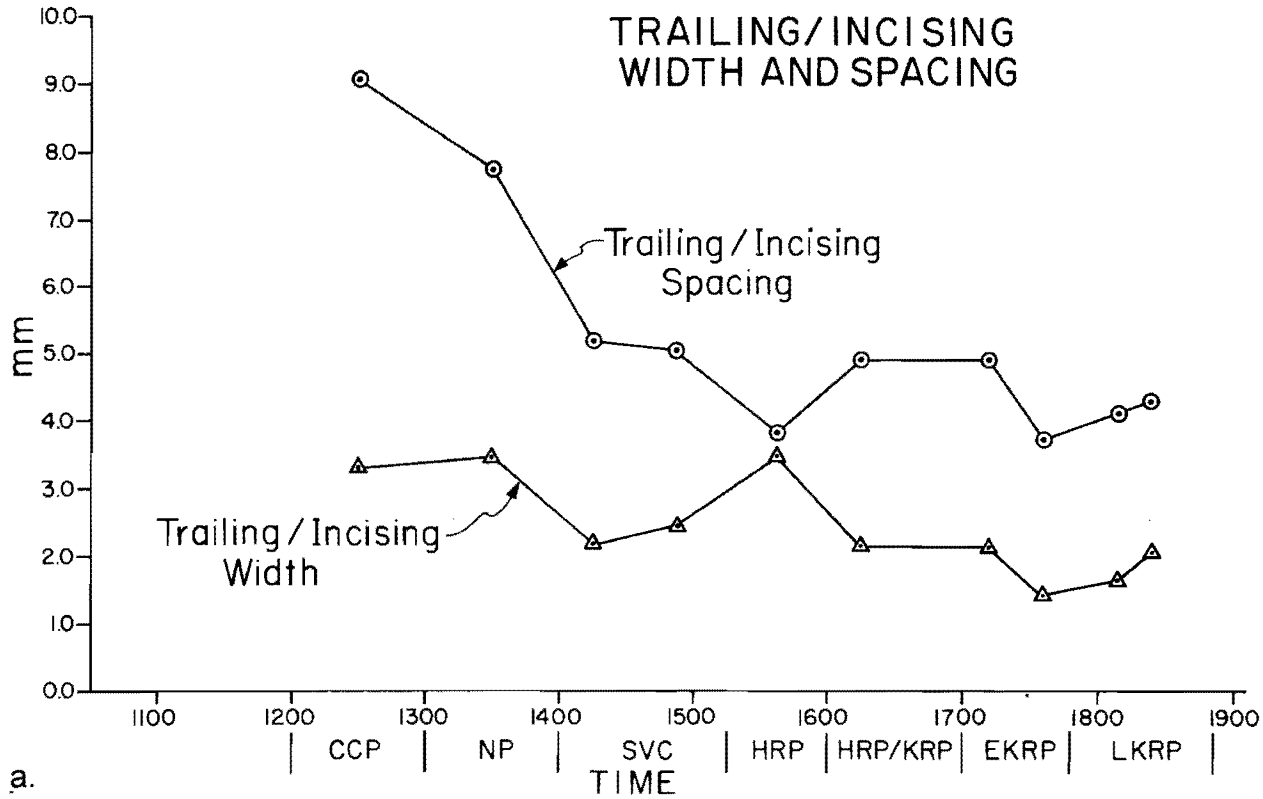


Figure 17.13. Data distributions by time period for Hidatsa tradition ceramic batches. a: percentages for selected decorative patterns in zone 3; b: percentages for selected decorative patterns in zone 5.



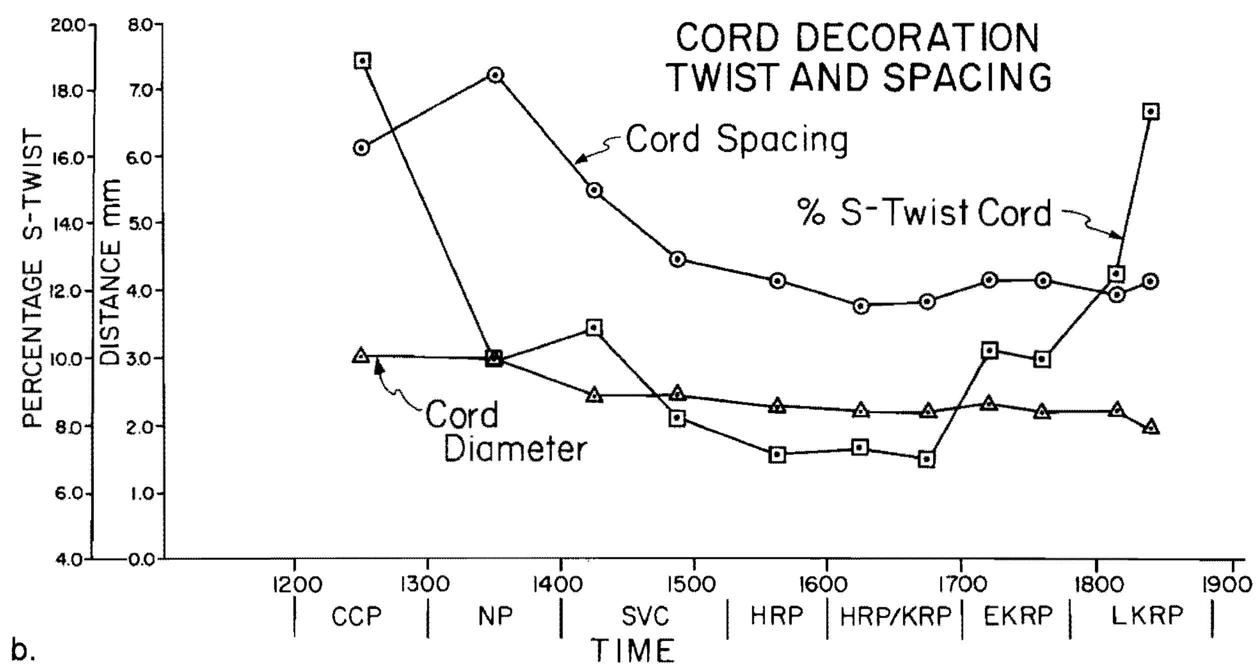
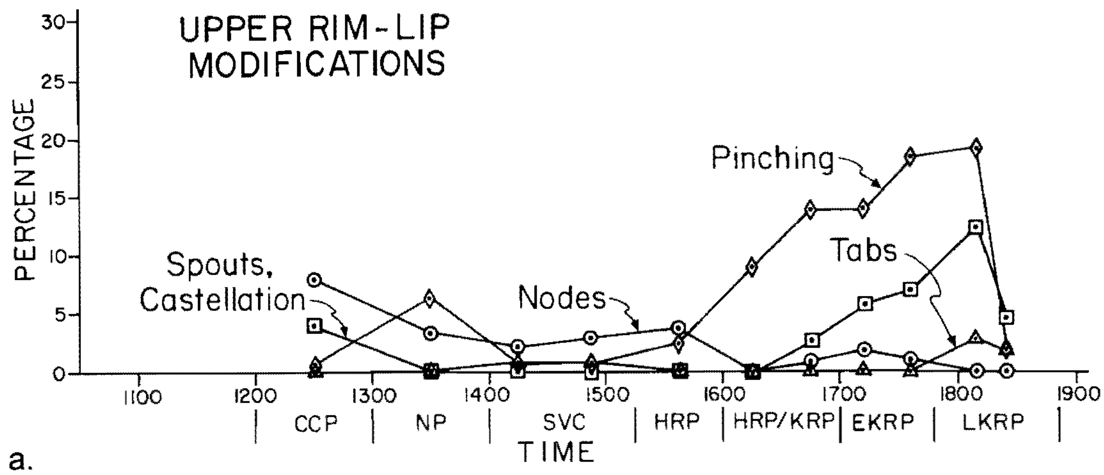


Figure 17.14. Data distributions by time period for Hidatsa tradition ceramic batches. a: trailing/incising width and spacing measurments occurring above zone 1; b: percentage of S-twist cordage and mean cord impression diameter and spacing.



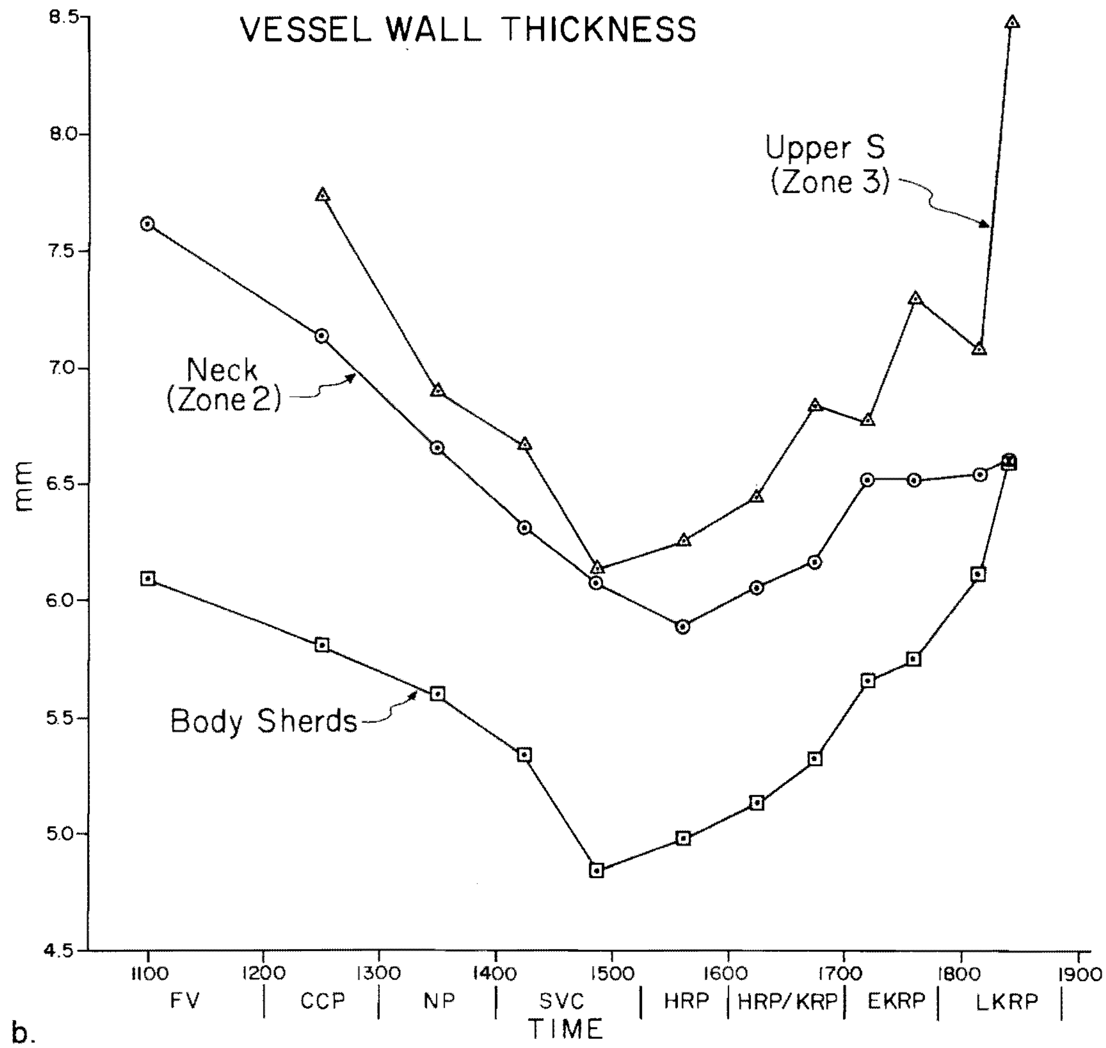


Figure 17.15. Data distributions by time period for Hidatsa tradition ceramic batches. a: percentages of classifiable vessels exhibiting various upper rim-lip modifications; b: vessel wall thickness measurements in various zones.

Vessel thickness measured at zone 7, the lip, is shown by analysis of variance to change significantly through time. This variable is not plotted graphically or discussed in detail, however, because such a measurement is thought to be highly correlated with variation in lip form and particularly the use of bracing on the vessel rim. Thus, for lip thickness data to be meaningful, they should be presented while controlling for presence or absence of bracing. Such a presentation is better handled as part of a detailed ware description.

It is worth noting that several other vessel measurements do not show significant variation through time, according to analysis of variance over time period groups. Among these are total rim height, the height of zone 2, zone 2 inflection, and vessel orifice diameter. For the record, we can note that the overall mean for vessel orifice diameter is 19.1 cm based on a sample of 210 vessels. Some of these measurements probably do differ significantly among vessel ware groupings, and such comparisons should be part of detailed ware descriptions based on the overall study sample.

Explanations for Ceramic Change

Many distinctive patterns of ceramic change have been illustrated in the previous pages of discussion and in Figures 17.7 through 17.15. The task remains to provide meaningful explanations of those changes, or at least to present testable hypotheses regarding the explanation for those changes. The results of the factor analysis of all comparative study collections clearly indicate that fundamentally different factors are affecting ceramic change in the respective early and late halves of the regional chronology. This pattern is also evident in the graphic displays of mean and percentage values for several ceramic variables expressed along time diagrams. Several variables exhibit distinctly different patterns or directions for change in the early versus late parts of the regional ceramic sequence. This is most evident in variables such as vessel wall thickness which decreases in the early half of the sequence and then increases in mean value in the late half of the sequence. Similar changes occur in basic rim form, with straight rims decreasing and then increasing in frequency through time. Bracing becomes common only in the late half of the sequence.

Such observations lead us to organize the discussion according to two broad time periods: changes which occur prior to and through the Heart River phase samples, from earliest samples pre-dating AD 1200 to roughly AD 1600; and changes which begin to occur in the Heart River phase (by AD 1525) and which culminate in the latest historic samples dating in the mid to late AD 1800s.

Early Period Change

The oral traditions of the Mandans and various subgroups of the Hidatas as recounted by Bowers (1948, 1950, 1965) and summarized for the Hidatsas by Wood in Chapter 12, this volume, provide one explanatory model for observed ceramic change in the study area. Even though Bowers does not develop an absolute chronology for any of the prehistoric age sites he studied in the region, his Heart River focus taxonomic unit is recognizably equivalent to the combined Heart River phase and Knife River phase units used in this study. He does estimate that the Heart River focus dates primarily after AD 1650. We can use Bowers' model of events in the region prior to his Heart River focus as an explanatory model for cultural change occurring in the periods preceding and including our Heart River phase. This model is developed both from Mandan and Hidatsa traditions and from Bowers' understanding of the early archeological record. According to information presented by Bowers (1948, 1950, 1965), the following sequence of major cultural events can be hypothesized for the early period of cultural development in the study area:

1. Ancestral Mandan village groups establish residence in the Heart River area and related peoples settle parts of the Missouri valley upstream from that area (Bowers 1948:94; 1950:16; 1965:477-479). Clark's Creek is identified as one of these early Mandan sites (Bowers 1965:484).

2. The Awatixa Hidatsas establish their first village on the Missouri River at the Flaming Arrow site (Bowers 1948:115-116; 1965:304). Awatixa mythology claims that they come from the sky; Bowers (1948:44; 1965:23,483) suggests a movement from eastern North Dakota. They find the region already inhabited by other villagers (presumably the Mandans, although they are not identified as such); warfare occurs between the early Awatixas and the other existing villagers (Bowers 1965:305).

3. After many trials and tribulations the early Awatixas prosper and multiply, budding off to establish many new villages (perhaps as many as 13) in the Missouri valley

between Square Buttes and Knife River. One of those early villages is specifically identified by the Awatixas as Upper Sanger (Bowers 1948:39, 118).

4. At about the same time as (3), the Awigaxa subgroup of the Mandans moves northward from the Grand River in South Dakota to settle one or more sites upstream from Square Buttes. One of the early Awigaxa Mandan villages is identified by Bowers as the Lyman Aldren site (1948:101-102); another potentially much later Awigaxa Mandan village identified by traditions is Lower Sanger (Bowers 1948:116-117). Through time and close interaction, the Awigaxa Mandans become very similar in culture to the main Mandan groups of long residence in the Heart River area (1948:23-24).

5. The Awatixas consolidate and settle near the Mandans at "Scattered Village" on the Heart River for a short period of time, then move to Lower Hidatsa Village on the Knife River where they remain in residence for a long period of time (Bowers 1948:17-18; 1965:21, 478).

The key elements in this sequence are:

* Initial Mandan settlement in the region.

* Awatixa Hidatsa migration from elsewhere and conflict with existing groups.

* Awatixa Hidatsa prosperity, population growth, and dispersal.

* Awigaxa Mandan migration into the upper Knife-Heart region from far south.

* Continued close association between lower and upper Knife-Heart groups.

* Awatixa consolidation and migration to the Heart River and then return to a single village at Lower Hidatsa.

In very general terms, this hypothetical sequence of events based on traditional information suggests the existence of a very dynamic archeological record, punctuated by discontinuities reflecting successive movements of peoples into the region from different points of origin in the surrounding areas. All this is occurring against an underlying background of ancestral Mandan cultural development in the region, with the Mandans at Heart River being the first residents in the region and with the same Mandans providing the dominant cultural force throughout the upper Knife-Heart region during the time frame being discussed.

Let us speculate on what this model might imply of the archeological record. We would expect long-term continuities in material culture in the regional ceramic samples, reflecting long-term influence throughout the region by the culturally powerful Mandan populations at Heart River. At the same time, we would expect numerous short-term discontinuities in the ceramic record, documenting the sporadic migrations of distant populations into the region from divergent geographic sources. Over the long term, we would expect changes in material culture toward a norm established by the Mandans at Heart River as suggested by the consolidation of the Awatixas, their brief movement to Heart River, and the continued close association between the Awatixas and Heart River groups.

Let us examine the character of ceramic change in the early period according to long-term versus short-term continuities and discontinuities. We look here at data from periods 10 through 50, from as early as AD 1000 to as late as AD 1600, drawing chiefly on the data presented in Figures 17.7 through 17.15 based on information in Table 17.7. In making this examination, it is useful to note the sparse data base for period 10 and the subsequent need to focus primarily on periods 20 through 50.

Several ceramic variables exhibit general monotonic change through the period in question, or principally in the period 20-50, from circa AD 1200-1600. Such variables include:

* Gross rim form, which changes from predominantly straight to predominantly S-shaped through time, the latter peaking in the final period;

* Detailed rim form, in which the preference for curved lower zone 3 junctures gradually increases through time, peaking in the final period;

* Vessel wall thickness, which at several places on the vessel becomes progressively thinner through time, reaching a minimum in or near the final period;

* Cord impression spacing and diameters, which decrease progressively through time, reaching a minimum in or near the final period;

* S-twist cordage, which progressively diminishes through this sequence, reaching a minimum near the end of this sequence;

* Trailed/incised line spacing, which gradually diminishes through time, reaching a minimum near the final period;

* Preference for cord-impressed decoration, which gradually increases throughout the period and reaches a peak in the terminal period;

* Brace height, which gradually increases through this period;

* Use of diagonal and curved rainbow decorative patterns in zone 3, which progressively increases throughout this period; and

* Both diagonal and no-orientation zone 5 decorative patterns, which progressively increase and decrease, respectively, though this period.

A roughly equal number of variables and attributes exhibit distinctly disjoint patterns of variation throughout the period sequence under study, including the following:

* Wares, in which a different combination of wares is characteristic of each of the periods or taxonomic units;

* Braced rim form, which progressively increases through the Scattered Village complex, then abruptly decreases in occurrence in the Heart River phase;

* Zone 3 height, high in periods 20 and 30, low in periods 41 and 42, high again in period 50;

* Lip shape, L- and T-shaped being common only in period 41, flat form common in period 30 and 40 then decreasing thereafter;

* Body surface treatment, cord-roughened in period 10 only, check-stamped dominant in period 30 only, and simple-stamped dominant in all other periods;

* Nodes, common in periods 20 and 30, less common in periods 41 and 42, more common again in period 50;

* Trailed/incised line width, greater in periods 20, 30, less in periods 41 and 42, higher again in period 50;

* Decoration on zone 3, less common in periods 41 and 42, more common in other periods;

* Tool-impressed decorative technique, peaks in period 20 only;

* Stab-and-drag decorative technique, common in period 30, peaks in period 41, little use at other times;

* Finger-impressed decorative technique, peaks in period 30, relatively less common at other times; and

* Trailed/incised decorative technique, peaks in period 41 and 42, less common in other periods.

When we examine the nature of the variables exhibiting long-term monotonic change versus those exhibiting short-term discontinuities, we note a pattern. The variables which seem to change in a more gradual, continuous pattern have to do primarily with general rim form characteristics or variables which express overall control of ceramic or textile technologies, such as basic distinctions between straight and S-shaped rims; the degree of curvature at the zone 2/3 juncture; vessel wall thickness; and cord diameters. Decorative attributes showing such changes are relatively few, consisting of incised line spacing, the overall use of cord decoration, and decorative patterns occurring primarily in cordage on zone 3 and in various mediums on zone 5.

In contrast, variables exhibiting short-term peaks confined primarily to a single period and taxonomic unit are concentrated heavily in the area of relatively minor decorative details, including lip shape, use of nodes, use and size of braces, carved paddle patterns used for surface treatment, and choices among several alternative minor decorative techniques. In general, it appears that the ceramic data for periods 10 through 50 behave in a manner consistent with the model of regional prehistory presented above based primarily on Bowers' study of Mandan and Hidatsa traditions and regional archeology. The dominant elements of the ceramic content assigned to each time period and taxonomic unit can be examined in more detail to offer a more complete description of possible events in the early periods, framed in terms of broader cultural developments in the Middle Missouri subarea.

The period 10 samples are basically unlike any of the ceramic samples assigned to subsequent time periods. Only the Flaming Arrow sample has been coded and chronometrically dated. Distinctive features include cord-roughened body surface treatment, simple straight rims with curved lower junctures, lack of the S-rim form, and simple decorative techniques and patterns, confined primarily to cord-wrapped-tool impressions on the lip or upper rim face. The Late Woodland pottery samples from various Cross Ranch sites (batch 99) share many of these attributes but have not been well dated by chronometric means. It is quite conceivable that the Flaming Arrow sample is precisely what the Awatixa oral tradition associated with the site implies: a site-unit intrusion of peoples foreign to the Middle Missouri subarea.

The date for the Flaming Arrow site, circa AD 1100, is relatively late compared to other firmly established early Plains Village sites in other regions. This makes it highly likely that the occupants of that small village encountered other peoples in the surrounding regions who had a full-blown Plains Village lifeway, as implied by the Charred Body myth. Groups assignable to the Extended variant of the Middle Missouri tradition (Lehmer 1971), well accepted by most researchers as the basic cultural stock from which the historic Mandans eventually developed, had reached all of South Dakota and had settled the area near the North/South Dakota border by as early as the mid-AD 1000s (based on dates for Helb and Paul Brave [Thiessen 1977:77, 79] and Jake White Bull [Ahler 1977:127-130]). It is likely that these ancestral Mandan groups had settled the Heart River area by this time, as well; the earliest occupations there may lie buried under mountains of refuse in later traditional Mandan sites. It is also thought possible that ancestral Mandan groups penetrated northward and upstream as far as the Garrison region by AD 1100. The Grandmother's Lodge site, presently undated, may be one such component; Stiefel, near the KNRI on the Knife River, also undated, could be another. Sites of this age and tradition, judging by the evidence at Grandmother's Lodge and Stiefel, would generally have a very low archeological visibility, and several more sites of such age and tradition may exist, undetected, in the region.

The period 20 sample, assigned to the Clark's Creek phase and consisting of materials from Stiefel, Clark's Creek, and PG, is characterized by predominant occurrence of Riggs straight rim ware, minor occurrence of Fort Yates ware, some occurrence of Anderson ware, and a suite of decorative characteristics which is consistent with the presence of these wares. The pottery content of these sites is generally indistinguishable from many other components in the Cannonball region, downriver, which are assigned to the earliest part of the Extended variant of the Middle Missouri tradition discussed in the preceding paragraph. In addition, the content in this period is basically characteristic of many other later components throughout a much larger area in the Missouri valley assigned to this same taxonomic unit (cf. Lehmer 1971:65-106). Thus, these sites in the study area seem to represent evidence of mainstream ancestral Mandan occupation in the region. The full range of dates, or in particular, the date of initial appearance of this cultural unit in the study area remains uncertain. Bracket dates of AD 1200-1300 are assigned to the Clark's Creek phase on the basis of three C-14 dates from that site and two dates from PG. Stiefel remains undated, and Grandmother's Lodge, a key site in both Mandan and Hidatsa origin traditions, also probably falls within the general taxonomic unit characterized here as the Clark's Creek phase but is also undated.

It is clear that there is some potential evidence in the archeological record for the coexistence of two diverse cultural groups in the region as early as AD 1100, as implied by the Awatixa origin traditions linked to the Flaming Arrow site. Flaming Arrow could represent an early Awatixa site-unit intrusion in the area, and sites such as Stiefel and Grandmother's Lodge may represent ancestral Mandan tradition settlements in the region occupied at roughly the same time.

The next time period and cultural unit, the Nailati phase in AD 1300-1400, reflects a distinct shift in ceramic content from the basic Extended Middle Missouri assemblage in the preceding Clark's Creek phase. Riggs ware is less commonly made, Fort Yates ware is more commonly made, Unnamed Straight and S-Rim wares distinguished by shortened rim heights and unusual lip modifications are more commonly made, and the bodies of vessels are prepared predominantly with check-stamped paddles. Other decorative details become common in this period: flattened rather than rounded lip forms become popular; neck areas of vessels are commonly brushed; and finger tip punctation and pinching are frequently used for vessel decoration on both straight and S-rim forms. We interpret these changes to reflect the influence of a ceramic tradition different in minor rather than major ways from the resident ancestral Mandan tradition (Extended variant of the Middle Missouri tradition) represented by the Clark's Creek phase. We suggest that the sites assigned here to the Nailati phase reflect primarily the prospering and growing Awatixa population described in native traditions who gained a foothold at Flaming Arrow and spread from there through the area north of Square Buttes. Many sites were settled by these budding Awatixa groups, and the geographic range of sites identifed here as Nailati phase corresponds closely with the traditional heartland of the Awatixas (from south to north, Upper Sanger, Mile Post 28, Cross Ranch, Angus, Mahhaha, White Buffalo Robe, Amahami, Buchfink, and Stanton Ferry).

Bowers (1948:220-224) identified most of these same sites (all but Buchfink, White Buffalo Robe, and Angus) with his Painted Woods focus, and, as we do, he interpreted them as early Awatixa in origin. As we do, he ascribed considerable significance to the heavy use of check-stamping in this period. On that basis he posited (1948:120, 121, 123) that these sites reflected cumulative long-term population movements from ancestral Awatixa areas in eastern North Dakota where check- stamping also occurs frequently in certain pottery collections (e.g., at the Schultz site). We have not examined the data from that area, but can concur that Bowers' hypothesis of Awatixa influence from that area appears reasonable.

The question of the relationship between the Flaming Arrow site, dating at AD 1100 and assumed to be ancestral Awatixa, and the Nailati phase, dating about 200 years later and also thought to reflect the early local Awatixa cultural tradition, remains unclear at the present time. Major differences exist between the ceramic assemblage from Flaming Arrow and the Nailati phase components, although the true nature of these differences cannot be fully assessed until a larger data set is available from Flaming Arrow. It is fully possible that ancestral Awatixa people did maintain an existence in the region from AD 1100 through 1300 and that their settlements were so ephemeral that most have remained archeologically undetected. It is possible that sites such as Lyman Aldren and Stanton Ferry, for which we have only composite surface collection data, may contain such evidence. This suggestion is based on the low but measureable frequency of cord-roughened body surface treatment in those samples.

Period 41, the Early Scattered Village complex, marks several additional changes in regional ceramic content which are interpreted here as reflecting major influences from geographic areas lying down the Missouri river. Many decorative details change markedly in this period. These include common use of L- and T-shaped lip forms, common use of trailed/incised and tool-impressed decorative techniques, and a peak in the use of stab-and-drag decoration. Vessels are no longer identifiable as Riggs or Fort Yates ware, based on both rim proportions and decorative techniques and patterns. Simple-stamping reappears as the dominant body treatment just as abruptly as check-stamping had appeared in the preceding Nailati phase. Certain metric variables show abrupt changes in this period, including a sudden narrowing of spacing distance between trailed/incised lines and a shortening of zone 3 height. Bowers' interpretation of Awatixa and Mandan traditional data calls for site-unit intrusions of Mandan subgroups from places of southerly origin near the Grand River in South Dakota (1948:23-24); these people brought with them pottery traditions involving heavy use of trailed/incised decoration (Bowers 1948:98-104). This hypothetical event is readily supported by the archeological data for the Early Scattered Village complex. Many of the attributes discussed above and many of the decorative details have nearly identical counterparts in what are usually termed Initial Coalescent or Extended Coalescent variant sites in South Dakota: horizontal trailed decorations in multiple parallel lines, frequent use of stab-and-drag decorations, frequent use of trailing and tool impression decoration on lip and brace (Lehmer 1971:114, 118). Bowers (1948:100-106) noted this connection in his assessment of the Lyman Aldren site which he interpreted as an Awigaxa Mandan intrusion and which we classify here as in the Early Scattered Village complex.

There is little question in the mind of the senior author that the Scattered Village complex reflects a local ceramic tradition significantly influenced by ideas and elements having a distinctly downriver origin. The archeological data fit well with the traditional account of migration and assimilation of southern Mandan groups in the area upstream from Square Buttes. The question of whether or not some of these sites assigned to this period can specifically be identified as Awigaxa Mandan in origin and others as Awatixa in origin cannot presently be answered. It is likely that both kinds of sites are included in the Scattered Village complex sample. The ceramic homogeneity in this series of samples, as demonstrated in the various cluster analyses, suggests a great deal of communication among the residents of these sites as well as with cultures outside the region. This level of communication is consistent with the lack of evidence for defensive fortifications and conflict at this time. The KNRI Early

Scattered Village complex settlements consist of sprawling, loosely defined communities presumably containing widely separated clusters of houses spread over large areas on elevated river terraces.

Period 42, the Late Scattered Village complex, exhibits many of the same distinctive ceramic elements characteristic of components assigned to the early part of this complex. In addition, the pottery sample in this period contains particular elements distinctive of the following Heart River phase, most important being the sharply increased frequency of Le Beau Cord Impressed ceramic ware. This increase in Le Beau ware is paralleled by increased use of inslanted lip forms and increased use of curved rainbow and diagonal decorative patterns. If we assume that the Heart River phase and the distinctive ceramic elements occurring with it have a point of origin in the large cluster of traditional Mandan sites near the mouth of the Heart River, then the Late Scattered Village complex sites in period 42 are best interpreted as reflecting local, relocated southern Mandans and resident Awatixa groups who have become increasingly influenced by and drawn into the strong cultural pattern of the dominant Heart River Mandans. Only three sites presently have components assigned to this cultural period: Bagnell (tentatively), Mandan Lake, and Mahhaha (tentatively). All sites are thought to contain evidence of continuous occupation beginning at least as early as the Early Scattered Village complex. Absent in this period are the dispersed, thinly scattered components characteristic of the Early Scattered Village complex. Drawing upon the vague Awatixa tradition which relates a brief period of occupancy for that group at Scattered Village at the mouth of the Heart River, we can hypothesize that Awatixa occupancy there should fall in period 42, AD 1450-1525, and that a significant portion of the Awatixa subgroup actually abandoned the region during that time before resettling after 1525 in a much more consolidated village at Lower Hidatsa.

The final period in the early groups being considered here, AD 1525-1600, is apparently characterized by strong ceramic homogeneity throughout all the components recognized in the region. This is the Heart River phase, characterized primarily by the dominant use of Le Beau ware pottery and by use of a relatively narrow range of decorative techniques, centered on cord-impression. The heterogeneous combination of alternative rim forms and decorative elements, characteristic of the preceding Scattered Village complex, is gone. It seems that the ceramic assemblages reflect strong influence from a single major cultural tradition.

This tradition, as well as can be determined, is the Heart River phase as expressed in this period in the lower Knife-Heart Region. We are severely hampered in assessing this idea, however, by the outstanding lack of well-dated and well-controlled archeological data from the key traditional Mandan sites near the mouth of the Heart River. Available descriptions of lower Knife-Heart region sites derive from works of Will and Hecker (1944), Strong (1940), and from Will and Spinden (1906), none of whom recognized the potential time depth in the major Heart River villages and conducted excavations and data analysis accordingly. Thus, the available data in the literature for "classic Heart River phase" almost certainly represent a composite of ceramic attributes spanning a several hundred year period, from sometime before AD 1600 until abandonment of the area in the late 1700s. With these severe limitations, we must at this time simply hypothesize that the Heart River phase sites in the upriver study area reflect a combination of local Mandan and local Awatixa groups who have been drawn rather completely into the vortex of the dominant Mandan culture centered at Heart River.

That both Mandan and Awatixa ethnic groups are represented in this phase is indicated by traditions which identify the Lower Sanger site as Mandan (Bowers 1948:39) and the contemporaneous Lower Hidatsa site as Awatixa (Bowers 1948:17-18; 1965:19). Other sites assigned to this period are of less certain possible ethnic derivation. Smith Farm is apparently a briefly occupied site, and it could represent a temporary settlement of Awatixas established after they moved out of the Heart River area. Hensler is a massive site with long occupancy, but it cannot presently be linked to any particular cultural tradition. Alderin Creek and White Buffalo Robe each appear to represent shorter term occupancy, and neither can presently be linked to a particular cultural or ethnic tradition.

The sequence of ceramic change and apparent cultural interaction just described is underlain by certain monotonic changes in ceramic data which suggest a degree of continuity in the fabric of the ceramic technology and ceramic traditions which account for the assemblages under study. We would venture further and suggest that the patterns of ceramic change which result in gross trends culminating in minimum or maximum variable values in the Heart River phase samples document a general process of cultural evolution and amalgamation which culminates in the emergence of the Mandan culture centered at Heart River. Mandan peoples by this time (AD 1525) had developed a strong tribal organization and a sense of tribal identity, and their influence spread through the "Hidatsa" groups to the north who did not yet possess as coherent a sense of tribal identity. Fundamental ceramic manufacturing practices were far different at this time than they were a few hundreds of years earlier; far deeper than changes in decorative patterns are technological changes which resulted in pottery of 1) the highest technical quality yet produced in the Plains Village sequence; and 2) pottery which is morphologically and technologically the most standardized of any to be produced in the subarea. The majority of the variables noted previously as changing in a monotonic manner throughout the early ceramic sequence (those dealing with vessel form, cord diameter and spacing, cord twist direction, vessel wall thickness, decorative techniques, etc.) characterize this fundamental transformation of regional ceramics which culminates in Heart River phase pottery. We would agree with Lehmer's (1971:204) assessment, when speaking of the pottery produced by the traditional Mandan villagers at Heart River, that Heart River phase pottery "ranks technologically and esthetically as some of the best made by any of the villagers of the Middle Missouri Valley."

We can provide additional data bearing on the above speculations about the trend toward a pinnacle of ceramic development centered on the Heart River phase. Specifically, we can compute a measure of "dominance concentration" or homogeneity in several of the nominal-scaled ceramic variables for each time period. The concentration index used is the Simpson index (Simpson 1949) as given in Whittaker (1975). This index provides a measure of homogeneity or the degree to which objects classifiable into several possible groups are concentrated in one or a few groups; it can be viewed as the inverse of a diversity index, and it is inversely correlated with diversity indices and equitability indices which might also be computed for the same data. The Simpson index (C) is computed with the following formula:

$$C = \text{Sum of } p_i^2 \text{, summed from } p = 1 \text{ to } p = s$$

where p is the proportion for a given category expressed as a decimal fraction and s is the number of categories.

The anticipation is that several ceramic variables will exhibit gradually increasing concentration index values through the time periods under study, with a maximum value obtained in period 50, the Heart River phase. C has a maximum value of 1.000 in all cases (a situation where all cases occur in a single category, where there is maximum homogeneity and minimum diversity). The minimum value for C varies with the number of possible categories or attribute states for a given variable; as the number of categories (s) increases, the possible minimum value for C, obtained when all cases are equally dispersed among categories, decreases.

Table 17.10 presents concentration index values for periods 20 through 50 for several major ceramic variables. The values are computed from variable class percentage data by time period for the Hidatsa tradition samples only, similar to the data produced in Table 17.7 but more complete in terms of inclusion of minor variable attribute states, etc. Data for period 10 were not computed due to the extremely small vessel sample size for that period. Adequate samples exist for all periods for each of the other time periods. The data show some interesting patterns, some of which were anticipated under the present hypothesis, and some which were not. The greatest number of variables (4) exhibit their highest concentration index values in period 50. These include ware classification (primarily Le Beau ware), decorative type (predominantly cord-impressed), zone 2 surface treatment (predominantly rough and smoothed), and zone 3 decorative technique (predominantly cord-impressed). Interestingly, minimum index values occur in period 50 for the two decorative pattern variables for zone 3 and zone 7, indicating that while the Heart River phase pottery samples are most homogeneous in terms of rim form and decorative techniques (Le Beau Cord Impressed dominates all samples), there is greater diversity in decorative pattern in this same pottery than in any other period.

The period 20 sample also exhibits several high concentration index values for several variables, with several others being second highest only to those for period 50. This indicates that the Clark's Creek phase samples are also very homogeneous with regard to rim form and decorative variation. This is in agreement with previous characterizations of the pottery in that period as being predominantly Riggs ware with decorated lip decoration. Details of rim form in this period vary within narrow parameters, with angular zone 2 and zone 3 junctures and round lip form dominating the samples.

Table 17.10. Simpson's concentration index values computed by time period for selected ceramic variables in the Hidatsa tradition ceramic data set.

Time Period	Ware	Decor Type	Zone2 Form	Zone3 Form	Zone5 Form	Zone7 Form	Zone2 SurTret	Dec Tech3	Dec Tech7	Dec Pat3	Dec Pat7	Body Tret
20	.499	.331	**.863**	**.858**		**.441**	.482	.829	.423	.327	.392	.418
30	.301	.241	.635	.635	.290	.407	.445	.488	.551	**.590**	**.564**	.349
41	.375	.258	.511	.513	.282	.263	.447	.391	.465	.461	.209	.500
42	.283	.449	.625	.793	**.401**	.380	.473	.732	**.653**	.351	.272	**.599**
50	**.643**	**.794**	.680	.781	.343	.362	**.483**	**.866**	.519	.231	.195	.554
Possible Minimum												
	.100	.111	.500	.500	.167	.100	.167	.059	.100	.052	.067	.167

Note: The lowest value for each variable is underlined; the highest value is boldfaced.

The Nailati phase period 30 sample is somewhat less internally homogeneous. Decorative patterns in zone 3 and zone 7 do have maximum values in this period, reflecting predominant use of multiple parallel lines on zone 3 and punctations with no orientation on the vessel lip in this period.

The Scattered Village complex sample in period 41 is the most internally diverse and heterogeneous with regard to varied rim form and decorative expression. Five of the 12 variables in Table 17.10 exhibit their lowest concentration index values in this period; these have to do with variations in rim form for zones 2, 3, 5, and 7 and with decorative techniques used in zone 3. This high degree of diversity in rim form and decorative element combinations has been noted previously as one of the hallmarks of the Scattered Village complex. The data presented here serve to support the hypothesis that these ceramic assemblages represent an aggregate of stylistic and technological attributes deriving from diverse geographic sources within and adjacent to the Middle Missouri subarea.

Late Period Change

Late period samples under examination here include the Heart River phase and all that follows, periods 50 through 83, AD 1525 to the late 1800s. Late period ceramic change is dominated by a single process in which Knife River ware gradually and completely replaces Le Beau ware through time (Figure 17.7b). A great number of other variables illustrated in Figures 17.8 through 17.15 also change through this time span in a monotonic or near-monotonic pattern. By far the majority of these are variables which are integrally linked to the definition or key characteristics of either Knife River ware or Le Beau ware, and the changes observed are merely another reflection of the inversely correlated frequencies of the two dominant wares in this late period sequence. Such variables include frequency of straight (KR ware), braced (KR ware), S-shaped (LB ware), and recurved (LB ware) rim forms; frequencies of round (KR ware) and inslant (LB ware) lip forms; occurrence of spouts and castellations (KR ware); frequency of cord-impressed (LB ware), plain (KR ware) and pinched (KR ware) decorative types; and frequency of decoration in body sherds (LB ware).

Interestingly, a few other variables can also be noted which exhibit monotonic change in this time sequence, these being variables which at face value are not necessarily as closely linked with the definition of one or the other of the two major ware groups. These variables include frequency of neck brushing (decreases through time); trailed/incised line width (decreases through time); decorative patterns on zone 3 surfaces (rainbows decrease and diagonals increase through time); decorative patterns on zone 5 (horizontals increase through time); zone 3 inflection distance (decreases through time); thickness measurements in the body, zone 2, zone 3, and zone 5 (all generally increase through time); and cord twist direction (S-twist becomes more common later in time).

We can note that the majority of the variables just listed as being part of the great Le Beau/Knife River ware replacement phenomenon are identified as integral parts of factor 1 in the principal components analysis (cf. Table 17.3). Virtually every variable loading highly on factor 1 occurs in the list just presented. Several other variables listed here as showing graphic patterns of monotonic change through this period were simply not included in the factor anlaysis. Thus the graphic presentations shown in Figures 17.7 through 17.15 merely provide another form for presenting data on the dominant ceramic transformation previously identified as factor 1 in the principal components analysis of all study collections.

A small number of other variables exhibit patterns of variation which are short-term and nonmonotonic, and therefore also seem somewhat independent of the great Le Beau/Knife River ware change. The patterns of change observed here may also be important, signifying cultural changes and influences impinging upon the regional populations which derive from factors independent from the main cultural evolutionary forces at play during the period in question. Observed patterns of this nature include increasing and decreasing frequency of Transitional ware, peaking in period 62; increasing/decreasing frequency of Deapolis ware, peaking in period 72; increasing/decreasing frequency of cord-wrapped-tool decoration, peaking in period 61; varying frequency of trailed/incised decoration, peaking in periods 61, 82, and 83; minor changes in node frequency, with a peak in period 71; and occurrences of diagonal decorative patterns in zone 5, peaking in periods 61 and 62 and declining thereafter.

The presence of yet another pattern of change, easily overlooked in the graphic presentations, should be noted. This is in essence the pattern extracted as factor 3 in the principal components analysis. Reference to Table 17.3 indicates that it consists primarily of high loadings for the presence of spouts, dentate stamping, pinched decorative type, and pinching as an upper rim/lip modification procedure. Also loading much less highly on this factor are plain type, undecorated zone 3 occurrences, and plain interior surfaces (the latter with a negative loading). Inspection of the factor score plot and the graphed frequency and measurement data indicates that this factor effectively separates most of the latest batch components (those in group V) from the immediately earlier components which may also be assigned to the Knife River phase (group IV in the general cluster analysis). Further inspection indicates that decreasing values for the variables noted tend to distinguish the latest group V batches from the group IV series. That is, the terminal Knife River phase components are characterized by decreased use of pinching, decreased use of dentate stamping, decreased presence of spouts, decreased occurrence of undecorated zone 3 areas, increased occurrence of plain type, and increased occurrence of vessels lacking interior decoration. All these patterns are discernable in the graphic and raw data (Table 17.7), but the existence of this pattern is subtle and tends to be hidden beneath the mega-trends enumerated above.

The mega-trend in which Le Beau ware is replaced by Knife River ware as the dominant ceramic ware has long been recognized by many scholars of Mandan and Hidatsa archeology. Most often this change has been identified specifically as something that happened to the pottery of the Mandan people. This conclusion has been based on the following observations: 1) traditional Mandan sites at the Heart River are dominated by Le Beau ware; 2) the Mandan sites at Heart River are known from traditional and historic data to have been abandoned late in the eighteenth century; and 3) traditional and documented Mandan sites at the Knife River, known to have been settled by population remnants from the Heart River villages, are dominated by the occurrence of Knife River ware. By observing that the pottery in the nineteenth century Hidatsa sites at the Knife River is essentially the same as pottery in the nearby contemporaneous Mandan sites, this transformation from Le Beau to Knife River ware is readily extended by most scholars from the Mandans to the Hidatsas as well (Will and Hecker 1944:69-75; Lehmer 1971:176, 204, 205; Lehmer et al. 1978:185-186).

The clarity and apparent chronological abruptness of this change from Le Beau to Knife River ware has prompted one group of scholars led by W. R. Wood and D. J. Lehmer to posit an explanation for the observed ceramic change. This hypothesis has been stated several times (Lehmer 1971:176; Lehmer et al. 1978:183-185; Wilson 1977:97; Lehmer 1977:109; Wood 1986c:18). The basis for this hypothesis lies in the ethnographic observation that among the Hidatsas (Bowers 1965:104, 120, 165-166, 374-375) and apparently among the Mandans (Bowers 1950:283) pottery making was a semi-craft specialization actively practiced by only a limited number of older members in each village. Pottery making occurred in secret, and both the craft and the rights to practice it and to use particular decorative designs on pottery were purchased by younger persons from older practitioners (see Chapter 16, this volume, for a more detailed discussion).

From these observations and the fact that a devastating smallpox epidemic swept the entire Plains as well as the Mandan and Hidatsa villages in 1780-1781, Lehmer and Wood move to the assumption that pottery specialists, being relatively advanced in age, would have been differentially removed by the smallpox epidemic. They hypothesize that the epidemic would, therefore, have led to a disruption in the culturally prescribed methods for transmission of pottery-making knowledge as well as the rights to practice the craft. They further hypothesize that one of the effects of this disruption by the 1780-1781 epidemic is visible in the archeological record as the apparently abrupt shift from manufacture of Le Beau ware, dominant in the Mandan sites at Heart River occupied before 1780, to manufacture of Knife River ware, which they observed to be common in several Mandan and Hidatsa sites at Knife River occupied after circa 1800.

The occurrence of Knife River ware, a pottery type visibly less technically sophisticated than Le Beau ware, is therefore explained as a direct product of the cultural and social disruption caused by the 1780-1781 epidemic. The possibility of historic antecedents or origins for Knife River ware dating prior to 1780, or even for the prior existence of a concept of pottery like Knife River ware, is not explored in this hypothesis. Wood and Lehmer apparently believed that Knife River ware had no existence prior to 1780; when both the knowledge of pottery making and the culturally prescribed means for the rights to that practice were destroyed in the 1780-1781 epidemic, the new, less adept potters uniformly plucked from the air the concept of a straight or braced rim form with simple decoration as the idea of the future. The new rim form with simple designs did not offend the rights of the deceased potters and the rules of the society, and it soon became the standard for the time.

This hypothesis is set forth in most detail by Wood and Lehmer in Wilson (1977:97) where they add another force affecting the technological degeneration of pottery making in the period after 1780. This was the increasing workload of women in historic times. Citing Krause (1972:111), they hypothesize that "demands on the women's time to prepare skins for the fur trade seriously reduced the amount of time available for the exacting demands of pottery making."

One might wonder why Lehmer and Wood felt compelled to assume and then explain the "invention" of Knife River ware by the Mandans, rather than consider plausible alternative origins for this pottery type which is essentially unlike anything else in the Missouri valley. The answer lies, the senior author believes, in the preeminent position which the Mandan culture is consistently afforded in virtually all early historic documents as well as in all early studies of regional archeology. Put simply, the prevailing thought has been for some time that the Mandans so dominated nearby cultural groups that it was inconceivable that they might have borrowed the concept of Knife River ware, in such a wholesale fashion, from some outside source.

Several lines of evidence can be brought to bear which concern this hypothesis. Hanson (Chapter 16, this volume) draws the distinction between the knowledge of pottery making and the rights to pottery making in Mandan and Hidatsa society. He notes that knowledge of pottery making techniques could have been fairly widespread within the village communities, while the rights to apply that knowledge may have been restricted by various cultural rules. If this is the case, then perhaps knowledge of pottery making would not have died with the older potters in the epidemics, and the epidemic of 1780-1781 would have caused no particular reason for change in pottery quality. Also, the death of knowledgeable persons was no stranger to the villagers. The rules for transmission of sacred rights were constantly adjusted in the societies to allow for continuity in the transmission of sacred lore of all kinds upon the death of the person holding the rights to such lore (Bowers 1965). There is little reason to suspect that mechanisms assuring continuity in fundamental domestic crafts such as pottery making and its decoration would not have existed for some time within the village cultures.

Current thinking on the frequency and timing of major epidemics in the study area also has a direct bearing on the Lehmer/Wood hypothesis of ceramic change. Trimble (Chapter 15, this volume) presents considerable data which indicate that a large number of catastrophic epidemics probably swept the region and the Mandan and Hidatsa populations well before the first historically recorded epidemic in 1780-1781. If pottery change is integrally linked to social disruption from epidemics, then one would expect the chronology of this process to have been much different than that proposed by Wood and Lehmer.

The Lehmer/Wood hypothesis of the origins of Knife River ware and ceramic change in the late period can be tested directly with the archeological data at hand. From this hypothesis, and the assumptions of Mandan cultural preeminence upon which it is based, several expectations can be predicted for the archeological record:

IA. Knife River ware will occur almost exclusively in contexts which date after AD 1780, and it will be rare to absent in contexts dating before AD 1780.

IB. Ceramic composition, expressed as Le Beau and Knife River ware frequencies, will be uniform among contemporaneous Mandan and Hidatsa sites in the Knife-Heart region. This will be true for the period before 1780-1781 and for the period following that time.

IC. Ceramic change, particularly from use of Le Beau ware to use of Knife River ware, when viewed through time will occur in a step-like fashion, with the step changes reflecting the effects of epidemic(s). We expect the most visible step change to occur before and after AD 1780. Variables which potentially measure the technological quality and labor input into pottery-making will also change in a step-like fashion, in synchronization with changes in ware frequency.

ID. Considering IB and IC together, we expect the changes in relative frequency of Knife River ware and Le Beau ware to occur in a synchronized and uniform fashion among virtually all contemporaneous Mandan and Hidatsa villages in the region.

IE. No antecedents for Knife River ware or similar wares from which Knife River ware could have developed will occur in the archeological record for areas outside the Knife-Heart region.

An alternate hypothesis explaining ceramic change in the late period samples can be offered, based primarily on oral traditions of the various Hidatsa and Mandan groups. Oral traditions of the various Hidatsa subgroups, as documented in various historic and ethnographic accounts and as summarized by Wood (1986b), are somewhat confusing and contradictory. The key to understanding these, as recognized by Bowers (1965:14) from his ethnographic work with the Hidatsas, is the fact that the different subgroups of the Hidatsas in fact have distinctly different origin traditions, and that these traditions were often confused or amalgamated in early historic accounts. Drawing primarily on the previous archeological work of Bowers (1948) and his interpretation of various the Hidatsa origin traditions (1965:297-308, 481-188) (the latter summarized by Wood in Chapter 12, this volume), we can identify the following key events or circumstances as being of particular relevance to an alternate hypothesis for the occurrence of Knife River ware and ceramic change in the late period sequence:

* Of the three distinct subgroups of Hidatsas, the Awatixas lived in the Missouri valley the longest and had established permanent residence at the Knife River following a long period of interaction with the Mandans living downriver. They were almost certainly residing there when the late period sequence studied here began about AD 1525.

* The Awaxawi subgroup of the Hidatsas was next to arrive in the Missouri valley, migrating from a former homeland to the east. Tradition says that they settled in the Missouri valley in a location near Square Buttes, intermediate between the Mandans at Heart River and the Awatixas at Knife River.

* The Hidatsa-proper subgroup of the Hidatsas was the latest to arrive in the Missouri valley. They derive from common ancestors with the Awaxawis, and they came by way of territory or former residence near Devils Lake in eastern North Dakota. The Hidatsas-proper share origin traditions with the Awaxawis, indicating a long period of close interaction between the two subgroups.

* The Hidatsas-proper first settled in one and perhaps two villages below and at the mouth of Heart River where they learned many things from the Mandans living there. After a time, they moved northward, probably in increments, and settled at Big Hidatsa Village, their major village of residence at Knife River.

* Movements of both the Awaxawis and the Hidatsas-proper into the Missouri valley were not single mass migrations, but occurred gradually in small population units over a relatively long period of time.

* The Hidatsas-proper, when they first arrived in the Missouri valley, were comprised of several bands with highly variable commitments to agriculture and sedentism. The Mountain Crows eventually split off to pursue a fully nomadic lifeway; the remaining Hidatsas-proper were always more nomadic than other Hidatsa subgroups.

* Prior to the AD 1780-1781 smallpox epidemic, the Mandans had a much larger population than the three combined Hidatsa groups in the Missouri valley. After the 1780 epidemic, the Mandans were reduced from at least six to two villages, while the Hidatsa groups maintained three villages, and from that time onward the Hidatsa subgroups together were the more numerous of the two tribal groups.

Based on these considerations, the following hypothesis is offered for explanation of the major patterns of ceramic change in the late period samples, dating from about AD 1525 through the late 1800s. Knife River ware was not invented by the Mandans. Rather, Knife River ware is a distinctive pottery ware traditionally manufactured by cultural groups which can be identified as both Hidatsas-proper and Awaxawis, the Hidatsa subgroups who are latecomers to the Missouri valley. Knife River ware has its historic origins in areas to the east of the Missouri valley within or near the margin of the eastern Woodlands. This ware was introduced into the Knife-Heart region as a consequence of migration of Hidatsa-proper and Awaxawi subgroups into the region from areas farther east. After this migration began, two distinct ceramic traditions existed in the region, one being the Mandan tradition dominated by manufacture of Le Beau S-Rim ware, and the other being the Hidatsa-proper/Awaxawi tradition, dominated by manufacture of Knife River ware or variants having the same rim form and manufacturing sequence. The relative proportions of these two ware groups in archeological sites reflect the degree to which a particular village group was influenced by or participated in the respective Mandan or Hidatsa-proper/Awaxawi cultural traditions. Epidemics have little to do with the origin of Knife River ware. The spread and adoption of Knife River ware throughout the region was affected, however, by village and social group reorganizations which may have been stimulated by the epidemics. If epidemics did in fact disrupt the culturally prescribed methods for transmission of pottery making practices, then the decorative elements applied to the vessel (the most individualistic mode of stylistic expression in a ceramic tradition dominated by a single vessel form), rather than rim form, would be the variables most likely to change as a consequence of epidemics.

This complex hypothesis has wide-ranging implications for observable ceramic change in the archeological record. Several expectations can be enumerated for the archeological record:

IIA. Knife River ware should occur prior to AD 1780, and it should have a long history of use in the Knife-Heart region, coincident with the period of occupation of the region by groups identifiable as Hidatsas-proper and Awaxawis. Bowers (1948:219) suggests Awaxawi migrations as early as AD 1600-1650; Knife River ware should be at least that old in the study area.

IIB. Proportions of Knife River ware and Le Beau ware will vary from one contemporaneous village to another, depending on village-specific tribal and subgroup affiliations. Knife River ware will be most common in villages traditionally identified with the Hidatsas-proper and Awaxawis, will be less common in contemporaneous traditional Awatixa sites, and will be least common in contemporaneous traditional Mandan settlements.

IIC. The chronological records for each Hidatsa subgroup and the Mandan groups will show different rates of replacement of Le Beau ware by Knife River ware. Synchronous, step-like changes linked to epidemics will not occur across all villages. Step-like changes may occur for Mandan groups alone in the period before and after 1780, reflecting the shift in numerical supremacy to the Hidatsas at that point in time.

IID. Because Le Beau ware and Knife River ware represent two different coexisting pottery traditions, each ware will exhibit internally distinct technological attributes which will differ from each other but which will not change significantly, within each ware group, through time. Knife River ware will appear early on as technologically distinct from Le Beau ware, and those differences will remain consistent and relatively constant through the period during which both ceramic traditions are pursued in the region.

IIE. Historic antecedents for Knife River ware pottery will occur in the archeological record in areas directly east of the Knife-Heart region, in locations and in time frames which are consistent with the origin and migration traditions of the Awaxawis and Hidatsas-proper.

Both the Lehmer/Wood hypothesis and the "oral tradition" hypothesis concerning ceramic change in the late period sequence can be tested using data from the ceramic study samples. The question of the absolute age of Knife River ware pottery is a key issue in both hypotheses and the related test expectations. The most direct assessment of the age of Knife River ware comes from thermoluminescence (TL) dating of actual rim sherds and other vessel pieces which have been typologically classified as Knife River ware. Most of the ceramic samples submitted some years ago to Washington University for TL dating as part of the KNRI chronometric program were body sherds, not individually classifiable in a typological sense. Rim sherds were not submitted at that time because of the need to analyze rims in more detail prior to their destruction in the TL dating process. As the chronometric program progressed, the need to obtain dates on actual Knife River ware vessels and to date the initial introduction of this ware in the region became obvious. With that in mind, a small number of additional Knife River ware vessel rim fragments were submitted from various contexts to Alpha Analytic, Inc., for TL dating.

Three Knife River ware samples could not be dated by Alpha Analytic for technical reasons, and chronometric dates are available on an additional 10 Knife River ware vessels. Provenience information and dating results for these vessels are given in Table 17.11. The dated sherds can be organized into two groups. The first includes four vessels which were selected because they were recovered from stratigraphically deep contexts, and, on the basis of various other evidence, they are thought to potentially be some of the earliest Knife River ware vessels occurring in the respective sites. A few stratigraphically deeper Knife River ware rim sherds do occur in both the Lower Hidatsa and Big Hidatsa sites, but those were not suitable for dating because of small size. Thus, the first four dates listed in Table 17.11 represent some of the earliest datable occurrences of Knife River ware in Big Hidatsa and Lower Hidatsa villages, both deeply stratified sites with long periods of apparently continuous occupation. Central tendencies for these dates range from AD 1600 to AD 1700, and they clearly indicate that Knife River ware first appears in these sites and in the upper Knife-Heart region in the AD 1600s, well before the epidemic of AD 1780-1781.

The other six TL dates listed in Table 17.11 are for Knife River ware sherds from a variety of contexts which are not thought to necessarily reflect particularly early occurrences of the ware in the region. These dates document quite well that Knife River ware was used throughout the 1700s in regional sites. Only two of the six dates fall at AD 1780 or later. The three dated vessels from the Mahhaha site are some of the deeper Knife River ware sherds in the site deposits there, but both the TL results and results of other analyses (cf. the factor and cluster analyses of the Mahhaha ceramic data) indicate that these vessels probably date in the eighteenth century and do not reflect particularly early occurrences of Knife River ware in the region.

Many other site samples from KNRI sites have been dated by TL and C-14. Even though these dates were run on organic material or on sherds which could not be classified typologically, the provenience of the dated materials in contexts having relatively high frequencies of Knife River ware vessels provides another way for indirectly dating the ware and assessing its time depth in the region. Available chronometric data for the deeply stratified deposits at both Lower Hidatsa Village and Big Hidatsa Village are summarized in Table 17.12, along with information on the percentages of Knife River ware and Deapolis ware (thought to be a companion ware to Knife River ware) in the various dated contexts. Some of the chronometric dates are individually subject to some error and may be somewhat less than fully acceptable based on associated stratigraphic, trade artifact, and other information (e.g., the C-14 date range midpoint of AD 1736 in period 6 at Big Hidatsa). However, the dates in general confirm that Knife River ware first appeared in these two sites during the seventeenth century and continued to occur through the eighteenth and nineteenth centuries in increasingly greater frequency.

The chronometric information available at this time clearly fails to support the Lehmer/Wood hypothesis and test implication IA. The occurrence of Knife River ware in the earliest deposits at Big Hidatsa post-dating isolated Scattered Village complex occupation there confirms that Knife River ware is firmly associated with the earliest known archeological deposits in the region which can be linked directly with the Hidatsas-proper. The chronometric information indicates that the Hidatsas-proper settled at the site around AD 1600, and that they made and used Knife River ware at that time. The data from Lower Hidatsa, traditionally associated with Awatixa occupation, indicate that Knife River ware was first used there at about the same early date. Thus, in general, test implication IIA is found to be true, and the second hypothesis attributing Knife River ware to Hidatsa-proper and Awaxawi occupation in the region is supported.

The next implications under each hypothesis are somewhat directly opposed, one (IB) positing uniform occurrence of Le Beau and Knife River ware frequencies in contemporaneous sites, with the other (IIB) predicting nonuniform occurrence at any given time level, with variation tied to subgroup and tribal identity. To examine these test implications in some detail we need to organize data on the frequency of Le Beau and Knife River ware according to individual time slices (specific or general time periods) and according to sites, recognizing where possible the ethnic affiliation of each site. Table 17.13 provides an organization chart for site batch samples arranged by time period and according to four ethnic associations, with the latter based on historic documentation and native traditions (see the summary of this information in Chapter 2 of this volume).

Big Hidatsa is the single site well-recognized as the home place for the Hidatsa-proper subgroup in the Knife River area. This subgroup may have lived in earlier times at one or more sites nearer the Heart River, but samples from such sites are not available for study. The Nightwalker's Butte site (in period 70) lies in traditional Hidatsa-proper territory, but it cannot be definitely linked to any particular subgroup of the Hidatsas. Two sites can be attributed to occupation by the Awaxawi subgroup of the Hidatsas. One is Amahami Village, well documented historically, and the other is Molander Village. Wood's analysis of the indirect historic evidence concerning the Molander site has convinced him that it is an Awaxawi village occupied in the 1700s, and we concur with that assessment for purposes of organizing the present data. At least three sites are considered to have been occupied by the Awatixa subgroup of the Hidatsas. Lower Hidatsa is a traditional place of residence for the Awatixas, prior to their move to Rock Village and their resettlement by circa AD 1800 at Sakakawea Village, the latter being historically documented. The Awatixas may have briefly reoccupied Rock Village after the 1837 epidemic. Awatixa components have been identified for all time periods except 81, AD 1780-1800.

There are insufficient data to warrant subdividing the Mandan components according to subgroups. We have usable data from three sites with evidence of Mandan occupation. Slant Village is documented as such by historic and traditional information. The earliest component at Sakakawea is identified here as the primarily Mandan village documented at that location by David Thompson in 1797-1798. Deapolis is an historically documented Mandan village.

Excluded from the organization in Table 17.13 are samples from Mahhaha of unknown subgroup/tribal derivation, from Greenshield which is primarily Arikara in origin, from Fort Clark which is mixed Mandan and Arikara in origin, and from Fishhook which is primarily Hidatsa but of mixed subgroup derivation.

The test implications concerning ware proportions noted above are examined by tabulating the frequency of Le Beau ware versus Knife River/Deapolis ware by site in each of the time periods. General frequency information on the occurrence of Deapolis ware (Figure 17.7b) indicates that it is a companion ware to Knife River ware; it differs from Knife River ware primarily in the form of the brace. For these reasons, counts of Deapolis ware and Knife River ware are combined in the ware frequency tabulations. Table 17.14 presents such data by site and time period. Knife River ware occurs in sufficient frequency to allow this comparison for samples in period 61 and later (post-AD 1600). Chi-square analysis is used to test the null hypothesis that there are no differences in ware composition between or among sites assigned to a single time period. Attention should be focused on the tabulations for specific subperiods (61, 62, 71, etc.) because they offer the best control of chronology as well as tribal/subgroup identification. Tabulations are also provided for major time periods such as AD 1600-1700 (batches assigned to periods 60, 61, and 62) to allow the inclusion of more site samples, some from mixed or unknown tribal/subgroup derivations. Such comparisons are instructive but are thought to provide less rigorous tests of the hypotheses than the data from specific short-term subperiods.

Test implication IB positing uniform ware composition across contemporaneous sites (the null hypothesis being tested in the chi-square analysis) is rejected for nearly all time periods. Only in period 61 and in period 82 are the proportions of the two ware groups statistically similar across sites. Statistically significant and substantive differences in ware composition occur across sites in all other time period samples. These results are in agreement with implication IIB for the oral tradition hypothesis set forth in this paper. The percentage values for Le Beau and Knife River/Deapolis ware in specific site samples which can be given tribal/subgroup identifications also conform to the pattern predicted in implication IIB. In subperiods 61 through 72, the Big Hidatsa samples attributable to the Hidatsas-proper contain the highest percentage of Knife River/Deapolis ware of all site samples. The Awatixa samples for the same period from the Lower Hidatsa site exhibit significantly lower frequencies of Knife River/ Deapolis ware and higher amounts of Le Beau ware in periods 62, 71, and 72. The Molander sample, attributed to the Awaxawis, is somewhat anomalous. It contains almost no Le Beau ware (2 percent), yet it is thought to predate AD 1780 and to be attributable to the Awaxawi subgroup who were both geographically closer to the Heart River Mandan villages and who have a documented record of close interaction with the Mandans (cf. Bowers 1965:14-15, 20-21, 23-24). This suggests that perhaps the Molander sample dates later than we have placed it; or that Molander may not be Awaxawi in origin; or that the Awaxawis played a more central role in the "Hidatsa-proper/Awaxawi" ceramic tradition than we have suspected.

We can note further that the degree of dissimilarity in ware composition among the sites diminishes greatly after AD 1780 (in periods 81 and following). While statistically significant differences maintain in periods 81, 83, and the composite 80-83 series, Knife River ware is dominant in all these samples, comprising at least 82 percent of each collection. This suggests that the transformation from use of Le Beau ware to use of Knife River ware, while ongoing at different rates in different villages and subtraditions, was largely completed in all subgroup populations by shortly after the AD 1780-1781 epidemic. The historic record indicates that the epidemic led to a period of somewhat chaotic reorganization (Bowers 1965:24, 26-27; 1950:8-12) which lasted for almost 20 years, with many temporary village and subgroup alignments being attempted and abandoned. It is clear also that this epidemic and the events that followed led to a shift in regional population dominance from the Mandans to the Hidatsas. The factors of population shift and village realignments almost certainly accelerated the sharing and diffusion of material culture traits among various villages. The net effect, evident in the ceramic data, is that certain elements of Hidatsa material culture, represented in Knife River ware,

Table 17.11. Thermoluminescence dates produced directly on rim sherds classified as Knife River ware in the ceramic study samples.

Site	Sample No.	Context	Date AD
Knife River Ware Vessels from Stratigraphically Deepest/Earliest Contexts within Sites:			
Lower Hidatsa 32ME10	Alpha-1522	Unit 3, L. 10, 160-175 cm sd	1700 ± 30
Lower Hidatsa 32ME10	Alpha-1523	Unit 3, L. 10, 160-175 cm sd	1600 ± 40
Lower Hidatsa 32ME10	Alpha-1524	Unit 3, L. 11, 175-190 cm sd	1680 ± 30
Big Hidatsa 32ME12	Alpha-1907	Unit 6, L. 10, 70-77 cm sd	1690 ± 30
Knife River Ware Vessels from Other Contexts:			
Lower Hidatsa 32ME10	WUTL-84b1	Unit 3, F. 4, 60 cm sd	1750 ± 20
Big Hidatsa 32ME12	Alpha-1901	Unit 4, L. 17, 150-165 cm sd	1780 ± 20
Big Hidatsa 32ME12	Alpha-1903	Unit 4, L. 18, 165-180 cm sd	1720 ± 30
Mahhaha 32OL22	Alpha-1909	Test 2, Level 3	1760 ± 20
Mahhaha 32OL22	Alpha-1910	Test 2, Level 3	1760 ± 20
Mahhaha 32OL22	Alpha-1911	Test 2, Level 3	1810 ± 20

Table 17.12. Summary data on chronometric dates and percentages of Knife River ware and Deapolis ware in early sites identified as Awatixa and Hidatsa-proper in subgroup affiliation.

Site and Batch	Mean TL Date AD	Corrected C-14 Range Midpoint	Ware Percentage K. River	Ware Percentage Deapolis
Awatixa:				
44. Lower Hidatsa, period 1	-	-	37%	22%
45. Lower Hidatsa, period 2	1729 ± 31	-	41%	7%
46. Lower Hidatsa, period 3	1739 ± 31	-	20%	1%
47. Lower Hidatsa, period 4	1687 ± 23	-	14%	0%
48. Lower Hidatsa, period 5	1634 ± 33	1555	0%	0%
49. Lower Hidatsa, period 6	-	1528	4%	0%
Hidatsa-proper:				
64. Big Hidatsa, period 1	-	-	78%	11%
65. Big Hidatsa, period 2	1725 ± 32	-	75%	4%
66. Big Hidatsa, period 3	1720 ± 33	-	62%	9%
67. Big Hidatsa, period 4	1645 ± 58	-	63%	7%
68. Big Hidatsa, period 5	1611 ± 25	1649	45%	2%
69. Big Hidatsa, period 6	-	1736	20%	0%

Table 17.13. Summary of tribe and subgroup identifications for selected ceramic batches, according to time period.

Period	Dates	Hidatsa-Proper		Awaxawi		Awatixa		Mandan	
83	1820/30-1845	64.	BigHid 1			59.	Sakaka 1	38.	Deapolis
82	1800-1820/30	65.	BigHid 2			60.	Sakaka 2		
81	1780-1800							61.	Sakaka 3
80	1780-1845			41.	Amahami	62. 63. 82.	Sak Ins Sak Oth Rock		
72	1740/45-1780	66.	BigHid 3			44.	LowHid 1	1.	Slant L
71	1700-1740/45	67.	BigHid 4			45.	LowHid 2	0.	Slant E
70	1700-1780	4.	Molander	53.	LowHid 61			2. 3.	Slant E Slant L

Table 17.13. Concluded.

Period	Dates	Hidatsa-Proper	Awaxawi	Awatixa	Mandan
62	1650-1700	68. BigHid 5		46. LowHid 3	
61	1600-1650	69. BigHid 6		47. LowHid 4	
60	1600-1700		54. LowHid 62 56. LowHid 71		
50	1525-1600		48. LowHid 5 49. LowHid 6 55. LowHid 63 56. LowHid 72		

Table 17.14. Tabulation of frequencies of Le Beau ware and Knife River/Deapolis ware by site (batch) for each subperiod and general time period.

Time Period	Batch/Site		Le Beau Ware n	%	K. River/Deap. Ware n	%	Total n	%
61	69.	BigHid 6	8	66.7	4	33.3	12	100.0
	47.	LowHid 4	64	83.1	13	16.9	77	100.0
	Total		72	80.9	17	19.1	89	100.0
		$X^2 = 1.83$	df = 1	p = > 0.10, < 0.20				
62	68.	BigHid 5	13	31.0	29	69.0	42	100.0
	46.	LowHid 3	82	74.5	28	25.5	110	100.0
	Total		95	62.5	57	37.5	152	100.0
		$X^2 = 24.64$	df = 1	p = < 0.001				
60,61, 62	30.	Mahha 2	21	36.8	36	63.2	57	100.0
	46,47,54,56. LowHid		178	70.4	75	29.6	253	100.0
	68,69.	BigHid	21	38.2	34	61.8	55	100.0
	Total		220	60.3	145	39.7	365	100.0
		$X^2 = 21.10$	df = 2	p = < 0.001				

Table 17.14. Continued.

Time Period	Batch/Site		Le Beau Ware n	%	n	K. River/Deap. Ware %	n	Total %
71	67.	BigHid 4	11	15.5	60	84.5	71	100.0
	45.	LowHid 2	28	45.2	34	54.8	62	100.0
	0.	Slant E	20	100.0	0	0.0	20	100.0
	Total		59	38.6	94	61.4	153	100.0
		$X^2 = 48.96$	df = 2		p = < 0.001			
72	66.	BigHid 3	18	16.7	90	83.3	108	100.0
	44.	LowHid 1	19	33.9	37	66.1	56	100.0
	1.	Slant L	12	75.0	4	25.0	16	100.0
	Total		49	27.2	131	72.8	180	100.0
		$X^2 = 25.79$	df = 2		p = < 0.001			
70,71, 72	66,67.	BigHid	29	16.2	150	83.8	179	100.0
	4.	Molander	2	2.5	78	97.5	80	100.0
	44,45,53.	LowHid	57	37.5	95	62.5	152	100.0
	0,1,2,3.	Slant	110	93.2	8	6.8	118	100.0
	29.	Mahha 1	2	10.0	18	90.0	20	100.0
	86.	NWButte	0	0.0	72	100.0	72	100.0
	Total		200	32.2	421	67.8	621	100.0
		$X^2 = 295.2$	df = 5		p = < 0.001			
81	19.	Greensh	2	2.8	70	97.2	72	100.0
	61.	Sakaka 3	3	17.6	14	82.4	17	100.0
	Total		5	5.6	84	94.4	89	100.0
		$X^2 = 5.73$	df = 1		p = < 0.02			
82	65.	BigHid 2	7	11.3	55	88.7	62	100.0
	60.	Sakaka 2	4	5.6	67	94.4	71	100.0
	Total		11	8.3	122	91.7	133	100.0
		$X^2 = 1.39$	df = 1		p = < 0.30, > 0.20			

Table 17.14. Concluded.

Time Period	Batch/Site		Le Beau Ware n	%	n	K. River/Deap. Ware %	n	Total %
83	35.	FtClark	0	0.0	20	100.0	20	100.0
	38.	Deapolis	0	0.0	304	100.0	304	100.0
	59.	Sakaka 1	4	5.2	73	94.8	77	100.0
	64.	BigHid 1	0	0.0	8	100.0	8	100.0
	83.	Star	0	0.0	1	100.0	1	100.0
	85.	Fishhook	0	0.0	18	100.0	18	100.0
	Total		4	0.9	424	99.1	428	100.0
		$X^2 = 18.38$	df = 5	p = < 0.01				
80,81, 82,83	41.	Amahami L	1	0.5	197	99.5	198	100.0
	59,60,61,62,63. Sakakawea		13	4.7	263	95.3	276	100.0
	64,65.	BigHid	7	10.0	63	90.0	70	100.0
	35.	FtClark	0	0.0	20	100.0	20	100.0
	38.	Deapolis	0	0.0	304	100.0	304	100.0
	83.	Star	0	0.0	1	100.0	1	100.0
	85.	Fishhook	0	0.0	18	100.0	18	100.0
	Total		21	2.4	866	97.6	887	100.0
		$X^2 = 35.48$	df = 6	p = < 0.01				

were adopted by virtually all the Mandans and Hidatsas as the standard for the region in the period after 1780.

The rates of change from Le Beau ware to Knife River ware posited in various test implications (IC, ID, IIB, IIC) can best be viewed in graphic form, as shown in Figure 17.16. This figure illustrates the percentage of Knife River/Deapolis ware (Figure 17.16a) and Le Beau ware (Figure 17.16b) for each of the tribe/subgroup sequences based on batch samples in Table 17.13 assigned to specific, small-scale subperiods. The graphed percentages are slightly different from those given in Table 17.14 because the graphed percentages are computed across all ware classes including those other than Le Beau, Knife River, and Deapolis ware. The graphed data illustrate quite readily that the ware composition at any point in time differs greatly from village to village (Hidatsa subgroup to subgroup). The graphs also indicate that the rates of change in ware composition differ as predicted in implication IIC. Synchronous, step-like changes in ware compositon, potentially related to epidemics as predicted in the Wood/Lehmer hypothesis, generally do not occur across multiple sites. The Hidatsa-proper and Awaxawi sequences begin with higher proportions of Knife River/Deapolis ware and then change more slowly than does the Awatixa series, which initiates with a higher proportion of Le Beau ware than the other Hidatsa samples.

The Mandan sequence of ceramic change is quite distinct. It is apparent that Le Beau ware continues to be the dominant ware well into the 1700s (in the limited data sample available to us) but that the change from the late period sample at Slant to the next available Mandan data set in Sakakawea period 3 was quite major. In a span of possibly only 20 years or so, it seems that the Mandans may have completely abandoned Le Beau ware, replacing it with Knife River/Deapolis ware. This is precisely the process or sequence of events which Lehmer/Wood suggested to have occurred in all sites in the region. The data reported here indicate that this process did not happen in Hidatsa sites, but that it may in fact be characteristic of what occurred among Mandan groups. The Hidatsa sequence suggests that the reasons for this change are quite different than the explanation offered by Lehmer and Wood. While the 1780-1781 epidemic may have triggered this ceramic tranformation at Mandan villages, the change from one ware to the other occurred because of settlement system disorganization and intertribal village amalgamations (a temporary change) accompanied by the ascent of the Hidatsas to the position of most numerous village tribe in the Upper Missouri (a permanent change). It would seem that after 1780 the Mandans were reduced to the status of refugees who sought protection from the Hidatsas, and in the process, were culturally transformed in some ways into an Hidatsa cultural pattern. In sum, the data on rates of change in ware composition strongly support the oral tradition hypothesis offered here concerning the origin of Knife River ware. These data also offer insights into heretofore poorly understood shifts in broader cultural dominance and cultural change in the study area.

We can turn attention now to the specific details of vessel form for both Le Beau ware and Knife River ware, considering changes in form through time and differences, where they can be measured, between the two wares. We focus here on the series of metric variables measured for the vessels. Test implication IC under the Lehmer/Wood hypothesis posits step-like changes through time in variables which might measure technological quality or labor investment in both wares. On the other hand, implication IID under the hypothesis proposed here posits more gradual changes in such properties through time and posits that certain comparable quantitative measures will differ between the two wares and that the differences will be maintained through time.

We can look first at changes through time within each ware as measured by several interval-scaled variables. The procedure was to use one-way analysis of variance to compare means for variables by time period, testing the hypothesis that the period samples are drawn from a single population. Knife River ware vessel data were compiled for periods 50 through 83, excluding the major periods 60, 70, and 80, and the Le Beau ware data were compiled for periods 50 through 72, excluding 60 and 70. These data were compiled for the sites identified as being in the Hidatsa sequence only, so that differences attributable to the Mandan samples occurring in only a limited number of time periods would not unduly bias the comparison across periods. Data for Deapolis ware were included with data for Knife River ware in this analysis.

In general, the analysis indicates that each ware varies little through time and is internally consistent in basic form and technological characteristics through time. For Knife River ware, the ANOVA shows no significant differences across periods for the following variables: trailing/incising spacing on the rim; trailing/incising line width on the rim; cord impression spacing (Figure 17.17a); mean zone 2 thickness (Figure 17.17b); mean lip thickness; total rim height; zone 2 height; and zone 2 inflection. Particularly interesting is the fact that neck thickness does not vary through time in Knife River ware (Figure 17.17b), even though the overall pattern is for this measurement to gradually increase through time when all vessel samples are considered together regardless of ware classification (Figure 17.15b). Variables which do show significant variation across time periods in Knife River ware include cord diameter; zone 5 thickness; zone 5 width or height; and vessel orifice diameter. The significant change in cord diameter is apparently attributable to a substantial decrease in diameter in the latest period sample (Figure 17.17a), possibly due to the use of trade cordage rather than native cordage in this late historic period. Both zone 5 dimensions become abruptly greater in the period 71, 72, and 82 samples (Figure 17.17c); this change is probably attributable to the occurrence of Deapolis ware with its distinctly broader and larger collared brace in these periods (cf. Figures 17.7b, 17.11b). The data on vessel orifice diameter are suspect because of very small sample sizes, but they suggest a reduction in vessel size in the latest time period (means by period: 72 - 20.4 cm; 82 - 19.1 cm; 83 - 14.4 cm; samples of 10, 7, and 11 vessels, respectively). Overall, these analyses indicate that Knife River ware does not change drastically in technological terms, as measured in vessel wall thickness, vessel size, or in decorative finesse, until the latest time period, if at all. They indicate a technologically homogeneous and stable sample, consistent with the second hypothesis proposed herein.

Le Beau ware exhibits a somewhat similar pattern of stability through time. Variables which show no significant differences across periods 50 through 72 include: cord impression spacing (Figure 17.17a); cord impression width (Figure 17.17a); zone 2 thickness (Figure 17.17b); brace thickness; lip thickness; zone 3 height; zone 3 inflection; brace width; and vessel orifice diameter. Only one variable shows significant variation through time, that being zone 3 thickness which gradually increases through the five time periods (Figure 17.17c). Again, the metric data fail to exhibit major differences between periods or step-like changes attributable to abrupt degeneration of ceramic technology. Le Beau ware appears to have continued to be made in basically the same way through the period from 1525 to 1780, consistent with implications IIC and IID and the oral tradition hypothesis proposed herein.

The two pottery wares can be directly compared on only a small number of interval-scale variables, due either to limits in sample size or differences in rim form which affect the comparability of measurements across wares. Variables which can be compared include cord impression spacing, cord impression diameter, and vessel thickness in zone 2 or the neck area. These comparisons are shown graphically in Figures 17.17a and 17.17b. Analysis of variance indicates statistically significant differences (shown by an asterisk) in cord spacing only in the period 50 samples, where spacing for Knife River ware is about 0.5 mm less than that for Le Beau ware; this measurement is effectively the same for each ware in periods 61 through 72. Cord diameter is also effectively the same throughout the period 50 through 72 sequence.

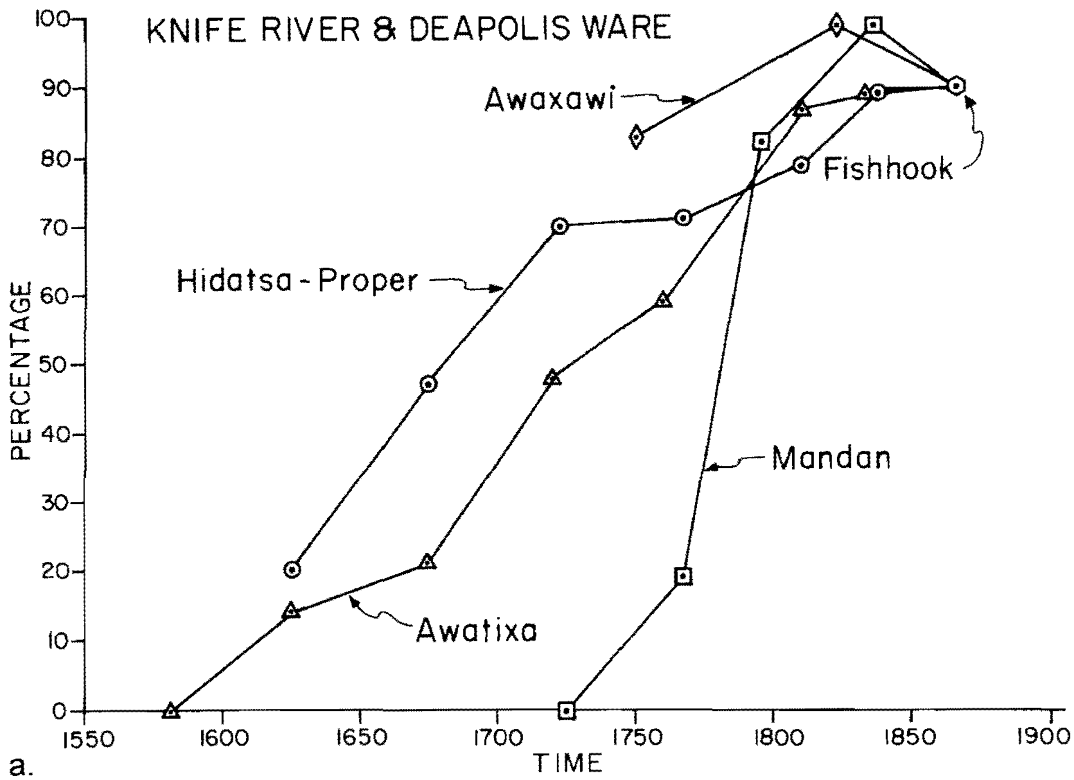
Zone 2 thickness can be compared in periods 50, 61, 62 , 71 and 72. Significant differences occur in period 61 and period 71 samples (asterisks in Figure 17.17b), with the mean measurement for Knife River ware in each case being about .85 mm (15 percent) greater that the Le Beau ware mean. These results are consistent with the general intuitive assessment that Knife River ware is "cruder" or less technologically finished than Le Beau ware. While the results are not unequivocal because differences were not found in all time periods, they tend to indicate that significant technological distinctions between the two wares existed and continued to occur over a considerable period of time. This is consistent with test implication IID and the second hypothesis proposed herein.

The internal stability of the formal characteristics of each ware can also be examined by cross-tabulating frequencies of various nominal-scaled variables across relevant time periods for each ware. The majority of these variables have to do with details of style and decoration rather than basic aspects of vessel form and technological considerations. For that reason, they can be expected to change significantly in the course of a 200-year or longer period such as that being studied here. Chi-square analysis was used to test the hypothesis that within a given ware no change occurs in the relative frequency of particular nominal-scaled variables across time periods. The test was conducted over periods 50, 61, 62, 71, and 72 for Le Beau ware, and over periods 50, 61, 62, 71, 72, 82, and 83 for Knife River ware (excluding Deapolis ware in this case because it is primarily a stylistic variant of Knife River ware). The tests were restricted to the Hidatsa tradition batch samples as defined previously in order to exclude interaction from sources linked to Mandan ethnic association.

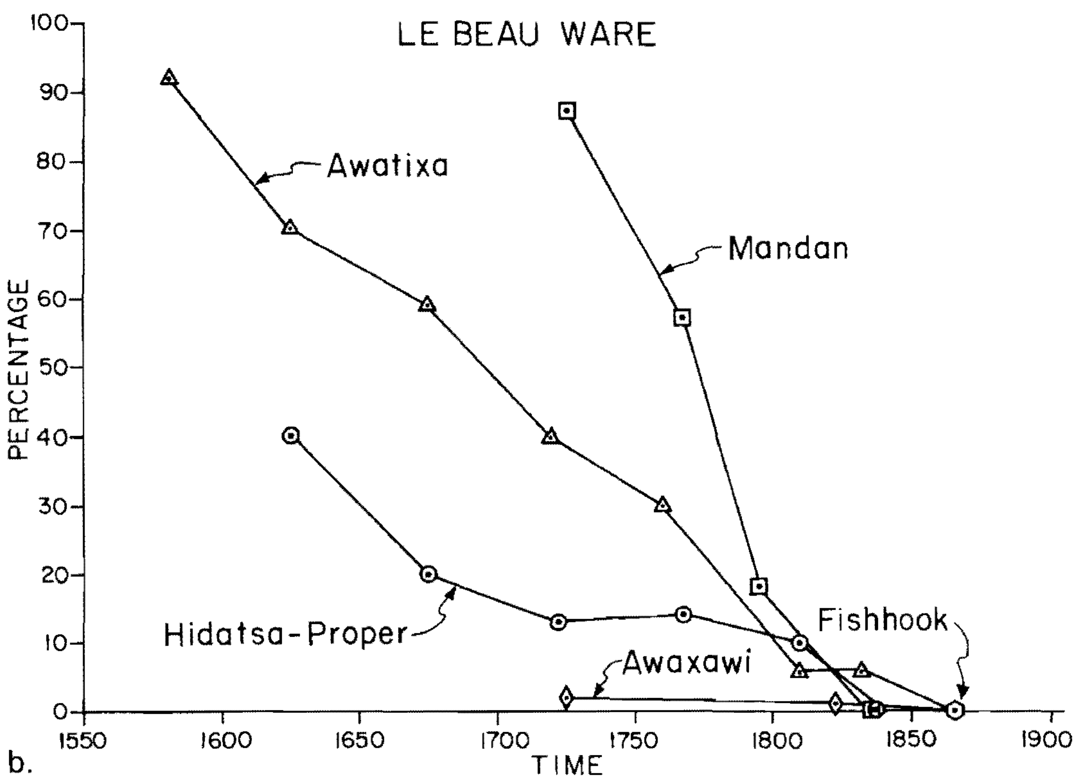
For Knife River ware the following variables exhibit what is considered to be substantive, nontrivial, statistically significant variation according to time period: lip shape (changes are complex); zone 2, neck surface treatment (high occurrence of brushing in periods 71 and 72); zone 5 decorative technique (plain increases through time, cord-impressed decreases, and cord-impressed above finger/tool-impressed is common in periods 62, 71, and 72); upper rim/lip modifications (spouts are absent in periods 61 and 83 and are present elsewhere, tabs are common in periods 82 and 83); decorative type (plain increases in period 83, cord-impressed decreases late in time, dentate stamped is common in period 82).

The following variables exhibit no significant variation through time in Knife River ware: rim form; zone 2 shape; zone 5 brace shape and location; zone 2 decorative technique; zone 7 decorative technique; interior decorative technique; zone 2 decorative pattern; zone 5 decorative pattern; zone 7 decorative pattern; and cord twist direction.

For Le Beau ware the following variables exhibit what is considered to be substantive, nontrivial, statistically significant variation through time: zone 3 shape (more angular after period 50); zone 5 brace shape and location (interior brace disappears after period 50); decorative type (plain and pinched increase through time, cord-impressed decreases through time, cord-wrapped-



a.



b.

Figure 17.16. Ware class percentages according to time period for batch samples identifiable by Hidatsa subgroup or Mandan tribal association. a: data for combined percentages of Knife River and Deapolis ware; b: data for Le Beau S-Rim ware.

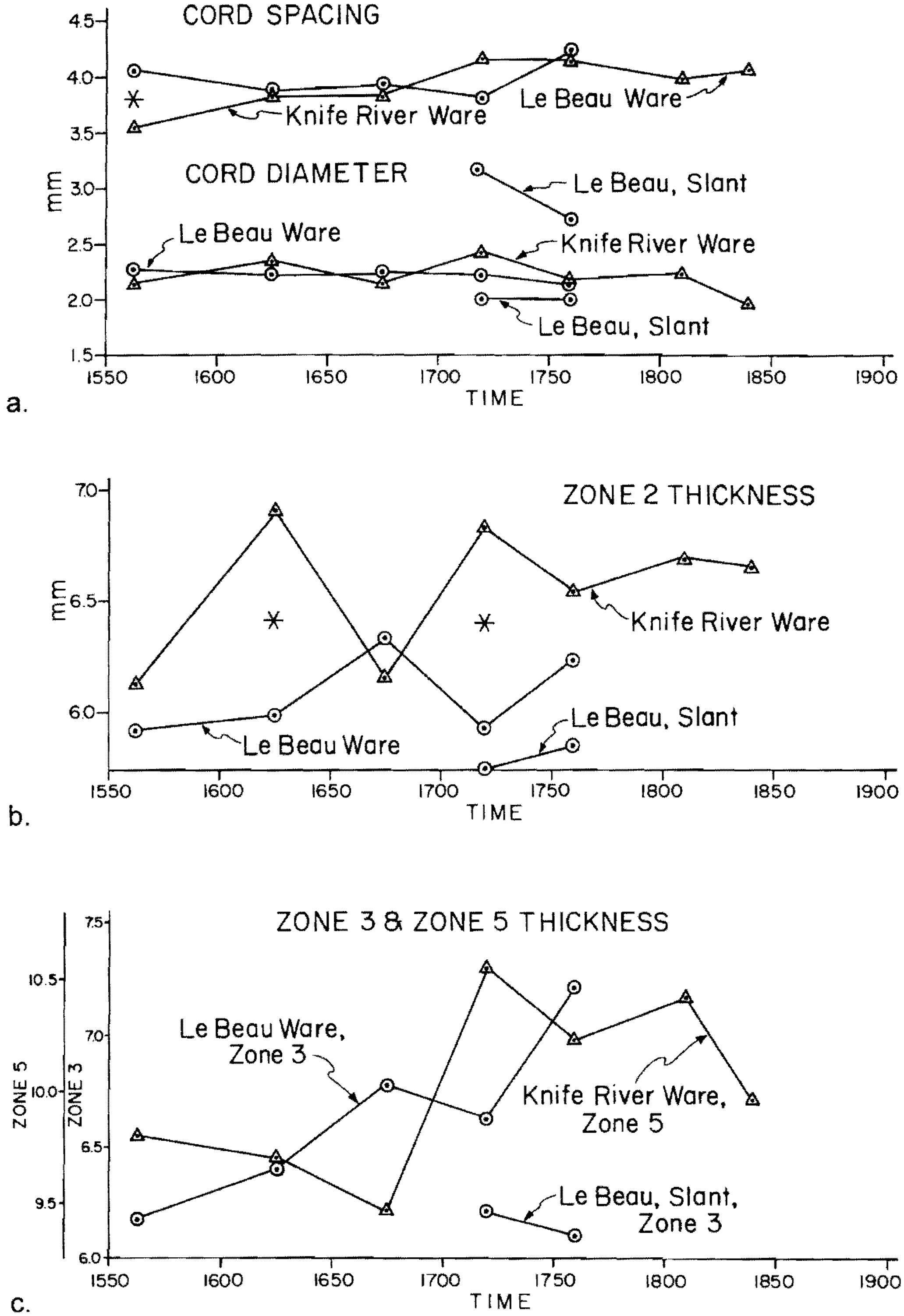


Figure 17.17. Data for selected ceramic variables by time period and controlled according to Knife River/Deapolis ware or Le Beau ware. a: data on cord spacing and diameter; b: data on zone 2 thickness; c: data on thickness in zone 3 (Le Beau ware) and zone 5 (Knife River ware). Primary data are derived from Hidatsa tradition samples only; Slant Village data are plotted separately. Asterisks indicate periods with statistically significant differences between Le Beau and Knife River ware.

tool-impressed is more common in periods 61 and 62); zone 3 decorative technique (plain increases through time, cord-impressed decreases through time, and cord-impressed above finger impressions increases in periods 50 through 71); zone 7 decorative technique (tool and finger impressions increase through time, trailed/incised decreases through time); zone 3 decorative patterns (changes are multiple and complex).

The following variables do not exhibit significant differences through time in Le Beau ware: rim form; occurrence of zone 4; lip form; zone 2 neck surface treatment; zone 2 decorative technique; zone 5 decorative technique; interior decorative technique; zone 2 decorative pattern; zone 5 decorative pattern; zone 7 decorative pattern; cord twist direction; upper rim-lip modifications.

Presentations of the details of these period by period, intraware comparisons are relevant to mapping the complexities of ceramic change in the late prehistoric and post-contact periods in the region, but such a presentation is beyond the scope of this treatment. The general trend of these changes can be summarized by the graphic and tabular summaries for several pertinent variables for all wares combined as given in Figures 17.7 through 17.15 and in Table 17.7 by time period.

The final topic for consideration deals with the antecedents of Knife River ware. Data presented so far overwhelmingly support the second hypothesis presented herein that Knife River ware is a pottery form intimately associated with a ceramic tradition distinct from that of the Mandans and carried into the region via migrations of Hidatsa-proper and Awaxawi peoples from areas to the east. To clinch this proposition, we need to find antecedents and technologically similar pottery types in the area geographically east of the Knife-Heart region. We should look for pottery with the basic rim form and technological elements expressed in Knife River ware, focusing specifically on elements most unique to Knife River ware which provide the greatest contrast with Le Beau ware. We expect to find pottery with the following combinations of attributes: vessels should have a straight to everted braced rim form. Most distinctive should be the use of castellations or spouting as a vessel rim modification, a feature which is common in the regional Knife River ware samples throughout time and which is completely absent in Le Beau ware samples. Cord-impressed decoration can be expected, although other decorative techniques may occur, confined primarily to the brace, lip, and rim interior. Shoulder and vessel body decoration should be rare.

Using oral traditions, many researchers have identified eastern North Dakota as the general place of origin of the Hidatsas (Bowers 1965:22-23, 482-483, 486; Wood 1986b:30-36). Specific references are made in relatively recent versions of Awaxawi and Hidatsa-proper origin traditions to emergence from beneath Devils Lake (cf. several accounts quoted in Wood 1986b), and the Stutsman focus centered on the James River (Wheeler 1963) has been cited as definite archeological evidence of early Hidatsa occupation of eastern North Dakota.

One early migration account recorded for the Awaxawis and Hidatsas-proper provides additional information on where we should expect to find the cultural ancestors of these subgroups and pottery complexes ancestral to Knife River ware. David Thompson (Tyrrell 1968:230-231) recorded a migration account provided by the resident trader, "Manoah" (or Menard), apparently for the Awaxawis, which documents the Awaxawis' former possession of all the streams in the drainage of the Red River and the head of the Mississippi River, and residence in a land with abundant wild rice and deer but lacking bison and the horse. This description clearly implies residence in a location in the woodlands east and possibly southeast of the Knife-Heart region at a time pre-dating introduction of the horse. This tradition suggests we should look farther east than eastern North Dakota. Figure 17.18 shows the area in which wild rice is most abundant west of the Great Lakes (the wild rice district in Jenks 1900), and the ancestral Awaxawi homeland can be expected to occur somewhere in this region; the specific reference to the headwaters of the Red and Mississippi Rivers suggests a location in what is now southern Minnesota or central Wisconsin.

The literature on archeological sites in eastern North Dakota is particularly lacking in evidence for pottery similar to Knife River ware. One site which does contain such evidence is the Hintz site (Wheeler 1963), the type site for the Stutsman focus, on the James River (Figure 17.18). Our analysis of a portion of the Hintz site collection (Table 17.7) indicates that Knife River ware comprises about 26 percent of the sample, Le Beau ware about 25 percent, and Unnamed Straight and S-Rim wares the majority of the remaining 49 percent. We would identify Wheeler's (1963:190-205, Table 3) Pingree Wedge

Rim ware, most of his Buchannan Cord Impressed, and most of his Stanley ware vessels as Knife River ware. On this basis, Wheeler's analysis of the full pottery collection yields a similar proportion of Knife River ware (roughly 25 percent) in the total site collection, with Melville Cord Impressed or Le Beau ware being the dominant ware (circa 40 percent). Two examples of castellations occur in our small sample from Hintz, one on a Knife River ware vessel and the other on a Knife River Fine ware vessel. Cord impression is the dominant decorative technique in our sample (74 percent of all vessels).

According to our analysis the ceramic composition of the Hintz site collection is very similar to samples from period 6 at Big Hidatsa Village and from period 3 and 4 at Lower Hidatsa Village. All are characterized by a majority of Le Beau ware and a significant occurrence of Knife River ware. The KNRI samples date in the seventeenth century (periods 61 and 62). We would suggest a similar date for the main occupation at the Hintz site, perhaps in the early 1600s; this is consistent with occurrence of rare trade artifacts in the excavated collection. This date and the general ceramic composition indicate to us that Hintz is not ancestral to any early Hidatsa cultural group in the Missouri trench, but that it is contemporaneous with and very closely related to the early Hidatsa-proper/Awaxawi/Awatixa occupations in the trench. The high percentage of Le Beau ware indicates strong influence from the Mandans at Heart River, while the relatively common occurrence of Knife River ware indicates a very general Hidatsa association for the Hintz sample.

Other examples of braced rim, castellated pottery from eastern North Dakota are extremely rare. Such rim and vessel forms are rarely if ever mentioned in several contract reports dealing with surveys and testing programs in the James and Sheyenne River valleys in North Dakota (for example, see the summary provided by Schneider [1982] of work conducted in the James River valley). One village site on the James River, Hendrickson III, has produced a small sample of six braced rims comprising about 10 percent of the site collection (Good et al. 1977:173-174); none of these is cord-impressed, all are tool decorated. One castellated, unbraced vessel is reported from Hendrickson III; the castellations consist of an estimated dozen or more peaks and scallops along the lip, and

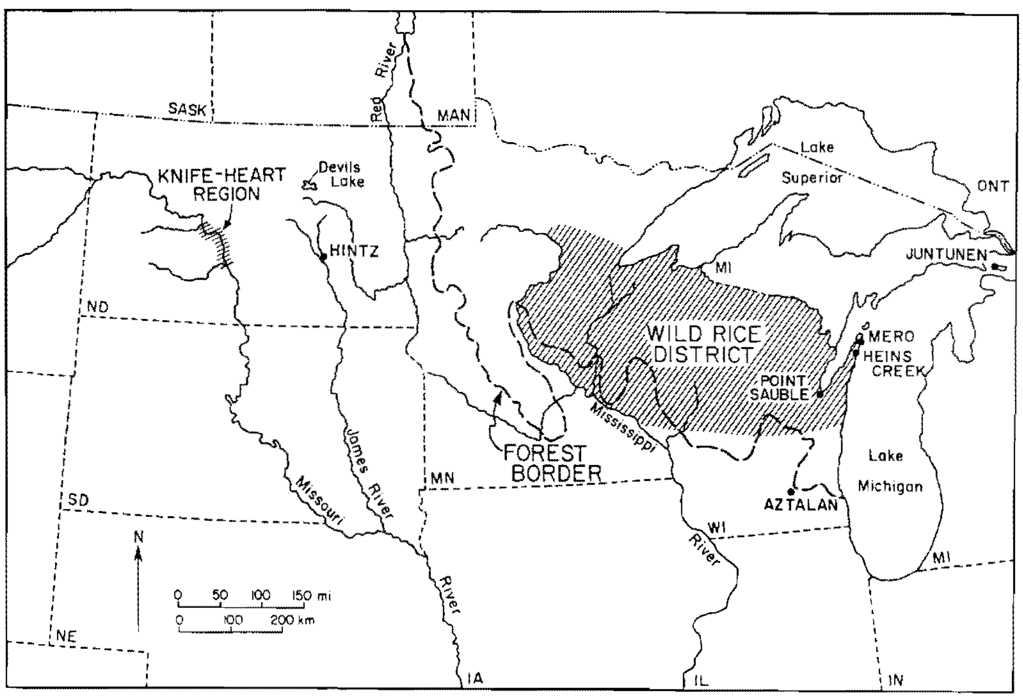


Figure 17.18. Map of the area from Lake Michigan to North Dakota showing the "Wild Rice District" as mapped by Jenks (1900), the prairie/forest border, and archeological sites discussed in the text relevant to Awaxawi/Hidatsa-proper migrations.

therefore it is different from Knife River ware. The Hendrickson III sample dates to circa AD 1400. The present authors' general assessment is that Hendrickson III shows little relationship to early Hidatsa-proper/Awaxawi ceramic complexes, and that it is more closely related to the Scattered Village complex and perhaps relatively early "Coalescent" tradition complexes in South Dakota.

Syms (1979:290), in his definition of the Devils Lake-Sourisford Burial complex, illustrates a series of three or four miniature vessels from mortuary contexts which appear to have castellated rims and an equal number which may be braced and uncastellated. Syms (1979:304) suggests a date of AD 900-1400 for the complex, and he attributes the complex to nomadic Siouan peoples, identifying the Crows as one of the possible ethnic groups responsible for the complex. It is quite possible that this burial complex does relate directly to the ancestral Hidatsa-proper/Awaxawi (and Crow) groups which we seek in eastern North Dakota, but this cannot be assessed more fully until nonmortuary sites related to the complex can be identified and studied in detail.

Looking farther to the east, we can note a virtual lack of reported ceramic collections from Minnesota which would appear to qualify as ancestral Hidatsa-proper/Awaxawi in origin. Virtually no braced rim, castellated, cord-decorated pottery is reported in the compendium of ceramic types recognized in the state of Minnesota (Anfinson 1979). This situation is mirrored in Anfinson's (1982) review of data from the Prairie Lakes region in southern Minnesota. If pottery of the nature we seek exists in Minnesota, we must assume that it is rare in the extant archeological collections.

Looking yet farther east in what is present-day Wisconsin we find two pottery types occurring throughout a wide area in Wisconsin which bear strong similarity to Knife River ware. These are Point Sauble Collared and Aztalan Collared; both are defined by Baerreis and Freeman (1958), and Aztalan collared is described in detail by Barrett (1933:298-322). Both of these types are grit tempered wares characterized by a collared, or in our terms, a braced rim form apparently made by folding the upper rim area to the outside, onto itself, just as in the production of Knife River ware. Both types are characterized by castellated rim forms, with such treatment apparently being more common in Aztalan Collared. The Aztalan Collared vessels sometimes have an angular or non-circular orifice, coincidental with the castellations, and an orifice with five peaks often occurs in Aztalan Collared ware. Both pottery types are decorated predominantly with cord impressions, placed either diagonally or horizontally or in cross-hatched patterns on the lip or the brace surface. In addition, cord decoration commonly occurs on the rim interior in both types, just as it does in Knife River ware. Also, a row of cord knot impressions or cord-wrapped-tool impressions often occurs at the base of the brace, a decorative pattern repeated in Knife River ware where finger punctations substitute for tool or cord knot impressions. Decorations by tool notching and by cord-wrapped-tool impressions are used occasionally in the Wisconsin types, particularly in the Aztalan Collared type. The two Wisconsin types differ from each other most in decoration in the neck area, with Aztalan Collared usually being undecorated below the brace, and with Point Sauble Collared usually being decorated in the neck area by diagonal or horizontal linear cord impressions.

The similarity between these Late Woodland period wares in Wisconsin and Knife River ware is remarkable (whole vessels and representative sherds are illustrated in the above references as well as in Mason 1981:Pl. 8.3 and 8.5; Brose 1978:Figure 3; and Hall 1962:Plates 51b, 69b, 70a). The major distinction between the two Wisconsin types and Knife River ware is the use of cord-roughened body surface treatment in the Wisconsin types as opposed to simple-stamping and smoothed surface treatment in Knife River ware.

As the name implies, Aztalan Collared is quite common at the Aztalan site (Barrett 1933; Baerreis and Freeman 1958) on the Crawfish River and at other nearby sites in southern Wisconsin. At the Aztalan site, the Aztalan Collared pottery is considered to be a Late Woodland ware which coexisted with Mississippian pottery types made by Mississippian people who migrated to this location from points to the southeast. Point Sauble Collared is common in sites farther north in east-central Wisconsin, particularly at sites such as Mero and Heinz Creek (Mason 1966:133-137, 252, 254, 255) and Point Sauble (Freeman 1956). Point Sauble Collared is thought to have a more northerly distribution than Aztalan Collared (John Richards, personal communication to Ahler, March 18, 1986). Point Sauble also occurs in lesser frequency at Late Woodland sites further north in northern Michigan such as the Juntunen site (McPherron 1967:110-111) where it occurs with Bois Blanc ware. The latter ware is also characterized by braced rims and castellations, but Bois Blanc shares decorative elements such as dominant use of cord-wrapped-rod impressions and other features with Blackduck ceramics which are common farther north and northwest (McPherron 1967:104-105). Brose (1978) notes that collared (braced) and castellated wares are common in the eastern Wisconsin area in late prehistoric times and that these features exist, less commonly, in many pottery wares in coeval Late Woodland complexes and phases such as the Juntunen phase, Late Lakes phase, and Keshena phase in northern and central Michigan and other areas farther east. Similar castellated, collared pottery such as Starved Rock Collared has been reported from sites in Illinois (John Richards, personal communication to Ahler, March 18, 1986).

Radiocarbon dates ranging from AD 750 to 1630 have been reported from the Aztalan site by Boszhardt (1977:131-133). Stoltman (1976) computed an average date of circa AD 1120 for this Aztalan series, and he reports another date of circa AD 1000 for Aztalan Collared pottery from Rosenbaum Rockshelter. Richards (1985:95-98) reports four additional C-14 dates from Aztalan ranging from AD 820 to 1100, with one or more of these dates being directly associated with Aztalan Collared pottery samples. Most reported radiocarbon dates for Aztalan Collared pottery fall in the range from AD 1000-1250 (Green and Behm 1980:473). Point Sauble Collared pottery is apparently less well dated; John Richards (personal communication to Ahler, March 18, 1986) suggests that it dates somewhat later than Aztalan Collared. Brose (1978:568) suggests that all of the pottery in the Late Woodland complexes mentioned here predates AD 1400. Hurley (1975:9-10) suggests that most of the Late Woodland complexes recognized in southern and central Wisconsin should be considered a continuation of the Effigy Mound tradition, and that this tradition or complex continues in the region until historic times. Thus, according to Hurley, the pottery types of interest to us here may have continued to be made somewhat later than AD 1400. The sites discussed here are mostly fortified villages with evidence of a horticultural subsistence base, although some of the more northern sites probably reflect mixed economic adaptations (Brose 1978:573).

The Aztalan Collared and Point Sauble pottery types of Wisconsin fit well with the hypothesized explanation for the occurrence of Knife River ware in the Middle Missouri subarea as a product of Awaxawi/Hidatsa-proper migrations. These types predate the first appearance of Knife River ware on the Missouri River by about 200 years or more, adequate time for some part of the Late Woodland populations to have moved in an incremental fashion first to the woodland-prairie margin and then onward to the Missouri River valley. The form expressed in these pottery types agrees quite well with the basic and unique elements of Knife River ware; Wisconsin pottery differs from Knife River ware in the use of cord-roughened surface treatment and, in the case of Point Sauble Collared, in the use of more elaborate neck decoration. The shift from cord-roughened surface treatment to grooved paddled or simple-stamped surface treatment could easily have occurred in this 200-year interval in question. The shift away from cord-roughened surface treatment is well documented to have occurred over a broad area in the Northern Plains region in the interval from roughly 1200-1600, for example, in the Initial and Extended variants of the Coalescent tradition in the Dakotas (Lehmer 1971). The loss of extensive neck decoration also is seen as a relatively minor decorative change during the two century or longer period of proposed migration. Such decoration is in fact maintained on vessels classified in the present study as Knife River Fine ware, perhaps as an anachronism harking back to former days in Wisconsin.

As unexpected as it seems at first glance, the archeological data readily support the concept that the Hidatsa-proper and Awaxawi subgoups of the Hidatsas developed directly from Late Woodland hunters/farmers/gatherers who resided in southern and central Wisconsin in the eleventh and twelfth centuries. This explanation agrees on virtually all points with native traditions. The Wisconsin area is well within the heartland of wild rice distribution, in an area where bison were rare or absent, and where deer was the dominant large game species. Reference to a large body of water or lake in the Hidatsa origin traditions may in fact be traceable to Lake Michigan or one of the other Great Lakes, rather than to Devils Lake as is often interpreted. The Hidatsa origin myths may have in fact been transferred to Devils Lake by the Hidatas themselves as they moved westward into what is now North Dakota.

The lack of sites in Minnesota which fit into this explanation, along the path of this migration route from Wisconsin, remains a mystery. Given the degree of supporting information for an ultimate Hidatsa-proper/

Awaxawi origin in Wisconsin, all that can be suggested now is that the appropriate sites dating in the appropriate period of AD 1400-1600 will eventually come to light in Minnesota.

MANDAN-HIDATSA DISTINCTIONS

The problem of distinguishing the material cultures of Mandan and Hidatsa peoples based solely on the archeological record is a central question in the KNRI program and one which can be pursued to a considerable degree with the ceramic data base. One view on this topic which has prevailed for a number of years (Will and Hecker 1944:25, 33; Lehmer et al. 1978:1, 436, 437; Wood 1986c:16, 18, 20) is that the material culture attributable to the two tribal groups is essentially indistinguishable. This view has indeed prevailed partly because no one has attempted to rigorously examine the assertions made by Will and Hecker. In all fairness, in recent years this view has been expressed more often as a topic for study rather than as an operating assumption. A dissenting view, offered several years ago by Bowers (1948; 1965:476-489) is that the two ethnic divisions have distinguishable ceramic and archeological traditions which can be traced far back into the prehistoric record. Bowers (1965:489) sees the Mandan and Hidatsa archeological records as most distinguishable in early periods and as progressively more similar in the more recent, post-contact time periods. The data available here offer a limited test of these competing hypotheses.

Hanson, in his review of ethnographic data for the Hidatsa in Chapter 16 of this volume, offers additional information which tends to parallel Bowers' hypothesis. He notes that given the traditional procedures for transmitting ceramic manufacturing and decoration practices to one's clan mates or relatives, together with reported lack of frequent intertribal marriages prior to the late historic period, one would expect strong intertribal differences to exist in some elements of ceramic manufacture and design, and that these differences would be maintained over a considerable period of time. We can expand this idea to suggest also that if women usually married within their village, then between-village as well as between-tribe differences in ceramic content should also be evident.

To explore this problem we ideally need to use ceramic data sets from contemporaneous villages identifiable as Mandan and Hidatsa in origin. The latter condition can be met with a degree of certainty only in the fully historic period; for earlier sites we must rely on traditional data to ascribe Mandan versus Hidatsa association to a particular site. We can explore this problem at different time levels in the archeological record. The foregoing discussion of ceramic change among the Mandans and Hidatsas illustrates quite clearly that during the seventeenth and eighteenth centuries the ceramic content of villages attributable to the Mandans (On-a-Slant) and to the various Hidsatsa subgroups (Big Hidatsa, Lower Hidatsa, Molander) differs greatly in basic ceramic content. These differences are quite marked at several levels of examination, one being in terms of ware composition or rim form preference. The data plotted in Figure 17.16 indicate quite clearly that Mandan-Hidatsa distinctions are quite marked in the period from AD 1600-1780. This comparison is quite limited, however, by the lack of data from multiple Mandan sites which fall in this time range.

The question of Mandan-Hidatsa distinctions can be explored further using data confined primarily to two other time periods. First, we can compare ceramic assemblages which have been assigned to the Heart River phase thought to date in the period AD 1525-1600. We can also compare assemblages which post-date the AD 1780 epidemic and which lie primarily in the period 1800-1845.

Heart River Phase Comparisons

In the Heart River phase comparison we are reaching relatively far back in time to study ceramic variation which existed in large measure before major influence from the Hidatsa-proper and Awaxawi migrations from the east. In essence we are attempting to draw distinctions between the Awatixa Hidatsas and possible Mandan groups, all assigned taxonomically to the Heart River phase. Several site samples are available for this comparison, including Smith Farm (batch 6), Lower Sanger (batch 7), Hensler (batches 20 and 21 combined), Alderin Creek (batch 37), the late component at White Buffalo Robe (batch 39), and the earliest components at Lower Hidatsa Village (here we will use the least mixed batches, 48 and 49 combined). All of these units are consistently assigned to the Heart River phase in the factor and cluster analyses and studies of regional taxonomy. Geographically, these sites extend throughout the upper Knife-Heart region. On the basis of native traditional data, two sites are attributed to specific tribal subgroups. Lower Hidatsa is a traditional village of the Awatixa Hidatsas (Bowers 1965:19; 1948:111; Wood 1986b:15, 35), and Bowers (1948:39, 43, 116-118) attributes the Lower Sanger site to the Awigaxa subgroup of the Mandans. The remaining sites in this list do not have clearly identified ethnic associations, although Bowers (1965:481) also attributes the Hensler site to the Mandans on the basis of ceremonial lodge architecture. One might suppose that based on the Mandan tradition of Awigaxa subgroup occupation for a period of time in the Painted Woods region that other Heart River phase sites south of Knife River might also be Mandan, as is claimed for Lower Sanger.

To this comparison we have chosen to add the ceramic data from the early period component at On-a-Slant Village (batches 0 and 2). We have done this primarily because this sample is consistently classified in the factor and cluster analyses as a typical Heart River phase component, regardless of the proposed date for this sample in the early 1700s and the proposed dates for the other Heart River phase samples in the mid to late 1500s. Subjective classification of the various pottery samples also leads to the same conclusion, that both Slant Village early samples and all the others share a basic taxonomic similarity which is broadly recognized as the Heart River phase. In addition, it is useful to include the Slant sample in this comparison because it is definitely Mandan in origin, based on a broad array of historic and ethnohistoric information collected shortly after the abandonment of this site in the late 1700s (Stewart 1974:289; Chomko 1986; Libby 1908). We choose to exclude the late period sample from Slant (batches 1 and 3) from this comparison because previous analysis has indicated that this assemblage differs in many ways from the early period batches (0 and 2) (cf. Breakey and Ahler 1985). These differences are probably both epidemic-related as well as related to influence from the Hidatsas in this period. The Mandan-Hidatsa comparison is more straightforward if we restrict it to the least altered early Slant Village period samples.

Before presenting the results of the quantitative comparisons of Heart River phase ceramic data, additional notes concerning the inadequacies of the present samples can be offered. Disparity between the dates for the Slant Village sample and the other village samples has already been noted. This makes the comparison less than optimal. No contemporaneous data from the Heart River area sites for the period AD 1525-1600 are available for study. Also, it is almost certain that the samples included in the comparison are not equally representative of the range of variation in any given village. The Slant data derive from only a small number of large storage pits lacking more detailed contextual information. The Smith Farm sample comes from a single test unit near the village margin. The Lower Sanger sample derives from several test units in several intra-site contexts. The Hensler sample derives from two tests in extrahouse contexts. The Alderin Creek sample derives primarily from a small number of intramural features in a single excavated house; this sample is internally extremely homogeneous, as if the vessels were made by a single potter over a very brief period of time. The White Buffalo Robe sample comes from features in a site having substantial earlier period occupation, and therefore it can be expected to contain some mixture from earlier components. The Lower Hidatsa sample comes from extremely spatially restricted tests on one site margin. In sum, it is clear that few of the samples used here are necessarily representative of the full range of variation likely to occur in any given site, and it is likely that some samples are highly unrepresentative of intrasite variation. Approximate vessel sample sizes in the various sites are: Slant - 80; Smith Farm - 19; Lower Sanger - 82; Hensler - 152; Alderin Creek - 123; White Buffalo Robe - 52; and Lower Hidatsa - 140. These numbers will, of course, decrease where data are missing for certain variables.

The comparison was conducted in two ways. First, the general composition of each site assemblage was compared by cross-tabulations of rim form, ware classification, and decorative type classification by site. The null hypothesis that ceramic composition will be uniform across sites is tested with chi-square analysis (program CROSSTABS in SPSS, Inc. 1983:287-301). Because Le Beau S-Rim ware constitutes the dominant ware category in all the sites (this being characteristic of the Heart River phase), further comparisons were restricted to more detailed study of Le Beau ware attributes only. Detailed rim form, decorative technique, and decorative pattern comparisons are made between sites and tested with chi-square analysis, and the SPSS-X program BREAKDOWN (SPSS, Inc. 1983:321-331) was used with one way analysis of variance to test the hypothesis of no variation across sites for several interval-scaled variables.

In general, the analysis indicates significant variation in ceramic content among the various Heart River phase village samples. Such variation is not only statistically significant but it also appears to be substantive in several cases. In general, between-village variation is strongest in what might be considered as relatively detailed aspects of vessel form and vessel decoration. In this regard, the results conform to the ethnographic model (cf. Bowers 1965:104, 128, 165-166, 343, 373-374) which suggests that not only general manufacturing techniques but also detailed decorative information was carefully guarded and passed along from generation to generation of potters in a culturally prescribed manner. The idea of micro-stylistic traditions within each village seems to be supported, subject to the many possible problems imposed by the sampling limitations noted above.

Many aspects of the comparative analysis are illustrated graphically in Figures 17.19 through 17.23. In those figures data are arranged according to the relative positions of the villages along the Missouri River. Lower Hidatsa on the left is the one village thought to definitely be Awatixa Hidatsa in origin, while Slant on the right, farthest downriver, is definitely Mandan in origin. Marked differences in data content between these ends of the spectrum could indicate key variables which measure tribal differences in ceramic traditions, although the disparate age of the Slant Village sample must also be noted in such an assessment. If Mandan-Hidatsa distinctions do occur in any patterned fashion, perhaps they will be expressed as an upriver-downriver gradient in frequencies or means for various ceramic attributes.

The site assemblages differ significantly in terms of rim form content, as illustrated graphically in Figure 17.19a. S-rim forms vary in relative frequency from less than 75 percent in some samples (Smith Farm and Lower Sanger) to more than 99 percent in the Alderin Creek sample. The Alderin Creek data indicate the extreme homogeneity of that sample, noted earlier. Straight rim forms are most common in the Smith Farm, Lower Sanger, and Hensler site samples. Other distinct differences among sites in terms of minor rim form variants can be noted. The practice of rim bracing is most common at mid-to-downriver sites, and is particularly common at Hensler. At that location, interior bracing occurs on at least 25 of the 111 identifiable Le Beau ware vessels. The occurrence of zone 4, the recurved portion of the S-rim, has an interesting distribution. The data in Figure 17.19a indicate that this feature occurs most commonly at Slant Village. The data for Le Beau ware alone provide a better intervillage comparison of this feature. At Slant Village zone 4 is used on 49 percent of the observable Le Beau ware vessels; this compares to 29 percent at Smith Farm, 12 percent at Lower Sanger, 7 percent at Alderin Creek, and 4 percent or less at the other three villages. A clear geographic pattern seems to occur in which the recurved S-rim occurs most commonly at downriver locations and less commonly at upriver locations. Whether this reflects a basic element of Mandan-Hidatsa differentiation or is explainable in chronological terms remains to be determined.

Significant differences in ware classification occur between the village samples for total site assemblages, as illustrated in Figure 17.19b. Percentage values by individual ware for the batch samples used in the comparison can be found in Table 17.7. At all sites Le Beau ware is the dominant form, as expected, constituting 60 percent or more of each sample. Le Beau ware constitutes more than 90 percent of the Alderin Creek sample, more than 85 percent of the Slant and Lower Hidatsa samples, and lesser amounts of the other site samples. Knife River ware and Knife River Fine ware occur in minor frequencies at several sites. The low frequencies of these groups in all samples, both possibly traceable to a ceramic tradition having its origin near the Great Lakes, suggests that the Hidatsa-proper/Awaxawi westward migration had not reached the Missouri valley by the time of the Heart River phase. No particular geographic pattern seems clear for the distribution of non-Le Beau ware classes, except perhaps that all straight rim forms appear to be most common in the Hensler, Lower Sanger, and Smith Farm sites. The relatively high percentage of other S-rim forms in the White Buffalo Robe site relates to Fort Yates and Unnamed S-Rim wares which probably occur there due to admixture from the earlier Nailati phase component at the site. Statistically significant differences in decorative type classification for all wares combined occur among the sites, as illustrated in Figure 17.20a. Percentage data for various batch samples are given for type classes in Table 17.7. Cord-impressed decorative type dominates all samples, being highly correlated with the occurrence of Le Beau ware. A few minority decorative types do exhibit particularly high frequencies at a few sites, however. Lower Sanger exhibits unusually high frequencies of tool-impressed, cord-wrapped-tool-impressed, and trailed/incised types. Tool-impressed and trailed/incised are also common types at Smith Farm. The data from Lower Sanger may conform with Bowers' (1948:116-118) assertion that this site was occupied by the Awigaxa Mandan subgroup following migration from parts of the Missouri valley in South Dakota, having brought with them incising and tool decoration techniques characteristic of the South Dakota part of the Missouri valley.

The decorative technique applied specifically to zone 3 in Le Beau ware does not vary significantly among the sites, being dominated by cord-impression, but the decorative pattern used on such vessels does vary significantly. Data for the main decorative motifs are illustrated in Figure 17.20b. Diagonal patterns are particularly common at Smith Farm, and such patterns also constitute the most common motif at Lower Hidatsa. At all other sites horizontal patterns are more common, often combined with a curved rainbow design motif. The data recording system does not allow a clear distinction between angular versus curved rainbow patterns, but there is a suggestion that curved rainbow patterns are most common in downriver sites (see individual batch percentage data in Table 17.7).

Decoration applied to the lip in Le Beau ware also varies strongly among sites (Figure 17.21a). Most vessels in all sites have plain, undecorated lips. Tool impression occurring as short trailed, diagonally oriented lines is found almost exclusively in the Alderin Creek sample where it occurs on nearly 35 percent of the vessel lips. Cord impression occurs on less than 15 percent of the lips in all sites except White Buffalo Robe and Lower Hidatsa. At Lower Hidatsa such decoration occurs on more than 35 percent of the Le Beau vessels. Because of the geographic distribution of cord-impressed lip decoration, being concentrated at upriver locations, it may constitute a distinctive element in Hidatsa tradition sites.

Figure 17.21b illustrates another distinctive characteristic related to cord impression in the two upriver sites. S-twist cordage, always a minority in all collections, exhibits unusually high frequencies at Lower Hidatsa and White Buffalo Robe compared to the relative frequency at most of the other sites. Again, this geographic pattern may point to a trait distinctive of the Awatixa Hidatsa ceramic traditon. Analysis of variance also indicates that cord impression diameter and spacing are statistically different among site samples in Le Beau ware pottery (Figure 17.21c). With regard to cord spacing, where the differences are most evident, Slant Village exhibits by far the narrowest mean cord spacing, while most upriver sites have relatively much wider spacing. A similar difference in cord spacing between Slant Village samples and contemporaneous Hidatsa components is illustrated in Figure 17.17a, where the Slant cord spacing is decidedly narrower than that in the contemporaneous Hidatsa samples. Again, this may be an important element for distinguishing Mandan and Hidatsa ceramic complexes.

Body sherd decoration (decoration on the vessel shoulder), itself a distinguishing feature of Heart River phase ceramics, varies considerably among the site samples (Figure 17.22a). The particularly low frequency at Smith Farm may be due to the small sample size (60 body sherds). The remaining intrasite variation exhibits no distinctive geographic pattern.

Analysis of variance applied to interval-scaled variables for Le Beau ware vessels indicates several additional intrasite differences. Lip thickness and thickness at zone 3 vary considerably among the sites, as shown in Figure 17.22b. The patterns of variation shown by these two variables are highly different, however. Lip thickness is markedly greater in the Alderin Creek sample, owing perhaps to the relatively high frequency of flattened lip forms in this sample. Zone 3 thickness, in contrast to lip thickness which reflects lip form, is probably a variable more deeply imbedded in general ceramic technology and the skill of the potter. This variable shows a distinct pattern in which zone 3 thickness is relatively low at all sites except the two upriver loci. The reader will remember the distinctions expressed at these sites in cord decoration attributes. Perhaps the vessel wall thickness variable is another measure of Mandan-Hidatsa distinction at this time level. The graphic display of vessel wall thicknesses measured at places lower on the vessel (Figure 17.22c) exhibits a pattern somewhat similar to that for zone 3 thickness. The greatest mean thickness values occur in the White Buffalo Robe sample, while the Lower Hidatsa sample is the next thickest.

The analysis also indicates that the size and shape of zone 3 in Le Beau ware differs significantly among sites. These differences, along with other variations among sites in lip form and bracing in Le Beau ware, are captured in Figure 17.23 which shows diagrammatic cross-sections of typical Le Beau rim forms for each site. These cross-sections are drawn using the mean zone 2, 3, and 7 thickness measurements, the mean inflection and height values for zone 3, and the most common lip form in the Le Beau ware sample for each site. Less common lip forms constituting more than 20 percent of the site sample are shown as dotted lines in the drawings. This figure illustrates quite well some of the main differences in Le Beau ware as it occurs in each of the sites. The Slant Village sample is by far the most distinctive; rim height is exceedingly tall and the recurved, zone 4 rim form (frequently occurring with a beaded outside lip form) is commonly used. Most other site samples are characterized by either rounded or inslanted lip form on relatively short rims. The Alderin Creek sample is somewhat distinctive; the zone 3 rim area is highly inflected, relatively tall, and usually carries a thick, flat lip form. As noted previously, interior bracing occurs commonly at Hensler but nowhere else.

In sum, the analysis indicates that on a detailed level of inspection the Heart River phase samples are quite heterogeneous. Some of the variation expressed in these samples probably indicates village-specific or even household/potter-specific microstylistic variation. Other variables which differ significantly among the sites offer possibilities for distinguishing Awatixa Hidatsa sites from Mandan sites at the AD 1525-1600 time level. Such variables include Le Beau ware vessel wall thickness (particularly in zone 3), cord spacing, S-twist cord direction, use of cord decoration on the lip, and possibly, diagonally-oriented decorative patterns in zone 3. All of these variables have high values or frequencies of occurrence at Lower Hidatsa Village and are potentially indicative of Awatixa sites. Possibly distinctive of Mandan association are low vessel wall thickness, narrow cord spacing, and frequent use of recurved S-rims. More definitive statements on such Mandan-Hidatsa variation at this early time level must await the study of large, well-dated samples from many of the key Mandan tradition sites at Heart River.

Late Knife River Phase Comparisons

The second detailed comparison is restricted to a small set of roughly contemporaneous samples post-dating the AD 1780 epidemic and for which we have definite Mandan and Hidatsa identifications. Here we use the Big Hidatsa period 1 and 2 samples (batches 64 and 65, Hidatsa-proper, dated circa AD 1790-1845), Sakakawea period 1 and 2 samples (batches 59, 60, 62, and 63, Awatixa, dated circa AD 1800-1834/1845),[8] the Amahami late period sample (batch 39, Awaxawi, dated circa AD 1800-1834/1845),[9] and the Deapolis sample (batch 37, Mandan, dated circa 1790-1862). The chronology for the Deapolis sample is the least certain of the group (cf. the batch definition and the discussion concerning the regional chronological sequence). It is possible that some of the Deapolis site collection post-dates the collections from the three Hidatsa villages.

Fort Clark was excluded from the comparison because the Mandan and Arikara elements of that collection cannot be separated at the present time. Much of the period of occupation at Fort Clark is also known to post-date the occupancy period for the three Hidatsa sites.

Another difference among the samples lies in the fact that the Big Hidatsa site in particular contains a long, continuous occupation sequence ending with the time periods of interest here. It is likely that somewhat earlier artifacts have unknowingly been included in the Big Hidatsa period 1 and 2 samples due to the cultural mixing processes which occurred at the site. Earlier components also occur at Sakakawea and Amahami, but at Sakakawea the earlier component was not of lengthy duration, and at Amahami the early component is fairly distinct from a typological point of view and has been well segregated from the late period sample. The potentially different degrees of mixing of pottery from earlier components at the various sites could affect the ceramic ware composition of each sample. For the time period of interest, early mixture will be particularly evidenced by the presence of pottery classes such as Le Beau, Transitional, and other wares not characteristic of the terminal Knife River phase. Because of the uncertain association or derivations of such pottery classes, the between-village comparisons will be restricted primarily to the study of Knife River ware and Deapolis ware which are two dominant pottery classes unequivocably associated with the late Knife River phase.

The methods of analysis are the same here as used in the study of Mandan-Hidatsa distinctions among the Heart River phase samples. The SPSS-X (SPSS, Inc. 1983) programs CROSSTABS and BREAKDOWN are used respectively in conjunction with chi-square analysis and one-way analysis of variance to test the general hypothesis that nominal and interval-scaled variables exhibit no significant differences among the individual village samples. Percentage data and mean measurement values for most of the variables of interest in the analysis are given

[8] See footnote 2, this chapter.

[9] See footnote 2, this chapter.

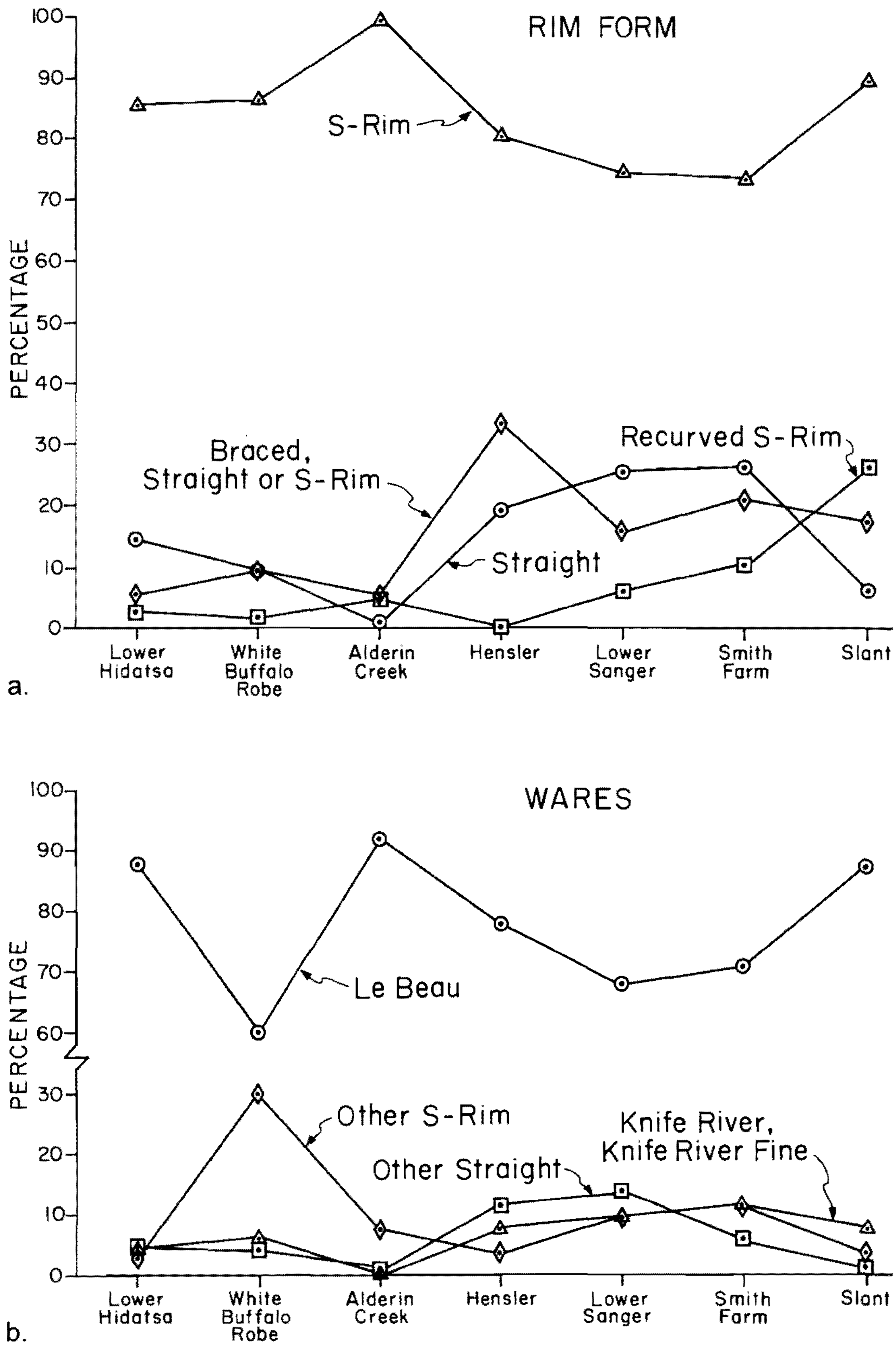
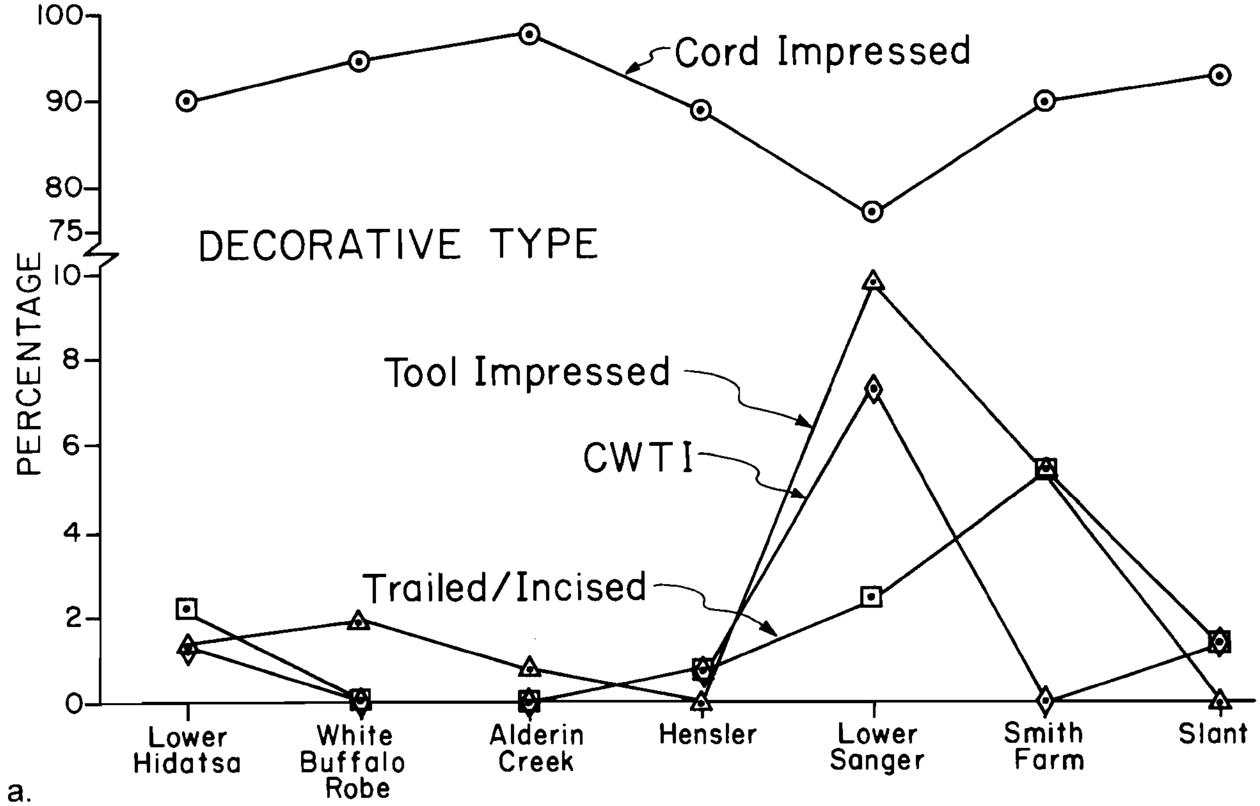


Figure 17.19. Comparison of ceramic data among Heart River phase sites. a: rim form class percentages; b: ware class percentages.



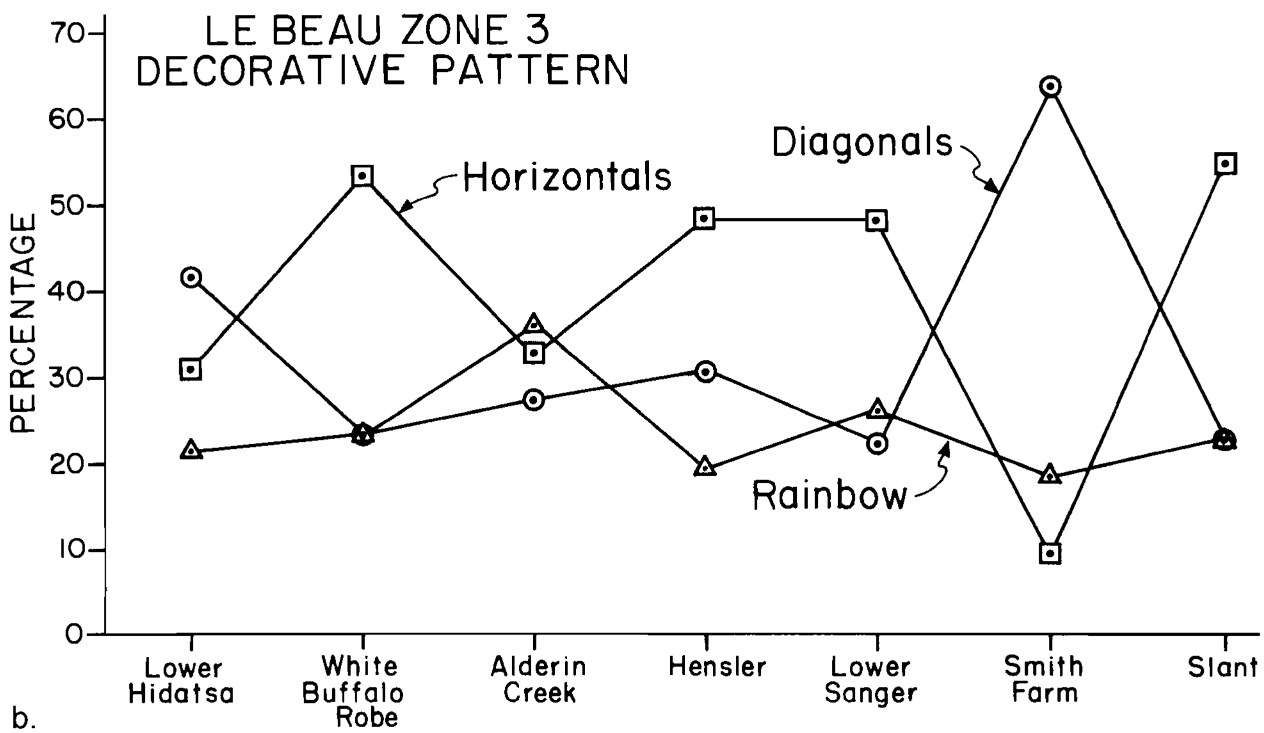


Figure 17.20. Comparison of ceramic data among Heart River phase sites. a: new type (decorative technique) class percentages; b: percentages for selected decorative patterns in zone 3, Le Beau ware only.

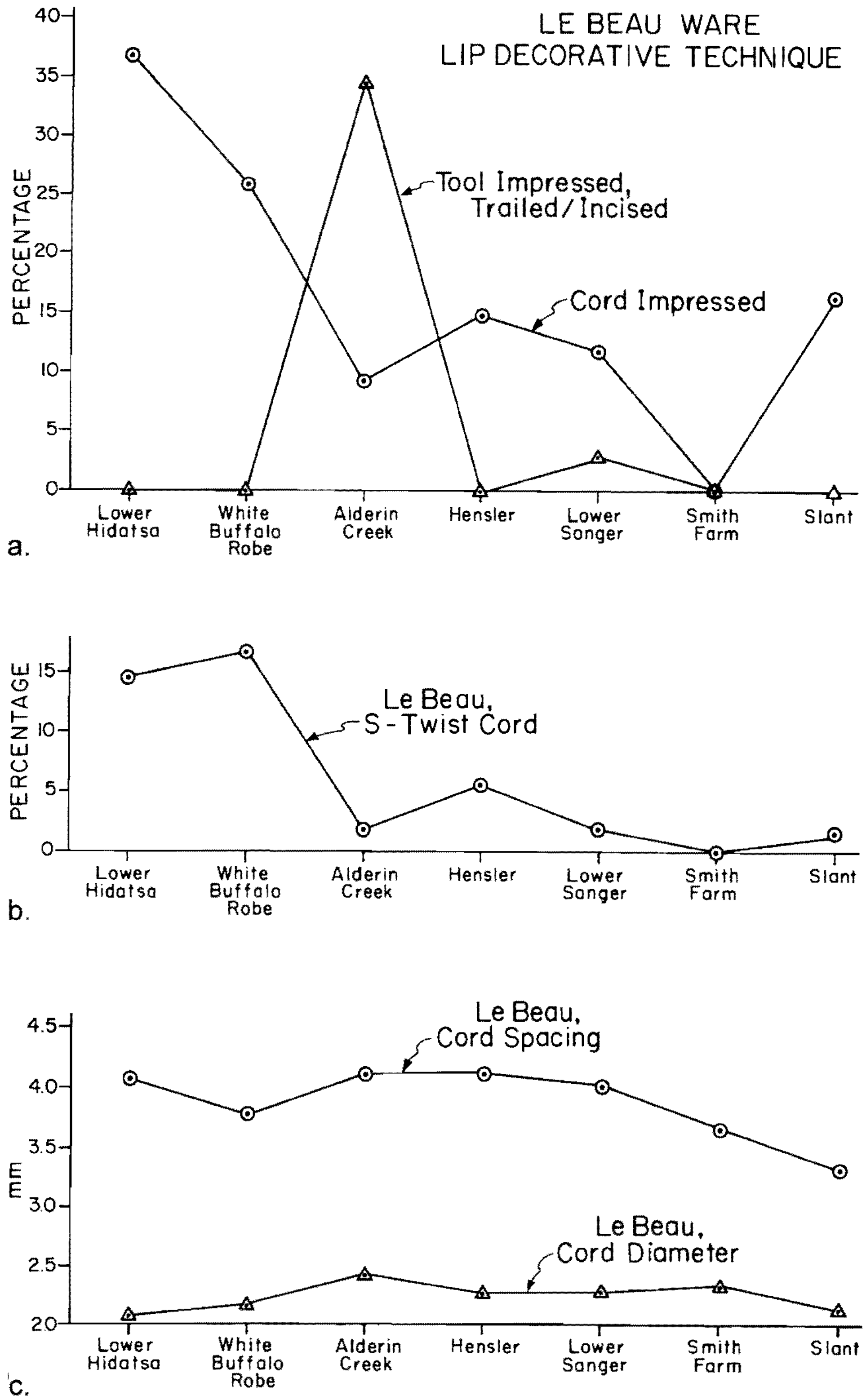


Figure 17.21. Comparison of ceramic data among Heart River phase sites. a: percentages for selected decorative techniques used on the lip, Le Beau ware only; b: S-twist cord percentage, Le Beau ware only; c: cord impression diameter and spacing, Le Beau ware only.

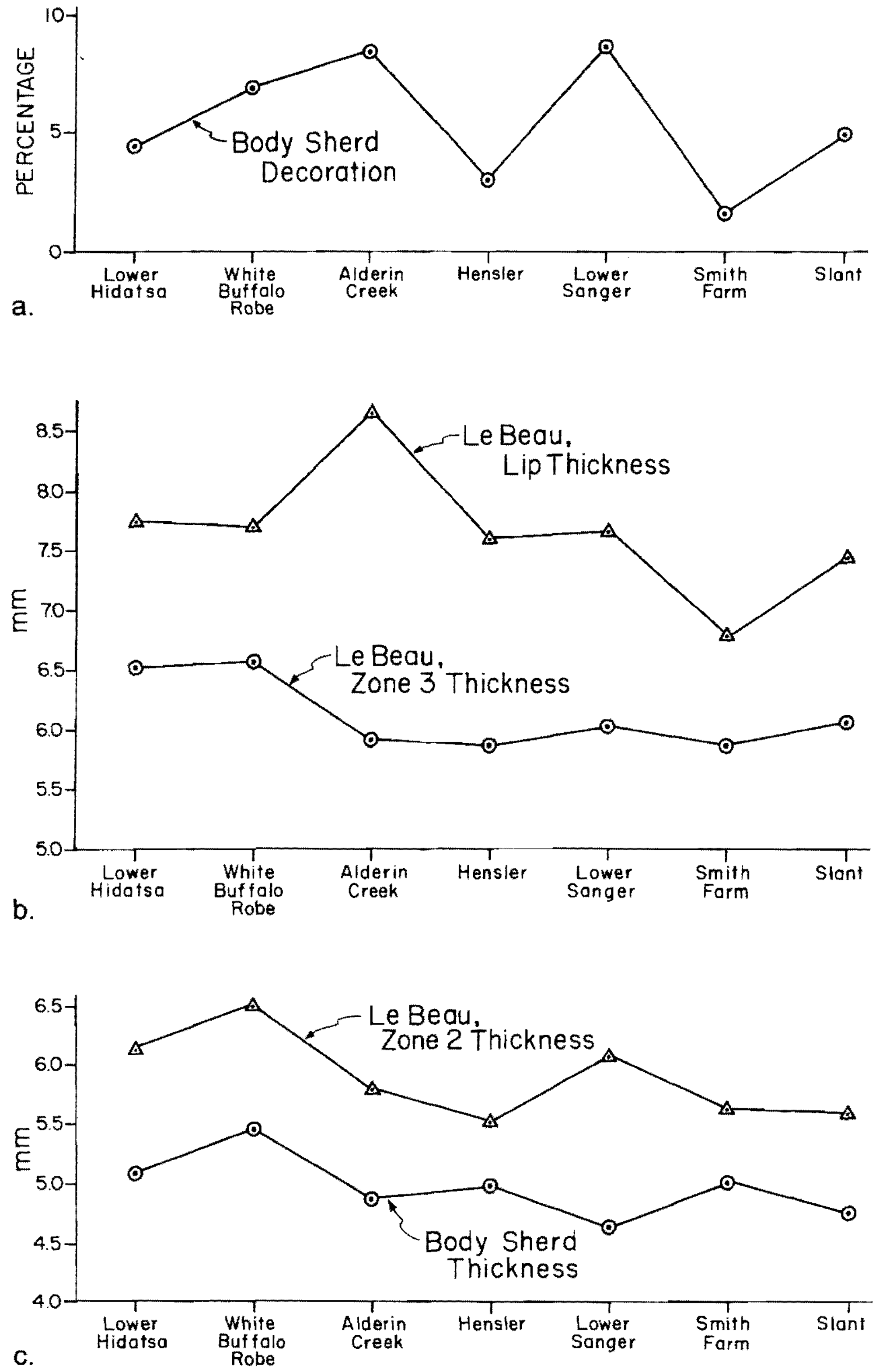


Figure 17.22. Comparison of ceramic data among Heart River phase sites. a: percentages of body sherds with decora-tion; b: lip and zone thickness measurements, Le Beau ware only; c: zone 2 thickness in Le Beau ware, and body sherd thickness measurements.

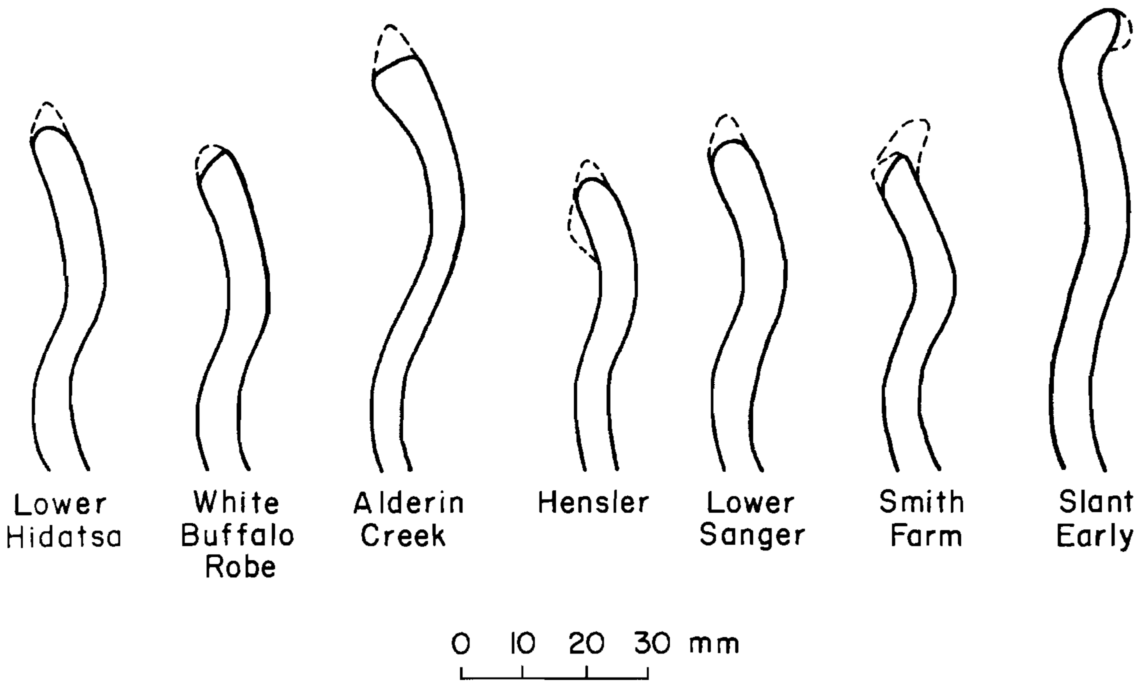


Figure 17.23. Comparison of typical Le Beau ware upper rim cross- sections among Heart River phase sites. Dashed lip form shapes are the second most common shapes at each site.

by batch in Table 17.7. Data for virtually all variables exhibiting significant differences among site samples are plotted graphically in Figures 17.24 through 17.28.

Considering first the complete pottery sample from each site, significant differences in ware classification occur among sites (Figure 17.24a). Most noticeable is the high frequency of Deapolis Collared ware in the Deapolis sample. The frequency for this ware class falls steadily in the Hidatsa sites upriver from Deapolis. The presence of this ware probably reflects meaningful ethnic differences because it has a long history of use in the region, occurring in relatively high frequencies in certain other batches such as Molander (batch 4), Mahhaha periods 1 and 2 (batches 29 and 30), and Lower Hidatsa period 1 (batch 44) (Table 17.7). Le Beau ware and Transitional ware exhibit highest relative frequencies at the upriver Hidatsa sites and lowest frequencies at Deapolis. As alluded to previously, the high frequencies of these wares at Big Hidatsa, in particular, may reflect mixture from earlier occupations at that location.

Rim form considered for all pottery classes exhibits significant variation among sites (Figure 17.24b). Patterns of variation parallel very closely the patterns for ceramic ware classification because rim form is a major consideration in ware classification. Among all straight/outflared rim vessels, the frequency of bracing is highest at Amahami and at Deapolis and is lowest at Big Hidatsa where the highest frequency of unbraced straight rim forms occurs. The frequency of S-rim vessels shows a pattern very similar to that for unbraced straight rims, with such vessels being nearly non-existent in the Deapolis and Amahami collections and with highest frequencies of S-rim vessels occurring upriver at Big Hidatsa. These patterns, while possibly affected to some degree by mixture from earlier components at Big Hidatsa, appear to represent meaningful differences in the material culture of the Mandans and particularly the Awatixas and Hidatsas-proper.

Major differences occur among the sites with regard to decorative techniques applied to vessels. The patterns of variation are essentially the same, regardless of whether one considers the major decorative type, decoration applied to the brace area, or decoration on the vessel lip. For simplicity, we can focus on the decorative techniques applied to the brace since decoration in this area usually determines decorative type classification for any braced rim vessel. We further confine the analysis here and hereafter to Knife River ware and Deapolis ware vessels, hopefully eliminating from consideration possible early, anachronistic Le Beau ware and Transitional ware vessels in various sites. Figure 17.25a illustrates the major differences in zone 5 (brace) decorative technique among the sites. The most striking pattern is for plain vessels to occur most frequently at both Amahami and Deapolis in contrast to much higher frequencies of cord-impressed decoration and other decoration in the other two Hidatsa sites. Other decoration, consisting of combined occurrences of techniques such as tool impression, incising-trailing, and dentate stamping, is most common at Big Hidatsa, which overall, exhibits the most heterogeneity in decorative techniques applied to the brace. The overall pattern here reveals a distinct dichotomy between Amahami and Deapolis on one hand versus Sakakawea and Big Hidatsa on the other.

Variation in decorative pattern applied on the brace (zone 5) is not statistically significant among the villages. For the record, general decorative pattern class percentages are illustrated in Figure 17.25b. Diagonal patterns are the most common in all sites, although horizontal patterns do show particularly high occurrences in the Sakakawea and Deapolis site samples.

Significant differences in brace shape occur among the sites (Figure 17.26a). Flattened or collared braces are most common at Deapolis, this being in part another expression of the high frequency of Deapolis Collared ware occurring there. Sakakawea and Big Hidatsa are characterized by high frequencies of wedge-shaped brace forms. Such forms are particularly rare at both Amahami and Deapolis. On this variable alone, another dichotomy seems to exist which separates Amahami and Deapolis from the two upriver Hidatsa villages.

Lip shape also varies significantly among sites. Relative frequencies of only the two most common lip forms are plotted in Figure 17.26b. The major distinction is for flat lip forms to be relatively more common at the Deapolis site than elsewhere. Again, this may be a useful variable for distinguishing Mandan and Hidatsa ceramic collections.

Zone 2 or vessel neck area surface treatment also varies significantly among the sites. Only the two most common surface treatment classes are illustrated in Figure 17.27a. The pattern is for brushing to be much more common in the two upriver sites than in the two downriver sites. This general pattern closely parallels differences in overall rim form (Figure 17.24b), other decorative techniques used on the brace (Figure 17.25a), and the occurrence of wedge-shaped braces (Figure 17.26a). Again, a dichotomy between the two upriver sites and the two downriver sites is suggested.

The relative frequency of upper rim/lip modifications varies significantly among the sites. Although these modifications are generally very rare, the patterns of occurrence do vary in apparently systematic ways among the sites. Deapolis Village exhibits the lowest overall frequency of such modifications in any form; overall, only about 7 percent of the Deapolis vessels exhibit modification of any type. Tabs are more frequent there than in any other site. Spouts occur in increasingly higher frequency as one moves upriver through the Hidatsa sites; castellations are most common at Sakakawea Village. Pinching exhibits a very strong trend toward increasing use at upriver sites, this feature being most common at Big Hidatsa Village.

Finally, we can note several interval-scaled variables which exhibit significant differences among villages. Cord impression spacing does not vary significantly among sites, while cord diameter does. This latter variation is illustrated at the bottom of Figure 17.28. Mean cord diameter is lowest at Big Hidatsa and is greatest at Amahami. Incidentally, cord twist direction does not vary significantly among sites, in contrast to the Heart River phase samples; overall, S-twist cordage is used on 16.1 percent of the cord-impressed Knife River and Deapolis ware vessels.

Several measures of vessel wall thickness exhibit significant differences among sites. Among these are thickness at the lip, at the brace, and in the neck area or zone 2 (Figure 17.28). The pattern of variation among sites is much the same for each variable. Thickness is generally highest at both Deapolis and Big Hidatsa, while the thickness measures are considerably lower at Amahami and less so at Sakakawea. Body sherd thickness does not vary significantly among sites, although, interestingly, the highest mean body sherd thickness is at Amahami which exhibits the thinnest ceramic sample based on several thickness measurements higher on the vessel rim. The only other rim form or shape measurement which exhibits significant variation among sites is the height or width of the brace (Figure 17.28). Deapolis and Amahami have distinctly higher or broader brace areas on the vessel, contrasting strongly with the Sakakawea and Big Hidatsa samples.

In summary, marked differences occur among the Mandan and Hidatsa villages in details of ceramic composition during the period circa AD 1800-1845. Features which are likely to be indicative of Mandan derivation include high frequency of Deapolis ware; higher incidence of bracing on straight rim vessel forms; higher frequency of plain, undecorated vessels; higher frequencies of collared brace forms and flat lip forms; more frequent use of tabs; and higher brace width. Many of these features occur to a slightly lesser degree in the Amahami Village sample. This pattern is consistent with historic documentation and traditional information indicating a much higher level of interaction during the historic period between the Awaxawis and Mandans than between the Mandans and the other Hidatsa subgroups (Bowers 1965:486). This pattern is also consistent with the relative geographic positions of the various villages along the Missouri River after AD 1800, with the village positions apparently intentionally chosen to reflect the broader patterns of territorial control within the Missouri valley which prevailed at earlier times (Bowers 1965:23, 24, 486) prior to the reorganization at the Knife River in the later 1700s. Ceramic features indicative of Hidatsa derivation, most particularly Hidatsa-proper and to a lesser extent Awatixa, include higher frequencies of unbraced vessels within the straight rim category; higher frequencies of use of cord-impressed brace decorations and greater heterogeneity in brace decoration in general; higher frequency of wedge-shaped brace forms; higher incidence of brushing on vessel neck areas; higher frequency of vessel modification by spouts, castellation, and pinching; and lower mean cord diameter.

Other Comparisons

Brief discussions can be provided concerning the comparison of ceramic data from the upper Knife-Heart and Garrison region sites to ceramic data from nearby areas which may be linked in some manner with cultural developments in the Missouri valley. We speak specifically of sites such as Hintz and Sharbono in eastern North Dakota and Hagen in eastern Montana, all of which have been been previously suggested to relate to the Hidatsa culture in the Missouri valley.

Hintz (32SN3)

The Hintz site is located on the James River in Stutsman County a few miles north of the present city of Jamestown. This site was excavated in the early 1950s and is reported in Wheeler (1963). Based primarily on ceramic data, Wheeler (1963:229) concludes that the site is probably an Hidatsa settlement linked closely with the Painted Woods focus identified by Bowers (1948) for the Missouri River valley. Here we have studied a portion of the excavated Hintz site ceramic collection, from Houses 3 and 4 (batches 89 and 90).

Because the origin and migration traditions of both the Hidatsa-proper and the Awaxawi subgroups of the Hidatsas speak of former homelands in eastern North Dakota and movements from that area into the Missouri valley (Bowers 1948:18-19; Wood 1986b and Chapter 12, this volume), it is logical to posit a relationship between the Hintz site and these Hidatsa subgroups. The composition of the ceramic sample from the Hintz site has already been discussed in a previous section relative to the question of Hidatsa-proper and Awaxawi migrations and the origin of Knife River ware. We can review the basic elements of the Hintz site ceramic sample and the interpretation of those data.

The Hintz site samples were included in the initial principal components analysis, and factor scores are generated for these samples and plotted in Figures 17.1 and 17.3. A cluster analysis of the first three factor scores was conducted which included all 78 batch samples used in the factor analysis (not being restricted to the Missouri valley samples). While the results of that clustering attempt are not reported in detail, it can be noted that the Hintz samples group with a number of other batches readily identifiable as the Heart River phase (Slant early, Smith Farm, Lower Sanger, Hensler, part of the Mandan Lake sample, Alderin Creek, White Buffalo Robe late, Lower Hidatsa periods 3, 4, 5, and 6, other early Lower Hidatsa samples [batches 55-57], and Scovill). It should be noted that this analysis did not include ware classification data, a variable which is thought to be particularly relevant to comparisons of ceramic samples from sites inside and outside the Missouri valley. The cluster analysis tentatively suggests a link between Hintz and the Heart River phase in the Missouri valley and perhaps a slightly altered version of Heart River phase as represented by the Lower Hidatsa samples post-dating AD 1600.

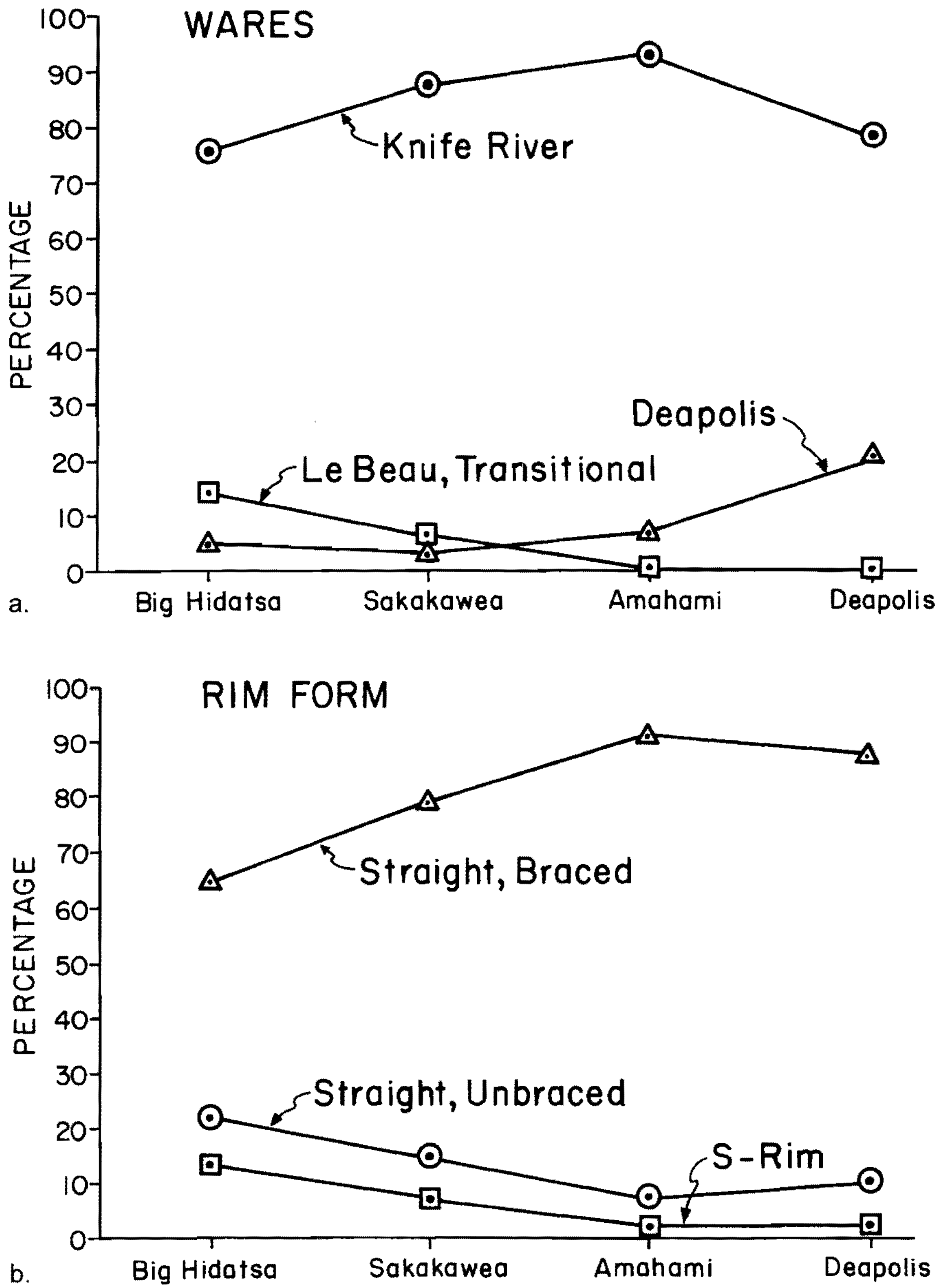


Figure 17.24. Comparison of ceramic data among post-AD 1800 Knife River phase sites. a: selected ware class percentages; b: selected rim form class percentages.

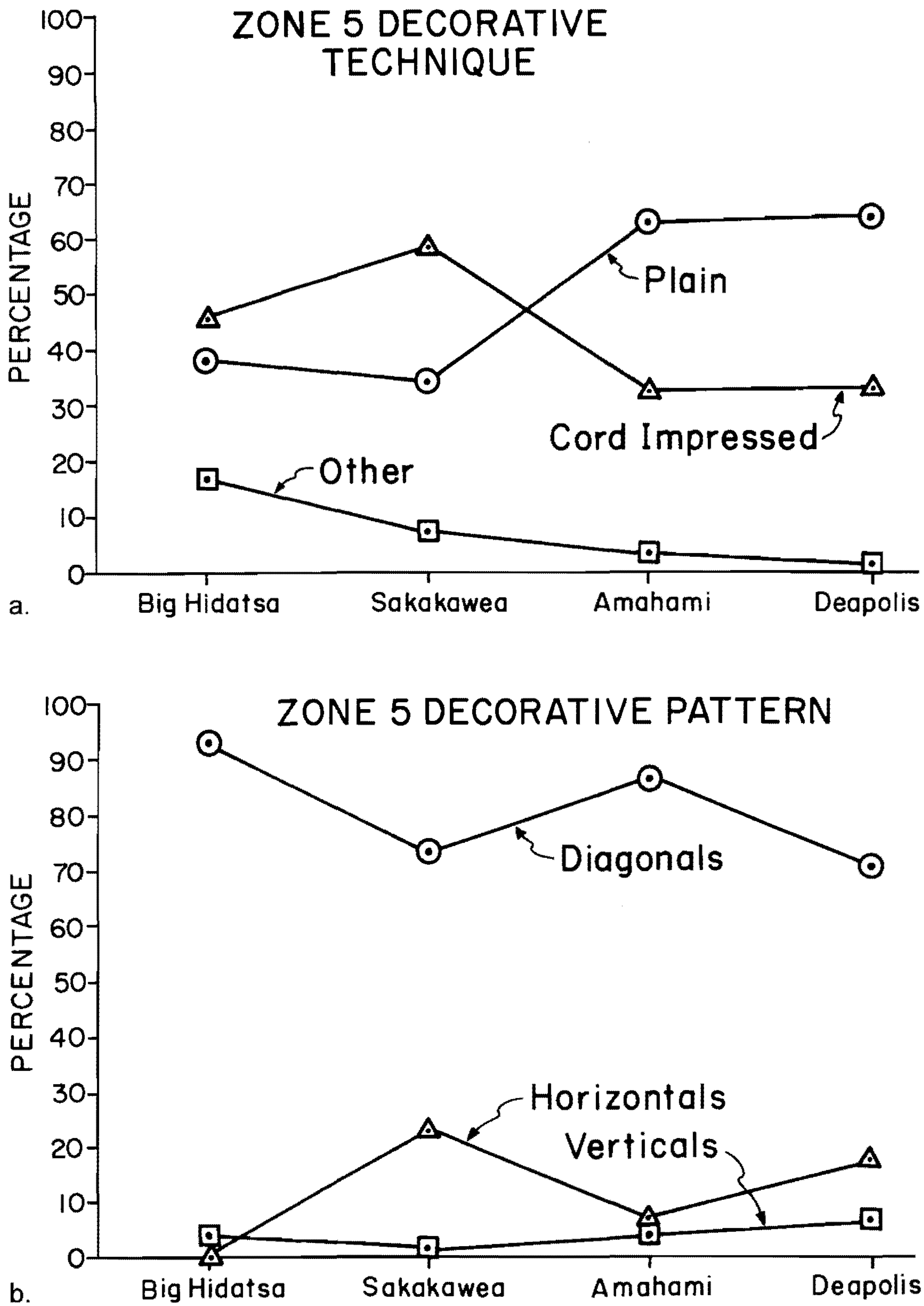


Figure 17.25. Comparison of ceramic data among post-AD 1800 Knife River phase sites. a: decorative technique class percentages applied to zone 5; b: selected decorative pattern class percentages applied to zone 5.

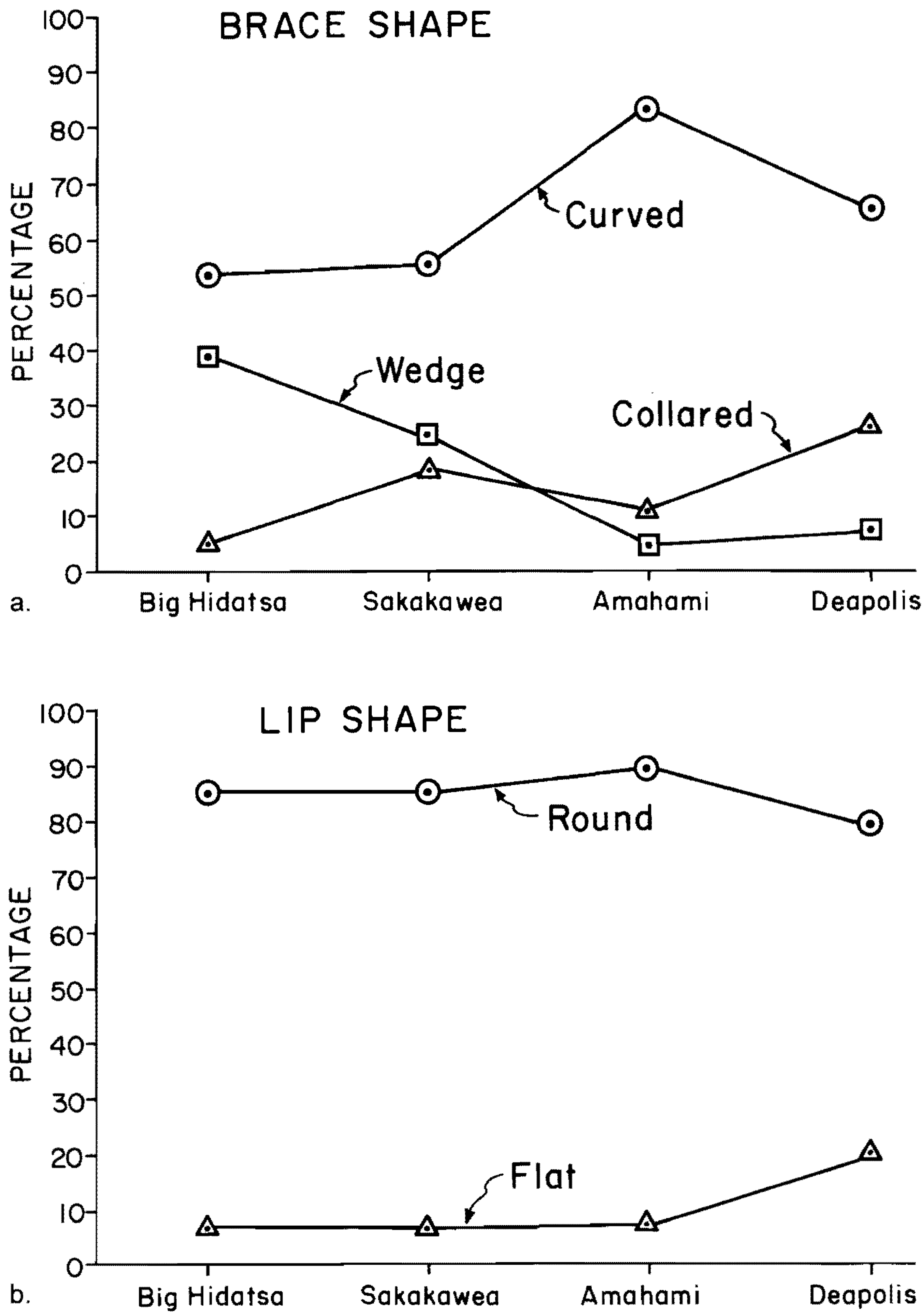


Figure 17.26. Comparison of ceramic data among post-AD 1800 Knife River phase sites. a: selected brace shape class percentages; b: selected lip shape class percentages.

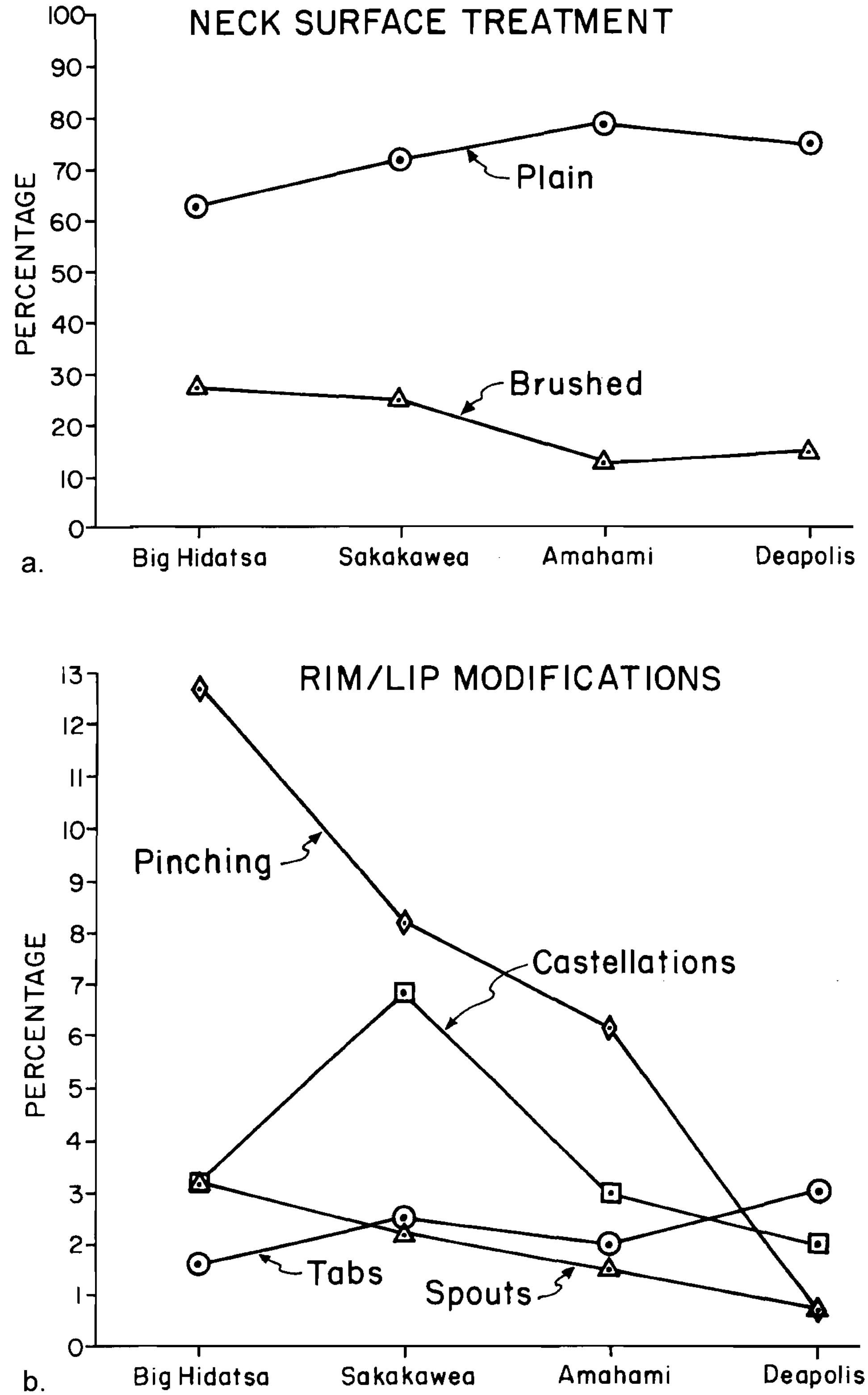


Figure 17.27. Comparison of ceramic data among post-AD 1800 Knife River phase sites. a: selected zone 2 surface treatment class percentages; b: percentages of classifiable vessels with various upper rim-lip modifications.

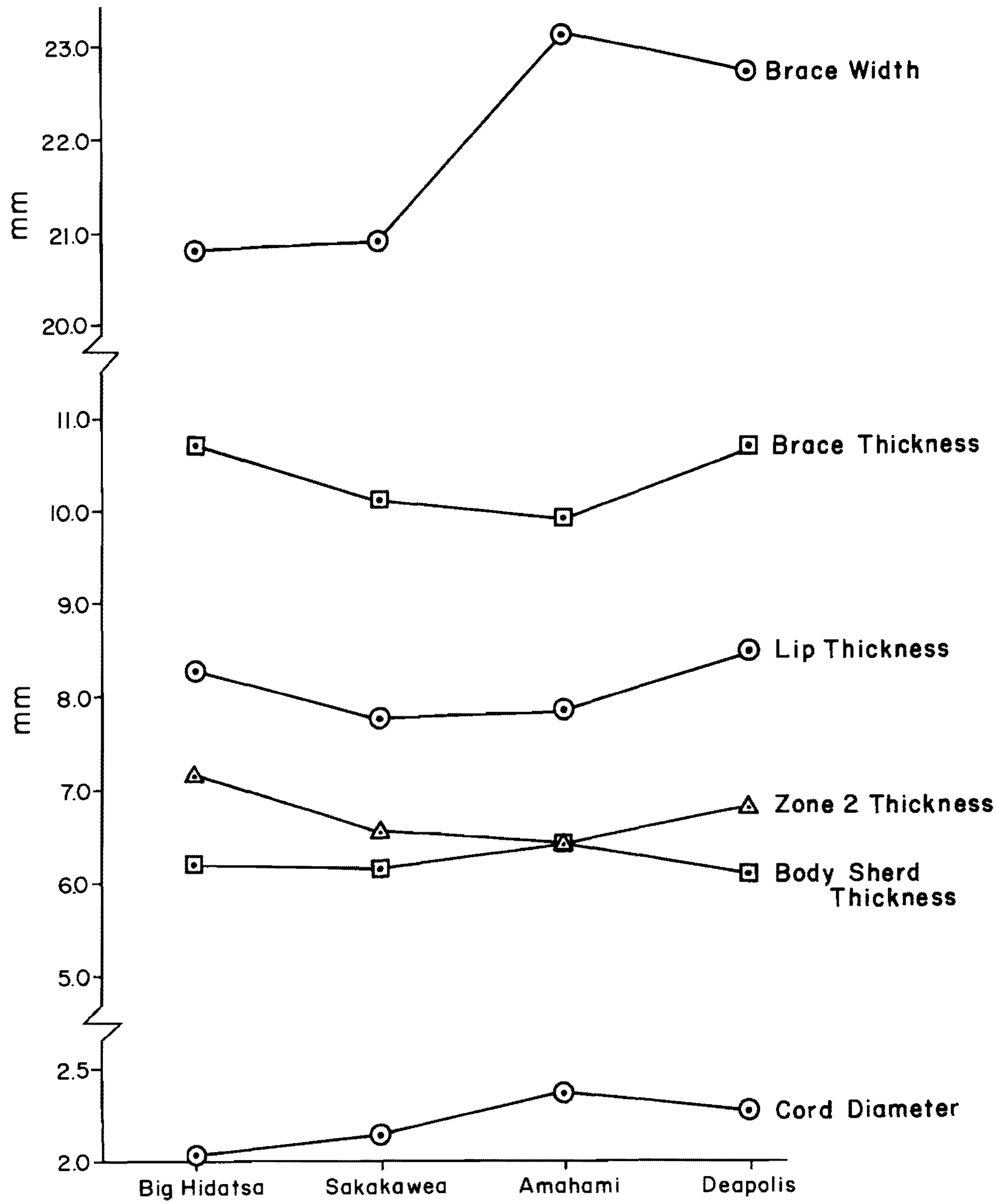


Figure 17.28. Comparison of ceramic vessel measurement data among post-AD 1800 Knife River phase sites, showing brace dimensions, thicknesses in zone 7, 2, and 1, and cord impression diameter.

Examination of data for individual variables in the Hintz sample provides perhaps a better picture of ceramic composition and between-site comparisons. The Hintz site sample contains a composite of several ware groups which we interpret here to reflect influence from both the Mandan ceramic tradition at the Heart River, expressed primarily in Le Beau ware, and the later Hidatsa pottery tradition of the Hidatsas-proper and Awaxawis, expressed primarily in Knife River ware. Percentage data for many key ceramic variables are presented for the two house batch units in Table 17.7. The Hintz sample contains overall about 25 percent Le Beau ware, 26 percent Knife River ware, about 2 percent Knife River Fine ware, with the remainder being assigned to Unnamed Straight (18 percent) and S-Rim (29 percent) ware groups. Concerning basic rim form, approximately 49 percent of the sample consists of some form of S-rim, with the remaining half of the sample equally divided between braced and unbraced straight rim forms. None of the pottery exhibits angular shapes for the lower zone 2 juncture or for the lower zone 3 juncture, a trait consistent with both Le Beau ware and Knife River ware. Decoration in the sample is dominated by cord impression which occurs in circa 70 percent of the sample, with tool impression and cord-wrapped-tool impression each comprising circa 13 percent of the sample. About 20 percent of the braces have a wedge-shaped form, with the remaining majority being curved.

Collectively, these ceramic characteristics indicate close associations with both Mandan groups and Hidatsa groups in the Missouri valley. We interpret the ceramic sample from Hintz as being most similar to the period 3 and 4 samples from Lower Hidatsa Village and to the period 6 sample from Big Hidatsa Village, each of which consists primarily of mixtures of Knife River and Le Beau ware vessels. All of these samples from the upper Knife-Heart region date in the AD 1600s, and all have been assigned to a unit representing transition from the local Hidatsa expression of the Heart River phase to the Knife River phase under the influence of Hidatsa-proper and Awaxawi migrations into the Missouri valley. A similar date of AD 1600-1700 is suggested for the Hintz site. It is likely that the site was indeed occupied by some subgroup of the Hidatsas who also resided periodically in the Missouri valley in the upper Knife-Heart region. A winter village is also likely, given the small house forms with extended entryways present at Hintz. It is difficult to identify the Hidatsa subgroup which occupied Hintz, although the Hidatsas-proper and Awaxawis are thought to be more likely than the Awatixas given the traditional eastern derivation and presumed eastern territory of the first two groups. The occupancy of Hintz, if correctly attributable to Hidatsa subgroups, was definitely conducted after the migrating eastern Hidatsa peoples had established close ties with the Mandan centers at the Heart River.

Sharbono (32BE419)

The Sharbono site lies near Devils Lake (Schneider 1983) and is of particular interest because it is a ceramic-bearing component which lies in the heart of the territory traditionally claimed by the Hidatsas-proper prior to their migration into the Missouri valley. The ceramic sample from the site contains elements which indicate cultural contacts with Missouri valley peoples, but unfortunately, the sample is too small and the provenience too imprecise to warrant any definitive conclusions in that regard.

The ware composition of the Sharbono collection is similar to that at Hintz, containing Le Beau ware, Knife River ware, and Unnamed Straight Rim and Unnamed S-Rim wares in roughly equal proportions. S-shaped rim forms are predominant, and bracing occurs on nearly half of the classifiable vessels (Table 17.7). Cord impression and cord-wrapped-tool impression are the dominant forms of decoration, with minor amounts of plain and tool-impressed vessels occurring. All zone junctures are curved. The body sherd sample contains small amounts of check-stamping and yet higher frequencies (12 percent versus 3 percent) of cord-roughening, while simple-stamping is the dominant surface treatment (36 percent). Horizontal, diagonal, and curvilinear decorative patterns occur on zone 3 on the vessels.

The collective characteristics of the Sharbono site collection are little different from the Hintz site, and on that basis, the site may also be interpreted as an early protohistoric settlement of the Hidatsas-proper or Awaxawis who had already established themselves on a semipermanent basis in the Missouri valley. Elements which contradict this are the relatively high frequencies of cord-wrapped-tool-impressed decoration and the relatively high frequencies of cord-roughened body sherd surface treatment. These elements may reflect mixture of lesser amounts of pottery from earlier time periods, or they may constitute basic elements of a pottery complex occurring at Sharbono but presently unrecognized at other locations. Larger and better controlled ceramic collections from the site will be necessary before more definitive interpretation can be offered.

Hagen (24DW1)

The Hagen site lies on the lower reaches of the Yellowstone River in eastern Montana. Unlike most sites in that region, it has produced a large ceramic sample. It has long been recognized as related in some way with cultural developments farther east and south in the Missouri valley, and several authors have speculated even or posited that the site represents a settlement of some subgroup of the Crows after they separated from Hidatsa subgroups near the Knife River (Mulloy 1942:99-103; Wood and Downer 1977). At least two Hidatsa/Crow separations occurred according to native traditions, an earlier one during which the Mountain Crows split from the Awatixa subgroup of the Hidatsas, and a much later one in which the River Crows split from the Hidatsas-proper (Bowers 1965:19-23, 484-485). This important fact, of relevance to the identification of Crow archeology, has been recognized by a few researchers (particularly Heidenreich 1979, and also Taylor 1979 and Hanson 1979), but has been overlooked by many archeologists who have sought an interpretation of the Hagen site pottery and Crow-Hidatsa archeological relationships (e.g., Wood and Downer 1977 and several other authors in the volume edited by Davis [1979]). Heidenreich (1979) in fact notes many significant facts in the historic, ethnohistoric, and ethnographic records which have been overlooked by archeologists in their studies of the Crow-Hidatsa schism.

Our study here is based on coding and analysis of a sample of 299 vessels from the existing Hagen collection which numbers at least twice that large. We can enumerate some of the key elements in the Hagen ceramic collection which are of relevance to detailed comparison with other site samples studied here. Summary percentage data for most of these variables occur in Table 17.7.

Virtually the entire collection consists of vessels unclassifiable according to the named ware classes for the study area. Only 3 percent of the sample is classified as Le Beau S-Rim ware, while 72 percent is Unnamed S-Rim ware and 25 percent is Unnamed Straight Rim ware. These figures illustrate the basic rim form composition of the collection which is comprised of more than 70 percent S-rim ware. About 4 percent of the sample exhibits the recurved S-rim form with zone 4, and about 4 percent of the sample exhibits bracing on straight rim forms. This rim form composition, distinguished by high frequencies of S-rim, moderate amounts of straight rim, little bracing, and presence of some recurved S-rim forms, is highly similar to samples from the study area classified as Scattered Village complex or Heart River phase (Table 17.7). S-rim percentages range from 65 percent in the Early Scattered Village complex to 84 percent for the Heart River phase. Bracing is least common in the Early Scatterend Village complex (12 percent) and more common in the Late Scattered Village complex samples (31 percent).

Other vessel shape characteristics also reveal general similarities with the Scattered Village complex. About 90 percent of the classifiable zone 2 occurrences at Hagen are judged to be angular rather than curved in form. About 48 percent of the zone 3 occurrences are judged to be angular in form. The figure for zone 2 form is atypical for any of the Missouri valley samples except for the Clark's Creek phase (Figure 17.9a). The latter figure for zone 3 lies within the range of zone 3 angular form percentages bracketed by the Early and Late Scattered Village complex (circa 42 percent and 88 percent, respectively, Table 17.7). Zone 3 height (35.3 mm) and inflection (4.73 mm) values for the Hagen sample are higher than Scattered Village complex means but lower than means for Heart River phase samples (Figure 17.8b). Brace height (mean of 11.9 mm) for Hagen is extremely low relative to Missouri valley samples (Figure 17.11b), suggesting that the sample definitely dates prior to AD 1600 when all brace heights increase to 18 mm or greater. A wide variety of lip forms occurs at Hagen including, in order of relative frequency, round (65 percent), flat (23 percent), L- and T-shaped (6 percent), pointed (3 percent), inslant (2 percent), and outslant (1 percent). This general lip form composition is most similar to that in the Late Scattered Village complex samples (Table 17.7), except for the absence of beaded lip form in the Hagen sample.

Six percent of the Hagen body sherd sample exhibits check-stamping, while simple-stamping is the dominant form. This figure correlates well with the frequency of check-stamping in several of the Scattered Village complex samples studied here, particularly the late complex samples grouped as a unit (Table 17.7). Mean values for cord spacing (4.41 mm) and cord diameter (2.30

mm), both of which are temporally sensitive variables in the Missouri valley samples, correspond closely with the values for Late Scattered Village complex samples a whole (Table 17.7; Figure 17.14b). Regarding the decorative patterns occurring on zone 3, the Hagen sample exhibits approximately equal frequencies of horizontal line patterns and diagonal line patterns, with lesser frequencies of angular and curved rainbow patterns and horizontal lines over punctations. All of these patterns are common in Nailati phase through Heart River phase samples from the Missouri valley; the relatively high frequency of diagonal line patterns at Hagen is most similar to the Heart River phase samples in particular.

Decorative technique in the Hagen sample is the single variable which distinguishes the sample most clearly from all other samples from the Missouri valley. Classification according to major decorative type adequately expresses the variation in the Hagen sample, with 53 percent of the sample being cord-wrapped-tool-impressed. Lesser frequencies of cord-impressed (21 percent), tool-impressed (11 percent), trailed/incised (8 percent), and plain (4 percent) occur. Again, the decorative heterogeniety in the sample is reminiscent of Scattered Village complex samples, but the high frequency of cord-wrapped-tool-impressed decoration is in itself highly distinctive and relatively unique.

The single most common rim form and decoration type combination at Hagen consists of S-rim vessels with cord-wrapped-tool-impressed decoration. Such vessels comprise 43.3 percent of the classifiable vessels at Hagen. If we track the presence and frequency of this specific rim form and decoration combination at other sites in the study samples, we find occurrences at On-a-Slant Village (late Mandan version of Heart River phase), Lower Sanger (Heart River phase), Hensler (Heart River phase), Mandan Lake (Late Scattered Village complex), Mahhaha (probably in Scattered Village complex and later deposits), Lyman Aldren (Early Scattered Village complex), Lower Hidatsa (transitional Heart River phase/ Knife River phase deposits), Big Hidatsa (early Knife River phase), and Forkorner east (Early Scattered Village complex). Such pottery is rare in all Missouri valley collections, but the highest frequencies occur at Lower Sanger (6 vessels) and at Forkorner east (3 vessels). All other occurrences at Missouri valley sites involve a single vessel per batch or at most two vessels in all combined site batch samples. The chronology from the Missouri valley sites suggests that such pottery began to appear in the general area by the beginning of the Scattered Village complex, around AD 1400, and continued to be made for at least 200 years thereafter.

Such S-rim, cord-wrapped-tool-impressed pottery is much more common in several other sites outside the Missouri valley. It comprises 9 percent of the sample at the Hintz site (probably dating in the 1600s) and 25 percent of the very small sample from Sharbono (undated).

The rim form and manufacturing technique similarities between Hagen and Knife-Heart and Garrison region study samples is quite clear. This is taken by these authors to indicate close cultural connections between the Hagen site and some sites in the Knife-Heart region. When all the above facts are taken together, we reach the conclusion that Hagen is highly similar to other assemblages classified here as Late Scattered Village complex which date in the period circa AD 1450-1525. A similar age is suggested for Hagen on the basis of ceramic evidence. The single radiocarbon date from the site which is thought to be associated with the ceramic assemblage is in agreement with that assessment (corrected range midpoint of AD 1460 and corrected crosspoint of 1425; see Chapter 8). The only unusual attribute at Hagen relative to other Late Scattered Village complex components lies in the use of cord-wrapped-tool-impressed decoration at Hagen.

The frequent use of cord-wrapped-tool-impressed ceramics at Hagen is taken to be indicative of contacts between Hagen and peoples or influences to the northeast, north, and northwest. Such decoration is common in virtually all pottery assemblages assigned to the Blackduck horizon in northern Minnesota and southern Manitoba which date in the period from AD 900-1500 (Syms 1977:102). The cord-wrapped-tool decorative technique occurs commonly in sites assigned to the Mortlach complex (Wettlaufer 1955:19-23), the Old Women's complex (Forbis 1962), and the Cluny complex (Forbis 1977; Byrne 1973:335-338), evidence of which occurs in northwestern North Dakota, southern Saskatchewan, southern Alberta, southwestern Manitoba, and eastern Montana (Gregg 1985:131-133, 135). Such sites are generally thought to date in the period from the eighth century AD to the late historic period. Specific linkages between Hagen and any of these complexes are not posited here, but the available evidence indicates a vast cultural reservoir in the region north of and outside the Missouri valley from which the cord-wrapped-tool decorative technique at Hagen may have been borrowed.

Concerning the specific hypothesis that Hagen can be identified as an early Crow settlement, the evidence seen here tends to support this possibility. Specifically, we would suggest that Hagen could easily have been occupied by a Mountain Crow group in the late 1400s following their separation from the Awatixa Hidatsas who resided in the upper Knife-Heart region and who we recognize archeologically there in the Early and Late Scattered Village complex components. The ceramic evidence suggests that the Hagen potters may have separated from the Missouri valley groups early in the 1400s. Such a date would allow time for interactions to develop with peoples farther north and west and for the distinctive decorative elements in the Hagen assemblage to be applied relatively uniformly to ceramics still made in the general fashion of Missouri valley, Scattered Village complex pottery.

SYNOPSIS

The study of a ceramic collection comprised of some 7,000 vessels and more than 30,000 body sherds has revealed highly significant information relevant in many ways to interpretation of the prehistory and history of peoples who lived at sites now in the KNRI and in the upper Knife-Heart region of the Missouri valley. A picture of very dynamic patterns of cultural change emerges. Cultural change is expected to be the rule, but the nature of change evidenced in the ceramic data base was hardly suspected for this region at the outset of this study. One of the most important general observations we can draw from this study deals with the apparent close correlation between the history of cultural development as told in Hidatsa oral traditions and the history gleaned from the archeological ceramic record. This correspondence is so close that it calls for a detailed reexamination of oral traditions of other cultural groups and for renewed efforts to integrate the study of such traditions into the study of prehistory in other parts of the Plains.

Factor analysis and subsequent cluster analysis of factor scores and raw ceramic data values have allowed the organization of multiple individual batch samples or site components into a temporal framework for the region having a total of 13 specific time periods spanning from at least as early as AD 1100 to the late nineteenth century. Cultural change evident in this span can best be studied in two general periods: in the period leading up to and culminating in the Heart River phase, AD 1525-1600; and in the period documenting cultural alterations of the Heart River phase through the subsequent period terminating in native abandonment of the region in the late 1800s.

The first general period is characterized by Late Woodland or Formative Village components, followed by Nailati phase, Scattered Village complex, and finally Heart River phase components. The Formative Village component found at the Flaming Arrow site conforms well to the Awatixa tradition of origin at the site at some distant time in the past. The linkage between that site, other Late Woodland components, and the next most recent dated Plains Village components, assigned to the Clark's Creek phase, cannot easily be made based on available data. It is likely that key components for the period spanning AD 1100 to 1250 or so exist in the study area but have not yet been discovered and studied.

The first clearly recognizable Plains Village taxonomic unit in the region, the Clark's Creek phase, shares broad and detailed ceramic similarities with samples from many sites scattered far down the Missouri valley which have been identified as belonging to the Extended variant of the Middle Missouri tradition. On the basis of these broad similarities, the Clark's Creek phase is tentatively identified as representative of resident ancestral Mandan populations who settled and populated the upper Knife-Heart region and perhaps the area upstream prior to AD 1300. The subsequent Nailati phase, fairly well dated in the period AD 1300-1400, is clearly distinguished from the Clark's Creek phase by ceramic attributes such as check-stamped vessel body treatment, vessel lip form, and basic rim form. We hypothesize that the Nailati phase can be identified ethnically as early Awatixa Hidatsa in origin, occurring as the resident village culture which was transformed from the Formative Village populations at Flaming Arrow, at sites on the Cross Ranch, and probably at several other sites in the region.

Influences from ceramic sources lying downriver are evident in the components assigned to the next major cultural unit, the Scattered Village complex. New traits occur in a heterogeneous combination of various tool modification and decorative elements used with many major and minor variations in rim form. Many of the decorative elements occuring in this period, particularly from AD 1400-1450, have counterparts occurring more frequently in sites usually categorized as Initial or Extended Coalescent in South Dakota. A possible mechanism for the transfer of these elements into the regional ceramic base lies in the Mandan origin traditions which describe a migration of the Awigaxa subgroup from the mouth of the Grand River in South Dakota to one or several village locations upstream from Square Buttes.

Following the emergence of the Scattered Village complex in the early 1400s there is a trend toward increased homogenization and decreased diversity in the regional ceramic complexes. This is evidenced in the ceramic data by adoption of S-rim pottery as the most common form and cord decoration as the nearly exclusive decorative technique. Decorative motifs and patterns also become more rigidly and narrowly defined in this period. This trend culminates in the emergence of the Heart River phase at several sites in the region, dating in the period AD 1525-1600. In cultural and ethnic terms, this ceramic change is interpreted here as representing 1) the amalgamation of several regional independent village units (probably bands) into what was historically recognized as the Mandan tribe, and 2) the increasingly dominant influence of the Mandan peoples centered at the Heart River over all other cultural groups in the region. The Awatixa subgroup of the Hidatsas continued to live within and claim territory in the upper Knife-Heart region at this time, but their material culture was strongly influenced by the classic Mandan culture and the numerically dominant Mandan peoples who lived just to the south. By AD 1600 or so, resident Awatixa Hidatsa peoples, living primarily at Lower Hidatsa Village, maintained a ceramic complex which differed from that of the Mandans only in relatively subtle details.

At about AD 1600 a shift in the winds of cultural change occurred, and this shift was maintained for the next 250 years. Trade artifacts of European origin began to filter into the region via indirect trade through the Great Lakes region to the east. Simultaneous with this was an actual migration, probably intermittent in pace, of new peoples also having their origins in lands near Lake Superior and Lake Michigan to the east. These peoples, now recognized as the Hidatsa-proper and Awaxawi (and River Crow) subgroups of the Hidatsas, were distant but linguistically compatible relatives of the Awatixas who had long resided in the upper Knife-Heart region. Settling first near the Mandans at Heart River, these new groups soon moved to the upper part of the region and controlled territories both east and west of the Missouri valley. They brought with them a new pottery tradition epitomized by the braced, castellated Knife River ware. This ceramic tradition had its roots in yet older ceramic traditions developed centuries earlier among Late Woodland peoples living in the region west of Lake Michigan.

The gradual and differential adoption of Knife River ware at the various villages in the Knife-Heart region chronicles both the long-term migrations of the new Hidatsa peoples into the area as well as the differential rates of adoption of a new Hidatsa cultural pattern. The resident Awatixa group at Lower Hidatsa Village, apparently recognizing cultural ties with the new Hidatsa immigrants, allowed these newcomers to settle near them and then subsequently adopted the new Hidatsa material culture relatively rapidly. A sense of tribal identity was growing among the Hidatsa bands at this time. The Mandans at Heart River, in contrast, entrenched themselves in that region and tended to continue with the traditional Mandan patterns of ceramic manufacture evident in the production of Le Beau S-Rim ware. Mandan and Hidatsa cultures diverged during this time. Recognizably distinct Mandan and new Hidatsa ceramic traditions were in existence by AD 1600, and these traditions continued to diverge through the next 150-180 years. Knife River ware became the dominant and nearly exclusive pottery form in the Hidatsa villages, while Le Beau ware continued to be the hallmark of Mandan potters at the Heart River.

Catastrophic epidemics, deriving from pathogens introduced from the Old World, probably occurred at multiple times during the 1600s and 1700s. Available ceramic evidence indicates that the effects of these epidemics remained largely invisible for some period of time in the regional ceramic record. In the mid-1700s, and certainly by the late 1700s, the forces of epidemic disease and hostilities from the Sioux and other nomads combined to cause major demographic and cultural transformations in the region. The once dominant Mandans at Heart River were so decimated by these forces that by the late 1700s they completely abandoned all of their traditional villages and the homeland they had occupied for several centuries at the Heart River. The various Hidatsa groups upriver, at least the Awatixas and the Hidatsas-proper, seem to have fared somewhat better during this critical period. By AD

1797 we have clear evidence that the Hidatsas were now the numerically dominant population in the valley. By this time, the diverse bands of the Hidatsas had developed a strong sense of tribal identity and unity, a necessary response for effective defense against the constantly marauding and now numerically superior Sioux and other nomadic groups. In contrast, by the 1780s and 1790s, the once powerful and still proud Mandans had been transformed into shattered refugee groups, seeking protection with the numerically superior Hidatsas at Knife River.

This shift in political power in the Missouri valley in the closing decades of the eighteenth century is well evidenced by a major transformation in Mandan pottery during this short period of time. Evidence from Slant Village indicates that traditional Mandan methods for decorating Le Beau ware were abandoned first; cord-impressed decoration was abandoned in favor of plain, punctated, tool-impressed, pinched, and simple-stamped vessels. This change was occurring at Slant Village in the 1700s prior to total destruction of that and other villages in the area and exodus of the Mandan refugees to the Knife River. After the exodus, the tradition of Le Beau ware pottery was nearly completely dropped from the Mandan pottery repertoire, and the manufacture of Knife River ware like that made by the Hidatsas was adopted. This was the Knife River ware made by the Hidatsas for more than 200 years, and its use was transferred from the Hidatsas to the Mandan refugees in part through the process of village fusion and intertribal marriages which occurred in the chaotic period of the closing two decades of the eighteenth century.

The period following AD 1780 was a time during which relatively homogeneous pottery manufacturing techniques were adopted by all Mandan and Hidatsa villages. Distinct Mandan and Hidatsa ceramic traditions can be distinguished during this period, but such distinctions are relatively well hidden as minor variations in decorative technique, decorative pattern, and rim form within the general theme of Knife River ware. This homogenization of pottery manufacture occurred in conjunction with rapid decline in overall pottery quality during this same period. By the time most of the Hidatsas moved out of the Knife River area to Like-a-Fishhook Village in 1845, ceramic manufacture was rapidly becoming a craft of little interest to native potters. By that time decoration was often completely omitted, and the pottery had become thicker, poorly fired, and generally of degenerate technical quality. By the 1860s, few Mandans and Hidatsas even knew how to make pottery, and the function of pottery was being fulfilled almost completely by metal containers readily obtained at the local trading posts.

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CHAPTER 18

KNRI AND UPPER KNIFE-HEART REGION LITHIC ARTIFACT ANALYSIS

Stanley A. Ahler and Dennis L. Toom

INTRODUCTION

This chapter contains a summary of the comparative analyses of lithic artifact collections from sites in the KNRI and from several sites in the upper Knife-Heart region. The primary purpose in this study has been to use data on lithic artifacts to further explore the culture-history and cultural taxonomy proposed for the region based on ceramic studies and to assess cultural interaction and cultural change in regional sites based on several aspects of lithic artifact technology and function. The most fine-grained data set used in the present study consists of information from more than 8,000 tools and a large sample of flaking debris from excavated sites within the KNRI. All aspects of data collection for the KNRI artifacts were overseen by Ahler in the course of preparation of technical reports on test excavations conducted at these sites. In addition, this basic data set has been augmented with lithic artifact data from a large number of sites lying outside the KNRI and scattered throughout the upper Knife-Heart region, expecially from sites studied in the 1968 Wood-Lehmer testing program (Wood 1986). Data from most of these off-KNRI collections were collected by or under the supervision of Dennis L. Toom. Toom also measured virtually all of the projectile points used in the stylistic analysis, with the exception of the points from Late Woodland and Plains Village sites derived from the 1980-1982 UND testing program at the Cross Ranch. Ahler compiled all the final data files used in this analysis, conducted the computer analysis, and wrote all sections of this chapter.

Several basic themes or general goals have been pursued in the analysis of the lithic artifacts. The first has been the study of stylistic variation in patterned lithic artifacts. Some attention has been given to the typology of arrowpoints, but the major emphasis has been on exploring stylistic variation through study of detailed measurements on side-notched arrowpoints. Several studies of this nature have been conducted with regional samples (Calabrese 1972:40-49; 1973; Ahler et al. 1982:247-258), and the approach in those examples was expanded to a larger data set in the present study. In addition, the study of stylistic variation also focused on the use of heat treatment in the production of small, patterned bifaces made of Knife River flint (KRF). Previous study (Ahler and Weston 1981:140, 142) has shown significant temporal variation in this practice at a single village, and this lead was pursued in a more comprehensive study of such artifacts from many regional sites.

A second major theme or avenue of study has been the examination of variation of raw materials used in the manufacture of lithic artifacts. Intersite variation has been studied to a limited degree, but the main focus has been on temporal change through the Late Woodland and Plains Village chronological sequence available for the area. The focus here has been both on assessing the relative intensity of use of Knife River flint, the dominant raw material, and also on changing patterns of use of nonlocal, exotic raw materials. Insofar as the latter raw materials provide some measure of the direction of contact between peoples in the upper Knife-Heart region and peoples in outside areas, this aspect of the study provides an avenue for assessing changing cultural influences hypothesized in Chapter 17 on ceramics.

A third major theme or goal has been study of changes in lithic tool technology and tool function in the regional samples and an assessment of these changes relative to expectations based on the changing influence from the fur trade and fur trade artifacts on the local cultures. In this study intersite variation has not been explored in detail, and the study sites are in fact assumed to be essentially similar in function, having served as long-term, multi-year settlements. The fur trade can be hypothesized to have affected the native lithic technological systems in two major ways. First, metal artifacts introduced through the fur trade can be expected to rapidly but differentially replace selected elements in the native lithic technological systems. Such replacements should be visible as changes in the technological and functional composition of the lithic artifact assemblages. Second, the economic aspects of the fur trade may have caused a shift in domestic activities in the villages toward hide preparation and production of other items useful in the trading process, and such economic changes should be reflected in lithic artifacts.

Five major sections follow in this chapter. The first deals with the methods used in the lithic analysis and a more detailed, site-by-site identification of the artifact collections used in the lithic study. The second deals with the subject of stylistic change in lithic artifacts, focusing on projectile point morphology, projectile point measurements, and heat treatment practices. Each of these types of data is explored relative to the temporal sequence and cultural taxonomy proposed in Chapter 17 on ceramic analysis. Next is a section that addresses variation in lithic raw materials in the regional study samples. This work focuses both on flaking debris as well as on chipped and ground stone tools. Following this is a major section on temporal changes in lithic assemblage technology and functional composition in regional sites. This study focuses on data from the KNRI sites where artifact recovery has been most consistently controlled. The final section in this chapter provides an overview and summary of cultural change in the regional sites based on the results of specific studies discussed in the previous sections. The general model of Mandan-Hidatsa relationships presented in the ceramic chapter is assessed, and the topic of changes in native technological systems is summarized here relative to the lithic artifact data base.

METHODS AND DATA BASE

The methods used in the lithic analysis varied somewhat according to the integrity of the individual artifact collections and the usefulness of each collection for study of particular problems. The most intensive methods of data collection and analysis were applied to artifact samples collected by UND through controlled excavation and consistent recovery and sorting procedures. The samples are thought to be the least biased and the most useful for study of the full range of topics identified in this report. In contrast, data collection and analysis procedures were far less intensive for virtually all artifact samples collected in the 1968 Wood-Lehmer testing program, through Smithsonian excavations, SHSND excavations, or other surface collection programs. This is because most of those artifact samples are biased to varying degrees against the recovery of certain artifact sizes or types, limiting their usefulness for particular kinds of analysis.

A more detailed and informative discussion of analytic methods is best couched in terms of the relative degrees of sampling bias in the various artifact samples studied here. Each sample from each analytic batch (batches identified in the ceramic analysis, Chapter 17), and in some cases, subparts of individual batches, can be categorized as having one of three levels of sampling bias, designated bias classes A, B, and C.

Bias class A samples are those with least sampling bias. These artifact samples all derive from UND excavations at KNRI sites, at White Buffalo Robe, at the Cross Ranch, and elsewhere. In each case all artifacts placed in this bias class were collected in the field using 4-per-inch mesh or finer screen, and all materials collected on the field screens were returned to the laboratories at UND for cleaning and sorting prior to analysis. This recovery procedure yields no sorting bias in the field for artifacts of size grade 3 and larger, and it yields presumably complete recovery of all stone tools and flaking debris of size grade 3 and larger. In many cases, the field recovery in these instances was over windowscreen mesh, and unbiased samples of size grade 4 lithic artifacts also exist. Bias class A artifact samples are most useful for the full array of lithic studies. The full array of both patterned and unpatterned tools and all flaking debris above size grade 3 have been recovered. Not only can studies of tool measurements, heat treatment, and raw material variation be conducted, but detailed quantification of tool technology and function involving both large and very small-sized artifacts can be conducted and reliably compared across sites.

Bias class B samples consist primarily of samples which were collected with 4-per-inch mesh field screen recovery but which were field sorted to some degree for the discard of natural rock, fire-cracked rock, and other noncultural debris. In this field sorting and discard process, applied to uncleaned artifacts, a substantial amount of the smaller-sized tools and flaking debris and a large portion of the ground stone tools made on otherwise unmodified stone cobbles are discarded and do not find their way into the retained artifact collections. This type of bias is apparent in a low proportion of ground stone tools in comparison to such tools in bias class A samples from otherwise functionally comparable village sites. Rough or crude chipped stone core tools are also less evident in bias class B samples. The loss of other small-sized chipped stone tools and flaking debris is also evident in some but not necessarily all of the bias class B samples. This size bias is evident as ratios of the count of grade 3 and larger flakes to the count of grade 3 and larger tools which fall below about 4.0, and ratios of counts of grade 3 flakes to counts of grade 2 flakes which fall below about 10.0 (cf. comparative data from bias class A samples in Ahler and Swenson 1985:170, 194 and Ahler and Weston 1981:115, 144). Samples in bias class B are thought to be useful for studies of projectile point style, heat treatment occurrence, and raw material variation, but are not thought to be useful for study of proportions of detailed technological class frequencies or functional class frequencies which vary greatly with artifact size. The majority of the lithic artifact samples collected in the 1968 Wood-Lehmer testing program are classified as bias class B samples. Certain intensive surface collections taken by UND (e.g., Ahler and Swenson 1980) are also regarded as bias class B samples.

Bias class C samples exhibit the greatest amount of sampling bias. These are generally samples of lithic artifacts which were high-graded in the field for retention of obvious patterned tools with attendant discard of most or some undefined part of the unpatterned tools and flaking debris. Field screening was used for the recovery of some bias class C samples (for example, at some of the sites tested in the 1968 Wood-Lehmer program), but it is apparent from the nature of the extant collections that most of the lithic artifacts were discarded in the field. Such bias class C samples are readily recognized by comparing the frequencies of flaking debris and tools; flaking debris counts are roughly equal to or are often less than the tool counts. Also, flake tools, which usually comprise about one-half of any bias class A lithic tool sample, comprise 10-15 percent or less of a typical bias class C sample. As noted, several of the site samples collected in the 1968 Wood-Lehmer testing program fall in this bias class, as do virtually all of the collections taken in SIRBS and SHSND excavations and in most surface collections. Bias class C samples are thought to be useful for study of projectile point typology and form and heat treatment occurrence under the assumption that these variables do not interact with the on-site decision for artifact retention or discard. Bias class C samples are not considered to be useful for studies of raw material variation in either tools or flaking debris, nor for study of tool technology and function.

The first step in the analysis of any of the artifact collections was the separation of stone tools from flaking debris. The basic definition of a stone tool is any artifact which exhibits evidence of use, potential use, or intended use to exert or transmit force to another object. Such evidence can take the form of 1) patterned flake removals from the object in question combined with a lack of evidence for the object having itself been subsequently removed from a larger mass of material, or 2) intentional modification or shaping by pecking, grinding, sawing, etc., or 3) modification due to use such as edge damage, pitting, scarring, abrasion, etc. As defined, the stone tool category includes both cores and other more commonly recognized tool forms. Flaking debris is defined as artifacts which exhibit evidence of conchoidal fracture removal from a larger or parent piece of raw material (from a tool or core) but which lack evidence of flaking modification or use modification occurring subsequent to the removal from the core or parent piece (Ahler and Swenson 1985:79-80). The separation of stone tools and flaking debris was conducted under strong direct light but primarily without the aid of magnification. Using this procedure, it is clear that a large number of microscopically use-worn but otherwise unmodified tools are probably included in the present flaking debris samples (note the frequent detection of micro-use-wear on otherwise unmodified tools reported by Keeley 1980 and Vaughan 1985:60-61).

From this point on in the analysis, the methods used varied to some degree according to the collection source and the bias category for each sample. The most intensive analysis was conducted for the bias class A samples, those being primarily from the controlled tests in the KNRI. The analytical procedure used for those tools and flaking debris began with an initial study of Plains Village chipped stone artifacts (Ahler 1975a, 1975b) from sites in South Dakota which has evolved over the years as more and more collections have been made from North Dakota and KNRI sites (cf. Ahler 1977b; Lovick 1980a, 1980b; Ahler et al. 1980; Ahler and Weston 1981; Ahler and Mehrer 1984; Ahler and Toom 1989). The most recent and comprehensive statement on these methods as applied to the KNRI artifact samples is found in Ahler and Swenson (1985:79-85 and related appendices). A brief synopsis of those methods is provided here.

The analysis of the stone tools is basically multidimensional in nature. Rather than each tool being placed into a single typological pigeonhole, the individual tool is coded according to a large number of discrete variables which collectively describe many aspects of variation in the dimensions of tool function, technology, raw material, style, and systemic context (cf. Ahler 1975a:15-16; 1992). The following list identifies the discrete variables coded or recorded for each artifact in the Big Hidatsa site sample:

descriptive category	sequence number
technological class	morphological class
functional class	use-phase class
color	raw material category
presence of burning	presence of heat treatment
degree of patination	presence of impact fracture
presence of resharpening	presence/type of recycling
multifunction code	presence of cortex
weight to 0.1 gm	provenience variables
completeness code	

Certain of these variables were not recorded for stone tools from other tested sites in the KNRI when those site collections were first reported. The stone tool samples from Sakakawea Village and from Lower Hidatsa Village were reexamined in detail to make sure that the functional class, technological class, heat treatment, and recycling variable codes were fully compatible with the system applied to the Big Hidatsa stone tool sample. Certain of these variables are not of major concern in the present study, but others can be noted which are of relevance to the analysis conducted and discussed in this chapter.

Morphological class is of relevance here only insofar as it applies to technologically finished (use-phase class 3 and 4) arrowpoints. Such artifacts are categorized as either side-notched, unnotched (isosceles triangular), or "other" in morphology. The use-phase classification and manufacturing sequences for these arrowpoints are discussed in some detail in Ahler (1992).

Ten discrete technological classes are recognized for the study collections, including eight chipped stone categories and two ground stone categories. These classes distinguish the basic manufacturing processes used in the production of stone tools and also serve to separate patterned from unpatterned tool forms. These classes are discussed in greater detail in Ahler and Swenson (1985:328).

Functional classification is according to a total of 65 possible groups identified in Ahler and Swenson (1985:329-341). Functional categorization is based on combined observations of tool morphology and observations of use-wear using low-magnification stereoscopic equipment (Ahler 1979). The functional classes delimit the relative hardness of the use material, the use motion, hafting or tool holding arrangements, and the nature of force application (Ahler 1979:302). For purposes of data summarization and simplification in analysis, these 65 functional classes are collapsed into a smaller series comprised of 17 generalized functional classes, as discussed in Ahler and Swenson (1985:83-84).

Stone tool raw material is recorded by categorizing the artifact according to one of 39 lithic types identified and described in Ahler and Swenson (1985:342-347). Some of these types are simply descriptive in nature, but most are intended to identify the geologic and geographic source location for the particular lithic material, thereby facilitating the study of lithic material exchanges reflected in the archeological record.

The presence of heat treatment and the relative certainty of its presence are recorded for tools made of Knife River flint, certain chalcedonies, and a few other raw material types. The physical characteristics exhibited by heat treated KRF are discussed in detail in Ahler (1983). The present study focuses on heat treatment in small, patterned thin bifaces made of KRF. This technological class is the one most likely to exhibit intentional heat treatment, and heat treatment in such artifacts has been shown to vary significantly through time at some sites (Ahler and Weston 1981:140,142).

Based on a technological study of stone tools and flaking debris in the Sakakawea and Lower Hidatsa site assemblages, Goulding (1980:119-120) has hypothesized that scavenging and recycling of preexisting stone tools was an increasingly common activity in late historic times when native manufacture of stone tools was on the wane. To assess this idea, evidence of recycling in stone tools was systematically recorded. Recycling is defined as the reuse of an artifact for a purpose or function different from that in the original tool, or reuse in a time period distinctly later than the period of manufacture. Such recycling is recognized either by overlapping use modifications indicating sequential use for different functions, or by reflaking of patinated, weathered artifact surfaces.

Detailed metric data were recorded for only a single stone tool group, this being side-notched arrowpoints. The data were recorded to facilitate stylistic analysis of these artifacts. Data on 12 linear measurements, three angles, weight, and haft dulling were recorded according to the definitions and format provided in Ahler (1975b:180-194), Lovick (1980b:81, 83), and Ahler et al. (1982:249).

Additional details about the other recorded variables can be found in Ahler and Swenson (1985:79-84).

Flaking debris was fairly rigorously studied in the bias class A artifact samples. Fundamental to the analysis is the process of size-grading in which the artifacts are sorted into size classes over a series of nested square-mesh screens (Ahler and Swenson 1985:69-70). Flakes in size grades 1, 2, 3, and 4, ranging in size from larger than 2.54 cm in width to circa 0.254 cm in width, were studied in detail. Each size grade sample was first sorted by the same raw material types used in the stone tool analysis (Ahler and Swenson 1985:342-347). Burned KRF was also separated from unburned KRF. For each size grade and raw material type, the total count of flakes was recorded as were the total weight of flakes, the number of flakes with cortex, and the number of patinated flakes. Because of the extremely large number of flakes found in most of the excavated KNRI village samples, only portions of the flake samples from Sakakawea Village and Lower Hidatsa Village were subjected to the full analysis sequence. The remaining flake samples from those sites were simply quantified by count and weight by size grade, without recording raw material, cortex, or patination.

Similar data sets were recorded for both the bias class B and class C lithic artifact samples, although it is recognized that the recorded information is not equally useful for the study of each sample type. In both cases, a more limited analysis procedure was applied than for the bias class A samples, generating data on only a small number of the variables listed and discussed above for both tools and flaking debris.

Bias class B and class C stone tool analysis was restricted primarily to the observations on technology, raw material type, burning in KRF, use-phase, and weight. Data were not recorded for each individual artifact; rather, the total sample of tools from each provenience was subdivided first by technological class, then by raw material type, and then by use-phase class within each raw material and technological class. The total count of artifacts in each of these sub-subgroups was recorded, as was the total weight in each sub-subgroup.

Artifacts in the small thin patterned biface technological class were then singled out for more intensive study. For the Knife River flint and chalcedony tools in this group, frequencies of certain, possible, absent, and indeterminate heat treatment were recorded. The focus was then narrowed to technologically finished, use-phase class 3 and 4 arrowpoints, and the morphological class of such specimens was recorded. For side-notched arrowpoints, the same set of metric measurements was recorded as was recorded for the bias class A sample specimens.

Analysis of flaking debris in the bias class B and bias class C samples was also more limited than for the bias class A samples. Flaking debris was size graded in grades 1, 2, 3, and 4, and then was sorted into raw material types for each size grade. Burned KRF was separated from unburned KRF. The total count and weight for each raw material/size grade group was recorded. Data on cortex and patination were not recorded, although moderately to heavily patinated flakes were segregated from the other flakes on the assumption that they are probably pre-Plains Village period in age. For surface collections from the Stiefel and Stanton Ferry site the flakes were simply counted by raw material type without consideration of size grade.

The total lithic artifact sample examined for the present study includes about 15,688 stone tools and 88,973 pieces of flaking debris of size grade 3 or larger. A small fraction of this total sample was not directly used in the present study, being derived from bias class C samples or being from archeological batch contexts unassigned to time period. Approximately 275,000 additional pieces of flaking debris, mostly in size grade 4, exist in the excavated collections from the KNRI sites; data on these flakes were used in only a very limited way in the present analysis. About two-thirds or 67 percent of the examined stone tools derive from the least biased, most intensively studied bias class A samples. About 57 percent of the studied flaking debris is from the bias class A samples. A total of 1,145 small, thin, patterned bifaces made of Knife River flint is included in the heat treatment study, and a total of 412 side-notched arrowpoints (not all classifiable by time period) were measured for the stylistic analysis of such artifacts.

A general inventory of the studied lithic artifacts is provided by analytic batch in Table 18.1. The definition of and justification for the batch units has already been provided in Chapter 17 concerning the KNRI ceramic analysis program. A brief discussion is given here concerning the source for and nature of the lithic artifact samples studied from each site and analytic batch. Deviations from the standard analytical methods described above will be noted where appropriate.

0,1,2,3. On-a-Slant Village (32MO26).

The lithic samples used here from On-a-Slant Village derive from the 1980 test excavations conducted there by UND for the North Dakota Parks and Recreation Department (NDPRD) (Ahler, Schneider, and Lee 1981). Due to the fact that the NDPRD failed to fund the analysis of the excavated collection, the lithic samples have not been fully studied and only limited data were available for use in this study. Stone tool data are limited to information on heat treatment in technological class 1 specimens from the specific pit features used for the pottery sample (Breakey and Ahler 1985:4-6). Data on flaking debris (Table 18.1) derive from an unpublished manuscript by Richert (1984), originally conducted as a class project at UND, which discusses the flaking debris from the same selected pit features. The distinctions made between batches 0 and 2 and between 1 and 3 based on pottery sherd size are irrelevant here, and the early period sample is designated batch 0/2 and the late period sample as batch 1/3.

4. Molander (32OL7).

The Molander sample derives from 1966 testing conducted by the SHSND (unreported) and 1968 testing in the Wood-Lehmer testing program (Wood 1986). Flake-to-tool ratios and flaking debris size grade data indicate that both of these samples were high-graded in the field for collection of patterned tool forms, and therefore they are placed in the bias class C.

5. Pretty Point (32OL8).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in virtually all of this excavation, and the entire sample is placed in bias class B.

6. Smith Farm (32OL9).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and the entire sample is placed in bias class B.

Table 18.1. Stone tool and flaking debris samples used in the KNRI lithic analysis program, organized by batch.

		Stone Tool Samples					Flaking Debris		
Batch	Site and Batch Name	Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Bias A	Bias B	Bias C
0/2	Slant Village, early 32MO26	9		other tools not studied			1413	-	-
1/3	Slant Village, late 32MO26	16		other tools not studied			2457	-	-
4	Molander, 32OL7	4	4	-	-	41	-	-	29
5	Pretty Point, 32OL8	38	12	-	415	-	-	2489	-
6	Smith Farm, 32OL9	3	2	-	48	-	-	172	-
7	Lower Sanger, 32OL11	15	4	-	221	-	-	374	-
8	Upper Sanger, 32OL12 time period 1	4	1	-	78	-	-	175	-
9	Upper Sanger, 32OL12 time period 2	21	4	-	312	-	-	969	-

Table 18.1. Continued.

Batch	Site and Batch Name	Stone Tool Samples					Flaking Debris		
		Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Bias A	Bias B	Bias C
10	Upper Sanger, 32OL12 time period 3	7	1	-	108	-	-	250	-
11	Upper Sanger, 32OL12 time period 4	12	4	-	114	-	-	317	-
12	Upper Sanger, 32OL12 other	-	-	-	-	7	-	-	-
13	Mile Post 28, 32OL13	9	8	-	93	-	-	328	-
14	Cross Ranch, 32OL14 test 1	7	-	-	90	-	-	575	-
14-17	Cross Ranch, 32OL14 general	-	16	-	-	-	-	-	-
18	Bagnell, 32OL16	22	7	-	176	-	-	1089	-
19	Greenshield, 32OL17	4	1	-	48	13	-	313	28
20	Hensler, test 1 32OL18	7	4	-	131	-	-	1003	-
21	Hensler, test 2 32OL18	19	5	-	246	-	-	2065	-
22	Hensler, other 32OL18	-	2	-	-	17	-	-	-
23	Mandan Lake, test 1, period 1 32OL21	4	2	-	97	-	-	538	-
24	Mandan Lake, test 3, period 1 32OL21	28	9	-	363	-	-	2570	-
25	Mandan Lake, test 4, period 1 32OL21	28	9	-	281	-	-	3586	-
26	Mandan Lake, 32OL21 time period 2	14	2	-	148	-	-	1699	-
27	Mandan Lake, 32OL21 time period 3	15	5	-	186	-	-	1143	-
28	Shoreline, 32OL103	no lithic artifacts located for this site							
29	Mahhaha, 32OL22 time period 1	11	9	-	-	34	-	-	-
30	Mahhaha, 32OL22 time period 2	18	7	-	-	56	-	-	9
31	Mahhaha, 32OL22 time period 3	14	6	-	-	37	-	-	-

Table 18.1. Continued.

Batch	Site and Batch Name	Stone Tool Samples					Flaking Debris		
		Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Bias A	Bias B	Bias C
32	Mahhaha, 32OL22 time period 4	26	7	-	95	42	-	1143	14
33	Mahhaha, 32OL22 time period 5	17	4	-	56	42	-	648	-
	Mahhaha, 32OL22 test 1	-	5	-	-	39	-	-	1
	Mahhaha, 32OL22 test 5	-	5	-	-	42	-	-	-
34	Clark's Creek, 32ME1	8	3	-	20	63	-	175	5
35	Fort Clark, 32ME2	-	-	-	-	9	-	-	17
36	Lyman Aldren, 32ME3	8	6	-	-	194	-	-	164
37	Alderin Creek, 32ME4		lithic materials from this site were not studied						
38	Deapolis, 32ME5		lithic materials from this site were not studied						
39	White Buffalo Robe, late, 32ME7	-	29	1214	-	-	4376	-	-
40	White Buffalo Robe, early, 32ME7	-	17	814	-	-	2714	-	-
41	Amahami, late, 32ME8		lithic materials from this site were not studied						
42	Amahami, early, 32ME8		lithic materials from this site were not studied						
43	Buchfink, 32ME9	13	3	106	-	14	449	-	-
44	Lower Hidatsa, 32ME10 time period 1	23	2	307	-	-	1428	-	-
45	Lower Hidatsa, 32ME10 time period 2	36	10	511	-	-	1199	-	-
46	Lower Hidatsa, 32ME10 time period 3	98	18	799	-	-	4154	-	-
47	Lower Hidatsa, 32ME10 time period 4	36	4	456	-	-	2890	-	-
48	Lower Hidatsa, 32ME10 time period 5	23	3	318	-	-	864	-	-
49	Lower Hidatsa, 32ME10 time period 6	17	5	292	-	-	-	-	-
50	Lower Hidatsa, 32ME10 mixed, misc.	36	9	137	-	69	-	-	-

Table 18.1. Continued.

Batch	Site and Batch Name	Stone Tool Samples Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Flaking Debris Bias A	Bias B	Bias C
53	Lower Hidatsa, 32ME10 Lehmer 6/1	1	1	-	-	15	-	-	-
54	Lower Hidatsa, 32ME10 Lehmer 6/2	9	4	-	-	71	-	-	-
55	Lower Hidatsa, 32ME10 Lehmer 6/3	4	1	-	-	9	-	-	-
56	Lower Hidatsa, 32ME10 Lehmer 7/1	2	-	-	-	21	-	-	-
57	Lower Hidatsa, 32ME10 Lehmer 7/2	4	3	-	-	16	-	-	-
59	Sakakawea, 32ME11 time period 1	15	7	133	-	4	352	-	-
60	Sakakawea, 32ME11 time period 2	14	5	135	-	2	331	-	-
61	Sakakawea, 32ME11 time period 3	5	3	26	-	-	112	-	-
62	Sakakawea, 32ME11 inside later houses	15	4	89	-	-	105	-	-
63	Sakakawea, 32ME11 other	9	8	39	-	105	-	-	-
64	Big Hidatsa, 32ME12 time period 1	8	3	98	-	-	334	-	-
65	Big Hidatsa, 32ME12 time period 2	15	2	344	-	-	1305	-	-
66	Big Hidatsa, 32ME12 time period 3	69	10	768	-	-	3343	-	-
67	Big Hidatsa, 32ME12 time period 4	53	11	552	-	1	2133	-	-
68	Big Hidatsa, 32ME12 time period 5	45	10	690	-	-	2668	-	-
69	Big Hidatsa, 32ME12 time period 6	11	2	244	-	-	1007	-	-
70	Big Hidatsa, 32ME12 time period 7	4	-	38	-	-	233	-	-
71	Big Hidatsa, 32ME12 other	15	6	121	-	109	1336	-	-

Table 18.1. Continued.

Batch	Site and Batch Name	Stone Tool Samples					Flaking Debris		
		Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Bias A	Bias B	Bias C
72	Stanton Ferry, 32ML6	2	3	-	135	-	-	313	-
73	Poly, 32ME407	25	5	189	-	-	1351	-	-
74	Elbee, 32ME408	11	1	241	-	87	1110	-	122
75	Scovill, 32ME409	7	1	99	-	14	828	-	-
76	Hotrok, 32ME412	4	-	37	-	6	263	-	-
77	Forkorner, 32ME413 east and central	14	2	276	-	8	1161	-	-
78	Forkorner, 32ME413 west	28	8	240	-	32	1517	-	-
79	Hump, 32ME414	3	2	49	-	6	181	-	-
80	Youess, 32ME415	33	15	568	-	21	2051	-	-
81	Stiefel, 32ME202	10	2	-	271	17	-	415	-
82	Rock, 32ME15		lithic materials from this site were not studied						
83	Star, 32ME16		lithic materials from this site were not studied						
84	Grandmother's Lodge, 32ME59	2	1	-	-	76	-	-	-
85	Like-A-Fishhook, 32ML2	-	1	-	-	90	-	-	-
86	Nightwalker's Butte, 32ML39		lithic materials from this site were not studied						
87	Mondrian Tree, 32MZ58	-	-	-	-	-	3580	-	-
88	Hagen, 24DW1		lithic materials from this site were not studied						
89	Hintz, house 3 32SN3		lithic materials from this site were not studied						
90	Hintz, house 4 32SN3		lithic materials from this site were not studied						
91	Arzberger, 39HU6		lithic materials from this site were not studied						
92	Flaming Arrow, 32ML4		lithic materials from this site were not studied						
93	Sharbono, 32BE419		lithic materials from this site were not studied						
94	Taylor Bluff, 32ME366 late		lithic materials from this site were not studied						
95	Taylor Bluff, 32ME366 early		lithic materials from this site were not studied						

Table 18.1. Concluded.

Batch	Site and Batch Name	Stone Tool Samples: Heat Treat.	Discrim. Study	Bias A	Bias B	Bias C	Flaking Debris: Bias A	Bias B	Bias C
96	Angus, 32OL144	26	6	198	-	-	1082	-	-
97	PG, 32OL148	9	3	73	-	1	265	-	-
98	Running Deer, 32ME383	3	-	20	-	-	164	-	-
99	Cross Ranch, Late Woodland 32OL156, 32OL159, 32OL161, 32OL162, 32OL177, 32OL252, 32OL253	-	27	305	-	-	1791	-	-
	Cross Ranch, Plains Village 32OL159	-	1	-	-	-	-	-	-
100	Sagehorn, 32ME101	lithic materials from this site were not studied							
Total		1145	412	10526	3732	1430	50547	22349	389

Notes: Bias A = screened over 4-per-inch or finer mesh; lab sorted; very little bias for all size grade 3 and larger artifacts

Bias B = screened over 4-per-inch mesh or very intensively surface collected; field sorted; loss of some smaller artifacts and most ground stone tools

Bias C = surface collection, profile collection, unscreened collection, or heavily high-graded screened collection; biased toward patterned tools and against all else

7. Lower Sanger (32OL11).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and the entire sample is placed in bias class B. It is evident from the low flake-to-tool ratio that flaking debris is particularly underrepresented in the collection, presumably having been discarded in the field. Even so, the flaking debris sample is thought to be useful as a bias class B sample for study of raw material variation.

8,9,10,11,12. Upper Sanger (32OL12).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and most of the sample is placed in bias class B. It is evident from low flake-to-tool ratios that flaking debris is particularly underrepresented in batch 8 and batch 10 samples (Table 18.1). The batch 12 sample, assigned to bias class C, consists of a small surface collection of stone tools.

13. Milepost 28 (32OL13).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and the entire sample is placed in bias class B.

14,15,16,17. Cross Ranch (32OL14).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986) and from later excavations conducted by Calabrese in 1969 (1972). The flaking debris and general stone tool data derive only from the lithic artifacts collected in the 1968 testing program. The heat treatment data also derive only from this test. The much more extensive lithic artifact collection from the 1969 excavations was not studied, due in part to lack of screening in that program and to logistic considerations regarding access to the collections. Projectile point measurement data were taken from the full sample of side-notched arrowpoints available from the site, without regard to batch or excavation year distinction (these same data were used in the arrowpoint study reported by Ahler et al. [1982:250-251]). Quarter-inch screens and selective field sorting were employed in the 1968 testing program, and the entire 1968 testing sample which was used here is placed in bias class B.

18. Bagnell (32OL16).

The lithic artifact data used here derive entirely from the 1968 Wood-Lehmer testing program at this site (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and the entire sample is placed in bias class B. The large lithic collection from major excavations at Bagnell conducted by Lehmer in 1970-1973 (Pepperl 1976) were not used in this study. While ceramic artifacts from this site have not been studied in detail, this batch sample from the 1968 test has been very tentatively placed in time period 42, Late Scattered Village complex (AD 1450-1525), for purposes of the present analysis.

19. Greenshield (32OL17).

The lithic artifact data used here derive in part from the 1968 Wood-Lehmer testing program at this site (Wood 1986) and in part from the trenching conducted there in 1973 by Lehmer (Nicholas and Johnson 1986). Quarter-inch screens and selective field sorting were employed during at least part of the 1968 excavation. The lithic tool and flaking debris artifact sample from 1968 test unit 3 was used in the present study as a bias class B sample. Few or no artifacts are available from tests units 1 and 2, and the stone tool sample from the 1973 trench is highly biased and is placed in bias class C (Table 18.1).

20,21,22. Hensler (32OL18).

The lithic artifact data used here as the batch 20 and batch 21 samples derive entirely from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screening and selective field sorting were used in the 1968 program, and the respective artifact samples have been been placed in bias class B. A small lithic artifact surface collection from the site taken by Alfred Bowers in 1963 has been placed in bias class C under batch 22.

23,24,25,26,27. Mandan Lake (32OL21).

The lithic data from this site derive from the 1968 Wood-Lehmer testing program (Wood 1986). Quarter-inch screens and selective field sorting were employed in this excavation, and the entire sample is placed in bias class B. The flake-to-tool ratios (see data in Table 18.1) indicate that there is very little bias in the flaking debris samples from this site.

28. Shoreline (32OL103).

Despite the fact that this site was tested in the 1968 Wood-Lehmer testing program (Wood 1986), no lithic artifacts could be found in the collections transferred from the University of Missouri for study at UND.

29,30,31,32,33. Mahhaha (32OL22).

The lithic data from this site derive entirely from the 1968 Wood-Lehmer testing program (Wood 1986). Recovery procedures varied significantly according to excavation unit. Test units 1, 2, 3, and 5 were excavated with very selective artifact recovery confined largely to patterned stone tools. Hence, materials from these test units in batches 29, 30, 31, 32, and 33 are assigned to bias class C. Lithic artifacts encountered in test unit 4 were more consistently recovered, and those specimens, assigned to batches 32 and 33, were placed in bias class B. Ceramic samples from test units 1 and 5 were not included in the comparative ceramic analysis, and for that reason lithic artifacts from those proveniences are not assigned to analytic batch units. Projectile points from those tests were measured, however, for purposes of stylistic analysis (Table 18.1).

34. Clark's Creek (32ME1).

The lithic data from this site derive entirely from the 1968 Wood-Lehmer testing program (Wood 1986). Lithic artifacts in feature 1 in test unit 1 were apparently recovered through screening and selective field sorting, and those artifacts are assigned to bias class B. The remaining lithic artifacts from test units 1 and 2 were severely high-graded in the field for retention of only patterned artifacts, and those materials are placed in bias class C.

35. *Fort Clark (32ME2).*

The lithic data from this site derive entirely from the 1968 Wood-Lehmer testing program (Wood 1986). All lithic samples from all tests appear highly biased toward retention of only patterned tools. On this basis, the total site sample is placed in bias class C.

36. *Lyman Aldren (32ME3).*

The lithic data from this site derive entirely from the 1968 Wood-Lehmer testing program (Wood 1986). The lithic materials occur in a large surface collection which has been assigned to bias class C.

37. *Alderin Creek (32ME4).*

A large sample of stone tools is available from this site through the excavations conducted by the SHSND in 1968 (unreported). We were initially interested in measuring a sample of the arrowpoints for inclusion in the stylistic study. Upon examining the site collections at the SHSND it was learned that every stone tool was individually wrapped in aluminum foil and that it would take several hours if not days to unwrap and locate the measurable specimens. Given time constraints, this discovery terminated our interest in studying the lithic sample from this important site.

39,40. *White Buffalo Robe (32ME7).*

The lithic artifact data which are used from this site are essentially those deriving from the study of the 1978 excavated collection reported in Lovick (1980a, b). The flaking debris samples derive from both features and "small sample" general level excavations which could be assigned to the respective Heart River phase or Nailati phase. The general stone tool sample derives from all feature and general level contexts assigned to these two primary phase units. Although the White Buffalo Robe artifacts were studied under the existing UND lithic analysis system, the analytical methods differed in minor details from those described for the most recent study of the Big Hidatsa Village lithic sample (Ahler and Swenson 1985). In particular, the White Buffalo Robe ground stone tools were not subdivided into patterned and unpatterned technological groups. Also, a complete breakdown of stone tool raw material by technological class was not available in the Lovick (1980a, b) reports. This meant that frequencies for certain raw material types such as other quartzite had to be estimated from other indirect data when analyzing the raw material breakdown for chipped stone tools alone (only technological classes 1-8). Also, the presence of heat treatment was not recorded in the original lithic analysis, and time constraints precluded the reanalysis of the stone tool samples for collection of these and other data. Arrowpoints measured for the stylistic analysis were restricted to those found in features only; this was done to enhance the certainty of the phase associations for the arrowpoint samples.

41,42. *Amahami (32ME8).*

This site contains two diverse cultural components (Lehmer et al. 1978), and the lithic artifacts in the 1968 Wood-Lehmer test conducted there could not be effectively separated by component. Ceramic analysis (cf. Chapter 17) did yield a component identification for several pit features encountered in the 1970-1972 excavation conducted by the SHSND. Examination of the SHSND artifact collections revealed, however, that most of these feature samples had never been sorted since recovery in the field. The unsorted condition of the SHSND collections and time constraints for the UND staff precluded meaningful study of the Amahami site lithic artifacts.

43. *Buchfink (32ME9).*

The lithic artifact sample from this site derives entirely from the 1979 and 1981 excavated collections reported in Ahler and Mehrer (1984:103-132). The controlled surface collection from this site taken in 1979 was not included in the lithic analysis. A small part of the stone tool sample obtained in 1981 comes from unscreened excavation of plowzone deposits; these artifacts are assigned to bias class C. The remaining coded stone tool and flaking debris samples are assigned to bias class A.

44,45,46,47,48,49,50. *Lower Hidatsa (32ME10).*

The lithic artifact sample for the first six of these seven batch units for Lower Hidatsa Village derive from the 1978 UND excavations as reported in Ahler and Weston (1981). The batch 50 sample, consisting of miscellaneous materials not assigned to time period, consists in part of stone tools from AC Unit 5 in the 1978 excavations as well as from unprovenienced stone tools collected by Lehmer in his 1965 tests (Lehmer et al. 1978:132-137). The stone tool analysis methods used in the 1981 study differ slightly from the methods used with the more recent 1985 study of Big Hidatsa artifacts. The entire Lower Hidatsa stone tool collection was reexamined and recoded where necessary according to tool function, recycling, and technology in a manner consistent with the analytic methods used here for most of the class A samples (Ahler and Swenson 1985:79-80). Only a portion of the flaking debris sample collected in the 1978 excavations has been completely analyzed according to raw material and other mass analysis data (samples from AC Units 2 and 3 only, as discussed in Goulding 1980 and Ahler and Weston 1981:142-154). That same subsample of flaking debris was included in the present study of raw material variation in flaking debris, and the incompletely studied flaking debris samples from the site were not included in the present analysis. All of the lithic materials identified for batch units 44-49 are assigned to bias class A.

51,52,53,54,55. Lower Hidatsa (32ME10).

The lithic artifact data included in this series of batches derive from Lehmer's 1965 test excavations (Lehmer et al. 1978:132-137; Ahler and Weston 1981). These samples contain primarily patterned stone tools and little else, and they are placed in bias class C.

59,60,61,62,63. Sakakawea (32ME11).

The lithic artifact data included in these analytic batches derive both from the 1965 testing program conducted by Lehmer (Lehmer et al. 1978:38-43) and also from the 1976-1978 UND/NPS excavation and bank profiling program (Ahler et al. 1980). The UND/NPS lithic sample was also studied by Goulding (1980). Lithic stone tool and flaking debris samples assigned to bias class A derive from the controlled UND/NPS excavations. Other artifacts assigned to bias class C include both Lehmer's 1965 excavated artifacts as well as several specimens recovered in UND/NPS bank profiling operations. The stone tool analysis reported in 1980 was more limited than that conducted for the Big Hidatsa collections, and the Sakakawea stone tool sample was completely reexamined for this study, recoding tool function, heat treatment, technology, and recycling in a manner compatible with the methods used here and reported in Ahler and Swenson (1985:79-85). The flaking debris samples used here constitute only a fraction of such material recovered in excavations, being those artifacts from AC Units 8-12 (Ahler et al. 1980:136) which were completely analyzed in the 1980 study according to raw material composition and other mass analysis variables.

64,65,66,67,68,69,70,71. Big Hidatsa (32ME12).

The lithic data from Big Hidatsa Village used in the present study derive entirely from the 1980 excavations at the site reported in Ahler and Swenson (1985:143-203). With the exception of a few profile artifacts and stone tools collected in unscreened trenching through a linear mound at the site, all of these artifacts are assigned to bias class A. The data used here are essentially the same as those reported by Ahler and Swenson (1985).

72. Stanton Ferry (32ML6).

The lithic data used here derive from the intensive surface collection made at that site in 1977 and reported in Ahler and Swenson (1980:33-62). Because of the intensity of this collection, sampling bias was modest and it seems appropriate to treat this as a bias class B sample. This sample was reexamined a second time for heat treatment in technological class 1 items and for raw material classification for purposes of this report, and the raw material data vary slightly from those presented in the Ahler and Swenson report (1980:59).

73. Poly (32ME407).

The data used here derive entirely from the lithic artifacts recovered in 1978 excavations at the site reported in Ahler and Mehrer (1984:133-161). Lithic artifacts from the surface collections taken in 1977 and reported in Ahler and Swenson (1980:5-32) were not included in the present study. The lithic data used here are those reported in the 1984 study, and all samples used here are placed in bias class A.

74. Elbee (32ME408).

The data used here are those reported in Ahler (1984) and VanNest (1984) based on the 1978 excavated sample. Only lithic artifacts from the Plains Village period components, identified as analytic units 1, 2, 3, and 5 in the 1984 report, are used here as the bias class A sample. Lithic artifacts recovered in unscreened plowzone excavations are identified as the bias class C samples in Table 18.1.

75. Scovill (32ME409).

The data used here are those reported in Ahler and Mehrer (1984:162-191) for the 1978 excavations at the Scovill site. The majority of the 1978 collection is considered as a bias class A sample; the few bias class C artifacts noted in Table 18.1 derive from collections made during bank profiling.

76. Hotrok (32ME412).

The data listed in Table 18.1 from the Hotrok site derive from the 1979 excavations reported in Ahler and Mehrer (1984:45-72). Bias class A samples include those from screened contexts, while the small number of bias class C stone tools derive from unscreened excavations in the plowzone.

77,78. Forkorner (32ME413).

The data on lithic artifacts used here are those reported in Ahler and Mehrer (1984:192-249) from the 1979 and 1981 UND/NPS test excavation program. Lithic artifacts from the 1979 controlled surface collection at the site (Lovick and Ahler 1982) are not included in the present study. Most artifacts are placed in bias class A, while the small number of bias class C specimens derive from unscreened plowzone excavations (Table 18.1).

79. Hump (32ME414).

The data on lithic artifacts used here are those reported in Ahler and Mehrer (1984:250-269) from the 1981 excavations at the site. Lithic artifacts from controlled surface collections made in 1978 and 1979 and reported in Lovick and Ahler (1982) are not included in the present study. Most artifacts listed in Table 18.1 are placed in bias class A; the few specimens noted for bias class C derive from unscreened plowzone excavations and from a localized surface collection of heavily patinated artifacts made during the 1981 field program.

80. Youess (32ME415).

The data on lithic artifacts used here are those reported in Ahler and Mehrer (1984:270-299) for the 1981 UND/NPS test excavation program. Lithic artifacts in the intensive surface collection taken in 1979 and reported in Lovick and Ahler (1982) are not used in the present study. Most of the excavated artifact collection is placed in bias class A. The few items in bias class C (Table 18.1) derive from unscreened plowzone excavations.

81. Stiefel (32ME202).

The lithic artifacts reported in the present study come primarily from an intensive surface collection made at the Stiefel site in 1977 as reported in Ahler and Swenson (1980:63-84). Because of the intensity of that collection, those artifacts are placed in bias class B (Table 18.1). The small sample of bias class C artifacts from the site comes from a surface collection made at the site during the 1968 Wood-Lehmer testing program. The 1977 surface collection was reexamined for heat treatment data and raw material data, and the latter data set used here differs slightly from that reported in Ahler and Swenson (1980:84).

82. Rock Village (32ME15).

Lithic artifacts from the 1947-1951 SIRBS salvage excavations at this site (Hartle 1960; Lehmer et al. 1978:11-63) are housed at the Smithsonian Institution. For reasons of sampling bias and time constraints, these artifacts were not studied for the present report.

83. Star Village (32ME16).

Lithic artifacts from the 1951 salvage excavations at this site (Metcalf 1963) are housed at the Smithsonian Institution. For reasons of sampling bias and time constraints, these materials were not incorporated into the present study.

84. Grandmother's Lodge (32ME59).

The lithic data from this site used in the present study derive from the 1952-1954 salvage excavations reported in Woolworth (1956). The extant collection presently housed at the SHSND is highly biased, consisting almost entirely of patterned stone tools, all of which are placed in bias class C (Table 18.1).

85. Like-a-Fishhook (32ML2).

The lithic sample from this site included in the present study consisted of the available artifacts in the collections of the SHSND. These materials derive primarily from salvage excavations conducted there in 1950-

1954 and reported in Smith (1972). This collection is highly biased toward patterned chipped and ground stone tools, and it is placed in bias class C.

86. Nightwalker's Butte (32ML39).

Lithic materials from this site, salvaged by the SIRBS in 1952 as reported in Lehmer et al. (1978:64-131), were not included in the present study due to time constraints and presumed sample bias.

87. Mondrian Tree (32MZ58).

Lithic data from the Mondrian Tree site are taken from the report by Toom (1983) based on the salvage excavations conducted in 1980. Only the raw material classification data for the flaking debris sample were used in the present study. Stone tools from Mondrian Tree were not studied due to the difficulty in assigning the excavated sample to a precise time period and due to the functionally distinct nature of the site, it being a temporary encampment in contrast to the permanent villages which comprise the major data source for the present study.

88. Hagen (24DW1).

The lithic artifacts from the Hagen site excavations reported by Mulloy (1942) were not incorporated in the present study due primarily to the geographic location of the Hagen site, far outside the Knife-Heart region.

89,90. Hintz (32SN3).

The lithic artifacts from the Hintz site (Wheeler 1963) were not incorporated into the present study, due primarily to the distant geographic location of the site lying far to the east of the Knife-Heart region.

91. Arzberger (39HU6).

The lithic assemblage from this site, reported in Spaulding (1956), was not examined in the present study.

92. Flaming Arrow (32ML4).

The lithic artifact sample from the 1983 excavation at this site (Toom and Root 1983; Toom 1988) has not been analyzed and was not included in the present study.

93. Sharbono (32BE419).

A small, selective surface collection of lithic artifacts from this site, reported in Schneider (1983), was not included in the present study.

94,95. Taylor Bluff (32ME366).

The lithic collections from the 1982 salvage excavations at the Taylor Bluff site (Ahler et al. 1983) are not well segregated chronologically and were not used in the present study. The more extensive artifact collections from the salvage excavations conducted there in 1983 were not fully analyzed in time to be included in the present study (Ahler 1988).

96. Angus (32OL144).

The lithic artifact sample from 1982 test excavations at the Angus site has been studied (Ahler and Picha 1985) and that portion of the sample from the major Plains Village period component there has been included in the present study. This collection is considered as a bias class A sample.

97. PG (32OL148).

The lithic artifact sample from 1982 test excavations at the PG site has been studied (Ahler and Picha 1985) and that portion of the sample from the major Plains Village period component there has been included in the present study. Most of this collection is considered as a bias class A sample (Table 18.1); a single artifact from unscreened excavation is included as a bias class C sample.

98. Running Deer (32ME383).

The lithic data set from this site is taken directly from the 1984 report (Ahler and Mehrer 1984:73-102) on the 1980 test excavations conducted there. The collection, poorly dated and too small to be analytically useful, is placed in bias class A.

99. Cross Ranch, Late Woodland Sites.

Data from lithic artifacts from seven Late Woodland period sites reported by Ahler, Lee, and Falk (1981) and Ahler et al. (1982) are included in the present study.

Technological and raw material classification data for both tools and flaking debris were derived from excavated samples from sites 32OL177, 32OL162, and 32OL253. Raw material classification data only were available for samples from sites 32OL161, 32OL252, and 32OL156. All of these are camp sites, presumably seasonally occupied. Late Woodland period arrowpoints from these sites were also measured, as were all of the Late Woodland points and a single Plains Village point from the Bundlemaker bison kill site (32OL159). Heat treatment data were not recorded for the artifacts in these collections.

100. Sagehorn (32ME101).

No lithic artifacts from this site were located in the 1968 Wood-Lehmer testing program collections transferred from the University of Missouri to UND for the present study.

STYLISTIC ANALYSIS

The stylistic analysis of the upper Knife-Heart region lithic artifact samples has been conducted using three types of data. First, morphological variation in artifacts functionally classified as arrowpoints was examined by placing such artifacts in simple formal groups or types having contrasting morphologies. Second, morphological variation in side-notched arrowpoints was examined more closely through a study of shape and size variation documented by measurements. Finally, variation in the practice of heat treatment applied to selected KRF artifacts was studied. In all cases, previous investigations within and/or outside the region have suggested that meaningful chronological patterns or changes may occur in each of these types of data. Also, in each instance the primary objective has been to examine such stylistic variation across the discrete time periods and culture-historic units defined for the study area in the ceramic and chronometric studies. The goal has been to see if lithic artifacts yield a stylistic structure for the region which parallels, adds to, or differs from the chronological and culture-historic framework previously identified in ceramic stylistic data.

Morphological Variation in Arrowpoints

Morphological variation in arrowpoints can be documented through a typological approach. Two arrowpoint forms occur commonly in the regional collections, and other forms occur in extremely low frequencies. Arrowpoints with a side-notched morphology are most common. Within this group there is considerable variation in the precise shape, size, and location of the notches, as documented by Kehoe (1973) and others, but for the present purposes all of the variants of side-notched arrowpoints will be considered as a single typological group. The detailed variation in notch shape and placement is the subject of the measurement analysis in the following section. The second major morphological type in the regional samples is the simple unnotched, isosceles triangular form. All other variations in morphology other than side-notched and unnotched triangular are here considered under a third group described simply as "other." This includes primarily distinctly corner-notched specimens (some of which may derive from reworking of a side-notched point broken through the notches), tri-notched or basally-notched specimens, and oval-based unnotched specimens. A few artifacts with distinctive morphologies can be mentioned which are included within this latter, "other" group. One such specimen is an Avonlea point (Kehoe and McCorquodale 1961) which was recovered from site 32OL159 on the Cross Ranch in what is thought to be a pre-Plains Village age context (Ahler, Lee, and Falk 1981:56, Figure 10d). Two basally-notched or tri-notched specimens were recovered in excavations at Lower Hidatsa Village (Ahler and Weston 1981:113, Figure 13h, i). Additional specimens with an "other" morphology are illustrated in Ahler and Weston (1981:113, Figure 13j, k) and Ahler et al. (1980:117, Figure 13i). Virtually all of the site reports dealing with the KNRI testing contain illustrations of numerous side-notched and unnotched triangular arrowpoints.

The production of a side-notched arrowpoint progresses through a sequence of steps which includes an unnotched triangular intermediary form (Ahler 1992). For this reason, a careful study of the manufacturing stage and use-phase classification of arrowpoints must be done in order to produce accurate quantifications of the relative frequencies of finished side-notched and finished unnotched triangular point forms. Such a procedure was carried out in this study. In a few other instances where use-phase classification has been carefully studied or where all artifacts can be assumed to be technologically finished (as in kill sites), data have been compiled which indicate that the proportions of unnotched and side-notched arrowpoint forms change considerably through time or through space within the Middle Missouri subarea and Northwestern Plains. For example, at the stratified Vore bison kill site, Reher and Frison (1980:103) note significant changes in the relative frequencies of side-notched, unnotched, and basally-notched arrowpoint forms through time. In another example, the relative proportions of unnotched and side-notched forms differ significantly between two Coalescent tradition site assemblages from South Dakota (Ahler 1975a:355; 1992) while in the same region, side-notched points are decidedly more common in early Middle Missouri tradition sites than in Coalescent sites in general (cf. data in Ahler 1977b). On this basis, there seems good reason to study the relative frequency of the notched and unnotched arrowpoint forms in the upper Knife-Heart region samples.

Table 18.2. Summary of arrowpoint morphological classification by time period for upper Knife-Heart region sites.

	Morphological Class			
Time Period	Unnotched Triangular	Side-Notched	Other	Total
10 pre-AD 1200	2	40	2	44
20 AD 1200-1300	0	12	0	12
30 AD 1300-1400	8	50	0	58
41 AD 1400-1450	5	86	2	93
42 AD 1450-1525	2	33	3	38
50 AD 1525-1600	9	108	2	119
60 AD 1600-1700	2	19	1	22
61 AD 1600-1650	2	16	1	19
62 AD 1650-1700	7	62	0	69
70 AD 1700-1780	1	14	0	15
71 AD 1500-1740/45	2	50	1	53
72 AD 1740/45-1780	3	34	1	38
80 AD 1780-1845	2	17	1	20
81 AD 1780-1800	0	4	0	4
82 AD 1800-1820/30	1	15	0	16
83 AD 1820/30-1886	0	12	0	12
Collapsed Time Periods				
10 pre-AD 1200	n 2	40	2	44
	% 4.5	90.9	4.5	100.0
20 AD 1200-1300	n 0	12	0	12
	% 0.0	100.0	0.0	100.0
30 AD 1300-1400	n 8	50	0	58
	% 13.8	86.2	0.0	100.0
40 AD 1400-1525	n 7	119	5	131
	% 5.3	90.8	3.8	99.9
50 AD 1525-1600	n 9	108	2	119
	% 7.6	90.7	1.7	100.0
60 AD 1600-1700	n 11	97	2	110
	% 10.0	88.2	1.8	100.0
70 AD 1700-1780	n 6	98	2	106
	% 5.7	92.5	1.9	100.1
80 AD 1780-1886	n 3	48	1	52
	% 5.8	92.3	1.9	100.0
Total	n 46	572	14	632
	% 7.3	90.5	2.2	100.0

Data concerning the morphological classification of arrowpoints according to time period are presented in Table 18.2. The first part of the table presents typological data as frequencies by general and specific time periods. In all instances, side-notched specimens dominant each time period. The maximum relative occurrence of unnotched triangular specimens occurs in period 30 where such artifacts comprise 13.8 percent of the sample. No particular chronological pattern in typological variation is apparent in this data set. In an attempt to elicit broader chronological patterns based on larger sample sizes, the data in the lower part of Table 18.2 were compiled which consist of morphological class frequencies summarized according to more generalized time periods of approximately a century in length, corresponding to the major culture-historic units recognized in the region. Again, no particular chronological pattern is evident in these data. Specimens with "other" morphology occur in a low but variable frequency in virtually all time units; unnotched specimens range in relative frequency from 0.0 percent in the Clark's Creek phase, AD 1200-1300 (based on a very small sample size), to 13.8 percent in the following Nailati phase. A chi-square test comparing the frequencies of unnotched points versus frequencies of all notched forms combined by time period yields a nonsignificant result ($X^2 = 7.60$, df = 7, p = >0.30).

These results indicate surprisingly little change in basic arrowpoint morphology through time in the regional samples, and suggest that influence from Coalescent tradition Plains Village groups living to the south, who typically made unnotched triangular points in high frequency, cannot be directly measured by changing frequencies of such points in the regional samples. These results fail to support the results of the ceramic analysis which suggest periods of strong interaction between the upper Knife-Heart region and regions to the south, particularly during the period from AD 1400 to AD 1600. The unnotched specimens which do occur in the regional samples could represent primarily unfinished and misclassified artifacts which were simply blanks intended for the production of side-notched forms. Such an explanation would account for the relatively constant but low frequency of such artifacts in nearly all time periods, spanning a full range of more than 700 years.

Attention is now turned to assessment of more subtle morphological variation in side-notched arrowpoints, the dominant point form in all time periods in the region. The method used here is multiple discriminant analysis or discriminant function analysis. Discriminant analysis has been used successfully for the study of stylistic variation in Plains Village period and Late Prehistoric period arrowpoints in several previous studies. Calabrese, in two studies (1972:40-49; 1973), compared arrowpoint samples from the Cross Ranch site and from several other sites assigned by him to the Middle Missouri tradition and Coalescent tradition in several regions of the Missouri valley. His main conclusion was that significant between-site differences existed in most of the samples, but that the major variation in his study samples could be attributed to region-wide chronological variation. The sites studied by Calabrese spanned the twelfth to the seventeenth centuries AD.

Reher and Frison (1980:116-121) have also conducted discriminant analysis of a large arrowpoint sample from stratified, well-dated deposits at the Vore site, a Late Prehistoric bison kill near the Black Hills. They find strong chronological differences among the Vore site samples, with most significant variation focused on haft element dimensions and measurements. They caution (1980:120) that Calabrese (1972, 1973) may not have effectively controlled functional variation in his study of Plains Village arrowpoints, and that much of the significant variation in those samples centered on blade element dimensions and measurements may in fact have to do with different sizes of points having been made for different game types rather than with "stylistic" variation.

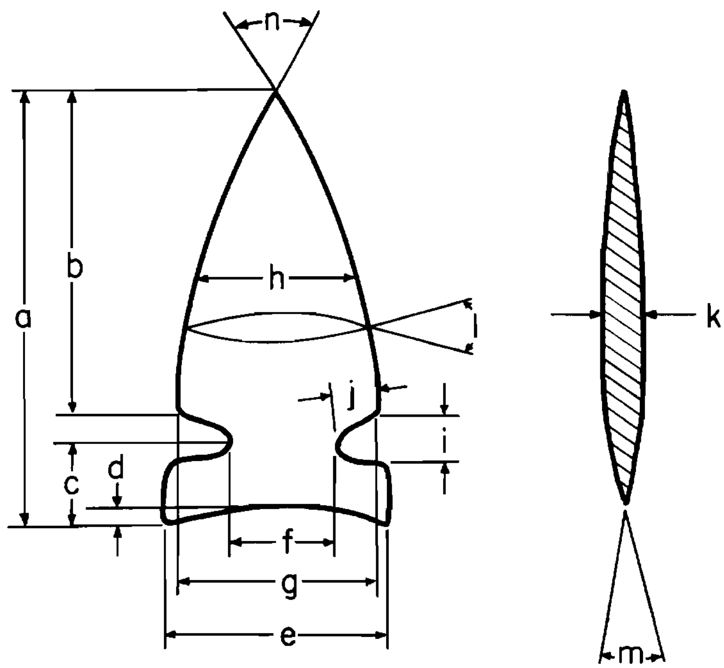
Useful discussions of discriminant analysis are provided in Klecka (1975) and Veldman (1967:268-280). The particular method used here is program DISCRIMINANT in the SPSSX package (SPSS, Inc. 1983:623-645). This analysis is based on a series of up to 18 metric measurements and other observations made on each side-notched arrowpoint. The points are assigned to groups, in this case based on time period or culture-historic unit, and the discriminant analysis assesses group distinctions based on the pool of measurement data or other discriminating variables recorded for each specimen in each group. The discriminant analysis computes a new series of variables or discriminant functions which maximize the differences between the predefined groups. Differences between and among groups are evaluated statistically using the chi-square distribution. Plotting the group means or centroids along these functions in a graphic manner presents a visual representation of the degree of separation among groups.

Pooled within-group correlations are computed between the original discriminating variables and each of the discriminant functions, and these correlations provide a measure of the role each original variable plays in group discriminations. To further assess the degree of group separation and distinction, each artifact is reclassified according to the most likely group membership based on its computed discriminant scores. The higher the percentage of correct classifications according to known group memberships, then the better the group distinctions. The lower the percentage of correct classifications, then the more overlap there is between groups and the less distinct they are. Classification functions and coefficients are computed which allow classification of new artifacts not included in the present study (cf. SPSS, Inc. 1983:640 for discussion of the method).

The procedure used here is essentially the same as that used in an earlier discriminant study of side-notched arrowpoints from the upper Knife-Heart region (Ahler et al. 1982:247-259). That study showed that significant differences exist between Late Woodland period and Plains Village period arrowpoints in the region, and it further suggested that significant morphological differences existed within the Plains Village points as well. That study provided the impetus for the present investigation. A total of 12 metric measurements are made on side-notched points, concentrating primarily on dimensions and proportions of the haft element. In addition, weight to 0.1 gm, presence (1) or absence (0) of basal grinding, three edge angles, and a ratio of basal blade element width to proximal haft width are recorded or computed internally. These measurements are defined or described by Ahler (1975b:180-194), Lovick (1980b:81, 83), and Ahler et al. (1982:249). Figure 18.1 illustrates the location of linear measurements and lists the variable names and abbreviations. In the present study no control was maintained over raw material in the arrowpoint samples. Raw material could conceivably affect the required manufacturing process and therefore arrowpoint form, or it could be linked to the cultural and geographical origin of the point makers, as discussed by Reher and Frison (1980:102-112). In our sample, KRF was the dominant material in all time period samples, comprising about 75 percent of all points in the sample. Due to the predominant reliance on KRF in all time periods, raw material variation was not taken into account in the present study.

Two separate discriminant studies using slightly different sets of variables were conducted for various time period group arrangements. The differing variable sets involved first a set of 18 variables which could be measured or estimated for all complete or nearly complete specimens (n = 254). The second set involved only 13 variables which could be recorded for the medial and proximal haft element parts of arrowpoints, allowing the inclusion of a significant number of fractured specimens with missing distal blade tips (n = 384). Variables dropped from the study of broken specimens include total length, blade element length, midblade width, distal juncture angle, and weight. The first set of variables provides best documentation of the complete size and shape characteristics of the arrowpoint sample, while the second reduced set of variables allows study of a significantly larger artifact sample. In all instances, the "direct" rather than the "step-wise" method of discriminant analysis was used, allowing simultaneous inclusion of all discriminating variables in the analysis rather than step-by-step inclusion or exclusion of selected variables.

The first set of analyses was directed toward study of differences among sixteen sample groups based on each of the previously defined generalized and specific time periods for the upper Knife-Heart region samples (periods 10, 20, 30, 41, 42, 50, 60, 61, 62, 70, 71, 72, 80, 81, 82, 83 as defined in Table 17.8). This analysis provides the most fine-grained study of chronological variation in the full regional arrowpoint sample. The results indicate that significant among-group differences exist in the data sets. The 18-variable, complete artifact analysis yielded four statistically significant discriminant functions (p = .05 or less), and the 13-variable, broken/whole artifact analysis yielded a similar number of significant functions. Examination of the classification results, however, indicates that the overlap between these 16 temporal groups is actually quite great and that, while statistically distinct, the groups grade heavily into one another based on the variables measured. The 18-variable, complete artifact analysis yielded a classification success rate of 48.4 percent, while the 13-variable, complete/broken artifact study yielded a dismal classification success rate of 36.5 percent. The group centroids or means for the complete artifact study are plotted on discriminant functions 1 and 2 in Figure 18.2. This figure illustrates that group 10 (Late Woodland) specimens are most distinctly separated from the the Plains Village specimens, that the group 20 through period 61 temporal progression is relatively consistent, but that all of the post-period 61 sample centroids cluster in the same general area. It appears that, in general, discriminant function 1 sorts groups chronologically, while the function



*a -	TOTLNG	total length	k -	MASTHIK	maximum thickness
*b -	BLADLNG	blade element length		PCTUNFLK	percentage unflaked surface
c -	DISHAFLN	distal haft element length		GRIND	basal edge dulling or grinding (presence/absence)
d -	BASINCUR	basal incurvature			
e -	PROXWID	proximal haft element width	*	WTESTWT	weight or estimated weight
f -	DISTWID	distal haft element width	l -	LATANGLE	lateral blade edge angle
g -	BASEWID	blade base width	m -	BASANGLE	basal edge angle
*h -	MBLADWID	mid blade width	*n -	BLADANGLE	distal blade juncture angle
i -	NOCHWID	notch width		BASEBODY	BASEWID:PROXWID ratio, or base-body index
j -	NOCHDEP	notch depth			

Figure 18.1. Schematic drawing of a side-notched arrowpoint showing measurement locations with a list of variable identifications. Asterisks indicate variables measured for complete specimens only.

2, operating on a different set of discriminanting variables, also tends to sort only the Plains Village period samples into a rough chronological sequence. Overall, these results, while of interest, suggest that the 16 period groups used here provide too fine a level of temporal subdivision for complete discrimination. The arrowpoint measurement data apparently do not allow segregation of the artifact samples into the fine-grained temporal groups recognized and developed from the ceramic data set.

Recognizing the limitations in the 16-group analysis based on detailed time period breakdowns, two more general chronological groupings were studied in an effort to more clearly isolate chronological change in the arrowpoint samples and to identify the variables most involved in chronological change. By looking at more general temporal clusterings, it might yet be possible to effectively use the discriminant analysis and classification procedures to assess the approximate chronological placement of regional arrowpoint samples.

The next analysis focused on eight rather than 16 chronological groups for the arrowpoint study sample. The eight groups are comprised of the more generalized chronological periods, about a century in length, which are associated with each of the major culture-historic or taxonomic units recognized in the pottery analysis for the region: Formative Village or Late Woodland (pre-AD 1200, period 10); Clark's Creek phase (AD 1200-1300, period 20); Nailati phase (AD 1300-1400, period 30); Scattered Village complex (AD 1400-1525, periods 41 and 42); Heart River phase (AD 1525-1600, period 50); Knife River/Heart River phase transition (AD 1600-1700, periods 60, 61, 62); Early Knife River phase (AD 1700-1780, periods 70, 71, and 72); and Late Knife River phase (post-AD 1780, periods 80, 81, 82, and 83).

The eight-group analysis again demonstrates successful among-group discrimination. The 18-variable, complete artifact analysis yielded five statistically significant discriminant functions and a classification success rate of 50.8 percent, a slight improvement over the 48.4 percent success rate for the 18-variable analysis based on 16 temporal groups. The group classification results are shown in Table 18.3. This table indicates that the success rate in classification varies widely by time period, ranging from around 41 percent for group 4 (AD 1400-1525) and group 6 (AD 1600-1700) samples to a maximum of more than 90 percent in the group 1, Late Woodland period sample. Figure 18.3 illustrates a plot of the centroids or group means for the eight groups based on the 18-variable analysis. A strong temporal pattern is indicated, closely resembling the pattern shown in Figure 18.2, but with far less clutter in the later periods. Function 1 clearly represents chronological changes spanning the Late Woodland through Plains Village periods, while function 2 tends to isolate chronological change from AD 1200 through AD 1700 in the Village period. The post-AD 1600 samples are still not well distinguished, although, as a group, these items seem to separate well from earlier samples.

The eight group, 13-variable analysis applied to broken/complete artifacts produced somewhat similar but slightly less satisfactory results. Four statistically significant discriminant functions are produced. The classification success rate in this case is only 38.5 percent, little improvement over the 36.5 percent success rate for the 16-group analysis of the same variables and data set. Table 18.4 summarizes the classification results by group or time period. The pattern here is somewhat the same as in Table 18.3 based on a larger series of variables; classification is best in the Late Woodland period sample and it is exceptionally poor in the group 6 sample (AD 1600-1700). Figure 18.4 illustrates a graphic plot of the eight group centroids on discriminant functions 1 and 2 in the 13-variable analysis. The pattern of group differences is basically the same as in the 18-variable analysis illustrated in Figure 18.3, although the separation of time period groups 5, 6, 7, and 8 is somewhat different.

To further focus on the dominant chronological patterns in arrowpoint morphological variation, analysis based on four, even more general, temporal period groups was conducted. In this analysis, artifacts were grouped into the periods pre-AD 1200 (Late Woodland and Formative Village), AD 1200-1400 (Clark's Creek and Nailati phases), AD 1400-1600 (Scattered Village complex and Heart River phase), and post-AD 1600 (Knife/Heart River phase transition and Early and Late Knife River phase). The 18-variable analysis for complete artifacts produced the best among-group discrimination. The results of this analysis are summarized in detail in Table 18.5. Three statistically significant discriminant functions are produced, indicating strong group discrimination. Figure 18.5 provides a graphic display of group centroids on functions 1 and 2. The basic pattern here with respect to time is very similar to that produced in previous analyses using a larger number of groups (Figures 18.4 and 18.3). Function 1 clearly identifies time variation among all four groups, while function 2 appears to maximally distinguish among Plains Village period groups 2, 3, and 4, in particular.

The pooled within-group correlations in Table 18.5 provide a means for identifying the variables which contribute most clearly to each discriminant function. The variables distal haft element length, notch depth, and maximum thickness are most highly correlated with function 1. Examination of raw data indicates that all of these variables increase in mean value through time; notches are placed higher on the blade, notches are deeper, and artifacts are thicker later in time. A larger suite of variables is involved in the definition of function 2. Most prominent are distal haft element width, proximal haft element width, the base-body index, and percentage unflaked surface. The pattern is for the width across the notches and the basal width to increase later in time in the three Village period groups, and for the base-body index and the percentage of unflaked surface to decrease through time in these same samples. These same patterns are identified on function 1 and function 2 in the previous analyses involving larger numbers of temporal groups, but they are clarified in the present analysis. Of interest is the fact that variables such as blade length and total length, measuring overall artifact size, play only a minor role in the group discriminations. Most of the significant variation in the data set seems to reside in the form of the arrowpoint haft element. The classification results, included in Table 18.5, indicate that the discrimination among groups is improved significantly in the four-group study over that in the studies of larger numbers of groups. Overall, about two-thirds of all specimens are classified correctly. A maximum of 95 percent correct classification is obtained for group 1 (pre-Village age specimens), and no group falls below a 61 percent correct classification rate.

Detailed results of the 13-variable analysis designed for broken and whole artifacts and based on the same four generalized time period groups are presented in Table 18.6. Again, three statistically significant discriminant functions are generated. The group centroids for this analysis are displayed on functions 1 and 2 in Figure 18.6. The pattern is much the same as in the analysis of 18 variables for complete arrowpoints, except that the distinction between Late Woodland (group 1) and Plains Village (groups 2, 3, 4) artifacts seems to be accentuated, while the separation of the Plains Village groups on function 2 is less strong. The pooled within-group correlation coefficients listed in Table 18.6 indicate that much the same suite of variables is important in group discrimination. The variables distal haft element length, notch depth, and maximum thickness are most important on function 1, while proximal haft element width, distal haft element width, basal incurvature, and the base-body index are most important on function 2.

Classification results in this four-group analysis are significantly improved over those in analysis of more time period groups. Overall, 56.5 percent of the arrowpoints can be correctly classified according to previously assigned temporal group. The Late Woodland period group is best classified (96.3 percent), while the period 3 group is least well classified (49.3 percent).

Regardless of the improvement in classification success, it is apparent that the projectile point samples are quite heterogeneous in all time periods, and that there is a great deal of overlap in measurement information in all the time period samples. Figure 18.7 provides an illustration of the maximum dispersion of discriminant scores on function 1 and function 2 on the 18-variable analysis for each artifact assigned to each of the four time period groups. This figure shows clearly that the group 1, Late Woodland period specimens are most readily distinguished from all the other artifacts, but that there is a great deal of heterogeneity and overlap in measurement characteristics for the later period groups. It also illustrates that group dispersion is greatest in the group 4, post-AD 1600 sample. The pattern is for within-group variance and heterogeneity to increase through time. This figure provides another way of illustrating the fact that, overall, about 35 percent of all Plains Village specimens will be incorrectly classified, even on a very general four-group time period level.

One explanation for the chronological increase in measurement heterogeneity probably has to do with increased cross-cultural communication through time. Cultural groups may have tended to be more isolated in the earliest periods, and may have tended to share ideas and actual material culture (trading of arrows and arrowpoints?) in later time periods as interregional trade systems became more highly developed. Another explanation for the high level of heterogeneity in the post-AD 1600 sample may have to do with artifact scavenging and recycling during that period. Such activity has been posited for the lithic assemblage from Sakakawea Village (Goulding 1980:119-121) and such activity would tend to mix artifacts of all time periods into contexts seeming to date in the later part of the post-AD 1600 period.

Heat Treatment in Knife River Flint

The presence of heat treatment in Knife River Flint artifacts was first noted during the analysis of artifacts from excavations at Lower Hidatsa Village. The procedure by which heat treatment can be produced in KRF and the attributes which are critical for its recognition have subsequently been reported in detail in Ahler (1983). The Lower Hidatsa study showed that the incidence of heat treatment in stone tools was concentrated in arrowpoints, and it was hypothesized that heat treatment was intentionally conducted to improve the flaking properties in such tools made almost exclusively by pressure flaking (Ahler and Weston 1981:122-124). Furthermore, study of the distribution of heat treated artifacts according to time period at Lower Hidatsa showed a strong pattern of increasing occurrence of heat treatment in the later time periods at that site (Ahler and Weston 1981:140-142). The pattern discovered at this site identified heat treatment as a technological or stylistic attribute worthy of consistent study in the regional artifact samples.

Table 18.3. Summary of discriminant classification results for 254 projectile points grouped into eight time periods, using 18 variables measurable on whole artifacts only.

Classification results -

Actual group	No. of cases	Predicted group membership 1	2	3	4
GROUP 1 PRE-1200	21	19 90.5%	1 4.8%	0 0.0%	1 4.8%
GROUP 2 1200-1300	4	0 0.0%	3 75.0%	1 25.0%	0 0.0%
GROUP 3 1300-1400	42	2 4.8%	3 7.1%	22 52.4%	5 11.9%
GROUP 4 1400-1525	69	2 2.9%	4 5.8%	7 10.1%	28 40.6%
GROUP 5 1525-1600	38	0 0.0%	0 0.0%	5 13.2%	7 18.4%
GROUP 6 GEN 1600-1700	22	1 4.5%	0 0.0%	0 0.0%	6 27.3%
GROUP 7 GEN 1700-1780	33	0 0.0%	0 0.0%	0 0.0%	2 6.1%
GROUP 8 GEN 1780-1880	25	1 4.0%	0 0.0%	0 0.0%	3 12.0%
UNGROUPED CASES	21	1 4.8%	0 0.0%	1 4.8%	5 23.8%

Actual group	No. of cases	Predicted group membership 5	6	7	8
GROUP 1 PRE-1200	21	0 0.0%	0 0.0%	0 0.0%	0 0.0%
GROUP 2 1200-1300	4	0 0.0%	0 0.0%	0 0.0%	0 0.0%
GROUP 3 1300-1400	42	3 7.1%	4 9.5%	3 7.1%	0 0.0%
GROUP 4 1400-1525	69	11 15.9%	10 14.5%	3 4.3%	4 5.8%
GROUP 5 1525-1600	38	18 47.4%	4 10.5%	2 5.3%	2 5.3%
GROUP 6 GEN 1600-1700	22	2 9.1%	9 40.9%	3 13.6%	1 4.5%
GROUP 7 GEN 1700-1780	33	1 3.0%	4 12.1%	19 57.6%	7 21.2%
GROUP 8 GEN 1780-1880	25	1 4.0%	4 16.0%	5 20.0%	11 44.0%
UNGROUPED CASES	21	3 14.3%	0 0.0%	7 33.3%	4 19.0%

Percent of "grouped" cases correctly classified: 50.79%

Table 18.4. Summary of discriminant classification results for 384 projectile points grouped into eight time periods, using 13 variables measurable on both whole and broken artifacts.

Classification results -

Actual group	No. of cases	Predicted group membership 1	2	3	4
GROUP 1	27	24	1	0	2
PRE-1200		88.9%	3.7%	0.0%	7.4%
GROUP 2	8	0	6	1	0
1200-1300		0.0%	75.0%	12.5%	0.0%
GROUP 3	61	5	9	20	10
1300-1400		8.2%	14.8%	32.8%	16.4%
GROUP 4	104	4	10	22	38
1400-1525		3.8%	9.6%	21.2%	36.5%
GROUP 5	58	2	0	3	10
1525-1600		3.4%	0.0%	5.2%	17.2%
GROUP 6	45	1	0	6	7
GEN 1600-1700		2.2%	0.0%	13.3%	15.6%
GROUP 7	47	0	1	3	2
GEN 1700-1780		0.0%	2.1%	6.4%	4.3%
GROUP 8	34	2	1	3	5
GEN 1780-1880		5.9%	2.9%	8.8%	14.7%
UNGROUPED CASES	31	1	1	1	7
		3.2%	3.2%	3.2%	22.6%

Actual group	No. of cases	Predicted group membership 5	6	7	8
GROUP 1	27	0	0	0	0
PRE-1200		0.0%	0.0%	0.0%	0.0%
GROUP 2	8	0	0	1	0
1200-1300		0.0%	0.0%	12.5%	0.0%
GROUP 3	61	3	6	5	3
1300-1400		4.9%	9.8%	8.2%	4.9%
GROUP 4	104	9	7	10	4
1400-1525		8.7%	6.7%	9.6%	3.8%
GROUP 5	58	20	8	10	5
1525-1600		34.5%	13.8%	17.2%	8.6%
GROUP 6	45	9	5	8	9
GEN 1600-1700		20.0%	11.1%	17.8%	20.0%
GROUP 7	47	3	8	23	7
GEN 1700-1780		6.4%	17.0%	48.9%	14.9%
GROUP 8	34	2	3	6	12
GEN 1780-1880		5.9%	8.8%	17.6%	35.3%
UNGROUPED CASES	31	6	3	8	4
		19.4%	9.7%	25.8%	12.9%

Percent of "grouped" cases correctly classified: 38.54%

Table 18.5. Output from the discriminant function analysis of 254 projectile points divided into four temporal groups, based on 18 variables recorded for whole artifacts only. See Figure 18.1 for explanation of abbreviated terms.

-------- DISCRIMINANT ANALYSIS --------

On groups defined by period

415	(Unweighted) cases were processed.
161	Of these were excluded from the analysis.
21	Had missing or out-of-range group codes.
130	Has at least one missing discriminating variable.
10	Had both.
254	(Unweighted) cases will be used in the analysis.

Number of cases by group

	Number of Cases		
Period	Unweighted	Weighted	Label
1	21	21.0	PRE-1200
2	46	46.0	1200-1400
3	107	107.0	1400-1600
4	80	80.0	POST-1600
Total	254	254.0	

Group means

Period	TOTLNG	BLADLNG	DISHAFLN	BASINCUR
1	23.15238	17.78571	4.40476	0.20952
2	23.36522	16.34130	5.51957	-0.06304
3	23.61028	16.36916	5.75514	0.28879
4	25.77625	18.14625	6.19625	0.50875
Total	24.21024	17.04094	5.73976	0.28780

Period	PROXWID	DISTWID	BASEWID	MBLADWID
1	12.53810	9.33333	12.76190	9.72381
2	11.81087	7.72609	12.42391	9.25217
3	12.49907	7.93271	13.08692	9.67757
4	13.83875	8.48125	13.27625	9.59500
Total	12.79961	8.18386	12.99961	9.57835

Period	NOCHWID	NOCHDEP	MAXTHIK	PCTUNFLK
1	3.71905	1.59048	2.74762	26.19048
2	3.58478	2.19130	3.08913	51.30435
3	3.49252	2.64579	3.18411	34.90654
4	3.22750	2.66125	3.49375	26.81250
Total	3.44449	2.48110	3.22835	34.60630

Period	GRIND	WTESTWT	LATANGLE	BASANGLE
1	0.23810	0.94762	39.66667	42.52381
2	0.04348	0.91522	45.80435	44.54348
3	0.18692	1.02243	42.14019	45.79439
4	0.05000	1.18750	42.76250	44.83750
Total	0.12205	1.04882	42.79528	44.99606

Period	BLADANGL	BASEBODY
1	61.57143	1.03058
2	64.34783	1.06942

Table 18.5. Continued.

Group means, continued

Period	BLADANGL	BASEBODY
3	72.95327	1.05592
4	74.46250	0.96851
Total	70.92913	1.02874

Group standard deviations

Period	TOTLNG	BLADLNG	DISHAFLN	BASINCUR
1	5.80290	5.59324	0.87549	0.62762
2	4.45233	4.14212	1.15866	0.94077
3	4.77242	4.43773	0.91983	0.68781
4	4.94922	4.72446	1.02345	0.74191
Total	4.95271	4.63224	1.09712	0.77264

Period	PROXWID	DISTWID	BASEWID	MBLADWID
1	1.84160	1.12842	1.64817	1.69024
2	2.30856	1.40672	1.87251	1.23193
3	1.92376	1.43762	1.78157	1.39523
4	1.99236	1.70977	1.76235	1.41787
Total	2.13755	1.56005	1.79733	1.40160

Period	NOCHWID	NOCHDEP	MAXTHIK	PCTUNFLK
1	0.88409	0.58558	0.47605	38.30485
2	0.93665	0.63555	0.49631	48.55049
3	0.73583	0.59610	0.56638	42.01292
4	0.69610	0.80387	0.74040	31.91408
Total	0.78847	0.74327	0.64273	40.84873

Period	GRIND	WTESTWT	LATANGLE	BASANGLE
1	0.43644	0.40573	7.51221	10.57175
2	0.20618	0.36513	9.94567	13.93749
3	0.39168	0.47171	6.65235	9.71260
4	0.21932	0.55333	5.35864	7.31124
Total	0.32799	0.48583	7.22516	10.02112

Period	BLADANGL	BASEBODY
1	8.66932	0.15894
2	12.24784	0.14178
3	15.39014	0.11232
4	11.58998	0.12782
Total	13.95089	0.13312

Pooled within-groups correlation matrix

	TOTLNG	BLADLNG	DISHAFLN	BASINCUR	PROXWID	DISTWID
TOTLNG	1.00000					
BLADLNG	0.97245	1.00000				
DISHAFLN	0.40650	0.22858	1.00000			
BASINCUR	0.15535	0.15358	0.11995	1.00000		
PROXWID	0.36238	0.29961	0.50257	0.08705	1.00000	

Table 18.5. Continued.

Pooled within-groups correlation matrix, continued

	TOTLNG	BLADLNG	DISHAFLN	BASINCUR	PROXWID	DISTWID
DISTWID	0.22456	0.20062	0.25801	0.05520	0.52307	1.00000
BASEWID	0.54125	0.50189	0.42814	0.08460	0.69616	0.55264
MBLADWID	0.64504	0.63142	0.32199	0.12697	0.46266	0.45289
NOCHWID	0.07077	-0.01332	0.07038	-0.10937	-0.09540	-0.06532
NOCHDEP	0.41030	0.35973	0.38554	0.05039	0.44998	-0.26929
MAXTHIK	0.47833	0.41248	0.39145	0.01147	0.39820	0.24160
PCTUNFLK	-0.14532	-0.12186	-0.16796	-0.10446	-0.18277	0.08076
GRIND	0.06657	0.05388	0.12062	-0.02207	0.14569	0.07876
WTESTWT	0.83732	0.78835	0.48061	0.09677	0.54864	0.40806
LATANGLE	-0.12386	-0.15270	0.06446	-0.05000	0.07125	0.09837
BASANGLE	-0.21727	-0.22334	-0.11971	-0.07713	-0.00536	0.10029
BLADANGL	-0.40455	-0.40368	-0.09894	-0.05114	-0.03346	0.07885
BASEBODY	0.13861	0.17463	-0.18032	-0.03678	-0.54551	-0.08426

	BASEWID	MBLADWID	NOCHWID	NOCHDEP	MAXTHIK	PCTUNFLK
BASEWID	1.00000					
MBLADWID	0.78190	1.00000				
NOCHWID	0.03420	0.02938	1.00000			
NOCHDEP	0.52887	0.39990	0.05871	1.00000		
MAXTHIK	0.45949	0.43608	0.19079	0.29708	1.00000	
PCTUNFLK	-0.07834	-0.06203	0.12160	-0.22283	-0.41512	1.00000
GRIND	0.10414	0.08931	-0.10465	0.07024	0.03527	-0.14393
WTESTWT	0.70537	0.73104	0.09095	0.41973	0.71479	-0.22638
LATANGLE	-0.02063	-0.15689	0.15384	-0.10104	0.35801	-0.07771
BASANGLE	-0.00630	-0.03601	0.16117	-0.13259	0.05138	0.08694
BLADANGL	0.04915	0.03780	0.06604	-0.05106	-0.08986	0.10248
BASEBODY	0.20089	0.27581	0.19844	0.00928	0.02071	0.16458

	GRIND	WTESTWT	LATANGLE	BASANGLE	BLADANGL	BASEBODY
GRIND	1.00000					
WTESTWT	0.08428	1.00000				
LATANGLE	-0.03130	0.08677	1.00000			
BASANGLE	-0.08181	-0.10839	0.17955	1.00000		
BLADANGL	-0.04646	-0.16820	0.13486	0.15570	1.00000	
BASEBODY	-0.08058	0.08666	-0.12029	-0.01412	0.10034	1.00000

Wilks' Lambda (U-Statistic) and Univariate F-Ratio with 3 and 250 Degrees of Freedom

VARIABLE	WILKS' LAMBDA	F	SIGNIFICANCE
TOTLNG	0.95310	4.101	0.0073
BLADLNG	0.96681	2.861	0.0375
DISHAFLN	0.81495	18.92	0.0000
BASINCUR	0.93580	5.717	0.0008
PROXWID	0.87677	11.71	0.0000
DISTWID	0.91683	7.560	0.0001
BASEWID	0.97141	2.453	0.0638
MBLADWID	0.98710	1.089	0.3541
NOCHWID	0.95866	3.593	0.0143
NOCHDEP	0.81384	19.06	0.0000
MAXTHIK	0.88912	10.39	0.0000
PCTUNFLK	0.95456	3.967	0.0087
GRIND	0.94737	4.629	0.0036

Table 18.5. Continued.

Wilks' Lambda (U-Statistic) and Univariate F-Ratio with 3 and 250 Degrees of Freedom, continued

VARIABLE	WILKS' LAMBDA	F	SIGNIFICANCE
WTESTWT	0.95563	3.869	0.0099
LATANGLE	0.94942	4.440	0.0046
BASANGLE	0.99181	.6878	0.5602
BLADANGL	0.89301	9.985	0.0000
BASEBODY	0.90065	9.193	0.0000

Direct Method: All variables passing the tolerance test are entered.

Minimum tolerance level 0.00100

Canonical Discriminant Functions
Maximum number of functions 3
Minimum cumulative percent of variance 100.00
Maximum significance of Wilks' Lambda 1.0000

Prior probability for each group is 0.25000

Classification function coefficients (Fisher's linear discriminant functions)

Period =	1 Pre-1200	2 1200-1400	3 1400-1600	4 Post-1600
TOTLNG	9.442835	11.80068	11.89228	12.47556
BLADLNG	-1.093579	-3.249038	-3.396783	-3.547372
DISHAFLN	2.069595	1.921723	1.547911	1.505890
BASINCUR	.4753916	.2351005D-01	.6964873	.9221295
PROXWID	131.2420	130.9406	129.5619	131.2906
DISTWID	3.239881	2.453763	3.647271	3.810990
BASEWID	-116.1810	-116.0325	-115.7182	-117.0961
MBLADWID	4.788957	4.735385	4.283102	3.582275
NOCHWID	-3.009752	-5.499204	-5.560057	-6.278279
NOCHDEP	-5.395650	-4.467795	-1.282897	-1.658592
MAXTHIK	-2.595542	-.1505780	.4892377	2.169234
PCTUNFLK	-.1631508	-.1260474	-.1303829	-.1275441
GRIND	1.638793	.7445887D-01	1.433474	-.1354064
WTESTWT	-112.6717	-116.5569	-115.5125	-118.7057
LATANGLE	1.916890	2.047349	1.922465	1.890142
BASANGLE	.6892943	.7153476	.7389570	.7418388
BLADANGL	.6673137	.7057990	.7674814	.8365249
BASEBODY	1530.188	1531.953	1519.501	1533.408
(CONSTANT)	-1018.327	-1034.991	-1022.062	-1049.394

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chisquare	Df	Sig
					:	0	0.2689	317.848	54	0.0000
1*	1.1264	63.46	63.46	0.7278	:	1	0.5718	135.278	34	0.0000
2*	0.3942	22.21	85.67	0.5318	:	2	0.7972	54.851	16	0.0000
3*	0.2544	14.33	100.00	0.4503	:					

* Marks the 3 Canonical Discriminant Functions remaining in the analysis.

Table 18.5. Continued.

Standardized Canonical Discriminant Function Coefficients

	Func 1	Func 2	Func 3
TOTLNG	3.39729	-1.74368	1.09901
BLADLNG	-2.48469	2.26170	-0.16020
DISHAFLN	-0.16591	-0.01967	0.17749
BASINCUR	0.14786	0.22235	-0.21523
PROXWID	0.02773	1.43473	2.70224
DISTWID	0.41997	0.62145	-0.89022
BASEWID	-0.51337	-1.11941	-1.17278
MBLADWID	-0.52483	-0.49176	-0.02120
NOCHWID	-0.58791	0.26104	-0.22860
NOCHDEP	0.75882	-0.05004	-1.20816
MAXTHIK	0.75170	0.10532	0.20359
PCTUNFLK	0.28698	-0.36651	0.17350
GRIND	-0.11519	-0.04578	-0.42551
WTESTWT	-0.68885	-0.13774	-0.86340
LATANGLE	-0.16920	-0.44654	0.40956
BASANGLE	0.14113	-0.03141	-0.10757
BLADANGL	0.65564	0.36519	-0.08810
BASEBODY	0.06776	0.56713	1.47791

Structure Matrix:
pooled within-groups correlations between discriminating variables and canonical discriminant functions
(variables ordered by size of correlation within function)

	Func 1	Func 2	Func 3
DISHAFLN	0.44576*	-0.07432	0.06513
NOCHDEP	0.41355*	-0.15553	-0.32312
MAXTHIK	0.32319*	0.09611	0.11594
NOCHWID	-0.17955*	-0.12064	-0.06491
DISTWID	-0.06498	0.46633*	0.02976
PROXWID	0.24133	0.43422*	0.04938
BASEBODY	-0.18226	-0.40402*	-0.18329
PCTUNFLK	-0.06623	-0.30280*	0.16001
BASINCUR	0.16828	0.27983*	-0.15149
BLADLNG	0.05541	0.26030*	0.12789
WTESTWT	0.16561	0.19847*	0.00414
TOTLNG	0.16213	0.19484*	0.13497
GRIND	-0.10959	0.01809	-0.40579*
LATANGLE	0.03671	-0.24844	0.32834*
BLADANGL	0.29174	0.06541	-0.29580*
MBLADWID	0.01190	0.09641	-0.19068*
BASEWID	0.11554	0.13901	-0.16328*
BASANGLE	0.05354	-0.08349	-0.09461*

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	Func 1	Func 2	Func 3
1	-2.78416	1.25763	-0.08249
2	-0.74224	-0.80564	0.76743
3	0.05897	-0.31650	-0.52780
4	1.07876	0.55643	0.28632

Table 18.5. Concluded.

Classification Results -

Actual Group		No. of Cases	Predicted Group Membership 1	2	3	4
Group	1	21	20	0	1	0
Pre-1200			95.2%	0.0%	4.8%	0.0%
Group	2	46	2	29	12	3
1200-1400			4.3%	63.0%	26.1%	6.5%
Group	3	107	4	19	66	18
1400-1600			3.7%	17.8%	61.7%	16.8%
Group	4	80	3	1	20	56
Post-1600			3.8%	1.3%	25.0%	70.0%
Ungrouped cases		21	1	1	8	11
			4.8%	4.8%	38.1%	52.4%

Percent of "grouped" cases correctly classified: 67.32%

Table 18.6. Output from the discriminant function analysis of 384 projectile points divided into four temporal groups, based on 13 variables recorded for whole and broken artifacts. See Figure 18.1 for explanation of abbreviated terms.

-------- DISCRIMINANT ANALYSIS --------

On Groups Defined by Period

415	(Unweighted) cases were processed.
31	of these were excluded from the analysis.
31	had missing or out-of-range group codes.
384	(Unweighted) cases will be used in the analysis.

Number of cases by group

Period	Number of Cases Unweighted	Weighted	Label
1	27	27.0	PRE-1200
2	69	69.0	1200-1400
3	162	162.0	1400-1600
4	126	126.0	POST-1600
Total	384	384.0	

Group Means

Period	DISHAFLN	BASINCUR	PROXWID	DISTWID
1	4.55185	0.18148	12.89259	9.51111
2	5.54638	0.04493	12.03043	7.74783
3	5.80617	0.36914	12.68148	8.03148
4	6.19444	0.49841	13.78016	8.48730
Total	5.79870	0.34010	12.93984	8.23411

Period	BASEWID	NOCHWID	NOCHDEP	MAXTHIK
1	13.12222	3.83333	1.68519	2.75185
2	12.73913	3.54928	2.35652	3.09420

Table 18.6. Continued.

Group means, continued

Period	BASEWID	NOCHWID	NOCHDEP	MAXTHIK
3	13.30617	3.41667	2.71358	3.22469
4	13.37222	3.18492	2.67143	3.44127
Total	13.21302	3.39375	2.56328	3.23906

Period	PCTUNFLK	GRIND	LATANGLE	BASANGLE
1	29.07407	0.29630	38.18519	39.81481
2	47.17391	0.04348	43.46377	43.23188
3	32.56173	0.18519	41.59877	45.45679
4	26.70635	0.10317	43.50794	44.20635
Total	33.02083	0.14063	42.32031	44.25000

Period	BASEBODY
1	1.02778
2	1.07413
3	1.06020
4	0.97935
Total	1.03389

Group Standard Deviations

Period	DISHAFLN	BASINCUR	PROXWID	DISTWID
1	0.98970	0.57715	1.84160	1.21792
2	1.04973	0.86984	2.08286	1.35382
3	0.96412	0.68672	2.06738	1.40564
4	1.04731	0.76608	1.99716	1.73459
Total	1.08787	0.75684	2.12335	1.56035

Period	BASEWID	NOCHWID	NOCHDEP	MAXTHIK
1	1.69894	0.90851	0.56616	0.50182
2	1.72961	0.96842	0.67071	0.58533
3	1.87377	0.69847	0.61941	0.57029
4	1.79442	0.67327	0.72981	0.69940
Total	1.81850	0.77981	0.71568	0.63901

Period	PCTUNFLK	GRIND	LATANGLE	BASANGLE
1	44.78661	0.46532	7.78577	10.64836
2	50.56648	0.20543	10.60741	13.36935
3	42.84972	0.38965	6.15076	10.47570
4	33.16723	0.30540	6.55286	7.50927
Total	42.08799	0.34809	7.49231	10.30324

Period	BASEBODY
1	0.14011
2	0.13961
3	0.12667
4	0.12476
Total	0.13485

Table 18.6. Continued.

Wilks' Lambda (U-Statistic) and Univariate F-ratio with 3 and 380 Degrees of Freedom

Variable	Wilks' Lambda	F	Significance
DISHAFLN	0.85415	21.63	0.0000
BASINCUR	0.95448	6.040	0.0005
PROXWID	0.90913	12.66	0.0000
DISTWID	0.91949	11.09	0.0000
BASEWID	0.98396	2.065	0.1044
NOCHWID	0.94648	7.163	0.0001
NOCHDEP	0.85267	21.89	0.0000
MAXTHIK	0.91661	11.52	0.0000
PCTUNFLK	0.97155	3.709	0.0118
GRIND	0.96113	5.123	0.0017
LATANGLE	0.96214	4.984	0.0021
BASANGLE	0.97937	2.668	0.0474
BASEBODY	0.91389	11.93	0.0000

Direct Method: All variables passing the tolerance test are entered.
Minimum tolerance level 0.00100
Canonical discriminant functions
Maximum number of functions 3
Minimum cumulative percent of variance 100.00
Maximum significance of Wilks' Lambda 1.0000

Prior probability for each group is 0.25000

Classification Function coefficients (Fisher's Linear Discriminant Functions)

Period =	1 Pre-1200	2 1200-1400	3 1400-1600	4 Post-1600
DISHAFLN	1.620963	3.301915	3.206335	3.431387
BASINCUR	-2.376051	-2.759427	-2.167277	-2.086217
PROXWID	114.5707	114.7104	113.9496	114.6601
DISTWID	4.885551	4.450190	5.464642	5.407875
BASEWID	-108.1734	-109.0929	-109.2804	-109.8292
NOCHWID	-1.717900	-3.417206	-3.549058	-4.037104
NOCHDEP	9.566111	11.62412	14.22623	13.77965
MAXTHIK	-16.47933	-15.31570	-15.16676	-14.66957
PCTUNFLK	-.7876672D-01	-.5147036D-01	-.5597942D-01	-.5298984D-01
GRIND	1.984171	-.2574828	.7904309	-.2182770
LATANGLE	1.257688	1.366875	1.329046	1.353849
BASANGLE	.4094330	.4642334	.5116021	.5006857
BASEBODY	1417.389	1426.382	1420.619	1424.308
(CONSTANT)	-798.7012	-811.3703	-808.0015	-814.1127

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chisquare	Df	Sig
					:	0	0.4671	285.079	39	0.0000
1*	0.6095	66.50	66.50	0.6154	:	1	0.7518	106.845	24	0.0000
2*	0.1729	18.86	85.37	0.3839	:	2	0.8817	47.134	11	0.0000
3*	0.1341	14.63	100.00	0.3439	:					

* Marks the 3 canonical discriminant functions remaining in the analysis.

Table 18.6. Continued.

Standardized Canonical Discriminant Function Coefficients

	Func 1	Func 2	Func 3
DISHAFLN	0.54694	-0.23992	-0.24481
BASINCUR	0.10345	0.33243	0.23482
PROXWID	-0.11858	0.33383	-1.92568
DISTWID	0.37815	0.84014	1.00520
BASEWID	-0.92547	-0.60835	0.49222
NOCHWID	-0.54189	-0.06539	0.21337
NOCHDEP	1.01933	0.32302	1.23230
MAXTHIK	0.34164	0.13545	-0.16303
PCTUNFLK	0.30994	-0.24502	-0.22099
GRIND	-0.19105	0.06971	0.46757
LATANGLE	0.18850	-0.16994	-0.30994
BASANGLE	0.33279	0.02824	0.36186
BASEBODY	0.19667	-0.24445	-0.80126

Structure Matrix:
Pooled within-groups correlations between discriminating variables and canonical discriminant functions
(Variables ordered by size of correlation within function)

	Func 1	Func 2	Func 3
DISHAFLN	0.51272*	0.22311	-0.11976
NOCHDEP	0.50595*	-0.00579	0.35341
MAXTHIK	0.35448*	0.26936	-0.11750
NOCHWID	-0.26905*	-0.25174	0.10496
PROXWID	0.14848	0.69352*	-0.15865
BASEBODY	-0.10828	-0.64052*	0.34708
DISTWID	-0.20054	0.60119*	-0.06541
BASINCUR	0.16531	0.40125*	0.15451
PCTUNFLK	-0.04488	-0.38644*	-0.12921
BASEWID	0.06918	0.23356*	0.17174
GRIND	-0.13034	0.17667	0.42909*
LATANGLE	0.19253	-0.07525	-0.34298*
BASANGLE	0.15420	-0.06409	0.20906*

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	Func 1	Func 2	Func 3
1	-2.63523	0.53903	0.03656
2	-0.29718	-0.68850	-0.46762
3	0.16368	-0.12577	0.40461
4	0.51699	0.42323	-0.27197

Table 18.6. Concluded.

Classification Results -

Actual group		No. of Cases	Predicted Group Membership 1	2	3	4
Group	1	27	26	1	0	0
Pre-1200			96.3%	3.7%	0.0%	0.0%
Group	2	69	5	39	11	14
1200-1400			7.2%	56.5%	15.9%	20.3%
Group	3	162	8	40	80	34
1400-1600			4.9%	24.7%	49.4%	21.0%
Group	4	126	5	18	31	72
Post-1600			4.0%	14.3%	24.6%	57.1%
Ungrouped cases		31	1	4	15	11
			3.2%	12.9%	48.4%	35.5%

Percent of "grouped" cases correctly classified: 56.51%

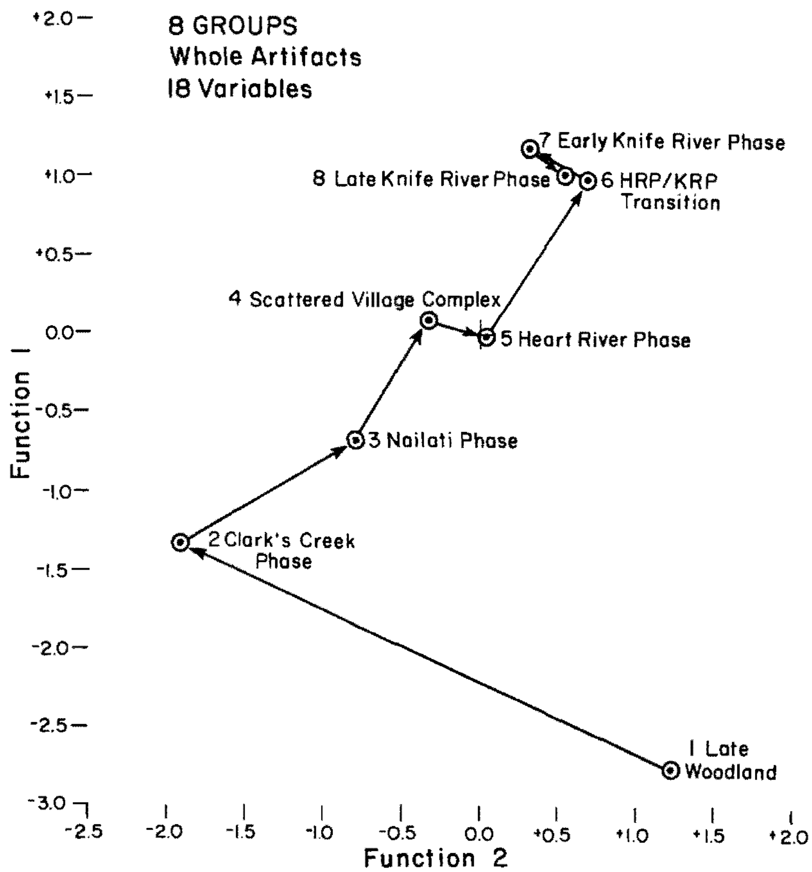


Figure 18.2. Plot of group centroids on discriminant functions 1 and 2 for 16 time period groups of whole artifacts analyzed by 18 discriminating variables.

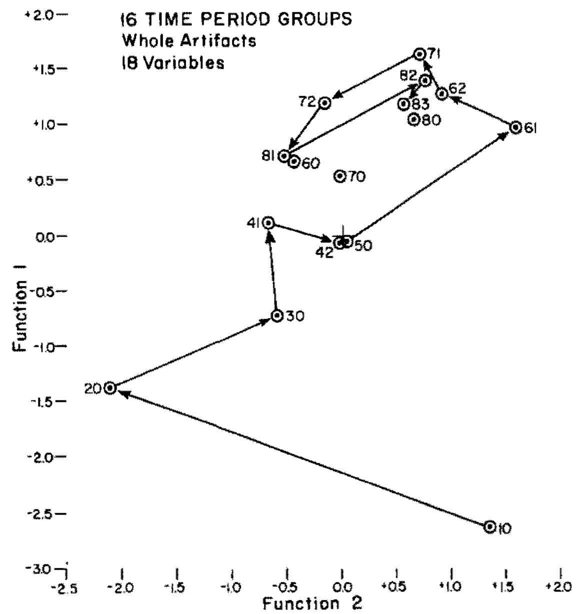


Figure 18.3. Plot of group centroids on discriminant functions 1 and 2 for eight time period groups of whole artifacts analyzed by 18 discriminating variables.

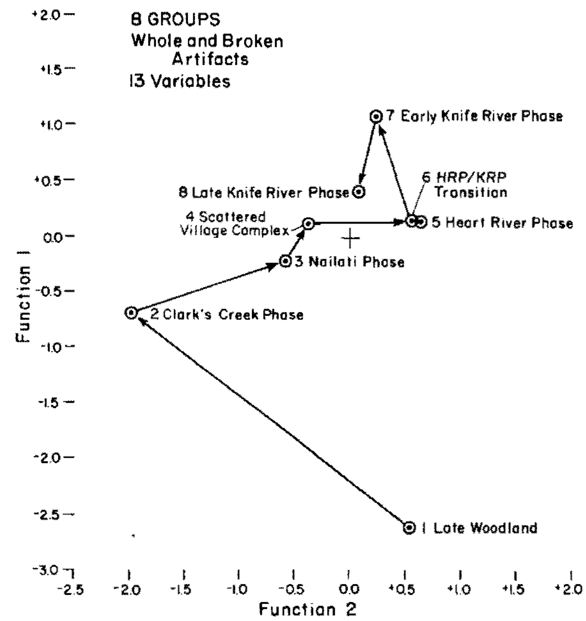


Figure 18.4. Plot of group centroids on discriminant functions 1 and 2 for eight time period groups of whole/broken artifacts analyzed by 13 discriminating variables.

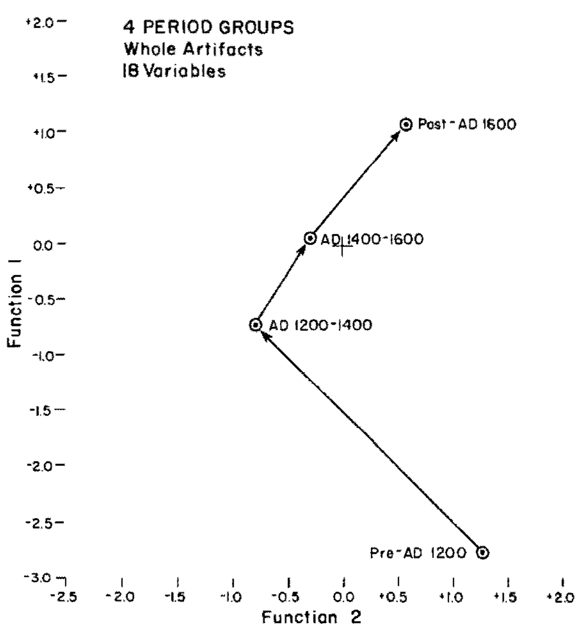


Figure 18.5. Plot of group centroids on discriminant functions 1 and 2 for four time period groups of whole artifacts analyzed by 18 discriminating variables.

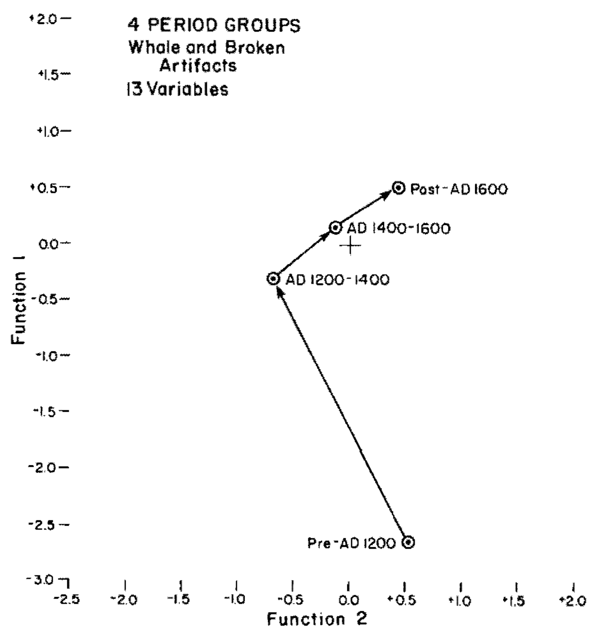


Figure 18.6. Plot of group centroids on discriminant functions 1 and 2 for four time period groups of whole/broken artifacts analyzed by 13 discriminating variables.

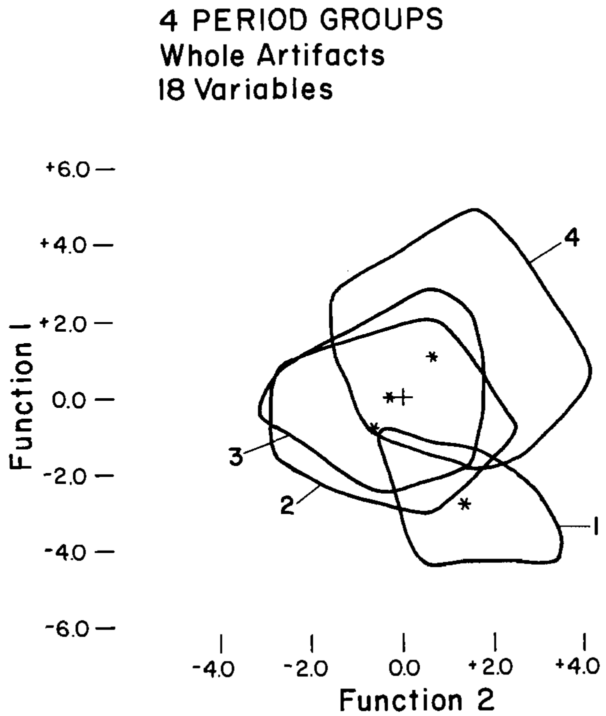


Figure 18.7. Illustration of maximum dispersions of discriminant scores on functions 1 and 2 for the members of the four time period groups of complete artifacts analyzed by 18 discriminating variables.

Subsequent studies of the Lower Hidatsa stone tool collection have indicated that heat treatment occurs primarily in two raw materials, in Knife River flint and in clear/grey chalcedony. In the latter raw material, heat treatment occurs in high frequency in nearly all tools regardless of technological class, and it seems that heat treatment was regularly applied to nearly all clear/grey chalcedony pieces to improve its flaking properties. In contrast, the KRF tools exhibit a distinct restriction of heat treatment to tools with a small thin patterned bifacial technology, with lesser frequencies of heating occurring in larger patterned KRF tools, and with heating being particularly rare in other technological classes in KRF. These data suggest that in the Lower Hidatsa sample heat treatment used with KRF was very selectively applied to small thin patterned, pressure flaked tools in technological class 1. This further suggests that if we wish to explore spatial or chronological patterns of the selective use or non-use of heat treatment, that the study can most productively be restricted to KRF tools in technological class 1.

Heat treatment in KRF projectile points was also studied in the analysis of lithic artifacts from the excavations at Big Hidatsa Village. In general, the incidence of heat treatment there was somewhat lower than that observed for comparable time periods at Lower Hidatsa Village, and the marked increase in the frequency of heat treatment in the period from roughly AD 1600 through AD 1780 or so observed at Lower Hidatsa is not particularly apparent at Big Hidatsa (Ahler and Swenson 1985:184, 187-188). These limited observations have prompted the more systematic examination of heat treatment in the present study.

The procedure here has been to restrict the examination to heat treatment in KRF stone tools in technological class 1, small thin patterned bifaces (almost all arrowpoints). Observations were also recorded on heat treatment for all the technological class 1 chalcedony artifacts in the Lehmer-Wood samples as well as the KNRI collections, but such information is not discussed here for the reasons mentioned above. Our emphasis here is primarily on chronological variation in heat treatment, so evident in the Lower Hidatsa sample. Some attention is also paid to between-site variation in heat treatment.

Raw data on the frequency of heat treatment in technological class 1 KRF stone tools are presented by analytic batch in Table 18.7. Chi-square analysis of the frequency distribution of heat treatment classes by time period (excluding the generalized period 60, 70, and 80 samples) shows the distribution to be statistically significant, indicating significant variation in heat treatment occurrence through time ($X^2 = 57.07$, df = 22, p = < 0.05). Figure 18.8a provides a graphic representation of the percentage of certain heat treatment and certain or possible heat treatment in the KRF tools through time. A very interesting temporal pattern occurs. Heat treatment, particularly certain plus possible treatment, exhibits a very low incidence in the Clark's Creek phase and then begins to increase quite rapidly immediately thereafter. A peak in certain/possible treatment is reached in the Heart River phase, then the incidence plateaus slightly for a time, then a higher peak occurs in period 71, the early part of the Early Knife River phase (AD 1700-1740/1745). Thereafter the incidence of heat treatment drops precipitously in the latter part of the eighteenth century, only to rebound slightly in the very latest time period dating post-AD 1820/1830. The percentage distribution for certain heating alone exhibits a somewhat similar pattern, except that a gradual rise rather than a plateau is apparent in the period from circa AD 1525 through 1740/1745.

The fact that certain/possible heat treatment in KRF increases rapidly up to and through the Heart River phase suggests that the use of heat treatment in tool manufacture is linked in some way with the general cultural influence of the Mandan populations centered at Heart River. A similar phenomenon is evident in many ceramic variables (cf. Chapter 17) which exhibit monotonic trends culminating in peak values during the Heart River phase. We take this to indicate that the increased occurrence of heat treatment can in some way be attributed to the growing influence of the Mandan cultural tradition during this period. The second peak in heat treatment that occurs in the early 1700s has a less straightforward explanation. We can hypothesize that the drop in incidence of heat treatment in the late 1700s is due to the increasing emphasis on metal trade artifacts in the native technological systems, with a related, rapidly diminishing interest in complex flintknapping procedures such as heat treatment applied to KRF.

As noted previously, there is clear indication that, regardless of the regularity of the temporal patterns just discussed, heat treatment was not practiced uniformly at all sites assigned to a given time period. An example of this can be seen by comparing data from Big Hidatsa Village to data from nearby Lower Hidatsa Village for periods 61, 62, 71, and 72, from circa AD 1600-1780/1790 when the sites were occupied contemporaneously by the respective subgroups of the Hidatsa tribe. Chi-square analysis applied to the frequency data for these sites and periods listed in Table 18.7 indicates that no difference in frequency of KRF heat treatment occurs in the period 61 samples, but that very strong and statistically significant differences occur in the period 62, 71, and 72 samples ($p = <.05$, $<.001$, and $<.001$, for the period samples, respectively). In each of the latter three cases, heat treatment is far more common in the Lower Hidatsa artifact samples.

This situation can be explored more systematically by using data in Table 18.7 to isolate batch units with exceptionally high occurrences of heat treatment. Table 18.8 provides a list of such batches; all the listed batches have combined percentage values for certain and possible heat treatment equal to or greater than 50.0 percent. This value was chosen because only a single time period unit, period 71 (AD 1700-1740/1745), exhibits a value this high or higher based on combined batch sample information (cf. Figure 18.8). The listed batches thus exhibit exceptional frequencies of heat treatment. The percentage values for the batches listed in the table range from 50.0 percent to a high of 78.6 percent. The latter figure derives from technological class 1 items in test unit 1 at the Mahhaha site. The ceramics from this test were not included in the pottery analysis, and this sample has not actually been assigned to a chronological period. A cursory examination of the pottery indicates that Knife River ware is the dominant form there, and the discriminant classification of five side-notched arrowpoints from this test according to the eight-group temporal analysis indicates that a period 70 association is likely for this test unit.

Of particular note here is the fact that the listed batches derive from a relatively small number of sites. Only seven sites account for the 14 batch samples. Of interest also is the fact that multiple batch samples are involved from several of the sites, most notably from Mandan Lake, Mahhaha, and Lower Hidatsa Village. This latter fact suggests that the relatively high frequency of heat treatment in those sites is not simply due to sampling error, because multiple batch samples from the same sites indicate the same pattern.

Of particular significance here is the meaning of these data on heat treatment. Because the data indicate that heat treatment was selectively practiced by only a small subset of the cultural groups in the region, we can suggest that its occurrence in high frequency minimally implies some type of cultural or social group connection or interaction among the sites with high occurrence. The linkage between heat treatment and the Mandan cultural tradition, centered at Heart River, touched on above, is further suggested by the high occurrence of heat treatment at Slant Village and at Lower Sanger Village, both of which are Mandan sites according to Mandan informants and traditions (Bowers 1948:39, 100; Strong 1940). We can venture further and suggest that the high frequency of heat treatment at Lower Hidatsa is due in large part to the high degree of interaction among the Awatixa Hidatsas at this village and the Mandans at Heart River. This degree of interaction is in conformance with oral traditions for the Awatixa subgroup. If this is so, then why does heat treatment become progressively more common in the later part of the Lower Hidatsa site sequence, rather than early in the sequence? Pottery data were used to suggest that the Mandan connection for Lower Hidatsa was strongest during the Heart River phase, and gradually faded thereafter as influence from the nearby Hidatsas-proper increased in the AD 1600s and 1700s. Perhaps more direct Mandan connection at Lower Hidatsa is suggested, with

Table 18.7. Data on the frequency of heat treatment in Knife River flint tools in technological class 1, according to analytic batch and time period.

Period	Batch	Absent	Possible	Certain	Total
20	34	8	-	-	8
	81	7	1	2	10
	97	9	-	-	9
	Total	24	1	2	27
30	11	9	-	3	12
	13	6	2	1	9
	14	7	-	-	7
	33	11	2	4	17
	43	11	2	-	13
	72	2	-	-	2
	96	23	1	4	28
	Total	69	7	12	88
41	5	18	13	9	40
	8	3	-	1	4
	9	12	4	5	21
	10	4	2	1	7
	26	8	4	2	14
	27	7	2	6	15
	32	9	9	8	26
	36	7	1	-	8
	70	4	-	-	4
	73	20	3	2	25
	75	6	-	1	7
	77	10	2	2	14
	78	23	-	5	28
	79	3	-	-	3
	80	26	-	7	33
	Total	160	40	49	249
42	18	12	7	3	22
	23	3	1	-	4
	24	15	9	4	28
	25	13	4	11	28
	31	7	4	3	14
	Total	50	25	21	96
50	6	1	1	1	3
	7	7	5	3	15
	20	5	1	2	8
	21	12	4	3	19
	48	13	2	8	23
	49	12	3	2	17
	55	-	2	2	4
	57	2	-	2	4
	Total	52	18	23	93
60	30	6	3	9	18
	54	3	3	3	9
	56	-	-	2	2
	Total	9	6	14	29

Table 18.7. Concluded.

Period	Batch	Absent	Possible	Certain	Total
61	47	18	5	13	36
	69	8	1	2	11
	Total	26	6	15	47
62	46	46	26	26	98
	68	32	6	7	45
	Total	78	32	33	143
70	4	2	-	2	4
	29	6	1	4	11
	53	1	-	-	1
	Total	9	1	6	16
71	0/2	3	2	4	9
	45	10	6	20	36
	67	34	10	10	54
	Total	47	18	34	99
72	1/3	11	2	3	16
	44	9	7	7	23
	66	56	2	11	69
	Total	76	11	21	108
80	62	9	1	5	15
	63	7	2	-	9
	Total	16	3	5	24
81	19	3	1	-	4
	61	4	1	-	5
	Total	7	2	0	9
82	60	12	1	1	14
	65	11	2	2	15
	Total	23	3	3	29
83	59	8	3	4	15
	64	8	-	-	8
	Total	16	3	4	23
Unassigned	50	15	10	11	36
	71	10	2	3	15
	74	8	1	2	11
	76	4	-	-	4
	84	2	-	-	2
	98	3	-	-	3
	Mahhaha test 1	3	4	7	14
	Mahhaha test 5	5	3	4	12

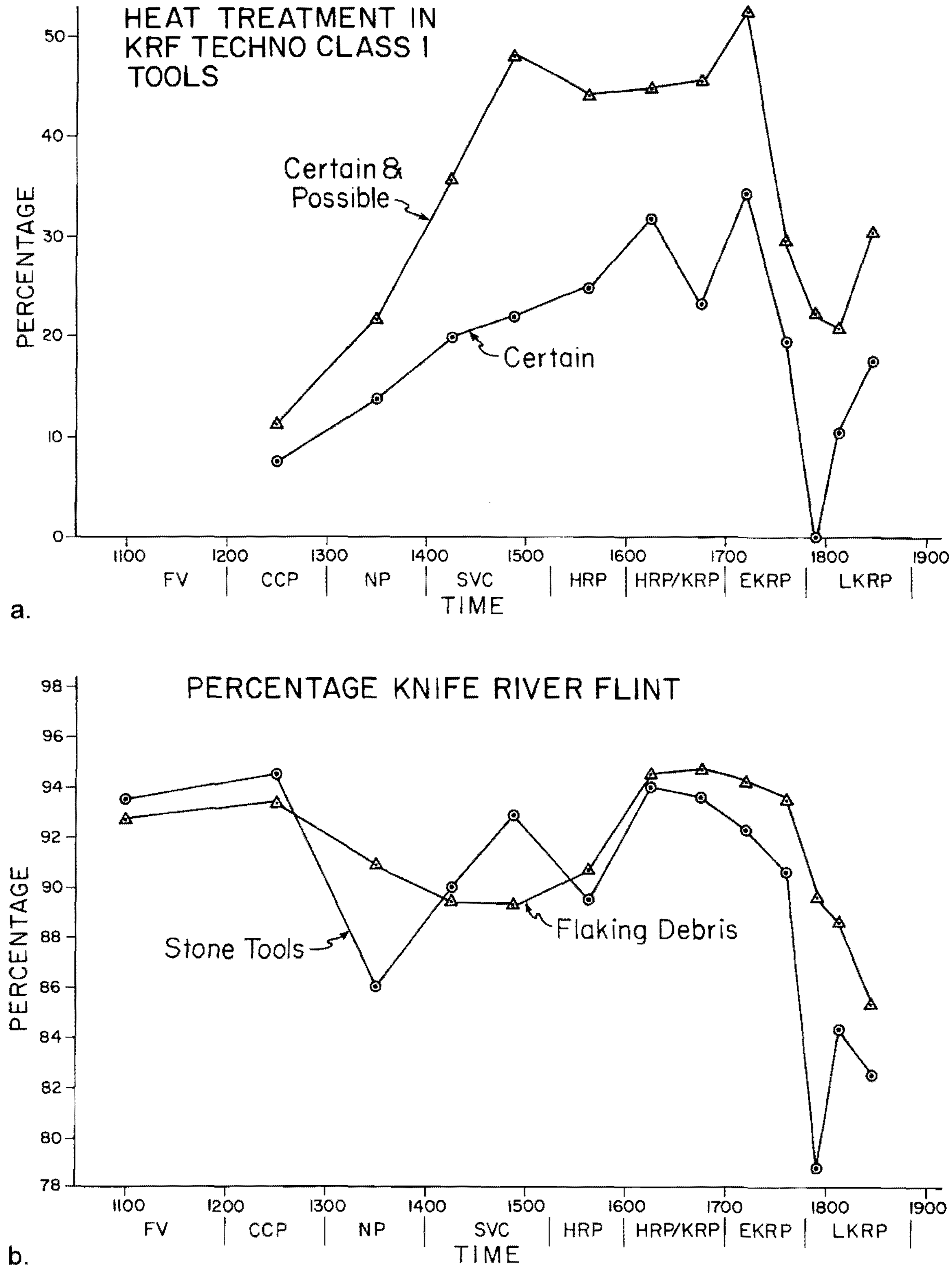


Figure 18.8. Distributions by time period for Hidatsa tradition lithic artifact data. a: percentage of certain and certain+possible heat treatment in KRF stone tools in technological class 1; b: percentage of KRF raw material versus all other lithic raw materi-als in stone tools and flaking debris.

Table 18.8. Data on analytic batches with combined percentages of certain and possible heat treatment of KRF equal to or greater than 50.0%, arranged chronologically, and ranked by heat treatment percentage.

Batch	Identification	Period	n	Percentage Certain+Possible	Rank
27	Mandan Lake P3	41	15	53.3	9
32	Mahhaha 4	41	26	65.4	4
5	Pretty Point	41	38	57.9	7
25	Mandan Lake T4, P1	42	28	53.6	8
31	Mahhaha 3	42	14	50.0	11
6	Smith Farm	50	3	66.7	3
7	Lower Sanger	50	15	53.3	9
30	Mahhaha 2	60	18	66.7	3
47	Lower Hidatsa 4	61	36	50.0	11
46	Lower Hidatsa 3	62	98	53.1	10
45	Lower Hidatsa 2	71	36	72.2	2
0/2	Slant Early	71	9	66.7	3
44	Lower Hidatsa 1	72	23	60.9	5
	Mahhaha Test Unit 1	-	14	78.6	1
	Mahhaha Test Unit 5	-	12	58.3	6

Mandan flintknappers actually moving onto the site in the late time periods.

The ethnic and subgroup associations for Mahhaha Village remain an enigma. The site deposits there are poorly dated and mixed to a large degree. Wood (Chapter 12, this volume) has posited that the late component(s) there represents occupation by the Awaxawi subgroup of the Hidatsas. Unfortunately, heat treatment data from the Molander Village, more firmly established as an Awaxawi subgroup site, are too limited to provide a test of this proposition. Based on the heat treatment similarities among sites listed in Table 18.8, we can offer an alternate interpretation of the late components at Mahhaha (primarily batches 29 and 30): that they represent occupation of refugee Mandan groups who had left the Heart River area in the late 1600s or 1700s. Historical records (e.g., Coues 1965, 1:196-199) indicate that the Mandan refugees lived at several locations on their way to more permanent settlements near the Hidatsas at Knife River, and it is possible that Mahhaha village reflects one of those temporary settlements. We can venture even further and suggest that the increased frequency of heat treatment in the later periods at Lower Hidatsa represents a similar process, the infusion or incorporation of Mandan refugee groups into the resident Awatixa population at the site. To test such ideas we sorely need better controlled, well-dated samples of pertinent components from sites such as Mandan Lake, Mahhaha, and in particular, from multiple villages at the Heart River. Heat treatment can readily be examined in existing collections at the SHSND from several of the Heart River phase sites, but the chronological control required for this study is presently lacking in these samples.

RAW MATERIAL VARIATION

The primary intent in this section is to examine variation in relative frequencies of lithic raw material types in both stone tools and flaking debris, to focus specifically on lithic materials with known source locations outside of the immediate study locality, and from this, to draw inferences about changing geographic and cultural connections through time in the study area. The ceramic analysis led to a complex model of very dynamic cultural interaction and influences in the study area, and the lithic resource data will be used to the extent possible to augment and verify this model.

The study of lithic raw material variation for purposes of interpreting cultural interactions has a long history in the Middle Missouri subarea. Lehmer (1954:103, 127, 131) was one of the first to note strong differences in the frequency of KRF and other raw materials among village sites in different cultural traditions in South Dakota, and he hypothesized that the frequency of KRF reflected the strength of trade activities in the direction of the KRF source area in North Dakota. Ahler (1977a) conducted a more systematic comparison of the lithic raw material composition of various sites near the mouth of the Grand River in South Dakota; he concluded that populations in the respective Middle Missouri and Coalescent traditions each used basically different suites of nonlocal lithic materials for tool manufacture. Most recently, C. Johnson (1984) has followed up on Ahler's 1977 study by conducting a more comprehensive comparison of lithic raw materials in a large number of Plains Village sites along a large stretch of the Missouri River in South Dakota. Johnson documents strong differences in lithic resource exploitation patterns according to geographic area, chronology, and cultural tradition. A recurring theme in these studies is that the earliest village cultures in the Middle Missouri subarea, including those components assigned in particular to the Initial and Extended variants of the Middle Missouri tradition, relied heavily on KRF, regardless of their location in the Missouri valley. In contrast, the Village components that fall later in time, most of which are assigned to the Coalescent tradition in Lehmer's (1971) scheme, indicate markedly lessened use of KRF and much heavier reliance on lithic source areas lying south of the KRF quarry area in North Dakota (Clayton et al. 1970).

Another significant study which makes use of detailed information on lithic source utilization is the work by Reher and Frison (1980:121-135) at the Vore site in eastern Wyoming. Focusing on KRF, Powder River porcellanite, and Spanish Diggings quartzite, they use lithic source variation to model shifts in the territories of population units using the Vore kill site.

All of the above referenced studies rely heavily on the study of raw material types which can be linked with reasonable certainty to known source locations. Knowledge of the local lithic resource base and of the general direction and distance to other nonlocal lithic source areas is fundamental to interpretation of lithic raw material variation in a site assemblage (Ahler 1977a:133). One other study relevant to this latter point should be mentioned. Schneider (1972) studied the frequency of lithic raw materials in waste flakes from several of the sites tested in the 1968 Wood-Lehmer testing program (Wood 1986). He concluded that the frequency of use of KRF decreased through time relative to other raw materials. He offers little interpretation for this change. Interpretation of Schneider's data set was indeed hampered by the lack at that time of understanding of chronology and knowledge of the source locations for any of the materials other than KRF. Regardless, Schneider's study does offer a first attempt to deal with lithic raw material variation in the study area, and it indicates that more systematic examination of the problem should prove fruitful from an interpretative perspective.

Since almost the inception of the KNRI program, study has been underway concerning the lithic source areas relevant to interpretation of Knife-Heart region village sites. A large comparative lithic source collection has continued to build at UND and a raw material type list pertinent to the regional lithic assemblages has been developed. A list of approximately 40 descriptive lithic types now exists, and most of these which are pertinent to chipped stone tool manufacture can be identified or linked to specific source locations. KRF, available in major quarries only a short distance west of the mouth of the Knife River (Clayton et al. 1970) and also available in local river terrace gravel deposits, is of course of major importance in all regional lithic samples. Data on other significant raw materials in the study area (e.g., Leonoff 1970; Fredlund 1976; Loendorf et al. 1984; Nowack and Hannus 1985; Ketcherside 1983; Clark 1985) have been incorporated into the discussions of lithic raw material types. The most current descriptions and discussions of regionally relevant lithic raw material types are found in Lovick (1980b:232-241) and in Ahler and Swenson (1985:342-347). The latter, involving 39 lithic types, is used as the basis for the present analysis.

Raw data on the frequency of various lithic raw material types are listed according to analytic batch and time period in Table 18.9. These data derive only from collections classified as being in bias class A or B in Table 18.1. The primary data in Table 18.9 also are restricted to chipped stone tools, those in technological classes 1 through 8. There are two reasons for this restriction. One is because most ground stone tools are made from locally available stones which are of less interest to us here. The second is so that data on lithic types in stone tools are maximally comparable to lithic raw material data generated from chipped stone flaking debris. Three definite or potentially nonlocal raw materials are identified in ground stone tools, these being a coarse, porous sandstone which is thought to derive from butte-top settings in South Dakota or in an equally distant location, Catlinite which is thought to derive from the main source area for this material in southwestern Minnesota (Sigstad 1973), and steatite or soapstone which probably derives from high-altitude source areas in the Big Horn or Rocky Mountains (cf. Frison 1982). These materials, which occur in relatively low numbers in the study samples, are also tabulated by batch for ground stone tools at the bottom of each page in Table 18.9.

Comparable raw data on the frequencies of various raw material types in chipped stone flaking debris are listed by batch and time period in Table 18.10.

A cursory examination of any regional lithic collection and these data tables indicates that KRF is the dominant raw material used for chipped stone artifacts. This material was not only available in some abundance in return for modest amounts of digging effort in the KRF quarry area some 80 km west of the study area (Clayton et al. 1970), but it was also available in relative abundance but in smaller form in older terrace gravels along the Missouri River directly within the study area. Even so, the relative dependence on KRF was not constant through time. The previous studies cited above by Ahler (1977a) and Johnson (1984) make it clear that the demand for KRF varied significantly throughout time within the Middle Missouri subarea, and it is reasonable to expect that the local village populations in the upper Knife-Heart region would also probably have varied their use of KRF to some degree through time based on changing demands for the material as a trade item and in response to the availability of other materials through trade or shifts in territorial exploitation.

It is useful to examine changes through time in the frequency of KRF relative to all other stone types in chipped lithic materials. Such information, derived from data in Tables 18.9 and 18.10, is displayed in Figure 18.8b. As anticipated, the percentages for KRF are not constant through time, but range from less than 83 percent to more than 95 percent in various time period samples. Except for a few potentially erratic oscillations in the frequency of KRF in stone tools, the patterns for both tools and flaking debris change in a fairly regular way; the parallel nature of the changes in data for stone tools and for flaking debris strongly indicates that the observed variation is not due to sampling or other random variation.

Two peaks in the frequency of occurrence of KRF can be observed. One is in the thirteenth century AD, for the assemblages assigned to the Clark's Creek phase. Immediately thereafter, with the onset of the Nailati phase, the incidence of KRF diminishes sharply. This lower level of use of KRF continues steadily in flaking debris through the subsequent Scattered Village complex and Heart River phases. Use of KRF in stone tools varies more erratically in this period, with a minor peak seeming to occur in the Late Scattered Village complex. Just as abruptly as the use of KRF declined in the AD 1300s, its use rises abruptly again at the onset of the AD 1600s. Peak use of KRF continued through the AD 1600s, then a decline developed in the AD 1700s and accelerated rapidly in the later part of that century and in the AD 1800s. Minimal values for the relative occurrence of KRF occur for both stone tools and for flaking debris in the period after AD 1780, and apparently in the final period in the region, after AD 1820/1830.

The extremely low percentage for KRF in stone tools in the period 81 sample is probably a result of the extremely small sample size. Alternatively, it may be a meaningful figure, because both the Sakakawea period 3 sample and the Greenshield sample assigned to this period are tentatively assigned at least in part to Mandan or Arikara refugee groups who recently migrated into the region. Perhaps the low percentage for KRF in period 81 reflects the movement of these people from regions where natural KRF was not so readily abundant.

It is tempting to interpret the two periods of peak occurrence of KRF, in the AD 1200s and again in the period from AD 1600 to circa AD 1750, as episodes of maximum exploitation of the nearby KRF quarries in western Mercer and Dunn counties. Lacking other evidence linking the villagers with the KRF quarry area, however, it is just as plausible that these peaks reflect simply increased use of local KRF gravel deposits rather than increased quarry exploitation.

Additional data useful for more specific interpretations of lithic utilization patterns, quarry use, and linkages with other territories can be found in the lithic materials other than KRF. Such materials have been grouped into three classes based on the probable direction of origin of these materials relative to the upper Knife-Heart region study area. The first group includes materials which could most readily be obtained by cultural contacts or actual travel movements into downriver locations. The key raw materials reaching the study area from a downriver direction or reflecting downriver contacts include, foremost, smooth grey Tongue River silicified sediment (TRSS), and of lesser importance, solid quartzite, Flattop chalcedony, plate chalcedony, and Bijou Hills silicified sediment. The geologic sources for these materials are discussed in Ahler (1977a:134-138). The smooth grey TRSS probably

Table 18.9. Frequencies of lithic raw material types in stone tool collections for the upper Knife-Heart region, limited to bias class A and B samples.

Period		10	20		30								
Batch		99	34	81	97	tot	11	13	14	33	40	43	72
Chipped Stone Tools:													
1.	Sm Grey TRSS	1	-	1	3	4	1	-	1	-	10	1	1
2/3.	Coarse TRSS	0	-	-	-	0	2	-	-	-	13	1	1
4.	Solid Quartzite	0	-	-	-	0	-	-	-	-	-	-	-
5.	Porous Quartzite	1	-	1	-	1	1	-	-	1	1	-	-
6.	Jasper/Chert	2	-	-	-	0	-	-	-	-	4	-	1
7.	Flattop Chal	0	-	-	-	0	-	-	-	-	1	-	-
8.	Clear/Gr Chal	1	-	3	1	4	1	3	-	-	7	3	8
9.	Yel/Lt Br Chal	3	-	-	-	0	2	13	-	-	9	-	-
10.	Dk Brown Chal	0	-	-	1	1	-	-	-	-	5	-	-
11.	Plate Chal	1	-	-	-	0	-	-	-	-	1	-	-
12.	Burnt Chal	0	-	-	-	0	1	-	-	-	-	-	-
13.	Basaltic	4	-	-	1	1	-	-	-	-	10	-	-
14.	Other	0	-	-	-	0	-	-	-	-	4	-	-
15.	Bijou Hills	0	-	-	-	0	-	-	-	-	-	-	-
16.	Quartz	0	-	-	-	0	-	-	-	-	-	-	-
17.	Porcellanite	0	-	5	-	5	1	-	-	-	31	-	3
18.	Obsidian	0	-	-	-	0	-	-	-	-	4	-	-
19.	Granitic	2	-	-	-	0	-	-	-	-	1	-	-
20.	Coarse Sandst	0	-	-	-	0	-	-	-	-	-	-	-
21.	Compact Sandst	0	-	-	-	0	-	-	-	-	-	-	-
28.	Knife R Flint	274	18	248	59	325	96	74	83	47	565	89	112
29.	Waxy Br Chert	0	-	3	-	3	-	-	1	-	2	2	-
30.	Grey-Green Ch	0	-	-	-	0	-	-	-	-	-	-	-
35.	Other Qtzite	3	-	-	-	0	-	-	-	-	9	-	-
36.	Scoria	0	-	-	-	0	-	-	-	-	-	-	-
37.	Siltstone	1	-	-	-	0	-	-	-	-	-	-	-
40.	NonVol Glass	0	-	-	-	0	-	-	-	-	-	-	-
Total		293	18	261	65	344	105	90	85	48	677	96	126
Exotic Ground Stone Tools:													
20.	Coarse Sandst	2	-	-	-	0	-	-	-	-	6	2	1
24.	Catlinite	0	-	-	-	0	-	-	-	-	1	-	1
38.	Steatite	0	-	1	-	1	-	-	-	-	1	-	-

Period		30	cont.	41									
Batch		94	tot	5	8	9	10	26	27	32	70	73	75
Chipped Stone Tools:													
1.	Sm Grey TRSS	8	22	16	2	8	2	-	1	1	-	-	-
2/3.	Coarse TRSS	-	17	3	1	-	-	1	-	-	-	-	-
4.	Solid Quartzite	4	4	-	-	-	-	-	-	-	-	-	-
5.	Porous Quartzite	2	5	2	-	-	-	1	-	-	-	-	-
6.	Jasper/Chert	2	7	3	-	1	-	-	-	1	-	-	-
7.	Flattop Chal	-	1	-	-	-	-	-	-	-	-	-	-
8.	Clear/Gr Chal	4	26	30	4	12	3	4	4	3	-	1	6

Table 18.9. Continued.

Period		30	cont.	41									
Batch		94	tot	5	8	9	10	26	27	32	70	73	75
Chipped Stone Tools, continued:													
9.	Yel/Lt Br Chal	4	28	2	-	4	2	-	1	-	-	-	-
10.	Dk Brown Chal	2	7	2	1	1	-	-	1	-	-	-	-
11.	Plate Chal	-	1	-	-	-	-	-	-	-	-	-	-
12.	Burnt Chal	-	1	2	-	1	-	-	1	-	-	-	-
13.	Basaltic	1	11	-	-	-	-	-	-	-	-	-	-
14.	Other	-	4	-	-	-	-	-	-	-	-	-	-
15.	Bijou Hills	-	0	-	-	-	-	-	-	-	-	-	-
16.	Quartz	-	0	-	-	-	-	-	-	-	-	-	-
17.	Porcellanite	7	42	9	-	1	2	2	1	1	-	4	2
18.	Obsidian	-	4	-	-	-	-	-	-	-	-	1	-
19.	Granitic	-	1	-	-	-	-	-	-	-	-	-	-
20.	Coarse Sandst	-	0	-	-	-	-	-	-	-	-	-	-
21.	Compact Sandst	-	0	-	-	-	-	-	-	-	-	-	-
28.	Knife R Flint	141	1207	328	70	282	94	136	176	89	38	173	87
29.	Waxy Br Chert	-	5	-	-	-	-	-	-	-	-	-	-
30.	Grey-Green Ch	-	0	-	-	-	-	-	-	-	-	-	-
35.	Other Qtzite	-	9	1	-	1	-	-	-	-	-	-	-
36.	Scoria	-	0	-	-	-	-	-	-	-	-	-	-
37.	Siltstone	2	2	1	-	-	1	-	-	-	-	-	-
40.	NonVol Glass	-	0	-	-	-	-	-	-	-	-	-	-
Total		177	1404	399	78	311	104	144	185	95	38	179	96
Exotic Ground Stone Tools:													
20.	Coarse Sandst	1	10	2	-	-	1	-	-	-	-	-	-
24.	Catlinite	-	2	-	-	-	-	-	-	-	-	-	-
38.	Steatite	-	1	-	-	-	-	-	-	-	-	-	-

Period		41	cont.				42					50	
Batch		77	78	79	80	tot	18	23	24	25	tot	6	7
Chipped Stone Tools:													
1.	Sm Grey TRSS	2	2	-	2	36	1	1	3	4	9	5	14
2/3.	Coarse TRSS	4	-	-	1	10	-	1	2	-	3	1	1
4.	Solid Quartzite	-	-	-	-	0	-	-	1	1	2	-	1
5.	Porous Quartzite	-	-	-	1	4	-	-	1	-	1	-	-
6.	Jasper/Chert	1	1	-	2	9	-	-	-	1	1	-	1
7.	Flattop Chal	-	-	-	-	0	-	-	-	-	0	-	-
8.	Clear/Gr Chal	17	14	2	40	140	4	5	13	8	30	5	8
9.	Yel/Lt Br Chal	-	-	-	1	10	-	-	3	-	3	-	2
10.	Dk Brown Chal	-	-	1	-	6	-	-	1	-	1	-	-
11.	Plate Chal	-	-	-	-	0	-	-	-	-	0	-	1
12.	Burnt Chal	-	-	-	-	4	-	-	1	1	2	1	-
13.	Basaltic	-	-	-	1	1	-	-	-	-	0	-	-
14.	Other	-	-	-	-	0	-	-	-	-	0	-	1
15.	Bijou Hills	-	-	-	-	0	-	-	-	-	0	-	-
16.	Quartz	-	-	-	-	0	-	-	-	-	0	-	-

Table 18.9. Continued.

Period		41	cont.				42					50	
Batch		77	78	79	80	tot	18	23	24	25	tot	6	7
Chipped Stone Tools, continued:													
17.	Porcellanite	4	1	-	5	32	1	-	5	2	8	1	-
18.	Obsidian	-	-	-	-	1	-	-	-	-	0	-	-
19.	Granitic	-	-	1	1	2	-	-	-	-	0	-	-
20.	Coarse Sandst	-	-	-	-	0	-	-	-	-	0	-	-
21.	Compact Sandst	-	-	-	-	0	-	-	-	-	0	-	-
28.	Knife R Flint	206	208	40	445	2372	154	85	330	253	822	32	181
29.	Waxy Br Chert	-	1	-	-	1	-	-	-	2	2	-	-
30.	Grey-Green Ch	-	-	-	-	0	-	-	-	-	0	-	-
35.	Other Qtzite	-	1	-	-	3	-	-	-	1	1	-	1
36.	Scoria	-	-	-	1	1	-	-	-	-	0	-	-
37.	Siltstone	-	-	1	-	3	-	-	-	-	0	-	-
40.	NonVol Glass	-	-	-	-	0	-	-	-	-	0	-	-
Total		234	228	45	500	2635	160	92	360	273	885	45	211
Exotic Ground Stone Tools:													
20.	Coarse Sandst	3	-	-	5	11	-	2	-	1	3	-	2
24.	Catlinite	-	-	-	-	0	-	-	1	-	1	-	-
38.	Steatite	-	-	-	-	0	-	-	-	-	0	-	-

Period		50	cont.					61			62		
Batch		20	21	39	48	49	tot	47	69	tot	46	68	tot
Chipped Stone Tools:													
1.	Sm Grey TRSS	2	7	17	2	-	47	1	-	1	-	1	1
2/3.	Coarse TRSS	-	-	9	-	-	11	2	-	2	2	-	2
4.	Solid Quartzite	-	-	-	1	-	2	-	-	0	4	-	4
5.	Porous Quartzite	-	-	5	-	-	5	-	1	1	-	1	1
6.	Jasper/Chert	-	-	6	-	1	8	-	1	1	1	3	4
7.	Flattop Chal	-	-	2	-	-	2	-	-	0	-	-	0
8.	Clear/Gr Chal	5	14	16	5	6	59	9	4	13	19	18	37
9.	Yel/Lt Br Chal	1	4	10	1	3	21	4	-	4	1	-	1
10.	Dk Brown Chal	-	1	18	-	1	20	-	-	0	1	3	4
11.	Plate Chal	-	-	2	-	-	3	-	-	0	-	-	0
12.	Burnt Chal	-	-	4	-	-	5	-	-	0	-	-	0
13.	Basaltic	-	-	7	-	-	7	-	-	0	-	-	0
14.	Other	-	-	4	1	-	6	-	-	0	-	-	0
15.	Bijou Hills	-	-	-	-	-	0	-	-	0	-	-	0
16.	Quartz	-	-	-	-	-	0	-	-	0	-	-	0
17.	Porcellanite	2	2	19	3	6	33	6	4	10	11	18	29
18.	Obsidian	-	-	1	-	1	2	3	-	3	5	-	5
19.	Granitic	-	-	1	-	-	1	-	-	0	-	-	0
20.	Coarse Sandst	-	-	-	-	-	0	-	-	0	-	-	0
21.	Compact Sandst	-	-	-	-	-	0	-	-	0	1	-	1
28.	Knife R Flint	119	214	945	289	242	2022	396	217	613	698	607	1305
29.	Waxy Br Chert	-	-	1	-	1	2	-	-	0	-	-	0
30.	Grey-Green Ch	-	-	-	-	-	0	-	-	0	-	-	0

Table 18.9. Continued.

Period		50	cont.					61			62		
Batch		20	21	39	48	49	tot	47	69	tot	46	68	tot
Chipped Stone Tools, continued:													
35.	Other Qtzite	-	-	-	1	-	2	1	-	1	-	-	0
36.	Scoria	-	-	1	-	-	1	-	-	0	-	-	0
37.	Siltstone	-	-	-	-	-	0	-	3	3	-	-	0
40.	NonVol Glass	-	-	-	-	-	0	-	-	0	-	-	0
Total		129	242	1068	303	261	2259	422	230	652	743	651	1394
Exotic Ground Stone Tools:													
20.	Coarse Sandst	-	-	3	1	-	6	-	-	0	-	-	0
24.	Catlinite	-	1	2	-	-	3	-	-	0	-	-	0
38.	Steatite	-	-	-	-	-	0	-	-	0	-	-	0

Period		71			72			80			81		
Batch		45	67	tot	44	66	tot	62	63	tot	19	61	tot
Chipped Stone Tools:													
1.	Sm Grey TRSS	1	1	2	1	-	1	1	-	1	1	-	1
2/3.	Coarse TRSS	1	1	2	4	-	4	-	1	1	-	-	0
4.	Solid Quartzite	1	-	1	3	-	3	-	-	0	-	1	1
5.	Porous Quartzite	-	1	1	-	1	1	-	-	0	-	-	0
6.	Jasper/Chert	2	1	3	1	6	7	1	-	1	-	-	0
7.	Flattop Chal	-	-	0	-	1	1	-	-	0	-	-	0
8.	Clear/Gr Chal	11	11	22	6	23	29	3	2	5	4	1	5
9.	Yel/Lt Br Chal	2	2	4	-	9	9	1	-	1	-	-	0
10.	Dk Brown Chal	1	-	1	-	1	1	-	-	0	1	-	1
11.	Plate Chal	1	-	1	1	-	1	-	-	0	-	-	0
12.	Burnt Chal	-	-	0	-	-	0	-	-	0	-	-	0
13.	Basaltic	-	-	0	-	-	0	3	-	3	-	-	0
14.	Other	-	-	0	-	1	1	-	-	0	-	-	0
15.	Bijou Hills	-	-	0	-	-	0	-	-	0	-	-	0
16.	Quartz	-	-	0	-	-	0	-	-	0	-	-	0
17.	Porcellanite	12	20	32	8	17	25	3	-	3	-	2	2
18.	Obsidian	1	-	1	-	-	0	2		2	-	-	0
19.	Granitic	-	-	0	-	2	2	-	-	0	-	2	2
20.	Coarse Sandst	-	-	0	-	-	0	-	-	0	-	-	0
21.	Compact Sandst	-	-	0	1	-	1	-	-	0	-	-	0
28.	Knife R Flint	422	466	888	254	627	881	50	21	71	40	12	52
29.	Waxy Br Chert	-	-	0	-	-	0	-	-	0	-	-	0
30.	Grey-Green Ch	-	-	0	-	-	0	-	-	0	-	-	0
35.	Other Qtzite	1	-	1	-	3	3	-	-	0	1	-	1
36.	Scoria	-	-	0	-	-	0	-	-	0	-	-	0
37.	Siltstone	3	-	3	1	1	2	-	-	0	-	1	1
40.	NonVol Glass	-	-	0	-	-	0	-	-	0	-	-	0
Total		459	503	962	280	692	972	64	24	88	47	19	66

Table 18.9. Concluded.

Period		71			72			80			81		
Batch		45	67	tot	44	66	tot	62	63	tot	19	61	tot
Exotic Ground Stone Tools:													
20.	Coarse Sandst	-	1	1	-	1	1	-	1	1	-	-	0
24.	Catlinite	-	-	0	-	-	0	-	-	0	1	-	1
38.	Steatite	-	-	0	-	-	0	-	-	0	-	-	0

Period		82			83			unclassified				
Batch		60	65	tot	59	64	tot	50	71	74	76	98
Chipped Stone Tools:												
1.	Sm Grey TRSS	-	-	0	-	-	0	-	-	-	-	-
2/3.	Coarse TRSS	1	-	1	-	-	0	1	-	7	5	-
4.	Solid Quartzite	-	-	0	-	-	0	-	1	-	-	-
5.	Porous Quartzite	-	-	0	-	-	0	-	-	-	-	-
6.	Jasper/Chert	1	2	3	-	-	0	-	1	-	-	-
7.	Flattop Chal	-	-	0	-	1	1	-	-	-	-	-
8.	Clear/Gr Chal	12	9	21	1	2	3	3	1	14	2	1
9.	Yel/Lt Br Chal	3	-	3	1	-	1	1	-	1	-	-
10.	Dk Brown Chal	-	-	0	3	-	3	-	1	1	-	-
11.	Plate Chal	1	-	1	-	-	0	-	-	-	-	-
12.	Burnt Chal	-	-	0	-	-	0	-	-	-	-	-
13.	Basaltic	1	-	1	1	1	2	-	-	-	-	-
14.	Other	-	-	0	-	-	0	-	-	-	-	-
15.	Bijou Hills	-	-	0	-	-	0	-	-	-	-	-
16.	Quartz	-	-	0	-	-	0	-	-	-	-	-
17.	Porcellanite	6	12	18	8	7	15	2	1	6	-	1
18.	Obsidian	-	-	0	-	-	0	-	-	-	-	-
19.	Granitic	-	-	0	-	-	0	-	-	2	-	-
20.	Coarse Sandst	-	-	0	-	-	0	-	-	-	-	-
21.	Compact Sandst	3	1	4	1	-	1	-	-	-	-	-
26.	Limonite	-	-	0	-	-	0	-	-	1	-	-
28.	Knife R Flint	67	239	306	64	68	132	119	110	188	28	15
29.	Waxy Br Chert	-	-	0	-	-	0	-	-	-	-	-
30.	Grey-Green Ch	-	-	0	-	-	0	-	-	-	-	-
35.	Other Qtzite	1	3	4	-	-	0	-	1	4	-	-
36.	Scoria	-	-	0	-	-	0	-	-	-	-	-
37.	Siltstone	-	1	1	1	-	1	-	-	-	-	-
40.	NonVol Glass	-	-	0	1	-	1	-	-	-	-	-
Total		96	267	363	81	79	160	126	116	224	35	17
Exotic Ground Stone Tools:												
20.	Coarse Sandst	-	-	0	-	1	1	-	-	1	-	-
24.	Catlinite	-	-	0	-	-	0	-	-	-	-	-
38.	Steatite	-	-	0	-	-	0	-	-	-	-	-

Table 18.10. Frequencies of raw material types in chipped stone flaking debris in size grades 3 and larger in collections from the upper Knife-Heart region, limited to bias class A and B samples.

Period		10	20				30						
Batch		99	34	81	97	tot	11	13	14	33	40	43	72
1.	Sm Grey TRSS	2	-	-	2	2	7	3	4	-	43	2	-
2/3.	Coarse TRSS	0	4	4	1	9	5	2	2	4	62	4	-
4.	Solid Quartzite	7	-	-	-	0	2	-	-	1	9	-	-
5.	Porous Quartzite	0	-	3	-	3	-	-	-	-	3	-	3
Period		10	20				30						
Batch		99	34	81	97	tot	11	13	14	33	40	43	72
6.	Jasper/Chert	10	-	-	-	0	-	-	-	-	9	1	-
7.	Flattop Chal	0	-	-	-	0	-	-	-	-	2	-	-
8.	Clear/Gr Chal	5	1	3	16	20	7	-	1	21	35	8	15
9.	Yel/Lt Br Chal	1	-	-	-	0	3	14	2	2	4	4	-
10.	Dk Brown Chal	5	-	-	-	0	2	1	-	-	5	-	1
11.	Plate Chal	0	-	-	-	0	-	-	-	-	-	-	-
12.	Burnt Chal	0	-	-	-	0	-	-	-	-	2	-	-
13.	Basaltic	25	-	2	6	8	-	-	-	-	20	3	2
14.	Other	0	-	-	-	0	-	-	-	-	-	-	-
15.	Bijou Hills	0	-	-	-	0	-	-	-	-	-	-	-
16.	Quartz	0	-	1	-	1	-	-	-	-	-	-	-
17.	Porcellanite	3	-	3	-	3	1	-	2	-	44	1	3
18.	Obsidian	0	-	-	-	0	-	-	-	-	-	-	-
19.	Granitic	2	-	-	-	0	-	-	-	1	1	-	-
20.	Coarse Sandst	0	-	-	-	0	-	-	-	-	-	-	-
21.	Compact Sandst	0	-	-	-	0	-	-	-	-	-	-	-
28.	Knife R Flint	1660	170	390	239	799	290	309	564	615	2449	424	289
29.	Waxy Br Chert	0	-	8	-	8	-	-	-	4	-	1	-
30.	Grey-Green Ch	0	-	-	-	0	-	-	-	-	-	-	-
35.	Other Qtzite	69	-	1	1	2	-	-	-	-	26	1	-
36.	Scoria	0	-	-	-	0	-	-	-	-	-	-	-
37.	Siltstone	2	-	-	-	0	-	-	-	-	-	-	-
40.	NonVol Glass	0	-	-	-	0	-	-	-	-	-	-	-
Total		1791	175	415	265	855	317	329	575	648	2714	449	313
Period		30	cont.	41									
Batch		96	tot	5	8	9	10	26	27	32	70	73	75
1.	Sm Grey TRSS	8	67	94	6	16	1	224	-	2	-	-	1
2/3.	Coarse TRSS	15	94	19	1	-	-	4	12	9	-	1	4
4.	Solid Quartzite	9	21	-	-	-	-	1	2	3	-	-	-
5.	Porous Quartzite	82	88	10	-	1	-	-	-	-	-	1	1
6.	Jasper/Chert	1	11	12	-	-	4	-	-	-	-	2	-
7.	Flattop Chal	-	2	-	-	-	-	-	-	-	-	-	-
8.	Clear/Gr Chal	3	90	97	7	23	11	40	63	30	-	15	41
9.	Yel/Lt Br Chal	-	29	31	1	4	3	-	2	4	-	3	2
10.	Dk Brown Chal	-	9	16	-	4	1	-	1	-	-	-	-
11.	Plate Chal	-	0	-	-	-	-	-	-	-	-	-	-
12.	Burnt Chal	-	2	-	-	-	-	-	-	-	-	-	-
13.	Basaltic	3	28	-	-	-	-	13	-	-	2	-	-
14.	Other	-	0	-	-	-	-	-	-	-	-	-	-
15.	Bijou Hills	-	0	-	-	-	-	-	-	-	-	-	-

Table 18.10. Continued.

Period		30	cont.	41									
Batch		96	tot	5	8	9	10	26	27	32	70	73	75
16.	Quartz	-	0	-	-	-	-	-	-	-	-	-	-
17.	Porcellanite	56	107	17	1	4	-	3	2	1	-	6	5
18.	Obsidian	-	0	1	-	-	-	-	1	-	-	-	2
19.	Granitic	-	2	-	-	-	-	-	-	-	-	-	-
20.	Coarse Sandst	-	0	-	-	-	-	-	-	-	-	-	-
21.	Compact Sandst	-	0	-	-	-	-	-	-	-	-	-	-
28.	Knife R Flint	903	5843	2181	159	916	230	1408	1060	685	220	1322	772
29.	Waxy Br Chert	-	5	1	-	-	-	-	-	-	-	-	-
30.	Grey-Green Ch	-	0	-	-	-	-	-	-	-	-	-	-
35.	Other Qtzite	2	29	-	-	-	-	-	-	-	1	-	-
36.	Scoria	-	0	-	-	-	-	-	-	-	-	-	-
37.	Siltstone	-	0	10	-	1	-	6	-	-	-	1	-
40.	NonVol Glass	-	0	-	-	-	-	-	-	-	-	-	-
Total		1082	6427	2489	175	969	250	1699	1143	734	223	1351	828

Period		41	cont.				42					50	
Batch		77	78	79	80	tot	18	23	24	25	tot	6	7
1.	Sm Grey TRSS	9	4	-	16	373	11	1	8	317	337	24	24
2/3.	Coarse TRSS	3	5	2	31	91	5	2	13	182	202	-	12
4.	Solid Quartzite	-	-	-	-	6	1	-	1	9	11	1	-
5.	Porous Quartzite	-	-	-	-	13	-	-	1	-	1	-	-
6.	Jasper/Chert	-	5	-	1	24	-	-	2	3	5	-	-
7.	Flattop Chal	-	-	-	-	0	-	-	-	-	0	-	-
8.	Clear/Gr Chal	163	83	8	258	839	31	23	71	84	209	8	11
9.	Yel/Lt Br Chal	-	9	1	2	62	13	1	8	7	29	1	1
10.	Dk Brown Chal	-	-	-	-	22	-	-	4	5	9	-	1
11.	Plate Chal	-	-	-	-	0	-	-	1	-	1	-	-
12.	Burnt Chal	-	-	-	-	0	-	-	-	-	0	-	-
13.	Basaltic	-	1	-	5	21	-	-	-	1	1	-	-
14.	Other	-	-	-	3	3	-	-	-	-	0	-	-
15.	Bijou Hills	-	-	-	-	0	-	-	-	-	0	-	-
16.	Quartz	-	-	-	-	0	-	-	-	-	0	-	-
17.	Porcellanite	2	2	-	8	51	2	-	4	10	16	-	2
18.	Obsidian	2	-	1	-	7	-	-	3	2	5	-	-
19.	Granitic	-	-	-	-	0	-	-	-	-	0	-	-
20.	Coarse Sandst	-	-	-	-	0	-	-	-	-	0	-	-
21.	Compact Sandst	-	-	-	-	0	-	-	-	-	0	-	-
28.	Knife R Flint	982	1408	170	1716	13229	1026	511	2447	2966	6950	142	323
29.	Waxy Br Chert	-	-	-	4	5	-	-	2	-	2	-	-
30.	Grey-Green Ch	-	-	-	-	0	-	-	-	-	0	-	-
35.	Other Qtzite	-	-	-	8	9	-	-	5	-	5	-	-
36.	Scoria	-	-	-	-	0	-	-	-	-	0	-	-
37.	Siltstone	1	-	-	2	21	-	-	-	-	0	-	-
40.	NonVol Glass	-	-	-	-	0	-	-	-	-	0	-	-
Total		1162	1517	182	2054	14776	1089	538	2570	3586	7783	176	374

Table 18.10. Continued.

Period		50	cont.				61			62			71
Batch		20	21	39	48	tot	47	69	tot	46	68	tot	45
1.	Sm Grey TRSS	16	34	120	7	225	8	3	11	9	17	26	8
2/3.	Coarse TRSS	3	14	89	-	118	1	3	4	5	9	14	2
4.	Solid Quartzite	1	5	3	1	11	2	-	2	2	5	7	-
5.	Porous Quartzite	-	-	7	-	7	2	6	8	-	-	0	-
6.	Jasper/Chert	1	-	17	1	19	3	-	3	7	11	18	12
7.	Flattop Chal	-	-	-	-	0	-	-	0	-	-	0	-
8.	Clear/Gr Chal	34	99	37	10	199	18	16	34	26	52	78	21
9.	Yel/Lt Br Chal	5	10	17	6	40	27	-	27	41	4	45	16
10.	Dk Brown Chal	6	12	16	7	42	28	-	28	17	3	20	18

Period		50	cont.				61			62			71
Batch		20	21	39	48	tot	47	69	tot	46	68	tot	45
11.	Plate Chal	-	-	-	-	0	-	-	0	-	-	0	-
12.	Burnt Chal	-	-	4	-	4	-	-	0	-	-	0	-
13.	Basaltic	-	-	12	-	12	1	-	1	1	4	5	-
14.	Other	1	-	4	-	5	1	-	1	2	-	2	-
15.	Bijou Hills	-	-	-	-	0	-	-	0	-	-	0	-
16.	Quartz	-	-	-	-	0	-	-	0	-	-	0	-
17.	Porcellanite	-	13	31	6	52	24	49	73	18	108	126	18
18.	Obsidian	-	-	-	-	0	6	-	6	1	-	1	1
19.	Granitic	-	-	-	-	0	-	-	0	-	-	0	-
20.	Coarse Sandst	-	-	-	-	0	-	-	0	-	-	0	-
21.	Compact Sandst	-	-	-	-	0	-	-	0	-	-	0	-
28.	Knife R Flint	932	1877	3933	823	8030	2763	918	3681	4017	2443	6460	1099
29.	Waxy Br Chert	-	1	8	1	10	-	-	0	2	-	2	3
30.	Grey-Green Ch	-	-	-	-	0	-	-	0	-	-	0	-
35.	Other Qtzite	-	-	11	2	13	6	5	11	6	11	17	1
36.	Scoria	-	-	-	-	0	-	-	0	-	1	1	-
37.	Siltstone	-	-	67	-	67	-	7	7	-	-	0	-
40.	NonVol Glass	-	-	-	-	0	-	-	0	-	-	0	-
Total		999	2065	4376	864	8854	2890	1007	3897	4154	2668	6822	1199

Period		71	cont.	72			80	81			82		
Batch		67	tot	44	66	tot	62	19	61	tot	60	65	tot
1.	Sm Grey TRSS	2	10	4	3	7	3	5	1	6	1	1	2
2/3.	Coarse TRSS	6	8	4	23	27	1	-	-	0	22	22	44
4.	Solid Quartzite	1	1	1	2	3	0	-	-	0	1	1	2
5.	Porous Quartzite	-	0	-	9	9	0	-	-	0	1	2	3
6.	Jasper/Chert	1	13	13	3	16	2	-	1	1	3	5	8
7.	Flattop Chal	-	0	-	-	0	0	-	1	1	-	-	0
8.	Clear/Gr Chal	40	61	24	76	100	2	11	5	16	13	20	33
9.	Yel/Lt Br Chal	2	18	28	1	29	2	3	2	5	3	4	7
10.	Dk Brown Chal	4	22	22	7	29	2	-	7	7	3	-	3
11.	Plate Chal	-	0	-	-	0	0	-	-	0	-	-	0
12.	Burnt Chal	-	0	-	-	0	0	-	-	0	-	-	0
13.	Basaltic	3	3	-	9	9	1	-	-	0	9	1	10
14.	Other	-	0	-	-	0	0	-	-	0	-	1	1

Table 18.10. Concluded.

Period		71	cont.	72			80	81			82		
Batch		67	tot	44	66	tot	62	19	61	tot	60	65	tot
15.	Bijou Hills	1	1	-	2	2	0	-	-	0	-	1	1
16.	Quartz	16	16	1	7	8	0	-	-	0	-	2	2
17.	Porcellanite	11	29	12	43	55	0	3	-	3	7	16	23
18.	Obsidian	-	1	2	-	2	0	1	-	1	1	-	1
19.	Granitic	-	0	-	-	0	0	-	-	0	-	-	0
20.	Coarse Sandst	-	0	-	-	0	0	-	-	0	-	-	0
21.	Compact Sandst	-	0	-	-	0	1	-	-	0	-	-	0
28.	Knife R Flint	2046	3145	1312	3147	4459	82	289	92	381	260	1187	1447
29.	Waxy Br Chert	-	3	-	-	0	0	1	-	1	-	-	0
30.	Grey-Green Ch	-	0	-	-	0	0	-	-	0	-	-	0
35.	Other Qtzite	6	7	5	11	16	7	-	2	2	7	13	20
36.	Scoria	-	0	-	-	0	0	-	-	0	-	-	0
37.	Siltstone	-	0	-	-	0	2	-	1	1	-	25	25
40.	NonVol Glass	-	0	-	-	0	0	-	-	0	-	-	0
Total		2139	3338	1428	3343	4771	105	313	112	425	331	1302	1633

							Other or Unassigned				
Period		83			71	72					
Batch		59	64	tot	0/2	1/3	71	74	76	87	98
1.	Sm Grey TRSS	-	2	2	823	310	2	3	8	33	1
2/3.	Coarse TRSS	5	9	14	73	18	-	5	95	3	-
4.	Solid Quartzite	1	-	1	31	36	-	1	-	-	-
5.	Porous Quartzite	-	1	1	-	-	-	-	-	69	1
6.	Jasper/Chert	8	-	8	26	39	-	2	-	189	-
7.	Flattop Chal	-	-	0	-	-	-	1	-	-	-
8.	Clear/Gr Chal	12	7	19	92	81	17	115	1	400	3
9.	Yel/Lt Br Chal	9	-	9	15	17	1	3	-	94	1
10.	Dk Brown Chal	11	1	12	15	11	-	2	-	225	-
11.	Plate Chal	-	-	0	2	-	-	-	-	-	-
12.	Burnt Chal	-	-	0	-	-	-	-	-	42	-
13.	Basaltic	4	-	4	1	1	-	2	1	18	-
14.	Other	-	-	0	-	1	-	3	-	7	-
15.	Bijou Hills	-	-	0	-	-	-	-	-	-	-
16.	Quartz	4	-	4	1	-	-	-	-	2	-
17.	Porcellanite	3	4	7	4	5	8	6	-	528	1
18.	Obsidian	1	-	1	-	-	-	1	-	-	-
19.	Granitic	-	-	0	-	-	-	-	-	-	-
20.	Coarse Sandst	-	-	0	-	-	-	-	-	-	-
21.	Compact Sandst	-	-	0	-	-	-	-	-	-	-
28.	Knife R Flint	286	308	594	1368	889	1303	965	158	1702	158
29.	Waxy Br Chert	1	-	1	1	-	-	-	-	-	-
30.	Grey-Green Ch	1	-	1	-	-	-	-	-	-	-
35.	Other Qtzite	6	9	15	-	1	4	-	-	268	-
36.	Scoria	-	-	0	-	-	-	-	-	-	-
37.	Siltstone	-	3	3	-	-	1	1	-	-	-
40.	NonVol Glass	-	-	0	5	4	-	-	-	-	-
Total		352	344	696	2457	1413	1336	1110	263	3580	164

is most abundant naturally in Sioux County, North Dakota, and in Corson County, South Dakota, and in the tiers of counties in each state ranging due west. The other stone types originate either in the Big Badlands areas in South Dakota, near the Black Hills, in the Spanish Diggings area in eastern Wyoming, in areas immediately south in the panhandle of Nebraska, or along the Missouri River in southern South Dakota.

The second group consists of those having a primarily western direction of origin relative to the study area. These include porcellanite, obsidian, waxy brown chert, flaked scoria, and nonvolcanic natural glass. Scoria and natural glass are simply subtypes of porcellanite and share the same natural distribution. Porcellanite, the most common material in this group, is most abundant naturally in eastern Montana and northeastern Wyoming and to a lesser extent in extreme western North Dakota. This material is discussed by Fredlund (1976) and Clark (1985). Obsidian is assumed to derive from the Yellowstone Park, Wyoming, source or some nearby source in the same direction from the study area; there is no evidence that any of the regional samples derive from the source in the Black Hills (see discussion of obsidian analysis in Chapter 8). We now recognize that the descriptive type waxy brown chert has been applied without distinction to both Rainy Buttes silicified wood (Loendorf et al. 1984) and also to Antelope chert (M. Beckes, personal communication to Ahler, July 24, 1981). Both these materials derive from extreme western and southwestern North Dakota.

A third general group consists of a large series of lithic materials which are thought to be locally available, either in high terrace gravels along the Missouri River, or in surface lag deposits only a short distance from the village sites under study. Some artifacts classified in these types could have been obtained from distant source locations because nearly all types have a wide-spread natural distribution, but all types are thought to occur in relative abundance in local geologic deposits. This group includes jasper/cherts, porous quartzite or Swan River chert, chalcedonies/silicified woods ranging in color from clear/grey through yellow, light, and dark brown, coarse yellow/red or grey TRSS or "silcrete," basaltic and granitic stones, quartz, other quartzite, and siltstone/limestone.

In pursuing this line of study we focus as closely as possible on the raw materials which are likely to be nonlocal in origin and which are likely to have been transported into the area through travel or trade. To follow this focus, we have further restricted the study of non-KRF lithic materials to those occurring in chipped stone tools which do not have a core-tool technology. The assumption is that core-tools of any sort are least likely to have been transported great distances and are least likely to reflect contacts with outside source areas or outside cultural groups. Thus, the study of stone tools is narrowed to those in technological classes 1, 2, 4, and 5, meaning patterned bifacial tools, patterned unifacial flake tools, and other flake tools (unifaces and simple use-modified flakes).

Frequencies of these various non-KRF raw material types are tabulated for the restricted stone tool classes by time period in Table 18.11. It can be noted that the finer-grained local lithic materials are well represented in the patterned bifacial and flake tools, but that coarser-grained local material are not well represented in these tool technological types. This is to be expected. To further enhance the comparability of the data on non-KRF lithic materials in patterned tools and flake tools with data on non-KRF materials in flaking debris, we exclude from the present consideration the coarse-grained raw materials in flaking debris, as tabulated in Table 18.12. Thus, by restricting the tool analysis to non-core tools, and by restricting the flaking debris analysis to fine-grained materials, we have effectively focused each data set on items that are most likely to represent artifacts and by-products deriving from distant source locations without overloading either the tool data set or the flaking debris data set with artifacts having to do with heavy core-reduction applied to local stones.

Another minor adjustment is the inclusion of jasper/chert, considered to be a local type in the flaking debris data, as a downriver, nonlocal type in the stone tool data set. Within the restricted tool classes under consideration, the chances are thought to be good that such materials in fact derive from the abundant highly colored and high-quality chert sources near the Black Hills; if all tools were being considered, then jasper/cherts as a group would probably derive from predominantly local gravel deposits.

To assess changing intensities of cultural contacts or movements according to downriver source areas, western source areas, or local source areas, the relative frequencies of the three source groups are computed for tools and debris from data listed in Tables 18.11 and 18.12. Note again that the stone tool computations include data for both fine-grained and coarse-grained local materials, while the flaking debris computations include only the listed fine-grained local materials. This computation is independent of the data on KRF tools and debris, providing an assessment of use of these source areas independent of any KRF extraction activities conducted by the local cultural groups.

Percentages of downriver, western, and local source materials, summing to 100 percent, are plotted by time period in Figure 18.9. In general, the patterns for both stone tools and for flaking debris for both downriver and western sources parallel each other closely, lending confidence that the temporal patterns are indeed meaningful. The stone tool and flaking debris data for the local sources agree less closely, particularly in the later time periods. The patterns for downriver and western materials are generally complementary, with one source diminishing as the other increases in relative importance. Figure 18.9a indicates that use of downriver sources was minimal in the Clark's Creek phase and was also minimal after about AD 1600 in the Knife River phase. Peaks in the use of downriver materials occur particularly in the period from about AD 1450 to 1600. A small secondary peak occurs for downriver sources late in the AD 1700s. Use of western sources exhibits somewhat of a mirror image pattern. A high frequency of western materials occurs in the Clark's Creek phase. A sharp decline in such material occurs in the subsequent Nailati phase and immediately thereafter and continues for another 200 years. Western sources again become prominent immediately after AD 1600, declining somewhat in the late AD 1700s, and rebounding (in flaking debris) in the terminal time periods.

When viewed in conjunction with relative frequency of KRF (Figure 18.8b), the above data sets offer a rather complex and interesting picture of dynamic patterns of cultural connections and resource/territorial exploitation in the study area. In the pre-village period, before AD 1200, a pattern of heavy use of KRF, heavy reliance on local resources, and little connection with the western source areas emerges. Some connections with downriver sources are indicated. We posit that for the particular cultural groups assigned to this time period unit (the Cross Ranch Late Woodland sites), there is little evidence of heavy use of the KRF quarries proper, with considerable evidence of exploitation of local terrace gravel resources. This might be a biased picture, however, because the functional and seasonal aspects of the sites included here may be different from the major villages comprising the origin for the remainder of the data set.

In the Clark's Creek phase there is strong evidence in the form of high percentages of KRF and high percentages of western raw materials (all of which are most common in areas farther west than the KRF quarries) for relatively intensive exploitation of the KRF quarries. It seems that Clark's Creek phase groups in the region had the most consistent ties to western areas, and less contact with people exploiting any of the characteristic downriver, southwestern lithic sources. This pattern is in basic agreement with previous studies (Ahler 1977a and Johnson 1984) which indicate a disproportionately high occurrence of KRF in Middle Missouri tradition sites all along the Missouri River. These data strengthen the idea developed from the pottery analysis that the Clark's Creek phase represents a local expression of the widespread Middle Missouri tradition, and that these local populations were within the mainstream of ancestral Mandan culture extending throughout the subarea. We would venture further and suggest that some of the primary activities of such populations in the upper Knife-Heart region was periodic exploitation of KRF at the quarries for purposes of trade and distribution to more southerly cultural groups in the same cultural tradition. Such activity centered on KRF may be reflected by the stone tool assemblage from the Grandmother's Lodge site (Woolworth 1956), suspected of belonging in this phase, which includes a subfloor cache of 23 KRF tools and a single piece of hematite. The tools include eight unfinished bifacial preforms, four tabular KRF tools, and 11 large flake tools.

In the following Nailati phase, AD 1300-1400, a sharp decrease in KRF occurs along with an increase in downriver source materials and a decrease in western source materials. This change is interpreted as a shift away from systematic exploitation of the KRF quarries, an opening of new linkages with territories and cultural groups to the south, and a general break in the lithic exploitation patterns evident for the preceding Clark's Creek phase. This break is consistent with the interpretation from ceramic analysis that the Nailati phase reflects Awatixa Hidatsa cultural groups who had recently established themselves in the area and who either displaced or coexisted with resident Mandan groups represented by the Clark's Creek phase.

The subsequent period from AD 1400 to AD 1600 continued with diminished reliance on KRF, strongly

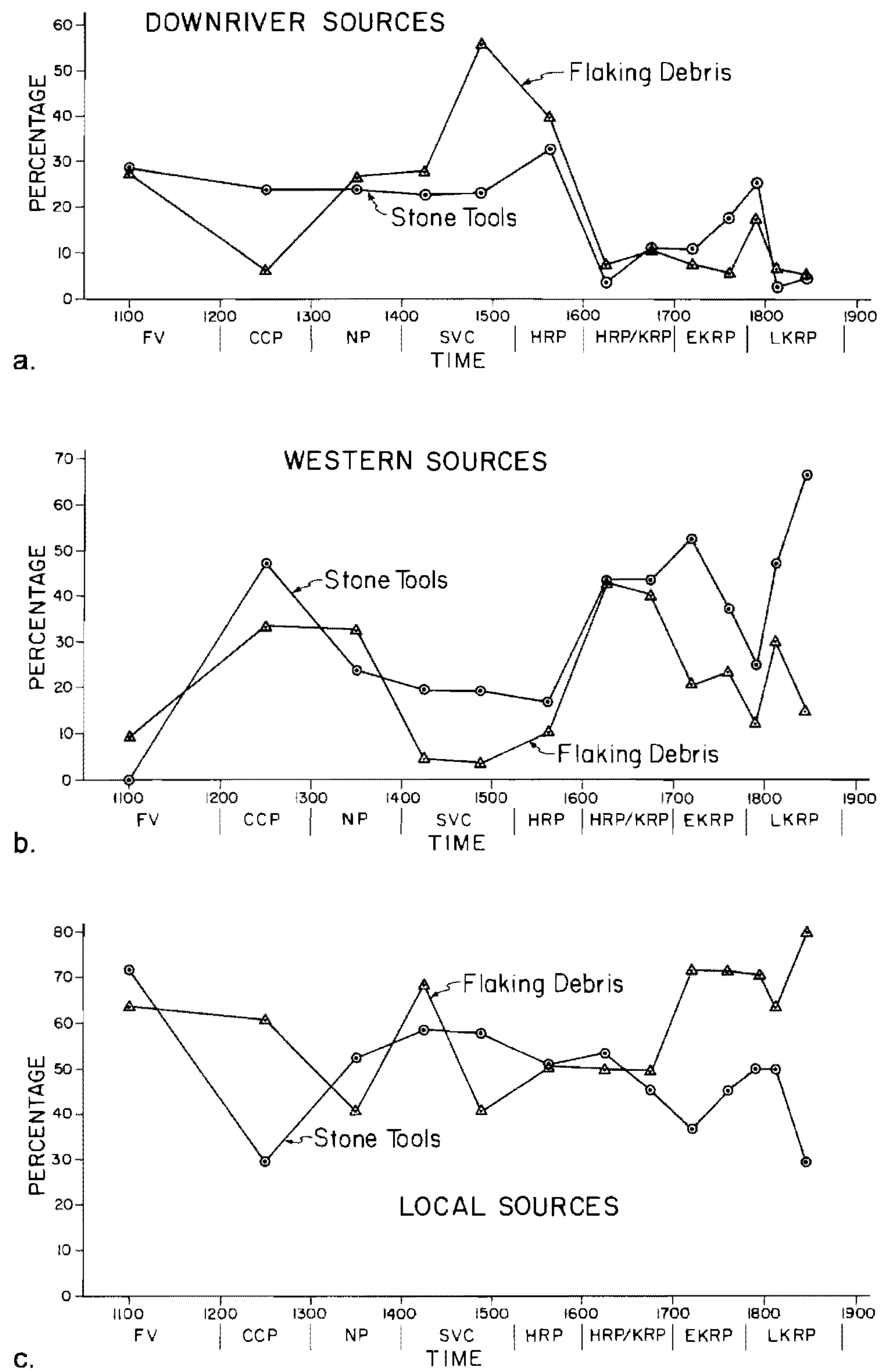


Figure 18.9. Distributions by time period for Hidatsa tradition lithic artifact data. a: percentage of lithic raw material types with downriver source directions for stone tools and flaking debris, excluding KRF data; b: percentage of lithic raw material types with western source directions for stone tools and flaking debris, excluding KRF data; c: percentage of lithic raw material types from local sources for stone tools and flaking debris, excluding KRF data.

diminished use of western source materials, and strongly increased use of downriver source materials. This pattern is thought to be consistent with the interpretation from ceramic analysis that the Early Scattered Village complex, first to occur in this period, reflects strong influence from and communications with peoples to the south, and also that in the following Late Scattered Village complex and Heart River phase that local populations in the study area are brought increasingly into the sphere of influence centered among the Heart River phase Mandan groups at Heart River. This strong bias in communication toward the south to the exclusion of other areas is clearly indicated by the much increased frequencies of smooth grey TRSS and much diminished occurrence of porcellanite in this period. That the increase in smooth grey TRSS indicates increased communications with Heart River area populations is supported by the high incidence of such material in sites such as Slant Village at the Heart River (cf. flaking debris data in Table 18.12).

From the pottery analysis we infer an abrupt shift in cultural influence and cultural change in the study area

Table 18.11. Frequencies of lithic raw materials other than Knife River flint in chipped stone tools in technological classes 1, 2, 4, and 5, organized by time period and by lithic source direction.

Period		10	20	30	41	42	50	61	62	71	72	81	82	83
Downriver:														
1.	Sm Grey TRSS	1	4	11	34	9	27	1	-	2	1	1	-	-
4.	Solid Quartzite	-	-	4	5	3	2	-	4	1	3	1	-	-
6.	Jasper/Chert	2	-	2	4	-	1	-	4	2	6	-	1	-
7.	Flattop Chal	-	-	-	-	-	-	-	-	-	-	-	-	1
11.	Plate Chal	1	-	-	-	-	1	-	-	1	1	-	-	-
Total		4	4	17	43	12	31	1	8	6	11	2	1	1
Western:														
17.	Porcellanite	-	5	14	32	8	14	10	27	29	23	2	17	15
18.	Obsidian	-	-	-	1	-	1	3	5	1	-	-	-	-
29.	Waxy Br Chert	-	3	3	3	2	1	-	-	-	-	-	-	-
36.	Scoria	-	-	-	1	-	-	-	-	-	-	-	-	-
40.	NonVol Glass	-	-	-	-	-	-	-	-	-	-	-	-	1
Total		0	8	17	37	10	16	13	32	30	23	2	17	16
Local, Fine-Grained:														
5.	Porous Quartzite	2	-	2	4	1	-	1	1	1	-	-	-	-
8.	Clear/Gr Chal	1	4	19	89	23	39	9	29	15	21	3	15	3
9.	Yel/Lt Br Chal	3	-	12	7	1	7	3	1	3	7	-	1	1
10.	Dk Brown Chal	-	-	1	6	1	1	-	3	1	-	-	-	3
Total		6	4	34	106	26	47	13	34	20	28	3	16	7
Local, Coarse-Grained:														
2/3.	Coarse TRSS	2	-	3	2	4	1	-	-	-	-	-	-	-
13.	Basaltic	-	1	-	1	-	-	-	-	-	-	-	-	-
16.	Quartz	-	-	-	-	-	-	-	-	-	-	-	-	-
19.	Granitic	-	-	-	-	-	-	-	-	-	-	-	-	-
35.	Other Qtzite	2	-	-	2	-	1	1	-	-	-	1	1	-
37.	Siltstone	-	-	-	-	-	-	2	-	1	-	-	1	-
Total		4	1	3	5	4	2	3	0	1	0	1	2	0
Grand Total		14	17	71	191	52	96	30	74	57	62	8	36	24

Table 18.12. Frequencies of lithic raw materials other than Knife River flint in chipped stone flaking debris organized by time period and by lithic source direction.

Period		10	20	30	41	42	50	61	62	71	72	81	82	83	0/2	1/3	87
Downriver:																	
1.	Sm Grey TRSS	2	2	67	373	337	225	11	26	10	7	6	2	2	823	310	33
4.	Solid Quartzite	7	-	21	6	11	11	2	7	1	3	-	2	1	31	36	-
7.	Flattop Chal	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-
11.	Plate Chal	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-
15.	Bijou Hills	-	-	-	-	-	-	-	-	1	2	-	1	-	-	-	-
Total		9	2	90	379	349	236	13	33	12	12	7	5	3	856	346	33
Western:																	
17.	Porcellanite	3	3	107	51	16	52	73	126	29	55	3	23	7	4	5	528
18.	Obsidian	-	-	-	7	5	10	6	1	1	2	1	1	1	-	-	-
29.	Waxy Br Chert	-	8	5	5	2	-	-	2	3	-	1	-	1	1	-	-
36.	Scoria	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
40.	NonVol Glass	-	-	-	-	-	-	-	-	-	-	-	-	-	5	4	-
Total		3	11	112	63	23	62	79	130	33	57	5	24	9	10	9	528
Local, Fine-Grained:																	
6.	Jasper/Chert	10	20	11	24	5	19	3	18	13	16	1	8	8	26	39	189
8.	Clear/Gr Chal	5	-	90	839	209	199	34	78	61	100	16	33	19	92	81	400
9.	Yel/Lt Br Chal	1	-	29	62	29	40	27	45	18	29	5	7	9	15	17	94
10.	Dk Brown Chal	5	-	9	22	9	42	28	20	22	29	7	3	12	15	11	225
Total		21	20	139	947	252	300	92	161	114	174	29	51	48	148	148	908
Local, Coarse-Grained:																	
2/3.	Coarse TRSS	-	9	94	91	202	118	4	14	8	27	-	44	14	73	18	3
5.	Porous Quartzite	-	3	88	13	1	7	8	-	-	9	-	3	1	-	-	69
13.	Basaltic	25	8	28	21	1	12	1	5	3	9	-	10	4	1	1	18
16.	Quartz	-	1	-	-	-	-	-	-	16	8	-	2	4	1	-	2
19.	Granitic	2	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-
35.	Other Qtzite	69	2	29	9	5	13	11	17	7	16	2	20	15	-	1	268
37.	Siltstone	2	-	-	21	-	67	7	-	-	-	1	25	3	-	-	-
Total		98	23	241	155	209	217	31	36	34	69	3	105	41	75	20	360
Grand Total		131	56	582	1544	833	815	215	360	193	312	44	185	101	1089	523	1829

around AD 1600, coincidental with the influx of Hidatsa-proper and Awaxawi migrants into the study area. A similar abrupt change in lithic exploitation patterns occurs at this time as well, and the data strongly support cultural reorientation away from the Mandan cultural centers to the south. From AD 1600 through at least the first half of the AD 1700s, there is a strong reemphasis on KRF, a strong emphasis on western source materials, and a near disappearance of downriver source materials (Figures 18.8b and 18.9). We interpret this to reflect the establishment of the late Hidatsa subgroups in the region as a cultural tradition independent of the Mandans and extension of Hidatsa hunting territories into geographic regions to the west encompassing the KRF quarries and source areas for porcellanite and waxy brown chert.

During the AD 1700s this pattern begins to change somewhat. Use of KRF begins to diminish, and this diminishment continues through the AD 1800s. Use of western sources in general tends to fall in the AD 1700s.

Use of local sources for stone tools also increases generally through this time span. We attribute this pattern mainly to increased hostilities from the Sioux and other nomadic groups, tending to limit the villagers' hunting expeditions and other seasonal movements ranging far to the west, and forcing their increased reliance on locally available lithic materials.

An interesting small increase in downriver materials occurs in the late AD 1700s, peaking briefly in the period 81 sample. This probably reflects the increasing decimation of Mandan populations at the Heart River and growing patterns of intertribal communication and eventual consolidation of Hidatsa and Mandan groups late in this period for purposes of mutual defense. The increasing influence of the Hidatsas on the Mandans during this period can be inferred from the lithic source data for Slant Village. At that site KRF increases in relative frequency from circa 55.7 percent to 62.9 percent across periods 71 and 72, thought to span AD 1700-1780. In this same period, use of smooth grey TRSS, available just to the west and south of Slant Village, diminishes from 33.5 percent to 21.9 percent. This suggests that Mandans at Heart River were increasingly isolated during this time by hostilities from nomads, and that they increasingly turned to the Hidatsas and/or the territory they controlled to the north and west for purposes of hunting and other off-village activities.

In the AD 1800s the pattern of increasing reliance on local resources continues. Downriver materials are practically nonexistent, now that the Mandans have resettled at the Knife River. Some renewed increase in western sources does occur in this time span (reflected primarily in flaking debris). This probably reflects continuing trade with the Crows and other mounted nomads to the west which may have been intensified by the economic pressures from the fur trade, which was in full swing at this time.

TECHNOLOGICAL AND FUNCTIONAL VARIATION

In this section we explore technological and functional variation in the stone tool collections. The focus, as in preceding sections, is primarily on temporal variation, with little attention paid to between-site variability. To explore technological variation we study differences in relative frequency of certain individual or combinations of technological classes. Ten technological classes are recognized for the project collections; the classes are briefly described in Table 18.13. Each class is meant to describe a general technological trajectory or suite of technological permutations often applied in a complex fashion to produce the desired end product. Some technological classes involve complex sequences of various kinds of flaking, while others reflect simple, one-step processes for transforming raw material into the desired end product. None of the class descriptions are meant to be exhaustive, and, within any class, several minor variations might be used to reach the end form. These technological classes have been used in many previous studies of Plains Village period and other stone tool collections (Lovick 1980a:224; Ahler and Weston 1981:110-111; Ahler and Mehrer 1984; Ahler and Toom 1989).

In general, the study of technological variation is based only on data from the bias class A samples, meaning those with consistent screened recovery and with a lack of field sorting. This includes all of the KNRI excavated samples, the White Buffalo Robe site sample, and data from the 1982 excavations at the Cross Ranch (cf. Table 18.1). For one aspect of technological analysis, focusing on core-tools alone, both the bias class A and the bias class B samples are used.

A working functional classification based on considerations of tool morphology and microwear and containing a total of 56 functional classes has been developed for Plains Village period and other collections from within or near the Middle Missouri subarea (Ahler 1975a, b; 1977b, 1979; Lovick 1983; Kay et al. 1984; Ahler and Toom 1989). Nine new functional classes were first defined to accommodate the Big Hidatsa Village stone tool collection (Ahler and Swenson 1985:83, 340-341), with the new categories containing primarily relatively rare ground stone tool forms and certain tool forms potentially characteristic of post-contact period assemblages. The entire stone tool samples from the Lower Hidatsa and Sakakawea villages have subsequently been reexamined and recoded according to this expanded list of functional classes. The small site collections from the KNRI, the White Buffalo Robe samples, and the Cross Ranch samples were not reexamined according to these new functional classes. A discussion of the definitive characteristics of each functional class is provided in Ahler and Swenson (1985:329-341). These 65 functional tool categories are referred to as specific functional classes, and the class names are listed for reference in Table 18.14.

Detailed functional classification was conducted for only the excavated samples from the KNRI, from White Buffalo Robe, and from the 1982 test excavations at the Cross Ranch (PG and Angus sites). Comparable stone tool functional data do not exist for any of the Wood-Lehmer test samples nor for any of the other site samples.

The specific functional classes convey considerable detailed information on how a tool was used and on what kind of work material was modified. However, data summarization and intrasite comparisons using as many as 65 classes are overly cumbersome and often unworkable. To facilitate data summary and data comparisons among various analytic units, the specific functional classes are collapsed into a much smaller number of "generalized" functional classes. Such generalized functional classes have been used in previous archeological studies in the subarea (cf. Lovick 1980a; Ahler, Lee, and Falk 1981; Ahler 1984; Ahler and Toom 1989), and exactly how the specific classes are combined into generalized classes often varies somewhat from one collection or set of research questions to another. The generalized functional class definitions used here follow the formulations in the Big Hidatsa study (Ahler and Swenson 1985:83, 84). Table 18.15 shows which specific functional classes, identified in Table 18.14, are collapsed into which generalized functional classes.

Technological classification was conducted for virtually all of the site stone tool samples identified in Table 18.1. Table 18.16 provides a summary by batch and bias class of the tool technological classification data set. Totals are provided for bias class A samples and for combined bias class A and B samples for each time period. The information in Table 18.16 constitutes the raw data for the following discussions of technological variation. Table 18.17 provides a summary of frequencies of specific stone tool functional classes, also organized by analytic batch and summed by time period. As noted, this data set derives only from the bias class A analytic batch samples. The frequency of recycled stone tools, independent of functional class, is also given in Table 18.17. Table 18.18 provides a summary by time period of the generalized stone tool functional class frequencies. These data derive directly from the raw data in Table 18.17 and the information on generalized class formulations provided in Table 18.15.

With one exception, virtually all of the analytic attention here is focused on changes in tool assemblage characteristics which might logically be a product of fur trade contact and introduction of metal tools into the villagers' subsistence and economic systems. The exception involves scrutiny of chronological variation in bipolar flaking as a core reduction or tool manufacturing technique. The reason for this interest is the fact that recent studies in the KRF quarries, only about 80 km west of most of the village sites studied here, have shown that bipolar core reduction was a technique very intensively utilized by presently unidentified Late Prehistoric period cultural groups at the flint quarries. Emphasis on bipolar flaking occurs in core and tool samples at several sites (Ahler and Christensen 1983:238-239; Ahler and VanNest 1985; Root et al. 1985:133-134; Root and VanNest 1985:190). One radiocarbon date of 200 ± 50 RCYBP (SMU-1196) exists for quarry site 32DU508, where bipolar reduction was very evident in some parts of the site. Knife River ware pottery has been found at site 32DU452, and late side-notched arrowpoints have been found at several sites. While some chronological information is in general association with the heavy concentrations of bipolar artifacts in the flint quarry area, the identification of the groups using this technique at the quarries remains uncertain. For this reason, we have examined the frequency of this reduction technology in stone tools in the present study sample.

To examine the frequency of bipolar reduction in the present study sample we have used the combined bias class A and class B samples listed in Table 18.16. Here we simply compare the relative proportions of cores or core-tools classified as having a nonbipolar, freehand percussion technology (technological class 7) with those designated as having a bipolar technology (technological class 8). Tools in other technological classes are excluded from consideration. The field sorting bias evident in bias class B samples is not thought to significantly affect the proportions of these two classes relative to each other, allowing the use of a larger data set for the comparison.

Figure 18.10a provides a graphic display of the relative frequency of bipolar core reduction through time. A very interesting chronological pattern is apparent. Bipolar reduction is most common in the period 10, pre-Plains village period samples where 80 percent of the cores/core-tools have a bipolar technology. This particular data base derives from only a portion of the Late Woodland sites on the Cross Ranch and is quite small (10 tools). Because all of these are camp sites, probably seasonally occupied for short durations, it is uncertain if these data are directly comparable with the remaining data from the major village sites. It is uncertain if the Late Woodland sample reflects any connection with the KRF quarries; perhaps the strategy was simply to maximize the production of flakes from locally available cobbles and pebbles. Certainly, these data indicate that knowledge and use of bipolar reduction were important parts of the technological repertoire of Late Woodland groups in the region.

The data from the subsequent Village period samples indicate high occurrence of bipolar reduction in the Clark's Creek phase, an abrupt falloff in use of the technique in the subsequent Nailati phase, a modest but steady occurrence of the technique through the period from AD 1300 to AD 1600, and then an abrupt, further decrease in bipolar technology after AD 1600. This latter event coincides well with many other changes in stone tool raw material composition and ceramic assemblage content which can presumably be correlated with migration of the late Hidatsa-proper and Awaxawi subgroups to the region. Within the Village period samples, the Clark's Creek phase samples exhibit maximal use of bipolar reduction. Most of the data for this phase derive from the Stiefel site, although the pattern there is supported by small samples from the Clark's Creek and PG sites (Table 18.16). The bipolar cores at the Stiefel site are generally KRF items of moderate to large size. One gains the impression that bipolar reduction there was not confined to application with small pebbles, but was used with sizable pieces of raw material which could easily have been flaked by either a bipolar or freehand technique. These are characteristics shared with the bipolar core samples from the KRF quarries and workshops in Dunn County. While this assessment is highly tentative and to a large degree speculative, we would suggest that the episodes of intensive bipolar reduction so evident in the KRF quarries can be related primarily to Plains Village groups in the Middle Missouri tradition, meaning the Clark's Creek phase peoples and Initial and Extended variant (Lehmer 1971) populations residing farther down the Missouri River in North and South Dakota.

The data in Figure 18.10a indicate some reduced persistence of bipolar technology through AD 1600, then an abrupt falloff in such technology thereafter. This pattern is certainly not consistent with any linkage between increased late Hidatsa use of the KRF quarries (based on lithic raw material data) and the incidence of bipolar reduction in the quarry area. This pattern further supports the suggestion that the peoples responsible for intensive bipolar reduction in the KRF quarry area were not the late Hidatsa groups but rather were the ancestral Mandan and Awatixa Hidatsa groups living in the region before AD 1600.

The sharp increase in bipolar reduction in the final time period, post-dating AD 1820/1830, is possibly explained by a degeneration of the villagers' knowledge of and interest in flintknapping by this point in time. Bipolar reduction is one of the simplest of all possible knapping and core reduction procedures and one which is likely to be used by anyone having minimal knowledge of how to control fracture in siliceous materials. A piece of raw material is simply placed on a hard anvil and is smashed from a blow from a hammer, resulting in some flakes and much shatter. Perhaps the terminal Knife River phase peoples frequently resorted to such simple and expedient procedures for production of an occasional cutting or scraping tool.

This latter point raises the topic of change in the native stone technological systems during the fur trade period. From here on the discussion focuses on this topic. The general and ultimate effect of the fur trade and Euroamerican contact on native stone technologies is well known. Use of metal tools obtained through trade with Euroamericans ultimately resulted in a complete replacement of native stone technologies by new, metal-based technologies and a near-complete loss of knowledge of flintknapping among native peoples (cf. Weitzner 1979:236, 240, 253, 259-260 for recollections among Hidatsa informants in the early 1900s concerning the lost arts of flint working relative to arrowpoint, knife blade, and scraper manufacture). What we are interested in here are the details of this technological transformation, regarding its differential progression in different subparts of the native technological system, and regarding timing relative to episodes of increasing Euroamerican contact (cf. Toom 1979 and Goulding 1980 for studies of the same subject). The general history of development and intensity of the fur trade can be briefly summarized here to provide background for the discussion of lithic technological variation.

Table 18.13. Descriptions of stone tool technological classes used in the upper Knife-Heart region lithic anlaysis.

Code	Definition or Description
1	Small thin, patterned bifacial tools produced exclusively by pressure flaking. Included here are arrowpoints, symmetrical perforators, etc.
2	Large thin, patterned bifacial tools produced by a complex sequence of controlled percussion thinning and possible pressure flaking for final finishing and shaping. Included here are most hafted and some unhafted bifacial cutting tools.
3	Small, unpatterned, irregular bifacial tools produced by poorly controlled percussion or pressure marginal flaking of small pebbles or tabular pieces. Included are expediently manufactured bifacial tools of irregular morphology.
4	Patterned flake tools manufactured by marginal flaking on a flake blank and usually characterized by bilateral symmetry and presence of a unifacially beveled working edge. Included here are hafted scraping tools and similarly patterned artifacts.
5	Other flake tools unpatterned in form, and modified by a wide range of techniques including marginal unifacial or bifacial pressure or percussion flaking, shear flaking, or use modification. This includes nearly all forms of unhafted retouched and utilized flakes.
6	Thick bifacial core-tools characterized by large size and bifacial edge formation by hard hammer freehand percussion, made on cobbles, nodules, or chunks of raw material.
7	Unpatterned non-bipolar cores/tools manufactured by freehand percussion applied in a non-bifacial manner to cobbles, pebbles, chunks or other nuclear pieces of stone. Included here are freehand cores of all types and large core-tools such as choppers, core-hammers, etc.
8	Unpatterned bipolar cores/tools manufactured by bipolar percussion applied to any size piece of raw material. Included here are bipolar cores and bipolarly modified punch/wedge tools.
9	Unpatterned pecked, ground, or other non-flaked stone tools are all pecked/ground tools in which the form is deter mined largely by the original shape of the raw material, including cobbles, pebbles, fire-cracked rock, etc., modified only by use.
10	Patterned ground stone tools having a highly shaped form created by processes of pecking, grinding, sawing, polishing, or some combination thereof. Included are many forms of highly shaped or stylized ground stone objects, some of non-utilitarian function.

Table 18.14. List of specific stone tool functional classes used in the upper Knife-Heart region lithic analysis.

1.	projectile point	16.	transverse scraper used on abrasive material (dry hide)
2.	perforator	17.	transverse scraper used on hard material
3.	light duty bilaterial cutting tool	18.	denticulated flake tool
4.	transverse-edged cutting tool	19.	slotting, grooving tool (beak)
5.	basal scraper/grinder	20.	generalized transverse scraping tool
6.	transverse scraper used on soft material (wet hide)	21.	core
7.	bilateral, heavy duty 1 bifacial cutting tool	22.	utilized flake used to saw or slice hard material
8.	expedient general purpose cutting tool	23.	retouched or utilized flake used on variable material
9.	heavy duty 3 ripping, sawing, tearing tool	24.	whetstone
10.	heavy duty 1 asymmetrical or unilateral cutting tool	25.	core/punch/wedge/chisel
11.	stone saw	26.	punch/wedge/chisel
12.	bifacial cutting tool used on hard material	27.	steep-edged heavy duty scraping/adzing tool
13.	lateral scraper used on soft material	28.	bipolar hammer or anvil
14.	heavy duty chopping, pounding tool	29.	hammerstone or pounder
15.	generalized patterned bifacial cutting tool	30.	graving, incising tool

Table 18.14. Concluded.

31.	tested raw material	49.	reamer
32.	heavy woodworking tool	50.	smoking pipe
33.	simple hand-held abrading tool	51.	pendant or bead
34.	simple hand-held grooved abrading stone	52.	pigment source
35.	complex hand-held grinding/crushing tool (mano)	53.	edge- or corner-ground tool
36.	complex anvil used in grinding/crushing (mortar, metate)	54.	generalized flake tool
37.	simple burnishing/smoothing tool	55.	digging tool
38.	unaltered fossil/concretion	56.	practice piece and miscellaneous chipped stone tool
39.	modified fossil/concretion	57.	striker flake
40.	unmodified manuport	58.	notched flake
41.	pounding/grinding tool	59.	edge ground flake
42.	edge ground saw (not used on stone)	60.	patterned disk or tablet
43.	gunflint	61.	rolled flake
44.	bifacial tools of generalized or unknown specific function	62.	ochre stained flakes or stones
45.	spokeshave	63.	perforated stone hammer
46.	large core-tool of uncertain function	64.	clinker cylinder or cone
47.	non-utilitarian item of uncertain function	65.	donut shaped stone
48.	complex grooved grinding tool (shaft smoother)		

Table 18.15. Summary of specific functional class numbers assigned to generalized functional class groups for analysis of the upper Knife-Heart region stone tool collections.

	Generalized Functional Class	Included Specific Functional Class Codes (see Table 14)
1.	Projectile Points	1
2.	Patterned Bifacial Cutting Tools	3, 4, 7, 10, 12, 15, 44
3.	Patterned or Heavy Duty Scraping Tools	5, 6, 13, 16, 17, 20
4.	Jagged, Expedient Cutting Tools	8, 18
5.	Prepared or Regularly Modified Unpatterned Flake Tools	23, 45, 58
6.	Unprepared or Irregularly Modified Unpatterned Flake Tools	22, 54
7.	Edge Ground Flake Tools	11, 42, 59
8.	Pointed Tools	2, 19, 30
9.	General Core-Tool Group	9, 14, 46, 55
10.	Cores or Potential Cores	21, 31
11.	Large Corner Ground Tools	27, 53
12.	Bipolar Tools or Potential Tools	25, 26
13.	Grinding Tools	24, 33, 34, 35, 36, 37, 40, 41, 48, 49
14.	Hammerstone/Anvils	28, 29
15.	Non-Utilitarian Group	38, 39, 47, 50, 51, 52, 60, 61, 62, 63, 64, 65
16.	Post-Contact Group	43, 56, 57
17.	Heavy Woodworking	32

Table 18.16. Summary of stone tool technological class frequencies according to time period and analytic batch for the upper Knife-Heart region collections.

Period	Batch	Bias Class	Technological Class 1	2	3	4	5	6	7	8	9	10	Total
10	99	A	18	4	4	9	49	0	2	8	3	2	99
20	34	B	-	1	2	1	11	-	3	-	2	-	20
	34	C	11	1	11	16	13	-	3	2	6	-	63
	81	B	11	12	14	21	133	-	39	29	11	1	271
	81	C	1	3	1	2	8	-	-	1	1	-	17
	97	A	10	2	-	-	42	-	1	10	8	-	73
	Total	A	10	2	-	-	42	-	1	10	8	-	73
	Total	A+B	21	15	16	22	186	0	43	39	21	1	364
30	11	B	20	12	3	4	65	-	2	1	7	-	114
	13	B	10	4	11	10	45	-	10	-	3	-	93
	14/17	B	8	4	10	4	52	-	1	6	5	-	90
	33	B	8	3	-	5	29	-	2	1	7	1	56
	33	C	11	10	-	10	8	-	-	-	3	-	42
	40	A	124	68	21	46	319	11	58	23	136	8	814
	43	A	13	7	9	3	54	-	4	6	10	-	106
	72	B	3	10	15	12	35	-	37	14	5	4	135
	96	A	42	11	5	2	99	2	12	4	21	-	198
	Total	A	179	86	35	51	472	13	74	33	167	8	1118
	Total	A+B	228	119	74	86	698	13	126	55	194	13	1606
41	5	B	73	44	45	25	179	2	15	16	16	-	415
	8	B	5	2	14	3	43	1	8	2	-	-	78
	9	B	27	14	45	22	173	3	17	10	1	-	312
	10	B	9	12	9	16	54	1	1	2	3	1	108
	26	B	22	4	14	12	87	-	4	1	4	-	148
	27	B	23	22	23	19	93	3	2	-	1	-	186
	32	B	14	5	3	3	66	-	1	3	-	-	95
	32	C	16	7	2	7	5	-	-	-	5	-	42
	36	C	12	20	31	30	67	1	12	15	4	2	194
	70	A	4	2	1	6	25	-	-	-	-	-	38
	73	A	28	7	13	6	118	-	4	3	10	-	189
	75	A	7	5	10	5	58	-	6	4	4	-	99
	77	A	17	19	16	17	130	-	23	12	39	3	276
	78	A	30	17	17	7	142	-	10	5	12	-	240
	79	A	4	2	6	1	29	-	3	-	4	-	49
	80	A	43	22	33	35	324	-	31	12	63	5	568
	Total	A	133	74	96	77	826	0	77	36	132	8	1459
	Total	A+B	306	177	249	177	1521	10	125	70	157	9	2801
42	18	B	24	10	31	9	81	-	8	7	5	1	176
	23	B	8	7	6	5	61	-	3	2	5	-	97
	24	B	54	20	37	21	211	-	14	3	1	2	363
	25	B	30	31	25	35	137	-	7	7	9	-	281
	31	C	16	7	1	2	3	-	-	-	5	3	37
	Total	B	116	68	99	70	490	0	32	19	20	3	917
50	6	B	7	8	3	2	23	-	-	2	-	-	45
	7	B	20	26	22	18	109	1	13	2	8	2	221
	20	B	15	7	25	7	61	-	7	7	1	1	131
	21	B	27	25	22	13	144	-	7	4	3	1	246
	22	C	3	3	1	6	4	-	-	-	-	-	17

Table 18.16. Continued.

Period	Batch	Bias Class	1	2	3	4	5	6	7	8	9	10	Total
			Technological Class										
50, cont.	39	A	183	108	41	70	592	8	46	29	136	1	1214
	48	A	28	28	21	29	172	1	20	4	15	-	318
	49	A	30	19	23	14	152	-	19	4	29	2	292
	55	C	5	1	1	1	-	-	-	-	1	-	9
	57	C	6	2	2	4	1	-	-	-	1	-	16
	Total	A	241	155	85	113	916	9	85	37	180	3	1824
	Total	A+B	310	221	157	153	1253	10	112	52	192	7	2467
60	30	C	22	8	1	10	5	-	-	1	8	1	56
	54	C	17	12	6	14	18	-	1	-	2	1	71
	56	C	2	1	-	8	9	-	-	-	-	1	21
61	47	A	46	40	44	15	247	3	26	1	33	1	456
	69	A	17	10	8	3	180	-	11	1	14	-	244
	Total	A	63	50	52	18	427	3	37	2	47	1	700
62	46	A	135	67	85	38	366	4	39	9	50	6	799
	68	A	72	39	36	48	427	-	25	4	33	6	690
	Total	A	207	106	121	86	793	4	64	13	83	12	1489
70	4	C	5	2	7	5	6	1	3	3	4	5	41
	29	C	16	6	1	7	-	-	-	1	3	-	34
	53	C	2	4	1	4	3	-	-	-	1	-	15
71	45	A	65	42	50	23	240	3	33	3	50	2	511
	67	A	72	15	44	27	311	1	30	3	47	2	552
	Total	A	137	57	94	50	551	4	63	6	97	4	1063
72	44	A	35	25	31	16	146	6	17	4	27	-	307
	66	A	94	28	87	49	381	1	43	9	67	9	768
	Total	A	129	53	118	65	527	7	60	13	94	9	1075
80	62	A	20	2	15	3	19	2	2	1	21	4	89
	63	A	2	3	1	-	15	-	2	1	13	2	39
	63	C	12	7	16	15	18	1	11	3	18	4	105
	Total	A	22	5	16	3	34	2	4	2	34	6	128
81	19	B	6	8	5	3	24	-	1	-	-	1	48
	19	C	-	-	3	-	3	1	-	-	5	1	13
	61	A	8	2	2	-	2	2	3	-	6	1	26
	Total	A+B	14	10	7	3	26	2	4	-	6	2	74
82	60	A	20	6	20	6	37	2	4	1	33	6	135
	60	C	-	-	-	1	-	-	-	-	1	-	2
	65	A	23	15	34	9	157	3	24	2	62	15	344
	Total	A	43	21	54	15	194	5	28	3	95	21	479
83	35	C	-	-	1	3	1	-	-	-	4	-	9
	59	A	18	6	12	5	29	1	5	5	47	5	133
	59	C	1	1	-	-	1	-	-	-	1	-	4
	64	A	14	5	8	5	43	-	3	1	15	4	98
	85	C	1	3	1	23	3	-	-	-	3	56	90
	Total	A	32	11	20	10	72	1	8	6	62	9	231

Table 18.16. Concluded.

Period	Batch	Bias Class	Technological Class 1	2	3	4	5	6	7	8	9	10	Total
Unas-signed	12	C	1	-	-	4	2	-	-	-	-	-	7
	50	C	45	27	23	21	61	1	8	4	14	2	206
	71	A+C	25	18	24	6	126	1	16	-	11	3	230
	74	A	16	20	11	19	129	5	15	9	13	4	241
	76	A	4	3	5	-	17	-	8	-	6	-	43
	84	C	3	22	7	11	20	1	2	-	9	1	76
	98	A	3	1	-	2	9	-	2	-	2	1	20

Table 18.17. Summary of stone tool specific functional class frequencies according to time period and analytic batch for the upper Knife-Heart region lithic collections, part 1.

Period	20	30				41								50			
Batch	97	40	43	96	tot	70	73	75	77	78	79	80	tot	39	48	49	tot
FC 1	9	122	11	39	172	4	28	7	17	29	2	44	131	176	28	29	233
FC 2	6	7	2	10	19	-	-	-	3	1	-	6	10	2	-	8	10
FC 3	0	-	-	-	0	-	-	-	-	-	-	2	2	1	-	-	1
FC 5	0	3	1	-	4	-	-	-	2	-	-	-	2	3	2	-	5
FC 6	0	26	-	1	27	3	6	3	6	2	1	17	38	35	18	9	62
FC 7	0	9	1	2	12	1	2	1	5	3	1	5	18	14	8	10	32
FC 8	0	18	5	5	28	1	10	10	12	14	4	22	73	41	7	11	59
FC 9	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 10	0	3	-	1	4	-	-	-	-	-	-	-	0	8	1	-	9
FC 11	0	1	-	1	2	-	-	-	-	-	-	-	0	-	-	2	2
FC 12	0	4	1	1	6	1	-	-	-	-	1	1	3	1	-	1	2
FC 13	0	-	-	-	0	-	-	-	-	-	-	1	1	-	-	1	1
FC 14	0	14	-	3	17	-	-	-	4	-	-	9	13	6	-	-	6
FC 15	2	53	8	7	68	1	8	4	13	14	3	18	61	84	24	14	122
FC 16	0	7	-	-	7	1	-	1	2	-	-	1	5	19	2	-	21
FC 17	0	10	2	-	12	1	-	-	4	3	-	12	20	10	1	-	11
FC 18	0	2	2	4	8	-	5	7	14	7	3	15	51	7	6	3	16
FC 19	0	-	-	-	0	-	-	-	-	-	-	2	2	-	-	-	0
FC 20	0	5	1	-	6	2	-	1	5	2	-	7	17	8	4	6	18
FC 21	3	37	7	9	53	-	5	7	24	9	3	34	82	35	15	16	66
FC 22	1	27	9	14	50	3	12	14	26	28	2	52	137	36	19	14	69
FC 23	33	247	42	72	361	19	101	37	89	107	24	245	622	538	151	119	808
FC 24	0	2	-	3	5	-	-	1	2	-	-	6	9	6	-	-	6
FC 25	8	22	3	1	26	-	2	3	9	5	-	7	26	27	4	4	35
FC 26	0	-	1	-	1	-	-	-	-	-	-	1	1	-	-	-	0
FC 27	0	16	-	1	17	-	-	-	3	2	-	-	5	12	-	-	12
FC 28	0	21	-	-	21	-	-	-	-	-	-	-	0	6	-	-	6
FC 29	0	44	1	3	48	-	-	2	11	1	-	19	33	28	5	7	40
FC 30	1	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 31	0	2	-	3	5	-	-	-	1	3	-	5	9	2	10	11	23
FC 32	0	2	-	-	2	-	-	-	-	-	-	-	0	-	-	-	0

Table 18.17. Summary of stone tool specific functional class frequencies according to time period and analytic batch for the upper Knife-Heart region lithic collections, part 2.

Period	20	30				41								50			
Batch	97	40	43	96	tot	70	73	75	77	78	79	80	tot	39	48	49	tot
FC 33	8	48	8	9	65	-	9	1	17	8	4	25	64	70	6	12	88
FC 34	0	6	-	1	7	-	1	-	3	-	-	4	8	9	3	8	20
FC 35	0	2	1	-	3	-	-	-	-	-	-	-	0	2	-	-	2
FC 36	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 37	0	1	-	-	1	-	-	-	-	1	-	-	1	2	1	2	5
FC 38	0	1	-	-	1	-	-	-	-	-	-	-	0	-	-	-	0
FC 39	0	-	-	-	0	-	-	-	-	-	-	-	0	1	-	-	1
FC 40	0	1	-	1	2	-	-	-	-	-	-	-	0	1	-	-	1
FC 41	0	-	-	-	0	-	-	-	-	-	-	-	0	-	3	-	3
FC 42	0	-	-	-	0	-	-	-	-	-	-	1	1	-	-	-	0
FC 43	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 44	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	1	1
FC 45	2	-	-	2	2	-	-	-	-	-	-	3	3	6	-	-	6
FC 46	0	8	-	3	11	-	-	-	-	-	-	-	0	6	-	-	6
FC 47	0	3	-	2	5	-	-	-	-	-	-	-	0	5	-	-	5
FC 48	0	-	-	-	0	-	-	-	2	-	-	3	5	-	-	-	0
FC 49	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 50	0	3	-	-	3	-	-	-	-	-	-	-	0	3	-	-	3
FC 51	0	-	-	-	0	-	-	-	1	-	-	1	2	3	-	-	3
FC 52	0	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	0
FC 53	0	-	-	-	0	-	-	-	1	-	-	-	1	-	-	-	0
FC 54	0	36	-	-	36	-	-	-	-	-	-	-	0	-	-	1	1
FC 55	0	1	-	-	1	-	-	-	-	1	1	-	2	-	-	-	0
FC 56	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 57	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	1	1
FC 58	*	*	*	*	*	1	*	*	*	*	*	*	1	*	-	-	0
FC 59	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 60	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	2	2
FC 61	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 62	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 63	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 64	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
FC 65	*	*	*	*	*	-	*	*	*	*	*	*	0	*	-	-	0
Total	73	814	106	198	1118	38	189	99	276	240	49	568	1459	1213	318	292	1823
Re-cycled	3	12	2	2	16	0	0	1	3	0	0	2	6	4	4	3	7

Part 1, continued.

Period	61			62			71			72			80			81
Batch	47	69	tot	46	68	tot	45	67	tot	44	66	tot	62	63	tot	61
FC 1	44	15	59	131	67	198	64	70	134	33	88	121	16	2	18	7
FC 2	3	3	6	11	4	15	8	2	10	5	7	12	4	-	4	1
FC 3	-	-	0	-	1	1	-	1	1	1	-	1	-	-	0	0
FC 5	1	1	2	4	2	6	-	1	1	-	5	5	2	-	2	1
FC 6	12	-	12	24	32	56	14	13	27	11	28	39	1	-	1	0
FC 7	4	3	7	10	4	14	3	1	4	4	2	6	1	-	1	0
FC 8	20	5	25	37	26	63	18	37	55	20	59	79	9	-	9	2

Table 18.17. Continued.

Part 1, continued.

Period	61			62			71			72			80			81
Batch	47	69	tot	46	68	tot	45	67	tot	44	66	tot	62	63	tot	61
FC 9	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 10	-	-	0	1	1	2	-	-	0	1	2	3	-	-	0	0
FC 11	2	-	2	-	-	0	1	-	1	-	-	0	-	-	0	0
FC 12	-	1	1	1	2	3	1	-	1	-	1	1	1	-	1	0
FC 13	-	3	3	2	3	5	1	3	4	1	11	12	1	-	1	2
FC 14	2	-	2	1	-	1	2	-	2	4	1	5	1	1	2	0
FC 15	51	5	56	87	30	117	49	12	61	23	24	47	1	1	2	0
FC 16	2	1	3	-	7	7	1	5	6	-	9	9	-	-	0	0
FC 17	-	2	2	4	7	11	2	5	7	1	9	10	-	-	0	0
FC 18	-	6	6	5	18	23	9	10	19	2	19	21	-	2	2	0
FC 19	-	-	0	1	-	1	1	4	5	-	2	2	-	-	0	0
FC 20	1	1	2	12	7	19	6	7	13	5	7	12	1	-	1	0
FC 21	20	9	29	36	21	57	27	25	52	9	37	46	1	3	4	2
FC 22	21	37	58	26	93	119	20	60	80	18	86	104	3	1	4	1
FC 23	218	127	345	312	280	592	194	216	410	117	231	348	15	8	23	1
FC 24	1	-	1	1	1	2	4	2	6	2	6	8	3	3	6	2
FC 25	1	-	1	8	3	11	3	1	4	3	3	6	1	-	1	0
FC 26	-	1	1	1	2	3	-	3	3	1	5	6	-	-	0	0
FC 27	-	-	0	-	-	0	-	1	1	-	2	2	1	-	1	0
FC 28	-	-	0	-	1	1	-	1	1	-	-	0	-	-	0	0
FC 29	9	1	10	9	7	16	9	7	16	9	12	21	3	2	5	1
FC 30	-	2	2	-	3	3	-	1	1	-	1	1	-	-	0	0
FC 31	12	4	16	16	11	27	24	7	31	13	19	32	-	-	0	1
FC 32	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0

Part 2, continued.

Period	61			62			71			72			80			81
Batch	47	69	tot	46	68	tot	45	67	tot	44	66	tot	62	63	tot	61
FC 33	13	9	22	28	15	43	29	17	46	12	32	44	12	5	17	3
FC 34	6	1	7	10	6	16	4	6	10	3	5	8	1	2	3	0
FC 35	-	-	0	-	-	0	1	5	6	-	1	1	-	-	0	0
FC 36	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1
FC 37	4	-	4	2	2	4	1	1	2	-	1	1	1	1	2	0
FC 38	-	-	0	-	-	0	-	1	1	-	-	0	-	-	0	0
FC 39	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 40	-	-	0	-	-	0	-	-	0	-	-	0	1	-	1	0
FC 41	-	-	0	1	-	1	-	2	2	-	-	0	-	-	0	0
FC 42	-	1	1	-	-	0	-	-	0	-	1	1	-	-	0	0
FC 43	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 44	2	-	2	1	-	1	-	-	0	-	-	0	1	2	3	1
FC 45	1	3	4	8	8	16	5	6	11	5	7	12	-	1	1	0
FC 46	1	-	1	2	-	2	-	2	2	-	2	2	-	-	0	0
FC 47	-	1	1	2	-	2	1	1	2	-	1	1	2	-	2	0
FC 48	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 49	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 50	-	-	0	-	-	0	-	-	0	-	1	1	2	2	4	0
FC 51	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 52	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0

Table 18.17. Continued.

Part 2, continued.

Period	61			62			71			72			80			81
Batch	47	69	tot	46	68	tot	45	67	tot	44	66	tot	62	63	tot	61
FC 53	-	1	1	-	1	1	2	1	3	2	4	6	-	-	0	0
FC 54	2	-	2	-	8	8	-	6	6	-	17	17	-	-	0	0
FC 55	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
FC 56	-	-	0	-	1	1	2	1	3	-	4	4	-	-	0	0
FC 57	2	-	2	1	4	5	4	4	8	2	5	7	3	3	6	0
FC 58	-	-	0	-	2	2	-	-	0	-	-	0	1	-	1	0
FC 59	-	-	0	-	3	3	-	-	0	-	1	1	-	-	0	0
FC 60	1	-	1	3	5	8	1	-	1	-	3	3	-	-	0	0
FC 61	-	-	0	-	-	0	-	2	2	-	1	1	-	-	0	0
FC 62	-	1	1	-	1	1	-	-	0	-	1	1	-	-	0	0
FC 63	-	-	0	-	-	0	-	1	1	-	-	0	-	-	0	0
FC 64	-	-	0	1	1	2	-	1	1	-	5	5	-	-	0	0
FC 65	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	0
Total	456	244	700	799	690	1489	511	552	1063	307	768	1075	89	39	128	26
Recycled	4	4	8	7	15	22	10	18	28	7	22	29	1	2	3	2

Part 1, concluded.

Period	82			83			Unassigned				
Batch	60	65	tot	59	64	tot	50	71	74	76	98
FC 1	19	23	42	15	14	29	21	14	16	3	3
FC 2	-	1	1	2	-	2	2	-	1	1	-
FC 3	-	-	0	-	-	0	-	-	-	-	-
FC 5	1	2	3	-	1	1	-	-	1	-	-
FC 6	2	6	8	1	1	2	3	4	11	-	1
FC 7	-	3	3	2	-	2	3	1	3	-	-
FC 8	17	25	42	8	6	14	6	13	10	5	-
FC 9	-	-	0	-	-	0	-	-	1	-	-
FC 10	-	-	0	1	-	1	-	1	-	-	-
FC 11	-	-	0	-	-	0	-	-	-	-	-
FC 12	-	1	1	1	-	1	-	1	2	-	-
FC 13	4	5	9	1	-	1	-	1	1	-	-
FC 14	1	4	5	1	-	1	1	-	4	-	-
FC 15	4	7	11	4	4	8	16	8	13	3	1
FC 16	1	-	1	1	1	2	-	1	4	-	1
FC 17	1	2	3	1	5	6	-	-	2	-	-
FC 18	-	11	11	2	2	4	1	1	5	-	-
FC 19	-	1	1	-	-	0	-	1	-	-	-
FC 20	1	1	2	2	-	2	2	-	2	-	-
FC 21	1	20	21	6	2	8	4	6	10	8	2
FC 22	6	29	35	6	9	15	5	8	25	2	1
FC 23	23	100	123	19	27	46	47	53	94	13	8
FC 24	3	3	6	4	1	5	-	-	2	-	-
FC 25	1	1	2	-	-	0	4	-	5	-	-
FC 26	-	-	0	-	1	1	-	-	1	-	-
FC 27	-	-	0	-	-	0	-	-	5	-	-
FC 28	-	1	1	1	-	1	-	-	-	-	-

Table 18.17. Concluded.

Part 1, concluded.

Period	82			83			Unassigned				
Batch	60	65	tot	59	64	tot	50	71	74	76	98
FC 29	3	16	19	7	5	12	3	-	4	-	1
FC 30	-	-	0	-	1	1	-	-	-	-	-
FC 31	1	10	11	1	1	2	10	-	4	-	-
FC 32	-	-	0	-	-	0	-	-	-	-	-

Part 2, concluded.

Period	82			83			Unassigned				
Batch	60	65	tot	59	64	tot	50	71	74	76	98
FC 33	19	35	54	25	7	32	5	3	-	2	2
FC 34	5	5	10	7	-	7	1	-	3	-	-
FC 35	1	1	2	1	1	2	-	-	1	-	-
FC 36	-	1	1	-	-	0	-	-	1	-	-
FC 37	-	3	3	-	1	1	1	-	2	-	-
FC 38	-	1	1	-	1	1	-	-	-	-	-
FC 39	-	-	0	-	-	0	-	-	-	-	-
FC 40	-	-	0	-	-	0	-	-	-	-	-
FC 41	1	-	1	-	-	0	1	-	1	-	-
FC 42	-	-	0	-	-	0	-	-	-	-	-
FC 43	1	1	2	2	1	3	-	-	-	-	-
FC 44	1	-	1	-	-	0	1	-	-	-	-
FC 45	-	2	2	-	-	0	-	1	3	-	-
FC 46	2	-	2	1	1	2	-	1	2	-	-
FC 47	1	2	3	2	-	2	-	-	2	-	-
FC 48	1	-	1	-	1	1	-	-	-	-	-
FC 49	-	-	0	1	-	1	-	-	-	-	-
FC 50	1	3	4	4	2	6	-	-	-	-	-
FC 51	1	-	1	-	-	0	-	-	-	-	-
FC 52	-	-	0	1	-	1	-	-	-	-	-
FC 53	1	1	2	-	-	0	-	-	-	-	-
FC 54	-	4	4	-	-	0	-	-	-	-	-
FC 55	-	-	0	-	-	0	-	-	-	-	-
FC 56	-	2	2	-	-	0	-	-	*	*	*
FC 57	8	6	14	3	1	4	-	2	*	*	*
FC 58	-	-	0	-	1	1	-	-	*	*	*
FC 59	-	-	0	-	-	0	-	-	*	*	*
FC 60	3	1	4	-	-	0	-	-	*	*	*
FC 61	-	-	0	-	-	0	-	-	*	*	*
FC 62	-	-	0	-	-	0	-	-	*	*	*
FC 63	-	-	0	-	-	0	-	-	*	*	*
FC 64	-	3	3	-	-	0	-	1	*	*	*
FC 65	-	1	1	-	-	0	-	-	*	*	*
Total	135	344	479	133	98	231	137	121	241	37	20
Recycled	12	8	20	7	5	12	1	3	1	0	0

Note: * = data not collected for these functional classes in these collections

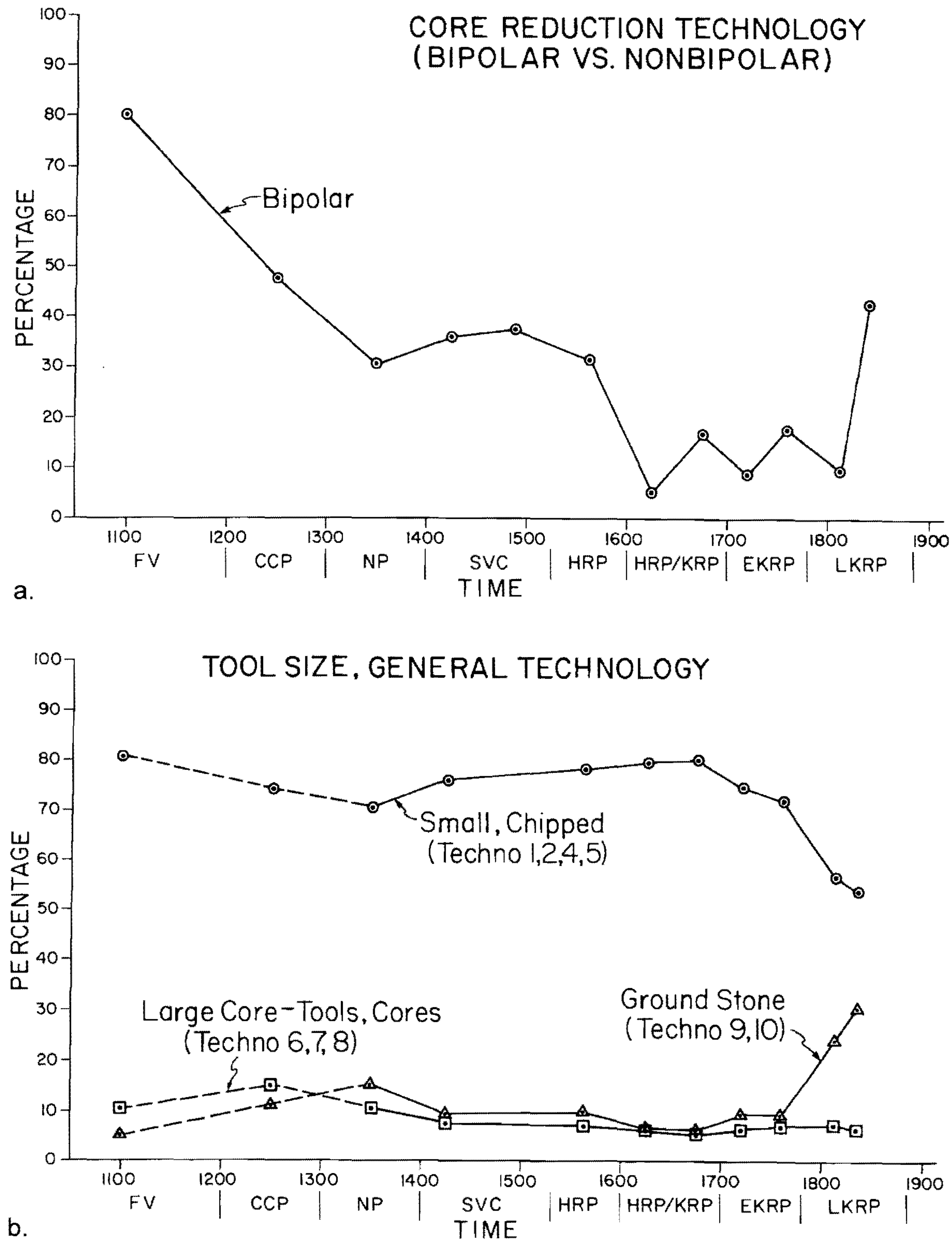


Figure 18.10. Distributions by time period for Hidatsa tradition lithic artifact data. a: percentage of stone tools with bipolar reduction technology (technological class 8) as opposed to nonbipolar technology (technological class 7), exclusive of all other technological classes; b: percentage of stone tools grouped by size and general technological classes.

Archeological evidence in the form of extremely minor amounts of trade metal and glass beads indicates that the local village populations had access to Euroamerican trade artifacts as early as about AD 1600 (cf. Ahler and Swenson 1985:203-217 and Chapter 21 in this volume). This coincides with our time period 61, which marks the beginning of the contact period for the region. Any access to Euroamerican trade items in this period was undoubtedly by way of native middlemen through indirect trade (Ray 1974, 1978), as the Euroamerican explorers, missionaries, and traders were only pushing as far west as the Great Lakes by the mid-AD 1600s. This period of indirect trade continued through the early part of the AD 1700s and probably through the mid-AD 1700s. Direct contact between Euroamerican traders and the local Mandan and Hidatsa populations took place at least as early as AD 1738 (Smith 1980). Access to Euroamerican trade artifacts was undoubtedly increasing by this time for the local villagers, although most or all trade up to this time was probably conducted indirectly through middlemen.

By the AD 1780s frequent direct contacts with northern traders coming from North West Company and Hudson's Bay Company posts in Canada began to be the rule (Wood and Thiessen 1985:24-29, Appendix Table 1; Alwin 1979). By this time, and probably a decade or two earlier, resident Euroamerican (tenant) traders also became established within the villages (Lehmer 1977; Wood and Thiessen 1985:42-43). Availability of Euroamerican trade artifacts was undoubtedly markedly increased at this time, coinciding roughly with the beginning of our time period 81 (AD 1780-1800) in the local village samples. The frequency of indirect and direct trading contacts continued to increase through the first two decades of the nineteenth century as the Americans entered the trade operations in full force and as several competing companies established short-lived trading outposts very near the mouth of the Knife River (cf. Wood and Thiessen 1985:29-42 and Chapter 13, this volume). The period from circa AD 1780 to 1820 (our periods 81 and 82) can be characterized as one of direct trade for the Mandans and Hidatsas; it is also a period during which the role of the villagers as middlemen between the Euroamericans and the more distant mounted nomadic groups farther to the west was maximized.

Around 1820 and certainly by AD 1830 the trade situation changed again abruptly for the villagers. Permanent trading posts were established at Knife River, the most prominent and long-lived of these being the American Fur Company post at Fort Clark about 1831 or slightly earlier (cf. Chapters 13 and 14, this volume). In the 1830s these posts began to be supplied by steamboats plying upriver from St. Louis. Two things happened at this time. The villagers' access to trade artifacts was markedly increased again; large and relatively bulky trade items such as iron hoes and copper kettles were made much more available via the steamboat traffic from St. Louis. Second, the role of the villagers as middlemen between the Euroamericans and nomads was somewhat altered from this time on. The nomads now could make direct contact at any time they chose with the traders at the posts, and the primary trading role of the villagers in this interaction was now to supply both nomads and Euroamericans with horticultural produce.

The lithic artifact collections which have been recovered with most control and analyzed in most detail span the full range from pre-contact times before AD 1600 to the date of abandonment of Big Hidatsa Village in AD 1845. Because of this long time period bridging practically the full duration of fur trade development in the region, we can expect the stone tool collections to exhibit substantial chronological changes reflecting the effects of the fur trade and the introduction of metal tools into native technological systems.

Several general expectations can be stated regarding anticipated alterations in the native lithic technological systems.

As traded metal tools replace lithic tools, we expect a change in the technological composition of the stone tool assemblages. Small stone tools with pointed or sharp cutting edges could be most efficiently and easily replaced by metal artifacts, and on this basis, we would expect small lithic tools of chipped technology to be replaced most rapidly and most completely by metal artifacts (cf. Toom 1979:154-156; Lehmer 1971:145-146). Large chipped stone tools with a core-based technology could be less readily replaced by trade artifacts until heavy metal items were available through direct trading contacts. Stone tools with ground technology could also be less readily replaced by metal or other fur trade artifacts (cf. Wood 1971:69-70). In fact, some of the most common ground stone tools such as hammers and grinding tools would have no ready, economical technological replacement in the Euroamerican trader's supply, and tools with these technologies should persist in importance through the fur trade period (Lehmer 1971:149).

As metal artifacts replace lithic tools, we expect to see evidence of less emphasis on the skills and time-consuming aspects of flintknapping. This change will be most evident in the chipped stone tools most readily replaced by metal trade artifacts. There will be less emphasis on the production of patterned artifacts which required considerable skill and labor investment, and greater emphasis on expedient knapping processes that could produce an item which could simply fill in during periods when metal artifacts were in short supply. Patterned cutting and scraping tools should diminish in relative abundance, being replaced by less complex flake tools and other expedient tool forms. Goulding (1980:113-115) studied this topic of patterned/unpatterned tool frequencies in chipped stone collections from Lower Hidatsa and Sakakawea villages and found little of the predicted technological variation through time in those assemblages. We will reexamine the topic here using larger and temporally more extensive artifact collections. Patterned ground stone tools probably will not behave in a manner comparable to chipped stone items, as they are not as readily replaced in a direct way by trade items. Patterned ground stone tools such as smoking pipes might in fact be more easily manufactured with metal trade artifacts such as files and saws, and artifacts of patterned ground stone technology might become relatively more frequent through time.

As metal artifacts replace lithic artifacts through time and as knapping skills are lost, the occasional need for lithic tools will be increasingly met by recycling or scavenging previously manufactured stone tools rather than by making new stone tools. Evidence of reuse of preexisting artifacts will occur as superimposed changes in tool function, or as more recent modification overlying and superimposed upon older flaking patterns. Goulding (1980:119-120) has suggested artifact recycling as an explanation for the continued occurrence of patterned chipped artifacts in relatively high proportions in site assemblages dating late in the post-contact period.

As emphasis on knapping skills and chipped stone tool production decrease through time, use of the complex technological procedure of heat treatment in Knife River flint (Ahler 1983) should decrease.

The functional composition of the stone tool collections should change through time as the economic interests of the villagers change in response to the fur trade. Hide scraping tools should occur more frequently as production of hides for the fur trade intensified. Monitoring this functional change in lithic tools alone may be difficult, however, as many of the hide scraping tools were probably themselves being made from trade metal. New types of hide working tools may occur, designed specifically to meet the demands of the fur trade (cf. Chapman 1986). Stone tools which functioned in direct interaction with metal trade artifacts, such as gunflints for traded pistols, rifles, and shotguns, and stone tools used as strikers in fire-making and used to fabricate metal artifacts, should increase in occurrence through the contact period. Like the occurrence of cutmarks on bone tools made by metal tools, such items may provide indirect evidence of the presence of trade artifacts in contexts where the trade items are themselves lacking.

In several of the figures to follow, the lines connecting the Formative Village and Clark's Creek data points are dashed to indicate that the samples for these data points are quite small and possibly inappropriate for comparison with the remainder of the data. Both the Late Woodland data and the Clark's Creek phase data derive from small camp sites on the Cross Ranch, and because of the functional nature of these sites, their stone tool content may not be technologically and functionally comparable to that from the major village locations represented by the other time period units. Also, in the following graphic presentations, data are generally omitted for time period 81. This period is represented by only a single bias class A batch from Sakakawea Village comprised of only 26 stone tools. The small size of this sample yields in many cases somewhat anomalous percentage values which detract from the clarity of general chronological trends evident in the other data samples. The raw data values in Tables 18.16, 18.17, and 18.18 may be consulted for details on the appropriate data for this time period.

Figure 18.10b provides a graphic representation of temporal changes in the general technological composition of the study collections. In this figure we see the percentages of contrastive sets of relatively small chipped stone tools in technological classes 1, 2, 4, and 5, larger chipped stone tools and cores in technological classes 6, 7, and 8, and all ground stone tools in classes 9 and 10. The core/core-tool group exhibits little variation through time, while the other two groups change as predicted in the preceding discussion. Small chipped stone tools, dominated by flake tools, do indeed decrease dramatically in

Table 18.18. Summary of stone tool generalized functional class frequencies by time period in the upper Knife-Heart region lithic collections.

Functional Class		Period											
		20	30	41	50	61	62	71	72	80	81	82	83
1.	Projectile	9	172	131	233	59	198	134	121	18	7	42	29
2.	Pat Bif Cutting	2	90	84	167	66	138	67	58	7	1	16	12
3.	Pat Scraper	-	56	83	118	24	104	58	87	5	3	26	14
4.	Jagged	-	36	124	75	31	86	74	100	11	2	53	18
5.	Prep Flake Tl	35	363	626	814	350	611	421	361	25	1	125	47
6.	Unprep Flake	1	86	137	70	60	127	86	121	4	1	39	15
7.	Edge Ground Fl	-	2	1	2	3	3	1	2	-	-	-	-
8.	Pointed	7	19	12	10	8	19	16	15	4	1	2	3
9.	Core Tool	-	29	15	12	3	3	4	7	2	-	7	3
10.	Core	3	58	91	89	45	84	83	78	4	3	32	10
11.	Corner Ground	-	17	6	12	1	1	4	8	1	-	2	-
12.	Bipolar	8	27	27	35	2	14	7	12	1	-	2	1
13.	Grinding Tool	8	83	87	125	34	66	72	62	29	6	78	49
14.	Hammer/Anvil	-	69	33	46	10	17	17	21	5	1	20	13
15.	Nonutilitarian	-	9	2	14	2	12	8	11	6	-	17	10
16.	Post-Contact	-	-	-	1	2	6	11	11	6	-	18	7
17.	Woodworking	-	2	-	-	-	-	-	-	-	-	-	-
Total		73	1118	1459	1823	700	1489	1063	1075	128	26	479	231

relative frequency in the post-contact time periods, with this decline appearing to begin in the AD 1700s and becoming particularly noticeable in the AD 1800s, with a total decline for such tools of about 25 percent. In contrast, ground stone tools increase markedly in relative importance among all stone tools in the late post-contact periods. This increase seems to be slight, if even present, prior to AD 1780, but is quite marked in the final two time periods. These patterns conform in general to the prediction that imported metal selectively replaced small, sharp edged chipped stone tools but did not effectively replace ground stone implements. It seems that this replacement process became visibly detectable by AD 1700, at a time when the villagers were only distant recipients of Euroamerican trade artifacts through an indirect trading process. This replacement process was quite advanced by the late AD 1700s, by which time ground stone tools began to show a noticeably higher representation in the overall lithic tool assemblage.

Figure 18.11 provides several graphs which illustrate other predicted aspects of change in native technological systems under influence from the fur trade. Here we examine the relative frequencies of complex or patterned tools versus simpler, expediently manufactured tool forms according to several subgroups. Dealing first with chipped stone tools which served primarily cutting functions, Figure 18.11a illustrates the relative proportions of three technological classes which can be distinguished by relative degree of energy input and skill in their manufacture. Highly patterned tools in technological class 2 are compared with less patterned flake tools in technological class 5 and the most expedient tools in technological class 3. The technological class 2 specimens require considerable knapping skill and involve a sequenced series of percussion and pressure flaking operations for their production. The technological class 5 specimens involve controlled knapping of a core to produce a usable flake, and in some cases, subsequent shaping, trimming, or retouch of the flake to a desired form or for resharpening. The technological class 3 specimens are primarily small pebble tools, characterized by removal of a few small percussion flakes in an irregular manner from the edge or margin of a small flat pebble of siliceous raw material; a sharp but irregular cutting or scraping edge or point is expediently produced in this way with a minimum of knapping skill.

Relative frequencies of these three tool classes are compared to each other, irrespective of other tool technological groups, in Figure 18.11a. The graphic patterns conform closely with the predicted changes for these tool forms in the post-contact period. The most expedient, technological class 3 tools more than double in relative frequency in the period following the Heart River phase, becoming most common in the post-AD 1800 samples. A steady decline in the least expedient, most patterned bifacial cutting tools also occurs through this same time span, except for a decided reversal in the final period 83 sample which shows a higher percentage of patterned bifaces that the previous three periods. The technological class 5 flake tools exhibit a relatively steady decline in relative frequency from AD 1600 on, with this decline apparently accelerating in the 1700s and 1800s.

The general patterns displayed in Figure 18.11a conform to expectations regarding a progressive loss of interest in patterned chipped stone tool technology during the post-contact period. The significance of and explanation for this pattern, however, becomes somewhat obscured with the realization that strong between-site differences exist in the relative proportions of technological class 2 and technological class 5 tool forms in the contemporaneous period 61 through 72 samples at Lower Hidatsa and Big Hidatsa villages (Table 18.16). Technological class 2 tools are decidedly more common and technological class 5 tools are less common in each of the common time period samples for the Lower Hidatsa collections. Whether this reflects fundamentally different lithic technological systems in operation at the two villages or simply reflects a greater degree of Hidatsa-proper involvement in the fur trade and metal artifact use cannot be assessed at this time.

The topic of changes in patternedness and expediency in manufacture of chipped stone tools is also examined from the perspective of scraping tools. In this instance, we compare the relative proportions of hafted hide scraping tools, identified as being in technological class 4 and in functional classes 6 and 16, with the relative proportion of functionally similar hide working tools in functional class 13, lateral scrapers. The former category consists of typical end scraper forms with a transverse working edge determined by use-wear analysis to have been used on hide (cf. Ahler and Swenson 1985:Figure 42f-m). The latter specimens are manufactured primarily by marginal bifacial retouch on a large tabular piece of KRF (cf. Ahler et al. 1980:Figure 15o and Ahler and Swenson 1985:Figure 42c-e); sometimes lateral scrapers occur on large spalls struck from quartzite cobbles. From their large size and irregular form, the lateral scraping tools appear to have been unhafted. The proportions of these two contrastive hide scraping tool forms, irrespective of other tool occurrences, are illustrated through time in Figure 18.11b. As predicted, the unhafted expedient forms become decidedly more common later in time during the post-contact period. A substantial number of the expedient forms occur in the period 61 sample, fewer occur in the following two periods, then this form of scraper becomes quite common in the early AD 1800s, period 82 sample. The expedient scraper form drops in percentage in the final time period, although this final value is based on very small sample size (n = 5).

The possibility remains that the unpatterned lateral scraper form may be a special tool designed for rapid preparation of hides and furs for the fur trade, while the traditional, typical hafted transverse scraper continued to be made and used for production of domestic leather, clothing, etc. Such a specialized, trade-oriented function has been suggested for similarly large, unhafted spall scrapers found in abundance in the late post-contact period sites of the Missouri and Osage Indians in Missouri (Chapman 1986); these tribes were heavily involved in production of deer hides for trade with the French at St. Louis. If this is the case, then the peak frequency of the lateral scraper form in period 82 would indicate maximum involvement of the Hidatsas in the actual preparation of furs for trade in the period from about 1800 to 1820/1830, followed by a rapid decrease in such involvement immediately thereafter. Such a pattern would conform to the changing role of the Hidatsas from important trading middlemen to bystanders and producers of food commodities at about this point in time.

Figure 18.11c presents data on the changing proportions of unpatterned and patterned tool forms within the general category of ground stone tools (proportions of technological class 9 versus class 10 tools), irrespective of other tool class frequencies. The temporal pattern conforms to that predicted, with patterned ground stone tool forms generally becoming more common later in time. One suggested explanation is the increased availability of metal tools and the increased ease with which ground stone tools can be carved and shaped with metal implements. Other factors, such as intensified ritual and ceremonial activities in which items such as pipes, discs, donut stones, and engraved objects are used, may also account in part for the observed temporal pattern.

As a footnote regarding the use of metal tools for the production of stone artifacts, we can mention that a systematic intensive examination was made of the notched stone arrowpoints in the Sakakawea Village collection for evidence of production with metal pressure flaking implements. In particular, we recorded the presence of iron oxide embedded in or adhering to the artifact edge in a location compatible with residue from use of an iron pressure flaking implement. We looked particularly in the notch area where a narrow metal punch would be particularly useful for pressing off the notch flakes. Of 29 notched arrowpoints examined, five exhibit definite iron oxide on the artifact margins. Four have residues in one or both notch areas, and one has residues in serrations on the blade edge. Such a pointed and systematic search for iron oxide stains has not been made among the notched arrowpoints in the Big Hidatsa, Lower Hidatsa, and other artifact collections.

Turning now to the next topic, that of tool recycling in the post-contact period, we can note that the process hypothesized by Goulding (1980) and predicted in the foregoing discussion can be directly verified by tabulating the percentage of recycled tools in the total tool collections through time (Table 18.17). Such data are displayed graphically for all time periods in Figure 18.12a. With the exception of the possibly anomalous high value in the Clark's Creek phase Angus site, recycling values for all pre-contact period samples lie below 2.0 percent. The value of more than 4.0 percent for the Angus site sample may not be comparable to the others due to the function of this site as a seasonal encampment. After AD 1700, recycling increases to more than 2.0 percent in all samples, and in the final two periods it rises to above 4.0 and 5.0 percent, respectively. The pattern of temporal change in the post-contact period seems to conform to the predicted model, with recycling becoming a visibly detectable activity by the AD 1700s.

Another means for measuring recycling behavior and the general level of activity devoted to new tool production versus use of existing chipped materials is through comparison of counts of flaking debris to counts of chipped stone tools in any given sample. As new tool production decreases due to lack of interest or skill in flintknapping and as scrounging for previously manufactured lithic items (either tools or flakes) for use as expedient replacements for valuable metal tools occurs, the ratio of flakes to chipped stone tools should decrease. This will be true because less debitage will be produced relative to each utilized item, and some debitage will actually be recycled and turned into expedient tools. The data used for computing the flake-to-tool ratios are presented in Table 18.19. The flaking debris data include counts of size grade 4 items, and the tool counts are taken only from the same contexts producing the size grade 4 flakes. The use of flakes in grades 1 through 4 seems most appropriate because it incorporates information on pressure flaking, a significant technological activity, which can be readily detected only in size grade 4 or smaller flaking debris.

A graphic presentation of changing ratios of flake-to-tool counts occurs in Figure 18.12b. While a strong decrease in the computed ratio occurs within and after period 62 (AD 1650-1700), the overall pattern is not what was predicted. Note that while relatively low ratio values are evident in the final post-contact periods, a yet lower value is obtained for the pre-contact age Scattered Village complex data sample. Note also that ratio values for contemporaneous artifact samples in periods 61 through 72 at Lower Hidatsa Village are consistently 1.5 to 2.0 or more times as great as the corresponding values for the same periods from Big Hidatsa Village samples. The last six

Big Hidatsa Village sample values actually exhibit a steady increase through the post-contact period, directly counter to the predicted pattern of change. In sum, it seems that the flake ratio data do not provide a good measure of recycling behavior, and therefore they do not provide a useful test of that hypothesis. If anything, the ratio data indicate fundamental differences in the flintknapping systems and tool production behavior at the contemporaneous Lower Hidatsa and Big Hidatsa Village sites. Explanation of these differences remains an intriguing topic for future study.

Temporal patterns of heat treatment in Knife River flint tools have been discussed in a previous section. As noted in that discussion, the general incidence of heat treatment decreases during the AD 1700s, then rises slightly again in the terminal time period in the 1800s (cf. Figure 18.8a). This decrease in heat treatment conforms to the predicted change during the late post-contact period when interest in complex flintknapping skills was on the wane. The late increase has been attributed to possible recycling and reuse of previously manufactured tools which were heat treated in earlier time periods.

Finally, we can examine the relative frequencies of particular stone tool functional classes which may have been integrally involved directly or indirectly with fur trade activities or with artifacts of Euroamerican origin during the post-contact period. The percentage of hide scraping tools computed over all tool classes is presented by time period in Figure 18.12c. Any pattern indicative of increased hide preparation corresponding to increased contact with fur traders later in time is not evident. The percentage of hide working tools seems to vary erratically from period to period. Consistent drops in percentage of scraping tools occur in the final two periods, and this may indicate replacement of stone scrapers with metal scrapers as more direct contact with traders developed. The incidence of possible specialized hideworking tools used in the fur trade has already been discussed (cf. Figure 18.11b).

The second functional tool group of interest here, termed the generalized "post-contact" group, contains gunflints, what are termed "striker flakes," and miscellaneous chipped items or "practice pieces." More complete descriptions of these functional classes are given in Ahler and Swenson (1985:338, 340). The purpose and function of gunflints is evident, as is their linkage with firearms obtained through the trading process. Only five of these items occur in the controlled excavated samples, and all of these occur in the period 82 and 83 samples, postdating AD 1790 at Big Hidatsa and AD 1800 at Sakakawea (see Table 18.17 for distributions by batch). All of these five are native-made artifacts of KRF, rather than imported specimens made of European flint. Four additional gunflints, three made of imported English flint, occur in unscreened collections from Sakakawea Village. The low frequency and late contexts for the gunflints indicate that firearms did not become common in the villages until after AD 1790, or after the initiation of intermittent direct trade.

Striker flakes are flake tools characterized by edge segments or flake ridges with areas of intensive battering and step flaking apparently caused by repeated percussion contact with a small diameter object. Retouch flake scars are not well resolved, and edge angles are quite steep, suggesting that the flake itself was struck repeatedly against a much more massive object, or that an oversized percussor struck the flake. Many small points of impact occur along the modified edge. Many of these tools are probably strike-a-lights, used in the flint-and-steel production of sparks for fire-making. Several examples have iron oxide stains along the modified edge, lending support to such an interpretation. Others may be flakes used to modify metal artifacts through a chopping or scraping use-motion. Most of these items are thought to relate to contact with metal artifacts in some way, while a small number of these artifacts may result from attempts at retouched flake manufacture by persons with little flintknapping skill.

In the KNRI study samples, such items occur in all periods ranging from the Heart River phase through the terminal Knife River phase (Table 18.17). One such artifact was identified in the period 50 sample from Lower Hidatsa Village, and artifacts in this specific group increase in relative frequency in later time periods. The absence of such specimens in earlier periods cannot be demonstrated because the small site samples were not reexamined for the identification of such specimens. The evidence suggests, however, that such artifacts are directly indicative of use with metal and therefore are particularly characteristic of the post-contact period. The presence of the single such item in the period 50 sample may reflect intrusion of a stone tool used on metal into earlier deposits, or possibly evidence of presence of metal at an extremely early post-Columbian date, or simply an artifact with wear deceptively similar to other specimens used in contact with metal.

Table 18.19. Data on the ratio of counts of flaking debris to counts of chipped stone tools from the same contexts in the upper Knife-Heart region lithic collections.

Period	Batch	Counts of G1-G4 Flakes	Counts of Tools	Flake:Tool Ratio
20	97	(2398)	65	36.9
30	40	14747	358	41.2
	43	2043	49	41.7
	96	(11176)	177	63.1
	total	27966	584	47.9
41	70	1377	38	36.2
	73	7217	179	40.3
	75	5662	95	59.6
	77	4405	201	21.9
	78	7812	228	34.3
	79	619	30	20.6
	80	8628	430	20.1
	total	35720	1201	29.7
50	39	16252	249	65.3
	48	12247	303	40.4
	49	6403	261	24.5
	total	34902	813	42.9
61	47	21981	422	52.1
	69	6561	230	28.5
	total	28542	652	43.8
62	46	62041	743	83.5
	68	20273	651	31.1
	total	82314	1394	59.0
71	45	28042	459	61.1
	67	17110	503	34.0
	total	45152	962	46.9
72	44	15891	280	56.8
	66	24766	692	35.8
	total	40657	972	41.8
80	62	2236	64	34.9
	63	639	17	37.6
	total	2875	81	35.5
81	61	492	19	25.9
82	60	2137	96	22.3
	65	9461	267	35.4
	total	11598	363	32.0
83	59	2227	81	27.5
	64	2829	79	35.8
	total	5056	160	31.6
Unassigned				
	74	6666	224	29.8

Note: Estimated counts of G1-G4 flakes are in parentheses.

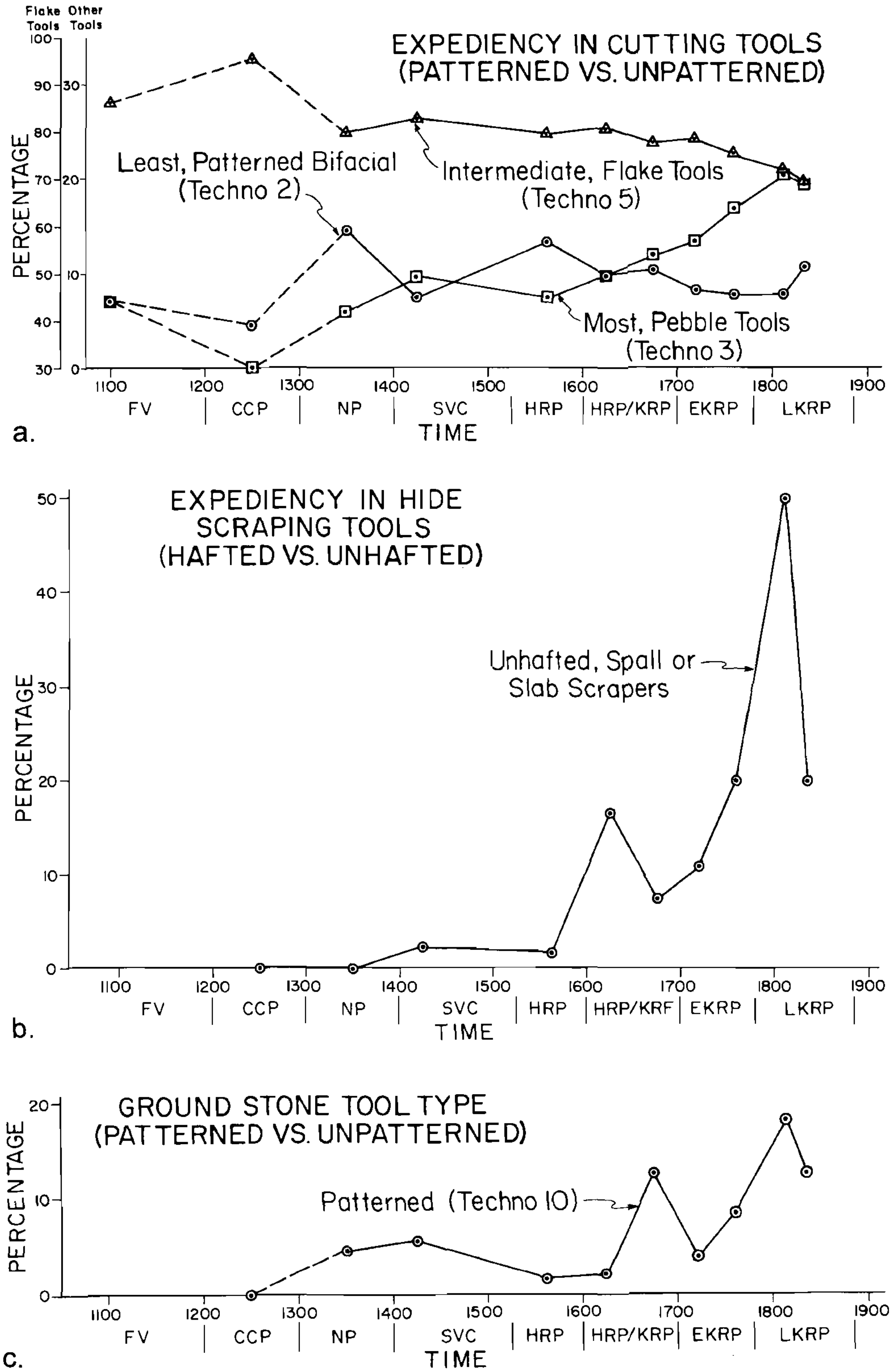


Figure 18.11. Distributions by time period for Hidatsa tradition lithic artifact data. a: percentage of stone tool cutting tool classes organized by degree of expediency in manufacture, exlcusive of other tool types; b: percentage of scraping tools with expedient, unhafted technology, as opposed to hafted transverse scrapers, exclusive of other tool types; c: percentage of patterned ground stone tools versus unpatterned ground stone tools, exclusive of other tool types.

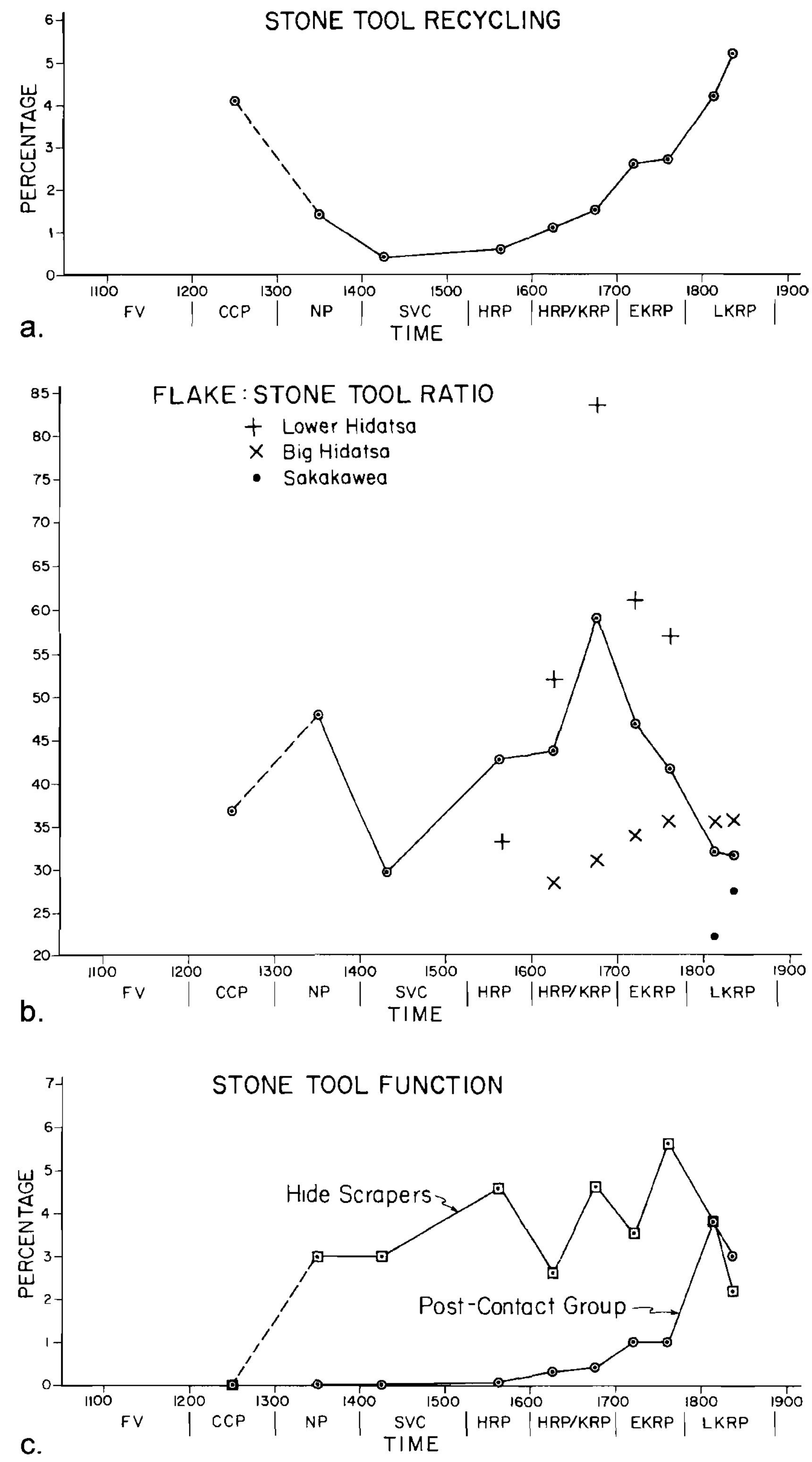


Figure 18.12. Distributions by time period for Hidatsa tradition lithic artifact data. a: percentage of stone tools exhibiting recycling; b: ratio of counts of size grade 1-4 flaking debris to counts of chipped stone tools from the same contexts; c: percentage of hide scraping tools and of tools in the post-contact functional group.

Practice pieces/miscellaneous tools are small and relatively thick, unpatterned objects modified by bifacial or unifacial retouch (usually percussion) around most or all of the tool perimeter. These tools lack use-wear, but usually exhibit particularly heavy battering, edge crushing, and step flaking from percussion flaking. These items are hypothesized to be stones non-purposely flaked by idle flint knappers or to be the results of efforts by inexperienced knappers (Ahler and Christensen 1983:154). Because of the hypothesized linkage between introduction of metal artifacts and loss of knapping skills, these items are thought to be potentially indicative of post-contact period knapping activities, and thus are included in the generalized post-contact period functional tool group. The distribution of these items tends to support a late historic period association. They first appear in the period 62 sample, and they remain relatively common in the period 71, 72, and 82 samples.

Figure 18.12c provides a graphic plot of the combined percentages of these three functional classes as the general post-contact period functional group. A strong tendency for these items to be most concentrated in the latest time periods is noted, confirming the association of these artifacts directly or indirectly with fur trade activities and products. Such artifacts are notably visible as a group in the AD 1600 samples, during a period of only remote indirect trade contact and low frequencies of trade artifacts in the Hidatsa villages. The presence of such items increases more than two-fold in the AD 1700s, signifying the increased influence from Euroamerican trading activity in that period, albeit still primarily by indirect processes through middlemen. After AD 1780 these artifacts increase again by a magnitude of twofold or more, attesting to the direct nature of the Euroamerican contact in that period and increased opportunity for the conjunction of native stone and introduced Euroamerican technologies and technological systems.

SUMMARY

The study of lithic artifact collections from the upper Knife-Heart region has involved examination and classification of some 15,688 stone tools and analysis of more than 88,000 pieces of size grade 3 and larger flaking debris. The majority of these samples derive from controlled excavations at sites within the KNRI, at White Buffalo Robe, and on the Cross Ranch. Only minor use has been made of collections from outside the upper Knife-Heart region, such as flaking debris samples from Slant Village and from the Mondrian Tree site. Thus, the study sample is by its nature restricted almost exclusively to Hidatsa tradition sites in the upper Knife-Heart region, and this analysis constitutes an assessment of lithic technological systems attributable to the various subgroups of the Hidatsas.

Analysis has focused on typology in arrowpoints, more subtle stylistic variation in side-notched arrowpoints, heat treatment in small KRF pressure-flaked bifaces, lithic resource utilization, and stone tool technology and function. The overwhelming emphasis has been placed on eliciting and offering explanations for general chronological changes in these variables, although in some instances intersite variation has also been taken into account.

Study of the relative frequency of alternative projectile point types including side-notched, unnotched triangular, and other forms indicates that there is no significant chronological change in these type frequencies through time in the study samples. Side-notched points, which constitute overall about 90 percent of the study sample, are the most common form in all time periods. No particular episode of increased interaction with Coalescent tradition peoples to the south can be documented by increased frequencies of unnotched triangular arrowpoints. This is contrary to conclusions reached in the ceramic study which posit significant interaction between the local study area and regions as far south as South Dakota during the Scattered Village complex period, AD 1400-1525.

The study of details of form and size in side-notched arrowpoints utilized the multivariate procedure of discriminant function analysis to assess differences in measurements in arrowpoint samples assigned to various time periods and taxonomic units. Several levels of analysis were performed with two sets of measurement taken on whole artifacts and proximal fragments, respectively. Discriminant analysis indicates that the 16-group, 8-group, and 4-group arrangements all yield statistically significant group differences. These differences are most clear and artifact classification is most accurate at the 4-group level of analysis. Even at that level, which involves placing artifacts in general time periods of circa 200 years duration, significant overlap in measurements occurs among all group samples. The distinction between the Late Woodland arrowpoints from sites on the Cross Ranch and all Plains Village arrowpoints is most clear, while the distinctions among various Plains Village period samples are less clear and less distinct. The first two discriminant functions define general chronological trends within the full arrowpoint sample, and chronological variation within the Plains Village samples, respectively. Strongest temporal change is evident in the variables distal haft length, notch depth, and artifact thickness, with arrowpoints having notches placed higher on the blade, with deeper notches, and with greater thickness later in time. These results generally conform to results obtained in a pilot study of a much smaller sample of artifacts (Ahler et al. 1982:247-250), and they generally conform to chronological patterns of change in arrowpoint form reported by Forbis (1962:85-92) based on his work at the Old Women's Buffalo Jump, Alberta, and by Kehoe (1973:47-48) for his work at the Gull Lake site in Saskatchewan. Thus, the patterns of detailed morphological variation observed in the regional samples constitute but a small reflection of stylistic or functional changes which are evident throughout a large part of the Northern Plains during the Late Prehistoric period.

The heat treatment study indicates strong temporal change in the incidence of heat treatment in KRF small thin patterned bifaces (primarily arrowpoints). Heat treatment is uncommon in the earliest time periods and increases in incidence in the periods up to and including the Heart River phase. The incidence of this technique remains relatively constant for a brief time, then increases again in the early AD 1700s, only to decrease rapidly thereafter. Strong differences in the incidence of heat treatment are noted between sites, and it is also noted that the patterns of high or low heat treatment tend to be consistent within sites. This suggests the coexistence of technological subtraditions within the study samples comprised of peoples who either did or did not routinely practice heat treatment. The general rise in the incidence of heat treatment up to and through the Heart River phase parallels several ceramic changes which follow the same pattern in this period, and it is hypothesized that heat treatment in KRF is a technological practice which can be identified most closely with the Mandan culture centered at Heart River. This hypothesis is supported by limited data on heat treatment from Slant Village, but it cannot be fully tested with the existing data sets. If we use this hypothesis as an operating assumption, then we are led to even more interesting explanations of the between-village variations in heat treatment. Heat treatment occurs in exceptionally high incidence at Lower Hidatsa Village, Mandan Lake, Mahhaha, and a few other sites. We hypothesize that the high incidence of heat treatment at each of these villages is due to Heart River Mandan influence or actual Mandan population presence at each site. At Lower Hidatsa this may involve incorporation of actual Mandan refugee populations into that village in the early AD 1700s. We can further speculate that Mahhaha is one of the villages where Mandan refugees from Heart River settled briefly during their migration to the Knife River during the AD 1700s.

The study of lithic raw material source variation has focused on changes in the relative frequency of four basic lithic source groups: KRF; a downriver source group dominated by smooth grey TRSS; a western source group dominated by porcellanite; and a local source group. KRF dominates among all materials in all periods, but variations in minority source types provide interesting data on changing directions of cultural interaction. Formative Village or Late Woodland groups seem to have had few connections with western source areas and they appear to have relied heavily on local lithic resources. It is suggested that much of the KRF used in this period derives from local terrace gravel sources. The picture for this period is perhaps confused by the decidedly temporary and probably seasonal nature of the sites producing the Late Woodland period samples.

In the Clark's Creek phase there is evidence for a heavy dependence on KRF. This, in combination with a relatively high occurrence of western source minority types and high incidence of bipolar reduction of medium to large KRF cobbles, leads us to hypothesize that Clark's Creek phase peoples heavily and systematically exploited the KRF quarries in Dunn and Mercer counties. The Clark's Creek phase populations in the region probably comprised an essential link facilitating the widespread distribution of KRF to other Middle Missouri tradition village sites throughout the Missouri River valley.

This system of heavy exploitation of the KRF quarries and redistribution into downriver villages seems to begin to break down with the advent of the Nailati phase. Interactions with downriver groups, thought to be primarily the Mandans at Heart River, increases at this time, but use of KRF diminishes. This pattern continues and becomes more accentuated through the Heart River phase in the AD 1500s. This is in agreement with ceramic data which suggest a strong Heart River phase Mandan influence throughout the whole region during this period of time. Around AD 1600 this pattern changes abruptly. KRF is again used more intensively, and strong evidence of linkages to western source areas is apparent. This change coincides with the arrival of the Hidatsa-proper and Awaxawi subgroups in the region and the growing identification of an Hidatsa ceramic tradition (and tribal identity) separate from the Heart River Mandans. Use of KRF declines steadily in the late AD 1700s and 1800s and local lithic materials are used more heavily during this time; this is attributed to decreased mobility of the villagers due to hostilities with the Sioux and a forced restriction of villagers' activities in regions far removed from the trench. When the Mandans move to the Knife River in the late AD 1700s they bring with them some downriver source material, but downriver connections seem to cease in the AD 1800s.

Studies of changes in lithic tool technology and function focused on evidence of the impact of the fur trade, both in the form of metal artifacts introduced into the native technological system, and in the form of changed economic patterns among the villagers. We studied the general technological composition of the lithic tool collections, changes in relative frequencies of patterned versus expedient tool forms, evidence of recycling, and special tool forms which directly express the impact of the fur trade. The presence of trade metal and glass beads indicates that artifacts of Euroamerican origin reached villagers at Knife River as early as AD 1600. The present study of lithic technology indicates that only minor alterations due to the fur trade can be seen as early as the AD 1600s, that more major changes began to appear in the AD 1700s, but that major transformations of the native lithic technological system did not occur until after circa AD 1780.

Changes in lithic technology attributable to the fur trade in the AD 1600s consist of the occurrence of very small numbers of stone tools called striker flakes used to fashion metal tools or used to strike sparks in a fire-making kit. Another artifact, potentially linked to the fur trade, which occurs at about this time in increased numbers is a large, unhafted, lateral-edged hide scraping tool. This tool form generally increases in frequency through the contact period, and it may be a tool used specifically for expedient preparation of trade furs.

Other relatively minor changes in native lithic technologies occur in the AD 1700s, during a period of continuing but increased indirect trade contacts. Small chipped stone tools begin to diminish in relative frequency, apparently in response to replacement by metal tool forms. Expedient pebble tools become more common, and patterned cutting tools decrease in relative frequency. Unhafted spall and slab form hide scrapers continue to increase in frequency, as do striker flakes and miscellaneous chipped forms indicative of marginal knapping skills/interests. Recycled stone tools become noticeably more common. Heat treatment is used less often in the production of arrowpoints. Throughout this period, up until the late AD 1700s, changes in the native technological system appear to be only minor adjustments brought on by increased use of lithics for modification of metal artifacts and by modest levels of replacement of lithic tools by metal counterparts.

Major changes in the native lithic technological systems occur after AD 1780/1790, following establishment of regular direct trade contacts first with northern traders and then with Spanish and American companies operating out of St. Louis. These changes include a significant reduction in the relative frequency of all small chipped stone tool forms (also reflected by an increased relative frequency of ground stone tool forms), significant increases in expedient cutting tools and scraping tools, a major increase in the occurrence of unhafted spall/slab hide scrapers, major increases in striker flakes and miscellaneous chipped forms, occurrence for the first time of gunflints, a relatively high incidence of recycled artifacts, and high incidence of patterned ground stone tools (many potentially manufactured more easily by metal implements). All components of the native lithic technological system remained in place during this time, but shifts in the relative emphasis placed on patterned forms, expedient forms, and recycled tools portend the imminent collapse and abandonment of native lithic technology. Only the ground stone tool technology was to survive relatively intact into the last half of the nineteenth century, as evidenced by the stone tool inventory from Like-a-Fishhook Village, which consists of 65 percent ground stone tools.

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Note: References in which an asterisk precedes the date were supported in whole or part by the Midwest Archeological Center's archeological and ethnohistorical research program for the Knife River Indian Villages National Historic Site.

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CHAPTER 19

KNRI AND UPPER KNIFE-HEART REGION UNMODIFIED FAUNAL REMAINS

Stanley A. Ahler, Lynn M. Snyder, Carl R. Falk,
and Holmes A. Semken, Jr.

INTRODUCTION

This chapter provides summary information on vertebrate remains collected through controlled excavations during Phase I investigations in the KNRI. Two aspects of these collections are emphasized. In Section I, identifiable vertebrate remains from animals likely to have played a role in the subsistence activities and other cultural pursuits of prehistoric human populations are discussed. This includes chronological trends in relative frequencies of various animal species as well as an expanded version of comparative and chronological analyses originally presented by Snyder (1988:202-205) for the faunal remains recovered from Taylor Bluff and other post-contact period contexts within the KNRI. Snyder's (1988) analysis is expanded to cover pre-contact age samples from collections obtained outside the KNRI. Section II is devoted to environmental and climatic change based on recovered microvertebrate remains from excavations at the KNRI and in other regional sites. This discussion is drawn entirely from a synthetic treatment by Semken and Falk (1987) which relies heavily on the large data base provided by the KNRI village sites.[1]

SECTION I: CULTURALLY SIGNIFICANT VERTEBRATE REMAINS

The data base discussed here is derived from 14 animal bone samples (Table 19.1) collected in systematic, screened excavations conducted in the upper Knife-Heart region. Table 19.1 also lists time period designations as outlined in Chapter 8 dealing with chronometric investigations, sample batch designations as identified in Chapter 17 on pottery analysis, and phase designations as formulated in Chapter 25 dealing with the regional culture-historic sequence. Fourteen samples are subdivided from six sites within and two outside the KNRI. These include prehistoric components at the Forkorner and Youess sites assigned to the Scattered Village phase (Ahler and Mehrer 1984:192-249, 270-299), deeply stratified deposits spanning many decades at both the Lower Hidatsa (Ahler and Weston 1981) and Big Hidatsa (Ahler and Swenson 1985) villages, and late post-contact age samples from Sakakawea (Ahler et al. 1980) and Taylor Bluff villages (Ahler 1988). Data from Nailati phase components at Cross Ranch Village (Calabrese 1972) and White Buffalo Robe Village (Lee 1980) are included to expand the temporal range farther into the pre-contact period.

The vertebrate assemblages considered in Section I are limited to the larger, size grade 1-3 remains (those caught in 1/4 inch screens). This is done to minimize differences resulting from sampling variations between Cross Ranch and sites in the KNRI, and also to focus the discussion on larger taxa which are most related to cultural procurement. Within the smaller-sized remains not considered in this section (those smaller than size grade 3), fish probably represent the only group present in sufficient abundance to be considered culturally significant. Certain of these smaller-sized remains are considered in the second section of this chapter.

Element frequency data (NISP, numbers of identified specimens, and MNI, minimum number of individuals, as appropriate) for economically or historically important animals are listed by species or appropriate identifiable group in Table 19.2. Species which occur in low frequencies (i.e., fish, birds, some mammals) and those considered probable natural intruders (amphibians, small rodents) are combined and discussed in groups. Data from Taylor Bluff Village are taken from Snyder (1988:203), and those for

[1] This chapter was prepared in 1990. Consequently, the authors were able to include information into this treatment which was not available when other studies of physical remains were written (e.g., Chapters 17, 18 and 21 were prepared in 1985 and 1986). Recent information used here comes primarily from salvage excavations at the Taylor Bluff Village reported in 1988 (Ahler 1988; Snyder 1988) and the revised regional phase classification presented in Chapter 25, herein, written in 1987. Since this writing, an inventory of faunal data from the Phase I inventory program has become available (Falk et al. 1991). (S.A.A.)

Cross Ranch are from Calabrese (1972:31-33). Data from all other sites are provided by Carl R. Falk from KNRI project records and his own identification inventories. Table 19.3 provides a list of identified faunal element frequencies collapsed into the appropriate phase or general time period (see Table 19.1) to provide a more general picture of chronological variation in vertebrate groups having potential economic or other cultural importance.

The contexts from which these assemblages were recovered vary greatly. The Taylor Bluff assemblage, for example, comes almost entirely from two midden-filled features; the Cross Ranch materials are from house fill, test excavations, and pit features; and the White Buffalo Robe Nailati phase materials are from both features and general level midden deposits. Materials from the three major Knife River villages are from house fill, features, and midden areas sampled during testing programs. While recognizing the potential for intrasite variation in the distribution and use of subsistence debris, as well as variation in recovered samples due to limited site testing, the samples are appropriate for general comments on assemblage composition and possible changes in relative representation of taxa through time.

Fishes

Fish taxa including goldeye, buffalo and sucker, and catfishes are commonly recovered from village sites in the Knife River region (Table 19.2). However, the relative proportions of fish remains in the vertebrate assemblages do show both intersite and chronological variation. No fish remains were recovered in the Nailati component at White Buffalo Robe, and only two specimens (0.2 percent of the total vertebrate collection) were recovered at Cross Ranch. In the Scattered Village sites and in the Hensler phase component at Lower Hidatsa fish contribute 0.1 percent to 1.3 percent of identified remains. The proportion of fish remains (NISP) at Lower Hidatsa rises slightly in the later components, to 2.9 percent in periods 71-72. Eighteenth century components at Big Hidatsa (periods 71-72) produced fish remains constituting 5.8 percent of the vertebrate samples. Two of the latest sites in the area, Sakakawea and Taylor Bluff, show distinct increases in proportions of fish remains over earlier collections. For two samples from Sakakawea, fish make up 8.1 to 13.7 percent of identified elements, respectively. At Taylor Bluff 100 size grade 1-3 specimens represent 10 percent of the identified sample. When collapsed across specific site

Table 19.1. Sources of collections used in the assessment of chronological changes in large fauna assemblage composition in the Knife River region.

Phase	Period	Batch	Site and Batch Name
Nailati (AD 1300-1400)	30	14-17 40	32OL14 Cross Ranch 32ME7 White Buffalo Robe, early
Scattered Village (AD 1400-1450)	41	77,78 80	32ME413 Forkorner 32ME415 Youess
Hensler (AD 1525-1600)	50	48,49	32ME10 Lower Hidatsa, period 5,6
Willows (AD 1600-1700)	60,61,62	46,47 68,69	32ME10 Lower Hidatsa, period 3,4 32ME12 Big Hidatsa, period 5,6
Minnataree (AD 1700-1780)	70,71,72	44,45 66,67	32ME10 Lower Hidatsa, period 1,2 32ME12 Big Hidatsa, period 3,4
Roadmaker (AD 1780-1830)	81,82	65 60-63	32ME12 Big Hidatsa, period 2 32ME11 Sakakawea, period 2,3
Four Bears (AD 1830-1886)	83	64 59 94	32ME12 Big Hidatsa, period 1 32ME11 Sakakawea, period 1 32ME366 Taylor Bluff, late

components and organized by time units (Table 19.3), these data show a very consistent increase in the use of fish through time. There is very little use evident in pre-contact periods; fish occurrence peaks in the post-contact period at 9.8 percent in the Roadmaker phase which brackets the closing decades of the eighteenth century and the opening decades of the nineteenth century.

Amphibians and Reptiles

Because of their small size (< grade 3) and presumed non-cultural origins, amphibian and snake remains are not common in the samples presented in Table 19.2. However, toads and frogs are present in relatively high frequencies at Cross Ranch where they constitute 19.6 percent of the vertebrate remains. Falk et al. (1980:605) record a total of 1,175 identified amphibian and snake elements at White Buffalo Robe, but consider them non-cultural in origin. A total of 23 size grade 1-3 toad elements and 170 grade 4-5 frog and toad specimens recovered from Taylor Bluff were concentrated almost exclusively in the lower levels of a single large undercut pit, where they are considered natural intrusions (Snyder 1988:202).

Reported turtle remains in the collections considered here are limited to scattered painted turtle elements recovered at Cross Ranch (one specimen), Lower Hidatsa (four specimens), and Big Hidatsa (12 specimens). Two western painted turtle elements were recovered at White Buffalo Robe (Falk et al. 1980:570), although they are not from the Nailati component considered here. Turtle remains do not constitute more than 0.3 percent of identified vertebrate remains in the sites under consideration, with the exception of the Willows phase component (periods 61-62) at Big Hidatsa, where five specimens represent 1.0 percent of the vertebrate sample. No turtle remains were identified at Sakakawea or Taylor Bluff.

Birds

Birds are present in low frequencies (0.8-3.2 percent) in all assemblages in the area from early to late (Table 19.2), and no distinct trends can be detected in their relative representation through time (Table 19.3). Possible subsistence taxa-ducks, geese, and upland game birds-and non-subsistence taxa including raptors, woodpeckers, and small perching birds are present in small numbers in all assemblages, but in no instance do they appear to constitute an important subsistence or economic resource. Ethnographic records of the use of bird bones, skins, and plumage in decoration and ceremonial bundles, and the presence of bird bone in modified assemblages (Parmalee 1977) do, however, attest to the regular use of some of these birds for non-subsistence purposes.

Mammals

Without exception, mammal remains constitute the major portion of all site and site component vertebrate samples. In 11 of the 14 data sets considered, 90 percent or more of recovered remains are those of mammals (Table 19.2). Two taxa, large canids and bison, are dominant in all samples. Falk (1977) has noted that this pattern is due in part to traditional archeological recovery techniques which emphasize recovery, often without systematic screening of deposits, of "identifiable" specimens, and which thus produce a bias toward larger taxa and/or specimens. Of the collections considered here, only a portion of the Cross Ranch sample was recovered without consistent screening (Calabrese 1972:8). Consequently, the dominance of bison and canid remains must reasonably reflect cultural selection processes centered on the use of bison as a primary subsistence resource and on the dog as both a food resource and a beast of burden.

Although no systematic attempt has been made to distinguish domestic dog from wolf and coyote remains in the Middle Missouri area assemblages (but see Morey 1986), the relatively high numbers of recovered canid specimens and cranial morphology suggest that most of the remains are those of domestic dogs. Large canids (domestic dogs) are present in all assemblages from early to late, and constitute from 0.5 to 35.2 percent of identified vertebrate remains. They are represented in highest frequencies in the Nailati phase component at White Buffalo Robe (527 specimens, 35.2 percent), the early Knife River component at Big Hidatsa (94 specimens, 20.0 percent) and the mixed period 80-83 sample from Sakakawea (352 specimens, 23.6 percent). It should be noted that extreme variations in intrasite frequency of canid elements also occur. For example, among a series of eight Nailati phase house areas at White Buffalo Robe, the relative frequency of canid elements in each subsample varies from a minimum of 3.4 percent to a maximum of 81.7 percent of identified remains. Such extremes in the intersite and intrasite occurrence of canids suggest a very complex taphonomy and a variable role for the domestic dog as a food resource among village groups, with its usage probably varying according to cultural preference and resource stress.

Bison, by number of identified specimens (NISP), minimum number of individuals (MNI), and estimated meat yield (Falk et al. 1980:607), clearly constitute the major animal subsistence resource throughout the Plains Village occupation sequence. Their relative frequencies, based on number of identified specimens, range from 58.7 percent of vertebrate remains in the Nailati component at White Buffalo Robe to 93.7 percent in the earliest component at Lower Hidatsa. When the average weight of this animal is considered, its dominance as a subsistence resource is even more obvious (cf. Falk 1977). Its relative abundance appears to be stable over time, with no clear indication of either an increase or decrease through these assemblages. The somewhat lower percentages of bison in the period 80-83 sample at Sakakawea (59.1 percent), the period 61-62 sample at Big Hidatsa (63.0 percent), and the period 30 sample at White Buffalo Robe (58.7 percent) result in large measure from the high frequency of canid remains in each of these samples; these samples do not follow in close chronological order.

Other large artiodactyls (wapiti, deer, and pronghorn) are present in all area assemblages but always in low frequencies. They never constitute more than five percent of mammalian remains, and show no consistent trends of increase or decrease through time.

One animal which might be expected to show greater frequency as Native American contact with European and American traders increased is the beaver. While beaver remains are relatively uncommon in all site samples (Table 19.2), the collapsed phase data (Table 19.3) show a clear indication of increasing frequencies of beaver remains from earlier to later time units in the Knife River area, consistent with expectations. Beaver remains are absent or present in very low frequencies (<0.3 percent) in pre-contact age and early contact age (AD 1700 and earlier) components. Frequency of beaver remains doubles in the eighteenth century Minnataree phase samples, and nearly doubles again (1.2 percent) by the latest time period, post-AD 1830. Beaver are relatively most abundant at Taylor Bluff (perhaps the least mixed post-AD 1830 sample) where they comprise 2.8 percent of identified mammal remains (Table 19.2).

Only two Old World mammal domesticates reflecting European contact are represented in these assemblages. A single domestic goat element was recovered at Taylor Bluff and may be of recent origin (Snyder 1988:203). Horse remains are quite rare (Table 19.2). The earliest occurrence is in nineteenth-century Minnataree phase samples from Big Hidatsa. Two additional specimens are identified from later components at Big Hidatsa, four horse bones are identified from Sakakawea, and two are present in the Taylor Bluff sample.

SECTION II: RODENT AND INSECTIVORE REMAINS AND ENVIRONMENTAL CHANGE

Semken and Falk (1987) provide a detailed analysis of rodent and insectivore remains from 95 Holocene and nine late Wisconsinan localities or sites in the Northern Plains (Iowa, Nebraska, and the Dakotas). In the portion of their analysis dealing with the latest part of the Holocene, they draw heavily on data from archeological sites in the upper Knife-Heart region, and particularly from KNRI sites. Table 19.4 provides a summary of data on the minimum number of individuals (MNI) of rodent and insectivore taxa identified for a total of 13 assemblages from 11 sites in the region. Samples from the KNRI include collections from Youess, Forkorner, Poly, Elbee, Lower Hidatsa, Big Hidatsa, Sakakawea, and Taylor Bluff. Site samples from locations outside the KNRI include White Buffalo Robe, Cross Ranch, and Bagnell villages. Data for Taylor Bluff Village listed in Table 19.4 derive from Snyder (1988:189) and VanNest and Semken (1988); all other data listed in Table 19.4 derive from Semken and Falk (1987:289-296). In the Semken and Falk study, only assemblages with 11 or more taxa were considered.

Semken and Falk organize their data and their assessment of environmental change according to climatic episodes identified by Wendland (1978) and Wendland and Bryson (1974). Only the two latest Holocene episodes are relevant here, the Pacific, 850-400 years BP (AD 1100-1550), and the Neo-Boreal, 400-100 years BP (AD 1550-1850). With reference to the major time periods used in this volume and identified for site assemblages in Table 19.4, the Pacific episode includes site samples in periods 30, 41, and 42, and the Neo-Boreal episode includes samples from sites assigned to time periods 50 through 83.

Table 19.2. Intersite comparison of unmodified vertebrate fauna from archeological sites in the Knife River area.

	Period, Site, and Batch Number														
Taxonomic Grouping	30 32OL14 14-17	30 32ME7 40	41 32ME413 77,78	41 32ME415 80	50 32ME10 48,49	61-62 32ME10 46,47	61-62 32ME12 68,69	71-72 32ME10 44,45	71-72 32ME12 66,67	81-82 32ME12 65	81-82 32ME11 60-63	83 32ME12 64	83 32ME11 59	83 32ME366 94	Total
Hiodon alosoides (goldeye)						2 (4.8)	2 (7.1)	11/3 (26.8)	30/4 (26.8)	6 (15.0)	84/10 (34.9)	1 (14.3)	13/2 (15.5)	1 (1.0)	150 (20.9)
Catostomidae/Ictiobus (suckers/buffalo)	1 (50.0)						1 (3.6)	2 (4.9)	3 (2.7)		2 (1.0)		12 (14.3)	9 (8.7)	30 (4.2)
Ictalurus sp. (catfishes)				2 (66.7)	12/2 (92.3)	38/3 (90.5)	21/3 (75.0)	27/3 (65.9)	61/5 (54.5)	30/5 (75.0)	129/17 (53.5)	5 (71.4)	36/4 (42.9)	70/11 (68.0)	431 (60.1)
Other fishes	1 (50.0)		1 (100.0)	1 (33.3)	1 (7.7)	2 (4.8)	4 (14.3)	1 (2.4)	18 (16.1)	4 (10.0)	26 (10.8)	1 (14.3)	23 (27.4)	23 (22.3)	106 (14.8)
Total Fishes (% site total)	2 (0.2)		1 (0.1)	3 (1.0)	13 (1.3)	42 (2.7)	28 (5.5)	41 (2.9)	112 (5.8)	40 (3.6)	241 (13.7)	7 (1.5)	84 (8.1)	103 (10.0)	717 (4.8)
Total Amphibians (% site total)	180 (19.6)					1 (0.1)					1 (0.1)			23 (2.2)	205 (1.4)
Total Reptiles (% site total)	1 (0.1)				1 (0.1)	1 (0.1)	5 (1.0)	2 (0.1)	5 (0.3)	2 (0.2)					17 (0.1)
Anatidae (waterfowl) (ducks, geese, swans)	1 (14.3)			1 (33.3)	2 (40.0)		1 (6.2)	3 (8.1)	7 (14.6)	2 (13.3)	1 (4.2)				18 (16.9)
Caradriidae/Phasianidae (plovers/grouse)	1 (14.3)				2 (40.0)	12 (40.0)	4 (25.0)	9 (24.3)	11 (22.9)	2 (13.3)	11 (45.8)	3 (60.0)	2 (20.0)	2 (9.5)	59 (22.1)
Raptors (hawks/eagles/owls)	2 (28.6)		1 (20.0)		1 (20.0)	6 (20.0)	5 (31.2)	14 (37.8)	13 (27.1)	5 (33.3)	5 (20.8)		5 (50.0)	12 (57.1)	69 (26.3)
Picidae/Passeriformes (woodpeckers/perch. bds)	2 (28.6)	35 (97.2)	3 (60.0)			6 (20.0)	4 (25.0)	3 (8.1)	9 (18.8)	2 (13.3)	5 (20.8)	1 (20.0)	2 (20.0)	2 (9.5)	74 (28.2)
Other birds	1 (14.3)	1 (2.8)	1 (20.0)	2 (66.7)		6 (20.0)	2 (12.5)	8 (21.6)	8 (16.7)	4 (26.7)	2 (8.3)	1 (20.0)	1 (10.0)	5 (23.8)	42 (16.0)
Total Birds (% site total)	7 (0.8)	36 (2.3)	5 (2.8)	3 (1.1)	5 (0.5)	30 (1.9)	16 (3.2)	37 (2.6)	48 (2.5)	15 (1.4)	24 (1.4)	5 (1.1)	10 (1.0)	21 (2.0)	262 (1.8)
Small mammal (rabbits/hares/squirrels)		8 (0.5)		4 (1.5)	3 (0.3)	4 (0.4)	7 (1.5)	1 (0.1)	17 (1.0)	4 (0.4)	4 (0.3)	2 (0.4)	2 (0.2)	3 (0.3)	59 (0.4)
Castor canadensis (beaver)	1 (0.1)				3/2 (0.3)	2 (0.1)	5 (1.1)	3/2 (0.2)	19/2 (1.1)	2 (0.2)	27/6 (1.8)	1 (0.2)	5 (0.5)	25/2 (2.8)	93 (0.7)
Small rodent (mice/voles/gopher)	20 (2.8)		1 (0.5)	3 (1.1)	2 (0.2)	12 (0.8)	1 (0.2)	4 (0.3)	7 (0.4)	3 (0.3)	31 (2.1)		2 (0.2)	9 (1.0)	95 (0.7)
Large canid (dog/wolf/coyote)	56 (7.7)	527 (35.2)	1 (0.6)	18 (6.7)	31 (3.1)	176 (11.8)	94 (20.0)	62 (4.6)	223 (12.6)	105 (10.0)	352 (23.6)	33 (7.2)	83 (8.8)	33 (3.7)	1794 (13.3)
Carnivora (fox/bear/cat)	2 (0.3)		33 (19.1)	6 (2.2)	3 (0.3)	3 (0.2)	1 (0.2)	5 (0.4)	2 (0.1)	5 (0.5)	4 (0.3)	2 (0.4)	2 (0.2)	1 (0.1)	69 (0.5)
Mustelids (badger/skunk)		2 (0.1)				3 (0.2)	1 (0.2)		1 (0.1)		2 (0.2)		1 (0.1)		10 (0.1)
Equus caballus (horse)									1 (0.1)	2 (0.2)	4/3 (0.3)			3 (0.3)	10 (0.1)
Cervus elaphus (wapiti)	2 (0.3)				7/2 (0.7)	11/3 (0.7)	6/2 (1.3)	5/3 (0.4)	33/4 (1.9)	13/2 (1.2)	9/3 (0.6)	1 (0.2)			87 (0.6)
Small artiodactyl (deer/pronghorn)	43 (5.9)	81 (5.4)	2 (1.2)	2 (0.7)	11 (1.1)	155 (10.4)	21 (4.6)	107 (8.0)	59 (3.3)	28 (2.7)	20 (1.3)	24 (5.2)	28 (3.0)	11 (1.2)	592 (4.4)
Bison bison (bison)	603/16 (82.9)	878 (58.7)	136/6 (78.6)	234/7 (87.6)	925/22 (93.7)	1113/26 (74.6)	319/8 (69.8)	1146/25 (85.8)	1391/20 (78.7)	886/20 (84.3)	1039/36 (69.6)	395/11 (86.2)	825/41 (87.0)	753/15 (85.4)	10643 (78.7)
Large artiodactyl (wapiti/bison)					2 (0.2)	12 (0.8)	2 (0.4)	2 (0.1)	15 (0.8)	2 (0.2)				44 (5.0)	79 (0.6)

Table 19.2. Concluded.

Taxonomic Grouping	Period, Site, and Batch Number 30 32OL14 14-17	30 32ME7 40	41 32ME413 77,78	41 32ME415 80	50 32ME10 48,49	61-62 32ME10 46,47	61-62 32ME12 68,69	71-72 32ME10 44,45	71-72 32ME12 66,67	81-82 32ME12 65	81-82 32ME11 60-63	83 32ME12 64	83 32ME11 59	83 32ME366 94	Total
Total Mammal (% site assemblage)	727 (79.3)	1496 (97.5)	173 (96.6)	267 (97.8)	987 (98.1)	1491 (95.3)	457 (90.3)	1335 (94.3)	1768 (91.5)	1492 (94.9)	1050 (84.9)	458 (97.4)	948 (91.0)	882 (85.7)	13531 (91.8)
Total Site NISP	917	1532	179	273	1006	1565	506	1415	1933	1107	1758	470	1042	1029	14732

Note: Percentage of taxon = % of class. Percentage of class = % of total site assemblage. Single species MNI > 1 indicated following /.

Table 19.3. Interphase comparisons of unmodified vertebrate fauna from archeological sites in the Knife River area.

Taxonomic Grouping		Phase and Time Period Nailati 30	Scattered Village 41	Hensler 50	Willows 61-62	Minna-taree 71-72	Road Maker 81-82	Four Bears 83	Total
Fishes	n	2	4	13	70	153	281	194	717
	%	<0.1	0.9	1.3	3.4	4.6	9.8	7.6	4.9
Amphibians	n	180	0	0	1	0	1	23	205
	%	7.3	0.0	0.0	<0.1	0.0	<0.1	0.9	1.4
Reptiles	n	1	0	1	6	7	2	0	17
	%	<0.1	0.0	<0.1	0.3	0.2	<0.1	0.0	0.1
Birds	n	43	8	5	46	85	39	36	262
	%	1.8	1.8	0.5	2.2	2.5	1.4	1.4	1.8
Small mammal/rodent/ carnivore/mustelid	n	32	47	8	32	37	53	24	233
	%	1.3	10.4	0.8	1.5	1.1	1.8	0.9	1.8
Castor canadensis (beaver)	n	1	0	3	7	22	29	31	93
	%	<0.1	0.0	0.3	0.3	0.7	1.0	1.2	0.6
Large canid (dog/coyote/wolf)	n	583	19	31	270	285	457	149	1794
	%	23.8	4.2	3.1	13.1	8.5	16.0	5.9	12.2
Equus caballus (horse)	n	0	0	0	0	1	6	3	10
	%	0.0	0.0	0.0	0.0	<0.1	0.2	0.1	0.1
Cervus elaphus (wapiti)	n	2	0	7	17	38	22	1	87
	%	<0.1	0.0	0.7	0.8	1.1	0.8	<0.1	0.6
Small artiodactyl (deer/pronghorn)	n	124	4	11	176	166	48	63	592
	%	5.1	0.9	1.1	8.5	5.0	1.7	2.5	4.0
Bison bison and unid. large artio.	n	1481	370	927	1446	2554	1927	2017	10722
	%	60.5	81.9	92.1	69.8	76.3	67.3	79.4	72.8
Total	n	2449	452	1006	2071	3348	2865	2541	14732
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 19.4. Taxonomic identifications and MNI counts for rodent and insectivore fauna from excavated collections from the KNRI and the upper Knife-Heart region. Data taken from Semken and Falk (1987:289-296) and Snyder (1988:189-190).

	Site Name, Number, and Time Period												
Taxon	White Buffalo Robe 32ME7 30	Cross Ranch 32OL14 30	Youess 32ME413 41	Forkor-ner 32ME415 41	Poly 32ME409 41	Bagnell 32OL16 42	White Buffalo Robe 32ME7 50	Elbee 32ME408 50?	Lower Hidatsa 32ME10 50-72	Big Hidatsa 32ME12 61-82	White Buffalo Robe 32ME7 80?	Sakaka-wea 32ME11 80	Taylor Bluff 32ME366 83
Insectivora													
Sorex cinereus	1	-	-	-	-	-	1	-	2	1	-	-	-
Sorex hoyi	-	-	-	-	-	-	-	-	-	1	-	-	-
Chiroptera	-	-	-	-	-	-	-	2	-	-	-	-	-
Lagomorpha													
Sylvilagus sp.	x	-	1	-	-	2	x	3	1	3	-	1	-
Lepus townsendii	-	-	1	-	2	2	-	-	3	4	-	-	1
Lepus sp.	-	-	-	-	-	-	-	-	1	4	-	2	-
Rodentia													
Spermophilus tridecemlineatus	3	1	2	2	1	-	2	2	10	11	1	5	1
Spermophilus richardsonii	-	-	1	1	-	-	-	-	2	4	-	-	-
Spermophilus sp.	-	-	-	-	-	x	-	-	-	-	-	-	-
Tamius minimus	-	-	-	1	1	-	-	-	-	-	-	-	-
cf. Tamius striatus	-	-	-	-	-	-	-	-	-	?	-	-	-
Cynomys ludovicianus	1	-	-	-	-	-	1	-	-	-	-	-	1
Thomomys talpoides	14	2	2	2	1	-	1	3	7	7	2	5	4
Perognathus flavescens	13	-	-	-	-	x	11	-	-	-	1	-	-
Perognathus sp.	-	-	3	1	1	-	-	-	5	2	-	1	1
Castor canadensis	-	1	-	-	-	2	x	1	3	4	x	2	2
Peromyscus maniculatus	20	2	2	4	3	-	21	-	-	-	9	-	-
Peromyscus cf. leucopus	-	-	-	-	-	-	-	-	-	-	-	-	11
Peromyscus sp.	-	1	8	2	1	x	-	7	59	185	-	84	-
Onychomus leucogaster	6	-	1	-	1	-	1	-	8	6	-	1	-
Neotoma sp.	-	-	-	-	-	-	-	?	-	-	-	-	-
Clethrionomys gapperi	5	-	1	-	-	-	1	2	4	5	1	3	2
Microtus ochrogaster	7	1	-	-	-	-	1	-	1	4	1	2	2
Microtus pennsylvanicus	25	-	1	3	4	-	10	5	8	15	3	12	2
Microtus sp.	-	-	-	-	-	-	-	1	-	-	-	-	-
Ondatra zibethicus	1	-	-	-	-	-	1	-	-	1	-	1	-
Zapus hudsonius	-	-	-	-	-	-	-	-	-	1	-	-	-
Rattus norvegicus	-	-	-	-	-	-	-	-	-	2	-	3	-
Mus musculus	-	-	-	-	-	-	4	-	-	-	-	-	-
Erithizon dorsaum	-	-	-	-	-	-	-	-	1	1	-	1	-
Total	96	8	23	16	15	6+	55+	26	114	261	18+	123	27

Note: Numbers indicate MNI; x = taxon present; ? = inconclusive.

Semken and Falk (1987) use two primary methods for extracting paleoenvironmental interpretations from the data sets. The first involves construction of maps showing the area of sympatry-"the geographic region of common occurrence of all (or most) species recorded in the site" (1987:180). The second involves the "relative abundance (percent) of both species and the minimum number of individuals (MNI) of each with respect to their centers of distribution" (1987:180). These methods are most reliably applied to large samples and Semken and Falk's analysis was therefore focused on the largest collections from the multicomponent White Buffalo Robe Village and from the Lower Hidatsa, Big Hidatsa, and Sakakawea villages within the KNRI.

The sample from White Buffalo Robe Village (Falk et al. 1980) is divided into three fanules representing distinct temporal units, based on cultural associations, identified with the Nailati phase (period 30), the Hensler phase (period 50), and either the Roadmaker or the Four Bears phase (period 80). The three samples from this village represent the only collections from North Dakota assigned to the Pacific episode which are studied in detail. Collectively, the micromammals in these three samples from White Buffalo Robe may reflect either a gradual increase in climatic severity through time or increased destruction of the local habitat as a result of continuing human activity or both (Semken and Satorius 1980; Semken and Falk 1987:214).

Sympatry data lead Semken and Falk (1987:214) to conclude that the Nailati phase samples indicate a reduced climatic gradient between North and South Dakota during the Pacific episode via a warming of temperatures in North Dakota during the Nailati phase occupation (AD 1300-1400). They also suggest that effective rainfall was reduced slightly in North Dakota from present regimes and that this condition remained much the same until the sixteenth century. By examining the relative abundance of particular species in each sample at White Buffalo Robe, Semken and Falk (1987:215) document a transition in dominance from grazers to browsers during the progression from the Pacific to the Neo-Boreal episode. They attribute this to a shift at White Buffalo Robe Village from typical prairie vegetation in Nailati Phase times to a shrub/herbaceous vegetation by the close of the nineteenth century. Fire, flood, landslide, aridity, and increased cultural activity are cited as possible controlling variables in this vegetation change at that locality.

The Neo-Boreal climatic episode is predicted to be cooler and more moist than either the recent episode (< 100 years BP) or the preceding Pacific episode (Semken and Falk 1987:215). Distributional data for micromammal remains from Lower Hidatsa indicate that the Neo-Boreal climate at that locality must have been cooler than during the preceding Pacific episode (Semken and Falk 1987:218). Various lines of evidence for the Big Hidatsa local fauna, largely contemporaneous with that from Lower Hidatsa Village, suggest a "tall-grass prairie parkland in central North Dakota during the Neo-Boreal episode" (Semken and Falk 1987:219). The micromammal data from Sakakawea village, falling into the late part of the Neo-Boreal episode, indicate a slight warming of climate, but with temperatures still below those reflected by the Pacific episode specimens from White Buffalo Robe Village (Semken and Falk 1987:219).

SUMMARY

The study of large and small vertebrate remains from excavations in the KNRI has proven useful for understanding subsistence and other cultural practices as well as elucidating environmental change during the period of Plains Village cultural development in the region. The data indicate that bison was the predominant food species throughout this period, with the diet supplemented by wapiti, deer, pronghorn, fish, and the domestic dog. These facts are largely consistent with historical and ethnographic information. Fish and domestic dog remains vary greatly in relative abundance from site to site but fish remains become strikingly more abundant in later samples. This could be a reflection of greater restrictions on bison hunting (perhaps due to intertribal hostilities) which forced a greater reliance on truly local resources. Such a scenario (or this decrease in bison in the samples) should be studied relative to the information it may provide regarding individual Hidatsa subgroup food preferences or episodes of subsistence stress which forced greater use of less optimal resources. Two taxa, beaver and horse, provide documentation of the growing influence from Euroamericans during the post-contact period. Beaver remains, though rare, become increasingly more common during this time sequence. Horse remains also occur only in deposits dated to the late eighteenth and early nineteenth centuries at sites in the KNRI.

Microvertebrate remains generally support an interpretation that the regional climate was substantially warmer and somewhat drier than at present during the Nailati phase; after the sixteenth century, the climate became somewhat cooler than in recent times. One can hypothesize that in this region of the Northern Plains, marginally dependable for maize horticulture, such changes may have had a telling effect on the success of horticultural practices and related settlement patterns.

CHAPTER 19

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CHAPTER 20

MODIFIED BONE AND ANTLER REMAINS FROM THE KNRI AND THE UPPER KNIFE-HEART REGION

Timothy Weston and Stanley A. Ahler

INTRODUCTION

The following chapter presents an analysis of modified bone and antler remains recovered during Phase I investigations at Plains Village sites within the KNRI and at other selected village sites in the upper Knife-Heart region.[1] In this analysis, the modified vertebrate artifacts are inventoried according to a descriptive typology, and changes in the composition of tool assemblages are examined through time. The primary focus of the investigation is on examining cultural change from the perspective of the native bone tool industry. A specific type of cultural change will be examined, that of acculturation. Acculturation has been well documented among living groups, but has seen minimal assessment in archeological situations where documentation is more difficult. This study represents an examination of acculturation from an archeological perspective, based, for the most part, on artifact samples from the KNRI.

Modified bone is a major aboriginal industry in virtually all Plains Village sites attributable to the Mandans, Hidatsas, and Arikaras (Lehmer 1966, 1971; Baerreis and Dallman 1961: Smith 1977; Smith and Grange 1958; Wood 1967; Hoffman 1967,1968; Krause 1972; Wood and Woolworth 1964; Woolworth and Wood 1964; Spaulding 1956; Caldwell et al. 1964; Neuman 1964; Calabrese 1972; Falk et al. 1980). It can be shown, and it will be demonstrated in this study, that bone tool assemblages change dramatically with the introduction of Euroamerican metal tools. Prior to contact, a large diverse bone tool industry is present. After contact, the disappearance of certain tool types, such as small piercing tools, can be documented as they are replaced with metal substitutes. In addition, bone tools modified with metal can be observed, followed later in the stratigraphic sequence by the all but complete replacement of the bone tool industry with metal tools.

This study has two specific goals. First is the construction of a model illustrating acculturation as reflected by the replacement of bone tools with metal substitutes, taking into account Euroamerican penetration of the area and the associated smallpox epidemics. The second goal is to define the relationship between assemblage structure and level of acculturation. This information will be relevant to archeology in areas where good historic documentation is not available.

Table 20.1 provides information on the collections and data sets included in the present analysis. Data from 12 sites will be summarized according to the phase structure and regional chronology presented in Chapter 25 of this report. Ten of the twelve village sites included in the present analysis are within the KNRI, and data from White Buffalo Robe Village (Lee 1980) and Cross Ranch Village (Calabrese 1972) are also included to expand the portions of the data set assigned to the prehistoric, pre-contact period. In the discussion of the data, we will make frequent reference to the fur trade periods defined by Thiessen (Chapter 13, this volume) for the Knife River area, which include: 1) the period of indirect trade, from the time of earliest diffusion of Euroamerican cultural elements into the region until circa AD 1740; 2) the period of intermittent trade contact, from circa AD 1740 to 1790; 3) the period of frequent trade contact, from circa AD 1790 to 1822; and 4) the period of local trade, from AD 1822 to 1860. With reference to the cultural phase units presented in Table 20.1, the Nailati and Scattered Village phases can be considered fully pre-contact and pre-trade in age; the indirect trade period appears to have started sometime during the Hensler phase (AD 1525-1600), as will be

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[1] This chapter was prepared in 1991. Consequently, the authors were able to include information into this treatment which was not available when other studies of physical remains were written (e.g., Chapters 17, 18, and 21 were prepared in 1985 and 1986). Recent information used here comes primarily from salvage excavations at the Taylor Bluff Village reported in 1988 (Ahler, ed. 1988; Snyder 1988) and the revised regional phase classification presented in Chapter 25, herein, written in 1987. An earlier version of this chapter was published in 1993 (Weston 1993). (S.A.A.)

shown from modified bone tool data, and to continue through the early part of the Minnataree phase; the period of intermittent trade contact is associated primarily with the late part of the Minnetaree phase; the period of frequent trade contact coincides largely with the Roadmaker phase; and the period of local trade is linked closely with the final, Four Bears phase.

This study draws quite heavily on research reported by Weston (1986; 1990) which focuses specifically on modified bone collections from the three major villages within the KNRI: Big Hidatsa, Lower Hidatsa, and Sakakawea. The tool typology developed by Weston (1986; 1990) is used for all samples analyzed in the present paper. Bone tool type frequency data for sites within the KNRI not included in Weston's study, previously unreported, are listed in Table 20.2. Direct examination and classification of tools listed in Table 20.2 was performed by Christopher Wenker, using Weston's system, under the direction of Ahler. Ahler reclassified modified bone and antler specimens reported by Falk et al. (1980), Calabrese (1972), and Snyder (1988) as accurately as possible according to the types used by Weston (1986; 1990). The examination of metal/stone tool modification marks on modified bone and antler specimens is limited to collections from the KNRI, as these were the only specimens which could be directly examined for such information by Weston, Ahler, or Wenker.

ACCULTURATION

Acculturation is a process of cultural change which occurs in contact situations. Many acculturation

Table 20.1. Chronological organization of data and collection sources used in the study of modified fauna from the upper Knife-Heart region.

Phase (Dates)	Period	Batch	Site and Batch Name	Reference
Nailati	30	43	32ME9 Buchfink	Table 20.2
(AD1300-1400)		40	32ME7 White Buffalo Robe, early	Falk et al. 1980
		14-17	32OL14 Cross Ranch	Calabrese 1972
Scattered	41	73	32ME407 Poly	Table 20.2
Village		75	32ME409 Scoville	Table 20.2
(AD 1400-1450)		77,78	32ME413 Forkorner	Table 20.2
		79	32ME414 Hump	Table 20.2
		80	32ME415 Youess	Table 20.2
		70	32ME12 Big Hidatsa, period 7	Weston 1986, 1990
Hensler	50	48,49	32ME10 Lower Hidatsa, per. 5,6	Weston 1986, 1990
(AD 1525-1600)		39	32ME7 White Buffalo Robe, late	Falk et al. 1980
Willows, early	61	47	32ME10 Lower Hidatsa, period 4	Weston 1986, 1990
(AD 1600-1650)		69	32ME12 Big Hidatsa, period 6	Weston 1986, 1990
Willows, late	62	46	32ME10 Lower Hidatsa, period 3	Weston 1986, 1990
(AD 1650-1700)		68	32ME12 Big Hidatsa, period 5	Weston 1986, 1990
Minnataree, early	71	45	32ME10 Lower Hidatsa, period 2	Weston 1986, 1990
(AD 1700-1740)		67	32ME12 Big Hidatsa, period 4	Weston 1986, 1990
Minnataree, late	72	44	32ME10 Lower Hidatsa, period 1	Weston 1986, 1990
(AD 1740-1780)		66	32ME12 Big Hidatsa, period 3	Weston 1986, 1990
Roadmaker	80-83	60-63	32ME11 Sakakawea, periods 1,2,3	Weston 1986, 1990
(AD 1780-1830)		65	32ME12 Big Hidatsa, period 2	Weston 1986, 1990
Four Bears	83	64	32ME12 Big Hidatsa, period 1	Weston 1986, 1990
(AD 1830-1886)		94	32ME366 Taylor Bluff, late	Snyder 1988

Table 20.2. Modified bone/antler type frequencies for small site collections from the KNRI.

Tool Type	Site and Time Period							
	Buchfink 32ME9 30	Running Deer ME383 ?	Poly ME407 41	Scovill ME409 41	For-korner ME413 41	Hump ME414 41	Youess ME415 41	Total
Split ribs (spatulas)	-	-	1	-	1	1	1	4
Scapula hoes	1	-	1	-	-	-	5	7
Scapula fragments	-	-	1	1	1	-	1	4
Antler tines	-	-	-	-	-	-	1	1
Antler beams	-	-	-	-	1	-	-	1
Antler strips	-	-	-	-	1	-	4	5
Piercing tools (awls)	-	1	1	1	2	1	8	14
Tubes/beads	-	-	-	-	1	-	2	3
Expedient tools	-	2	-	-	1	1	3	7
Fleshing tools	-	-	-	-	-	-	-	-
Cancellous tools	-	-	-	-	-	-	-	-
Polished bone frag.	-	-	-	3	2	-	-	5
Ornaments	-	-	-	1	-	-	-	1
Unique objects	-	-	-	1	2	-	-	3
Manufacturing debris	-	-	-	-	1	-	1	2
Total by site	1	3	4	7	13	3	26	57
Metal/stone modification:								
Metal	-	-	-	-	1*	-	-	1
Stone	-	-	2	-	-	-	5	7
Indeterminate	1	3	2	7	12	3	21	49

* Note: This artifact is from Feature 13, in the central part of the Forkorner site; glass trade beads were recovered in association. On this basis, the metal tool modification is probably accurate, but it is considered a post-contact age artifact, intrusive into the pre-contact age deposits which form the dominant component at the site.

studies are published in the literature dating from the 1930s through the early 1960s. Most center on the changes brought about by contact between Euro-americans and native societies (Herskovits 1938; Redfield et al. 1936; Broom et al. 1954). Drastic changes in native cultures after contact have been described, including changes in material culture, social organization, residence patterns, and ceremonial life.

An extensive review of acculturation literature is presented by Teske and Nelson (1974), in an effort to distinguish between acculturation and assimilation and to clarify the definitions of both. They define acculturation as a process by which a culture adapts to new conditions imposed as the result of contact with another culture. The following series of key points in the process of acculturation was derived (Teske and Nelson 1974:358). It is seen as both an individual and a group phenomenon, and it is bidirectional or reciprocal. Direct, first-hand contact is necessary, and dominance of one culture over the other is a factor in determining the degree and direction of acculturation. Acculturation is not contingent on a change in values or reference group, and it is not necessary for either group to have a positive orientation toward the other.

Dominance of one culture over another in an acculturative situation is operative when one group is larger or more technologically advanced and can force changes in the other (Herskovits 1949:529). The related concept of directed contact occurs when one group interferes with another group's cultural elements and/or inhibits that group's existing patterns (Linton 1940:501-502). The Euroamerican fur traders can be described as dominant in their contacts with the villagers, especially late in the fur trade period after the construction of permanent posts such as Fort Clark.

Acculturation was the process of cultural change experienced by the Hidatsas in the Knife River villages during most of the fur trade period. Diffusion was the operative process during the indirect trade period (cf. Chapter 13, this volume), prior to direct contact between the Hidatsas and Euroamerican traders. Diffusion, and especially acculturation, provide the means to illustrate what took place when a well-developed and successful native culture came into contact with the expansionist Euroamerican cultures of the seventeenth, eighteenth, and nineteenth centuries.

During the process of Euroamerican contact, the native cultures of the Missouri valley were altered, and finally almost destroyed. Disease was certainly a major factor, with devastating smallpox epidemics recorded in 1780-1781 and 1837 (Trimble 1985, 1986; and Chapter 15, this volume). Earlier epidemics can be inferred from a variety of sources (Dobyns 1983). However, the influx of new technology also made a considerable contribution to changing the native cultures. During contact, cultural elements, including technology, were transferred almost exclusively from the Euroamericans to the Indians. With the notable exception of hardy strains of corn and beans (Will and Hyde 1917), few cultural elements moved the other direction. There was a clear pattern of dominance by the Euroamericans in the contact situation, especially late in the Hidatsa occupation of the Knife River villages.

In this situation of contact, diffusion, and acculturation, the artifacts left behind in archeological sites are all (aside from historic records and oral traditions) that are available to work with. The historic documentation of the Hidatsa occupation during contact is very good, but it is the artifacts, bone tools in this case, which provide the detailed picture of change. During the process of acculturation, objects are accepted first, often without face to face contact between the two groups. Patterns of behavior, beliefs, concepts, and ideas change much more slowly. Elements lacking concrete expression in objects or overt behavior are the most difficult to document (Linton 1940:485).

In the Knife River Hidatsa case, long-term survival of concepts and ideas has been documented. The Mandan (and by extension, Hidatsa) ceremonial structure, beliefs, clan system, and age grade societies survived the fur trade period, up until 1862 (Bruner 1961:228-233). What finally broke up many of these institutions was forced allotment of the Fort Berthold Reservation in the 1880s. Material culture certainly changed dramatically as a result of the fur trade, even if other more abstract cultural elements did not (Bruner 1961:229). Tenacity and survival of cultural elements on the Fort Berthold Reservation has been documented in detail by Gilman and Schneider (1987). It is not possible to derive a picture of changes in abstract cultural institutions such as age-grade societies and clans from examination of bone tools. Even if it were possible, it might not illuminate much change, since many of those elements survived the fur trade period.

What can be derived from bone tool analysis is a picture of developing economic dependence by the Indians toward the traders, and from that can be inferred social disruptions. The Spaniards in New Mexico were practicing directed contact in attempting to destroy Pueblo religion while forcing Catholicism on the people (Linton 1940:501-502). In the Mandan/Hidatsa case, at least in the early fur trade period, trade was conducted by company representatives from Canada and by tenant traders who lived among the Indians. During this period, the fur trading companies apparently allowed the balance of power to stay with the Indians (Bruner 1961:215). For this reason, Spicer (1961:522-523) believes that all of the fur trade period, up until 1862, was an example of nondirected contact.

The Hidatsa contact situation may not fit the definition for directed contact, but the traders were by no means passive in their dealings with the Indians. The traders believed themselves to be superior to the Indians, and attempted at all times to maintain that role (Saum 1965). The traders manipulated the situation to their advantage by securing consistent trading partners, or by dispensing favors to those Indians deemed to be cooperative. They were not passive players in a nondirected contact situation. Their active manipulation had consequences for cultural change, and by extension, for changes in the modified bone assemblages.

Within the fur trade context described above, metal began to move into the Hidatsa villages. The social changes which followed can be inferred from other situations documented in the literature. A new item of technology can advance the prestige of those low in social standing if it is sufficiently superior to existing artifacts (Linton 1940:472-473). Metal was clearly superior to bone or stone for equivalent tasks, and possession of it could advance an individual's social standing or prestige. One could bypass bone tool craft specialists, and avoid paying for laboriously manufactured bone tools. While craft specialization on the Plains is rare, the Hidatsas did have ceramic specialists (Bowers 1965:273). It is therefore reasonable to infer the presence of bone tool specialists, as well.

As metal was introduced, such specialists would have been idled as demand for their product lessened. The established social structure could be bypassed as well. People of low status, or those possessing little power, could use the new technology to move up or to acquire power outside of established channels. The established channels of authority and social hierarchy would have become more and more threatened as the early trickle of metal in the indirect trade period became a flood in the direct trade period. Metal tools were therefore not just equivalent replacements for bone tools, as has been suggested for other early Euroamerican trade items (Bruner 1961:205).

The traders would certainly have taken advantage of such a situation to reward those Indians who had proven useful for their purposes. However, the traders might have been advancing the social standing of individuals who would never have achieved prominence or power under the native system. The qualities valued by the traders might not have been those valued by the Hidatsas. The classic paper describing such social disruptions is that of Lauriston Sharpe (1952) which describes the social consequences of the introduction of steel axes to the Yir Yoront Australian Aboriginals. The Yir Yoront are unusual in that one technological item was so crucial to the maintenance of social structure. A better example of the social disruptions brought by contact can be found among the seventeenth and eighteenth century Kickapoo in what is now Wisconsin (Silverberg 1957). In that case, social disruptions preceded the arrival of French traders. After their arrival, they took an active role in changing Kickapoo culture to further their own commercial interests. In a more extreme and controversial case, the eastern Algonkians may have hunted out all the fur-bearing animals in their region after being decimated by Euroamerican diseases (Martin 1978). When their medicinal procedures could not cure the diseases, they took it to be the result of betrayal of a long-standing relationship with the animals, and so hunted them out in retaliation. Not all of these processes occurred among the Hidatsas, but it is safe to say that social disruptions preceded the traders, and accelerated after their arrival. In this study, only changes in bone tool assemblage structure may be measured directly. However, given the level of social disruption documented among living groups as the result of introduced trade goods, it is reasonable to assume similar consequences at the Knife River villages. Changes in bone tool assemblages as the fur trade progressed are therefore believed to represent a reflection of ongoing social disruptions.

Another factor to be considered in the fur trade sequence is the introduction of a market economy. The Hidatsas were certainly deeply involved in trade prior to contact, but the trade which followed contact was geared to serve distant Euroamerican markets. Serving this market, through production of buffalo robes and other furs, as well as garden produce, changed much of the Hidatsa economy. Examination of the introduction of a market economy into other Indian groups suggests that in each case, economic dependence was the eventual result (White 1983). The Hidatsas were progressively drawn into a market economy, especially late in the occupation when river traffic from St. Louis became common.

METHODOLOGY

The study of modified bone assemblages has a long history, but has never been as prominent in the literature as lithic or ceramic analyses. The literature dealing with modified bone is divided into two distinct aspects. The first is closely connected with faunal analysis and views bone artifacts as faunal elements. The second major aspect of modified bone analysis consists of studies which treat bone tools as artifacts, rather than as faunal elements. Such studies focus on patterned or formal bone tools from habitation sites, where there is no doubt of human presence. Weston (1986:133-158; 1990:133-158) provides a synopsis of both types of investigations and gives a history of the development of formal bone tool analysis in the Middle Missouri subarea.

Bone tool analysis for the village sites in the present study focuses primarily on patterned formal artifacts, in a setting where human habitation is not in doubt. Some expedient tools are present, but they are not used as the sole determinant of human occupation. All of the modified bone and antler specimens used in the present analysis were originally separated from unmodified vertebrate remains by Carl R. Falk or by someone working directly under Falk's supervision. Modified bone technology in the Middle Missouri subarea was extremely stable for a very long time. The only period during which major technological change occurs in modified bone assemblages is during Euroamerican contact. The Knife River villages present a unique opportunity to examine modified bone in this context.

One of the first considerations in the analysis is tool typology. An extensive bone tool typology has been developed for the subarea, originally based on Kidder's (1932) research at the Pecos ruin. Changes were made, based upon regional variations in tools, and upon available ethnographic information. For the purposes of this study, the established descriptive typology will be used, but function will only be assigned when based upon ethnographic information, especially that supplied by Hidatsa informants (Wilson 1917). Determination of function on the basis of use-wear analysis will not be attempted. Use-wear studies have been undertaken (Tyzzer 1936; Semenov 1964; Chomko 1975; Moore 1985), but there is no substantial body of experimental analogs upon which to base bone tool use-wear determinations.

One primary focus of the present work is on how bone tools were manufactured. The distinction between manufacture with stone tools versus metal tools is of considerable significance. Another major focus is on the composition of the tool assemblage, and how it changes through time as metal tools are introduced. Thus, two variables of most interest here are tool type and metal/stone modification. Weston (1986:172-182; 1990:172-182) discusses other variables such as use-phase classification and detailed provenience data recorded for a major part of the KNRI collection, which do not play an important part in the present discussion.

Tool Type

A simplified version of the established tool typology for the Middle Missouri subarea is employed in the study by Weston (1986, 1990), and a simplified or collapsed version of that typology is used for the present synthesis. This typology draws heavily on a working classification of the KNRI modified bone/antler collections performed independently by Carl R. Falk. Ultimately, this typology is quite similar to and is grounded in similar typologies reported in the regional literature (e.g., Wood and Woolworth 1964; Woolworth and Wood 1964; Calabrese 1972; Falk et al. 1980). All of these typologies are based primarily upon biological element and morphology, and are similar to that originally developed at Pecos ruin in New Mexico (Kidder 1932). The tools are grouped as to element, so for example, scapula tools constitute a category separate from rib tools. Little can be accomplished with examination of differences in species use, because virtually all of the Knife River bone tools are made from bison bone.

One tool type requires further discussion. Expedient bone butchering tools have been defined in a series of Plains bison kill sites where they have been used to define cultural activities (Frison 1970, 1978:301-328; E. Johnson 1982). Their interpretation as tools has not, however, met with universal acceptance (Binford 1981). The spiral fractures associated with them are not entirely unique to human modification, in that similar spiral fractures have been found on bones from Miocene deposits, where they were presumably produced by trampling (Myers et al. 1980). Expedient tools were therefore carefully separated from unmodified fauna for this analysis according to criteria established in the recent literature (Frison 1970, 1978; E. Johnson 1982). The separation was made conservatively, and the expedient tools identified here are thought to represent human alteration rather than alteration by other taphonomic processes.

Metal/Stone Modification

The type of tools used in the manufacture of bone tools is very important in the determination of prehistoric change during Euroamerican contact. Much of the metal introduced through the fur trade was iron, which has not preserved well in the village deposits. Brass and copper kettles were also converted to useful implements and ornaments, but iron was probably the most useful for working bone. The presence of metal can, in many cases, be inferred from the marks left on bone tools even if metal tools are absent in the archeological collections. The presence of metal cut marks on bone is one measure of the time at which the Hidatsas became a part of the fur trade system, and, as such, is very important.

The determination of metal or stone manufacture on the basis of cut marks on bone tools can be very difficult. There is no systematic body of experimental literature dealing with types of cut marks on bone. In general, metal tools leave narrow cuts with sharp, distinct edges while stone tools leave wider cuts with sloping, ragged edges. A metal blade will cut cleanly with a minimum of strokes, while a stone blade will cut more slowly and require many more strokes.

Other researchers have provided definitions of metal and stone cut marks on bone. Binford's (1978) research among the Nunamiut focuses on bones which had been butchered with metal tools, leaving very thin cut marks. Stone tools are thicker, and do not have a single smooth cutting edge, so the cuts tend to be short, and have a more open cross section and ragged appearance than those produced with metal tools (Binford 1981:105).

These criteria for determining metal and stone modification are obviously not rigorous or quantifiable. Walker and Long (1977) have conducted controlled experiments of bone cutting, using both metal and stone tools. Casts were taken of the cuts, and examined microscopically in cross section, revealing distinct differences between cuts produced by metal and stone tools. Walker and Long's (1977) study is almost alone in its approach. Therefore, in the present study, metal/stone determinations are made primarily on the basis of macroscopic identification, supplemented by examination under a 10X binocular microscope. Similar procedures were employed by Moore (1985) in differentiating between metal and stone modification on the bone tools from On-A-Slant Village. There is a substantial gray area of cut marks which could have been made with either metal or stone tools. During analysis, cut marks are conservatively coded as having been made by metal or stone tools and only fairly clear cases were assigned as such. The majority of tools are coded as having indeterminate metal/stone cut marks.

DATA PRESENTATION AND DISCUSSION

Table 20.3 provides a cross-tabulation of general tool type frequencies according to the cultural phase units or time periods used in the present synthesis (see Table 20.1 for sources of raw data). Table 20.4 provides a cross-tabulation of frequencies of metal/stone tool modification according to a similar chronological structure, but with this data set limited to KNRI collections which could be physically examined by the authors. The following discussion is organized by time period, and more generally, according to fur trade periods as outlined by Thiessen (Chapter 13, this volume) and in the introductory section to this chapter. The focus of the discussion is on elucidation of chronological changes in modified bone assemblage composition and assessment of the implications of such change for the acculturative process impinging upon the Hidatsas through time.

Pre-contact Period (AD 1300-1450)

The Nailati and Scattered Village phases in this period represent the pre-contact comparative baseline against which to examine the changes that follow. The data in Table 20.3 indicate that most tool forms which occur during any part of the village period are present at this time. Slotted rib tools (knife handles) are absent, as they continued to be for some centuries to follow. Fleshers appear to be particularly abundant during the Nailati phase (Table 20.3), but this is probably a reflection of sampling variation, with many of the 27 specimens noted in Table 20.3 being represented by cached specimens found in a few storage pits at White Buffalo Robe Village (Lee 1980). Available data indicate the absence of metal modification on the bone tools (Table 20.4), as would be expected during the pre-contact period.

At this time, a well-developed native modified bone industry is present, exhibiting a wide variety of formal bone tools. Many tools are assumed to have been laboriously manufactured by individuals with considerable skill in their craft. As was the case with other industries such as pottery (Bowers 1965:373), there were probably bone tool specialists, from whom tools, or the rights to make them, had to be purchased. In this period a complex social and ceremonial system may have been intact. The Hidatsas were well adapted to the severe climate of the Northern Plains in their substantial villages, sustained by their gardens and the bison herds of the prairies. They had achieved at least security, and perhaps some prosperity through regular trade contacts with distant tribes in other parts of the continent.

Transition from Pre-contact to Earliest Indirect Trade (AD 1525-1600)

Trade artifacts such as glass beads and metal items are lacking from archeological deposits dated to this period (Hensler phase). Even so, one bone tool assigned to this period is modified with a metal tool. It is a fragmentary scapula hoe from Lower Hidatsa Village which exhibits faint cut marks that appear to have been made with a metal blade. It is difficult to draw sweeping generalizations from a single artifact, since the possibility of metal in the villages prior to 1600 is theoretically possible but not probable. If the artifact is not intrusive, it likely dates from near the end of the period.

Aside from the metal-modified specimen, the tool sample from this period has much the same composition as that for the pre-contact samples. If some metal found its way to the villages at this time, it would have passed through the hands of many other Indian groups. If present at all, metal would have been very scarce, and likely would have caused little social disruption of the type discussed below.

Indirect Trade (AD 1600-1740)

The first metal artifacts appear during the first part of this period (see Chapter 21 by Ahler and Drybred in this volume), along with three bone artifacts modified with metal (Table 20.4). Early in this period, awls form a substantial but decidedly smaller fraction of the collections than in previous periods (8.1 percent compared to 14.3-23.6 percent; Table 20.3). The relative frequency of awls steadily declines during this period, from 8.1 percent to 4.4 percent, and the implications of that change will be discussed below. The other major tool types are all represented.

The first knife handles slotted for metal blades appear during the middle part of the indirect trade period, sometime before AD 1700. They correspond to Quimby and Spoehr's (1951:124-125) category B-1, native types of artifacts modified by contact. They represent clear and convincing evidence of not only the presence, but also the use of metal. These artifacts represent not only changes in the modified bone industry, but in stone tools as well, since the metal blade replaces a chipped stone cutting element. There is a continuing increase in metal modification of bone tools (Table 20.4).

During the early part of this period, the leading edge of the zone of indirect trade reached and passed the Hidatsa villages. For native peoples, this meant that unfamiliar metal objects became available from their regular trading partners in other tribes. Likely sources of the earliest metal artifacts were a series of small settlements along the eastern coast of North America, such as Quebec, on the St. Lawrence River, established in 1608. Some social changes can be postulated from this evidence. Those who possessed metal would have learned of its superior cutting properties and durability. This superiority would have created a demand for the material, and begun to confer prestige upon those who possessed it. The stage was thus set for more drastic changes more than a century before actual contact with Euroamericans.

The decline in frequency of awls during this period indicates that some replacement of formal bone tools was beginning to occur. Piercing tools were a prime candidate for replacement, since they could be replaced with very small items such as nails, commercial awls, or scraps of metal. Their small size facilitated transfer over great distances from one Indian group to another. The social changes associated with this replacement became evident, even at this early date. Prestige surely accrued to those who had the metal awls, and social advancement may have followed outside of the usual channels. Those who made bone tools may have begun to feel a decrease in demand for their products and a change in their role within the community.

The presence of knife handles slotted for metal blades represents the incorporation of metal into existing tool types. This implies social changes, in the form of acceptance of metal as a material superior to stone or bone. The replacement of chipped stone cutting elements probably had much the same social effect as the replacement of awls, which begins in this period. The increase in expedient tools suggests an increased importance for these simple artifacts. No manufacturing skill was required to make them, so they could be made and used by anyone. As will be seen in later periods, this may be related to the influx of metal and the loss of formal bone tools such as awls and associated dependence upon traders.

Intermittent Trade Contact (AD 1740-1790)

During this period, the Hidatsas moved into a lucrative role as middlemen in the fur trade. Changes in the composition of the modified bone assemblage continues along many of the trends established earlier. Bone awls continue to decline in relative frequency, becoming decidedly rare in samples dated to this period (Table 20.3). Expedient tools increase in relative frequency, as do metal

Table 20.3. Cross-tabulation of general tool categories by temporal or cultural phase units for upper Knife-Heart region sites (see Table 20.1 for specific data sources).

General Tool Categories		Nai-lati 1300-1400	Scattered Vil-lage 1400-1450	Hensler 1525-1600	early Willows 1600-1650	late Willows 1650-1700	early Minna-taree 1700-1750	late Minna-taree 1740-1790	Road-maker 1790-1837	Four Bears 1830-1845	Total
		Cultural Phase and Dates (AD)									
Split Ribs	n	21	5	9	9	12	9	8	5	0	78
	%	9.4	9.1	5.4	12.2	11.3	7.8	5.9	2.2	0.0	6.6
Slotted Ribs	n	0	0	0	0	6	2	2	10	0	20
	%	0.0	0.0	0.0	0.0	5.7	1.8	1.5	4.5	0.0	1.7
Perforated Ribs	n	2	0	4	0	1	0	2	5	0	14
	%	0.9	0.0	3.3	0.0	0.9	0.0	1.5	2.2	0.0	1.2
Scapula Tools	n	89	11	56	21	23	38	40	106	18	402
	%	39.7	20.0	33.5	28.3	21.7	33.3	29.6	46.9	23.7	34.1
Antler Tools	n	27	7	13	13	7	8	17	15	5	112
	%	12.1	12.7	7.8	17.5	6.6	7.0	12.6	6.6	6.6	9.5
Awls	n	32	13	27	6	6	5	3	3	1	96
	%	14.3	23.6	16.2	8.1	5.7	4.4	2.3	1.3	1.3	8.1
Fleshers	n	16	0	2	1	0	1	2	3	3	28
	%	7.1	0.0	1.2	1.4	0.0	0.9	1.5	1.3	3.9	2.3
Cancellous Tools	n	3	0	1	2	0	1	2	5	1	15
	%	1.3	0.0	1.6	2.7	0.0	0.9	1.5	2.2	1.3	1.3
Fish Hooks	n	1	0	1	0	2	4	1	0	0	9
	%	0.4	0.0	0.6	0.0	1.9	3.5	0.7	0.0	0.0	0.8
Tubes-Beads	n	9	3	13	3	14	13	8	15	7	85
	%	4.0	5.5	7.8	4.1	13.2	11.4	5.9	6.6	9.2	7.2
Expedient Tools	n	11	5	8	7	6	12	15	26	20	110
	%	4.9	9.1	4.8	9.4	5.7	10.5	11.2	11.5	26.3	9.3
Ornaments	n	2	1	1	1	1	0	0	3	1	10
	%	0.9	1.8	0.6	1.4	0.9	0.0	0.0	1.3	1.3	0.8
Other*	n	11	10	32	11	28	21	35	30	20	198
	%	4.9	18.2	19.2	14.9	26.4	18.4	25.9	13.3	26.3	16.8
Total	n	224	55	167	74	106	114	135	226	76	1177
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Note: The category "other" includes manufacturing debris (n=59), polished fragments (n=94), ochre stained bone (n=4), unique objects (n=36), dorsal spines (n=3), and horn core/frontal tools (n=2).

Table 20.4. Cross-tabulation of metal/stone tool modification by temporal or cultural phase units for upper Knife-Heart region sites (see Table 20.1 for specific data sources; non-KNRI sites are excluded from the data).

Modification Type		Scattered Village 1400-1450	Hensler 1525-1600	early Willows 1600-1650	late Willows 1650-1700	early Minna-taree 1700 1750	late Minna-taree 1740-1790	Road-maker 1790-1837	Four Bears 1830-1845	Total
		Cultural Phase and Dates (AD)								
Indeterminate	n	48	55	61	77	92	103	166	62	664
	%	87.2	90.2	82.4	72.6	80.7	76.3	73.4	81.6	78.4
Stone	n	7	5	10	22	12	22	14	0	92
	%	12.7	8.2	13.5	20.8	10.5	16.3	6.2	0.0	10.9
Metal	n	0	1	3	7	10	10	46	14	91
	%	0.0	1.6	4.1	6.6	8.8	7.4	20.4	18.4	10.7
Total	n	55	61	74	106	114	135	226	76	847
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

artifacts and glass beads (cf. Chapter 21). Modification of bone tools with metal continues at frequencies similar to those during the preceding period (Table 20.4). Spatulate, split rib tools, many of which are suspected to be pressure flaking implements used for modifying chipped stone artifacts, become decidedly less common than they had been during the preceding 150 years.

During this period, Canadian traders established regular contact with the Hidatsas. Tenant traders also became common fixtures in the villages. Face-to-face contact with Euroamerican traders was thus established, at least on an intermittent basis. However, the Hidatsas' main role was that of middlemen in the trade system. At this time, they found themselves between the advancing frontier of the horse from the southwest, and the gun from the northeast. They reaped considerable prosperity by passing such goods back and forth, always at a substantial markup. Some trends discussed earlier continued here as well. The social disruptions already mentioned certainly continued here, although with more intensity, given the larger quantities of trade goods.

Frequent Trade Contact (AD 1790-1822)

During this period, represented largely by samples assigned to the Roadmaker phase (Tables 20.3 and 20.4), the Hidatsas achieved their maximum level of involvement in the fur trade. They achieved considerable prosperity as middlemen, but that changed abruptly at the end of this period with the construction of short-lived trading posts near the Knife River.

The modified bone assemblage shows the culmination of several trends which had been present for some time. Maximum percentages of scapula hoes, knife handles slotted for metal blades, and expedient tools are recorded (Table 20.3). Sharp increases in metal modification of bone tools (Table 20.4) and frequencies of metal objects and glass beads can be documented (cf. Chapter 21). Awls are practically absent from the collections, being less than one-tenth as abundant as they were in pre-contact times.

The large number of scapula tools may indicate an effort by the Hidatsas to increase output from the gardens for use in trade. This suggests a high level of involvement in a market economy, a trend which began earlier. As was the case with other Indian groups, involvement in such an economy may have brought prosperity initially, but dependence upon the traders soon followed. A similar increase in hide-processing tools (fleshers and cancellous tools) is not seen (Table 20.3), despite the obvious market value of hides. However, metal scraps were used to work hides at this time, so the frequency of hide-working tools made of bone may not be an accurate measure of such activities. Garden produce was apparently the most important, marketable commodity at this time. Another factor in the persistence of scapula hoes might have been their size. Iron hoes were large, heavy, and were still difficult to transport into the area.

The high percentage of expedient tools indicates that this category had assumed considerable importance. This importance had gradually increased through the fur trade period. Expedient tools have been interpreted as butchering implements, and experimental studies have shown them to be effective for this purpose (Frison 1978:301-341). Therefore, the increase in expedient tools late in the fur trade could be related to increased butchering and hide preparation. Another possibility is that the increased number of expedient tools is related to increased dependence upon the traders. The large influx of metal at this time meant that many formal bone tools were being replaced. This developed dependence upon the traders, as the only source of the metal. As discussed earlier, such dependence would have worked to the traders' advantage. Expedient tools thus gained importance as dependence increased and the knowledge of manufacturing formal bone tools was lost. Expedient tools could be used by anyone, with no knowledge of difficult manufacturing techniques required.

Local Trade (AD 1822-1860)

This period is represented by the samples assigned to the Four Bears phase. In general, the collection is dominated by coarsely-made patterned bone tools, unusable fragments, and expedient rib tools (cf. Snyder 1988:214-215). Scapula tools, antler tools, and ornaments are all present, while formal rib tools are absent. Awls are virtually absent, being represented by only one specimen. Expedient rib tools, on the other hand, represent a large fraction of the sample. Comparisons with other Knife River assemblages suggest that this period can be interpreted as a culmination of trends observed in earlier periods (cf. Snyder 1988:216).

CONCLUSIONS

The value of research into modified bone assemblages has been established in this study. However, such studies can only be productive in well-documented situations. The interpretations made here depend upon good chronological and stratigraphic control, along with consistent recovery procedures. Excellent historic documentation has also been critical to this analysis.

The limitations of modified bone studies are numerous. In the Middle Missouri, it is not possible to do the same sort of fine-grained chronological analysis with bone tools as is possible with pottery. Modified bone technology exhibits too much stability for many chronological comparisons. The only exception is the period of Euroamerican contact, where there is sufficient change in a short period of time for modified bone analysis to be productive.

At the outset of this study, two specific goals were set forth. The first was the construction of a model illustrating acculturation as reflected in the replacement of bone tools with metal substitutes, while the second was to define the relationship between assemblage structure and level of acculturation. While limitations in the data preclude construction of a model in the strict sense of the term, some general trends can be discussed. The earliest indications of acculturation in the form of assemblage changes appear during the indirect fur trade period. Initially, some bone tools modified with metal are observed, followed by the beginning of a decline in awls as they are replaced with metal substitutes. Knife handles slotted for metal blades appear, and expedient tools begin to increase. These changes suggest the beginning of acculturation as metal became available and began to disrupt the established social structure. In the subsequent intermittent contact trade period, modification of bone with metal increases sharply, and awl frequencies continue to decline while expedient tools increase. These trends reach their culmination during the time of frequent direct contact, just prior to the establishment of local trading posts.

The changes in modified bone technology through the fur trade as derived in this study may have some benefit in other contact situations. In any case, modified bone research is a viable and exciting field of study which can provide meaningful information for anthropological interpretations.

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CHAPTER 21

ANALYSIS OF EUROAMERICAN TRADE ARTIFACTS

Stanley A. Ahler and Amy Drybred

INTRODUCTION

This chapter deals with an analysis of available information on Euroamerican artifacts which entered the native settlements at the Knife River Indian Villages National Historic Site and in adjacent regions by way of the Euroamerican fur trade industry. Emphasis here is placed directly on only two general artifact classes, metal objects and glass trade beads, which include the vast majority of trade artifacts recovered from controlled excavations in KNRI sites. Other artifacts of Euroamerican origin, such as bottle and flat glass items, glazed pottery, etc., occur in extremely small numbers in the KNRI sites and are given only the briefest treatment in this chapter.

The primary intent in the present analysis is to provide an inventory of the metal and glass bead artifacts which occur in the KNRI and upper Knife-Heart region sites, to assess the general frequency of such artifacts according to the village site chronology developed for the region, and to assess the internal composition of the major metal and glass bead artifact groups and changes in such composition through time. The intent is to provide hard data to document the gradual increase of influence from the fur trade and white contact among the village populations, and to provide data documenting the changing nature of this contact through time as the fur trade evolved into a major economic institution which at one time affected all human inhabitants in the study region.

Metal artifacts are studied primarily through examination of data on artifact size, metal type, and functional classification, summarized according to time periods developed for the region. Glass beads are studied via variables dealing with size, color, method of manufacture, shape, and structure.

The patterned metal artifacts which hold functional information are relatively few in number, and their analysis was accomplished in a relatively simple fashion through application of a functional classification based on metal type and form. In contrast, the bead collections were quite large, and analysis of data on beads required application of a computerized coding system to the extant bead collections. The tedious and time-consuming task of sorting, describing, and coding the substantial bead collections fell to Amy Drybred. Ahler conducted most of the analysis of the metal artifacts, relying heavily on descriptive reports prepared for various site excavations by several members of the UND staff, and he authored all sections of this chapter.

Five additional sections follow in this chapter. The one immediately following deals with a brief review of the chronology of the fur trade in the upper Knife-Heart region, focusing on the changing trade processes which can reasonably be assumed to have directly affected both the quantity and type of trade artifacts reaching the Knife River villages. The next general section deals with an analysis of metal artifacts, providing inventories of metal items by analytic batch, time period, and other variables of interest. The next section deals with analysis of glass trade beads, summarizing chronological changes in bead frequency and assemblage composition. A brief section which follows provides a statement on other artifacts of Euroamerican trade origin which occur in the study sample sites. The final section in this chapter summarizes patterns of chronological change in trade artifact composition, comparing metal and bead artifact frequencies through time, and assessing the nature of contact and exchange between native and Euroamerican parties as reflected in the trade artifacts found in the village sites.

FUR TRADE CHRONOLOGY AND PROCESSES

This section provides a brief synopsis of the chronology of the Euroamerican fur trade in the upper Knife-Heart region intended to provide background information for the discussions of chronological changes in trade artifacts which occur in following sections. This synopsis is taken directly from Thiessen's discussion of fur trade development and chronology (Chapter 13, this volume).

Four periods are currently recognized for the development of the fur trade industry in the upper Knife-Heart region: Indirect Trade, AD 1600-1740; Intermittent Trade Contact, AD 1740-1790; Frequent Trade Contact, AD 1790-1822; and Local Trade, AD 1822-1860. The first and last of these period names embody terminology offered by Ray (1974, 1978) regarding the nature of contact between natives and Euroamericans. The term "indirect" implies no direct contact between the natives and Euroamericans, with all trade items reaching the natives through the hands of other native middlemen. The term "local" describes a situation of sustained native/Euroamerican contact facilitated by trading posts established in direct proximity to the native settlements.

The beginning date for the indirect trade period, AD 1600, is based on archeological evidence from the present study which suggests that trade artifacts were present in very small quantities in site deposits which can be dated in the period AD 1600-1650. The sole, direct evidence for this contact consists of three small fragments of iron and four glass trade beads found in village midden deposits at both Lower Hidatsa and Big Hidatsa villages; these middens can be dated by chronometric and stratigraphic means to the approximate time period noted. It can be noted that Weston and Ahler provide evidence in Chapter 20, this volume, further supporting indirect Euroamerican contact by AD 1600. They record the presence of three bone tools having metal modification marks from deposits dating in the period AD 1600-1650, and a single bone tool with metal modification marks from deposits dated AD 1525-1600.

This potential beginning date of AD 1600 for earliest evidence of contact is distinctly earlier than the date of AD 1675 for first contact offered by Lehmer (1971:131, 164-168; 1977). Lehmer's date is based on the date of establishment of trading posts along the shores of Hudson Bay and James Bay in the decade of AD 1670 (Lehmer 1977:92). The earlier date suggested here is acceptable, even with chronometric information aside, given the fact that the French established Quebec as a trading center in AD 1608 (Lehmer 1977:92) and that the direct influence and direct contact of French explorers, traders, and missionaries had penetrated into the western Great Lakes region by the mid-AD 1600s (Ray 1974:4-12). One of the main native groups contacted there by the French was the Assiniboin tribe, later documented as a longstanding eastern trading partner of the Mandans/Hidatsas (Smith 1980:53, 56). These geographic and chronological considerations, coupled with the fact that the Hidatsa-proper and Awaxawi subgroups had themselves in AD 1600 only recently migrated from eastern territories (see the discussion of pottery analysis, Chapter 17), make it highly feasible that trade artifacts of Euroamerican origin should appear in low frequencies in village deposits dated in the period AD 1600-1650.

This indirect trade period is characterized by an absence of direct contact between Euroamericans and the native peoples in our study area and by the receipt of trade goods only through one or more native middleman populations (see Chapter 13, this volume). We can imagine that multiple middlemen were involved with any trade artifacts in the early part of this period, and that fewer middlemen were involved in the later part of this indirect trade period. Any trade items reaching the Hidatsas and Mandans probably would have seemed quite exotic to the native peoples, were probably highly valued by them, and were likely to have been recycled and reused repeatedly and frequently passed on to other native trading partners farther from the artifact source via pre-existing native trade systems (cf. Ray 1978 and Toom 1979 on the subject of flow-through of trade artifacts).

The next period is termed the period of intermittent trade contact and is dated in the period AD 1740-1790 (Thiessen, Chapter 13, this volume). The beginning date for this period is determined by the first documented contact between Mandans/Hidatsas and Euroamericans, marked by the La Vérendryes' repeated visits to the Mandan villages, presumably near the Heart River, in AD 1738-1742 (Smith 1980). The remainder of this period is marked by a series of apparently infrequent, poorly documented visits from French and Canadian traders based at posts to the north and east of the study area (Thiessen, Chapter 13, this volume).

The beginning date of AD 1740 for this period also marks the approximate date of introduction of the horse into the region from Spanish sources in the southwest (Thiessen, Chapter 13, this volume; Ewers 1954). From that time forward, the Mandans and Hidatsas were in a position to establish themselves as middlemen in the movement of Euroamerican items, with horses moving through their hands from the southwest, and with guns and smaller trade items moving through from the northeast. During this period the Mandans/Hidatsas probably obtained many of their material goods, other than horses, by direct contact with Euroamericans from the northeast who visited the villages at irregular intervals, and also from "resident" or "tenant" Euroamerican traders (Lehmer 1971:169; 1977) who settled in the villages but made trips to the French and Canadian posts to the northeast for trade supplies. Throughout this period the villagers were also receiving trade goods from other native groups who continued to serve as middlemen between the trading posts and the village area. We can expect the volume of trade artifacts moving into the villages to increase substantially during this period, but we can also expect that a large part of what the Mandans/Hidatsas saw in the way of trade artifacts was probably passed on to more remote native trading partners. Thus, the archeological record should document an increase in overall trade artifact frequency in this period, but an increase not fully consistent with the increased volume of trade items passing through the villages (Ray 1978; Toom 1979).

The subsequent period is one characterized by frequent trade contact, dated in the period AD 1790-1822 (Thiessen, Chapter 13, this volume). In this period regular annual trading expeditions were sent into the village area from major Hudson's Bay Company and North West Company posts on the Assiniboine River to the northeast. Occasional trade contacts occurred with traders operating out of St. Louis, but the dominant force of trade in the region continued to come from the Canadian direction. The villagers continued to receive horses from native trading partners to the west and south. At least two short-lived trading posts were established in direct proximity to the village sites, and Euroamerican resident traders were quite common within the villages themselves during this period.

This is a period of frequent, direct but not prolonged contact between the Euroamericans and the Mandans/Hidatsas. The villagers had ample access to trade goods, but the presence of Euroamericans within the village area was tenuous enough that the villagers were able to maximize their role of middlemen between the more nomadic groups to the west and the Euroamericans to the northeast. The majority of trade artifacts received by the villagers were probably still passed on to other native trading partners farther down the line, but the overall frequency of trade access probably increased noticeably during this period. The volume of trade artifacts in the village sites should be noticeably higher in this period, and the nature of the artifacts themselves should change to include a larger amount of manufactured, unrecycled goods obtained directly by the villagers rather than second-hand items passed through the technological filter of up-the-line trading partners.

The final period, designated as the local trade period, is dated at AD 1822-1860. Its beginning is marked by the establishment of the first of a succession of relatively permanent, St. Louis-based trading posts in direct proximity to the villages (Thiessen, Chapter 13, this volume). In sequence, these include Fort Vanderburgh, Tilton's Post, Kipp's Post, Fort Clark, Sublette and Campbell's post, and Fort Primeau (see Chapter 14, this volume). The end of this period is marked by the abandonment of Fort Clark in AD 1860. With the establishment of permanent trading posts in direct proximity to the villages, two things happened concerning the trade situation at the villages. First, the villagers' access to trade artifacts was again significantly increased, and second, the role of the villagers as middlemen in the trade process was significantly altered and diminished. Because various nomadic groups to the east and west could now themselves establish direct contact with the traders at the posts at any time they chose, the role of the villagers in the trade process changed to one of primarily provisioners for the men at the posts as well as for nomadic native groups coming into the area for trade (Thiessen, Chapter 13, this volume).

Another event which has great bearing on the nature of the fur trade in this final period, and indeed on many other aspects of native culture change, was the opening of steamboat traffic on the Missouri River. The first successful steamboat link between St. Louis and the villages took place in 1832, and regular traffic occurred from then on (Thiessen, Chapter 13, this volume). The steamboat allowed movement of vast amounts of bulky or heavy trade items into the hands of the natives, and at the same time provided an efficient means for removing cumbersome buffalo skins to the market in the east. Therefore, after AD 1822 we would expect to see a very large and significant increase in the amount of trade artifacts in the villages, and also a change in the nature of these artifacts to include large, unrecycled items.

Figure 21.1 shows the relationship between the time periods established for the ordering and dating of artifactual information from the archeological samples in this study and the fur trade period designations established by Thiessen. Three analytic time periods, 61, 62, and 71, encompass the whole of the indirect trade period, AD 1600-1740. We would expect trade artifacts in these time periods to occur in extremely low frequency, reflecting first the smallest of trickles in highly recycled, reused items into the region, followed by small increases in artifacts as the direct trade front moved closer and closer to the upper Knife-Heart region during the late seventeenth and early eighteenth centuries.

The following intermittent trade contact period, AD 1740-1790, coincides relatively well with time period 72 (AD 1740/45-1780/90) defined for the artifact analysis. In this period we expect the frequency of trade artifacts to rise in the archeological record, and we expect the nature of the recovered artifacts to change somewhat to reflect the growing direct contact between the cultures involved. Unrecycled manufactured goods should be present, along with a broad array of recycled artifacts reflecting continued involvement of middlemen.

The period of frequent trade contact, AD 1790-1822, coincides roughly with analytic time periods 81 and 82 defined for the artifact analysis (AD 1780-1820/30). Trends toward increased frequency of trade artifacts should continue in this period, as should the trend for increased occurrence of manufactured items and decreased occurrence of native-made, recycled metal artifacts. These same trends should also continue in the final local trade period, AD 1822-1860, which coincides approximately with analytic time period 83 (post-AD 1820/30). A major increase in trade artifact frequency should occur in this period coincidental with the establishment of steamboat traffic from St. Louis. The functional nature of the trade artifacts should reflect both the altered role of the villagers in the trade system and more general changes in village culture, such as adoption of the horse. Manufactured items should be quite common, and native-made recycled items should become less common. In addition, trade artifacts should now include large bulky items, such as hoes and mattocks, emphasizing the increasing role of

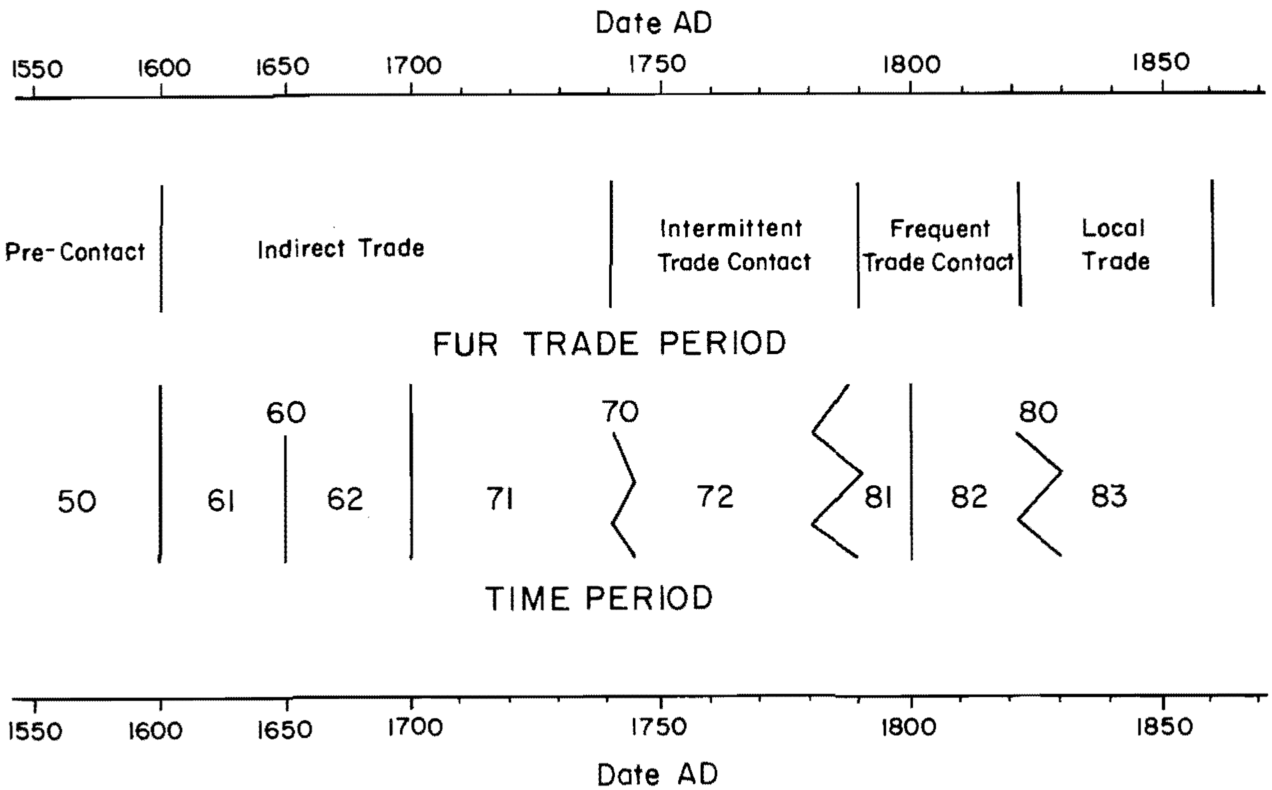

Figure 21.1. Schematic diagram of the relationship between fur trade periods defined by Thiessen for the upper Knife-Heart region and time periods defined for the archeolgical data sets.

the villagers as provisioners for the surrounding and resident non-farming peoples.

METAL TRADE ARTIFACTS

Sample Definition and Methods

This section provides a summary and tabulation of available data on metal trade artifacts recovered from the KNRI villages and from regional post-contact period sites. The analysis has focused most directly on samples from controlled excavations at the major villages in the KNRI (Sakakawea, Lower Hidatsa, and Big Hidatsa) where chronological control is most precise and where consistency of recovery is also the greatest. Less attention has been given to collation of data from other village collections from the region.

The metal trade artifact study has focused on two kinds of data. The first involves information on all types of metal artifacts, including scraps and bits of functionally unidentifiable metal as well as the functionally more interpretable, "patterned" metal artifacts. This attention has naturally centered on the excavated collections from the KNRI villages which have each been collected with similar, systematic fine-screen recovery processes, maximizing the potential for the discovery of even the smallest of metal artifacts. The analytic emphasis here is on studying the chronological changes in the frequency of all such metal artifacts, an endeavor which can only be approached with consistently collected, screened artifact samples. As well as looking at overall metal artifact frequency, we also briefly examine the changes in the basic kinds of metal artifacts which have reached the villages, referring to the types of metal represented (iron [Fe], brass [br], copper [Cu], and lead [Pb]). In compiling this information, we have used the data presented by time period in the Big Hidatsa report (Ahler and Swenson 1985:203-213), and the data from Sakakawea Village (Ahler et al. 1980:160-166) and Lower Hidatsa Village (Ahler and Weston 1981:164-168) reorganized according to the time period structure and batch units defined in the present volume.

Data on metal artifacts from Slant Village, another sample collected with consistent fine-screened recovery, are also included. All metal artifacts from Slant Village were reexamined and requantified in some detail, and the final quantifications differ slightly from artifact counts presented by Breakey and Ahler (1985:5); this is because a few broken, refitted items were recounted as single occurrences, and because a few size grade 5 items were reclassified as ferric concretions rather than as iron metal fragments as recorded by Breakey and Ahler. Another metal artifact sample was recovered by fine-screen processes from the White Buffalo Robe site (Smith and Lee 1980). In the original White Buffalo Robe report this metal was assigned to an ill-defined "Knife River phase" component. The dating and taxonomic placement of this material, and even the integrity of this component, remain highly uncertain; for that reason, the White Buffalo Robe metal artifacts originally assigned to the Knife River phase (and also the pottery and lithic artifacts so designated) have not been included in the present study. Data from salvage excavations at the Taylor Bluff site (Ahler 1988) were not available at the time of this writing (1986) and were not included in the present analysis.

The second type of data examined in this study deals with the functional/morphological classification of patterned or shaped metal artifacts. For this study we have not restricted ourselves to the fine-screen collections but have included information from many other poorly controlled collections available from regional sites. This was done in order to include large and interpretable collections available from a few sites in the region. Even so, the patterned artifact data from the most finely controlled chronological units still derive primarily from the small samples from KNRI site excavations. This data set includes both wire-like metal artifacts as well as more complex and functionally interpretable metal items. Not included here are simple scraps of metal which seem to have no recognizable form and which may represent simply manufacturing scrap from larger items recycled by the villagers or artifacts too decomposed to retain original form. The patterned metal artifact data reported for the Big Hidatsa collection (Ahler and Swenson 1985:Table 61) were used directly in this analysis. Patterned metal artifact samples reported from Lower Hidatsa Village (Ahler and Weston 1981:164-168) and Sakakawea Village (Ahler et al. 1980:160-166) were redefined to include metal wire pieces and were reorganized to conform to the present time period and batch definitions used in this study. Patterned metal artifacts were classified anew for the Slant Village sample.

For virtually all other sites, patterned metal artifact classifications and counts were taken directly from reported or published information. Data for Amahami, Rock, Nightwalker's Butte, and Deapolis villages were taken directly from the report by Lehmer et al. (1978:315-373, Figures 8.18-8.20) on those sites. The reader is encouraged to examine that report for both detailed artifact descriptions and representative artifact illustrations. Data on patterned metal artifacts from Star Village are taken from Metcalf (1963). Data on the Like-a-Fishhook Village excavated collection are taken from Smith (1972:73-88); it should be noted that Smith's quantification was less than precise for several artifact classes ("several knives," etc.). In such cases, "several" was counted as 10 items in the present study. Finally, we have included data on a small number of patterned metal artifacts from sites tested in the 1968 Wood/Lehmer test excavation program in the upper Knife-Heart region. The Mahhaha and Amahami site samples include small numbers of patterned metal artifacts from batch contexts studied here. The Fort Clark site tests produced a substantially larger metal artifact sample, previously unreported, as did the Greenshield site excavations, previously reported in Nicholas and Johnson (1986).

The procedure here has been to classify the patterned metal artifacts according to specific functional classes suggested by the artifact size and form. In many cases we have only bits and fragments of the original items, so such functional classification is often uncertain. Wood and Thiessen (1985:Appendix Tables 2-4) provide useful inventories of incoming trade artifacts used in the period AD 1797-1806 which provide a guide as to what to expect in the archeological record, assisting somewhat in the functional classification of the village artifacts. These specific functional classes are grouped in turn into more general functional groups which represent basic spheres of activity on the part of the villagers and/or reflect the degree of native involvement in the production of the metal artifacts. These general functional or activity groups can be briefly described.

Weapons/hunting gear includes metal arrowpoints, iron and lead shot or bullets, metal gun parts, miscellaneous weaponry (saber, lance), and metal fishhooks. Most of these items could function in warfare as well as for taking of game. Virtually all of these items represent manufactured goods. The gun parts for the most part reflect bits and pieces of worn out weaponry broken apart and recycled for other uses. The arrowpoints may have been manufactured or may have been made by the villagers from recycled metal stock; the more elaborate arrowpoint forms with serrated stems and haft elements (cf. McGonagle 1973) are most likely to be of Euroamerican manufacture.

Domestic items include large and small household and gardening implements ranging from butcher knives, awls, and scrapers to axes, hoes, and buckets. Most of these items are of Euroamerican manufacture, although a few are artifacts shaped by the villagers from recycled metal stock. The latter would include scraper bits and fleshers commonly recycled from gun barrels and other artifacts. Nearly all the quantified bucket or kettle parts probably are merely remnants of vessels which had been recycled by the villagers to other purposes. Such remnants are functionally recognizable by the presence of a rolled or crimped edge which once formed the vessel lip, or by the presence of riveted fasteners for the handle.

Horse gear includes only bridle bit parts and a single spur. Other horse gear may exist in the collections, now only recognizable as recycled ornaments or patterned metal scrap pieces.

Ornamental or decorative items are subdivided into two groups based on whether the artifact appears to be basically of Euroamerican manufacture, or of native manufacture from recycled metal stock. The native-made ornaments consist predominantly of rolled tubes or cones made from copper, brass, or less commonly iron; these were probably most often made from recycled bucket and kettle parts. The manufactured items take on a greater diversity of forms, including complex pendants and ear bobs, finger rings, bracelets, bells, buttons, whistles, etc.

A final group is designated as *miscellaneous*, including many different kinds of artifacts which appear to have been shaped in some fashion but which have no ready, single functional interpretation. These are broken down according to metal type and according to form, including cut items, perforated items, and wire pieces. Some coiled wire items or springs are included here; it has been suggested (Smith 1972:76) that these occasionally served as tweezers for the removal of body hair. Like the unpatterned metal scrap pieces, these functionally unidentifiable items are relatively most common in the samples recovered by fine-screen process and relatively least common in the unscreened excavated or surface collected samples. Tabulations are provided for all specific functional class frequencies by analytic batch so that the reader may rearrange and recollapse the artifact types as desired according to different generalized groupings.

A final variable studied here is the size of metal arrowpoints. Metcalf (1963:111) has noted that the size of metal arrowpoints increases through time in the post-contact period. He suggests that this is a functional change linked to the introduction and use of the horse in hunting and warfare. We have attempted to document metal arrowpoint size according to time period in the present samples, and provide hard data to substantiate Metcalf's generalization. We have chosen to record arrowpoint total length and blade length as a measure of arrowpoint size; weight measurements were thought to be unreliable due to the decomposition of the metal artifacts in many cases and the variations in soil and ferric compounds bonded to the metal artifacts. The data compiled here are confined to the samples which we could examine directly, including the KNRI excavated village samples and that from Slant Village. We did not attempt to reexamine the large sample of metal arrowpoints from Deapolis Village studied by McGonagle (1973), nor the other specimens described in Lehmer et al. (1978).

Results

All Metal from Fine-Screened Contexts

A summary tabulation of all metal recovered in size grades 1-5 from tested KNRI sites and from Slant Village is presented in Table 21.1. This table gives a breakdown of metal counts and weight by size grade and by metal type without regard to size grade by analytic batch and time period. Excavated volumes of site fill are also given for each analytic batch in Table 21.1.

These data can be used to assess chronological change in the frequency of use of metal artifacts in the regional village sites through time. To pursue such an endeavor, we need to convert the metal counts or weight data to a scale which is comparable across sites, one which is independent of the magnitude of excavations at each site, and one which measures the actual frequency of use of metal artifacts in a given site context or temporal context. The most direct measure of this sort is an expression of metal density in count or weight per cubic meter of excavated site matrix. If we can reasonably assume that the depositional rate is constant at all sites and constant through time, then such volumetric density data provide a feasible means for making intersample comparisons. If site samples that are assigned to the same time period in fact produce similar volumetric density values, and if successive time period sequences within a given site exhibit progressive increases in metal artifact density, then the operating assumptions behind the use of volumetric density measures would seem to be reasonable.

In actuality, however, these stated assumptions for volumetric density comparisons may not be reasonable. If settlement intensity or the nature of domestic activities is substantially different among sites, then volumetric comparisons among sites may not be valid. Consider, for example, the fact that the Hidatsas-proper are usually characterized as being significantly more nomadic and less sedentary than the other two Hidatsa subgroups (Bowers 1965:18). If this is so, we might expect the rate of midden accumulation, the rate of sediment accumulation from lodge roofs, and the overall intensity of activity at Big Hidatsa Village to be substantially lower than at Lower Hidatsa Village or Sakakawea Village. If such is true, then the overall sedimentation rate at Big Hidatsa could have been substantially lower than at the other two major village sites, making volumetric comparisons across the sites invalid.

This problem has been discussed at length in previous reports (Ahler and Weston 1981:176-178; Ahler et al. 1980:183-195; Ahler and Swenson 1985:243-245). A second measure of overall artifact frequency was proposed and used in those reports, this being based on the density of metal artifacts expressed as counts or weight per unit weight of vertebrate animal bone debris. This approach has the advantage of being independent of variation in sediment depositional rates, and provides a useful means for between-sample comparisons as long as we can assume that a unit weight of vertebrate remains reflects an equal period or level or unit of measure of site occupancy or human activity in each locus. Again, however, the hypothesized differences in settlement strategy and, presumably, in hunting emphasis, between the village subgroups may make this an inappropriate measure for intervillage comparisons. Such may be indicated by data which show markedly different vertebrate faunal volumetric density data (kg per cubic meter) between Lower Hidatsa Village and Big Hidatsa Village (Ahler and Swenson 1985:245, 249).

For the moment, we are left without a perfect means for comparing metal artifact frequency through time or across sites. At present, we will defer the bone density approach and will focus on the volumetric density data, attempting to see if between-site regularities in such data justify their application as an intersite comparative technique. Volumetric density data are presented by site (batch) and by time period in Table 21.2, expressed as counts of metal in grades 1-5 per cubic meter, counts of metal in grades 1-3 per cubic meter, and total weight in grades 1-5 per cubic meter.

Examination of the G1-5 counts per cubic meter data indicates marked differences by site and some anomalous changes through time. These data are graphically displayed in Figure 21.2. Particularly disturbing are the marked differences across sites in periods 71 and 72, with the Lower Hidatsa values being particularly low in comparison to Big Hidatsa in period 71, and with the Slant and Big Hidatsa values being particularly high in period 72. The anomalously high value of 116.0 in period 71 at Big Hidatsa is in fact the highest for any time period sample at the site, suggesting a problem with temporal classification of that sample or some other sampling problem. An

Table 21.1. Summary of count, weight, size grade, and type data for non-recent metal artifacts organized by time period and batch for all site samples processed by fine-mesh recovery.

		Count by Size Grade				Weight by Size Grade				Count by Type				Excv. Vol.
Period	Batch	G1-3	G4	G5	Tot	G1-3	G4	G5	Tot	Fe	Cu	Br	Pb	cu m
61	47	2	-	-	2	1.1	-	-	1.1	2	-	-	-	2.477
	69	-	1	-	1	-	0.4	-	0.4	1	-	-	-	1.632
	tot	2	1	0	3	1.1	0.4	0.0	1.5	3	0	0	0	4.109
62	46	4	9	-	13	1.8	2.3	-	4.1	8	5	-	-	4.466
	68	11	18	-	29	40.3	2.2	-	42.5	28	-	1	-	3.614
	tot	15	27	0	42	42.1	4.5	0.0	46.6	36	5	1	0	8.080
71	0/2	-	5	4	9	-	0.9	0.2	1.1	5	4	-	-	2.000
	45	5	5	-	10	4.0	0.3	-	4.3	8	2	-	-	2.161
	67	111	364	123	598	66.8	36.7	1.7	105.2	588	7	2	1	5.153
	tot	116	374	127	617	70.8	37.9	1.9	110.9	601	13	2	1	9.314
	67*	30	65	31	126	27.9	7.2	0.4	35.5	118	5	2	1	4.165
	tot*	35	75	35	145	31.9	8.4	0.6	40.9	131	11	2	1	8.326
72	1/3	21	50	45	116	11.1	5.7	0.9	17.7	110	5	1	-	1.151
	44	10	7	-	17	8.7	0.7	-	9.4	15	1	1	-	1.302
	66	138	379	118	635	111.6	39.9	1.8	153.3	595	18	20	2	8.819
	tot	169	436	163	768	131.4	46.3	2.7	180.4	720	24	22	2	11.272
80	62	208	117	11	336	451.6	18.0	0.4	470.0	294	17	18	7	6.149
81	61	33	21	20	74	21.2	3.1	0.6	24.9	64	2	8	0	1.393
82	60	129	77	7	213	168.9	10.7	0.5	180.1	193	11	9	-	4.458
	65	186	249	89	524	303.3	36.9	1.3	341.5	481	13	24	6	6.259
	tot	315	326	96	737	472.2	47.6	1.8	521.6	674	24	33	6	10.717
83	59	231	171	24	426	317.5	28.8	2.0	348.3	353	26	42	5	6.610
	64	77	124	41	242	113.5	16.5	0.8	130.8	225	1	11	5	2.100
	tot	308	295	65	668	431.0	45.3	2.8	479.1	578	27	53	10	8.710

Note: * indicates data for period 71 and batch 67 from Big Hidatsa Village exclusive of data from AC Unit 3.

Table 21.2. Density by excavated volume data for metal artifacts, organized by site and time period.

Data Type	Time Period	Lower Hidatsa	Big Hidatsa	Sakakawea	Slant	All Sites
Counts per cubic meter grades 1-5	61	0.8	0.6			0.7
	62	2.9	8.0			5.2
	71	4.6	116.0		4.5	66.2
	71*	4.6	30.3*		4.5	17.4*
	72	13.0	72.0		100.8	68.1
	81			53.1		53.1
	82		83.7	47.8		68.8
	83		115.2	64.4		76.7
	80			54.6		54.6
Counts per cubic meter grades 1-3 only	61	0.8				0.5
	62	0.9	3.0			1.9
	71	2.3	21.5			12.5
	71*	2.3	7.2*			4.2*
	72	7.7	15.6		18.2	15.0
	81			23.7		23.7
	82		29.7	28.9		29.4
	83		36.7	34.9		35.4
	80			33.8		33.8
Weight (gm) per cubic meter grades 1-5	61	0.4	0.2			0.4
	62	0.9	11.8			5.8
	71	2.0	20.4		0.6	11.9
	71*	2.0	8.5*		0.6	4.9*
	72	7.2	17.4		15.4	16.0
	81			17.9		17.9
	82		54.6	40.4		48.7
	83		62.3	52.7		55.0
	80			76.4		76.4

Note: * indicates computations excluding data from AC Unit 3, time period 71, batch 67 at Big Hidatsa Village.

examination of the raw data from Big Hidatsa indicates that the majority of this sample assigned to period 71 derives from two horizons within a single excavation unit, AC Unit 3. AC Unit 3 is an inside-house excavation which was not chronometrically dated and which was not included in the multivariate analysis of temporally sensitive information. It was assigned to time period 4 at the site (our period 71) based primarily on pottery content. Thus its temporal placement is perhaps less certain than for other samples from the site. In addition, it may simply represent a particularly localized high concentration of metal atypical of its general time period, but one which nonetheless causes anomalous density values.

For purposes of further discussion, we have recomputed density values for the period 71 sample from Big Hidatsa while excluding the data from AC Unit 3. These revised counts and weight data are presented in Table 21.1 (*), and alternate density values are similarly shown in Table 21.2. Figure 21.2 also plots the altered density values for period 71. These revised density computations are much more in line with other time period sample values from that site, but Big Hidatsa samples in general remain high in comparison with density values from other presumably contemporaneous components. The suggestion remains that perhaps the chronology for the various sites is in error, or that the assumptions behind the volumetric density computations are not valid, or that some other inconsistency exists in the data set.

Another interesting between-site difference can be noted by examining data in Table 21.1 which show that the size grade distribution of metal artifacts differs considerably among sites. In the Big Hidatsa samples and in the late sample from Slant Village the highest frequency of metal artifacts occurs in the size grade 4 sample, and grade 5 also produces a substantial number of artifacts. In the Lower Hidatsa sample, grade 5 metal artifacts are completely lacking, and overall, there is an equal number of grade 4 and grade 3 artifacts. A similar contrast can be seen in the Sakakawea Village samples; grade 5 artifacts are rare, and grade 3 rather than grade 4 produces the largest frequency of artifacts. These contrasts between sites indicate that substantial differences in artifact fragmentation processes may have occurred at the various sites, or that inconsistencies in the sorting procedures for fine-screen debris have occurred during the analysis of each site collection.

One solution to this problem is to examine just the larger artifacts in size grade 3 and larger grades which presumably are least subject to varying fragmentation and which are presumably large enough to be free from significant sorting bias. Nearly all of the grade 4 and grade 5 sized artifacts consist of small chips or flecks of ferric oxide,

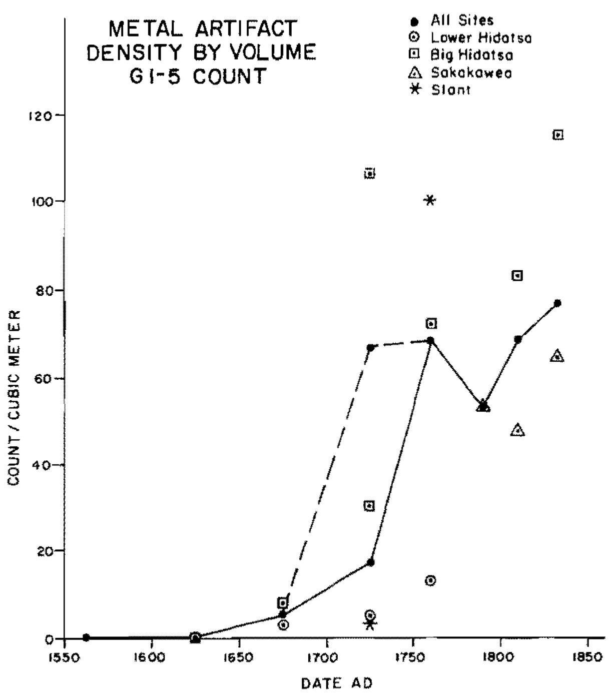

Figure 21.2. Metal artifact volumetric density data as counts of size grade 1-5 items per cubic meter plotted by time period. Dashed line includes data from Big Hidatsa AC Unit 3; solid line excludes such data.

apparently being bits and pieces of once larger iron artifacts. The exclusion of these items from the density computation seems to make analytical sense if there is a possibility that a significant portion of these artifacts was created by the archeologists in the excavation/analysis process or by other postdepositional processes. Metal artifact count density values for grade 1-3 artifacts only are presented by site and time period in Table 21.2, and these data are plotted graphically by period in Figure 21.3. The table and figure also show the data computed for Big Hidatsa period 71 with the exclusion of the AC Unit 3 sample. The density values are considerably more consistent across site samples assigned to the same time period, suggesting that the volumetric density computation provides a useful way to study change in intensity of use of metal artifacts, particularly if restricted to the larger-sized metal items.

The composite time line for all site samples combined, shown in Figure 21.2, provides the best overall measure of temporal change in use of metal in the regional sites. Extremely minor amounts of metal artifacts occur in the period 61, 62, and 71 samples, with each successive period showing about a twofold increase in the presence of metal over the preceding period. Following period 71, at the beginning of the intermittent trade contact period, the rate of increase changes significantly. A large increase in metal occurrence is evident in period 72, and the use of metal continues to increase at about the same rate from that time forward. The density curve is almost a straight line with a steep slope from period 72 onwards.

Volumetric density values expressed as weight of metal artifacts per cubic meter of excavated fill are shown in Table 21.2 and are plotted graphically by time period in Figure 21.4. These values are based on the total weight of metal artifacts in all size grades; the weights in size grades 4 and 5 generally contribute very little to the total weight of metal artifacts, so all size grades are included in the computations. When the AC Unit 3 data are excluded from the Big Hidatsa period 71 computations, the weight density values can be seen to be fairly consistent across site samples within a single time period. Again, these consistencies support the use of volumetric computations as a means for cross-sample comparisons and time series analysis.

By examining the weight density values (Figure 21.4), an interesting temporal pattern can be noted which is not entirely similar to the temporal changes in metal artifact counts (Figure 21.3). Weight density values seem to increase in a steplike fashion, rather than in progressive, even slope fashion. Density by weight is extremely low in period 61, then jumps to a substantially higher level in period 62 which is maintained in period 71. This rate of increase in these periods is markedly greater than the increase in metal artifact counts (Figure 21.3). This suggests that the nature of trade contacts or trade mechanism changed significantly between period 61 and 62, allowing substantially larger artifacts to enter the village deposits. Another steplike increase in density by weight occurs between period 71 and 72, and the increased value is maintained in the period 81 sample. The most dramatic increase in metal artifact density by weight occurs in the final two time period samples which exhibit a two- to threefold increase over eighteenth century values. These samples represent primarily both the period of frequent trade contact and the period of local trade. As expected, the density of metal by weight in the final period increases, but the increase is not as marked as the increase exhibited in the preceding period. Apparently a major change in access to trade artifacts had begun before the advent of fully local trade, during the period when frequent direct trade was occurring primarily by way of trading expeditions into the region from nearby established posts.

An apparent chronological change in metal types can be noted from the data in Table 21.1. In all cases, iron is the dominant metal type in all time periods, but it decreases slightly in relative importance later in time. The most notable chronological pattern has to do with the proportions of brass and copper items. Copper appears to be the dominant of the two in the period 62 and 71 samples; the two types are of about equal importance in the period 72 samples; and brass becomes the more important item in the latter two time periods (82 and 83). This change can be attributed to both the shift from indirect to direct trade and to the increasing introduction of brass as part of the fittings on trade weapons in the later time periods. The occurrence of lead in the metal artifact samples can be thought of as chronicling the introduction and dispersion of the gun. Within the trader's inventory, lead occurs almost exclusively as musket balls and shot (Wood and Thiessen 1985:Tables 3, 4), and its presence signals the use of the gun even when guns or gun parts may not be evident. Lead first occurs in the period 71 sample, late in the indirect trade period, and it gradually becomes more common from that time onward.

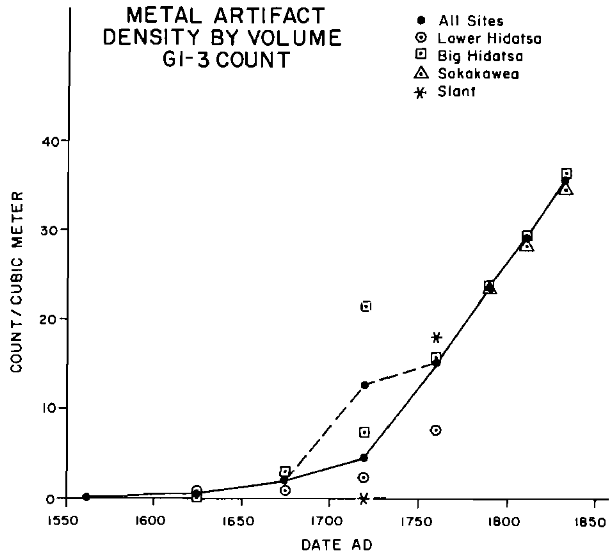

Figure 21.3. Metal artifact volumetric density data as counts of size grade 1-3 items per cubic meter plotted by time period. Dashed line includes data from Big Hidatsa AC Unit 3; solid line excludes such data.

Patterned Metal Artifacts

Data on the frequency of occurrence of patterned metal artifacts are presented by analytic batch, time period, and artifact class in Table 21.3. Data on the percentages of major artifact class groups, excluding counts of miscellaneous items, are presented graphically by time period in Figure 21.5. The graphed data derive from all site samples assignable to the refined time period units. Similar data computed from waterscreened site samples (not illustrated) only show very similar chronological patterns.

Several significant patterns of chronological change in general artifact classes can be noted. One of the most obvious is in the occurrence of native-made ornaments, consisting almost entirely of metal tubes or beads and metal cones. These artifacts constitute about 45 percent to nearly 70 percent of all artifacts in the samples dating from the seventeenth and eighteenth centuries, being the dominant general artifact class in all samples in that time range. It seems that if a trade artifact sample consists of 40 percent or more native-made ornaments, then it can be dated to the eighteenth century or earlier. This generally corresponds to the period of indirect trade as well as to the period of intermittent direct trade contact. In the samples dated after AD 1800 (periods 82 and 83), native-made ornaments decrease abruptly to less than 20

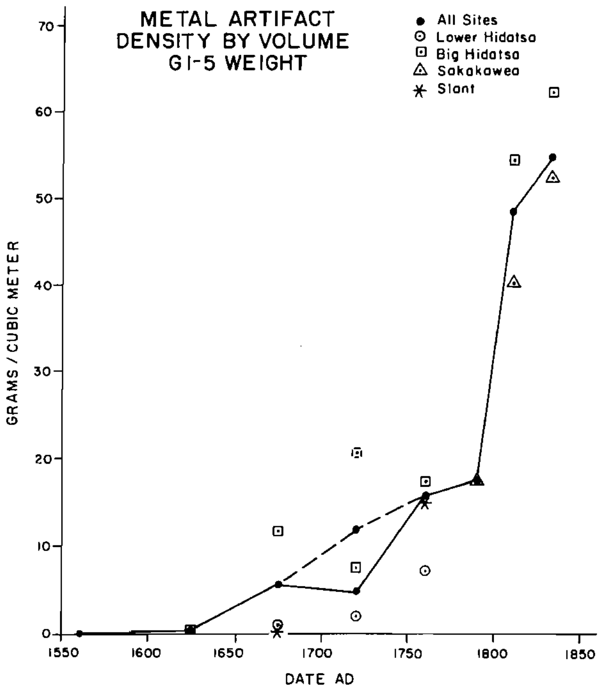

Figure 21.4. Metal artifact volumetric density data as weight of size grade 1-5 items per cubic meter plotted by time period. Dashed line includes data from Big Hidatsa AC Unit 3; solid line excludes such data.

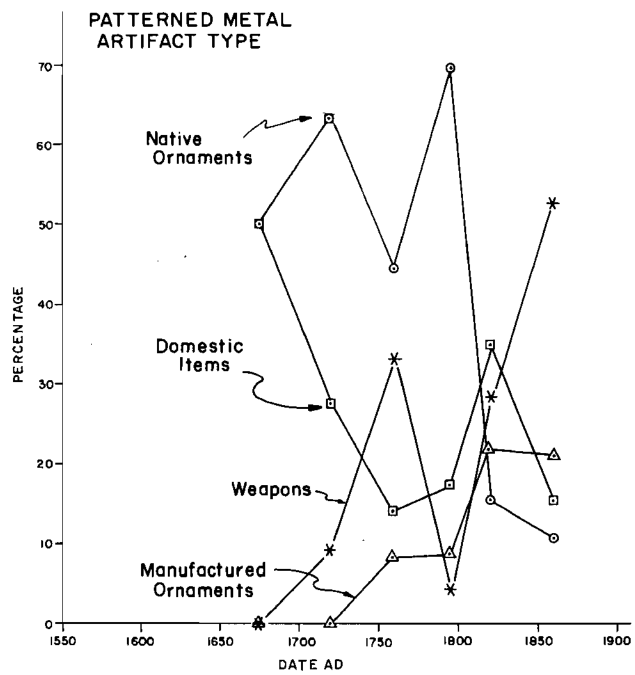

Figure 21.5. Patterned metal artifact functional class percentages plotted by time period.

percent in each time period sample. In general, there is a tremendous increase in functional diversity in the samples dating in periods 82 and 83. This apparently reflects the effects of frequent to constant direct contact between the cultures, versus the earlier effects of recycling the Euroamerican trade items through the hands of native middlemen.

Another interesting pattern can be noted regarding native-made ornaments. Rolled tubes or beads constitute the most common form of such artifacts (as opposed to the conical form) in the period 62, 71, and 72 samples. In the period 81 samples, conical items (tinklers) become the more common form, as they are in the period 82 samples, and in period 83 the rolled tubular/bead form disappears altogether. The common occurrence of the rolled tubular form in the early post-contact periods may reflect continued native manufacture of copper and brass items in a morphology similar to that used for items made of native copper during the fully prehistoric period.

The temporal distribution of manufactured ornaments presents an interesting pattern. Such items are completely absent until period 72, corresponding to the beginning period of infrequent but direct contact with northern traders. Throughout the latter part of the eighteenth century such items constitute a small but visible part of the collections (circa 8 percent of the samples). In the post-AD 1800 samples such items increase markedly in relative frequency, comprising slightly more than 20 percent of each of the period 82 and 83 samples. This increased occurrence of manufactured metal items is related apparently to the increase in frequency and duration of direct trade contacts.

Weapons show a pattern of chronological change characterized by erratic frequencies but a general increase through time, with a peak occurrence in such items in the final time period where weapons and related materials constitute more than half of the documented period 83 sample. Internal changes within this group are significant. Arrowpoints are common in the earlier periods, and gun parts do not appear in any meaningful frequency until period 82, and particularly, in period 83. This pattern of replacement of the bow and arrow with the gun is consistent with the nature of changes in the trade situation.

While the gun undoubtedly occurred in eighteenth century and possibly earlier samples, it was probably extremely rare and was not widely used until the opening of local direct trade in the final time period. The bow and arrow would have been the common weapon until that time.

Temporal changes in domestic items are difficult to generalize about, with percentages ranging from 50 percent in period 62 to a minimum of about 14 percent in period 72, with an increase again through period 82, and with a decrease in the final period 83. Of most note perhaps is the fact that the eighteenth century and earlier domestic items consist almost entirely of relatively small and portable punches, awls, and an occasional knife. Large, bulky items do not become common or even frequent until the final period, when mattocks, hoes, axes, saws, files, wedges, and chisels become part of the available recovered sample. Note that mattocks, hoes, and wedges seem to be missing from the traders inventories compiled for 1797-1806 (Wood and Thiessen 1985:Tables 3, 4). Sampling bias may also account in part for occurrence of much larger domestic items in the final time period, because the great majority of the period 83 sample derives from the massive surface collection from the Deapolis site (Thompson 1961). In contrast, the majority of the samples from period 82 and earlier derive from extremely small-scale excavations at the KNRI sites.

Arrowpoint Length

Data concerning the lengths of measurable arrowpoints are presented by artifact, batch, and time period in Table 21.4. Where possible, both a blade length and a total length were recorded. Missing data for total length indicate that the arrowpoint occurred as a simple stemless triangle; it was usually impossible to determine if the stem has been broken from such items or if they had originally been made without a stem.

Table 21.3. Summary of patterned metal artifacts organized by functional class for post-contact period analytic batches for upper Knife-Heart and Garrison region sites.

Part 1

Period	60	61			62			70				71	
Batch	54	47	69	tot	46	68	tot	29	53	86	tot	0/2	45
Weapons/Hunting Gear													
arrowpoint	1	-	-	0	-	-	0	-	1	7	8	-	-
Pb ball/shot	0	-	-	0	-	-	0	-	-	-	0	-	-
iron shot	0	-	-	0	-	-	0	-	-	-	0	-	-
cartridges	0	-	-	0	-	-	0	-	-	-	0	-	-
gun parts	0	-	-	0	-	-	0	-	-	-	0	-	-
powder flask	0	-	-	0	-	-	0	-	-	-	0	-	-
lance	0	-	-	0	-	-	0	-	-	-	0	-	-
saber	0	-	-	0	-	-	0	-	-	-	0	-	-
fishhook	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	1	0	0	0	0	0	0	0	1	7	8	0	0
Domestic Items													
awl/punch	0	-	-	0	-	1	1	-	-	-	0	-	-
knife	0	-	-	0	-	1	1	1	-	-	1	-	-
thimble	0	-	-	0	-	-	0	-	-	-	0	-	-
axe/hatchet	0	-	-	0	-	-	0	-	-	-	0	-	-
fire steel	0	-	-	0	-	-	0	-	-	-	0	-	-
bucket	0	-	-	0	-	-	0	-	-	-	0	-	-
scraper	0	-	-	0	-	-	0	1	-	-	1	-	-
scissors	0	-	-	0	-	-	0	-	-	-	0	-	-
rod	0	-	-	0	-	-	0	-	-	1	1	-	-
saw	0	-	-	0	-	-	0	-	-	1	1	-	-

Table 21.3. Continued.

Part 1, continued.

Period	60	61			62			70				71	
Batch	54	47	69	tot	46	68	tot	29	53	86	tot	0/2	45
Domestic Items, continued													
hoe	0	-	-	0	-	-	0	-	-	-	0	-	-
file	0	-	-	0	-	-	0	-	-	-	0	-	-
spoon	0	-	-	0	-	-	0	-	-	-	0	-	-
mattock	0	-	-	0	-	-	0	-	-	-	0	-	-
wedge	0	-	-	0	-	-	0	-	-	-	0	-	-
chisel	0	-	-	0	-	-	0	-	-	-	0	-	-
tweezers	0	-	-	0	-	-	0	-	-	-	0	-	-
auger bit	0	-	-	0	-	-	0	-	-	-	0	-	-
nail	0	-	-	0	-	-	0	-	-	1	1	-	-
cup	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	0	0	0	0	0	2	2	2	0	3	5	0	0
Horse Gear													
bridle bit	0	-	-	0	-	-	0	-	-	-	0	-	-
spur	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0

Part 2

Period	60	61			62			70				71	
Batch	54	47	69	tot	46	68	tot	29	53	86	tot	0/2	45
Manufactured Ornaments													
pendant/bob	0	-	-	0	-	-	0	-	-	-	0	-	-
finger ring	0	-	-	0	-	-	0	-	-	-	0	-	-
bracelet	0	-	-	0	-	-	0	-	-	-	0	-	-
geometric	0	-	-	0	-	-	0	-	-	-	0	-	-
token ?	0	-	-	0	-	-	0	-	-	-	0	-	-
wire braid	0	-	-	0	-	-	0	-	-	-	0	-	-
brass chain	0	-	-	0	-	-	0	-	-	-	0	-	-
brass tack	0	-	-	0	-	-	0	-	-	-	0	-	-
bell	0	-	-	0	-	-	0	-	-	-	0	-	-
button	0	-	-	0	-	-	0	-	-	-	0	-	-
mirror frame	0	-	-	0	-	-	0	-	-	-	0	-	-
whistle	0	-	-	0	-	-	0	-	-	-	0	-	-
broach	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0
Native Ornaments													
cone/bangle	0	-	-	0	-	1	1	-	-	-	0	-	1
tube/bead	0	-	-	0	1	-	1	-	-	-	0	1	-
disc/pendant	0	-	-	0	-	-	0	-	-	1	1	-	-
lead effigy	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	0	0	0	0	1	1	2	0	0	1	1	1	1

Table 21.3. Continued.

Part 2, continued.

Period	60	61			62			70				71	
Batch	54	47	69	tot	46	68	tot	29	53	86	tot	0/2	45
Miscellaneous													
complex iron	0	-	-	0	1	-	1	-	-	-	0	-	-
perfor. iron	0	-	-	0	-	-	0	-	-	-	0	-	-
perf. br./cu	0	-	-	0	-	-	0	-	-	-	0	-	-
iron wire	0	-	-	0	-	1	1	-	-	-	0	-	-
brass/cu wire	0	-	-	0	-	-	0	-	-	-	0	-	1
cut iron	0	-	-	0	-	-	0	-	-	-	0	-	-
cut brass/cu	0	-	-	0	-	-	0	1	-	-	1	-	-
spring	0	-	-	0	-	-	0	-	-	-	0	-	-
chain	0	-	-	0	-	-	0	-	-	-	0	-	-
subtotal	0	0	0	0	1	1	2	1	0	0	1	0	1
Total	1	0	0	0	2	4	6	3	1	11	15	1	2

Part 1, continued.

Period	71 cont		72				80					81	
Batch	67	tot	1/3	44	66	tot	41	62	63	82	tot	19	61
Weapons/Hunting Gear													
arrowpoint	-	0	3	1	6	10	12	1	5	13	31	1	-
Pb ball/shot	-	0	-	-	2	2	1	-	-	-	1	-	-
iron shot	1	1	-	-	-	0	-	2	-	-	2	-	-
cartridges	-	0	-	-	-	0	-	-	-	-	0	-	-
gun parts	-	0	-	-	-	0	6	1	-	2	9	-	-
powder flask	-	0	-	-	-	0	-	-	-	-	0	-	-
lance	-	0	-	-	-	0	-	-	-	-	0	-	-
saber	-	0	-	-	-	0	-	-	-	-	0	-	-
fishhook	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	1	1	3	1	8	12	19	4	5	15	43	1	0
Domestic Items													
awl/punch	3	3	-	-	5	5	5	-	-	3	8	3	-
knife	-	0	-	-	-	0	-	-	1	1	2	1	-
thimble	-	0	-	-	-	0	1	-	-	-	1	-	-
axe/hatchet	-	0	-	-	-	0	-	-	1	1	2	-	-
fire steel	-	0	-	-	-	0	-	-	-	1	1	-	-
bucket	-	0	-	-	-	0	1	1	-	-	2	-	-
scraper	-	0	-	-	-	0	-	-	-	-	0	-	-
scissors	-	0	-	-	-	0	-	-	-	-	0	-	-
rod	-	0	-	-	-	0	-	-	-	-	0	-	-
saw	-	0	-	-	-	0	-	-	-	-	0	-	-
hoe	-	0	-	-	-	0	1	-	-	-	1	-	-
file	-	0	-	-	-	0	-	-	-	-	0	-	-
spoon	-	0	-	-	-	0	-	-	-	-	0	-	-
mattock	-	0	-	-	-	0	-	-	-	-	0	-	-
wedge	-	0	-	-	-	0	-	-	-	-	0	-	-
chisel	-	0	-	-	-	0	-	-	-	-	0	-	-

Table 21.3. Continued.

Part 1, continued.

Period	71 cont		72				80					81	
Batch	67	tot	1/3	44	66	tot	41	62	63	82	tot	19	61
Domestic Items, continued													
tweezers	-	0	-	-	-	0	-	-	-	-	0	-	-
auger bit	-	0	-	-	-	0	-	-	-	-	0	-	-
nail	-	0	-	-	-	0	1	1	-	-	2	-	-
cup	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	3	3	0	0	5	5	9	2	2	6	19	4	0
Horse Gear													
bridle bit	-	0	-	-	-	0	-	-	-	-	0	-	-
spur	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0

Part 2, continued.

Period	71 cont		72				80					81	
Batch	67	tot	1/3	44	66	tot	41	62	63	82	tot	19	61
Manufactured Ornaments													
pendant/bob	-	0	-	-	1	1	1	-	-	-	1	1	-
finger ring	-	0	-	-	-	0	1	-	-	1	2	1	-
bracelet	-	0	-	-	1	1	-	-	-	-	0	-	-
geometric	-	0	-	-	1	1	-	-	-	-	0	-	-
token ?	-	0	-	-	-	0	-	-	-	-	0	-	-
wire braid	-	0	-	-	-	0	2	-	-	-	2	-	-
brass chain	-	0	-	-	-	0	-	-	-	-	0	-	-
brass tack	-	0	-	-	-	0	-	-	-	-	0	-	-
bell	-	0	-	-	-	0	1	-	-	1	2	-	-
button	-	0	-	-	-	0	1	-	-	-	1	-	-
mirror frame	-	0	-	-	-	0	-	-	-	1	1	-	-
whistle	-	0	-	-	-	0	-	-	-	-	0	-	-
broach	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	0	0	0	0	3	3	6	0	0	3	9	2	0
Native Ornaments													
cone/bangle	1	2	2	1	2	5	8	1	1	-	10	11	-
tube/bead	4	5	1	-	10	11	-	-	-	2	2	4	1
disc/pendant	-	0	-	-	-	0	-	-	-	2	2	-	-
lead effigy	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	5	7	3	1	12	16	8	1	1	4	14	15	1
Miscellaneous													
complex iron	-	0	-	-	-	0	-	-	-	-	0	-	-
perfor. iron	-	0	-	-	-	0	-	-	-	-	0	-	-
perf. br./cu	-	0	-	-	2	2	-	1	1	-	2	-	-
iron wire	1	1	-	-	-	0	-	-	-	-	0	-	-
brass/cu wire	-	1	-	-	-	0	-	2	1	-	3	-	-
cut iron	9	9	-	-	6	6	1	5	3	-	9	4	-

Table 21.3. Continued.

Part 2, continued.

Period	71 cont		72				80					81	
Batch	67	tot	1/3	44	66	tot	41	62	63	82	tot	19	61
Miscellaneous, continued													
cut brass/cu	2	2	-	-	5	5	3	2	1	-	6	6	-
spring	-	0	-	-	-	0	-	-	-	-	0	-	-
chain	-	0	-	-	-	0	-	-	-	-	0	-	-
subtotal	12	13	0	0	13	13	4	10	6	0	20	10	0
Total	21	24	6	2	41	49	46	17	14	28	105	32	1

Part 1, concluded.

Period	81 cont	82			83							unassigned	
Batch	tot	60	65	tot	35	38	59	64	83	85	tot	50	71
Weapons/Hunting Gear													
arrowpoint	1	2	4	6	1	237	7	3	1	47	296	-	-
Pb ball/shot	0	-	6	6	-	37	3	2	1	20	63	-	-
iron shot	0	-	-	0	-	-	-	-	-	-	0	-	-
cartridges	0	-	-	0	-	-	-	-	-	178	178	-	-
gun parts	0	1	-	1	3	36	1	1	-	43	84	1	-
powder flask	0	-	-	0	-	-	-	-	-	1	1	-	-
lance	0	-	-	0	-	-	-	-	-	1	1	-	-
saber	0	-	-	0	-	-	-	-	-	1	1	-	-
fishhook	0	-	-	0	-	10	-	-	-	-	10	-	-
subtotal	1	3	10	13	4	320	11	6	2	291	634	1	0
Domestic Items													
awl/punch	3	2	12	14	-	17	-	3	-	-	20	2	-
knife	1	-	-	0	1	31	1	1	2	11	47	-	-
thimble	0	-	1	1	-	1	-	-	-	2	3	-	-
axe/hatchet	0	-	-	0	-	7	-	-	-	-	7	-	-
fire steel	0	-	-	0	-	1	1	-	-	1	3	-	-
bucket	0	-	-	0	-	7	2	-	3	-	12	-	-
scraper	0	-	-	0	-	9	-	-	-	7	16	-	-
scissors	0	-	-	0	1	3	-	-	-	-	4	-	-
rod	0	-	-	0	-	1	-	-	-	-	1	-	-
saw	0	-	-	0	-	3	-	-	-	-	3	-	-
hoe	0	-	-	0	-	2	-	-	-	1	3	-	-
file	0	-	-	0	1	5	-	-	2	-	8	-	-
spoon	0	-	-	0	-	1	-	-	-	-	1	-	-
mattock	0	-	-	0	-	4	-	-	-	1	5	-	-
wedge	0	-	-	0	-	6	-	-	-	-	6	-	-
chisel	0	-	-	0	-	2	-	-	-	-	2	-	-
tweezers	0	-	-	0	-	-	-	-	-	2	2	-	-
auger bit	0	-	-	0	-	-	-	-	1	-	1	-	-
nail	0	1	-	1	14	6	1	-	15	-	36	-	-
cup	0	-	-	0	-	-	-	-	2	-	2	-	-
subtotal	4	3	13	16	17	106	5	4	25	25	182	2	0

Table 21.3. Concluded.

Part 1, concluded.

Period	81 cont	82			83							unassigned	
Batch	tot	60	65	tot	35	38	59	64	83	85	tot	50	71
Horse Gear													
bridle bit	0	-	-	0	-	3	-	-	-	1	4	-	-
spur	0	-	-	0	-	-	-	-	-	1	1	-	-
subtotal	0	0	0	0	0	3	0	0	0	2	5	0	0

Part 2, concluded.

Period	81 cont	82			83							unassigned	
Batch	tot	60	65	tot	35	38	59	64	83	85	tot	50	71
Manufactured Ornaments													
pendant/bob	1	-	2	2	-	14	-	1	-	-	15	-	-
finger ring	1	-	2	2	3	24	-	1	1	-	29	-	-
bracelet	0	-	2	2	-	22	-	-	-	3	25	-	-
geometric	0	-	4	4	-	-	-	-	-	-	0	-	-
token ?	0	-	-	0	-	-	1	-	-	-	1	-	-
wire braid	0	-	-	0	-	7	1	-	-	-	8	-	-
brass chain	0	-	-	0	1	-	-	-	-	-	1	-	-
brass tack	0	-	-	0	3	99	-	-	-	-	102	-	-
bell	0	-	-	0	-	14	-	-	-	1	15	-	-
button	0	-	-	0	-	38	-	-	-	14	52	-	-
mirror frame	0	-	-	0	-	-	-	-	-	-	0	-	-
whistle	0	-	-	0	-	-	-	-	-	2	2	-	-
broach	0	-	-	-	-	-	-	-	-	3	3	-	-
subtotal	2	0	10	10	7	218	2	2	1	23	253	0	0
Native Ornaments													
cone/bangle	11	-	5	5	3	106	3	1	3	4	120	-	-
tube/bead	5	-	2	2	-	-	-	-	-	-	0	1	1
disc/pendant	0	-	-	0	-	6	-	-	-	-	6	-	-
lead effigy	0	-	-	0	-	1	-	-	-	-	1	-	-
subtotal	16	0	7	7	3	113	3	1	3	4	127	1	1
Miscellaneous													
complex iron	0	-	-	0	-	-	-	2	1	-	3	-	-
perfor. iron	0	-	-	0	-	-	-	1	-	-	1	-	-
perf. br./cu	0	1	2	3	2	-	1	-	-	-	3	-	-
iron wire	0	-	1	1	-	-	2	1	-	-	3	-	-
brass/cu wire	0	5	4	9	-	-	13	5	-	5	23	-	-
cut iron	4	3	7	10	6	-	2	14	-	5	27	1	-
cut brass/cu	6	-	8	8	1	-	-	3	2	-	6	1	-
spring	0	-	-	0	-	8	1	-	-	-	9	-	-
chain	0	-	-	0	-	2	-	-	-	-	2	-	-
subtotal	10	9	22	31	9	10	19	26	3	10	77	2	0
Total	33	15	62	77	40	770	40	39	34	355	1278	6	1

Table 21.4. Data on metal arrowpoint dimensions organized by time period.

Period	Batch	Cat. No./Site	Blade Length	Total Length	Material
60	54	39(Lehmer)/32ME10	(28.0)	-	Fe
70	53	28(Lehmer)/32ME10	18.6	22.5	Fe
72	1/3	5324/32MO26	(20.0)	(25.0)	Fe
72	1/3	5324/32MO26	24.0	29.7	Br
72	44	107/32ME10	19.5	24.5	Br
72	66	69/32ME12	21.0	-	Fe
72	66	139/32ME12	23.0	-	Fe
72	66	151/32ME12	31.0	-	Br
72	66	205/32ME12	19.0	-	Br
72	Mean		22.5	26.4	
80	62	218/32ME11	24.5	-	Fe
80	62	139/32ME11	47.5	-	Fe
80	Mean		36.0	-	
81	19	32OL17	29.5	36.5	Fe
82	60	177/32ME11	24.0	30.0	Fe
82	60	150/32ME11	21.5	28.0	Fe
82	65	70/32ME12	31.0	47.5	Fe
82	65	437/32ME12	20.0	25.0	Fe
82	Mean		24.1	32.6	
83	35	32ME2	24.0	32.0	Fe
83	59	502/32ME11	20.0	28.0	Fe
83	59	607/32ME11	43.0	52.0	Fe
83	59	649/32ME11	33.5	41.0	Fe
83	59	166/32ME11	31.0	39.0	Fe
83	59	174/32ME11	(25.0)	(31.0)	Fe
83	64	315/32ME12	43.5	50.5	Fe
83	64	315/32ME12	29.0	-	Fe
83	Mean		31.1	39.1	

Toom and Redmond (1983) study of the glass beads from the Mondrian Tree site. Their approach was to record data on every individual bead according to all of the discrete variables identified by Kidd and Kidd as being relevant to bead typology. This information was computer coded. The Toom and Redmond system allowed independent study of individual bead attributes or combinations of attributes which might be of analytic interest, as well as recreation of Kidd and Kidd type and variety frequencies, if such were of interest. One drawback in this system is that it required individual examination and coding of information on about seven variables for each individual bead. This was a manageable undertaking with the 287 specimens in the Mondrian Tree collection, but for relatively large collections such as those we intended to study from the KNRI, this would require a large labor investment in the data recording process (6,084 records of data would be required for study of the present samples).

Because many of the actual beads to be examined are actually identical in all variables and attribute states, we devised a simpler way of coding much the same information. Rather than focusing on the individual bead as the point of analysis, we focused on the "batch" or "lot" of beads from a given provenience context. We identified several key variables of interest, drawing on the system of Kidd and Kidd for help in this regard; then we identified the key classes or attribute states which were expected to occur for each major variable. Then the batch of beads was independently sorted and counted, first with respect to one variable (for example, size class), and then was resorted and counted according to another independent variable (for example, manufacturing technique). This approach has the advantage of allowing relatively rapid data recording (a total of 684 records on as many batch samples were used to document the 6,084 individual beads), and, like the Toom and Redmond system, it facilitates independent study of individual variables of interest. The major disadvantage of this system is that it does not allow for cross-correlation of co-occurrences of individual variables because the data are recorded on a batch rather than on individual specimens. Therefore, we cannot precisely reconstruct from this code system the frequencies of individual types, such as those identified by Kidd and Kidd, defined by combinations of attributes.

To partially counter the above limitation and to facilitate recording of information on the most complex of beads, we added other features to the present analysis procedure. Recognizing that the vast majority of the bead collection we were to study consisted of relatively simply decorated and simply structured beads in the small and very small size classes, we decided to restrict the collection of most quantitative data to only these simplest and most common forms, meaning tubular or drawn beads in the small and very small size classes. This would eliminate a great deal of concern one might have about missing important, complex combinations of variables during the application of the data recording system. To complement the quantified data, we decided to individually describe (according to variables identified by Kidd and Kidd 1970, 1983) all beads which were in the medium or large size classes. This process would preserve and record the most complex attributes of color, structure, shape, etc., on items where they were most likely to occur, and would at the same time allow relatively rapid recording and straightforward analysis of simple descriptive data on the majority of each bead sample under scrutiny. In the end, a total of 197 medium-sized or larger beads were individually described, while 5,861 small and very small drawn beads were subjected to the more complete batch sorting and quantified analysis.

As mentioned, all medium and larger size beads were individually described according to variables identified as being pertinent in the Kidd and Kidd (1970) system. This work was conducted by Drybred, as was the sorting and quantification of the full bead samples. Time has not allowed either Drybred or Ahler to translate this descriptive information into a meaningful typological classification nor to transcribe and condense such information for presentation in this report. To analyze and interpret the significance of the individually recorded data on the medium-sized and larger beads would require far more training and experience than either author possesses at present, and, seemingly, a career commitment to the decipherment of nuances of glass bead attributes. For these reasons the larger beads have not been analytically included in the present study, other than to record their place and frequency in the overall size classification and manufacturing technique composition of each analytic batch. Drybred's descriptive notes on all these specimens remain on file in the project records, available for further study.

Having dealt with the rationale for the present methodology, we can turn to a more detailed discussion of the variables which were recorded for the study collections. Table 21.5 presents a summary of the quantified analysis format used in the present study, giving variables, attributes states, and the coding format on 80-column computer records. All beads in a given bead lot or batch sample (regardless of size and manufacturing technique) were sorted by *size class*, using the five-class system noted in Kidd and Kidd (1983:234): very large, > 10.0 mm diameter; large, 6.0-10.0 mm diameter; medium, 4.0-6.0 mm diameter; small, 2.0-4.0 mm diameter; and very small, < 2.0 mm diameter. In the present analysis, the bead batches were partially size-sorted by passing them over nested brass U. S. Standard Testing Sieves having 4.00 mm and 2.00 openings (No. 5 and No. 10 screens, respectively). Beads retained on the larger sieve, medium-sized or larger, were then measured with calipers to determine their precise size classification. Beads caught on the smaller sieve are all small size class beads, and those passing through to the pan are in the very small size class. Broken beads were examined and individually measured if necessary to determine their proper size classification.

It can be noted that beads in all five size classes will be retained with the use of window-mesh screening for fine-screen recovery in the field. The field screens used in the KNRI program have a nominal 16-per-inch square wire mesh. A mesh opening of 1.33 mm was measured on some of the KNRI fine screens, although some variation in this opening size can be expected from one sample of screen to another bought at the local hardware store. Some locally available windowscreen is actually 18-per-inch mesh which would produce an average opening size of circa 1.16 mm. Regardless, both 16-per-inch screen and 18-per-inch screen are significantly smaller than the 2.00 mm cutoff between small and very small size class beads, meaning that if beads less than 2.00 mm in diameter exist in the archeological site, then some portion of them will be retained in the field screening process as conducted in the KNRI sites, at White Buffalo Robe, and at the Mondrian Tree site. If a reasonably large bead sample exists (perhaps n = 30 or larger) in which no very small beads occur, it can be assumed that very small beads are actually absent from the sample and that the mean bead size is actually considerably larger than 2.00 mm in diameter.

Regardless of minor variation in fine-screen mesh size and some possibility of field loss of extremely small beads, few if any should be lost in the laboratory size-grading process. The size grade 5 screen opening is 1.18 mm, considerably smaller than the nominal 1.33 mm field screen opening size. Any bead retained in field screening should theoretically be retained in one of the defined size grades during the lab size-grading process.

Toom and Redmond (1983:20.6-20.7) note the possibility of extremely small diameter beads having been lost through the field screens and the effort at the Tree site to retain beads even if they were smaller than the screen mesh being used. Being concerned that the sample from the Tree site was biased toward beads smaller than the standard recovery sizes and that the sample was therefore uncomparable to the other collections, we tested some of what appeared to be the smallest beads in the Tree site sample and found that none of those tested would pass through the size grade 5 lab screen. Apparently very few beads actually smaller than the field screen openings were actually retained in the Tree site samples, regardless of the fieldworkers' attempts to collect such small items (Toom and Redmond 1983:20.7).

Regardless of the consistency among the present samples, it is clear that extremely small beads do exist which can be lost during the use of waterscreening with windowscreen. In such cases only a partial sample of beads will be retained. Nevertheless, it should be possible to quantitatively compare the size distribution in such samples with any other samples collected with comparable field equipment and field and lab methods.

The bead samples were sorted and counted according to four categories of method of manufacture or *manufacturing technique*: wire-wound, blown, molded, and drawn or tubular. All beads of all sizes were so sorted and quantified. No blown beads occur in the present sample, and but a single molded bead occurs. Wire-wound beads are distinguished from drawn beads by the orientation of small fibers and air vesicles within the glass matrix, these being oriented parallel to the axis of the perforation in the drawn beads and concentrically wrapped around the perforation axis in the wire-wound beads. These methods of manufacture are discussed in greater detail in Davis (1973:15-19), Kidd and Kidd (1983:220-223), Toom and Redmond (1983:20.9-20.9), and in references cited therein.

Manufacturing technique, bead structure, and colors were determined while examining the beads through a stereoscopic binocular microscope with 10X-60X magnification.

Upon determination of manufacturing technique, the samples were segregated for purposes of further description and analysis. All beads manufactured by drawing and in the small or very small size classes were subjected to sorting and quantification according to the variables discussed in the following paragraphs. All small or very small wire-wound beads and all medium, large, and very large beads, regardless of manufacturing technique, were set aside from the drawn small/very small beads and were individually described in narrative fashion. All the quantification data for the variables to follow deal only with drawn small or very small beads, 5,861 in number, constituting about 96.3 percent of the available collection.

The variable *structure* or *color scheme* refers to the arrangement of different bodies of glass, usually of differing colors, within the bead. Three variants are recognized: striped, layered, and simple. Beads with a striped structure exhibit narrow strips of glass on the exterior which are bonded to the larger body of glass and which usually parallel the axis of the perforation. These are uncommon in the present sample of drawn small/very small beads (n = 5). These would be type Ib, Ibb, Ib', IIb, IIbb, IIb',IIIb, IIIbb, IIIb', IVb, IVbb, or IVb' beads in the Kidd and Kidd (1983) system. Beads with layered structure have two or more concentric bodies of glass, one at the interior along the perforation axis, and at least one other surrounding this layer. Each layer is of uniform thickness, comprising a tube within or outside another tube. These would be type IIIa and IVa beads in the Kidd and Kidd (1983) system. Simple beads are those composed of only a single body of glass; these would be designated as type Ia or IIa beads in the Kidd and Kidd (1983) system.

It can be noted with reference to color and structure that the vast majority of the small drawn beads in the present collections which appear at first glance to be simple in structure and white in color actually prove, upon microscopic inspection, to be layered monochrome or bichrome beads. Most frequently these have what we have termed a clear or silver colored outer layer over an opaque white inner or core layer. Kidd and Kidd might classify this outer layer as translucent oyster white in color, although no apparent replica for this bead type was noted in their illustrated specimens. Most beads in our samples with an opaque white exterior are also layered, having an opaque white or off-white interior or core layer. In our samples the white core layer is often slightly decomposed into a brown surface residue which may scale off but which, if present, gives the beads a brown or dirty appearance on each end. No specific tabulation of this particular color combination in the drawn beads was taken, although the presence of "clear" or "white" primary color in the data tabulations is a very good indicator and fairly accurate quantification of the presence of such layered specimens in the current samples. Only in the Taylor Bluff sample did we note that most of the white drawn beads were actually simple in structure in accord with their unmagnified appearance.

Five specific *shape* classes are identified in the small to very small drawn beads. These include oval, round or spherical, cylindrical or tube, subcylindrical or subtube, and ring or donut or circular shaped. Most of these shapes are self-explanatory, and virtually all except subcylindrical follow descriptions and examples illustrated in Kidd and

Table 21.5. Variable coding format for glass trade beads in the upper Knife-Heart region collections.

Card	Card Column	Variable and Attributes
1	1-3	Site Code
1	4	Site Catalog Series
1	5-8	Catalog Number
1		Size Class
	9-10	count of very large, > 10.0 mm diameter
	11-12	count of large, 6.0-10.0 mm diameter
	13-14	count of medium, 4.0-6.0 mm diameter
	15-17	count of small, 2.0-4.0 mm diameter
	18-20	count of very small, < 2.0 mm diameter (actual range is 1.15 mm [G5] - 2.0 mm)
1		Manufacturing Technique (all size classes)
	21	count of wire-wound
	22	count of blown
	23	count of molded
	24	count of drawn, tubular
1		Structure or Color Scheme - drawn small and very small only
	27	count of indeterminate or other
	28	count of striped
	29-30	count of layered
	31-32	count of simple
1		Shape Class - drawn small and very small only
	34	count of indeterminate or other
	35	count of oval

Table 21.5. Continued.

Card	Card Column	Variable and Attributes
1		Shape Class - drawn small and very small only, continued
	36-37	count of spherical
	38-39	count of cylindrical or tube (Kidd type I or III)
	40-41	count of subcylindrical or subtube (some edge rounding)
	42-44	count of round, ring, or donut shaped
1		Color Complexity - drawn small and very small only
	45	count of polychrome (3 or more colors)
	46-47	count of bichrome (2 colors)
	48-50	count of monochrome (single color)
1		Secondary Color on Bi- or Polychromes - drawn small and very small only
	51-52	brown
	53-54	white
	55-56	clear
	57-58	red
	59-60	yellow
	61-62	green
	63-64	
1	72	Card Number
1	73-74	Archeological Context or Excavation Unit
1	75-76	Horizon within Unit
1	77-78	Time Period or Component (site-specific)
1	79-80	Analytic Batch Assignment
2	1-3	Site Code
2	4	Catalog Series
2	5-8	Catalog Number
2		Primary or Dominant Color - drawn small and very small only
	9-10	count of clear, silver, translucent milk-white
	11-12	count of grey
	13-14	count of brown
	15-16	count of black
	17-18	count of yellow, gold, or citron
	19-20	count of red, pink, wine
	21-22	count of white, off-white (all opague)
	23-24	count of green (not within following Munsell ranges)
	25-26	count of Munsell 5BG 7-9/1-8 (light 5BG)
	27-28	count of Munsell 5BG 5-6/1-8 (medium 5BG)
	29-30	count of Munsell 5BG 2.5-4/1-8 (dark 5BG)
	31-32	count of Munsell 10BG 7-9/1-8 (light 10BG)
	33-34	count of Munsell 10BG 5-6/1-8 (medium 10BG)
	35-36	count of Munsell 10BG 2.5-4/1-8 (dark 10BG)
	37-38	count of Munsell 5B 7-9/1-8 (light 5B)

Table 21.5. Concluded.

Card	Card Column	Variable and Attributes
2		Primary or Dominant Color - drawn small and very small only, continued
	39-40	count of Munsell 5B 5-6/1-8 (medium 5B)
	41-42	count of Munsell 5B 2.5-4/1-8 (dark 5B)
	43-44	count of Munsell 10B 7-9/1-8 (light 10B)
	45-46	count of Munsell 10B 5-6/1-8 (medium 10B)
	47-48	count of Munsell 10B 2.5-4/1-8 (dark 10B)
	49-50	count of Munsell 5PB 7-9/1-8 (light 5PB)
	51-52	count of Munsell 5PB 5-6/1-8 (medium 5PB)
	53-54	count of Munsell 5PB 2.5-4/1-8 (dark 5PB)
1	72	Card Number

Kidd (1983). The cylindrical or tube beads are those which have not been remelted and rounded after the drawing process, and these would be either type I or type III specimens in the Kidd and Kidd system (1983), depending on their structure. All the other shape classes used here would be variants of type II and type IV specimens in the Kidd and Kidd system (1983). The subcylindrical shape recognized here is used to document beads which have only mildly rounded corners or ends and which have a length greater than their diameter.

Color complexity refers to the number of discrete colors which can be recognized in the bead. The classes monochrome, bichrome, and polychrome (more than two colors) are recognized. There is an obvious and somewhat redundant relationship between color complexity and bead structure. All simple structure beads must by definition be monochromes. All layered and striped beads have the potential to be bichromes or polychromes; and would be monochromes only if we could detect two or more bodies of the same colored glass being used in the bead (this does occur in white beads, as noted above). In the present sample, two of the five striped beads are polychromes while the other three are bichromes.

Two color class variables were used. A *secondary color* class was recorded for bichrome and polychrome beads. The secondary color is the color of the interior layer of glass in layered beads and of the stripes in striped beads. The term secondary is used in the sense that it is the color less visible to the observer, or the color making up the lesser part of the outside surface area of the bead. A simple subjective color class scheme was used for secondary color with the categories recognized being brown, white, clear/silver, red/pink/wine, yellow/gold/citron, and green.

The *primary color* class was recorded in a more complex fashion. The primary color is the only color present in a monochrome/simple structure bead; is the exterior layer color in a layered bead; and is the main body or matrix color in a striped bead. No attempt was made to use the elaborate colloquial color terms identified in Kidd and Kidd (1983) which account for practically every color term imaginable, mingled with the concept of translucency. Because relatively few beads in our samples occur with colors other than white, clear, and some variant of blue, we decided to simplify and subjectify the recording of most of the primary colors. Other than variants of blue, the following primary color classes are recognized: clear (including silver, translucent milk white), grey, brown, black, yellow (including gold and citron), red (including pink and wine variants), and white (including off-white variants). Because beads with some variant of blue are extremely common in the collections (making up circa 63 percent of the sample), and because a wide range of color variants occurs within the "blue" group, ranging from blue-green through pure blue and purple-blue, we decided to record the blue color variants in a more systematic and objective fashion. We surmised that this would allow us to study color heterogeneity and color control in a more systematic and objective fashion, and would allow more objective documentation of the most subtle color variations within the sample.

To do this we used five Munsell color charts in five separate hues for color sorting and color documentation within the blue range. The Munsell hues used are 5BG, 10BG, 5B, 10B, and 5PB (blue-green to blue to purple-blue). Note that the Munsell Color Company manufactures intervening hue charts (7.5BG, 2.5B, etc.) which we did not use, thinking that the five hues chosen would provide sufficient color documentation without splitting hairs too finely. To simplify the color coding we segmented each color chart (hue page) into light, medium, and dark zones, with all chips with values of 7/, 8/, or 9/ being light (any chroma from /1 to /10); with all chips of values 5/ or 6/ being medium (chroma from /1 to /10); and with all chips with values of 2.5/, 3/, or 4/ being dark (chroma of /1 to /10). Thus, with the five hue cards and three dark-medium-light subdivisions, the "blue" beads were sorted into one of 15 possible color classes based on Munsell nomenclature. All beads were wetted with water before determining either primary or secondary color.

In order to provide some cross reference with the blue color terminology employed by Kidd and Kidd (1983), we attempted to classify the colored bead illustrations in that document according to the chips available in our Munsell color charts. The result of that classification is presented for the reader's reference in Table 21.6.

A small amount of additional provenience and location data was also recorded in the computerized bead quantification in order to facilitate sorting and data summarization. Such variables include site code, catalog series, catalog number for each batch sample, archeological context or excavation unit, horizon within excavation unit, time period or component (site specific), and analytic batch designation as developed in this report (see Table 21.5). Data summaries used in the present analysis were derived by sorting and compiling sums for each variable and attribute state by analytic batch number by means of the program REPORT in the SPSS-X library of computer programs (SPSS, Inc. 1983:332-375).

Results

Frequency and Intensity of Bead Use

A summary of the frequency of occurrence of glass beads is presented according to analytic batch, time period, and by size class, in Table 21.7. Batch samples which were collected by waterscreen recovery are noted by an asterisk in that table, signifying those data sets which are pertinent to more precise quantitative analysis. Omitted from that table are five small to very small beads in batch 1/3 (time period 72) at the Slant Village site (Breakey and Ahler 1985:5); no beads occur in batch 0/2 (time period 71) at Slant Village. The Slant beads were overlooked in the formal coding process but are included in the present discussions because they were collected under controlled conditions, can be dated, and are therefore subject to density analysis.

Density of bead counts per cubic meter of excavated site volume were computed based on the frequency data in pertinent batch samples in Table 21.7 (including the Slant Village beads just mentioned) and using the excavated volume figures previously given in Table 21.1. The resulting density values are summarized in Table 21.8 and are plotted graphically in Figure 21.6. The density values for various site samples (Table 21.8) are in fair agreement with one another, except perhaps for the Slant Village values, which seem particularly low in periods 71 and 72. In light of the extremely steep increase in bead density between periods 82 and 83, the wide differences in the period 83 density values for Big Hidatsa and Sakakawea (almost a twofold difference) may simply reflect a small difference in age in the two batch samples assigned to this same period. The Big Hidatsa sample is estimated to date AD 1830-1845 with a median age of AD 1837.5, while the Sakakawea sample is estimated to date AD 1820-1845 (perhaps only AD 1820-1834) for a median date of AD 1832.5 or slightly earlier.

These differences are not thought to be severe enough to detract from the use of the volumetric density data as a means for measuring intensity of use of trade beads across combined site samples and across time periods. With this in mind, the curve for all sites expressed in Figure 21.6 is thought to give a fairly accurate representation of the intensity of use of glass beads through time in the regional archeological sites. Access to beads and the use of beads can be seen to have been extremely low throughout the entire indirect trade period (AD 1600-1740), then to progressively and rapidly increase in the following intermittent contact and frequent contact periods (AD 1740-1790, AD 1790-1822). In the final local trade period (AD 1822 and later) the density data indicate a virtual explosion in the use of beads among the villagers. Apparently access to these items was increased severalfold in this final period, and the use of these artifacts was becoming extremely common, judging by the high rate of loss into the archeological record.

Changes in the Composition of the Bead Collections

In this section we will examine in tabular and graphic form several of the discrete variables identified in the discussion on methods of quantification of the bead samples. The focus is on characterizing the nature of the bead samples (with an emphasis on the most numerous small or very small drawn beads) and, particularly, on isolating variables which are sensitive to temporal variation within the time sequence available to us in this study (AD 1600-1845/62). Between-site differences for the most part will be ignored, except in rare cases where a particular site sample seems to stand out as anomalous among others in the same time period.

Size. We can first examine variation in bead size. The frequency data for this variable, broken down by the five size classes very large through very small, have been presented in Table 21.7. In the study of size variation we must restrict our examination to the samples noted in Table 21.7 (*) as having been recovered with consistent fine-screen waterscreening process, and we further focus the study on those batch samples assigned to a specific time period.

Size variation can be examined in two ways, one of which is to compute percentages for each size class by time period. Such values are plotted graphically in Figure 21.7 for the period 71 through 83 sequence. Frequencies for medium, large, and very large beads, which are low in any period sample, are combined for purposes of graphic presentation. Readily apparent here is a trend toward smaller beads through time. While the earliest period 61 sample may be too small for accurate quantification (n = 4) it does contain a 25 percent share of larger beads which forms the beginning end of a progression toward lower and lower relative frequencies of such specimens through time. The only aberration in the otherwise smooth curves for combined large beads and the small beads occurs in the period 81 sample. This bump or blip may itself be due to sampling variation, because this sample consists of only 40 beads from only a few contexts within a single site. Very small beads show the most interesting pattern, being completely absent from the record until period 72 and then showing increases thereafter. The greatest increase (nearly threefold) in very small beads occurs in the final period.

A second way to present size data is to compute a mean bead size value for each time period sample from the grouped (size class) data. To do this we multiply the median size value for each size class by the count of specimens in each class, sum these values, and then divide by the total count in all size classes combined. The very large class is open-ended (does not have an upper size limit), so we use an estimated median value of 12.00 mm for the computation related to very large beads. The other size class median values used for computation are: large - 8.0 mm; medium - 5.0 mm; small - 3.0 mm; and very small - 1.59 mm (range of 1.18 mm to 2.00 mm). Mean size values computed in this manner are shown graphically in Figure 21.8. Again, the general temporal trend toward smaller beads later in time is quite evident. The only irregularity in the trend occurs with the period 81 sample, as noted previously in the discussion of size class percentages. The data strongly suggest, whether expressed as size class percentages or mean bead size, that bead size is a variable quite sensitive to temporal change in the regional village collections.

Regarding size, we can provide a comment concerning the unusual size distribution of the Mondrian Tree bead sample. Slightly more than 70 percent of this sample consists of beads in the very small size class. This figure is more than seven times as great as the single site batch sample (batch 64, Big Hidatsa) having the highest percentage of very small beads in the dated regional village samples. The Mondrian Tree sample has a computed mean size of 2.06 mm, markedly smaller than any of the dated samples and completely off the scale in Figure 21.8. The existing data indicate that the Mondrian Tree glass beads are completely different with regard to size from any of the studied and dated bead samples which can be linked to the Hidatsa peoples in the period AD 1600-1845.

Manufacturing Technique. Data on manufacturing technique are presented for all bead samples of all sizes in Table 21.9. A single molded bead occurs in the period 83 Big Hidatsa sample (batch 64), and no blown beads occur in the study samples. Beads made by the drawing technique are the dominant ones in the collection, comprising overall about 97.9 percent of all specimens. Wire-wound is the only other technique present in any frequency (n = 125, overall 2.1 percent). Twenty-six of these wire-wound specimens are in the small size class, while the remaining 99 are scattered among the medium, large, and very large size classes. Study of the percentage of wire-

Table 21.6. Suggested equivalencies between blue and blue-green glass bead colors illustrated in Kidd and Kidd (1970) and Munsell colors.

Kidd and Kidd Color Name	Munsell - Hue Value/Chroma
surf green	5BG 8/2
teal green	5BG 4/4
turquoise	10BG 6/6
light aqua blue	5B 9/2-9/3
aqua blue	5B 8/4-7/6
pale blue	5B 9/1
brite blue	5B 7/8
robins egg blue	5B 5/6-5/8
brite copan blue	10B 8/2-8/4
cerulean blue	10B 5/8-6/8
shadow blue	10B 6/4-6/6
dark shadow blue	10B 5/4
ultramarine	2.5PB 7/8 (estimate, not on charts we used)
dark navy	5PB 4/6
brite navy	5PB 5/8-5/10

Table 21.7. Summary of glass bead size classification data by batch and time period.

Period	Site	Batch	V.large	Large	Medium	Small	V.small	Total
61	* Lo Hid 4	47	0	0	0	2	0	2
	* Big Hid 6	69	0	0	1	1	0	2
	Total		0	0	1	3	0	4
62	* Lo Hid 3	46	0	1	1	5	0	7
	* Big Hid 5	68	1	0	0	27	0	28
	Total		1	1	1	32	0	35
70	Mahhaha 2	29	0	1	0	0	0	1
71	* Lo Hid 2	45	0	1	0	13	0	14
	* Big Hid 4	67	0	0	1	36	0	37
	Total		0	1	1	49	0	51
72	* Lo Hid 1	44	0	1	1	16	0	18
	* Big Hid 3	66	0	0	2	182	4	188
	Total		0	1	3	198	4	206
80	Amahami Late	41	0	1	0	0	0	1
	* Sakaka Inside	62	0	9	18	1243	117	1387
	Sakaka Other	63	1	15	15	374	15	420
	Total		1	25	33	1617	132	1808
81	Greenshield	19	0	0	7	112	0	119
	* Sakakawea 3	61	0	1	1	37	1	40
	Total		0	1	8	149	1	159
82	* Sakakawea 2	60	1	1	5	166	8	181
	* Big Hid 2	65	0	2	7	450	10	469
	Total		1	3	12	616	18	650

Table 21.7. Concluded.

Period	Site	Batch	V.large	Large	Medium	Small	V.small	Total
83	Ft Clark	35	2	18	15	209	5	249
	* Sakakawea 1	59	0	7	23	1267	71	1368
	* Big Hid 1	64	1	2	25	943	106	1077
	Total		3	27	63	2419	182	2694
Unasgn.	* WBR Latest	39	0	0	0	36	0	36
	* Lo Hid Other	50	0	0	0	2	0	2
	* Big Hid Other	71	0	2	1	24	2	29
	* Elbee	74	0	0	2	39	0	41
	* Scovill	75	0	0	0	9	0	9
	* Forkorner West	78	0	0	0	14	0	14
	* Mondrian Tree	87	1	1	1	82	202	287
	* Taylor Bluff	94	0	0	1	49	0	50
	* Running Deer	98	0	0	0	8	0	8
	TOTAL		7	63	127	5346	541	6084

Note: * indicates samples collected with fine-mesh waterscreen recovery.

Table 21.8. Density by excavated volume data for glass beads, organized by site and time period.

Data Type	Time Period	Lower Hidatsa	Big Hidatsa	Sakakawea	Slant*	All Sites
Counts per cubic meter grades 1-5	61	0.8	1.2			1.0
	62	1.6	7.7			4.3
	71	6.5	7.2		- *	5.5
	72	13.8	21.3		4.3*	18.7
	81			28.7		28.7
	82		74.9	40.6		60.7
	83		512.9	207.5		280.7
	80			121.2**		121.2**

Notes: * Slant Village data are based on 0 beads in batch 0/2, period 71 sample and 5 beads in batch 1/3, period 72 sample.
** Excludes 642 beads from the unreported 1981 inside-house excavations; inclusion of those data yields a density value of ca. 179 beads per cubic meter.

wound beads is confined to samples with controlled recovery because the presence of the technique is clearly related to bead size and therefore collection technique. The wire-wound technique does not occur until period 72, but this may be a function of its generally rare presence and the low frequencies of all beads in the early periods. In period 72 and subsequent periods wire-wound beads constitute the following proportion of all beads of all sizes in controlled samples: period 72 - 1.0 percent; period 81 - 5.0 percent; period 82 - 1.5 percent; and period 83 - 1.3 percent. If we consider only the medium sized and larger beads where the wire-wound technique is used most commonly, we again see an absence before period 72 and then the following data: period 72 - 50.0 percent; period 81 - 50.0 percent; period 82 - 31.5 percent; and period 83 - 44.8 percent. No major temporal trend is apparent, and we conclude that after circa AD 1740 (period 72), wire-wound beads have a relatively steady frequency of occurrence among the medium and larger-sized beads in the samples.

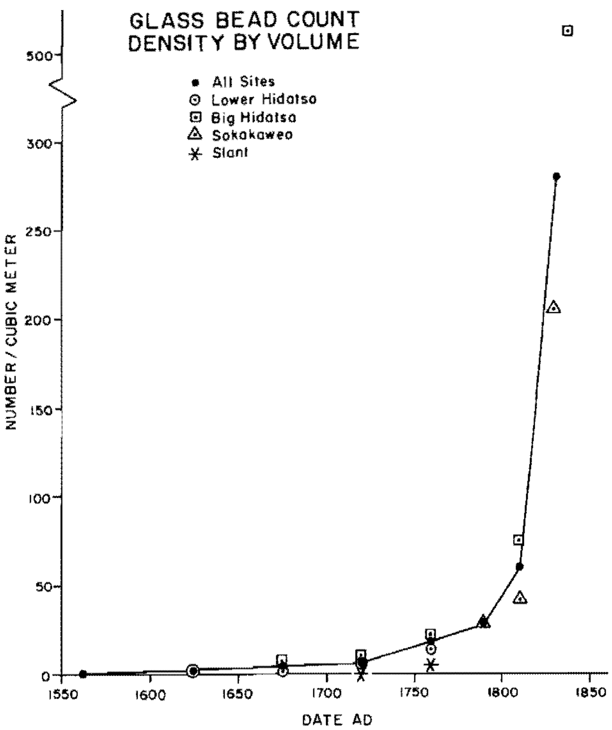

Figure 21.6. Glass bead volumetric density data as counts of size grade 1-5 items per cubic meter ploted by time period.

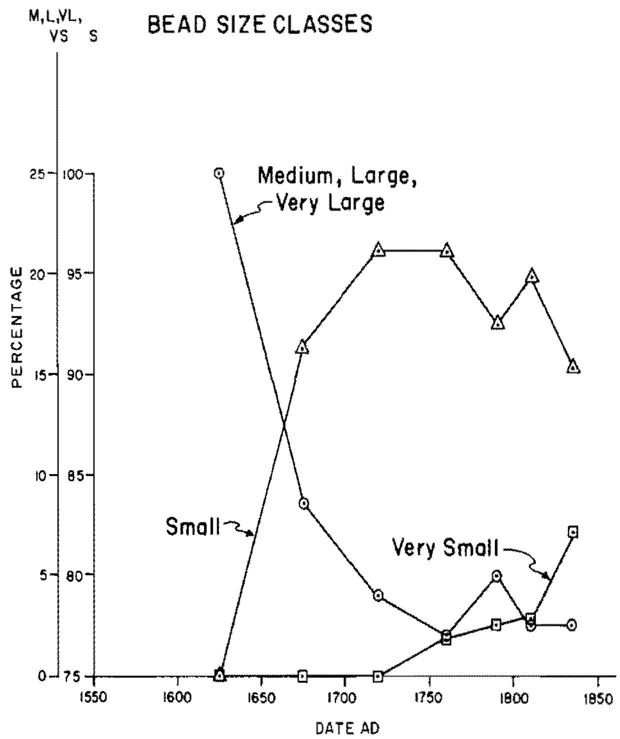

Figure 21.7. Glass bead size class percentages plotted by time period, all beads from fine-screen collections.

Structure. This and the following variables are summarized for small and very small drawn beads only. Unless otherwise stated, the recovery procedure is not considered, and samples processed by waterscreening are considered along with samples collected by other means. This is done because the samples studied are already greatly restricted in size to the two smallest size classes, and because the presence or absence of these variables is not dependent upon recovery process.

Three structural variants are recognized: striped, layered, and simple. Frequency data on these variants are tabulated by batch unit in Table 21.9, and percentage data for the two most common variants, layered and simple, are plotted by time period in Figure 21.9. A total of five striped beads occur in the samples, all being from relatively late deposits, two from Big Hidatsa Village and three from Sakakawea Village. These are ignored in the graphic analysis. The graphed percentages (Figure 21.9) show a very strong temporal pattern in which layered beads are absent or relatively uncommon in the earliest periods (61 and 62), reach a maximum relative frequency in period 71, and steadily decrease in occurrence again in subsequent periods. The data for the earliest two periods in the seventeenth century are based on very small sample sizes and may not be reliable. The trend from AD 1700 onwards is based on generally larger samples and may be more indicative of a meaningful temporal pattern.

It can be noted that the data for bead structure are nearly identical to the data on color complexity (Table 21.11) because all simple structure beads will by definition contain only one color and because the vast majority of all layered beads will be recorded as bichrome in color complexity. For this reason, the data on color complexity are not individually plotted in a graphic fashion, with Figure 21.9 serving to illustrate trends in both variables.

It is almost certain that the distinctive temporal pattern noted is largely explainable as a function of primary color preferences expressed in the bead samples. Nearly all of the beads with a clear/silver primary color are in fact layered bichrome beads with a white core color. This is one of the dominant bead forms in the samples under study.

The other dominant color is some variation of blue, and these specimens are almost without exception beads with simple structure. Thus, the systematic change in bead structure illustrated in Figure 21.4 is probably simply an expression of changes in bead color preferences, either on the part of the suppliers, but more likely on the part of the Indian recipients. It is unlikely that the Indians or that most of the traders even recognized that the clear/silver on white beads were, in fact, layered in structure, for upon casual examination they appear to be pure white in color. It is likely that the layering clear over white was done at the factory to give the beads an iridescent effect, a little extra sparkle that was absent from white monochrome, simple structure beads.

Structure data may be of some assistance in dating some of the less well dated samples quantified in this study. For example, the small White Buffalo Robe bead collection contains 47.2 percent layered and 52.8 percent simple structure beads. These values are very similar to those for the dated period 72 samples, and a date in the last half of the eighteenth century can be posited on this basis for the White Buffalo Robe post-contact period component. In contrast, the small Taylor Bluff sample contains only 18.4 percent layered beads and 81.6 percent simple beads. This suggests either a very early or a very late date for this sample; all other evidence from the major post-contact period component at the site (based on 1983 excavations, not analyzed at the time of this writing) suggests a date of circa AD 1840 or later. The bead data seem to support a very late post-contact period occupation at the site, perhaps in the mid-AD 1800s.[1] Lastly, we can examine the structure data for the Mondrian Tree site sample, comprised of 44.6 percent layered and 54.4 percent simple. If the Tree site sample falls within the age range of village components studied here, these data would suggest a date in the late 1700s or earlier. There is little other evidence at the site to support such an age determination. An alternate conclusion is that the Mondrian Tree glass bead sample is unlike any of the other samples studied here, and cannot be readily compared to the other samples and data sets.

Shape. Shape class frequencies for small and very small drawn beads are tabulated in Table 21.10 and are illustrated graphically in Figure 21.10. Oval and spherical beads occur in very minor frequencies which reflect no meaningful temporal pattern. The dominant form is ring or circular (donut) which makes up about 94 percent of the sample. Relatively small frequencies of cylindrical and subcylindrical forms occur. Figure 21.10 illustrates that the cylindrical form and the ring/circular form vary inversely through time in an apparently significant pattern. The cylindrical form, being tube beads which have been cut or snapped but which have not been remelted and rounded, do not appear until period 71, AD 1700-1740/45. These beads increase steadily in relative frequency to a peak in the period 81 sample and then they decrease in importance even more rapidly thereafter through the final two time periods in the 19th century. Ring-shaped beads exhibit a mirror image pattern, decreasing in relative frequency to a minimum in period 81, then increasing markedly thereafter, especially in period 83. Thus, cylindrical-shaped beads would seem to be a sensitive time marker; if a regional sample contains more than 6-7 percent of such specimens, it should presumably date in the closing decades of the eighteenth century.

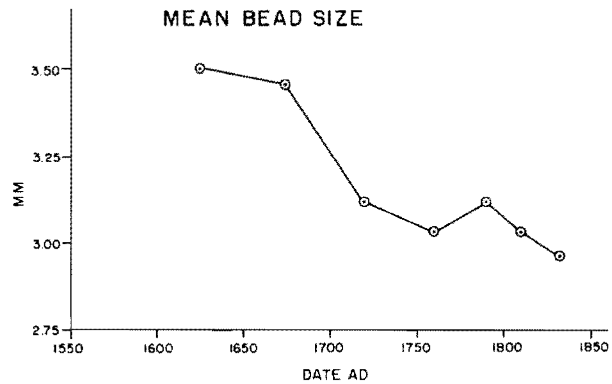

Figure 21.8. Mean glass bead size plotted by time period, all beads from fine-screened collections.

Cylindrical beads are virtually absent in several of the poorly dated sites such as White Buffalo Robe, Elbee, Mondrian Tree, and Taylor Bluff. Their absence or near absence in those sites suggests that none of those components are likely to date in the latter decades of the eighteenth century and first decade or two of the nineteenth century when cylindrical beads were most commonly used in the region. Dates of occupation either before or after that period seem most likely.

[1] Analysis presented by Ahler (1988) indicates dates of AD 1834 to 1845 for the main component at Taylor Bluff. (S.A.A.)

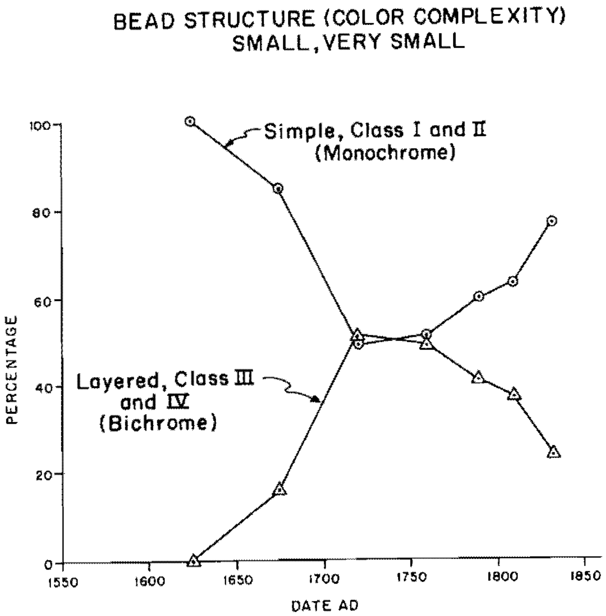

Figure 21.9. Glass bead structure class percentages plotted by time period, small and very small drawn beads only.

Color Complexity. Only two polychrome beads occur in the sample of small and very small drawn specimens, both of these being at Sakakawea Village (Table 21.11). Monochrome beads dominate the sample, with bichromes being next most common. As previously noted, the patterns of change in relative proportions of bichrome and monochrome beads closely parallel the patterns for layered and simple structure, respectively, as plotted in Figure 21.9. Also, as previously noted, these changes probably reflect primarily shifting preferences for blue (monochrome, simple) versus sparkly, iridescent white (layered, clear/silver on white bichrome) beads.

Secondary Color. There is little variety in secondary or interior color in bichrome small to very small drawn beads (Table 21.11). Nearly all bichrome beads have a white secondary color (96 percent of the sample). Single examples of red, yellow, and green secondary colors occur. Small numbers of beads with a clear secondary color occur scattered through virtually all of the larger samples. A concentration seems to occur in the period 81 sample where 25 percent of the bichrome beads have a clear secondary color. The significance of this becomes unclear, however, when it is noted that all 12 specimens from this period derive from the Greenshield site sample. When we note that the Greenshield sample probably represents in large part an Arikara site-unit intrusion from far to the south, we might suppose that the anomalous secondary color pattern at that site reflects both sampling vagaries as well as perhaps regional differences in the source of bead supplies for the fur trade (the Arikaras perhaps being supplied from St. Louis or even Spanish southwestern sources, while the Hidatsas were supplied from Canadian sources in this period).

Primary Color. Primary bead color can be examined in at least two ways. One is through study of the general color classes. The other is by means of a closer inspection of detailed color breakdown among the dominant blue/blue-green/purple-blue color group.

Frequency data for the general, subjective primary color classes are shown in Table 21.12. Nine major color variants occur. Three variants occur in extremely low frequency, each comprising less than 0.5 percent of the full sample (grey, brown, and the yellow group). Grey beads occur exclusively at the Sakakawea site in contexts postdating AD 1800. The brown beads are restricted to contexts which postdate AD 1780. They comprise circa 2.0 percent of the period 81 sample and decrease in relative frequency thereafter. A similar pattern exists for the few yellow group beads; they are absent before period 81, they comprise 2.0 percent of the period 81 sample, and they are less common thereafter.

The remaining six color groups each comprise at least 1.6 percent or more of the total bead sample. In order of decreasing importance these consist of the blue group, clear/silver, white, black, the red group, and green. Percentage data for all of these classes except the red group are plotted by time period in Figure 21.11. The red group is not plotted because nearly half of the available sample derives not from the dated village samples but from the Mondrian Tree site collection.

Before proceeding further we can note an anomalous difference in primary color composition for the Greenshield and Sakakawea batch 81 samples which have both been assigned to period 81, AD 1780-1800. The Greenshield sample contains disproportionately large numbers of red and green beads which are totally absent in the Sakakawea sample, and the reverse can be said for brown beads which occur in the Sakakawea sample. All of these are relatively rare forms within the regional collections.

The suggestion is that these two site samples are not comparable in terms of color composition, and that perhaps they should not be combined for across-period comparisons. As noted previously, the Greenshield sample is perhaps the least appropriate for comparison to the other time period samples, reflecting as it does potential bead sources in the south rather than in the north during this time period. On that basis, the graphed data for period 81 in Figure 21.11 are based solely on the Sakakawea batch 61 sample. This has little effect on the major patterns of change between blue and clear/silver beads, but it does have the effect of eliminating some potential irregularities in the minor color class frequencies.

The plot of major color class percentages in Figure 21.11 illustrates several apparently significant temporal trends. The color composition in the period 61 sample and in the period 62 sample, both of which are quite small in size, is quite distinct from the composition in later periods. Perhaps each of these early period samples should be considered individually, rather than attempting to fit them into broader temporal trends in color composition. The period 61 sample seems unusual in that black beads make up two-thirds of the sample. The period 62 sample, comprised of a somewhat larger number of specimens, is somewhat devoid of color diversity which marks the later period samples. Only clear (on white) and blue beads occur at that time, with the blue specimens dominating the small sample (circa 85 percent). Blue beads do not attain this percentage in any of the subsequent dated samples. This particular color composition, dominated by single color and devoid of much diversity, may reflect vagaries of sampling for period 62. This possibility is accentuated by the fact that 14 beads comprising more than half of the Big Hidatsa sample for this period derive from a single pit feature in a less than optimally dated context within a house at that site (Ahler and Swenson 1985:213).

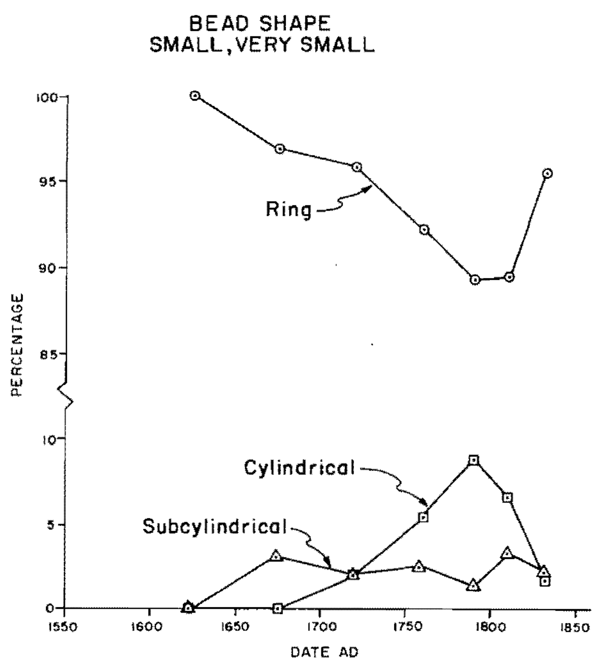

Figure 21.10. Glass bead shape class percentages plotted by time period, small and very small drawn beads only.

An abrupt change in color composition occurs in the period 71 sample, and from that time onward (after AD 1700) regular changes seem to occur in the color composition of the dated samples. In the period 71 sample clear/silver suddenly becomes the dominant color class. These are primarily layered beads with clear overlying white glass, and we judge that they would have been observed and tabulated as "white" specimens in all the previous reports on major site excavation in the KNRI. Blue beads are slightly less common than clear ones in period 71, and black and white color groups also occur. Following period 71 there is a strong temporal trend in which clear/silver beads become increasingly less common; this decrease accelerates through time and is particularly marked in the final time period when such specimens comprise less than 15 percent of the study sample. These clear/silver specimens are replaced largely by beads in the blue color group. Blue group beads comprise less than 50 percent of the sample in period 72 and increase to nearly 70 percent of the sample in the final time period (Figure 21.11). Potentially meaningful changes also occur in the minor color groups, as well. Black beads steadily increase to a peak occurrence of over 10 percent in the period 81 sample (AD 1780-1800), then virtually disappear by the final period (after AD 1820/30). Green beads are less common but exhibit a time pattern very similar to the black color group. White beads vary erratically through most of the period 71-82 sequence, then increase to more than 12 percent of the sample in the final time period.

Color diversity is a concept which has been mentioned more than once in characterizing the bead

Table 21.9. Summary of manufacturing technique data for all glass beads and structure data for drawn small and very small glass beads.

			-- Manuf Technique --				-- Structure --			
Period	Site	Batch	Wound	Molded	Tubular	Total	Striped	Layered	Simple	Total
61	Lo Hid 4	47	0	0	2	2	0	0	2	2
	Big Hid 6	69	0	0	2	2	0	0	1	1
	Total		0	0	4	4	0	0	3	3
62	Lo Hid 3	46	0	0	7	7	0	1	4	5
	Big Hid 5	68	0	0	28	28	0	4	23	27
	Total		0	0	35	35	0	5	27	32
70	Mahhaha 2	29	0	0	1	1	0	0	0	0
71	Lo Hid 2	45	0	0	14	14	0	4	9	13
	Big Hid 4	67	0	0	37	37	0	21	15	36
	Total		0	0	51	51	0	25	24	49
72	Lo Hid 1	44	1	0	17	18	0	6	10	16
	Big Hid 3	66	1	0	187	188	0	93	93	186
	Total		2	0	204	206	0	99	103	202
80	Amahami L	41	1	0	0	1	0	0	0	0
	Sakaka In	62	24	0	1363	1387	1	337	1013	1351
	Sak Other	63	25	0	395	420	1	95	290	386
	Total		50	0	1758	1808	2	432	1303	1737
81	Greensh	19	1	0	118	119	0	47	65	112
	Saka 3	61	2	0	38	40	0	13	24	37
	Total		3	0	156	159	0	60	89	149
82	Saka 2	60	5	0	176	181	1	50	121	172
	Big Hid 2	65	5	0	464	469	1	182	274	457
	Total		10	0	640	650	2	232	395	629
83	Ft Clark	35	21	0	228	249	0	106	108	214
	Saka 1	59	23	0	1345	1368	0	276	1058	1334
	Big Hid 1	64	8	1	1068	1077	0	235	813	1048
	Total		52	1	2641	2694	0	617	1979	2596
Unassigned	WBR	39	0	0	36	36	0	17	19	36
	Lo Hid Oth	50	0	0	2	2	0	1	1	2
	Big H Oth	71	1	0	28	29	1	9	16	26
	Elbee	74	4	0	37	41	0	4	33	37
	Scovill	75	0	0	9	9	0	3	6	9
	Fork W	78	0	0	14	14	0	0	14	14
	Mon Tree	87	3	0	284	287	0	129	154	283
	Taylor Bl	94	0	0	50	50	0	9	40	49
	Run Deer	98	0	0	8	8	0	2	6	8
	Total		125	1	5958	6084	5	1644	4212	5861

Table 21.10. Summary of shape data for drawn small and very small glass beads.

Period	Site	Batch	Indet	Oval	Round/ Sphere	Cylin	Subcyl	Circular/ Ring	Total
61	Lo Hid 4	47	0	0	0	0	0	2	2
	Big Hid 6	69	0	0	0	0	0	1	1
	Total		0	0	0	0	0	3	3
62	Lo Hid 3	46	0	0	0	0	1	4	5
	Big Hid 5	68	0	0	0	0	0	27	27
	Total		0	0	0	0	1	31	32
70	Mahhaha 2	29	0	0	0	0	0	0	0
71	Lo Hid 2	45	0	0	0	0	0	13	13
	Big Hid 4	67	0	0	0	1	1	34	36
	Total		0	0	0	1	1	47	49
72	Lo Hid 1	44	0	0	0	0	0	16	16
	Big Hid 3	66	0	0	0	11	5	170	186
	Total		0	0	0	11	5	186	202
80	Amahami L	41	0	0	0	0	0	0	0
	Sakaka In	62	1	0	0	49	51	1250	1351
	Sak Other	63	0	0	0	9	15	362	386
	Total		1	0	0	58	66	1612	1737
81	Greensh	19	0	0	1	11	2	98	112
	Saka 3	61	0	0	0	2	0	35	37
	Total		0	0	1	13	2	133	149
82	Saka 2	60	0	0	0	18	7	147	172
	Big Hid 2	65	0	0	4	24	13	416	457
	Total		0	0	4	42	20	563	629
83	Ft Clark	35	0	0	0	0	1	213	214
	Saka 1	59	5	1	0	37	43	1248	1334
	Big Hid 1	64	12	0	0	4	14	1018	1048
	Total		17	1	0	41	58	2479	2596
Unassigned	WBR	39	0	0	0	0	1	35	36
	Lo Hid Oth	50	0	0	0	0	0	2	2
	Big H Oth	71	0	0	0	1	2	23	26
	Elbee	74	0	0	0	0	0	37	37
	Scovill	75	0	0	0	0	0	9	9
	Fork W	78	0	0	0	0	0	14	14
	Mon Tree	87	1	0	0	0	2	280	283
	Taylor Bl	94	0	0	0	1	0	48	49
	Run Deer	97	0	0	0	0	0	8	8
	Total		19	1	5	168	158	5510	5861

Table 21.11. Summary of color complexity and secondary color data for drawn small and very small glass beads.

			-- Complexity --				-- Secondary color --					
Period	Site	Batch	Poly	Bi	Mono	Total	White	Clr	Red	Yell	Green	Total
61	Lo Hid 4	47	0	0	2	2	0	0	0	0	0	0
	Big Hid 6	69	0	0	1	1	0	0	0	0	0	0
	Total		0	0	3	3	0	0	0	0	0	0
62	Lo Hid 3	46	0	1	4	5	1	0	0	0	0	1
	Big Hid 5	68	0	4	23	27	4	0	0	0	0	4
	Total		0	5	27	32	5	0	0	0	0	5
70	Mahhaha 2	29	0	0	0	0	0	0	0	0	0	0
71	Lo Hid 2	45	0	4	9	13	4	0	0	0	0	4
	Big Hid 4	67	0	21	15	36	20	1	0	0	0	21
	Total		0	25	24	49	24	1	0	0	0	25
72	Lo Hid 1	44	0	6	10	16	6	0	0	0	0	6
	Big Hid 3	66	0	93	93	186	93	0	0	0	0	93
	Total		0	99	103	202	99	0	0	0	0	99
80	Amahami L	41	0	0	0	0	0	0	0	0	0	0
	Sakaka In	62	1	336	1014	1351	306	30	0	1	1	338
	Sak Other	63	1	95	290	386	94	2	1	0	0	97
	Total		2	431	1304	1737	400	32	1	1	1	435
81	Greensh	19	0	47	65	112	35	12	0	0	0	47
	Saka 3	61	0	13	24	37	13	0	0	0	0	13
	Total		0	60	89	149	48	12	0	0	0	60
82	Saka 2	60	0	51	121	172	51	0	0	0	0	51
	Big Hid 2	65	0	183	274	457	182	1	0	0	0	183
	Total		0	234	395	629	233	1	0	0	0	234
83	Ft Clark	35	0	106	108	214	105	1	0	0	0	106
	Saka 1	59	0	276	1058	1334	270	6	0	0	0	276
	Big Hid 1	64	0	235	813	1048	234	1	0	0	0	235
	Total		0	617	1979	2596	609	8	0	0	0	617
Unasgn.	WBR	39	0	17	19	36	17	0	0	0	0	17
	Lo Hid Oth	50	0	1	1	2	1	0	0	0	0	1
	Big H Oth	71	0	10	16	26	8	2	0	0	0	10
	Elbee	74	0	4	33	37	4	0	0	0	0	4
	Scovill	75	0	3	6	9	2	1	0	0	0	3
	Fork W	78	0	0	14	14	0	0	0	0	0	0
	Mon Tree	87	0	129	154	283	129	0	0	0	0	129
	Taylor Bl	94	0	9	40	49	8	1	0	0	0	9
	Run Deer	98	0	2	6	8	2	0	0	0	0	2
	Total		2	1646	4213	5861	1589	58	1	1	1	1650

Table 21.12. Summary of primary color for drawn small and very small glass beads.

Period	Site	Batch	Silver/ Clear	Grey	Brown	Black	Gold/ Yellow	Pink/ Red	White	Green	Blue Group	Total
61	Lo Hid 4	47	0	0	0	2	0	0	0	0	0	2
	Big Hid 6	69	0	0	0	0	0	0	0	0	1	1
	Total		0	0	0	2	0	0	0	0	1	3
62	Lo Hid 3	46	1	0	0	0	0	0	0	0	4	5
	Big Hid 5	68	4	0	0	0	0	0	0	0	23	27
	Total		5	0	0	0	0	0	0	0	27	32
70	Mahhaha 2	29	0	0	0	0	0	0	0	0	0	0
71	Lo Hid 2	45	4	0	0	0	0	0	0	0	9	13
	Big Hid 4	67	20	0	0	3	0	0	1	0	11	35
	Total		24	0	0	3	0	0	1	0	20	48
72	Lo Hid 1	44	6	0	0	0	0	0	1	0	9	16
	Big Hid 3	66	90	0	0	14	0	0	8	5	68	185
	Total		96	0	0	14	0	0	9	5	77	201
80	Amahami L	41	0	0	0	0	0	0	0	0	0	0
	Sakaka In	62	190	2	3	25	0	22	146	16	947	1351
	Sak Other	63	74	0	2	9	1	3	23	0	274	386
	Total		264	2	5	34	1	25	169	16	1221	1737
81	Greensh	19	36	0	0	16	1	12	0	5	42	112
	Saka 3	61	13	0	3	4	2	0	0	0	15	37
	Total		49	0	3	20	3	12	0	5	57	149
82	Saka 2	60	52	2	3	15	0	0	2	5	93	172
	Big Hid 2	65	157	0	3	29	0	1	30	4	233	457
	Total		209	2	6	44	0	1	32	9	326	629
83	Ft Clark	35	1	0	0	6	11	5	104	3	84	214
	Saka 1	59	203	0	8	32	8	7	82	28	966	1334
	Big Hid 1	64	105	0	4	23	1	1	145	9	760	1048
	Total		309	0	12	61	20	13	331	40	1810	2596
Unasgn.	WBR	39	14	0	0	4	0	0	3	3	12	36
	Lo Hid Oth	50	1	0	0	0	0	0	0	0	1	2
	Big H Oth	71	6	0	0	3	0	0	3	0	14	26
	Elbee	74	1	0	1	1	0	0	4	0	30	37
	Scovill	75	2	0	0	0	0	1	0	0	6	9
	Fork W	78	0	0	0	0	0	0	0	0	14	14
	Mon Tree	87	17	0	0	19	3	48	128	17	51	283
	Taylor Bl	94	5	0	0	1	0	0	6	0	37	49
	Run Deer	98	2	0	0	0	0	0	0	0	6	8
	Total		1004	4	27	206	27	100	686	95	3710	5859

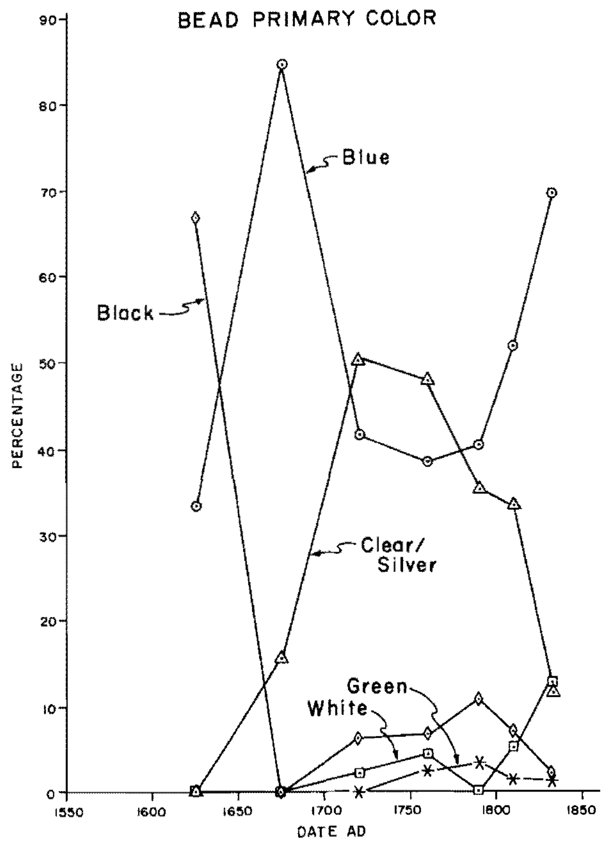

Figure 21.11. Glass bead primary color class percentages plotted by time period, small and very small drawn beads only.

samples from certain time periods. This concept can be measured or at least objectified by the computation of numerical indices, as discussed in literature on ecology. One index which may be useful is the Shannon-Wiener index which measures equitability, or the combined concepts of both diversity and evenness. By diversity we mean in simplest terms the number of different classes that are present in any given sample, and by evenness, we mean the degree of equality of dispersion of frequencies among the classes that are recognized. The Shannon-Wiener index will become larger both as the number of observed classes increases and as the observed items are spread more evenly among the classes that are recognized. Davis (1973:34) has observed that through time, glass bead collections in the Northern Plains tend to become more diverse in color. This equitability index would seem to be a good way to measure such a phenomenon, if it does occur. Here we use the formula as given in Whittaker (1975:95):

$$H' = -\text{Sum of } p_i \log p_i, \text{ summed from } i = 1 \text{ to } S$$

where p equals the percentage for a class (as a decimal) and S is the number of classes.

Figure 21.12a illustrates a graphic plot of equitability index values by time period. In general, there is an overall trend toward higher index values in later time periods, although the maximum equitability value occurs in the period 81 sample. In general, these index values express the facts that few color classes are observed in the early time periods, that more color classes are observed in the later time periods, and that in the period 81 sample, the beads are maximally dispersed among the observed color classes. After that point in time (AD 1780-1800), the observed samples tend to become more concentrated in only a few color classes (particularly in the blue group), even though the sample size is large and several color categories are present. It should be noted that this equitability index is largely free from the effects of sample size, except in very small samples such as in period 61 where the number of specimens is significantly fewer than the potential number of color classes.

We can now turn to the detailed color classification data for the beads in the blue primary color group which were sorted according to Munsell color charts. These data are summarized in Table 21.13. In this case one of our concerns is variation in color heterogeneity or homogeneity within this general blue color group which dominates nearly all samples in all time periods. It can be hypothesized that through time minor variations in color would have become less pronounced as quality control increased in the bead manufacturing industry. Early in time, color, particularly in the blue group which exhibits obvious variation, might have varied widely from one glass batch to the next. Later in time, standard color formulas might have come into use, at least within the largest bead factories, which tended to produce more standard colors consistent from sample to sample.

To measure the homogeneity or heterogeneity of blue color variation we use another index called the Simpson dominance concentration index. This index provides an objective measure of the degree of classification concentration that exists in the classification of objects which can conceivably belong to many classes. This concentration index is in a sense measuring the opposite of what is measured with the equitability index. We use the formula given in Whittaker (1975:95) for what is termed the Simpson index:

$$C = \text{Sum of } p_i^2, \text{ summed from } i = 1 \text{ to } S$$

where p is the percentage for a given class (expressed as a decimal) and where S is the number of classes.

Simpson index values are computed for the frequency data in Table 21.13 and are presented in graphic form by time period in Figure 21.12b. Aside from the index value of 1.0 computed for the single blue specimen in period 61, the variation in index values reveals a fairly regular pattern through time. The concentration index falls gradually to a minimum value in period 72, and then consistently increases thereafter, reaching a peak in the final period 83 sample. These index values show that blue beads are most heterogeneous and are most dispersed among the 15 possible color categories in the period 72 sample; thereafter, they tend to become more and more concentrated into a smaller and smaller number of discrete color classes. For the samples ranging from periods 72 through 83 (AD 1740-1862), the data seem to conform to the predicted change in color quality control through time.

To express the pattern in alternate terms we can note the following. If all bead samples were evenly distributed among all 15 possible blue group color classes, approximately 6.7 percent of each sample would occur in each color class. In period 72, five of the 15 color classes have values this large or larger; in the period 83 sample where the sample size is actually much larger, only three color classes have percentages this large or larger, indicating that blue colors are more distinctly concentrated in fewer color variants in the latest time period samples. To express the blue color data in more colloquial terms, we can note that in the period 72 sample the most common color classes are what would include something between teal green and surf green (5BG medium), brite navy (5PB dark), and turquoise (10BG medium), in that order. In the period 83 sample, the blue bead group is dominated by specimens in the turquoise (10BG medium) color group with robins egg blue (5B medium) a distant second.

We can briefly examine primary color composition and color diversity in some of the undated samples to see how they compare to the dated samples. Both the Elbee sample and the Taylor Bluff sample have more than 10 percent white primary color and greater than 75 percent blue group primary color, a combination of characteristics which suggests placement at the latest end of the time trend, equivalent to the period 83 samples or even slightly later in time. This assessment is consistent with other data for Taylor Bluff, and provides no contradictory information for Elbee.

The White Buffalo Robe sample is quite different. There are roughly equal frequencies of clear and blue group beads, with the clear specimens being the most common (38 percent); black beads make up more than 11 percent and green specimens comprise more than 8 percent, a figure higher than in any other sample. This combination of characteristics strongly indicates that the White Buffalo Robe sample dates in the final decades of the eighteenth century where roughly equal frequencies of clear and blue occur and where peak frequencies for black and green occur in the dated samples.

The Mondrian Tree sample is unlike any other studied here in terms of primary color composition. White is the dominant color, comprising more than 45 percent of the sample, a value more than three times as great as the greatest frequency of white beads seen in any of the studied village samples excepting the Fort Clark sample. Red beads are exceedingly common (17 percent), as are black and green beads. Clear specimens are relatively uncommon. The Shannon-Wiener equitability index for the Tree site sample is 0.668, a value larger than any observed for the dated period samples, indicating how diverse and dispersed the color composition is at the Tree site. In general, the diversity and composition indicate a particularly late date for the Tree site sample, and it is likely that the actual date falls outside the range of any particular batch sample included in the dated village series.

OTHER TRADE ARTIFACTS

A small number of other artifacts occur in the major KNRI village site collections which by their nature, appear to have been introduced into the villages via the fur trade connections. These items will be briefly enumerated here, but because of their low frequencies and non-diagnostic nature, they have not been subjected to any detailed analysis.

The Sakakawea Village collection contains two size grade 4 fragments of historic, Euroamerican-made pottery in the period 83 context. Both are cream-colored glazed ware, but each is too small for meaningful analysis. The Sakakawea sample also contains 56 fragments of glass other than trade beads. The few fragments which are large enough for morphological identification appear to be fragments of flat or pane glass, possibly pieces of mirrors. Five glass fragments occur in period 82 deposits, while the remaining 51 pieces occur in period 80 (mixed) or period 83 deposits.

The Big Hidatsa collection contains 13 pieces of miscellaneous fragmented glass other than trade beads. The few pieces which are large enough for morphological identification appear to be fragments of flat or pane class, apparently pieces of mirrors. Twelve of the 13 pieces are from period 83 deposits, and the remaining specimen is from period 82 deposits. Two other glass objects which are definitely not flat glass also occur. One is a small fragment of shaped blue glass which may be part of a native-made bead or ornament manufactured from recycled trade beads (cf. Gilmore 1924; Will and Spinden 1906:115-116). This item is associated with time period 82. The second is a fragment of a small molded clear glass ornament of some kind. This item is in time period 83 deposits.

Two sherds of Euroamerican-made, white-glazed earthenware occur in the Big Hidatsa collection. The largest of these is a triangular piece which has been ground around the edges, apparently having been recycled as a native ornament. This item occurs in period 82 deposits.

No trade artifacts other than beads and metal occur in the Lower Hidatsa Village collections. The absence of such items at this site and in the earlier period deposits at Big Hidatsa highlights the fact that such items as mirrors and glazed ware apparently did not reach the villages in any quantity until at least the period of frequent trade contact and probably only by the local trade period, post-AD 1822. The importation of Euroamerican-made pottery into the region was almost certainly coincidental with the establishment of permanent trading posts; such material was not a common trade commodity (cf. inventories in Wood and Thiessen 1985:Tables 2-4), and its presence signifies the long-term presence of Euroamericans at locations very near the Hidatsa villages.

SYNOPSIS

The study of trade artifacts has focused on two major classes, metal items and glass beads, which occur in relatively high frequencies in the regional village site samples. The emphasis has been on assessing the changing intensity of use of these items through time as the fur trade frontier approached and passed through the region, and on assessing the changes through time in the internal composition of each major artifact class.

Density values expressed as counts of items per cubic meter of excavated fill are found to be a reasonable way of measuring the intensity of use of metal artifacts at any given point in time among the village sites. This measure is particularly useful if it is restricted to size grade 3 and larger metal artifacts and fragments, excluding smaller chips and bits which are probably for the most part the product of archeological practices and other postdepositional processes. Density of metal artifacts expressed as weight per unit volume is also another useful way of expressing the relative frequency of such artifacts in the village cultural systems at any point in time. Volumetric density by count data are similarly computed for glass beads in order to examine temporal changes in the intensity of use and discard of such items in the native culture.

As is to be expected, both metal artifacts and glass beads show striking overall increases in frequency of use during the post-contact period under examination here, roughly AD 1600-1862. Minor bits of metal and small numbers of glass beads occur in deposits assigned to the period AD 1600-1650, signalling remote and indirect contact with Euroamericans then living on frontiers at least a few hundred miles distant. Both classes of trade artifacts show steady increases in frequency of use in all subsequent periods, documenting the progressive and accelerating integration of trade items into the native technological systems and exchange systems.

Figures 21.13, 21.14, and 21.15 express the volumetric density by count data for respective metal (grade 1-3 items only) and glass beads according to the village chronology for the region. Also shown in Figure 21.13 are the periods of fur trade development defined by Thiessen (Chapter 13, this volume). Figure 21.13 compares metal and glass bead density values along the same scale at the left of the figure. Because the absolute density values

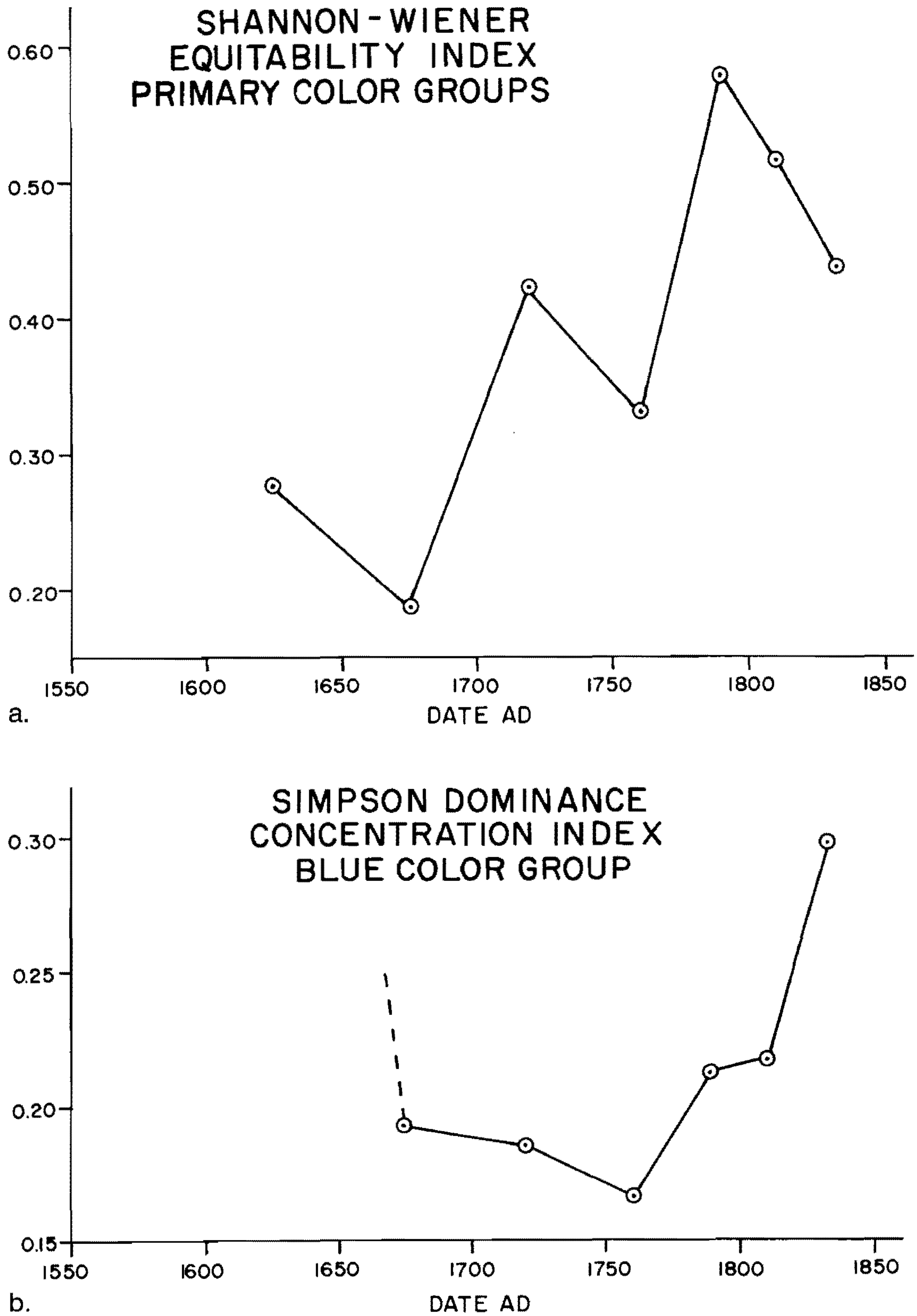

Figure 21.12. Indices of equitability and dominance concentration plotted by time period, small and very small drawn beads only. a: Shannon-Weiner index computed for primary color classes; b: Simpson index computed for Mumsell colors within the blue primary color group.

Table 21.13. Summary of specific color data on drawn small and very small blue group glass beads, part 1.

Period	Site	Batch	5bg-l	5bg-m	5bg-d	10bg-l	10bg-m	10bg-d	5b-l	5b-m
61	Lo Hid 4	47	0	0	0	0	0	0	0	0
	Big Hid 6	69	0	0	0	0	1	0	0	0
	Total		0	0	0	0	1	0	0	0
62	Lo Hid 3	46	0	0	0	0	0	1	0	0
	Big Hid 5	68	1	4	0	0	7	0	1	6
	Total		1	4	0	0	7	1	1	6
70	Mahhaha 2	29	0	0	0	0	0	0	0	0
71	Lo Hid 2	45	0	2	1	0	0	0	0	0
	Big Hid 4	67	0	2	1	0	0	0	0	0
	Total		0	4	2	0	0	0	0	0
72	Lo Hid 1	44	0	0	2	0	0	0	0	0
	Big Hid 3	66	3	19	1	2	15	6	1	3
	Total		3	19	3	2	15	6	1	3
80	Amahami L	41	0	0	0	0	0	0	0	0
	Sakaka In	62	23	192	37	48	411	82	5	56
	Sak Other	63	7	71	18	1	102	41	0	10
	Total		30	263	55	49	513	123	5	66
81	Greensh	19	0	1	1	0	9	3	0	15
	Saka 3	61	0	4	1	0	5	1	1	1
	Total		0	5	2	0	14	4	1	16
82	Saka 2	60	2	19	3	4	32	4	1	13
	Big Hid 2	65	10	47	6	9	97	8	1	16
	Total		12	66	9	13	129	12	2	29
83	Ft Clark	35	1	4	0	3	23	7	1	15
	Saka 1	59	36	109	22	32	439	60	9	189
	Big Hid 1	64	9	92	18	27	458	40	2	52
	Total		46	205	40	62	920	107	12	256
Unasgn. WBR		39	0	2	0	0	2	2	0	0
	Lo Hid Oth	50	0	0	0	0	1	0	0	0
	Big H Oth	71	0	5	2	0	3	1	0	1
	Elbee	74	0	3	0	0	15	9	0	1
	Scovill	75	0	0	0	0	3	3	0	0
	Fork W	78	0	0	0	0	6	6	0	1
	Mon Tree	87	0	0	0	0	2	0	0	17
	Taylor Bl	94	0	20	8	0	6	2	0	0
	Run Deer	98	0	0	0	0	4	1	0	0
	Total		92	596	121	126	1641	277	22	396

Table 21.13. Continued.

Part 2

Period	Site	Batch	5b-d	10b-l	10b-m	10b-d	5pb-l	5pb-m	5pb-d	Total
61	Lo Hid 4	47	0	0	0	0	0	0	0	0
	Big Hid 6	69	0	0	0	0	0	0	0	1
	Total		0	0	0	0	0	0	0	1
62	Lo Hid 3	46	0	0	1	0	0	0	2	4
	Big Hid 5	68	0	0	0	0	0	0	4	23
	Total		0	0	1	0	0	0	6	27
70	Mahhaha 2	29	0	0	0	0	0	0	0	0
71	Lo Hid 2	45	0	0	1	2	0	1	2	9
	Big Hid 4	67	0	1	1	1	0	1	4	11
	Total		0	1	2	3	0	2	6	20
72	Lo Hid 1	44	0	0	0	0	0	0	7	9
	Big Hid 3	66	2	0	0	0	1	6	9	68
	Total		2	0	0	0	1	6	16	77
80	Amahami L	41	0	0	0	0	0	0	0	0
	Sakaka In	62	9	0	5	5	1	15	58	947
	Sak Other	63	9	3	1	0	0	3	8	274
	Total		18	3	6	5	1	18	66	1221
81	Greensh	19	0	0	0	0	0	1	12	42
	Saka 3	61	0	0	0	0	0	0	2	15
	Total		0	0	0	0	0	1	14	57
82	Saka 2	60	3	0	0	0	1	4	7	93
	Big Hid 2	65	4	1	4	6	0	6	18	233
	Total		7	1	4	6	1	10	25	326
83	Ft Clark	35	25	0	1	4	0	0	0	84
	Saka 1	59	33	2	1	1	3	10	20	966
	Big Hid 1	64	26	4	2	3	0	12	15	760
	Total		84	6	4	8	3	22	35	1810
Unasgn. WBR		39	0	0	1	0	0	3	2	12
	Lo Hid Oth	50	0	0	0	0	0	0	0	1
	Big H Oth	71	0	0	0	0	0	2	0	14
	Elbee	74	2	0	0	0	0	0	0	30
	Scovill	75	0	0	0	0	0	0	0	6
	Fork W	78	1	0	0	0	0	0	0	14
	Mon Tree	87	11	0	0	6	0	0	15	51
	Taylor Bl	94	0	0	0	1	0	0	0	37
	Run Deer	98	1	0	0	0	0	0	0	6
	Total		126	11	18	29	6	64	185	3710

become so different for the two classes in the later time periods, it is perhaps useful to see the data plotted in different ways in order to compare and contrast the patterns of introduction and adoptions of each artifact class among the village cultures. Figure 21.14 shows the respective density data plotted on different vertical scales for the two artifact classes. In this figure, the beginning and ending points along each curve have been placed in approximately the same vertical position by using separate scales for each artifact class. Finally, Figure 21.15 shows the volumetric density data for beads and metal plotted on a semi-logarithmic scale. A purely exponential function will appear as a straight line on such a graph; neither of the plotted curves are entirely exponential in nature, and they show particularly divergent patterns late in time.

All of these various graphs show that beads and metal artifacts were integrated into the native cultures at different rates and in different ways. Each shows a different curve or pattern for increasing frequency of use among the villagers. Metal artifacts are introduced very slowly at first, then show a distinct change in the rate of increase between the first and second halves of the eighteenth century. This change in the rate of introduction of metal coincides fairly well with the change from solely indirect trade contacts to intermittent direct trading contacts between natives and Euroamericans (Figure 21.13). From this time onward (after circa AD 1740), the rate of increase in the introduction of metal artifacts remains relatively constant. Developmental changes in the fur trade industry are not particularly reflected as abrupt changes in the rate of incorporation of metal into the native cultures.

The curve for beads follows a distinctly different pattern. A distinct change in rate occurs post-AD 1740, pretty much as it does for metal, but thereafter the rate of increase in use of beads continues to accelerate at an ever-increasing pace. A major increase corresponds with the shift from intermittent contact to frequent direct contact, and an even more abrupt change occurs coincidental with the shift to local trade processes (Figure 21.13).

This difference in patterns and rates of occurrence and disposal of metal and glass beads is probably for the most part a product of the different function of the two artifact classes taken as a whole. Glass beads are purely ornamental in nature, while the metal artifacts are for the most part very utilitarian in function, potentially being integratable into a wide array of domestic and subsistence pursuits. If the two artifact classes were actually functional equivalents and therefore equivalent in demand and supply, we would expect to see beads occur in astronomically greater numbers throughout all time periods, given the fact that a pound of seed beads might contain several thousand individual artifacts (Orser [1984:6] estimates 22,700 to 45,400 seed beads per pound) while a pound of metal might be comprised of only two or three knives, awls, etc. If we were to express the densities of both artifact classes in terms of weight by unit volume, metal would be seen to vastly outweigh the presence of beads in all time periods, with the values tending to converge only, if ever, in the latest time periods, when beads were moved into the villages by the hundreds and thousands of pounds (note the traders' inventories of hundreds and thousands of pounds of beads for dates ranging from AD 1829-1851, as given in Davis 1973:Appendices E-I).

The fact that beads vastly outnumber metal artifacts only in the later periods reflects the differing values placed on these items as well as the evolving nature of the trade contact situation. During the indirect trade period and well into the period of direct contact the emphasis was on metal artifacts which were vastly more useful and versatile than the glass beads, regardless of their representation by counts in the archeological record. Only in the later periods, generally post-AD 1800, were beads integrated into the native systems on a scale comparable to that for metal artifacts.

An index can be computed which expresses the ratio of frequencies of glass beads to frequencies of size grade 1-3 metal artifacts in each time period (Figure 21.16). This ratio can be seen to vary considerably through time. There is a gradual downward trend in the time periods in the seventeenth and eighteenth centuries, with a minimum ratio value obtained for the late AD 1700s sample. After AD 1800, the ratio increases severalfold in a short period of time. Such a ratio may prove of value in assessing the approximate chronological position of a consistently recovered artifact assemblage containing both metal and glass beads which cannot otherwise be dated by chronometric means.

Several aspects of the internal composition of metal and glass bead assemblages change significantly through time in the regional study samples. Iron is the dominant type of metal in all time period samples, but the less common brass, copper, and lead types show interesting

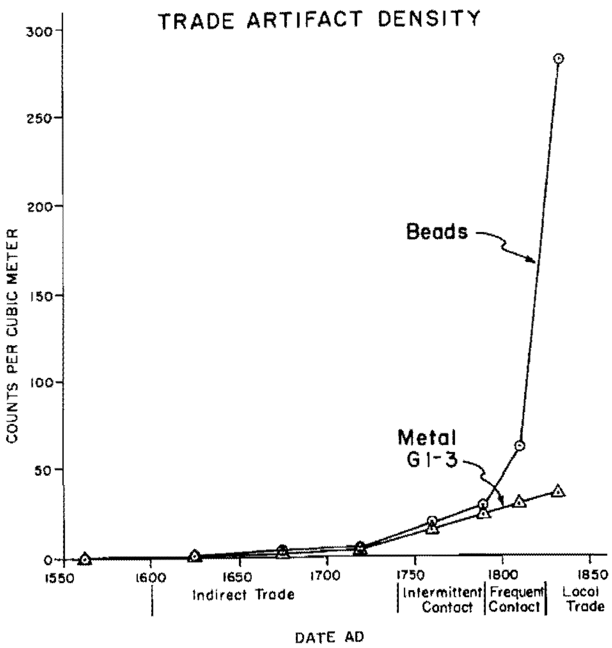

Figure 21.13. Comparison of density values for glass beads and size grade 1-3 metal artifacts according to time period, using a common volumetric density scale for each artifact class.

chronological patterns. Brass becomes more common than copper only in the post-AD 1800 time periods, apparently reflecting the increasing introduction of trade guns into the villages, with their attendant brass fittings and decorations which were rapidly recycled by the villagers into other useful items. Lead, probably an indicator of the presence of shot or balls and the trade gun, first appears in the first half of the eighteenth century and becomes relatively more common thereafter.

Until AD 1800 and thereafter, the metal artifact assemblages are characterized by high frequencies of native-made ornaments. These are primarily rolled copper/brass/iron tubes and cones which were apparently made by the Indians from recycled kettles and other sheet metal. If a metal artifact assemblage consists of 40 percent or more of these native-made ornaments, there is high likelihood that it predates AD 1800. There is also evidence of a temporal change in the shape of native-made ornaments. Tubular items are most common in the earliest time periods, and these give way entirely to conical-shaped items in the latest time period. After AD 1800 a great proliferation in the functional diversity of metal artifacts occurs, due almost certainly to the shift in metal supplier from the native middleman to the Euroamerican trader. A great array of manufactured ornaments, domestic items, weaponry, and related paraphernalia appear in the later period samples. Early domestic items, occurring primarily before AD 1800, consist largely of awls, punches, and an occasional knife. In the late period samples many heavy and massive artifacts such as hoes, adzes, wedges, chisels, and mattocks occur. The introduction of the latter items was no doubt facilitated by the initiation of steamboat connections with St. Louis in AD 1832.

Glass bead assemblages also show several changes in composition through time. These changes are largely a reflection of shifts in bead manufacturing practice (what was available from the supplier) and changes in bead preference on the part of the natives, rather than functional and transportation system changes as posited for metal artifacts. Although several intriguing temporal changes are documented in the bead assemblages, comparative data necessary to determine if these are purely regional or local patterns or if they reflect broad trends are presently unavailable. Few previous studies of glass beads have collected rigorously quantified data such as those presented here. Based on a study of many Northern Plains collections spanning the same time period under study here, Davis (1973:30-34) does offer some generalizations about chronological changes in beads. He notes that blown and molded beads appear relatively late in time, that there is a general trend for size reduction through time, and that there is a trend for an increase in color variety and for an increase in frequency of bright colors through time. All of these trends seem to be confirmed in the present data set, and the present study has the advantage of documenting these changes in objective terms useful for intersite and interregional comparisons.

The bead analysis presented here focused on the batch sample rather than the individual bead as the unit of study. Consequently, frequency of occurrence data can be computed for a number of discrete variables according to excavated batch or analytic batch, but an assessment of the bead assemblages in terms of previously defined bead types is not possible. The focus here has been on abstracting as much information as possible from the most common kind of bead, this being the drawn beads in the small and very small size classes. Descriptions of larger beads and wire-wound beads exist in project records.

Bead size is seen to vary significantly through time, with an overall trend toward size reduction. Beads in the very small size class occur only after AD 1740, and these become appreciably more common in the final post-AD 1820/30 time period. A 16-percent reduction in computed mean bead diameter is documented through the time span being studied here (AD 1600-1845).

Bead structure and color complexity change significantly through time within the small and very small, drawn beads. The earliest samples consist largely of simple, monochrome specimens. An abrupt increase in layered, bichrome specimens occurs in the early 1700s; thereafter, the monochrome, simple structure beads gradually increase again in relative frequency, finally constituting more than 70 percent of the samples in the latest time period. Bead shape also changes significantly through time among the small and very small drawn specimens. Cylindrical, unrounded specimens increase abruptly in frequency in the late 1700s, then diminish rapidly in importance thereafter.

Primary color among the the small and very small drawn beads also exhibits significant change through time. The blue bead group is dominant in the first sample of any size, dated in the late 1600s. Immediately thereafter clear/silver becomes the most common primary color group. Following that, the clear/silver primary color group decreases in relative frequency, gradually being replaced through time by beads in the blue color group. Black and green specimens become more common through time, peaking in relative frequency in the late AD 1700s. White beads become noticeably more common in the final time period, post-AD 1820/30.

The vast majority of such specimens noted as having a clear/silver primary color would probably be categorized as "white" beads in descriptions of bead samples from other Northern Plains sites dating in the AD 1700s. Most of the specimens examined here, although they appear white at first glance, are actually layered bichrome specimens composed of an outer layer of silvery or iridescent milk glass over an inner layer of opaque white glass. Even the majority of specimens designated as having a white primary color can be seen upon magnification to be

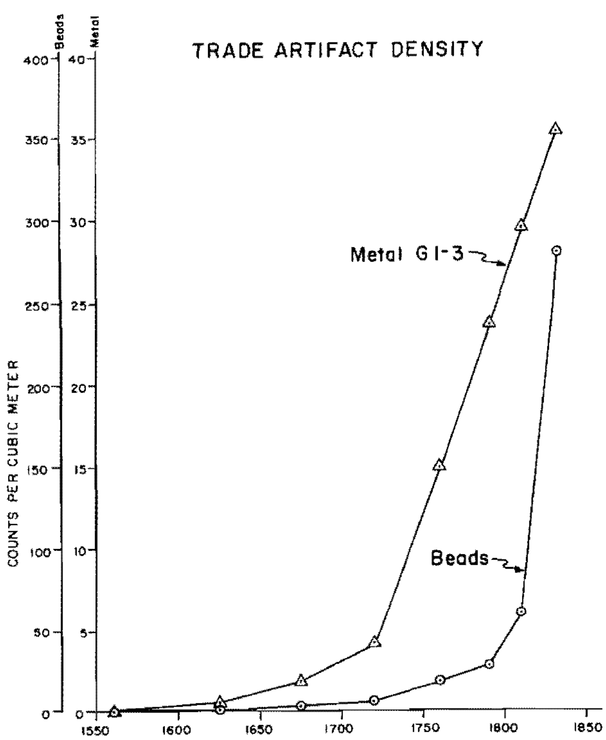

Figure 21.14. Comparison of density values for glass beads and size grade 1-3 metal artifacts according to time period, using a different volumetric density scale for each artifact class.

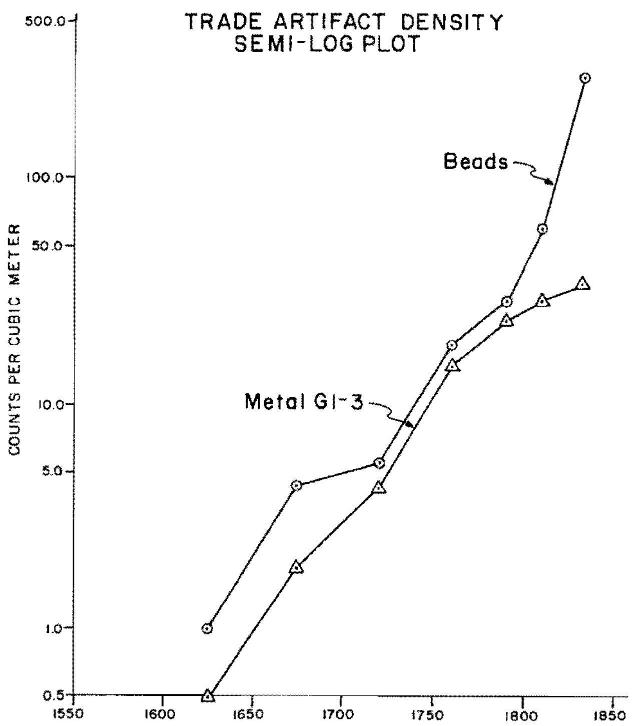

Figure 21.15. Comparison of density values for glass beads and size grade 1-3 metal artifacts according to time period, using a common semilogarithmic volumetric density scale for each artifact class.

layered specimens composed of two layers of opaque white glass; the core layer is often more chalky in nature, subject to decomposition.

Studies of primary color diversity and equitability or evenness based on the Shannon-Wiener index show that color diversity generally increases through time. The index value actually reaches a maximum in the period 81 sample (AD 1780-1800), however, and decreases somewhat thereafter as the blue color group begins to clearly dominate the local bead samples. A Simpson index of dominance concentration is computed for blue group specimens broken down into 15 Munsell color groups. This index shows that the bead samples become more homogeneous with reference to blue color variation through time, and tend to become concentrated into fewer and fewer specific color classes later in time. This supports the concept of greater color quality control in the bead production industry later in time.

Overall, the studies of trade artifacts conducted here have documented the anticipated trends in trade artifact frequency through time in the regional samples. More importantly, however, these studies provide a quantified objective documentation of the changing influence of the fur trade and Euroamerican culture on the native Hidatsa cultural systems, and they provide relatively rigorous measures of temporal changes which may in turn be helpful for assessing the chronological placement of other archeological samples. The glass bead data are probably most useful in the latter regard. Using such information we can estimate the temporal placement for several glass trade bead (and metal artifact) samples from other regional archeological sites which have not yet been well dated.

On this basis, we would suggest that both the Elbee site sample and the Taylor Bluff sample lie near the end of the temporal sequence for samples studied here, perhaps in the period AD 1830-1850. This agrees well with other information which has been gathered in large scale excavations at Taylor Bluff but which, at the time of this writing, have not yet been subjected to full analysis.[2]

We would suggest that the glass bead and trade metal samples from the White Buffalo Robe site, indicative of a poorly defined and poorly understood set of post-contact period activities there, probably date in the period from circa AD 1775-1800. Given the proximity of this site to the posited location of Jusseaume's trading post established in the AD 1790s (see Thiessen, Chapter 14, this volume), it is possible that the post-contact period component at White Buffalo Robe is directly indicative of native activities peripheral to but functionally linked to operation of that post.

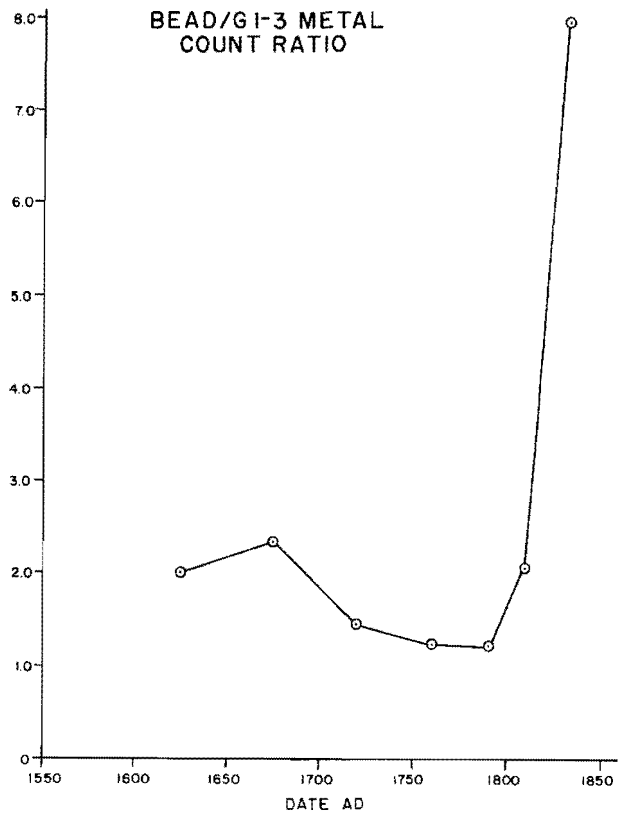

Figure 21.16. The ratio of counts of glass beads to counts of size grade 1-3 metal artifacts plotted by time period.

Finally, we can note that the composition and characteristics of the Mondrian Tree site bead sample suggest that the sample is distinctly different from any of the village-derived samples studied here. This is particularly true with regard to bead size and bead color composition. We would guess that the Tree site bead sample derives from a trading source qualitatively different from any used by the Hidatsa villagers studied here, and also that it is highly likely that the sample postdates the period under study in this report. The Tree site sample probably dates after AD 1865, and may well date from the early twentieth century.

[2] Information presented by Ahler (1988) indicates dates for the main component at Taylor Bluff of AD 1834-1845. (S.A.A.)

CHAPTER 21

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REPORT CERTIFICATION

I certify that "The Phase I Archeological Research Program for the Knife River Indian Villages National Historic Site, Part III: Analysis of the Physcial Remains"

has been reviewed against the criteria contained in 43CFR Part 7 (a)(1) and upon recommendation of the Regional Archeologist has been classified as available.

Regional Director

3/2/94
Date

Classification Key Words:

"Available"–Making the report available to the public meets the criteria of 43CFR 7.18 (a)(1).

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