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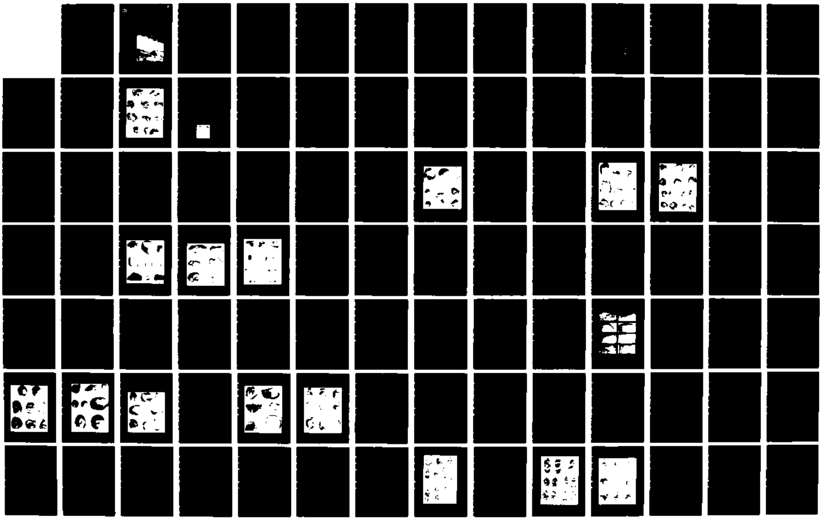

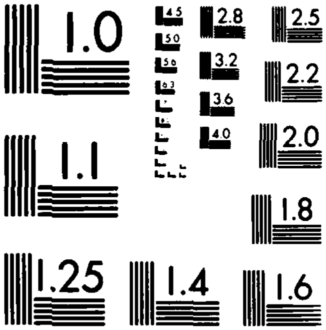

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US Army Corps
of Engineers
Kansas City District

Harry S. Truman Dam and Reservoir, Missouri

By Illinois State Museum Society
Springfield, Illinois

Holocene Adaptations Within the Lower Pomme de Terre River Valley, Missouri

Volume II

Marvin Kay, Editor

June 1982

DACW41-76-C-0011

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO. AD-A147 653

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Harry S. Truman Dam and Reservoir, Missouri, Holocene Adaptations Within the Lower Pomme De Terre River Valley, Missouri (Volumes I, II, & III)

5. TYPE OF REPORT & PERIOD COVERED
Final 1976-1981

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Marvin Kay, Editor

8. CONTRACT OR GRANT NUMBER(s)
DACW41-76-C-0011

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Illinois State Museum Society
Spring and Edwards
Springfield, Illinois 62706

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
US Army Corps of Engineers, Kansas City District
700 Federal Building, 601 E. 12th St.
Kansas City, Missouri 64106

12. REPORT DATE
June 1982

13. NUMBER OF PAGES
746

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Further information is available in the 1982 published report: Harry S. Truman Dam and Reservoir, Missouri, Phillips Spring, Missouri: 1978 Investigation (completed under same contract number).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

archeology
Rodgers Shelter
vegetational reconstruction
stratigraphy
Holocene naiad record
environment
Phillips Spring
geochronology
ethnobotany
palynology
Ozark Highland
Western Missouri
Pomme de Terre River Valley
artifact techno-funtional/stylistic studies

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Excavations at Rodgers Shelter were conducted intermittently beginning in 1963 and ending 1976. The major work was completed in four summer field seasons, from 1964 to 1968. Excavations in excess of 9 m defined a sequence of human habitation that spans the past 10,500 years. Limited excavations were conducted in 1974 and 1976. The 1974 excavation dealt mainly with Phillips Spring. The 1976 excavation was part of the Corps of Engineers mitigation program for Rodgers Shelter, a National Register Site.

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Unclassified

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This report is a synthesis of the available knowledge gained from excavations and ancillary studies of the environment of the Ozark Highland/southern Prairie Peninsula region. Data from previous studies are incorporated and assessed in light of new radiometric and stratigraphic controls for Rodgers Shelter and Phillips Spring. This research has altered, modified, and, on occasion, rejected previously held hypotheses, and has advanced ones of its own for future consideration. New information was collected that will allow for a reformulation of cultural process and taxonomy in this region.

Research reported includes historical vegetation reconstruction; ethnobotanical and faunal identification; clinial variation in gastropods and small mammals; examination of sediments; Holocene palynology; technological, functional and stylistic studies of major stone industries; and synthetic statements of site activity and activity areas.

The results of these often disparate studies promote and balanced view of how man existed for several millennia in a physiographically varied region that underwent considerable change of its own.

CHAPTER 10

RODGERS SHELTER TECHNO-FUNCTIONAL STUDIES

I. Introduction

Marvin Kay

As students of prehistory, there are a number of things we must consider in examining ancient technological systems. These include the limitations inherent in the archaeological record and methods of analysis. The system as it relates to culture and environmental interaction are essential areas of study. Evaluation is not easy because technological items are as often as not unknown or unknowable. For those items that do preserve, especially stone tools, one might regard the "life history" and archaeological context of artifacts (Schiffer 1972) as rational points of departure, and attempt to chart their complex, convoluted paths.

No single approach is sufficient to examine every facet of technology. But any approach is an attempt to simplify with the hope of highlighting crucial aspects of technologies. Thus, we regard the dichotomy formally advanced by Binford and Binford (1966:291-292) between tools used for extractive tasks (direct manipulation of biotic and natural resources) and those involved in maintenance tasks (fulfilling nutritional and technological requirements of the group) as a systematic organizing principle having multidimensional features. In brief, these minimally include (a) mutually dependent factors of function and style (Jelinek 1976), and (b) the cycle(s) of manufacture and use through which artifacts pass.

Our endeavor will be to examine the function, style and use of artifacts from Rodgers Shelter. These data comprise the material remains of sequential cultures of the Ozark Highland of Missouri for most of its prehistory. The samples from Rodgers Shelter are of primary interest because they accord a rare opportunity to explore changes in prehistoric technology that were basic to everyday life in the Ozarks for thousands of years. Samples from Phillips Spring, described separately, are supplemental to those from Rodgers Shelter and add needed spatial and temporal perspective.

By and large, the artifacts considered will either be strictly utilitarian or will be by-products of tool manufacture. A few items such as pendants or engraved plaques probably had other usage as either ornaments or served in a symbolic capacity. A third group, ground minerals, will be shown to be not tools *per se* but artifacts of industrial (extractive) tasks where a powdered pigment was desired. Lastly, a relatively small number of artifacts, regardless of original function, were included as mortuary furniture and presumably had some ceremonial significance or identity with a buried individual.

The studies to follow have a two-fold purpose. First, there is and will continue to be a need for technical description of tools or other artifacts from Pomme de Terre sites excavations. These studies dealing with Rodgers Shelter are offered with this in mind and also present analytical procedures that could be used as is or modified for investigations elsewhere. Second, the analysis of diachronic change holds special promise here as it does for few places in eastern North America. Our purpose will be to illuminate tangible elements of technology and style that formed the nexus for cultural adaptation.

This and the following chapter summarize the major technological and stylistic developments chronicled at Rodgers Shelter. Data presented are then used (Chapter 12) in the spatial analysis of activity at Rodgers Shelter, as this pertains to extractive and maintenance activity areas. This chapter describes in individual sections completed technological and/or experimental studies, dealing with chipped, ground stone or mineral artifacts. Bone artifacts are described by Ahler and McMillan (1976) and what little pottery occurs has also been discussed by them.

Our treatment of lithic or mineral artifacts will be consistent insofar as attempts are to identify source materials and their probable origin, manufacture processes, and diachronic trends in use. Similar attention will be accorded questions of form and function. Artifact style, a confused if not complex subject, will receive its greatest discussion with respect to a limited number of chipped or ground stone and mineral artifact categories that exhibit distinctive form and consumate skill in manufacture. Primary data are present in either histogram and/or contingency table formats, keyed to individual or grouped Rodgers Shelter horizons (see Table 4.4). *Statistical Package for the Social Sciences* (Nie *et al.* 1975) subroutines for chi square, principal components factor analysis (PA1), direct and stepwise (Mahalanobis) discriminant function analysis, and linear regression were used in some or in part of these studies. Data presented in tabular form are observed rather than expected values, a source of confusion to reviewers of the draft report. Data not presented in this and Chapters 11 and 12 are on file with the Corps of Engineers, Kansas City District.

Even though these studies required a major effort, it was impossible to assimilate all technological or stylistic information of the Rodgers Shelter collections. We have previously discussed sampling limitations as these pertain especially to debitage and unifacially flaked tools. These two artifact classes were purposefully overlooked or received only cursory attention. Their discussion here is supplemental to that of the analysis of chipped stone tool manufacture and use and is not meant to be comprehensive.

The present studies have benefited from Rodgers Shelter analyses by R. Bruce McMillan (1971; 1976a,b) and Stanley A. Ahler (1971; 1976; Ahler and McMillan 1976), and they should be considered as a sequel to their work. Ahler's (1971) study of the function of Rodgers Shelter projectile points is well known; his and McMillan's later efforts to classify artifacts by individual use and inferred activity represent natural areas of common interest with this work. These studies, however, consider a greater range of lithic and mineral implements or their by-products. With the exception of chipped stone points, most artifacts are not stylistically sensitive but all illustrate cycles of tool use through which most implements pass or record mistakes and errors in manufacture.

We shall describe what can be thought of as changing but still conservative, or even rudimentary technological systems that had diagnostic stylistic elements. One might ask whether or not this resulted from a similar conservatism in culture, a bias in our emphasis on a single site having novel features of landscape and preservation, or correlated change in the physical environment. We shall want to return to these questions in the concluding assessments.

II. HEAT TREATMENT EXPERIMENTS

Jeffrey Behm

Heat treatment, or thermal alteration of siliceous materials, is a widely studied (Collins and Fenwick 1974; Crabtree and Butler 1964; Mandeville 1973; Mandeville and Flenniken 1974; Purdy 1971; Purdy and Brooks 1971) and reported (Hester 1972; Sollberger and Hester 1972) technique. However, its application to individual quarry areas and localized prehistoric lithic technologies is far from complete. As a result, this study was conducted with a focus on Rodgers Shelter, its lithic technologies and the available chert resources, in an attempt to understand those industries because heat treatment is a fundamental component of the manufacturing and maintenance activities associated with Rodgers Shelter chipped stone tools.

Successful heat treatment is understood to be the result of two separate factors. The material must be heated to the necessary temperature to initiate alteration and it also must be maintained at that temperature for this alteration to become complete. Although several variables are involved, this experiment considered test specimens heated under similar conditions, with the intent that change would be defined by altering maximum temperatures. Optical techniques were used to note any changes in the material.

LITHIC RESOURCES AVAILABLE AT RODGERS SHELTER

At Rodgers Shelter the raw materials for flintworking are extensive in amount but limited in variety. At least five separate bedrock outcropings of suitable material occur in the Jefferson City formation dolomite bluff above Rodgers Shelter. These outcrops have been mapped and collected for this study. A short description of these Jefferson City units is included:

Bedrock Collection Station No. 1 - This quartzite occurs in a thin layer approximately one and one half feet thick, and is stratigraphically the lowest. The predominant color is a white, and when held in a bright light, the surface sparkles. When viewed under a binocular microscope, small sand grains composed primarily of quartz are seen to be held in the matrix of one of the duller cryptocrystalline quartz minerals. The sparkling noted in the hand specimen is caused by the imbedded sand grains.

Bedrock Collection Station No. 2 - A mottled, oolitic chert is the first of the four known chert units which make up Collection Stations 2 through 5. While the material is primarily a light gray, the mottling and banding appear as darker grays and browns. When viewed under the microscope, individual sand grains stand out as separate inclusions.

Bedrock Collection Station No. 3 - This is a highly mottled, banded, non-oolitic chert. The mottling is primarily a dark gray or tan over the base color of very light gray and white.

Bedrock Collection Station No. 4 - A second oolitic chert occurs here. Like Station 2 chert, it is banded and mottled, with the darker grays and browns to be found as the banding over the lighter grays and whites. When viewed microscopically, there appears to be a much larger percentage of included quartz sand grains in Station 2 chert versus Station 4 chert.

Bedrock Collection Station No. 5 - The last and stratigraphically highest outcrop is slightly oolitic, cross banded chert. Present are very intense, thin wavy lines that tend to occur at an angle to the larger scale banding, and inclusions of dense brown chert.

In addition to these bedrock outcrops, there are several other sources of suitable flintworking materials. From the hillside below these outcrops, a large amount of Jefferson City chert can be found which was derived from these outcrops. Then too, fossiliferous Chouteau and Burlington formations cherts are also above the Jefferson City on the hill crest above Rodgers Shelter. Pomme de Terre River gravel was used as still another source of redeposited cherts. Although the source location is variable, derivation of Rodgers Shelter chert can usually be traced to either Jefferson City or Burlington formation outcrops. Unless noted otherwise, specimens for this study are from Jefferson City or Burlington formation outcrops.

TECHNIQUES

Test specimens were produced by removing large flakes from a chert or quartzite core. From each core, several flakes were set aside as unheated controls. Prior to heating, the remaining flakes were thoroughly washed to remove all soil and algae, and subsequently color coded to standard Munsell colors (Munsell Soil Color Charts, 1971 edition). The latter is a laborious process involving the careful tracing of each specimen showing dorsal flake scar arrises, inclusions, cortex surfaces and other textural features, and their respective pre-heating colors, which were designated by a letter. After heating, Munsell colors were again recorded, and any difference in pre- and post-heating colors were tabulated and graphed for each experiment.

Following the initial color coding, each specimen was again washed and labeled, and using an analytical balance, was weighed to the nearest 0.001 gram. After heating, specimens were reweighed. However, due to differences in specimen size and time between experimental heating, cooling and weighing, weight loss -- generally attributable as evolution of molecular water and, at higher temperatures, carbon dioxide (Purdy 1971: 23; Purdy and Brooks 1971:323) -- is not consistent with increase in temperature (Table 10.1; Fig. 10.1). Better control may be achieved by standardizing specimen size and using a desicator for storage of fired specimens prior to weighing.

Firing of test specimens was conducted in an oxidizing, octagonal kiln, with specimens placed in a sand bath. The sand was sifted through a 1/16 inch mesh screen to remove all large grit thereby facilitating recovery of any small pieces of shatter in the event of thermal fracture.

Temperature control was maintained with a pyrometer whose thermocouple had been placed in a sand bath inside the kiln. Temperatures were recorded at regular intervals for each experimental firing and continued until the pyrometer again registered near room temperature. (At approxi-

TABLE 10.1

Heat Treatment Weight Loss Data

Experiment Number	10	7	9	8	6	11
	Temperature					
Test Material	230°	267°	305°	350°	367°	400°
Bedrock Collecting Station No. 1	0.2904	0.2133	0.1784	0.6167	0.1845	0.2910
Bedrock Collecting Station No. 2	0.1617	0.2337	0.1303	0.1539	0.2710	0.1968
Bedrock Collecting Station No. 3	0.2038	0.2614	0.1615	0.3395	0.3494	0.1705
Bedrock Collecting Station No. 4	0.1699	0.2514	0.2242	0.2959	0.3156	0.3010
Bedrock Collecting Station No. 5	0.2345	0.2839	0.2618	0.2321	0.3273	0.3634

mately 15 to 20 degrees centigrade lower than the desired temperature, the kiln was turned off. This 15 to 20 degree lag was the result of using electric heating elements, which continued to add thermal energy to the system even after the kiln was turned off.) Temperature curves produced during the course of each experiment (Fig. 10.2) demonstrate the close similarity of all experiments.

We originally planned a series of experiments with maximum temperatures from 225° to 400° C, in intervals of 25°C. This was approximated by seven experiments, having maximum attained temperatures of 230°, 267°, 305°, 367°, 375° and 400°C. Two additional experiments, attaining maximum temperatures of 400° and 450°C, but using a variety of silicious resources and resulting in massive thermal fracture, will be described as well.

SUMMARY OF EXPERIMENTS

The first several experiments calibrated equipment (Fig. 10.2), and, inadvertently, provided useful data on thermal fracture. During the third experiment, for instance, a maximum temperature of 450°C was attained. Severe deformation and fracture of test specimens occurred, regardless of material. An additional experiment, attaining a temperature of 400°C, also fractured large chert cobbles but did not affect smaller flakes and probably relative differences in the amount of insulation provided by individual sand baths was responsible for fracture of the cobbles. In all subsequent experiments, no thermal fractures occurred. Only the smaller test specimens previously described were used, each separatedly insulated in a sand bath. These experiments (Nos. 6-12) provided controlled data on color change and weight loss, previously summarized. Table 10.2 records color change data for the later experiments.

By viewing only those colors that occur on at least three specimens

Fig 10.1

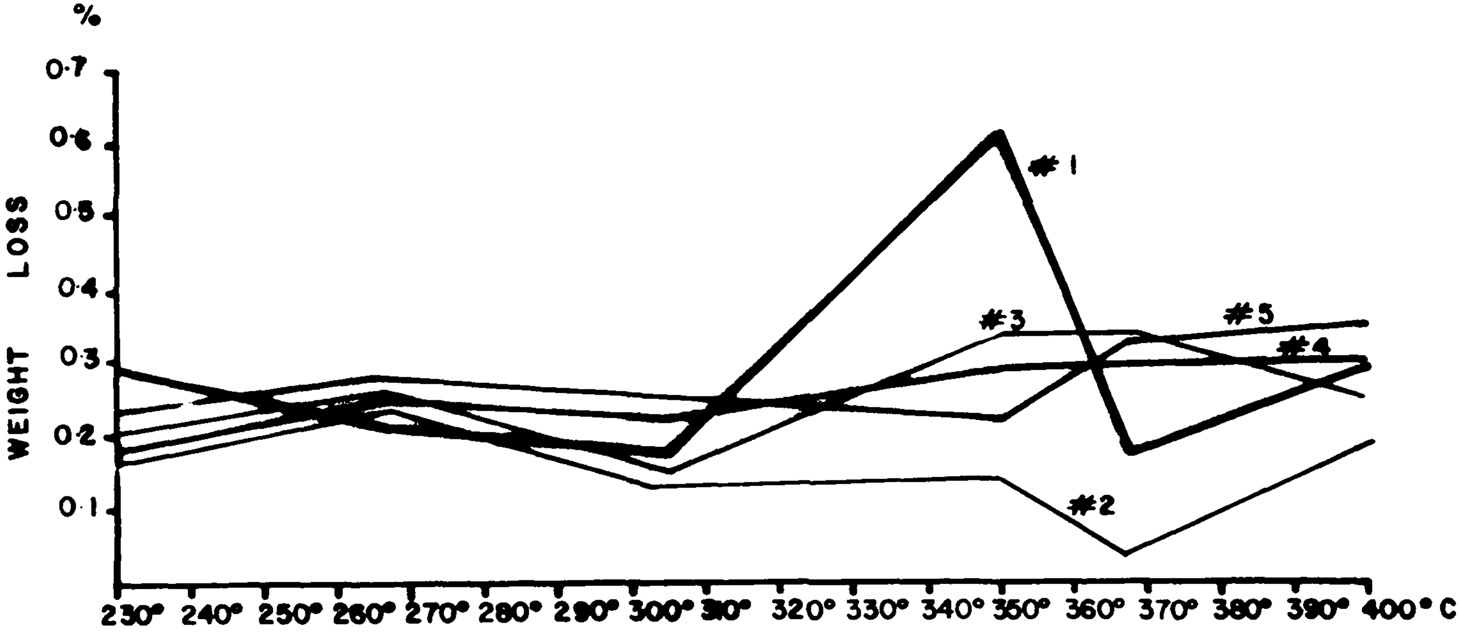

Figure 10.1. Weight loss data for five bedrock stations (see Table 10.1).

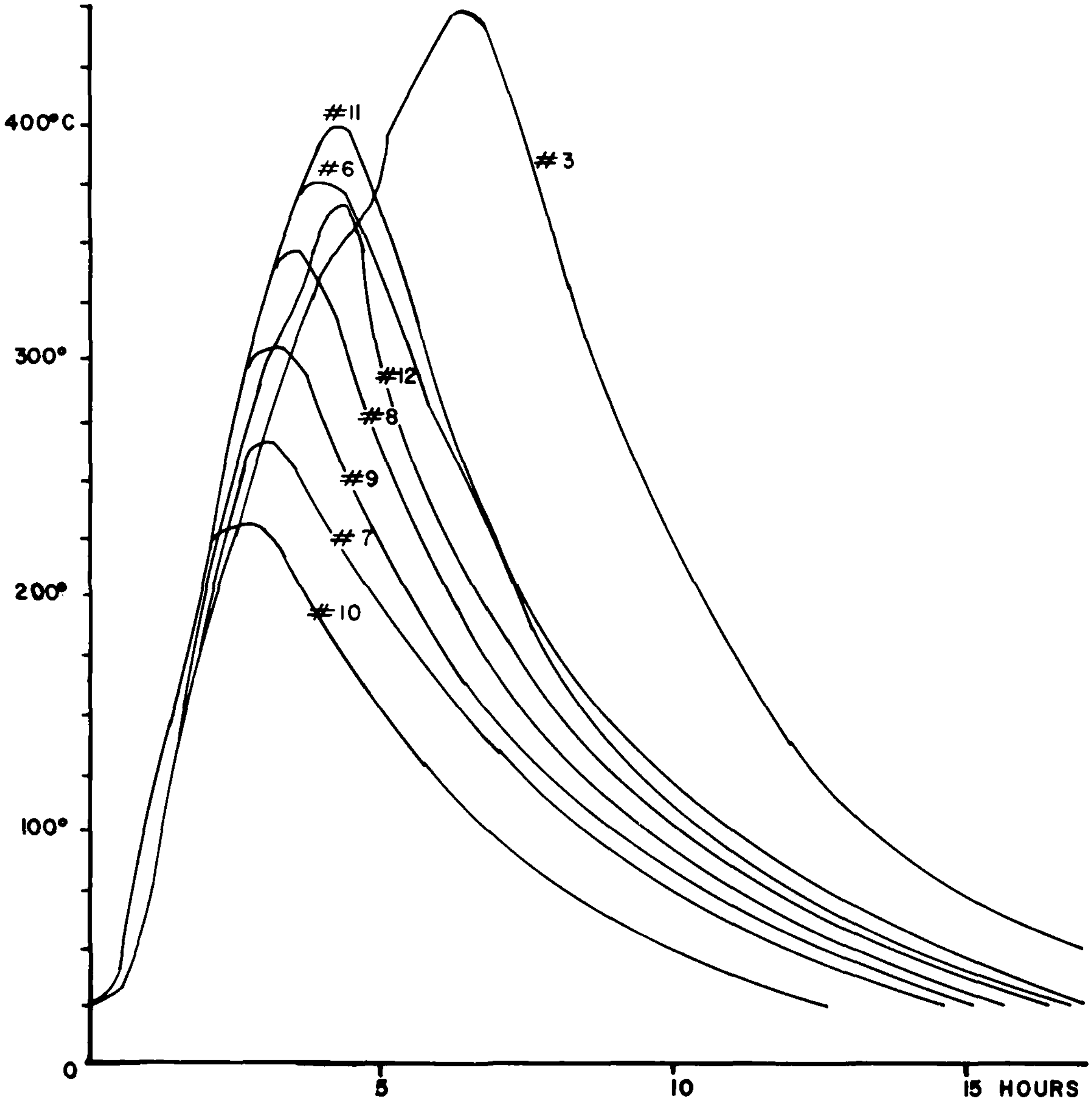

Figure 10.2. Heat treatment experiments temperature curves.

for specific collection stations, it is possible to summarize trends in color shifts (Table 10.2):

1. Color alteration is very subtle. Generally, those colors that were originally a white or off-white remained so. Any changes were seen as slight shifts toward red, with hue and chroma recording the greatest change. Shift in chroma would have been the most readily apparent change, but such alterations rarely occurred in these experiments.

2. The darker gray colors behaved much like the whites. Usually, there was a slight shift to the red, with the least amount of change occurring in chroma. In a few cases, the shift was toward darker colors, producing deeper grays. In both cases, the magnitude of these changes was no greater than that observed in the lighter pre-heating colors.

3. Under test conditions, that is, a very limited time at maximum temperature, there was a considerable overlap of colors. Naturally occurring colors were duplicated by heating other, similar colors to a variety of maximum temperatures. This picture is further complicated by the fact that many colors appear to remain unchanged while other, quite similar ones do change.

It should be noted that the few color changes noted during this series of experiments are in line with those reported by Purdy (Purdy and Brooks 1971:323) but are of a much lower magnitude. It must be remembered that during these experiments the material was not held at the maximum temperature but allowed to cool soon after the maximum was reached. This time factor, which others (Crabtree and Butler 1964:1, Mandeville 1973: 188-189, Purdy 1971:41-43) have determined to be the controlling variable for successful alteration, was not intended for testing by these experiments. However, this should be of primary interest in other experiments with Jefferson City chert.

COMMENT

Many of the questions concerning heat treatment and Rodgers Shelter have yet to be approached. Along with the often reported color changes, others (Collins and Fenwick 1974:137, Crabtree and Butler 1964:2, Purdy and Brooks 1971:323, Mandeville 1973:191) note correlated change in the luster of the material as a result of heating. Material that has been heated and then flaked may exhibit a change toward a greasier or waxier luster on this new surface. Change in luster and color have become heat treatment standards (Collins and Fenwick 1974:135, 137; Mandeville 1973: 191; Purdy and Brooks 1971:323). But these experiments on Jefferson City chert suggest both may be ambiguous. Thermoluminescence further confirms the limitations of color and luster for other chert samples (Melcher and Zimmerman 1977).

Other studies, such as flaking heated blocks of chert (Crabtree and Butler 1964:1) or using a scanning electron microscope (Purdy and Brooks 1971:323) to visually assess thermal alteration together with thermoluminescence, should be considered in an expansion of these studies of Jefferson City chert. Nevertheless, much of value has come from these experiments.

We have demonstrated that short term heating of cherts from both the Jefferson City and Burlington formations is very difficult to determine by optical means but it was possible to cause extensive thermal fracture at the higher temperatures without significant alteration of

TABLE 10.2

Summarization of Color Change Data from Phase One Experiments

Experiment Number			10	7	9	8	12	11
Conditions		Pre-heating Color	225°C	267°C	305°C	350°C	375°C	400°C
Bedrock Collection Station No. 1 Quartzite	Quartzite	10YR7/3	10YR5/3	2.5Y6/4	10YR5/4			
		10YR8/1	5YR8/1	5Y8/1	5YR8/1	10YR7/1 7.5YR6/0	10YR6/1	
		2.5Y7/0		10YR7/1 10YR3/1		10YR6/1		7.5YR7/0
		2.5Y8/0		10YR8/2		2.5Y7/2 2.5Y5/2		7.5YR8/0
Bedrock Collection Station No. 2	Chert	2.5Y7/0	2.5Y7/0 2.5Y6/0		2.5Y7/0	10YR6/1		
		2.5Y8/0	2.5Y8/0	10YR8/1		10YR6/1		10YR8/1
		5Y5/1	5Y5/1			5Y5/1	5Y6/1	
Bedrock Collection Station No. 3	Chert	7.5YR8/0	7.5YR8/0	7.5YR8/0		7.5YR7/0		
		10YR6/1	10YR6/1		10YR6/1 5YR6/1			10YR6/1
		10YR6/2	10YR6/2			7.5YR5/2		10YR4/2; 5/1;6/1;6/2
		10YR8/1	10YR8/1	10YR7/1	10YR8/1 5YR8/1			10YR8/1
		2.5YR6/0	2.5Y6/0		2.5YR6/0		10YR5/1 2.5Y 6/0	2.5YR6/0
		2.5Y6/2	2.5Y6/2				10YR6/2	2.5Y6/2
		2.5Y7/0	2.5Y7/0		2.5Y7/0 10YR7/1		2.5Y7/0 10YR8/1 7.5YR7/0	2.5Y6/0
		2.5Y8/0	2.5Y7/0			10YR7/1	10YR8/1 7.5YR8/0	10YR8/1
Bedrock Collection Station No. 4	Chert	2.5Y5/2	2.5Y5/2	2.5Y5/2		2.5Y5/2	10YR5/2	
		2.5Y6/0	2.5Y6/0			2.5Y6/0		5Y6/0 2.5Y6/0
		2.5Y7/0	2.5Y7/0	2.5Y7/0			10YR7/1	10YR7/1
Bedrock Collection Station No. 5	Chert	10YR8/1		10YR8/2	5YR8/1	10YR7/3	10YR7/1 7.5YR8/2	5YR8/1
		2.5Y4/0	2.5Y4/0	2.5Y4/0			5YR4/1	2.5Y4/0 2.5Y3/0
		2.5Y6/0	2.5Y6/0	2.5YR6/0 2.5YR6/2	5YR5/1 2.5YR6/0		10YR6/1	5YR5/1
		2.5Y7/0	2.5Y7/0		5YR6/1	10YR7/1	10YR6/1 10YR7/1	10YR6/1
		2.5Y8/0	2.5Y8/0		5YR7/1	10YR8/1	10YR8/1	10YR7/1 5YR6/1

color in the Jefferson City cherts. Although some color change in the Burlington chert is easily discernible, it is not of the magnitude represented in archaeological specimens from Rodgers Shelter.

Rodgers Shelter chipped stone tools and chipped debris exhibit various types of thermal fracture (Purdy 1975), both with and without correlated changes in color and luster. This may indicate that heat has been applied in a similar fashion to those used in these experiments, but perhaps being most similar to instances of poor insulation and/or limited time at a useful firing temperature. Other Rodgers Shelter tools have all the accepted signs of successful thermal alteration including waxy luster, red or pink color, and wavy ripple marks, and/or are extensively heat crazed or fractured.

Though we recognize limitations in applying these purely visual measures of heat treatment, the sheer size of the Rodgers Shelter collections precludes a more systematic assessment. The criteria of Collins and Fenwick (1974) concerning fracture, luster and color of heat treated cherts are at least nominally applicable to Rodgers Shelter and are followed here.

III. CORES

Jeffrey Behm

Chipped stone cores are remnants of a specialized form of tool production in which flakes mainly are desired. These flakes, primarily detached by percussion flaking techniques, may have an immediate application in cutting, scraping, shaving or gouging tasks, or as blanks for unifacial or bifacial tools. The appearance of cores varies with the type, size, shape and number of flakes produced, the presence of natural flaws such as inclusions, cavaties or cracks, the size of the core blank, and the skill of the flintworker; generally trichotomized as unprepared, prepared platform (with many derivatives), or bi-polar cores. The latter, mainly recognized from regions where large pieces of chert or other suitable stone are scarce (MacDonald 1968:85-90, 139), does not occur at Rodgers Shelter, and is not further described. Unprepared cores exhibit naturally shaped and placed platforms, requiring no modification prior to flake removal. In contrast, prepared platform cores possess intentional flaking, grinding, or pecking of the platform or its edge facilitating controlled flake detachment. Flakes from unprepared and prepared platform cores can range from highly regular to irregular shapes, although it is conceded (Newcomer 1971) that careful platform preparation results in better controlled flake production. An additional, if not final, variable in flintworking is heat treatment. For certain cherts, apparently including those found near Rodgers Shelter, heating enhances flaking qualities.

The entire collection of Rodgers Shelter cores, consisting of 971 complete and 192 fragmentary specimens, was examined in an attempt to delineate the overall manufacturing technology, potential differences in material, or application of heat treatment. As an initial step, chi-square contingency tables (cf., Nie *et al.* 1975:218-245) were used to assess potential temporal trends in and among these data.

SAMPLE DESCRIPTIONS

The cores reflect several related but different states of manufacture ranging from unprepared cores with a single platform to cores made from biface fragments. A typology that expresses the complete range (Fig. 10.3), includes all of the unprepared cores and a sixth category for biface fragments reused as cores (Fig. 10.4).

The simplest and most abundant of unprepared cores are the single platform cores (type 1), while double platform cores (type 2) include all cores that have two separate platform areas that exhibit no fixed relationship to each other. Amorphous platform cores (type 3) include all examples with three or more unprepared platform areas. All three types were produced by percussion flaking, and overlap in size, weight, and the number of flake removals. Although this grouping of unprepared cores facilitates analysis, it probably represents a progression of core manufacture and utilization from the unmodified material to an exhausted or otherwise useless remnant. Depending on the original shape of the material, only one platform may be necessary to extensively work the core. Or, it might become necessary to shift to another area to remove the desired flakes, quickly producing either a double or amorphous platform core. Size similarly reflects a continuum, with larger flake blanks produced from large cores; as cores become exhausted or smaller, they will naturally produce smaller flakes.

A special kind of unprepared core is one possessing opposing platforms (type 4). The platforms for flake removal are located at opposite ends of the specimen and the flake removals from both platforms are on the same face or faces. This manner of flake removal has the advantage of prolonging the life of the core when it would otherwise have been discarded. When a flake from one platform terminates in a step or hinge fracture, it is often possible to remove this impediment by flaking from the opposite platform. With this type of core one platform usually dominates the other.

Prepared cores (type 5) include all cores having carefully prepared platforms, shaped by flaking and with the edge ground before flake removal. Like unprepared cores, prepared cores may be either large or small, reflecting the size of flake blanks or blades produced. Most prepared cores possess only one platform but in a few cases more than one is present. These differ from the multiple unprepared platform cores in the amount or care of preparation for flake removal, and in their overall size. Generally, unprepared cores produce large flake blanks while the relatively smaller prepared cores would produce smaller, regularly proportioned flakes.

Some biface fragments were reused as cores, but this sixth type is rare in the collection. The snapping of a biface during manufacture or use produces two or more segments suitable for use as cores. In such a case, the snapped surface would then serve as a platform. In some, the bifacial edge was purposely removed in a manner similar to burin faceting (Fig. 10.5) (Epstein 1963). Identifying these cores can be difficult. After only minimal working all of the bifacial flake scars can be obliterated, resulting in a core indistinguishable from various prepared cores.

The cores are manufactured from materials locally available as either river gravels or hillside bedrock outcrops and weathered out

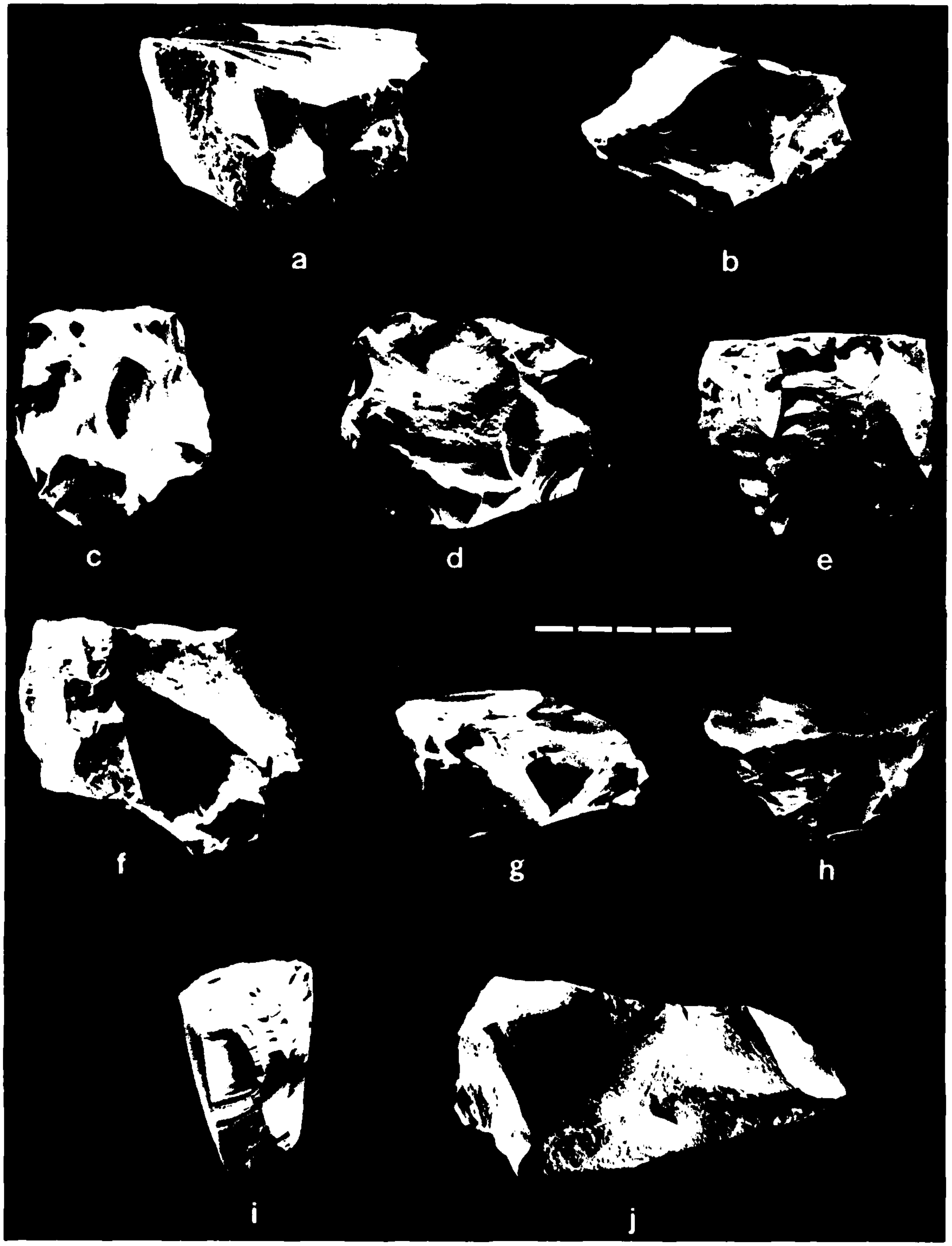

Figure 10.3. Cores from Rodgers Shelter: a, Type 1; b, Type 2; c-e, Type 3; f-g, Type 4; h-j, Type 5.

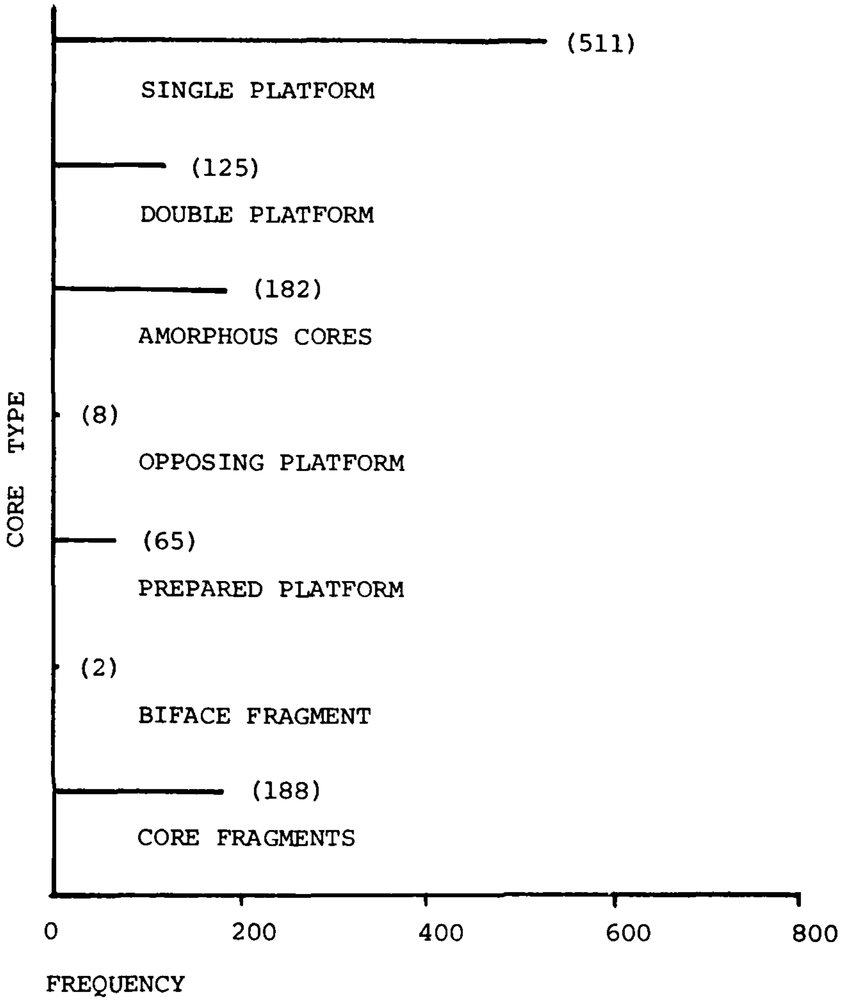

Figure 10.4. The frequency of core types.

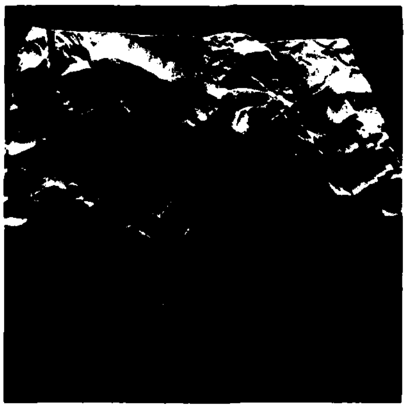

Figure 10.5. Burin faceting on broken Hidden Valley point from Rodgers Shelter

nodules and blocks which are scattered throughout the soil. Jefferson City cherts are the most readily available near Rodgers Shelter and represent the predominant core material (Fig. 10.6).

Macroscopic changes caused by heating have been experimentally determined for these cherts and, in general, the variations in luster, color, ripple marks, crazing and potlid fractures noted by Collins and Fenwick (1974) apply to heated Jefferson City, Chouteau and Burlington cherts. Nevertheless, differences among heated and unheated Jefferson City cherts, in particular, are often subtle and in many cases determining heat treatment is impossible. Only in a few cases (Fig. 10.7) could heating be accurately determined. A small number of cores also exhibit the characteristic fractures and crazing caused by improper or unintentional heating (Faulkner 1974; Purdy 1975).

The distribution of cores by horizon (Fig. 10.8) clearly shows that the heaviest use of the site occurred in the Middle Archaic horizons (Table 4.4) of Stratum 2. The approximately 3000 year period of Late Archaic/Woodland occupation produced fewer cores and core fragments; even less occur in the 1000 year period of intermittent Dalton occupations. Between these temporal groupings, there are large units of very sparse occupations at the site.

ANALYSIS

To examine differences in core type, material, heat treatment and size grade through time, a series of two and three way contingency tables were computed (Table 10.3). The first set of two way crosstabulations investigate the relationships between size grade, material, heat treatment, core type and weight groupings with time (Table 10.4). On the basis of a 0.05 level of confidence, Horizon by Size Grade, Horizon by Material, Horizon by Heat Treatment, and Material by Heat Treatment all have chi-squares and associated significant probabilities indicating the the variables are interrelated.

Horizon by Material ($\chi^2 = 165.698$; df = 97; p = 0.0000) identified several utilization trends for the various material types (Table 10.5). A high level of use of Jefferson City cherts was maintained throughout all strata with the possible exception of Horizon 11. Even then, banded Jefferson City chert represented the majority of the specimens from that horizon. An inverse relationship can be demonstrated for Burlington and Chouteau cherts with river gravels. With Stratum 1, Burlington chert disappears and only one Chouteau core occurs. However, recognizable river gravels are present in increased numbers, especially during the Dalton occupations of Horizon 10. Deeply buried hillslope exposures of chert during the Dalton period would result in the exploitation of the nearby river gravels as chert resources. Erosion of these deeply covered slopes would gradually free the bedrock exposures, explaining diminished use of river gravels after the Dalton horizons.

Examining the use of heat treatment through time ($\chi^2 = 36.92$; df = 14; p = 0.0008) records heat treatment occurs with all except the Jefferson City quartzite. But the overwhelming majority of all the material types exhibit no detected heat treatment.

When comparing core type with all horizons (Table 10.6) there is a potentially meaningful relationship ($\chi^2 = 75.11$; df = 55; p = 0.0516).

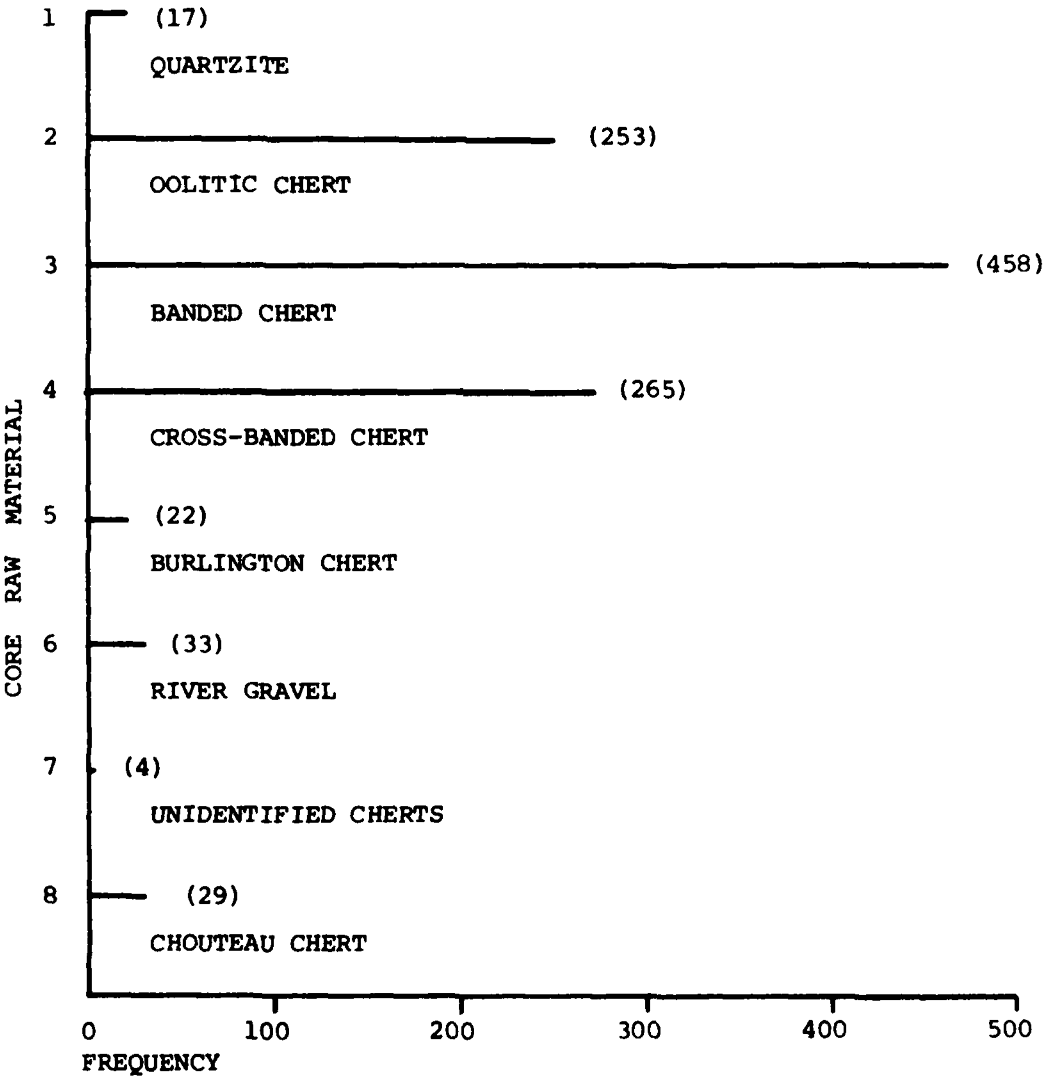

Figure 10.6. Core raw materials (Jefferson City Formation: 1-4).

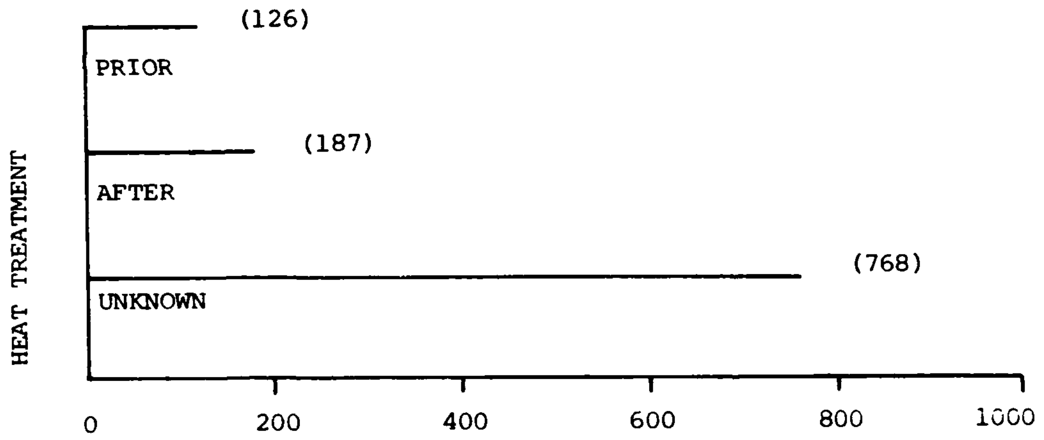

Figure 10.7. Heat treatment of the cores from Rodgers Shelter.

TABLE 10.3

Contingency Tables Used in the Analysis of Cores

Two-way Tables:
- Horizon by Size Grade
- Horizon by Material
- Horizon by Heat Treatment
- Core Type by Horizon
- Core Type by Horizons 5 to 8
- Weight Groups by Heat Treatment
- Material by Heat Treatment
- Core Type by Heat Treatment

Three-way Tables:
- Core Type by Material by Horizon
- Core Type by Horizon by Material
- Core Type by Heat Treatment by Material

TABLE 10.4

Summary of Contingency Tables

Table	Chi-square	df	Level of Significance
Horizon by Size Grade	69.57324	44	0.0083
Horizon by Material Type	166.59828	77	0.0000
Horizon by Heat Treatment	45.65216	22	0.0022
Core Type by Horizon	75.11314	55	0.0516
Core Type by Horizons 5 to 8	15.49709	15	0.4162
Weight Groups by Horizon:			
Single Platform Cores	57.92491	44	0.0777
Double Platform Cores	52.24736	40	0.0929
Amorphous Platform Cores	41.33681	40	0.4121
Opposing Platform Cores	17.77776	12	0.1226
Prepared Platform Cores	31.17316	36	0.6974
Biface Fragment Cores	0.50000*		
Material by Heat Treatment	36.92477	14	0.0008
Core Type by Heat Treatment	15.97616	10	0.1003

*Biface Fragment Core Weight Groups by Horizon produced a 2 x 2 table which automatically caused SPSS to use Fisher's Exact Test instead of calculating chi-square.

Restricted to Stratum 2 and the upper part of Stratum 1 (Table 10.7) there is a random relationship ($\chi^2 = 15.497$; df = 15; p = 0.4162), demonstrating the homogeneous character of core reduction with the Early and Middle Archaic that systematically differs with core distributions in other horizons.

TABLE 10.5

Diachronic Trends in Materials Used for Cores

TABLE 10.6

Core Types by Horizon

```
* * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * * * * * * * * * *
   V24      CORE TYPE                                       BY  V3        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *            * * * * * * * *

                     V3                                                                                  V3
              COUNT  I
            ROW PCT  IONE       TWO       THREE     FOUR      FIVE      SIX       SEVEN     EIGHT     NINE      TEN       ELEVEN     ROW
            COL PCT  I                                                                                                             TOTAL
            TOT PCT  I       1 I       2 I       3 I       4 I       5 I       6 I       7 I       8 I       9 I      10 I      11 I
V24         ---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  1  I      23 I      43 I      35 I       6 I     101 I      83 I      94 I      38 I      22 I      26 I       4 I    475
 SINGLE   PLATFORM   I     4.8 I     9.1 I     7.4 I     1.3 I    21.3 I    17.5 I    19.8 I     8.0 I     4.6 I     5.5 I     0.8 I   56.3
                     I    44.2 I    45.3 I    50.0 I    50.0 I    64.3 I    50.0 I    63.9 I    59.4 I    73.3 I    56.5 I    80.0 I
                     I     2.7 I     5.1 I     4.1 I     0.7 I    12.0 I     9.8 I    11.1 I     4.5 I     2.6 I     3.1 I     0.5 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  2  I       9 I      12 I       7 I       1 I      20 I      33 I      20 I      13 I       1 I       8 I       0 I    124
 DOUBLE   PLATFORM   I     7.3 I     9.7 I     5.6 I     0.8 I    16.1 I    26.6 I    16.1 I    10.5 I     0.8 I     6.5 I     0.0 I   14.7
                     I    17.3 I    12.6 I    10.0 I     8.3 I    12.7 I    19.9 I    13.6 I    20.3 I     3.3 I    17.4 I     0.0 I
                     I     1.1 I     1.4 I     0.8 I     0.1 I     2.4 I     3.9 I     2.4 I     1.5 I     0.1 I     0.9 I     0.0 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  3  I       9 I      24 I      20 I       5 I      28 I      34 I      26 I      10 I       7 I      10 I       0 I    173
 AMORPH   CORES      I     5.2 I    13.9 I    11.6 I     2.9 I    16.2 I    19.7 I    15.0 I     5.8 I     4.0 I     5.8 I     0.0 I   20.5
                     I    17.3 I    25.3 I    28.6 I    41.7 I    17.8 I    20.5 I    17.7 I    15.6 I    23.3 I    21.7 I     0.0 I
                     I     1.1 I     2.8 I     2.4 I     0.6 I     3.3 I     4.0 I     3.1 I     1.2 I     0.8 I     1.2 I     0.0 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  4  I       1 I       3 I       0 I       0 I       1 I       3 I       0 I       0 I       0 I       0 I       0 I      8
 OPPOSINGPLATFORM    I    12.5 I    37.5 I     0.0 I     0.0 I    12.5 I    37.5 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I    0.9
                     I     1.9 I     3.2 I     0.0 I     0.0 I     0.6 I     1.8 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                     I     0.1 I     0.4 I     0.0 I     0.0 I     0.1 I     0.4 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  5  I      10 I      13 I       7 I       0 I       7 I      12 I       7 I       3 I       0 I       2 I       1 I     62
 PREPAREDPLATFORM    I    16.1 I    21.0 I    11.3 I     0.0 I    11.3 I    19.4 I    11.3 I     4.8 I     0.0 I     3.2 I     1.6 I    7.3
                     I    19.2 I    13.7 I    10.0 I     0.0 I     4.5 I     7.2 I     4.8 I     4.7 I     0.0 I     4.3 I    20.0 I
                     I     1.2 I     1.5 I     0.8 I     0.0 I     0.8 I     1.4 I     0.8 I     0.4 I     0.0 I     0.2 I     0.1 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                  6  I       0 I       0 I       1 I       0 I       0 I       1 I       0 I       0 I       0 I       0 I       0 I      2
 BIFACE   FRAGMENT   I     0.0 I     0.0 I    50.0 I     0.0 I     0.0 I    50.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I    0.2
                     I     0.0 I     0.0 I     1.4 I     0.0 I     0.0 I     0.6 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                     I     0.0 I     0.0 I     0.1 I     0.0 I     0.0 I     0.1 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
             COLUMN         52        95        70        12       157       166       147        64        30        46         5      844
              TOTAL        6.2      11.3       8.3       1.4      18.6      19.7      17.4       7.6       3.6       5.5       0.6    100.0
RAW CHI SQUARE =    71.58038 WITH    50 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0243

NUMBER OF MISSING OBSERVATIONS =   237
```

TABLE 10.7

Core Types, Stratum 2

```
* * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * *
   V3        HORIZON                                           BY  V23        CORE TYPE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      V23
             COUNT  I
            ROW PCT ISINGLE   DOUBLE   AMORPH    OPPOSING PREPARED BIFACE      ROW
            COL PCT IPLATFORM PLATFORM CORES     PLATFORM PLATFORM FRAGMENT  TOTAL
            TOT PCT I     1  I     2  I     3  I     4  I     5  I     6  I
V3          --------I--------I--------I--------I--------I--------I--------I
                  5 I   101  I    20  I    28  I     1  I     7  I     0  I   157
  FIVE              I  64.3  I  12.7  I  17.8  I   0.6  I   4.5  I   0.0  I  33.4
                    I  36.3  I  27.4  I  31.8  I  25.0  I  26.9  I   0.0  I
                    I  21.5  I   4.3  I   6.0  I   0.2  I   1.5  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  6 I    83  I    33  I    34  I     3  I    12  I     1  I   166
  SIX               I  50.0  I  19.9  I  20.5  I   1.8  I   7.2  I   0.6  I  35.3
                    I  29.9  I  45.2  I  38.6  I  75.0  I  46.2  I 100.0  I
                    I  17.7  I   7.0  I   7.2  I   0.6  I   2.6  I   0.2  I
                   -I--------I--------I--------I--------I--------I--------I
                  7 I    54  I    11  I    15  I     0  I     6  I     0  I    86
  SEVEN             I  62.8  I  12.8  I  17.4  I   0.0  I   7.0  I   0.0  I  18.3
                    I  19.4  I  15.1  I  17.0  I   0.0  I  23.1  I   0.0  I
                    I  11.5  I   2.3  I   3.2  I   0.0  I   1.3  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  8 I    40  I     9  I    11  I     0  I     1  I     0  I    61
  EIGHT             I  65.6  I  14.8  I  18.0  I   0.0  I   1.6  I   0.0  I  13.0
                    I  14.4  I  12.3  I  12.5  I   0.0  I   3.8  I   0.0  I
                    I   8.5  I   1.9  I   2.3  I   0.0  I   0.2  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
             COLUMN     278       73       88        4       26        1      470
              TOTAL    59.1     15.5     18.7      0.9      5.5      0.2    100.0

RAW CHI SQUARE =     15.49709 WITH    15 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.4162

NUMBER OF MISSING OBSERVATIONS =    611
```

The density of core types through time reflects, to a degree, the intensity of occupation for each horizon. Therefore, it is not surprising to find the majority of each core type in Horizons 1 through 3 and 5 through 7. However, as single platform cores are the most numerous for each horizon, a focus on producing large flake blanks for later modification into tools is suggested.

Another set of two-way tables compared the weight of each core type with time. To divide the individual weights into a more manageable form, frequencies were calculated using each core type's weights. Because single platform cores have the greatest range, that frequency listing was used; subdivided into five groups at 20 percent intervals of the cumulative percentage (Table 10.8). Applying an 0.05 level of confidence, none of the resultant tables produced a large chi-square. The null hypothesis would be accepted; differences in core size through time are minor or insignificant. However, the two tables (Tables 10.9 and 10.10) for single platform and double platform cores were close to the 0.05 level, having chi-squares with associated probabilities of 0.0777 and 0.0929 respectively, and may indicate that systematic relationships exist. Because of the small number, no table could be constructed for biface fragment cores.

TABLE 10.8

Weight Groups for Single Platform Cores

Weight (grams)	Cumulative %	Value Numbers
8 to 41	20	1
41 to 91	40	2
91 to 144	60	3
144 to 197	80	4
197 to 1057	100	5

One last set of two-way tables compared heat treatment with both material and core type. Material by Heat Treatment (Table 10.11) is highly significant ($\chi^2 = 36.92$; df = 14; p = 0.0008), while the latter ($\chi^2 = 15.98$; df = 10; p = 0.10) is essentially random. The patterning of Table 10.11 is attributable to the high number of Jefferson City chert cores, a material in which signs of heating are difficult to identify. Thus, the majority are those having either an unheated or an unknown heating state.

Other tables (Tables 10.12 and 10.13) tested for any relationship of core type with material through time. Core Type by Material by Horizon produced a non-random relationship ($\chi^2 = 32.98$; df = 18; p = 0.017) for Horizon 7b (portion of Horizon 7 in front of the overhang). All other horizons had low chi-squares supporting the null hypothesis that there is no difference. With Core Type by Horizon by Material, the tables for Jefferson City quartzite and banded chert produced significant chi-squares (quartzite: $\chi^2 = 21.67$; df = 12; p = 0.0414; banded chert: $\chi^2 = 72.72$; df = 55; p = 0.0550). With controls for quartzite, there were few other types of cores beyond the basic single platform cores, along with the other forms of unprepared cores completely dominated the prepared platform cores. The relatively few prepared platform cores are clustered

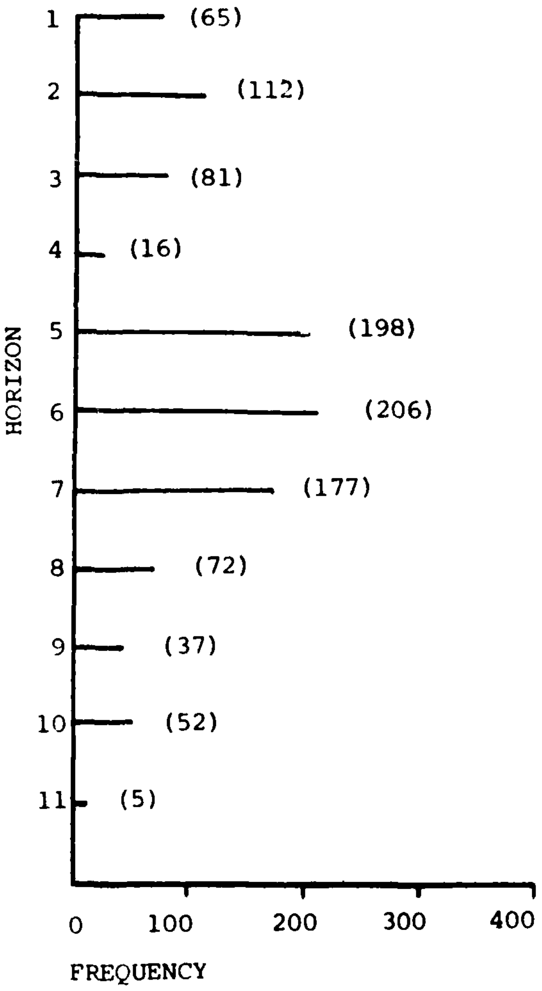

Figure 10.8. Frequency of cores by horizon. Sixty core in sample are either unprovenienced or are from the West Terrace.

TABLE 10.9

Single Platform Core Weight by Horizon

```
• • • • • • • • • • • • • • • • • • •   C R O S S T A B U L A T I O N   O F   • • • • • • • • • • • • • • • • • • • • • • • • •
   V8        WEIGHT GROUPS, SINGLE PLATFORM CORES         BY  V3          HORIZON                                GROUPS, SINGLE
• • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • PAGE  1 OF • • • • • • • • •

                       V3                                                                                          V3
               COUNT  I
             ROW PCT  IONE       TWO       THREE     FOUR      FIVE      SIX       SEVEN     EIGHT     NINE      TEN       ELEVEN     ROW
             COL PCT  I                                                                                                              TOTAL
             TOT PCT  I       1 I       2 I       3 I       4 I       5 I       6 I       7 I       8 I       9 I      10 I      11 I
V8            --------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                    1 I       2 I       1 I       0 I       1 I       8 I       3 I       4 I       2 I       1 I       0 I       0 I      22
 0-41     GRAMS       I     9.1 I     4.5 I     0.0 I     4.5 I    36.4 I    13.6 I    18.2 I     9.1 I     4.5 I     0.0 I     0.0 I     4.2
                      I     7.1 I     2.0 I     0.0 I    14.3 I     7.3 I     3.1 I     4.0 I     5.1 I     4.3 I     0.0 I     0.0 I
                      I     0.4 I     0.2 I     0.0 I     0.2 I     1.5 I     0.6 I     0.8 I     0.4 I     0.2 I     0.0 I     0.0 I
                     -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                    2 I       8 I       3 I       3 I       3 I      36 I      19 I      19 I       5 I       4 I       4 I       1 I     105
 41-91    GRAMS       I     7.6 I     2.9 I     2.9 I     2.9 I    34.3 I    18.1 I    18.1 I     4.8 I     3.8 I     3.8 I     1.0 I    20.1
                      I    28.6 I     6.0 I     7.9 I    42.9 I    33.0 I    19.4 I    19.0 I    12.8 I    17.4 I    15.4 I    25.0 I
                      I     1.5 I     0.6 I     0.6 I     0.6 I     6.9 I     3.6 I     3.6 I     1.0 I     0.8 I     0.8 I     0.2 I
                     -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                    3 I       8 I      13 I       6 I       0 I      20 I      18 I      15 I       8 I       4 I       7 I       0 I      99
 91-144   GRAMS       I     8.1 I    13.1 I     6.1 I     0.0 I    20.2 I    18.2 I    15.2 I     8.1 I     4.0 I     7.1 I     0.0 I    19.0
                      I    28.6 I    26.0 I    15.8 I     0.0 I    18.3 I    18.4 I    15.0 I    20.5 I    17.4 I    26.9 I     0.0 I
                      I     1.5 I     2.5 I     1.1 I     0.0 I     3.8 I     3.4 I     2.9 I     1.5 I     0.8 I     1.3 I     0.0 I
                     -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                    4 I       5 I       8 I      10 I       2 I      20 I      20 I      20 I       5 I       3 I       4 I       1 I      98
 144-197 GRAMS        I     5.1 I     8.2 I    10.2 I     2.0 I    20.4 I    20.4 I    20.4 I     5.1 I     3.1 I     4.1 I     1.0 I    18.8
                      I    17.9 I    16.0 I    26.3 I    28.6 I    18.3 I    20.4 I    20.0 I    12.8 I    13.0 I    15.4 I    25.0 I
                      I     1.0 I     1.5 I     1.9 I     0.4 I     3.8 I     3.8 I     3.8 I     1.0 I     0.6 I     0.8 I     0.2 I
                     -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                    5 I       5 I      25 I      19 I       1 I      25 I      38 I      42 I      19 I      11 I      11 I       2 I     198
 >197     GRAMS       I     2.5 I    12.6 I     9.6 I     0.5 I    12.6 I    19.2 I    21.2 I     9.6 I     5.6 I     5.6 I     1.0 I    37.9
                      I    17.9 I    50.0 I    50.0 I    14.3 I    22.9 I    38.8 I    42.0 I    48.7 I    47.8 I    42.3 I    50.0 I
                      I     1.0 I     4.8 I     3.6 I     0.2 I     4.8 I     7.3 I     8.0 I     3.6 I     2.1 I     2.1 I     0.4 I
                     -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
               COLUMN        28        50        38         7       109        98       100        39        23        26         4      522
                TOTAL       5.4       9.6       7.3       1.3      20.9      18.8      19.2       7.5       4.4       5.0       0.8    100.0

RAW CHI SQUARE =    56.25639 WITH    40 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0456

NUMBER OF MISSING OBSERVATIONS =    559
```

TABLE 10.10

Double Platform Core Weight Groups by Horizon

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * * *
   V10       WEIGHT GROUPS, DOUBLE PLATFORM CORES          BY  V3        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  PAGE  1 OF  1

                      V3
             COUNT   I
             ROW PCT IONE       TWO      THREE     FOUR      FIVE      SIX       SEVEN     EIGHT     NINE      TEN        ROW
             COL PCT I                                                                                                  TOTAL
             TOT PCT I     1  I     2  I     3  I     4  I     5  I     6  I     7  I     8  I     9  I    10  I
V10          --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                   1 I     1  I     1  I     0  I     0  I     0  I     2  I     1  I     0  I     1  I     0  I       6
  0-41     GRAMS     I  16.7  I  16.7  I   0.0  I   0.0  I   0.0  I  33.3  I  16.7  I   0.0  I  16.7  I   0.0  I     4.4
                     I  11.1  I   7.7  I   0.0  I   0.0  I   0.0  I   5.1  I   4.8  I   0.0  I 100.0  I   0.0  I
                     I   0.7  I   0.7  I   0.0  I   0.0  I   0.0  I   1.5  I   0.7  I   0.0  I   0.7  I   0.0  I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                   2 I     0  I     4  I     1  I     0  I     5  I     7  I     1  I     4  I     0  I     3  I      25
  41-91    GRAMS     I   0.0  I  16.0  I   4.0  I   0.0  I  20.0  I  28.0  I   4.0  I  16.0  I   0.0  I  12.0  I    18.4
                     I   0.0  I  30.8  I  14.3  I   0.0  I  21.7  I  17.9  I   4.8  I  28.6  I   0.0  I  37.5  I
                     I   0.0  I   2.9  I   0.7  I   0.0  I   3.7  I   5.1  I   0.7  I   2.9  I   0.0  I   2.2  I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                   3 I     3  I     3  I     0  I     0  I     7  I    12  I     8  I     6  I     0  I     1  I      40
  91-144   GRAMS     I   7.5  I   7.5  I   0.0  I   0.0  I  17.5  I  30.0  I  20.0  I  15.0  I   0.0  I   2.5  I    29.4
                     I  33.3  I  23.1  I   0.0  I   0.0  I  30.4  I  30.8  I  38.1  I  42.9  I   0.0  I  12.5  I
                     I   2.2  I   2.2  I   0.0  I   0.0  I   5.1  I   8.8  I   5.9  I   4.4  I   0.0  I   0.7  I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                   4 I     2  I     0  I     1  I     1  I     5  I     6  I     4  I     2  I     0  I     1  I      22
  144-197 GRAMS      I   9.1  I   0.0  I   4.5  I   4.5  I  22.7  I  27.3  I  18.2  I   9.1  I   0.0  I   4.5  I    16.2
                     I  22.2  I   0.0  I  14.3  I 100.0  I  21.7  I  15.4  I  19.0  I  14.3  I   0.0  I  12.5  I
                     I   1.5  I   0.0  I   0.7  I   0.7  I   3.7  I   4.4  I   2.9  I   1.5  I   0.0  I   0.7  I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                   5 I     3  I     5  I     5  I     0  I     6  I    12  I     7  I     2  I     0  I     3  I      43
  >197     GRAMS     I   7.0  I  11.6  I  11.6  I   0.0  I  14.0  I  27.9  I  16.3  I   4.7  I   0.0  I   7.0  I    31.6
                     I  33.3  I  38.5  I  71.4  I   0.0  I  26.1  I  30.8  I  33.3  I  14.3  I   0.0  I  37.5  I
                     I   2.2  I   3.7  I   3.7  I   0.0  I   4.4  I   8.6  I   5.1  I   1.5  I   0.0  I   2.2  I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             COLUMN        9       13        7        1       23       35       21       14        1        8      136
              TOTAL      6.6      9.6      5.1      0.7     16.9     28.7     15.4     10.3      0.7      5.9    100.0

RAW CHI SQUARE =    50.72804 WITH    36 DEGREES OF FREEDOM.   SIGNIFICANCE =  0.0527

NUMBER OF MISSING OBSERVATIONS =   945
```

TABLE 10.11

Material by Heat Treatment

```
* * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
  V5        MATERIAL                               BY  V6          HEAT TREATMENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                  V6
         COUNT   I
       ROW PCT   IPRIOR      AFTER      UNKNOWN      ROW
       COL PCT   I                                   TOTAL
       TOT PCT   I       2  I       3  I       4  I
        ---------I---------I---------I---------I
                1 I       0  I       2  I      15  I      17
QUARTZ- ITE       I     0.0  I    11.8  I    88.2  I     1.6
                  I     0.0  I     1.1  I     2.0  I
                  I     0.0  I     0.2  I     1.4  I
                 -I---------I---------I---------I
                2 I      16  I      33  I     204  I     253
OOLITIC CHERT     I     6.3  I    13.0  I    80.6  I    23.4
                  I    12.7  I    17.6  I    26.6  I
                  I     1.5  I     3.1  I    18.9  I
                 -I---------I---------I---------I
                3 I      62  I      93  I     303  I     458
BANDED  CHERT     I    13.5  I    20.3  I    66.2  I    42.4
                  I    49.2  I    49.7  I    35.5  I
                  I     5.7  I     8.6  I    28.0  I
                 -I---------I---------I---------I
                4 I      40  I      52  I     173  I     265
X-BANDED CHERT    I    15.1  I    19.6  I    65.3  I    24.5
                  I    31.7  I    27.8  I    22.5  I
                  I     3.7  I     4.8  I    16.0  I
                 -I---------I---------I---------I
                5 I       3  I       4  I      15  I      22
BURLNGTN CHERT    I    13.6  I    18.2  I    68.2  I     2.0
                  I     2.4  I     2.1  I     2.0  I
                  I     0.3  I     0.4  I     1.4  I
                 -I---------I---------I---------I
                6 I       3  I       0  I      30  I      33
RIVER   GRAVEL    I     9.1  I     0.0  I    90.9  I     3.1
                  I     2.4  I     0.0  I     3.9  I
                  I     0.3  I     0.0  I     2.8  I
                 -I---------I---------I---------I
                7 I       0  I       1  I       3  I       4
OTHER   CHERT     I     0.0  I    25.0  I    75.0  I     0.4
                  I     0.0  I     0.5  I     0.4  I
                  I     0.0  I     0.1  I     0.3  I
                 -I---------I---------I---------I
                8 I       2  I       2  I      25  I      29
CHOUTEAU CHERT    I     6.9  I     6.9  I    86.2  I     2.7
                  I     1.6  I     1.1  I     3.3  I
                  I     0.2  I     0.2  I     2.3  I
                 -I---------I---------I---------I
           COLUMN       126        167        768       1081
            TOTAL      11.7       17.3       71.0      100.0

 AW CHI SQUARE =     36.92477 WITH     14 DEGREES OF FREEDOM.
SIGNIFICANCE =  0.0008
```

TABLE 10.12

Core Type by Material Controlled for Each Horizon

Horizon	Chi-square	df	Level of Significance
1	16.50484	12	0.1692
2	33.91380	28	0.2037
3	13.99120	24	0.9468
4	8.42000	6	0.2089
5	17.16922	24	0.8414
6	17.09207	25	0.8784
7a	17.72679	18	0.4738
7b	32.98254	18	0.0168
8	4.38029	12	0.9756
9	8.53132	8	0.3834
10	6.50076	9	0.6889
11	0.40000*		

*Fischer's Exact Test calculated

TABLE 10.13

Core Type by Horizon Controlled for Material

Material	Chi-square	df	Level of Significance
Jefferson City quartzite	21.66660	12	0.0414
Oolitic Jefferson City chert	43.65840	50	0.7243
Banded Jefferson City chert	72.71620	55	0.0550
Cross banded Jefferson City chert	25.20905	40	0.9671
Burlington chert	18.61487	24	0.7722
River gravel	25.87025	30	0.6817
Other cherts	3.00000	2	0.2231
Chouteau cherts	17.53265	18	0.4868

with the periods of highest density of occupation. The other materials do not appear to have such a clear cut separation between prepared and unprepared cores. This correlation of banded chert and single platform cores is not surprising, as both represent the majority of the cores.

Certain trends in material use or availability are suggested by these tables. Quartzite is restricted to Strata 2 and 4, with the majority of examples from Horizon 5. Although banded Jefferson City cherts were utilized throughout the entire history of the site, the greatest use occurs above Stratum 1. Gradually eroding hillslopes would slowly uncover the bedrock sources, increasing their availability toward the present. As the quartzite is the lowest member of the stratigraphic sequence, it would have the shortest record of availability. However, cultural selection must also be recognized, as the quartzite, available throughout the Middle Archaic, Late Archaic and Woodland periods, is generally restricted to the late Middle Archaic.

Examining the importance of heat treatment for each core type by material (Table 10.14) produced only one table possessing a significant chi-square (quartzite: $\chi^2 = 13.00$; df = 3; p = 0.0046). As there are only 13 quartzite cores in the sample, this information is of dubious value. In all other cases, the null hypothesis is accepted; that is, heating is not particular to a single core type, regardless of material. In general, the heating of cores was apparently unimportant, though it did occur in most horizons.

TABLE 10.14

Core Type by Heat Treatment Controlled for Material

Material	Chi-square	df	Level of Significance
Jefferson City quartzite	13.00000	3	0.0046
Oolitic Jefferson City chert	7.69215	10	0.6589
Banded Jefferson City chert	13.35738	10	0.2044
Cross banded Jefferson City chert	6.11713	8	0.6341
Burlington chert	1.08000	4	0.8974
River gravel	2.21222	3	0.5295
Other cherts	-------	--	-----
Chouteau cherts	2.29500	3	0.5135

SUMMARY AND CONCLUSIONS

The goal of this study was to assess temporal trends or patterns of core types, material used, and the application of heat treatment, both as individual variables and when considered together. Conclusions follow:

1. Material utilization focuses on the Jefferson City chert as the primary resource for most Rodgers Shelter horizons. However, an intensive use of river gravels is noted in the intermittent Dalton occupations (Horizon 10), not seen in later levels. If the bedrock sources of the Jefferson City cherts were buried, then Dalton flintworkers may have been forced to exploit the nearby river bed as a source of flintworking materials. As later erosion of the slopes exposed the outcrops and other weathered out pieces of chert, the emphasis apparently shifted from the gravel beds to the hillslopes. Thus, a model of hillslope stability before 9500 B.P. followed by erosion and exposure of the slopes continuing to the present is proposed.

2. Core manufacturing and utilization techniques as evidenced in the six core types do not exhibit any special emphasis on heat treatment. Although heat treatment was employed, it is not an important step in any

of the core manufacturing technologies. Even prepared platform cores are mainly not heated. Heat treatment appears to have been highly selective and restricted to later stages of manufacture after the flake blank had been produced.

3. The distribution of core types through time indicates that the production of large flake blanks was the prime objective. This would explain the lack of thermal alteration of the cores. Heat treatment probably preceded bifacial shaping of flake blanks during tool production.

4. In other Dalton sites, bi-polar cores have been found (Goodyear 1974:73; Morse 1973:28). This is a very distinctive technology usually employed where a dependence on small river gravel and nodules results from the lack of large pieces of chert or other suitable material. That this technology is apparently missing at Rodgers Shelter is interesting as the Dalton horizon possibly represents a period of buried bedrock, restricting the availability of chert, and forcing a dependence on river gravels. Exactly why this occurred is not known but many of the river gravels are of sufficient size to permit utilization of other core reduction techniques.

IV. HAMMERSTONES

Jeffery Behm

Hammerstones are rocks used to batter, smash or otherwise hammer another object and, as such, are maintenance tools used for a variety of purposes. Primary tasks include flintworking and ground stone tool fabrication (pecking-and-grinding) as well as processing of minerals (pigment), plant or animal food, or fiber production. Some common flintworking usages are core reduction, bifacial preforming, unifacial retouch, or bipolar splitting of cobbles. In flintworking the hammerstone functions to detach flakes from a larger block, either by a glancing blow to a surface or, as in bipolar flaking, by a perpendicular blow to a cobble supported on an anvil. With the exception of bipolar work, flintworking hammerstone wear is similar in that with progressive use an ever-increasing area of abrasion, pitting or battering results. Similar wear occurs from pecking with a hammerstone in ground tool production. Bipolar wear manifests itself as a shallow depression in the working faces of the hammer and anvil that increases in depth and size with repeated use, but there is no evidence of this at Rodgers Shelter. In the context of Rodgers Shelter, I think of hammerstones as mainly ground stone fabricators or flintworking tools that exhibit battering, although other uses are not ruled out.

This study is a descriptive analysis of all 186 hammerstones and 92 hammerstone fragments excavated from the site. Potential trends in hammerstone use are assessed by differences in frequencies of materials, heat treatment, shape, amount and location of wear, indications of other uses on combination tools. These characteristics, or variables, are treated individually or in combination with repsect to time by use of chi-square contingency tables. Appropriate nominal and interval scale observations were encoded for electronic data processing, to include:

artifact provenience, size, material, hardness, weight, blank geometry and shape due to use; type, amount and area of hammerstone wear as well as any subsequent flake removals; previous and later usages.

SAMPLE DESCRIPTION

Rodgers Shelter hammerstones vary in shape, size, type and degree of wear and materials used. Ninety-one and four-tenths percent are larger than three inches (7.62 cm), and hammerstones of graded sizes and weights for stone fabricating tool kits are inferred. As with the cores and other items of chipped stone, the hammerstones are of local materials. Jefferson City chert (Fig. 10.9) accounts for 81.0% of the sample as compared to 11.1% for combined totals of Chouteau, Burlington and river gravel cherts, and 7.8% of other non-chert materials. Sixty and eight-tenths percent cannot be evaluated for heat treatment; 52 (19.4%) hammerstones were heated prior to use, and only 8.6% are thermally fractured or show other signs of uncontrolled or unintentional heating. Original blank shapes are unknown for 186 (69.4%) specimens, are nodular for 72 (26.86%) and blocky for 10 (3.73%), indicating that use-wear generally obscured the hammerstone blanks shapes and other landmarks. Replicative wear experiments with eight hammerstones suggest that minor use produces extensive battering, severe surface erosion, rounding and fracture (Fig. 10.10). After sustained use, all irregularities and protrusions are smoothed or removed, resulting in a spheroidal shape. As a result of use, hammerstone shapes are mainly amorphous, spheroidal or sub-spheroidal.

Hammerstone wear conforms to a continuum of three stages: (1) one fact with moderate wear, (2) a partial band with moderate wear, and (3) a complete band with moderate to heavy wear. Stage 1 wear requires no other description. The second stage consists of multiple battered faces that tend to merge. In the final stage (Stage 3), battering covers the majority of the specimen, producing a complete band about the working edge of the tool. (Battering also occurs on the sides of some hammerstones, probably not from flintworking though it is reminiscent of bipolar flaking, or work with an anvil. The battering is nearly perpendicular to the hammerstone surface on areas that would be difficult if not impossible to use in flake removal from an unsupported core or biface. Only twenty specimens (7.5%) exhibit this and of these most show only minimal use.)

In addition to battering, hammerstone wear is evident also in the number of flakes and other fragments removed in use. Specimens that possess multiple use flake removal scars exceed those with no flake removals by more than 3 to 1 (i.e., 14 with one to four flake removals, and 159 with five or more flake removals). This surface fracturing may proceed until the tool is damaged. There are also 32 flake and 15 large hammerstone irrepairable fragments (17.5% of the total).

These data suggest a hammerstone typology (Fig. 10.11). Tabular and biconvex forms are considered together, and are distinguished from amorphous and spheroidal shapes. Continued use of non-spheroidal forms ultimately results in a spheroidal shape. In this manner, spheroidal hammerstones with stage 3 wear (i.e., a complete band with moderate to heavy battering) may well outnumber the total of unmodified spheroidal hammerstone blanks. The crosstabulation of hammerstone types with time

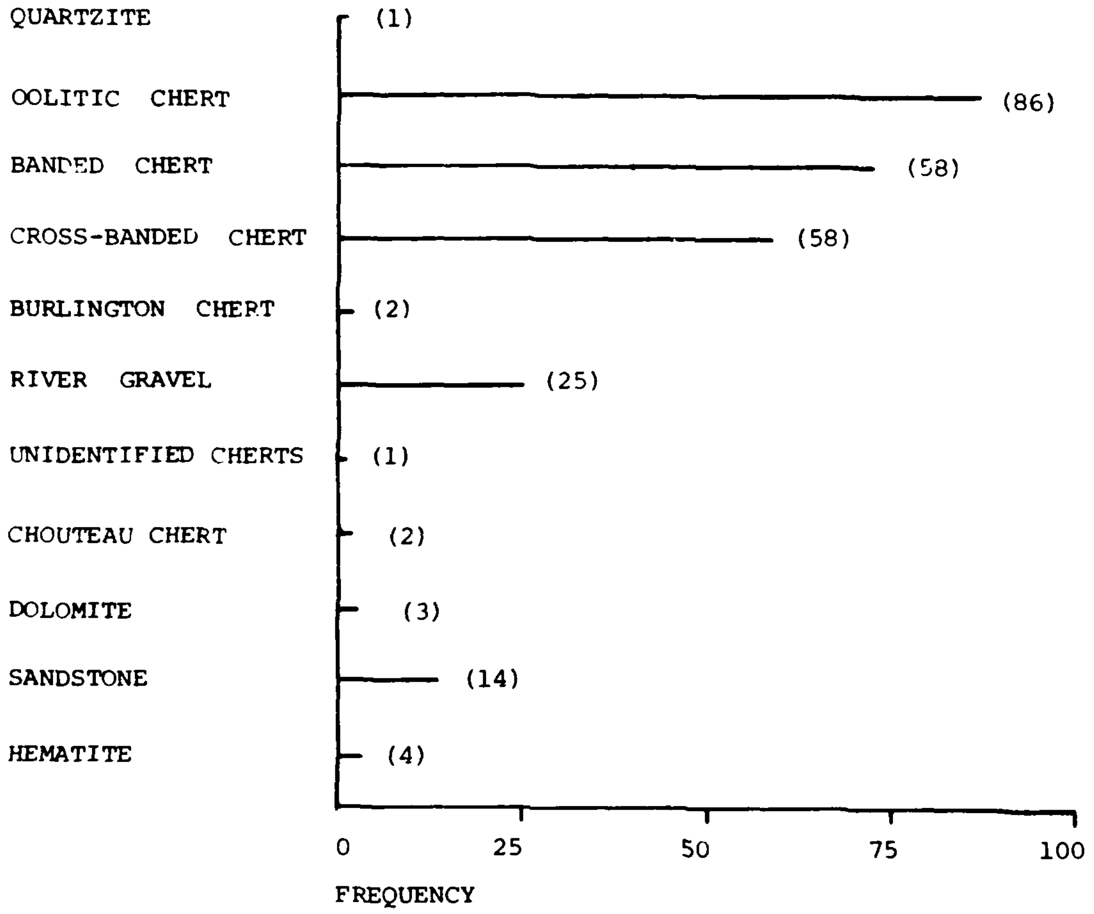

Figure 10.9. Histogram of hammerstone raw materials (Jefferson City formation are the top four).

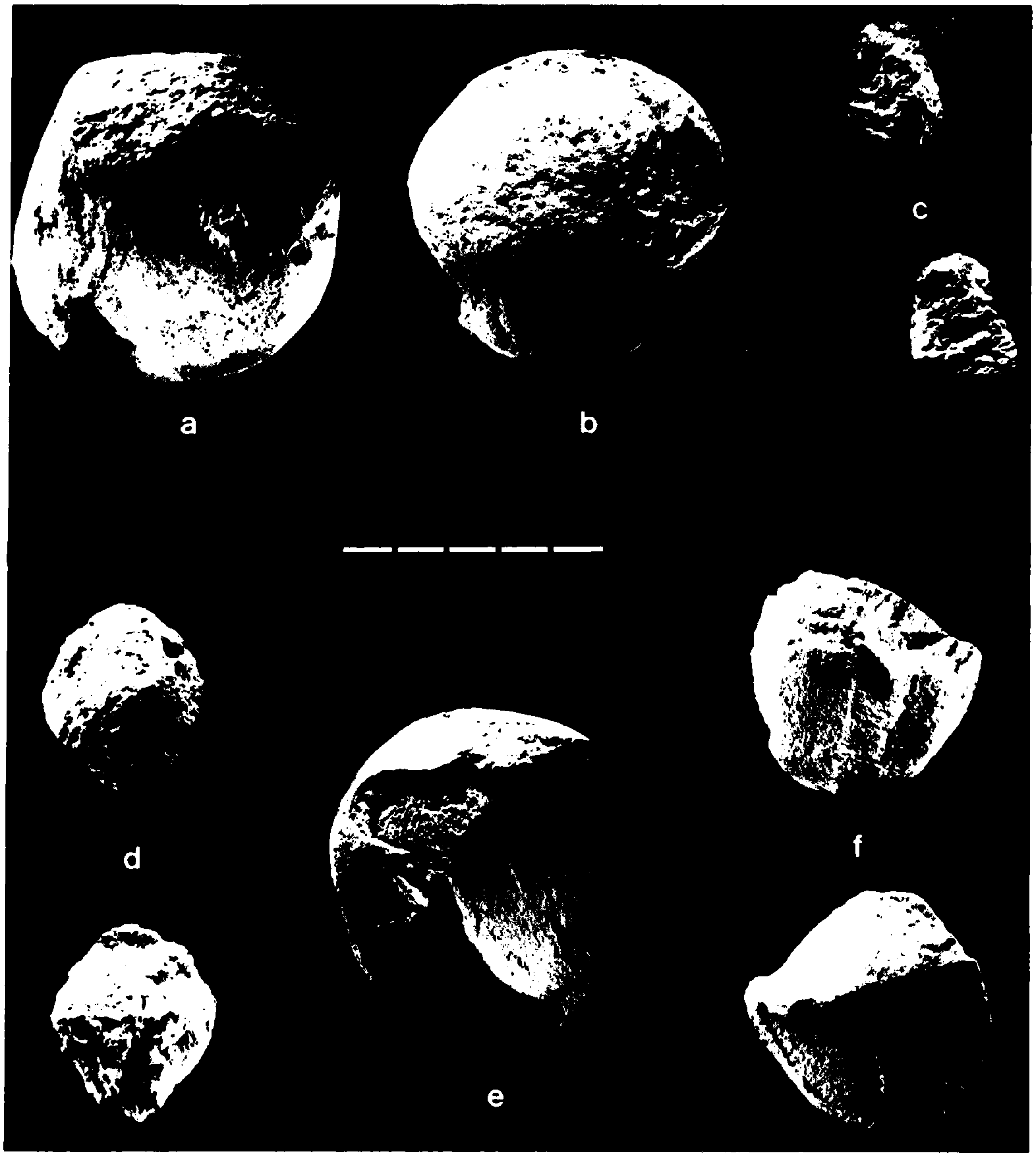

Figure 10.10. Experimental hammerstones and impact flakes: a-b, two views of hammer showing local pitting and battering after limited use; c, impact flake from a; e, second hammerstone with impact flakes d and f. Scale in cm.

		Shape		
		Spheroidal	Amorphous	Tabular/ Biconvex
Wear	Stage 3	1	2	3
	Stage 2	4	4	4
	Stage 1	5	5	5

Figure 10.11. Hammerstone typology.

(Table 10.15) has an insignificant chi-square and suggests that hammerstone use was little different from one horizon to the next. The greatest number of spheroidal hammerstones with stage 3 wear is in Stratum 2. Representative examples are illustrated in Figures 10.12 and 10.13.

Occasionally, hammerstones were used in other tasks either before or after use as a hammer. Prior and post-utilization of hammerstones in other, non-battering tasks is represented, respectively, by only 28.7% and 1.1% of the sample. Because hammerstones hit or otherwise batter another object, many stone artifacts could serve double duty. Thirty manos were used as hammers, which represents 11.2% of all hammerstone. Chipped stone

TABLE 10.15

Hammerstone Types Through Time

```
• • • • • • • • • • • • • • • • • • • •  C R O S S T A B U L A T I O N   O F  • • • • • • • • • • • • • • • • • • • •
   V28        HAMMERSTONE TYPES                                        BY  V4         HORIZON
• • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • •  PAGE  1 OF  2

                  V4
          COUNT  I
         ROW PCT IONE      TWO      THREE    FOUR     FIVE     SIX      SEVEN    EIGHT    NINE         ROW
         COL PCT I                                                                                    TOTAL
         TOT PCT I      1 I      2 I      3 I      4 I      5 I      6 I      7 I      8 I      9 I
V28      --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               1 I      1 I      3 I      5 I      0 I     12 I      7 I      8 I      3 I      1 I     40
TABULAR 1 TO 2   I    2.5 I    7.5 I   12.5 I    0.0 I   30.0 I   17.5 I   20.0 I    7.5 I    2.5 I   22.6
                 I   20.0 I   42.9 I   71.4 I    0.0 I   23.1 I   12.5 I   20.5 I   37.5 I   50.0 I
                 I    0.6 I    1.7 I    2.8 I    0.0 I    6.8 I    4.0 I    4.5 I    1.7 I    0.6 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               2 I      0 I      0 I      1 I      1 I      7 I      8 I      2 I      1 I      0 I     20
TABULAR PARTBAND I    0.0 I    0.0 I    5.0 I    5.0 I   35.0 I   40.0 I   10.0 I    5.0 I    0.0 I   11.3
                 I    0.0 I    0.0 I   14.3 I  100.0 I   13.5 I   14.3 I    5.1 I   12.5 I    0.0 I
                 I    0.0 I    0.0 I    0.6 I    0.6 I    4.0 I    4.5 I    1.1 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               3 I      0 I      1 I      0 I      0 I      7 I      3 I      4 I      0 I      0 I     15
TABULAR BAND     I    0.0 I    6.7 I    0.0 I    0.0 I   46.7 I   20.0 I   26.7 I    0.0 I    0.0 I    8.5
                 I    0.0 I   14.3 I    0.0 I    0.0 I   13.5 I    5.4 I   10.3 I    0.0 I    0.0 I
                 I    0.0 I    0.6 I    0.0 I    0.0 I    4.0 I    1.7 I    2.3 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               4 I      1 I      2 I      0 I      0 I     10 I     13 I      9 I      1 I      1 I     37
AMORPH  1 TO 2   I    2.7 I    5.4 I    0.0 I    0.0 I   27.0 I   35.1 I   24.3 I    2.7 I    2.7 I   20.9
                 I   20.0 I   28.6 I    0.0 I    0.0 I   19.2 I   23.2 I   23.1 I   12.5 I   50.0 I
                 I    0.6 I    1.1 I    0.0 I    0.0 I    5.6 I    7.3 I    5.1 I    0.6 I    0.6 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               5 I      0 I      0 I      1 I      0 I      9 I     11 I      5 I      1 I      0 I     27
AMORPH  PARTBAND I    0.0 I    0.0 I    3.7 I    0.0 I   33.3 I   40.7 I   18.5 I    3.7 I    0.0 I   15.3
                 I    0.0 I    0.0 I   14.3 I    0.0 I   17.3 I   19.6 I   12.8 I   12.5 I    0.0 I
                 I    0.0 I    0.0 I    0.6 I    0.0 I    5.1 I    6.2 I    2.8 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               6 I      2 I      0 I      0 I      0 I      1 I      5 I      5 I      0 I      0 I     13
AMORPH  BAND     I   15.4 I    0.0 I    0.0 I    0.0 I    7.7 I   38.5 I   38.5 I    0.0 I    0.0 I    7.3
                 I   40.0 I    0.0 I    0.0 I    0.0 I    1.9 I    8.9 I   12.8 I    0.0 I    0.0 I
                 I    1.1 I    0.0 I    0.0 I    0.0 I    0.6 I    2.8 I    2.8 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               7 I      0 I      1 I      0 I      0 I      1 I      1 I      1 I      0 I      0 I      4
SPHERE  1 TO 2   I    0.0 I   25.0 I    0.0 I    0.0 I   25.0 I   25.0 I   25.0 I    0.0 I    0.0 I    2.3
                 I    0.0 I   14.3 I    0.0 I    0.0 I    1.9 I    1.8 I    2.6 I    0.0 I    0.0 I
                 I    0.0 I    0.6 I    0.0 I    0.0 I    0.6 I    0.6 I    0.6 I    0.0 I    0.0 I
         --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               8 I      1 I      0 I      0 I      0 I      0 I      1 I      1 I      1 I      0 I      4
SPHERE  PARTBAND I   25.0 I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I   25.0 I   25.0 I    0.0 I    2.3
                 I   20.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8 I    2.6 I   12.5 I    0.0 I
                 I    0.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6 I    0.6 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               9 I      0 I      0 I      0 I      0 I      5 I      7 I      4 I      1 I      0 I     17
SPHERE  BAND     I    0.0 I    0.0 I    0.0 I    0.0 I   29.4 I   41.2 I   23.5 I    5.9 I    0.0 I    9.6
                 I    0.0 I    0.0 I    0.0 I    0.0 I    9.6 I   12.5 I   10.3 I   12.5 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    2.8 I    4.0 I    2.3 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          COLUMN        5        7        7        1       52       56       39        8        2        177
           TOTAL      2.8      4.0      4.0      0.6     29.4     31.6     22.0      4.5      1.1      100.0

RAW CHI SQUARE =    67.71857 WITH    64 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.3561

NUMBER OF MISSING OBSERVATIONS =     91
```

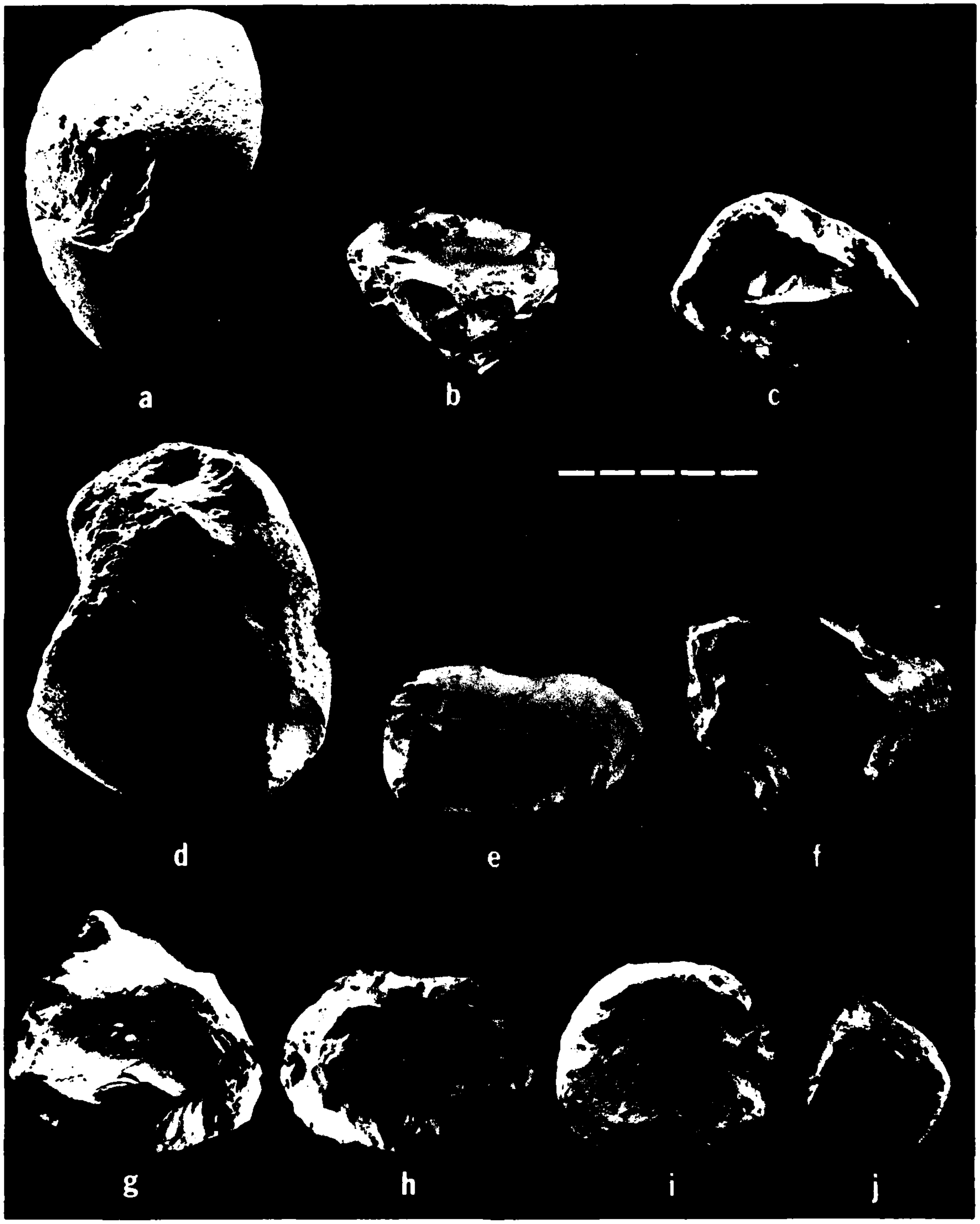

Figure 10.12. Rodgers Shelter hammerstone wear: a, Stage 1; b-c, two views of Stage 2 wear on tabular hammer; d-g, Stage 2 wear on amorphous hammers; h-i, Stage 3 wear on spheroid hammers. Scale in cm.

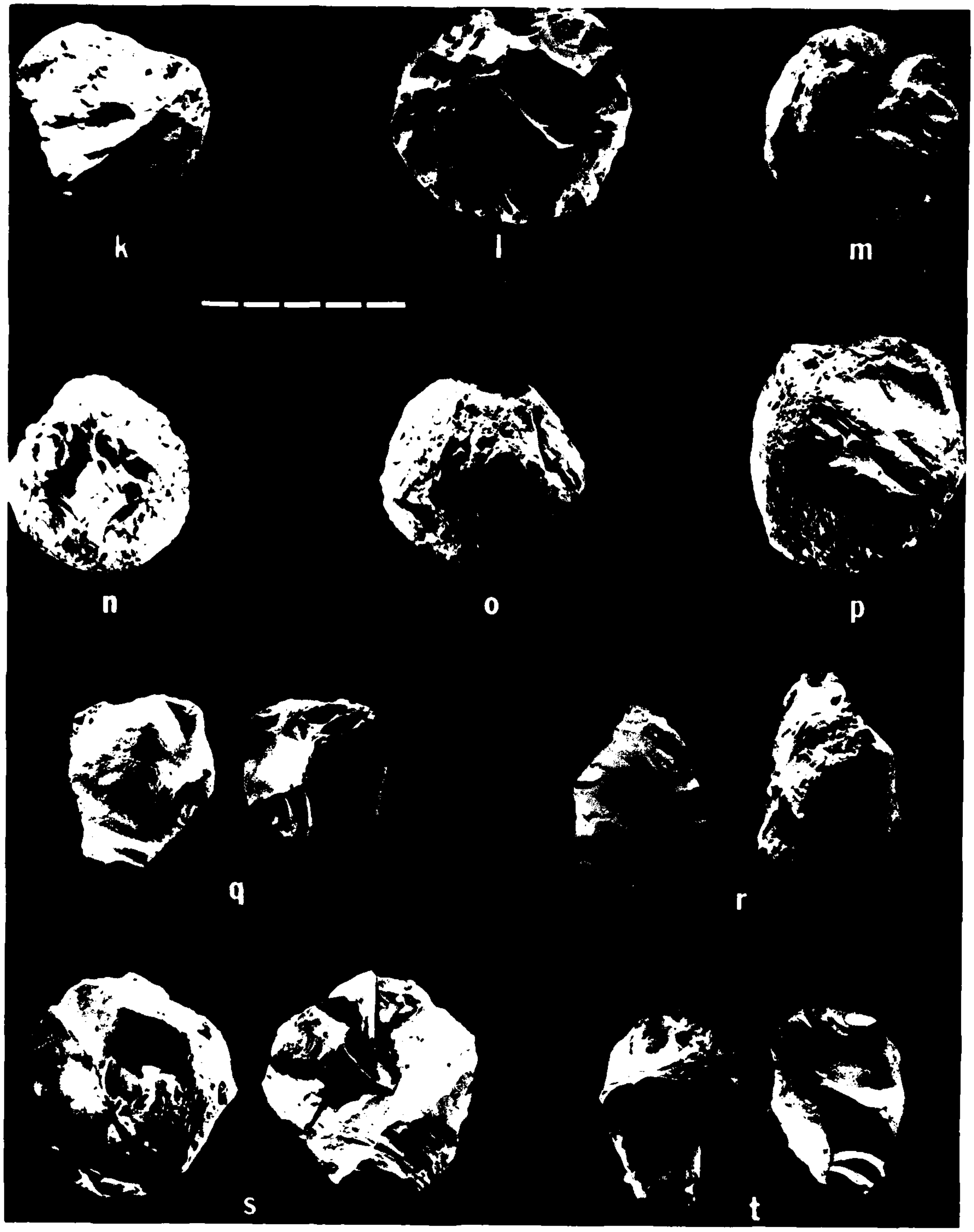

Figure 10.13. Rodgers Shelter spheroidal hammerstones and impact flakes: k-p, Stage 3 wear on hammers; q-t, impact flakes. Scale in cm.

bifaces and cores were also used in 45 instances, respectively, 4.5% and 12.3% of the total. Two large flakes modified for use as hammers are also of interest. Both had been prepared by trimming of edges to produce a useable hammerstone blank.

The distribution of hammerstones through time corresponds closely to that of cores from the site (Fig. 10.14). The greatest densities are in Stratum 2, with Horizon 6 having the most of both artifact classes. Although cores occur throughout, hammerstones are absent from the lowest two horizons.

ANALYSIS

Table 10.16 summarizes chi-square crosstabulations. Only Horizon by Size Grade, with a chi-square of 74.45 and 36 degrees of freedom is a significant crosstabulation at the 0.05 level of confidence. Because hammerstones are not randomly distributed with respect to size, and their density through time is highly patterned, this table would naturally demonstrate a certain degree of interrelatedness between the two variables.

TABLE 10.16

Index of Two-way Contingency Tables

Table Name	Chi-square	df	Level of Significance
Horizon by Size Grade	74.45213	36	0.0002
Horizon by Material	75.28104	90	0.1334
Horizon by Heat Treatment	31.28104	27	0.2513
Horizon by Shape-Original	123.44057	144	0.1094
Horizon by Shape-Cultural	179.26102	180	0.4949
Hammerstone Type by Horizon	74.23952	72	0.4101
Hammerstone Type by Horizons 5-7b	18.90471	24	0.7571
Previous Tool Type by Horizon	21.17274	21	0.4484
Previous Tool Type by Horizons 5-7b	13.17081	9	0.1550
Later Tool Type by Horizon	3.00000	2	0.2231
Later Tool Type by Horizons 5-7b	--------	--	------

The random relationship of material with time is interesting, as it indicates that there was no difference either in the availability of the various raw materials or the selection on the part of the flintworkers through time. If there was little or no difference in the type of tasks to which hammerstones were applied, then it is quite possible that the same types of material would be used. A uniformity of tasks might explain the random relationships of blank shape and use shape with time.

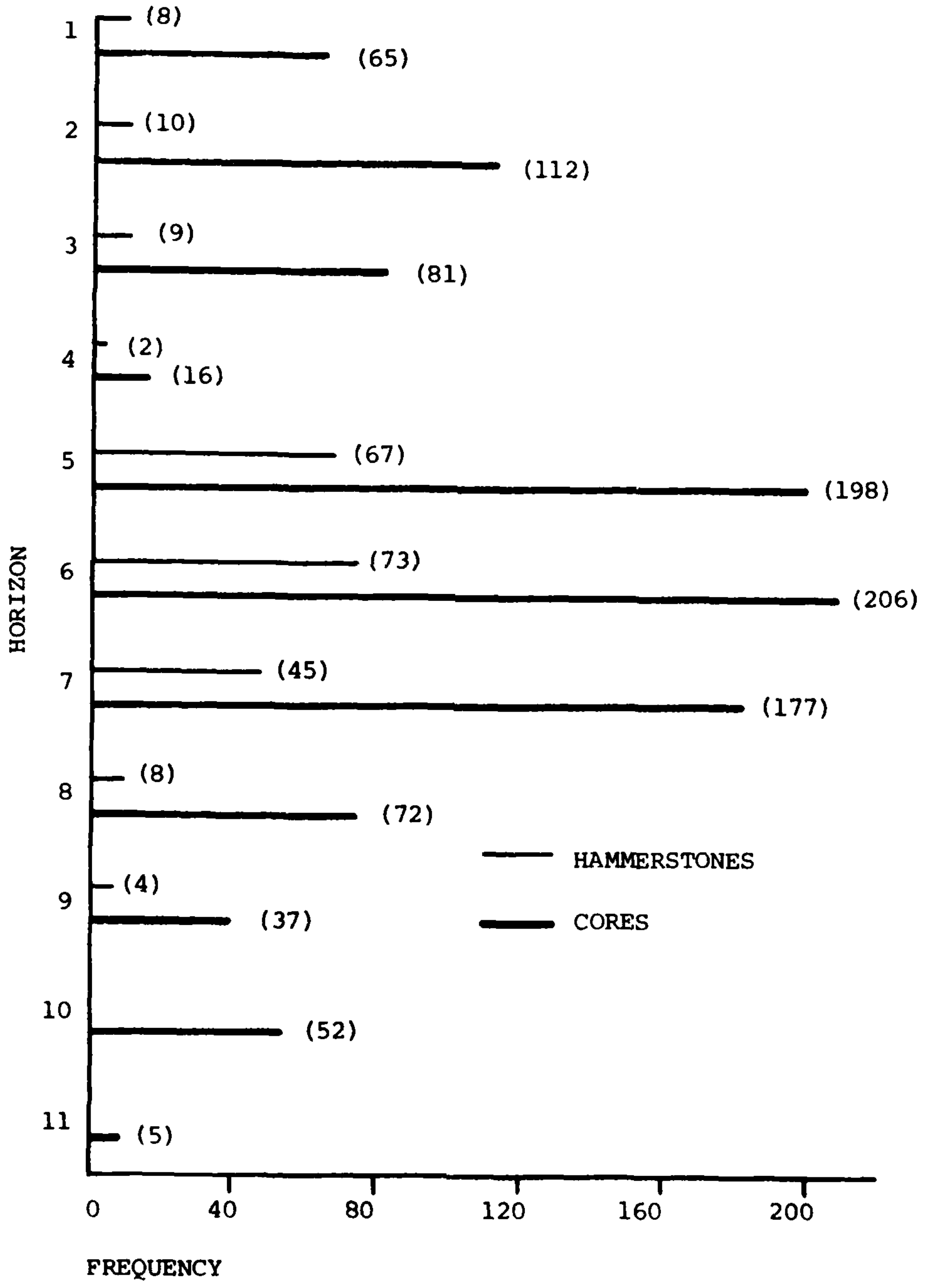

Figure 10.14. Diachronic comparison of core and hammerstone frequencies.

DISCUSSION AND SUMMARY

Rodgers Shelter hammerstones are predominately Jefferson City chert. Most appear to be unheated, while those that are heated are mainly cores or bifaces recycled as hammerstones. The few non-chert hammerstones may well represent tasks other than stone tool fabrication; these mainly show prior use as a hand held grinding implement, or mano. Three basic hammerstone shapes correlate with stages of wear. Experimental replication indicates that as use progresses form becomes spheroidal. Spheroidal, extensively worn hammerstones occur mainly in upper Stratum 1 and Stratum 2 and are suggestive of flintworking or ground stone tool fabrication.

V. MINERALS

Jeffrey Behm

Aboriginal use of the minerals hematite, limonite, and galena, primarily as sources of pigment, is well documented (Broyles 1971:42; Chapman 1977:90; Holmes 1903, 1919; Meyer 1967; Nash 1976:119; Prufer and Shane 1970:150; Shepard 1954:36-40; Wyckoff 1964:85), ranging from Archaic to historic contexts. Pulverizing and grinding, often preceded by heating to improve the color (Dragoo 1963:129-130), is recognized as one method for processing hematite. Powdering of the other minerals presumably utilized similar techniques. Harder varieties of these minerals, primarily hematite, were also pecked, ground, carved, and in some cases, flaked to produce axes, pipes, plummets, gorgets, and bannerstones (Brown 1910; hm 1951). Although these harder varieties of hematite are present at Rodgers Shelter, only a few examples of pecked, ground or flaked axes and bifaces are known.

Hematite (Fe_2O_3) is the most common oxide of iron and exhibits a wide range of physical properties. The purer forms have a hardness between 5.5 and 6.5 (Moh's Hardness Scale), are reddish brown to black in color, and may have a metallic luster. In the earthier, impure varieties, hematite may be softer (from 2 to 5.5), possess a very dull luster, and are slightly redder in color (Hurlburt 1971:282). Aboriginal processing involved washing and then pulverizing either prior to or after heating. The amount of heat to which the hematite was subjected determined the degree of oxidation, which controlled the intensity of the red induced in the mineral. Depending on the presence of impurities, hematite exhibits a slight variation in the resultant color, from bright red to crimson (Dragoo 1963:129-130).

Limonite ($HFeO_2$) is a common hydrated ferric oxide weathering product of the purer iron ores and, as such, is usually found in association with hematite deposits. Varying in color from yellowish brown to dark brown, limonite ranges from 5.5 to less than 3 in hardness and possess a rather dull luster (Hurlburt 1971:304-305). Processing of this mineral would be very similar to hematite.

The lead sulfide mineral, galena (PbS), is very common in the central Mississippi Valley, found in veins, cavity fillings, or replacement bodies in limestone located at shallow depths. This is a very soft mineral, with a Moh's hardness of 2.5. Fresh surfaces are bright metallic with a gray color, while weathered specimens are very dull off-whites (Hurlburt 1971:246-249). Because of the mineral's softness, processing would be limited to abrading or grinding for a specific shape.

Mineral surveys conducted during the mid-nineteenth century in the areas surrounding Rodgers Shelter recorded large, economically exploitable quantities of all these minerals, readily available in surface and shallow sub-surface deposits, or as stream gravels (Broadhead 1880; Shumard 1867). It is highly likely that similar supplies were available to the prehistoric inhabitants of the site. Such an abundance is indicated by the mineral inventory: 1152 pieces of hematite, 10 pieces of limonite, and 37 pieces of galena, a total of 1199 worked and unworked specimens.

This collection was studied in an attempt to define the processing technologies, possible differences in mineral utilization and any temporal trends in overall mineral exploitation at Rodgers Shelter. Chi-square contingency tables were calculated to investigate the interrelationships of various variable pairs along with potential temporal trends.

SAMPLE DESCRIPTION

Hematite, at 96.1% of the total, far outweighs limonite and galena (0.8% and 3.1% respectively). Of the three, only limonite was not modified. The 1152 pieces of hematite include 655 unmodified specimens, while only 16 of the 37 pieces of galena were worked.

Grinding and abrading are the most common modifications and led to faceted surfaces of variable geometry. A few specimens of the denser, harder hematite were flaked, sometimes followed by grinding and pecking. Four bifacially flaked and ground hematite axes, bifaces with varying degrees of grinding, and 35 flakes are present as well. Heavy grinding of the dorsal surface of some flakes prior to detachment indicates that the hematite had been ground into shape prior to flaking. Several of the unifacially and bifacially flaked specimens had been extensively flaked and then ground. This grinding ranges from minimal alteration to almost total masking of the original flaking scars. In addition nine specimens exhibit the characteristic wear resulting from use as a hammer. Modification of the softer galena is restricted to abrading and grinding of surfaces. Representative samples of worked minerals are illustrated in Figures 10.15 to 10.17.

The presence of all minerals including unmodified specimens is probably cultural in origin. Eighty-one and seven tenths percent of all the provenienced minerals are from Stratum 2 or the upper part of Stratum 1. Stratum 4 has 11.8% of the sample. A few examples are found in Stratum 3.

ANALYSIS

To examine differences in mineral utilization, both as a series of overlapping technologies and with respect to time, a series of two- and three-way contingency tables were calculated (Table 10.17). The first set examined the relationship between material, size, hardness, and cultural modification with time. Employing an 0.05 level of confidence,

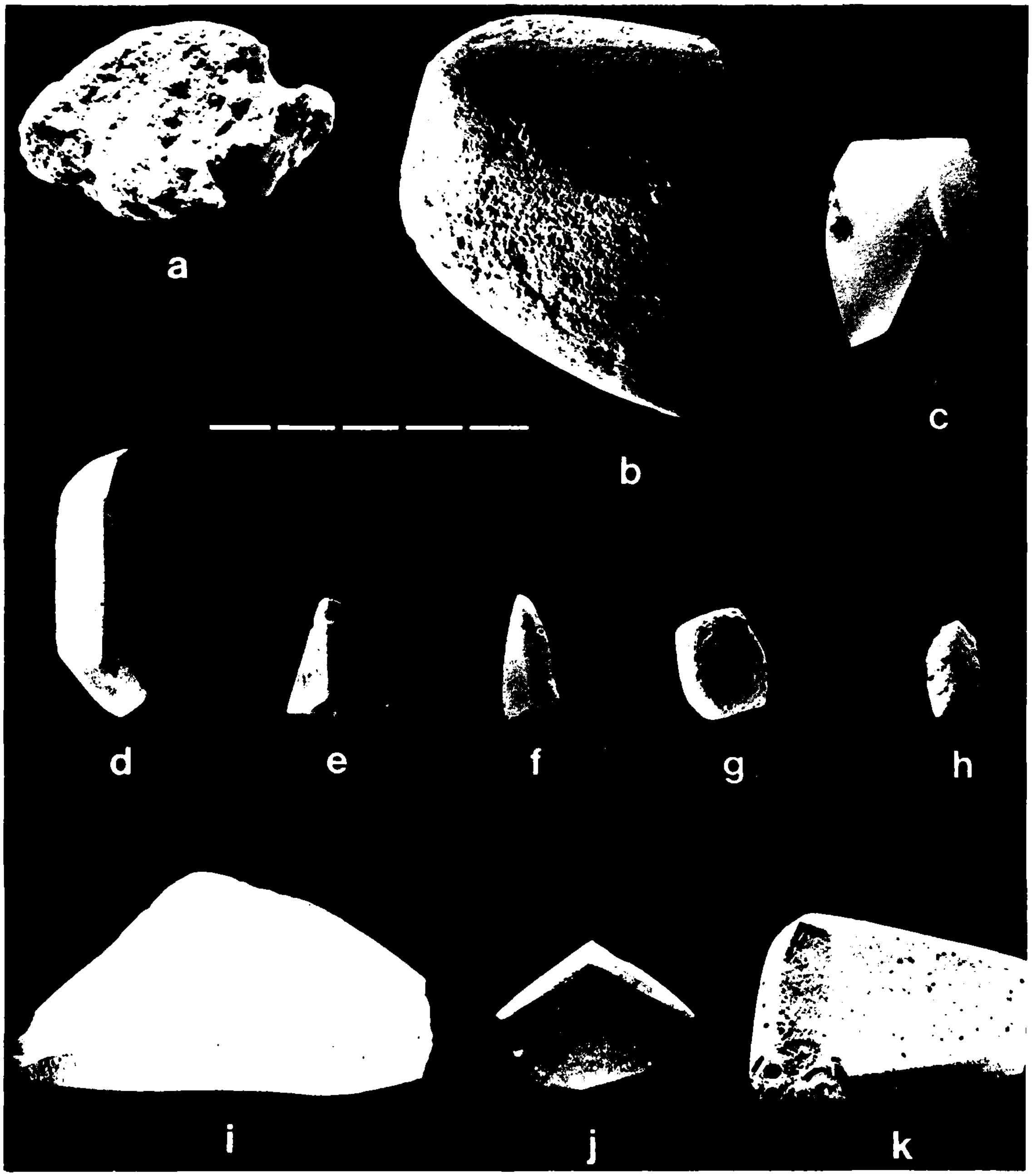

Figure 10.15. Ground and abraded forms of hematite and galena: a, unmodified hematite; c-f, faceted hematite; g-h, faceted galena; b, ground blocky hematite; i-k, ground tabular hematite. Scale in cm.

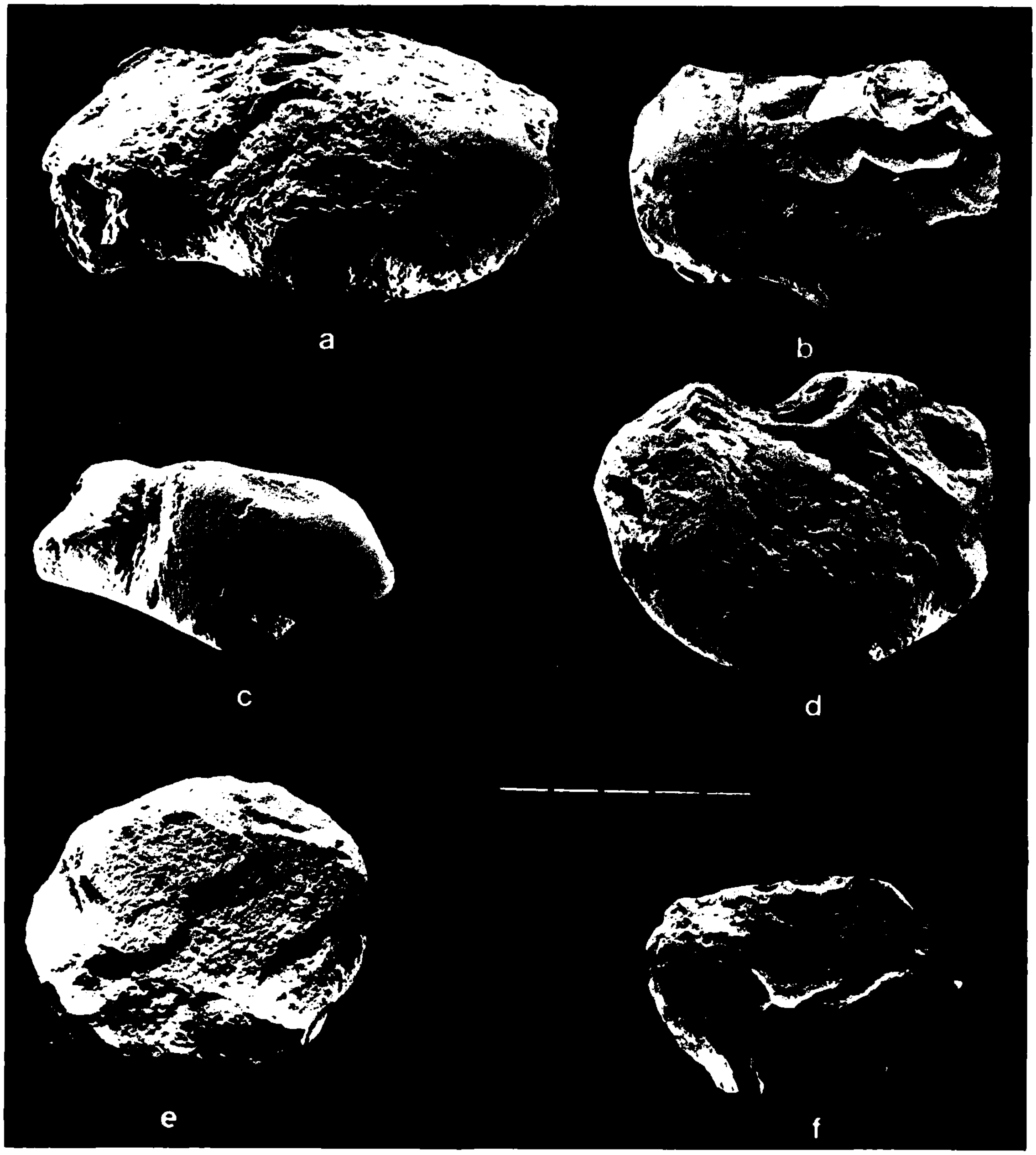

Figure 10.16. Hematite axes and hammerstones: a-d, axes; e-f, hammerstones. Scale in cm.

Figure 10.17. Hematite biface and flakes exhibiting flaking both before and after grinding: a, biface; b-f, flakes; g, potlid. Scale in cm.

TABLE 10.17

List of Contingency Tables

Two-way Tables:
- Horizon by Material
- Horizon by Size Grade
- Horizon by Hardness
- Horizon by Shape-Cultural
- Horizon by Pitting and Battering
- Ground and Abraided Shape by Horizon

Three-way Tables:
- Shape by Hardness by Material

only three tables, Horizon by Material, Horizon by Size Grade and Horizon by Hardness, produced significant chi-squares indicating that the variables are interrelated (Table 10.18).

TABLE 10.18

List of all Two-way Contingency Tables

Table	Chi-square	df	p
Horizon by Material	38.69295	22	0.0153
Horizon by Size Grade	265.74268	55	0.0000
Horizon by Hardness	123.10631	22	0.0000
Horizon by Shape-Cultural	193.69685	220	0.1019
Horizon by Pitting and Battering	20.07037	33	0.9625
Ground and Abraided Shape Groups by Horizon	67.53572	66	0.4299

Because there is a preponderance of hematite throughout all horizons, while the few limonite specimens are unevenly distributed throughout the strata, and galena is absent from Strata 3 and 4, Horizon by Material was far from random (Table 10.19). Whether or not these distributions indicate availability or cultural preference is not known and would be difficult to test on the basis of so few non-hematite specimens. However, the abundance of these minerals in the two mid-nineteenth century surveys would tend to support the hypothesis of cultural selection.

Sorting the material through a series of nested screens with decreasing mesh size, produced a size grading on the basis of the largest mesh through which the particular specimen would not pass. Examining the distribution of size grades through time (Table 10.20) resulted in a significant relationship ($\chi^2 = 265.74$; df = 55; p = 0.0). Larger specimens commonly are found in Stratum 2, with only a few from Strata 1 and 4. Because most specimens and, therefore, all size grades are from Horizons 5 through 7, the resultant table is highly patterned. It is interesting that the majority of minerals, even the apparently unmodified ones, are

TABLE 10.19

Minerals Through Time

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
    V4        HORIZON                                                 BY  V6         MATERIAL
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                     V6
             COUNT  I
           ROW PCT  IHEMATITE LIMONITE GALENA      ROW
           COL PCT  I                               TOTAL
           TOT PCT  I    16   I    17   I    18   I
V4         ---------I---------I---------I---------I
                 1  I     20  I      0  I      0  I     20
  ONE               I  100.0  I    0.0  I    0.0  I    1.9
                    I    2.0  I    0.0  I    0.0  I
                    I    1.9  I    0.0  I    0.0  I
                   -I---------I---------I---------I
                 2  I     35  I      1  I      0  I     36
  TWO               I   97.2  I    2.8  I    0.0  I    3.4
                    I    3.5  I   11.1  I    0.0  I
                    I    3.3  I    0.1  I    0.0  I
                   -I--- ----I---------I---------I
                 3  I     68  I      0  I      0  I     68
  THREE             I  100.0  I    0.0  I    0.0  I    6.5
                    I    6.7  I    0.0  I    0.0  I
                    I    6.5  I    0.0  I    0.0  I
                   -I---------I---------I---------I
                 4  I      7  I      0  I      0  I      7
  FOUR              I  100.0  I    0.0  I    0.0  I    0.7
                    I    0.7  I    0.0  I    0.0  I
                    I    0.7  I    0.0  I    0.0  I
                   -I---------I---------I---------I
                 5  I    319  I      2  I      9  I    330
  FIVE              I   96.7  I    0.6  I    2.7  I   31.4
                    I   31.6  I   22.2  I   26.5  I
                    I   30.3  I    0.2  I    0.9  I
                   -I---------I---------I---------I
                 6  I    185  I      3  I     12  I    200
  SIX               I   92.5  I    1.5  I    6.0  I   19.0
                    I   18.3  I   33.3  I   35.3  I
                    I   17.6  I    0.3  I    1.1  I
                   -I---------I-- -----I---------I
                 7  I    324  I      1  I      9  I    334
  SEVEN             I   97.0  I    0.3  I    2.7  I   31.7
                    I   32.1  I   11.1  I   26.5  I
                    I   30.8  I    0.1  I    0.9  I
           ---------I---------I---------I---------I
                 8  I     38  I      1  I      2  I     41
  EIGHT             I   92.7  I    2.4  I    4.9  I    3.9
                    I    3.8  I   11.1  I    5.9  I
                    I    3.6  I    0.1  I    0.2  I
                   -I---------I---------I---------I
                 9  I      6  I      1  I      2  I      9
  NINE              I   66.7  I   11.1  I   22.2  I    0.9
                    I    0.6  I   11.1  I    5.9  I
                    I    0.6  I    0.1  I    0.2  I
                   -I---------I---------I---------I
                10  I      6  I      0  I      0  I      6
  TEN               I  100.0  I    0.0  I    0.0  I    0.6
                    I    0.6  I    0.0  I    0.0  I
                    I    0.6  I    0.0  I    0.0  I
                   -I--- ----I---------I---------I
                11  I      1  I      0  I      0  I      1
  ELEVEN            I  100.0  I    0.0  I    0.0  I    0.1
                    I    0.1  I    0.0  I    0.0  I
                    I    0.1  I    0.0  I    0.0  I
                   -I---------I---------I---------I
            COLUMN      1009         9        34      1052
             TOTAL      95.9       0.9       3.2     100.0

RAW CHI SQUARE =    38.59386 WITH    20 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0075

NUMBER OF MISSING OBSERVATIONS =    147
```

TABLE 10.20

Mineral Size Grade Data

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * *
   V4       HORIZON                                          BY  V5          SIZE GRADE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      V5
            COUNT   I
            ROW PCT ITWO INCH ONE INCH HALF     QUARTER  EIGHTH   SIXTEENT  ROW
            COL PCT I                  INCH     INCH     INCH     H INCH    TOTAL
            TOT PCT I     2  I     3  I     4  I     5  I     6  I     7  I
V4          --------I--------I--------I--------I--------I--------I--------I
                  1 I     0  I     2  I    10  I     7  I     1  I     0  I    20
  ONE               I   0.0  I  10.0  I  50.0  I  35.0  I   5.0  I   0.0  I   1.9
                    I   0.0  I   2.1  I   3.0  I   1.8  I   0.5  I   0.0  I
                    I   0.0  I   0.2  I   1.0  I   0.7  I   0.1  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  2 I     1  I     5  I    23  I     6  I     1  I     0  I    36
  TWO               I   2.8  I  13.9  I  63.9  I  16.7  I   2.8  I   0.0  I   3.4
                    I  12.5  I   5.2  I   6.8  I   1.5  I   0.5  I   0.0  I
                    I   0.1  I   0.5  I   2.2  I   0.6  I   0.1  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  3 I     0  I    15  I    30  I    21  I     2  I     0  I    68
  THREE             I   0.0  I  22.1  I  44.1  I  30.9  I   2.9  I   0.0  I   6.5
                    I   0.0  I  15.6  I   8.9  I   5.3  I   1.0  I   0.0  I
                    I   0.0  I   1.4  I   2.9  I   2.0  I   0.2  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  4 I     0  I     0  I     3  I     4  I     0  I     0  I     7
  FOUR              I   0.0  I   0.0  I  42.9  I  57.1  I   0.0  I   0.0  I   0.7
                    I   0.0  I   0.0  I   0.9  I   1.0  I   0.0  I   0.0  I
                    I   0.0  I   0.0  I   0.3  I   0.4  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  5 I     1  I    33  I   130  I   147  I    19  I     0  I   330
  FIVE              I   0.3  I  10.0  I  39.4  I  44.5  I   5.8  I   0.0  I  31.4
                    I  12.5  I  34.4  I  38.5  I  36.9  I   9.9  I   0.0  I
                    I   0.1  I   3.1  I  12.4  I  14.0  I   1.8  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                  6 I     1  I    25  I    69  I    80  I    22  I     2  I   199
  SIX               I   0.5  I  12.6  I  34.7  I  40.2  I  11.1  I   1.0  I  18.9
                    I  12.5  I  26.0  I  20.4  I  20.1  I  11.5  I  10.0  I
                    I   0.1  I   2.4  I   6.6  I   7.6  I   2.1  I   0.2  I
                   -I--------I--------I--------I--------I--------I--------I
                  7 I     4  I    13  I    62  I   107  I   132  I    16  I   334
  SEVEN             I   1.2  I   3.9  I  18.6  I  32.0  I  39.5  I   4.8  I  31.8
                    I  50.0  I  13.5  I  18.3  I  26.9  I  69.1  I  80.0  I
                    I   0.4  I   1.2  I   5.9  I  10.2  I  12.6  I   1.5  I
            --------I--------I--------I--------I--------I--------I--------I
                  8 I     1  I     3  I     5  I    18  I    12  I     2  I    41
  EIGHT             I   2.4  I   7.3  I  12.2  I  43.9  I  29.3  I   4.9  I   3.9
                    I  12.5  I   3.1  I   1.5  I   4.5  I   6.3  I  10.0  I
                    I   0.1  I   0.3  I   0.5  I   1.7  I   1.1  I   0.2  I
                   -I--------I--------I--------I--------I--------I--------I
                  9 I     0  I     0  I     4  I     4  I     1  I     0  I     9
  NINE              I   0.0  I   0.0  I  44.4  I  44.4  I  11.1  I   0.0  I   0.9
                    I   0.0  I   0.0  I   1.2  I   1.0  I   0.5  I   0.0  I
                    I   0.0  I   0.0  I   0.4  I   0.4  I   0.1  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                 10 I     0  I     0  I     1  I     4  I     1  I     0  I     6
  TEN               I   0.0  I   0.0  I  16.7  I  66.7  I  16.7  I   0.0  I   0.6
                    I   0.0  I   0.0  I   0.3  I   1.0  I   0.5  I   0.0  I
                    I   0.0  I   0.0  I   0.1  I   0.4  I   0.1  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
                 11 I     0  I     0  I     1  I     0  I     0  I     0  I     1
  ELEVEN            I   0.0  I   0.0  I 100.0  I   0.0  I   0.0  I   0.0  I   0.1
                    I   0.0  I   0.0  I   0.3  I   0.0  I   0.0  I   0.0  I
                    I   0.0  I   0.0  I   0.1  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I
             COLUMN         8       96      338      398      191       20     1051
              TOTAL       0.8      9.1     32.2     37.9     18.2      1.9    100.0

RAW CHI SQUARE =   262.31006 WITH    50 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =    148
```

from the smaller size grades, where further grinding or pulverizing would be difficult.

Examination of hardness through time (Table 10.21) also produced a highly significant correlation ($\chi^2 = 123.11$; df = 22; p = 0.0), indicating that the full range of hardness exhibited by the minerals is not equally represented. Instead, most are softer than a hardness of 5.5, the norm for pure hematite. Either through selection, weathering, or purposeful modification such as heating, a situation has resulted favoring the more easily ground and pulverized varieties.

Horizon by Shape, examining the types of modification to the minerals for each of the horizons, produced an unacceptably low chi square ($\chi^2 = 193.7$; df = 220; p = 0.1019); the null hypothesis that there was no significant variation in mineral processing through time is accepted. The axes and the majority of the flakes of hematite originated with Horizons 5, 6 and 7, producing a pattern of special interest. All of these are the extremely hard variety of hematite, closely approaching chert in flaking characteristics. It is possible that they represent nothing beyond the utilization of an available material for some immediate task, instead of some special, temporally limited "flintworking" technique. As ground stone tools, however, hematite might well fill the gap between the harder cherts and the much softer limestones and dolomites, producing a more desirable and durable cutting edge.

One would also accept the null hypothesis in examining the few examples of pitting and battering, presumably as a result of hammering or pecking ($\chi^2 = 20.07$; df = 33; p = 0.9625); these types of wear are randomly distributed with respect to time.

The majority of the hematite and modified galena were ground or abraded, producing either a slightly rounded or flat surface. There is often more than one flat abraded surface to a specimen, resulting in wedges, prisms, or more complex pyramids. These surfaces were the result of a reciprocal motion and often are finely striated with many parallel scratches. Grinding, as it is here used, involves a rocking and rotary motion, smoothing the surface. Unlike the abraded surfaces, intersections of ground surfaces are not as sharp and distinct. While the abraded specimens tend toward prismatic or pyramidal shapes, the ground specimens are often tabular or convex. These shapes crosstabulated with time produced an insignificant chi-square ($\chi^2 = 67.53$; df = 66; p = 0.4299). Thus, we accept the null hypothesis of no difference in the grinding and abrading techniques through the entire history of the site.

As the tabular forms do not show any evidence of finishing (i.e., perforations, grooves, or notches) toward gorgets, or any other artifact type, the question arises as to why these tabular forms exist. If the goal was to produce pigment, then it is reasonable to assume that the hardness of the specimen will favor certain powder producing motor activities. To test this hypothesis, a crosstabulation (Table 10.22) of shape by hardness of material, controlling for hematite ($\chi^2 = 73.94$; df = 18; p = 0.0) conclusively demonstrates that shape and hardness are highly correlated. The majority of the faceted hematite possesses hardness less than 5.5. Because of the rather gross divisions in the hardness scale used here, the specimens in a specific group can appear either softer or harder than they really are. Although the majority of the faceted hematite falls in the range of 2.5 to 5.5, they actually are grouped nearer the softer end of the range. The converse applies for the tabular and

TABLE 10.21

Mineral Hardness

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * *
    V4         HORIZON                                              BY  V9         HARDNESS
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V9
           COUNT   I
          ROW PCT  I<2.5      2.5 TO   5.5 TO 7   ROW
          COL PCT  I          5.5                 TOTAL
          TOT PCT  I      1  I      3  I      4  I
V4        ---------I---------I---------I---------I
               1   I      4  I     14  I      2  I     20
  ONE              I   20.0  I   70.0  I   10.0  I    1.9
                   I    1.1  I    3.4  I    0.7  I
                   I    0.4  I    1.3  I    0.2  I
                  -I---------I---------I---------I
               2   I      8  I     15  I     13  I     36
  TWO              I   22.2  I   41.7  I   36.1  I    3.4
                   I    2.2  I    3.6  I    4.7  I
                   I    0.8  I    1.4  I    1.2  I
                  -I---------I---------I---------I
               3   I      9  I     47  I     12  I     68
  THREE            I   13.2  I   69.1  I   17.6  I    6.5
                   I    2.5  I   11.4  I    4.4  I
                   I    0.9  I    4.5  I    1.1  I
                  -I---------I---------I---------I
               4   I      5  I      1  I      1  I      7
  FOUR             I   71.4  I   14.3  I   14.3  I    0.7
                   I    1.4  I    0.2  I    0.4  I
                   I    0.5  I    0.1  I    0.1  I
                  -I---------I---------I---------I
               5   I     89  I    157  I     84  I    330
  FIVE             I   27.0  I   47.6  I   25.5  I   31.4
                   I   24.5  I   37.9  I   30.5  I
                   I    8.5  I   14.9  I    8.0  I
                  -I---------I---------I---------I
               6   I     73  I     87  I     40  I    200
  SIX              I   36.5  I   43.5  I   20.0  I   19.0
                   I   20.1  I   21.0  I   14.5  I
                   I    6.9  I    8.3  I    3.8  I
                  -I---------I---------I---------I
               7   I    149  I     77  I    108  I    334
  SEVEN            I   44.6  I   23.1  I   32.3  I   31.7
                   I   41.0  I   18.6  I   39.3  I
                   I   14.2  I    7.3  I   10.3  I
                  -I---------I---------I---------I
               8   I     19  I      7  I     15  I     41
  EIGHT            I   46.3  I   17.1  I   36.6  I    3.9
                   I    5.2  I    1.7  I    5.5  I
                   I    1.8  I    0.7  I    1.4  I
                  -I---------I---------I---------I
               9   I      5  I      4  I      0  I      9
  NINE             I   55.6  I   44.4  I    0.0  I    0.9
                   I    1.4  I    1.0  I    0.0  I
                   I    0.5  I    0.4  I    0.0  I
                  -I---------I---------I---------I
              10   I      2  I      4  I      0  I      6
  TEN              I   33.3  I   66.7  I    0.0  I    0.6
                   I    0.6  I    1.0  I    0.0  I
                   I    0.2  I    0.4  I    0.0  I
                  -I---------I---------I---------I
              11   I      0  I      1  I      0  I      1
  ELEVEN           I    0.0  I  100.0  I    0.0  I    0.1
                   I    0.0  I    0.2  I    0.0  I
                   I    0.0  I    0.1  I    0.0  I
                  -I---------I---------I---------I
          COLUMN        363       414       275      1052
           TOTAL       34.5      39.4      26.1     100.0

RAW CHI SQUARE =   110.18689 WITH    20 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =    147
```

TABLE 10.22

Comparison of Shape and Hardness of Hematite

```
* * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * * * *
   V25        SHAPE                                                BY  V9        HARDNESS
CONTROLLING FOR..
   V6         MATERIAL                                             VALUE..    16   HEMATITE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V9
             COUNT  I
           ROW PCT  I<2.5     2.5 TO    5.5 TO 7   ROW
           COL PCT  I         5.5                  TOTAL
           TOT PCT  I     1  I     3  I     4  I
V25        --------I--------I--------I--------I
                1  I    16  I    37  I    43  I     96
  UNKNOWN          I  16.7  I  38.5  I  44.8  I   19.5
                   I  15.0  I  16.7  I  26.1  I
                   I   3.2  I   7.5  I   8.7  I
                  -I--------I--------I--------I
                2  I    10  I    45  I    33  I     88
  TABULAR          I  11.4  I  51.1  I  37.5  I   17.8
                   I   9.3  I  20.4  I  20.0  I
                   I   2.0  I   9.1  I   6.7  I
                  -I--------I--------I--------I
                3  I    15  I    30  I    10  I     55
  FACETED          I  27.3  I  54.5  I  18.2  I   11.2
                   I  14.0  I  13.6  I   6.1  I
                   I   3.0  I   6.1  I   2.0  I
                  -I--------I--------I--------I
                4  I     0  I     1  I     0  I      1
  CONCAVE          I   0.0  I 100.0  I   0.0  I    0.2
                   I   0.0  I   0.5  I   0.0  I
                   I   0.0  I   0.2  I   0.0  I
                  -I--------I--------I--------I
                5  I     0  I     0  I     2  I      2
  CONVEX  SURFACE  I   0.0  I   0.0  I 100.0  I    0.4
                   I   0.0  I   0.0  I   1.2  I
                   I   0.0  I   0.0  I   0.4  I
                  -I--------I--------I--------I
                6  I     0  I     0  I     4  I      4
  AXE              I   0.0  I   0.0  I 100.0  I    0.8
                   I   0.0  I   0.0  I   2.4  I
                   I   0.0  I   0.0  I   0.8  I
                  -I--------I--------I--------I
                7  I     1  I     2  I     2  I      5
  BLOCKY           I  20.0  I  40.0  I  40.0  I    1.0
                   I   0.9  I   0.9  I   1.2  I
                   I   0.2  I   0.4  I   0.4  I
                  -I--------I--------I--------I
                8  I    63  I    95  I    47  I    205
  AMORPH           I  30.7  I  46.3  I  22.9  I   41.6
                   I  58.9  I  43.0  I  28.5  I
                   I  12.8  I  19.3  I   9.5  I
                  -I--------I--------I--------I
                9  I     0  I    11  I    24  I     35
  FLAKE            I   0.0  I  31.4  I  68.6  I    7.1
                   I   0.0  I   5.0  I  14.5  I
                   I   0.0  I   2.2  I   4.9  I
                  -I--------I--------I--------I
               10  I     2  I     0  I     0  I      2
  DAMAGED          I 100.0  I   0.0  I   0.0  I    0.4
                   I   1.9  I   0.0  I   0.0  I
                   I   0.4  I   0.0  I   0.0  I
                  -I--------I-------  I--------I
            COLUMN     107      221       165      493
             TOTAL    21.7     44.8      33.5    100.0

RAW CHI SQUARE =    73.93762 WITH    18 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000
```

slightly convex forms. Again, the majority fall within the 2.5 to 5.5 range, but in this case, the clustering is closer to the higher end. The shapes of modified hematite are determined by hardness, this suggests that there was no real difference in the purpose of these modifications; namely, to produce powder for use as pigment. Pigment production as defined by ground and abraded shapes, through time, shows consistent patterning ($\chi^2 = 67.5$; df = 66; p = 0.42), though it is a primary extractive activity in the Early and Middle Archaic strata.

SUMMARY AND CONCLUSIONS

1. Modification of minerals from Rodgers Shelter has taken several forms. Most worked hematite and all utilized galena exhibit a reduction grinding process to produce powder, presumably for use as a pigment. Depending upon the hardness of the mineral, grinding produces either faceted or slightly convex surfaces, resulting in simple geometric, tabular, or slightly convex forms. Galena and the softer forms of hematite are easily abraded, producing one or more extremely flat surfaces, or facets. The intersection of these surfaces is generally sharp and distinct. Harder varieties of hematite (approaching a hardness of 5 to 5.5) are not as easily abraded. As a consequence, these varieties will often produce convex instead of flat surfaces during abrasion. Instead of the sharp intersections of the faceted specimens, these edges are usually round, or otherwise distinct.

2. Differences in shape are attributable to the mechanics involved in grinding. As a softer piece is abraded, relatively greater amounts of powder are produced when compared to harder forms, making it easier to maintain a single orientation necessary to produce a flat surface. Because the harder hematite would produce less powder than the softer varieties for a given grinding stroke, it is inferred that a longer arc of movement is needed. Maintaining only one orientation during grinding would be further hindered, increasing the likelihood of convex over faceted surfaces. Thus, there is a tendency for galena and softer hematite to exhibit faceting while harder hematite generally occurs as blocks or tabular shapes.

3. In addition to the grinding, several specimens, both of hematite and galena, possess deep grooves scratched into their surfaces. This gouging is quite likely another method of obtaining pigment. Either a hard pointed gouge or a sharp flake was used to score the material, producing the powder (Wyckoff 1964:85).

4. Some of the harder forms of hematite, possessing almost chert-like fracture qualities have been flaked into a desired shape. In a few cases this is in conjunction with pecking and/or grinding to produce cutting tools, including full grooved axes. Several bifacially flaked specimens were extensively ground, either as preforms for some ground stone tool or reused as a source of pigment powder. In some cases, flaking followed extensive grinding, possibly representing a pigment source that was utilized as some type of tool.

5. Yet another form of utilization, battering from use as a hammerstone, is found on a minority of the hardest hematite specimens. Because

they are only slightly softer than chert, they would have been well suited to flintworking. Also, as chert hammers may have been too hard to optimally work hematite, these hematite hammers may be responsible for the flaked hematite.

6. The thermally fractured hematite, although few in number, testifies to a potentially intentional application of heat. Dragoo (1963:129-130) posits employment of heat treatment techniques to enhance the color and possibly to soften the material. At Rodgers Shelter, the presence of a large number of very soft and highly oxidized hematite lends support for such a technique.

7. The relative absence of galena from the collection is interesting as mineral surveys in the area during the 1860's and 1880's identified large supplies of this mineral on the surface. Because availability should not have been a problem disinterest with galena as a pigment source is suggested in the Late Archaic and Woodland horizons.

VI. GROUND STONE

Christine K. Robinson

Traditionally, ground stone refers to stone implements either manufactured by or used in a grinding, rubbing-abrading process. Ground stone includes a wide variety of tools which stylistically are not as sensitive as chipped stone points or ceramics. However, Woodbury (1954) notes that some ground stone artifacts, particularly manos, metates and axes, are, at times, culturally diagnostic.

Research at Rodgers Shelter has dealt primarily with modeling man-land relationships over the last 10,500 years. Functional description of some ground stone implements by McMillan (1971) and by Ahler and McMillan (1976) has been important in assessing activities of Rodgers Shelter's prehistoric occupants. Our objective is to further refine the ground stone activity sets or indicators presented in previous work through examination of the complete inventory of ground stone. Specifically, this study develops data about manufacturing techniques, functional and morphological characteristics of ground stone at Rodgers Shelter and its use through time.

METHODOLOGY

The ground stone sample includes all artifacts and a substantial number of natural rock specimens excavated from Rodgers Shelter. Most were recovered from 1963-1968. All potential ground stone was sorted into four provisional categories: (1) Implements that could have been comfortably manipulated in the hand (hand held); (2) tools that, due to their size and bulk, would have had to remain stationary in order to be used; (3) tool fragments and assorted tabular pieces of ground stone tools; and (4) natural rock debris, primarily sandstone, which show no modification attributed to cultural activity. The hand held, stationary and fragmentary tool groups were further subdivided into pitted and non-pitted categories. The pitted specimens were set apart by the presence of intentionally modified pits, or depressions, as a result of either a manufacturing process or actual use. Data (Table 10.23) were computer coded in five areas: (1) manufacture, (2) use wear, (3) morphological features, (4) vertical and horizontal provenience, and (5) techno-functional class.

For the most part, analysis of manufacture and use wear was based on macroscopic observation. Nominal, ordinal and interval scale observations follow. However, a binocular microscope at low powers (10x - 30x) was used selectively to differentiate actual use wear from merely a natural surface which simulated use wear (i.e., natural facets or striations). Since a large portion of the sample is of naturally transported cobbles as well as tabular sandstone fragments, samples of these materials were collected for comparison. The comparative samples are from sources within the Rodgers Shelter locale where we are reasonably sure that they were not associated with any cultural activity; present-day stream beds, sandstone outcrops and hillslopes served as collecting areas.

Microscopic examination was invaluable as well for sorting items with residual hematite from staining that simulated mineral residues, particularly on sandstone. Sandstone from the Rodgers Shelter locale will oxidize and acquire an orange-red cast which, to the naked eye, is very difficult to distinguish from residual hematite. Microscopic examination revealed that, in cases of hematite staining, minute fragments of the mineral adhere to the surface. Small amounts of residual hematite were noted also as questionable on specimens which could have been the result of damage in storage.

Figure 10.18, a hypothetical ground stone implement, illustrates descriptive terminology applying to manufacture and wear of Rodgers Shelter ground stone. Figure 10.19 illustrates coded shape categories, potentially important in defining mental templates used in the procurement and/or manufacture of specific tools, as functional and stylistic requirements for specific tools are prime controlling factors in overall shape.

Interval scale measures of mass include maximum length, width, thickness (recorded to the nearest mm), weight (to the nearest gm) and volume (to the nearest ml). And specimens were preliminarily sorted by size-grade (from 3" to 0.25") as well. Data on hardness, location, number, shape and relation of pits and utilized faces were coded also for both hand held and stationary ground stone tools. These data are important both for description and for understanding the function(s) of hand held and stationary pitted ground stone tools. For instance, the function of hand held ground stone implements posed a particularly vexing problem to other researchers. Suggested functions of the pits exhibited on these tools include: finger grips for pounding stones (Rohn 1971:210), as receptacles for unground seeds and grain in the grinding process (Waugh 1916:59), as finger grips when the lateral edges of a mano serve as the primary working surfaces of the tool (Greenwood 1969:18-19) and as anvils involved in bipolar flint knapping (Mac Donald 1968:67).

The relation of striations to one another and to the long axis of the specimen was included to determine the direction, or directions, of tool use. A primary distinction was made between striations in a single direction and random striations on an implement indicative of several different motions. Also noted was the extent of wear, or the maximum area, with respect to the descriptive terminology in Figure 10.18, on which various wear types could be observed.

TABLE 10.23

Morphological and Wear Features

Feature	Hand Held N	Hand Held %	Stationary N	Stationary %	Fragments N	Fragments %
Size grade						
3"	23	10.6	54	93.1	52	21.0
2"	145	67.7			76	30.9
1"	48	22.2	4	6.9	104	42.3
½"					12	4.9
Weight						
50-1280 gm	121	100.0				
Volume						
30-530 ml	X	X				
Maximum length						
45-184 ml	X	X				
Maximum width						
20-115 ml	X	X				
Maximum thickness						
15-85 ml	X	X				
Overall shape						
Ovate	--	35.0	1	---	*	*
Amorphous	--	27.0	15	51.7	*	*
Subtriangular	--	19.7	1	---	*	*
Circular	--	5.8	1	---	*	*
Subrectangular	--	10.2	8	27.6	*	*
Squared	--	2.2	2	6.9	*	*
Triangular	--	---	1	---	*	*
Too fragmentary	79	36.6	29	50.0	*	*
Shape in long section						
Plano convex	--	31.0	--	3.5	--	3.2
Bi-convex	--	24.1	--	1.8	--	3.8
Bi-plano	--	20.1	--	78.9	--	73.7
Concave-convex	--	13.3	--	1.8	--	2.7
Plano-concave	--	7.0	--	10.5	--	13.4
Airfoil	--	3.8	--	3.5	--	1.6
Bi-concave	--	---	--	---	--	1.6
Too fragmentary	--	26.9	--	---	--	---
Shape in cross section						
Bi-convex	--	34.4	--	1.7	--	1.8
Bi-plano	--	25.4	--	66.7	--	79.5
Plano-convex	--	17.5	--	7.0	--	1.8
Concave-convex	--	12.7	--	---	--	1.8
Airfoil	--	7.4	--	7.0	--	3.1
Plano-concave	--	2.6	--	17.5	--	10.7
Bi-concave	--	---	--	---	--	1.3
Too fragmentary	--	12.7	--	---	--	---

* Observation not made, original shape nonassessable

TABLE 10.23 (concluded)

Feature	Hand Held		Stationary		Fragments	
	N	%	N	%	N	%
Pit 1 depression location						
Unifacial	--	64.6	--	69.2	--	73.3
Bifacial	--	29.3	--	20.5	--	5.1
Trifacial	--	3.7	--	5.1	--	---
Total number of Pit 1 depression						
1	--	63.4	--	49.0	--	73.3
2	--	28.0	--	15.4	--	13.3
3	--	6.1	--	7.7	--	---
4	--	---	--	10.3	--	---
Pit 1 depression relation						
Multiple	27	32.9	13	---	--	---
Opposing	22	81.5	9	---	2	---
Adjacent	5	18.5	4	---	--	---
Pit 1 depression shape						
Irregular	19	23.5	2	5.1	**	**
Rounded	28	34.6	22	56.4	**	**
Oval	12	14.8	9	23.1	**	**
Grooved	1	1.2	--	---	**	**
Irregular-round-oval	21	25.9	6	15.4	**	**
Used face location						
Unifacial	148	80.4	30	51.7	183	76.9
Bifacial	30	16.3	26	44.8	55	23.1
Trifacial	5	2.7	2	3.4	--	---
Quadrifacial	1	0.6	--	---	--	---
Total number of utilized faces						
1	149	81.9	30	51.7	183	74.4
2	30	16.5	26	44.8	55	22.4
3	3	1.6	2	3.4	--	---
4	2	1.1	--	---	--	---
Used face relation						
Opposing	25	71.4	27	46.6	54	98.2
Adjacent	10	28.8	--	---	1	1.8
Relation pit to use						
Same face	51	87.9	25	64.1	9	64.3
Opposing	6	10.3	--	---	--	---
Adjacent	1	---	--	---	1	---
Same and opposite	--	---	14	35.9	4	28.8

**Could not be observed

A final consideration is that a substantial number of ground stone surfaces exhibit residual hematite. McMillan (1971) and Ahler and McMillan (1976) posit that hematite processing became an important industrial activity at Rodgers Shelter from 7000-6300 B.P. (see also this chapter, V.). The ground stone artifacts were examined for residual materials, including hematite staining, in order to determine what role

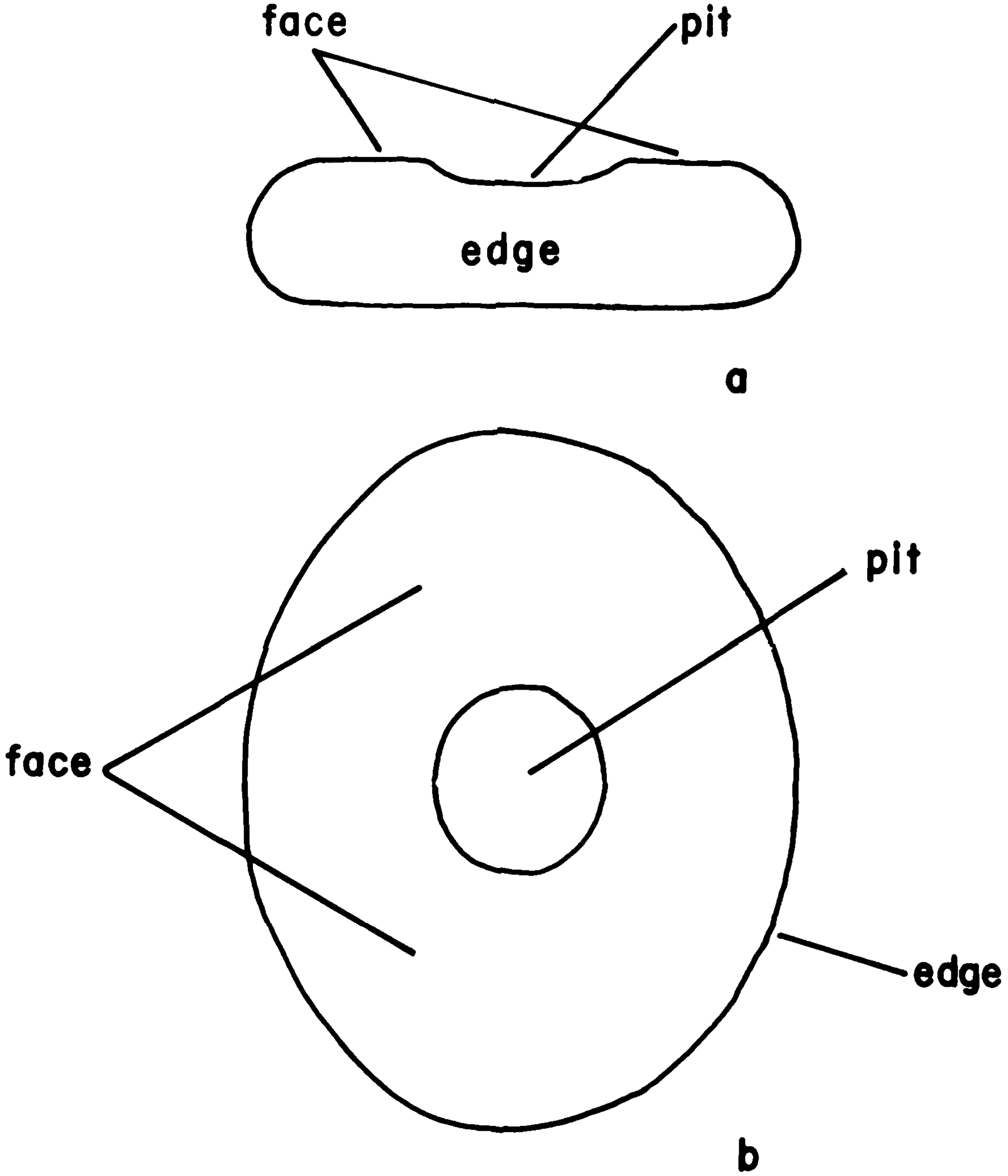

Figure 10.18. A hypothetical ground stone specimen illustrating descriptive terminology: a, longitudinal section; b, planar view.

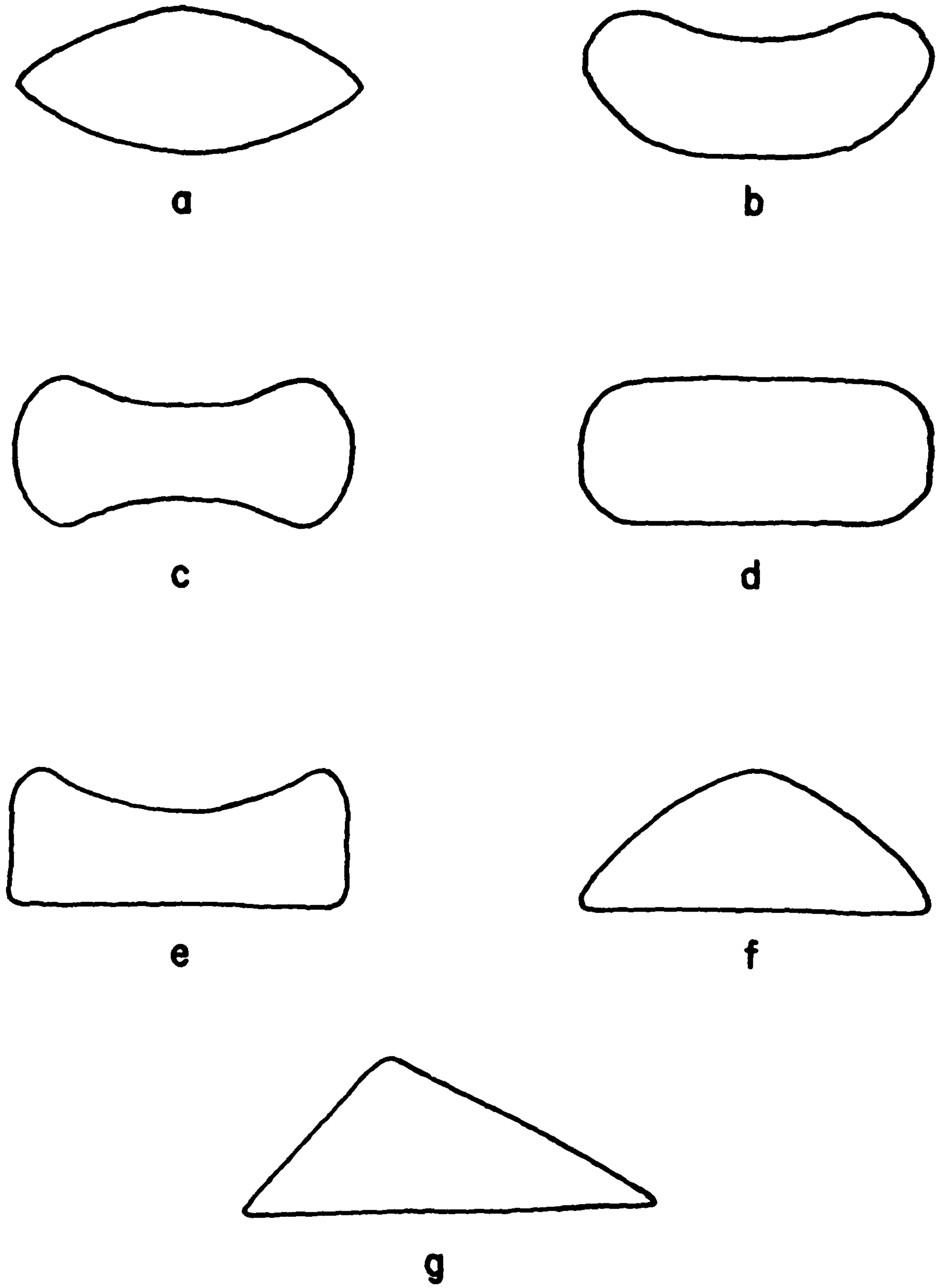

Figure 10.19. Shape categories for longitudinal and cross section observations: a, Biconvex; b, Concave-convex; c, Biconcave; d, Biplanar; e, Plano-concave; f, Plano-convex; g, Airfoil.

ground stone tools may have played in hematite processing activities.

Considering all observations, techno-functional categories, or classes, are proposed for the ground stone artifacts. Principal components analysis is used to assess these provisional categories for Rodgers Shelter as a whole.

SAMPLE DESCRIPTION

A total of 994 specimens are included in this study; consisting of 529 ground stone artifacts and 465 specimens of natural rock debris. Of the 529 ground stone specimens are 216 (40.8%) hand held implements, 58 (11.0%) stationary items, 9 (1.7%) axes and 246 (46.5%) ground stone fragments. The hand held tool group consists of 82 (38.0%) pitted and 134 (62.0%) non-pitted tools of variable shape. Ovate, amorphous or subtriangular forms are most common with plano-convex, biconvex and biplano cross sections. Stationary ground stone implements are composed of 39 (67.2%) pitted and 19 (32.8%) non-pitted items. Complete specimens are amorphous and generally unstylized but an occasional subrectangular or square form occurs as well. Stationary items are mainly biplano in cross section, as are the fragmentary specimens. Among the fragments, only 15 (6.1%) were pitted. Most of the ground stone has a single utilized face although stationary specimens with two used faces occur in about equal frequency, and the faces are usually opposing. Similarly, the location of pitted surfaces is primarily unifacial though both bifacial and trifacial pitting occurs. Although the number of pits ranges from one to five, most specimens have but one. Where multiple pits occur, they are mainly on opposing faces.

Ahler and McMillan (1976) describe and illustrate an engraved ground stone plaque and an atlatl weight; these two items and a limestone gorget from midden deposits are not further considered in this study.

Ground stone artifacts are either surface, general midden, or are provenienced to excavation units in the main excavation and shelter area (Fig. 3.2). Surface and general midden specimens include 43 hand held implements, 15 stationary items, and 25 ground stone fragments. Figure 10.20 summarizes the total occurrence of provenienced ground stone, including ground stone axes. With respect to this figure, hand held items have a bimodal distribution with peaks in the Late Archaic and Woodland horizons 1-3 (37.0% of all hand held tools) and in the Early and Middle Archaic horizons 5-7 (56.0%). A similar bimodal curve, however, is not evident for either stationary or fragmentary ground stone, which have their highest frequencies in the Early and Middle Archaic horizons 5-7 (respectively, 79.1% and 85.5%). Axes occur only in the Early and Middle Archaic horizons.

Rodgers Shelter ground stone material types include chert, dolomite, sandstone, limestone and cottonrock. In hand held tools, sandstone composes the largest (40.3%) portion of the sample. Assorted chert lithologies follow in frequency at 36.6%. Burlington chert, at 13.9%, is the most common chert lithology. Dolomite composes 19.9% of the total hand held sample; limestone and cottonrock occur in low frequencies. Stationary implement group lithologies include cherts, dolomite, sandstone and limestone. However, stationary tools are predominately constructed of dolomite (56.9%) and sandstone (34.5%). In the fragmentary group, most of

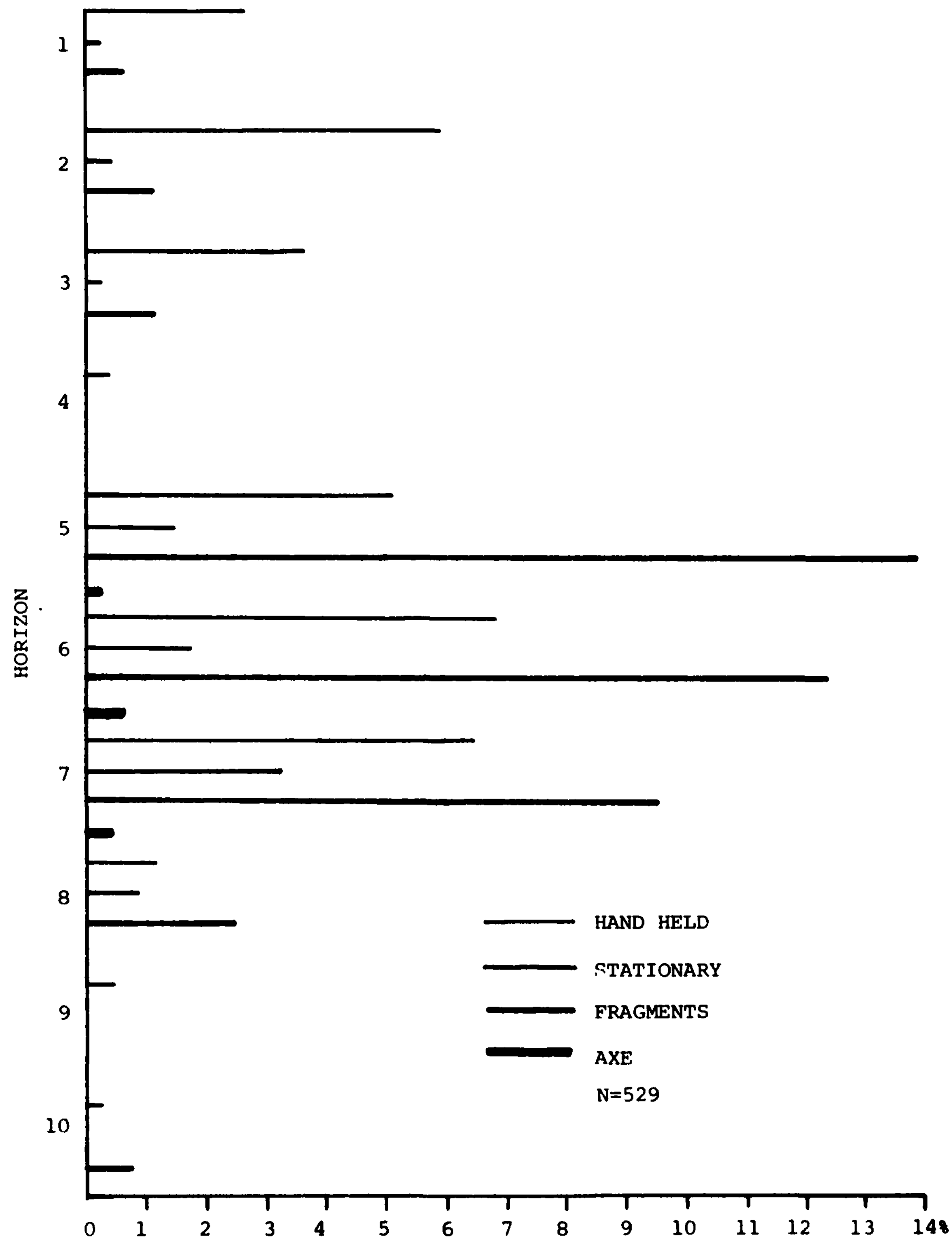

Figure 10.20. Distributions of Rodgers Shelter ground stone, not included are unprovenienced items including 42 (8.1%) hand held, 15 (2.8%) stationary, 25 (4.7%) fragments and 3 (0.6%) axes.

which are probably some sort of stationary implements, a similar pattern emerges with sandstone (79.7%) and, to a lesser extent, dolomite (19.8%) in highest frequency; oolitic chert (7.3%) also is an important component. Table 10.24 summarizes the lithologies present in all three groups.

All of these raw materials are presently available within the Rodgers Shelter locale. Five bedrock sources of quartzite and Jefferson City chert types are within 0.4 km above the site. Other raw material sources include the hillslope residuum and the Pomme de Terre River south of the site. Other materials, such as dolomite, occur at the site while sandstone occurs in the hillslope residuum and in the river.

Specimen origin is dichotomized between river gravels and raw materials obtained from other sources such as the hillslope residuum or bedrock outcrops. Patination is the primary distinguishing factor in determining specimens from a river source. In the hand held ground stone tool group, river source materials contribute 41.2% of the hand held sample. However, in the stationary and fragment groups, river source materials compose only 5.2% in the stationary sample and 1.4% in the fragments. Of the entire sample, only 8.5% are from a river source. These differences in raw material choice and hardness (discussed next) may be a reflection of preferences for specific materials chosen for their durability and suitability for specific tasks.

Measured on a medofied Moh's scale of hardness (i.e., from 1 through 7), the majority (72.2%) of the hand held implements have a hardness of >7. The next most frequent hardness is <2.5 at 14.8%. The remaining 12.9% range from >2.5 to <7. Among stationary items, 86,2% fall between >5.5 and >7 (at 44.8% [>5.5, >5.5, >7] and 41.4% [>7]. The next highest occurrence observed is 12.1% at hardness <2.5. The remaining cases fall at 1.7% for hardness of >2.5, <5.5, >3<5.5. In the fragmentary group, 89.9% of the sample has hardness of >7; from >2.5 to <7 are 5.6% and 4.5% fall below <2.5.

MANUFACTURE

Of the total sample of hand held ground stone implements, 134 (62.0%) do not exhibit any form of pitting or pit manufacture. In the remaining 82 pitted specimens, 68.3% show evidence of pecking, 1.2% exhibit grinding-striating, 4.9% appear to have natural pits that showed use wear and 24.4% are indeterminate due to use wear or material type. Among the stationary group, 19 (32.8%) of the specimens are not pitted. Of the remaining 39 implements, 71.8% show evidence of pecking, 2.6% have natural pits which had been used and in 25.6% of the cases manufacture was indeterminate due to use wear or the material type. Only 15 (7.1%) specimens in the fragmentary group exhibited pits. Twenty-six and seven tenths percent showed pecking, 33.3% exhibited usage of a natural pit and 33.3% could not be judged due to use wear or the material type. Table 10.25 summarizes pit manufacture in the total ground stone sample.

The faces of Rodgers Shelter ground stone tools do not exhibit any other type of manufacturing or maintenance techniques other than pecking. But it is difficult, if not virtually impossible, to establish whether the face of an implement had been initially pecked prior to use or if the pecking served as a maintenance technique during the use of the tool. Specimens of soft dolomite or cottonrock are very susceptible to excavation and storage damage. Also on surfaces which exhibit use wear, the manu-

TABLE 10.24

Lithological Summary of Rodgers Shelter Ground Stone Tool Categories

	Hand Held			Stationary			Fragments		
			Cumulative			Cumulative			Cumulative
Lithological Type	N	%	%	N	%	%	N	%	%
Quartzite									
Oolitic chert	19	8.8	9.3	3	5.2	5.2	18	7.3	7.7
Banded chert	9	4.2	13.4	-	---	---	1	0.4	8.1
Burlington chert	30	13.9	27.3	1	1.7	6.9	-	---	---
River gravel	2	0.9	28.2	-	---	---	-	---	---
Other chert	16	7.4	35.6	-	---	---	4	1.6	9.8
Chouteau chert	2	0.9	36.6	-	---	---	-	---	---
Dolomite	43	19.9	56.5	33	56.9	63.8	24	9.8	19.5
Sandstone	87	40.3	96.8	20	34.5	98.3	196	79.9	99.2
Limestone	2	0.9	97.7	1	1.7	100.0	-	---	---
Cottonrock	5	2.3	100.0	-	---	---	2	0.8	100.0

TABLE 10.25

Pit Manufacturing Techniques

Manufacture Type	Hand Held N	Hand Held %	Stationary N	Stationary %	Fragments N	Fragments %
Natural but used	4	4.9	1	2.6	5	33.3
Pecked	55	67.1	28	71.8	5	26.7
Ground-striated	1	1.2	-	---	-	---
Undetermined	21	25.6	10	25.6	6	40.0

facturing and utilization processes tend to blur beyond recognition. Of the hand held ground stone tools, only 30 (13.9%) specimens are pecked on the working face of the tool. Similarly, among the stationary specimens, 36.2% are pecked while the majority (63.8%) do not exhibit this manufacture-maintenance technique. The vast majority (225 or 91.5%) of the fragments are not pecked, the remaining 8.5% of the sample does exhibit pecking. Table 10.26 summarizes face manufacture or maintenance techniques.

TABLE 10.26

Ground Stone Face Manufacture and Maintenance

Face Manufacture Type	Hand Held N	Hand Held %	Stationary N	Stationary %	Fragments N	Fragments %
None	186	86.1	37	63.8	225	91.5
Pecked	30	13.9	21	36.2	21	8.5

Of the hand held ground stone tools, 94.4% of the specimens show no evidence of edge manufacturing techniques. Five (2.3%) specimens are pecked, one (0.5%) shows a grinding-striating process. Edge manufacturing techniques are indeterminate in 2.8% of the cases. Similarly, of the stationary tools only five specimens (8.6%) are edge ground and one specimen (1.7%) exhibits edge chipping, two specimens (3.4%) are indeterminate. For 236 (95.9%) fragmentary items, edge observations either could not be taken or showed no evidence of edge manufacture. Only one artifact (0.4%) is edge chipped and nine are indeterminate. Table 10.27 summarizes these data for the sample.

In sum, manufacturing and maintenance activities were rudimentary other than in cases in which pits or axes were created, and largely resulted in stylistically indistinctive utilitarian implements. Of the total number of specimens in the sample that exhibited pits, 64.0% are pecked. Only 13.8% of the total number of specimens show evidence of face manufacturing and maintenance activities in the form of pecking. Edge manufacturing activities are reflected in only the axes and 13 (2.5%) other ground stone tools from Rodgers Shelter.

TABLE 10.27

Summary of Ground Stone Edge Manufacture

Edge Manufacture Type	Hand Held N	Hand Held %	Stationary N	Stationary %	Fragments N	Fragments %
None	204	94.4	50	86.2	236	95.9
Pecked	5	23.1	-	---	-	---
Ground-striated	1	0.4	-	---	-	---
Ground	-	---	5	8.6	-	---
Chipped	-	---	1	1.7	1	0.4
Undetermined	6	2.8	2	3.4	9	3.7

USE WEAR

Figure 10.21a-e depicts five basic wear types that either occur singly or in combination on the implements in this study. The five wear categories are discussed below:

(a) *Marred.* Surface is scarred by irregularly spaced, small, deep, elongated divots or grooves.

(b) *Ground.* Surface is generally smoothed and may assume a number of states depending on the raw material from which the implement was constructed. In cherts, the surface is very smooth and quite often the cortex has been altered by grinding or rubbing so that the color and texture of the cortex appears to have been worn away. It is not unusual to see cherts that have developed a very high sheen or polish as a result of use, although it remains undetermined if this is a function of the duration of use or the materials that were being worked with the implement. In sandstone and granular dolomites, a ground surface is again characterized by a general smoothing. Winters (1969:61) notes the "erosion of the edges of minute, natural pits on the same surfaces, so that the edges become square rather than rounded as they are in the natural state." This condition also characterizes Rodgers Shelter ground stone surfaces.

(c) *Striated.* Striated surfaces are characterized by relatively shallow grooves which are often localized to selected areas of the worked surface. Striations are in appearance most similar to pin scratches.

(d) *Battering.* Battered surfaces are most often encountered on the edges of ground stone tools. Battering is used here in the same sense as for hammerstones, i.e., a wear type defined by a general crushing and subsequent rounding of an edge or prominence.

(e) *Polished.* Polished surfaces have a glossy sheen that reflects light. This wear type may be easily confused with highly smoothed surfaces of patinated river gravels (Fig. 10.21g) except that use wear polish is often associated with other kinds of use wear.

Of the 82 pitted, hand held implements, 43 (52.4%) exhibit pit use wear, including marred (2.3%), ground (93.0%), polished (2.3%), as well as marred and ground (2.3%). Thirty-three (40.2%) have no evidence of pit use wear and six (7.3%) are indeterminate. Among the 39 pitted or depressed stationary items, 31 (79.5%) are worn and 8 (20.5%) are indeterminate. Pit wear includes ground (77.4%), ground-striated (9.7%), ground-

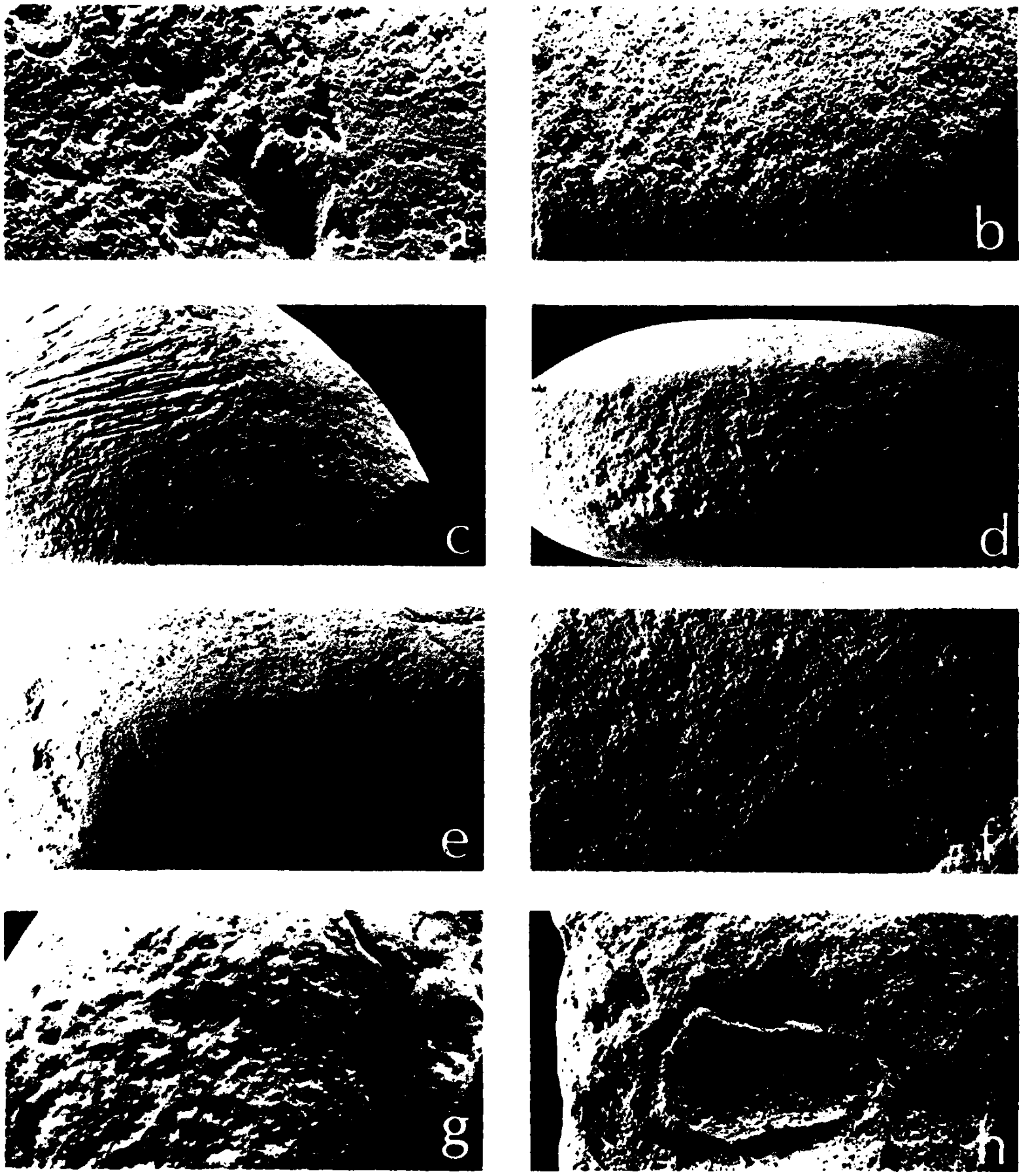

Figure 10.21. Basic wear types observed in Rodgers Shelter ground stone tools and natural rock surfaces observed in comparative sample: a, marring; b, ground; c, striated; d, battered; e, polished; f, natural surface of a water worn stream cobble; g, natural patination on river gravel; h, natural surface of tabular, non-riverine sandstone slab.

polished (9.7%), and ground-striated-polished (3.2%). Of the 15 pitted or depressed fragments, 13 (86.7%) are worn; pit wear on the remaining two is indeterminate. Wear types include ground (69.2%), marred-ground (15.4%) and ground-striated (15.4%).

Only 14.4% of the hand held tools have no evidence of face use wear or are observed to have marred, ground-striated, battered and polished faces, either singly, or in various combinations. Over one-half (56.9%) of these specimens exhibit ground wear. Marred, striated and battered wear as well as their combinations comprise the rest of face wear on hand held tools. Of the stationary ground stone group, 32.8% exhibit no use wear or are unclassifiable; 20 specimens (34.5%) have ground faces only; singly marred and striated surfaces occur in low frequencies (3.4% and 1.7%); polish occurs in combination with ground, marred and striated wear; multiple use wear comprises 28.6% of the sample. The fragmentary group has 19 (7.7%) specimens with no observable or unclassifiable face wear. Two hundred twelve (86.2%) fragmentary tools have ground faces only while 6.1% have combinations of the single wear types, marred, striated and polished.

In contrast, edge wear is highly limited. The hand held ground stone includes 146 (67.6%) specimens having no edge wear. Another ten (4.6%) were indeterminate. Fifty-one specimens (23.6%) have some sort of battering either by itself or in combination with another wear type. The remaining specimens (4.2%) have marred, striated and ground edge wear occuring singly or in combination with another or with polishing. Stationary items exhibit no identifiable edge wear—93.1% showing no edge wear, 6.9% being unclassifiable. Among the fragmentary group, 244 (99.2%) specimens were too fragmentary or were constructed of a material where wear type could not be identified. Battering on two (0.8%) specimens is the only wear observed among the fragments.

Unfortunately, a similarly small number of specimens have observable striations. Hand held ground stone specimens include 186 (86.1%) that exhibit no striations. Among the 30 (13.9%) striated specimens, 17 (7.9%) have parallel striations and 13 (6.0%) showed random striations. Respective to the long axis of the tool, these striations include 23.3% parallel, 20.0% perpendicular, 16.7% oblique and 36.6% random; the orientation of striations to the long axis of one specimen could not be identified. Fifty (86.2%) of the stationary sample have no striations. The remaining eight (13.8%) include four each with parallel or random striations. Only 11 (4.4%) of the fragmentary specimens are striated of which seven (2.8%) are parallel and four (1.6%) are random.

Similarly, 13.8% of striated surfaces in the stationary ground stone are oriented to the long axis of the specimen with 12.5% parallel, 25.0% perpendicular, 50.0% random and 12.5% random-oblique. Striations, with respect to the longest dimension observed on fragmentary specimens are parallel (18.1%), perpendicular (18.1%), oblique (18.1%), random (36.4%) and parallel-oblique (9.1%).

With respect to hand held items, only 58 (28.6%) specimens are worn on a pit or pit periphery, or to the center of the face of non-pitted items; wear extending just to the edges of a face totaled 128 (63.1%); 17 (8.4%) have wear extending across a face onto one or more edges; 13 (6.0%) specimens are too fragmentary for observation.

MINERAL RESIDUES

Of the hand held tools, 140 have neither weathering nor mineral residues. Forty-three (19.9%) are either oxidized or encrusted with calcium carbonate. Twenty-eight (13.0%) have residual hematite and/or limonite and five (2.3%) are both weathered and stained with hematite/limonite residues. Similarly, 30 (51.7%) of the stationary specimens have neither weathering nor mineral residues. Three (5.2%) have calcium carbonate or oxidation and 18 (31.0%) have hematite or limonite staining; seven others (12.1%) have both. In contrast, 86 fragments (35.0%) are stained with hematite and/or limonite. Eight-seven (35.4%) are neither weathered nor hematite impregnated. Seventy-three (29.7%) are encrusted with calcium carbonate and/or are oxidized.

TECHNO-FUNCTIONAL CLASS

Hand Held:

Ten provisional techno-functional classes categorize most of the 216 hand held ground stone artifacts and include five classes of possible multiple utilization:

1. *Unclassified.* Twenty-nine (13.4%) specimens are unclassified. This group mainly consists of pitted specimens which exhibit no use wear and modification was limited to pit construction. These artifacts may represent hand held preforms which had never been used but, in view of the other hand held tools, they probably represent finished tools which were never used or were used for an unknown function.

2. *Grinding stones/manos.* Twenty-four (11.1%) exhibit resharpening of the working surface in the form of pecking. The primary use wear is grinding although some specimens are striated and polished. The ground faces also exhibit resharpening in the form of pecking. Wear on these tools generally encompasses the entire face and in some instances extends onto the edges of the tool. Utilized faces may be convex or planar and exhibit both the presence or absence of pits.

3. *Rubbing stones.* One hundred eleven specimens are similar but lack pecking as a resharpening process. The raw materials of both manos and rubbing stones are generally hard and abrasive.

4. *Anvils.* Ten (4.6%) specimens exhibit pitted surfaces that differ from those in grinding and rubbing stones insofar as the pits are very irregular in shape; primary use wear is marred, usually concentrated near the center of the face. Small areas of grinding, striations and/or polish are observed in some specimens. The raw material ranges from very soft cottonrock to harder rock.

5. *Abraders.* Eleven (5.1%) specimens consist of grooved specimens as well as items of abrasive sandstone with one or more flat surfaces which also would have been suitable for this purpose.

The remaining twenty-six hand held specimens have the morphology and wear of combinations of these five techno-functional classes and are classed as possible multiple use tools.

6. *Hammerstones.* Five (2.3%) specimens exhibit extensive battering on the edges of the tool as well as use wear characteristics of ground

stone tools. They are multiple use tools.

7. *Grinding stone-anvils* compose 0.5% of the total hand held specimens.

8. *Grinding stone-hammerstones* 2.3%.

9. *Rubbing stone-hammerstones* 8.8%.

10. *Rubbing stone-anvil and hammerstone*, one tool (0.5%).

Figures 10.22, 10.23 and 10.24 illustrate hand held ground stone tools from Rodgers Shelter.

Stationary:

Thirteen techno-functional classes are represented.

11. *Hematite processing slabs.* Fourteen (21.4%) specimens are tabular sandstone fragments of varying thickness, with ground and occasionally polished and striated surfaces. Utilized faces may occur unifacially or bifacially and are stained with hematite residues.

12. *Large ground slab.* One (1.7%) specimen is a tool similar to hematite processing slab in wear, shape and material composition but lacking hematite staining. Generally, ground slabs are fragmentary tools.

13. *Large grinding slabs.* Three (5.2%) specimens are similar to ground slabs with the exception that the other working surfaces are resharpened by pecking.

Other single-use tools include 16 (27.¢%) cupstones, three (5.2%) metates, two (3.4%) large anvils, and a single (1.7%) mortar:

14. *Cupstones* include stationary items, usually of sandstone or dolomite, with one or more small circular depressions worn into one or more faces of the tool. These tools have also been called nutting stones.

15. *Metates* are stationary tools with an oval depression, open at one or both ends, worn into one face. In some specimen, areas of polish and striations can be observed both in the depression and the faces of the tool.

16. The *mortar* is a large stationary sandstone item with a single large depression worn in one face. The perimeters of the depression enclose the area and the ground surface extends over the sides of the depression onto the face of the tool.

The remaining 18 specimens are multiple use tools including:

17. *Ground slab-metates* 6 (10.3%)

18. *Ground slab-cupstones* 5 (8.6%)

19. *Grinding slab-cupstones* 2 (3.4%)

20. *Hematite processing slab cupstones* 2

21. *Abrader-cupstone* 1

22. *Metate-cupstone* 1

23. *Hematite processing slab-mortar* 1

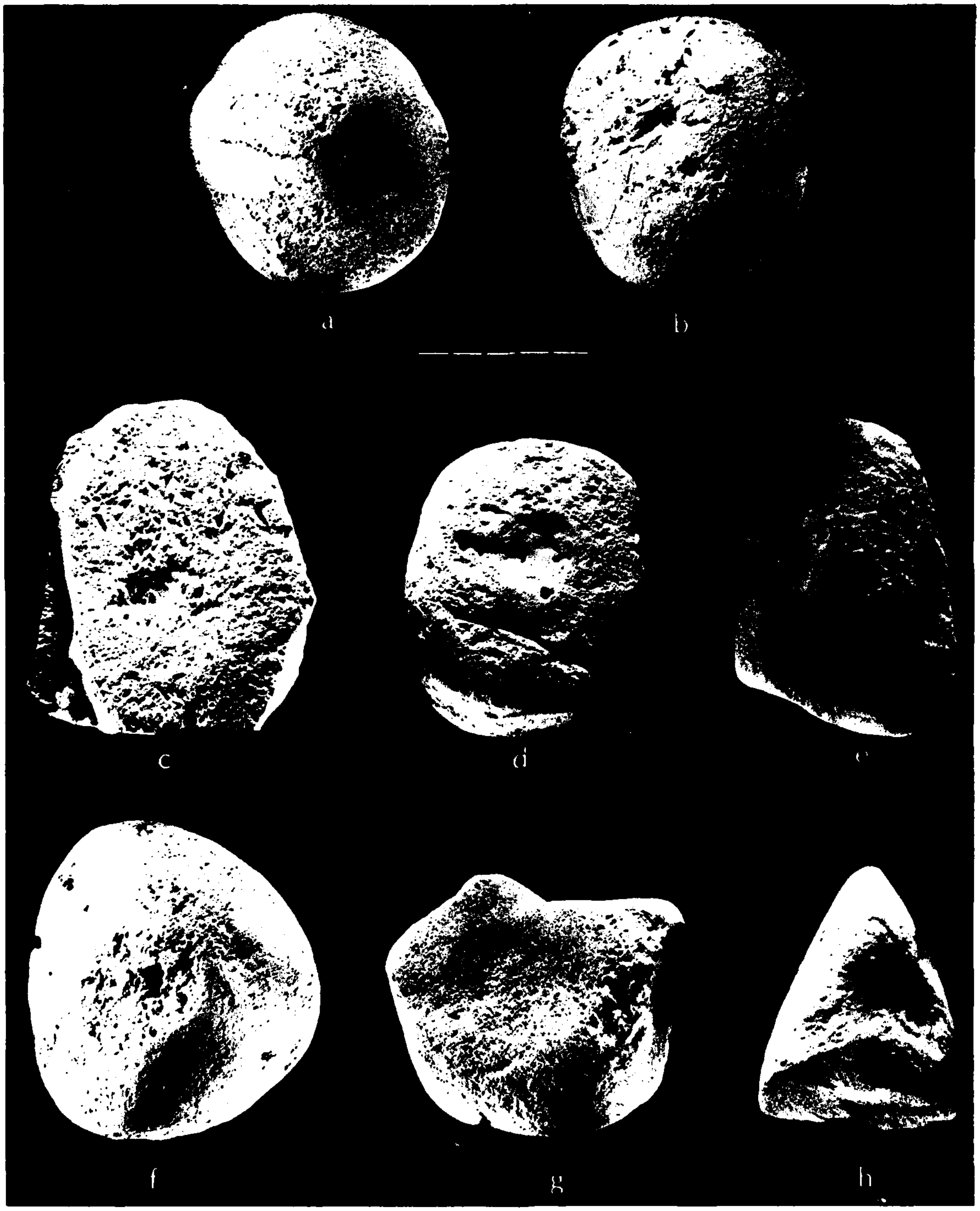

Figure 10.22. Hand held implements: a-b,f,g, grinding stones/manos; c-d, anvils; e,h, undifferentiated. Scale in cm.

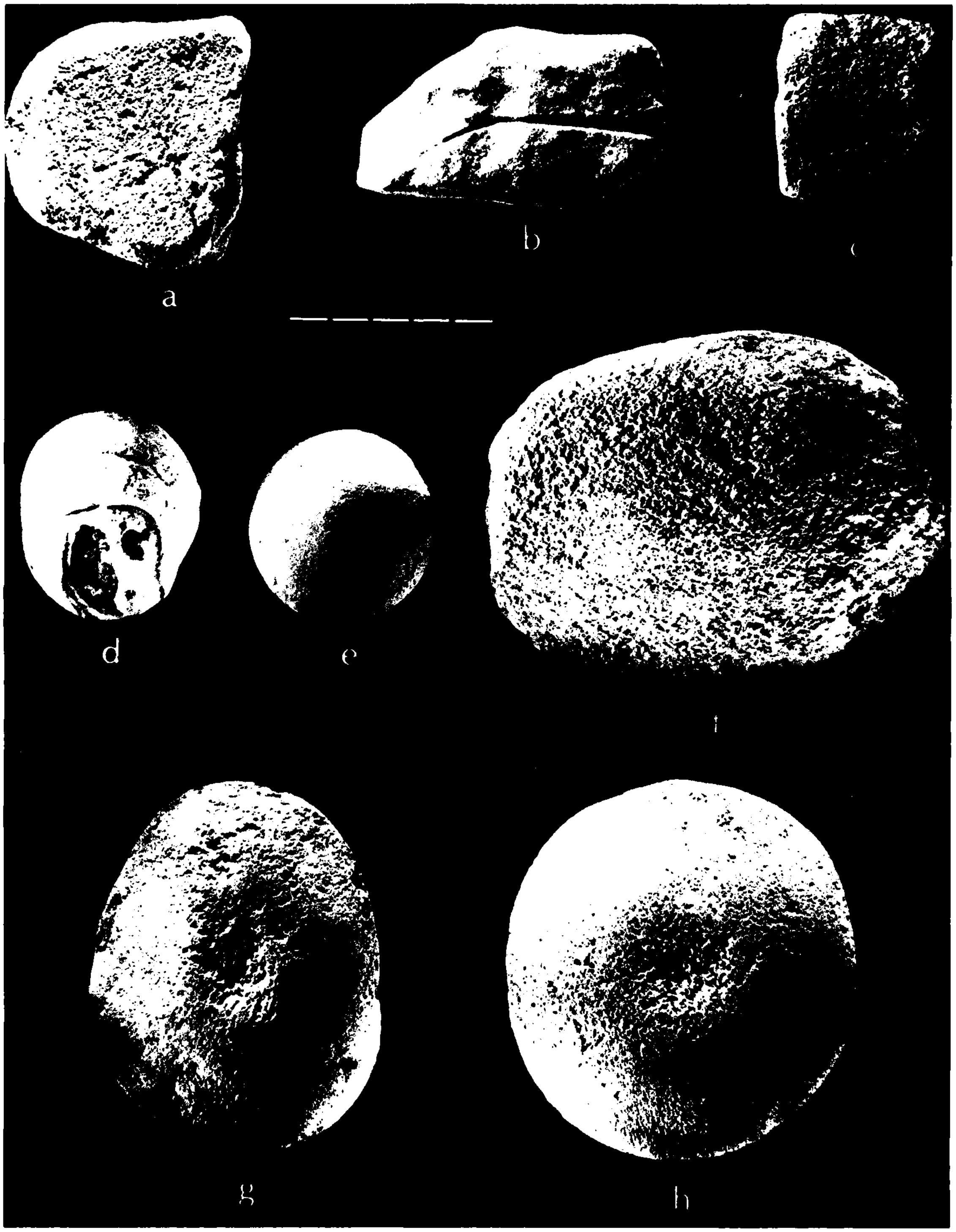

Figure 10.23. Hand held abraders (a-c,f), rubbing stones (e,g-h) and problematic grooved object (d). Scale in cm.

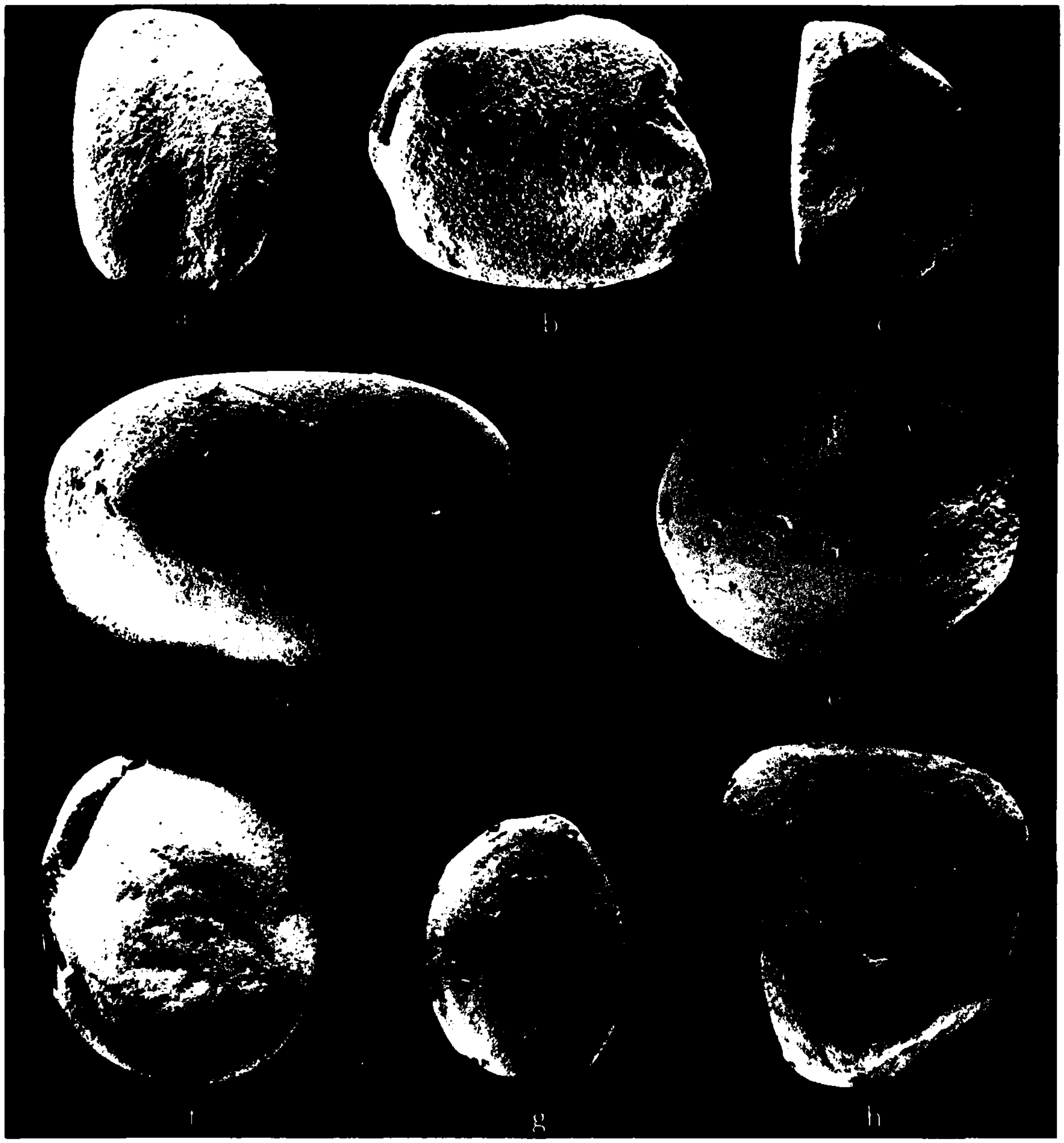

Figure 10.24. Hand held abraders (a-c) and rubbing stones (d-h). Scale in cm.

Figure 10.25 illustrates several of the implements included among the stationary items.

Fragmentary:

24. Twenty-six (10.6%) specimens are classed as being *ground*.

25. Twenty-five (10.2%) items are classed as *undetermined fragments* which were probably parts of ground slabs or abraders and eleven (4.5%) are classed in the same group with the exception that these specimens were hematite stained.

26. Eighty-two (33.3%) specimens are classed as *small ground slab fragments* or *whetstones*.

27. Sixty-six (26.8%) are *hematite processing slab fragments*.

28. Twenty-eight (11.4%) items probably represent *metate* or *mortar fragments*.

29. One *small anvil fragment* is among the remaining specimens.

30. One *single abrader-cupstone fragment*.

31. Four *waste flakes* with ground and striated dorsal surfaces.

AXES

Twelve ground stone *axes* (Fig. 10.26) are also in the ground stone assemblage from Rodgers Shelter. One specimen was not notched or grooved for hafting. Eight specimens are full grooved while two have notches chipped into either side of the specimens. Eight axes are constructed of a cherty dolomite and four are made of chert, two of which are Chouteau and the other two are unidentifiable. Nine of the axes are pecked either in the groove or, in a single notched specimen, across the area that would have been hafted. All but two specimens exhibit extensive grinding on both the bit and poll ends of the tools, five of which also show extensive pecking in these areas. On all extensively ground specimens, striations, generally random in orientation, can be observed. The remaining two axes appear to have been chipped into shape but they are not as extensively ground as the other specimens. The working edges of the bits exhibit considerable dulling and crushing of the surfaces. Five speciments also show evidence of flake removals which suggest that dulled edges had been resharpened. Only one specimen exhibited battering on the poll end. The six provenienced specimens are all from the Early and Middle Archaic Horizons 5-7. See also the corresponding discussion of hematite axes.

SEQUENCES OF USE

Of the hand held ground stone specimens from Rodgers Shelter, only six showed multiple use in which the sequence of uses could be determined. One specimen had been used as a grinding stone, another as a hammerstone and four had been previously used as rubbing stones.

No use sequence could be established for the stationary ground stone specimens, while one fragmentary specimen had been previously a large ground slab.

Figure 10.25. Stationary ground stone: a, cupstone; b, metate; c-e, ground slabs; f, mortar. Scales in cm.

Figure 10.26. Early and Middle Archaic full grooved axes. Scale in cm. See also Figure 10.16a-d.

ANALYSIS

Analysis of these data is in three parts. First, the interrelationships of variable pairs are assessed by chi-square for each ground stone group and techno-functional class. Then, we focus on diachronic relationships among the techno-functional classes, also using chi-square. Lastly, Kay considers the composition and temporal trends among Rodgers Shelter ground stone tool kits through employment of principal components analysis.

CHI-SQUARE CROSSTABULATIONS

Differences in material, its origin, pitting, pit, face and edge wear, and its extent, striations, hematite staining, overall and sectional shapes are crosstabulated in Tables 10.28, 10.29, and 10.30. Table 10.31 summarizes diachronic relationships. Individual crosstabulations having statistically meaningful results are appended.

Observations dealing with the first series of relationships (i.e., Tables 10.28, 10.29 and 10.30) follow.

With respect to hand held, stationary and fragmentary techno-functional classes:

1. Selection of specific raw materials is not random and probably relates to functional prerequisites of individual grinding tools. Grinding and rubbing stones are constructed of a wide variety of materials including quartzite, chert, dolomite and sandstone. Hammerstones include chert and sandstone. Anvils include dolomite, sandstone, very soft cottonrock as well as Burlington chert. Abraders are exclusively constructed from abrasive dolomite and sandstone. Most stationary tools are constructed of dolomite and sandstone as are the fragmentary specimens.

2. Source of materials, even among hand held tools ($\chi^2 = 13.121$; df = 9; p = 0.157) with a high percentage of river gravels, is insignificant. Selection of hand held ground stone appears to be dependent on size, hardness and abrasive qualities rather than on location.

3. Differences in pitting among all three ground stone types are far greater than would be expected by chance (i.e., Table 10.28, general ground stone type). In the hand held group, pitted and non-pitted grinding stones appear in approximately equal frequency while among rubbing stones more than twice as many specimens are non-pitted than exhibit pits. All anvils have pits while the majority of hammerstones and abraders lack pitting.

4. Overall shape of stationary items only is not random ($\chi^2 = 185.154$; df = 91; p = 0.000). Most stationary tools are amorphous rather than subrectangular, mainly a product of selected raw material forms that subsequently, were not further altered. Among the hand held tools, one shape is as likely to occur as any other ($\chi^2 = 42.141$; df = 54; p = 0.879). Hence, stylistic variation imparted by all Rodgers Shelter ground stone implements is minimal.

5. Differences in longitudinal and cross sectional shapes are important among both hand held and fragmentary group implements (Table 10.28) but are not among the stationary group. This suggests that variable grinding surface shapes are functional prerequisites of both hand held and fragmentary groups, and would serve to differentiate techno-

TABLE 10.28

Crosstabulations of Techno-Functional Class by Selected Variables

Techno-functional Class by	Hand Held Raw Chi-square	Hand Held df	Hand Held p	Stationary Raw Chi-square	Stationary df	Stationary p	Fragments Raw Chi-square	Fragments df	Fragments p
Material type	177.960	90	0.0000	76.810	52	0.0142	434.450	60	0.0000
Origin	13.121	9	0.1570	-----	--	-----	-------	--	------
General Ground Stone type	51.243	9	0.0000	53.784	13	0.0000	124.369	10	0.0000
Overall shape	42.141	54	0.8790	195.154	91	0.0000	-------	--	------
Longitudinal shape	106.810	54	0.0000	85.432	78	0.2670	419.490	70	0.0000
Cross section shape	116.147	54	0.0000	70.650	65	0.2980	313.039	70	0.0000
Pit use wear	41.664	45	0.6141	122.229	65	0.0000	124.369	40	0.0000
Face use wear	709.967	126	0.0000	143.446	104	0.0050	409.960	70	0.0000
Edge use wear	196.312	81	0.0000	5.577	13	0.9600	46.620	20	0.0000
Nature striations	11.300	18	0.8810	24.850	26	0.5280	-------	--	------
Relation striations	23.594	45	0.9960	50.610	52	0.5290	-------	--	------
Residues/weathering	51.198	27	0.0030	60.458	39	0.0150	206.052	20	0.0000

TABLE 10.29

Crosstabulation of Extent of Wear by Selected Variables

Extent of Wear by	Raw Chi-square	df	p
Material type	131.5440	70	0.000
General ground stone type	67.8860	7	0.000
Longitudinal shape	30.4180	35	0.689
Shape in cross section	39.5280	35	0.275
Face use wear	350.0486	91	0.000
Residues/weathering	15.8800	21	0.776
Techno-functional class	225.9450	63	0.000

functional classes within each of these two groups. However, there are no meaningful relationships between sectional shapes and extent of wear (Table 10.29), suggesting that differences in sectional shape are more a product of purposeful material selection for certain forms than is due to tool use. Among stationary items, sectional shapes are essentially unimportant; what is important are the working face or faces of these tools.

6. Face use wear is highly correlated with all techno-functional classes (Table 10.28) and is a prime criterion of tool function, as is edge wear for hand held and fragmentary groups (Table 10.28). Similarly, extent of wear (Table 10.29) correlates highly with techno-functional classes, material types and face use wear.

7. In contrast, pit use wear differentiates only stationary (χ^2 = 122.229; df = 65; p = 0.000) techno-functional categories. Among hand held specimens, pit use wear is uniform.

8. The presence and orientations of striations is random for all three groups. Multidirectional grinding is inferred.

With respect to residues, specifically hematite staining:

9. There is random association with extent of wear (χ^2 = 15.880; df = 21; p = 0.776). Hematite impregnated tools show areas of use no different than unstained tools.

10. There are significant differences in material types of hematite stained hand held and fragmentary tools (Table 10.30), which tend to be sandstone. But among stationary tools there are no differences in material between hematite stained and unstained tools. Generally speaking, hematite impregnated tools are sandstone or dolomite.

11. Among hematite impregnated hand held tools, there are no other obvious differences with unstained implements.

12. Whereas pit use wear is significantly different among stationary tools (χ^2 = 17.875; df = 4; p = 0.001); hematite stained tools show a very low frequency of polished and striated wear types in conjunction with ground wear types in contrast to the non-hematite stained tools.

TABLE 10.30

Crosstabulations of Residues by Selected Variables

	Hand Held			Stationary			Fragments		
Residues by	Raw Chi-square	df	p	Raw Chi-square	df	p	Raw Chi-square	df	p
Material type	20.095	10	0.028	3.756	4	0.4401	19.693	6	0.003
Complete weight classes	3.402	6	0.757	-----	--	------	------	--	-----
Complete maximum length classes	3.580	6	0.733	-----	--	------	------	--	-----
Complete maximum width classes	7.644	6	0.265	-----	--	------	------	--	-----
Complete maximum thickness classes	2.402	6	0.879	-----	--	------	------	--	-----
Hardness	2.638	4	0.620	4.163	3	0.2440	19.362	4	0.000
Overall shape	9.352	4	0.053	2.950	5	0.7080	------	--	-----
Longitudinal shape	16.440	5	0.005	3.533	5	0.6180	5.814	6	0.444
Shape in cross section	2.976	5	0.704	5.538	4	0.2360	3.188	6	0.785
Pit use wear	0.469	4	0.976	17.875	4	0.0010	2.152	3	0.541
Face use wear	11.597	13	0.560	11.439	7	0.1200	19.268	6	0.004

TABLE 10.31

Crosstabulation of Horizon by Selected Variables

	Hand Held			Stationary			Fragments		
Horizon by	Raw Chi-square	df	p	Raw Chi-square	df	p	Raw Chi-square	df	p
Material type	208.5840	100	0.000	14.488	21	0.848	88.357	48	0.000
Origin	10.1750	10	0.425	------	--	-----	------	--	-----
Pit use wear	41.8950	50	0.786	34.059	35	0.513	42.227	32	0.107
Face use wear	120.0165	140	0.113	46.248	49	0.585	69.708	56	0.103
Edge use	98.6570	90	0.252	11.722	7	0.110	16.401	16	0.425
Weathering/residues	26.4310	30	0.651	25.102	21	0.243	39.511	16	0.000
Mineral staining	7.9060	10	0.638	3.871	7	0.795	16.686	8	0.034
Techno-functional class	81.0280	90	0.258	79.412	70	0.208	109.295	72	0.002

13. In addition to material types, fragmentary group hematite impregnated specimens are also significantly different in hardness (χ^2 = 19.362; df = 4; p = 0.000) and face use wear (χ^2 = 19.268; df = 63; p = 0.004).

14. As a general conclusion, the comparisons of hematite impregnated tools with the other tools indicates there is little difference between these tools. This does suggest that for whatever reasons not all tools possibly associated with hematite processing are necessarily impregnated with this mineral. Diachronic relations (Tables 10.31) are summarized as follows:

15. Considered individually, hand held and stationary groups express insignificant differences in techno-functional class, or evidence of tool use including residues.

16. Correlated differences in presence of residues, techno-functional class and material type are apparent for fragmentary group specimens. The statistically significant differences relate primarily to Early and Middle Archaic hematite processing.

17. There are important material differences among hand held implements. The Late Archaic (χ^2 = 208.584; df = 100; p = 0.000) or Woodland horizons 1-3 exhibit primary usage of dolomite, sandstone, oolitic and banded Jefferson City chert and Burlington chert. The Early and Middle Archaic horizons 5 - 7 have a higher frequency of dolomite and sandstone coupled with a lower frequency of chert.

Comment

The ground stone tools from Rodgers Shelter were constructed from an assortment of locally available materials. Hand held tools particularly reflect this variety. The raw material, its hardness and abrasive quality appear to be associated with ground stone tool functions. The utilization of specific raw materials for hand held and fragmentary tool classes also appears to shift through time with a later higher reliance on chert represented, particularly, in hand held tools. Most of the ground stone raw materials were obtained from bedrock and hillslope residuum areas, although some hand held ground stone tools were from river gravel.

For the most part, Rodgers Shelter ground stone tools are stylistically indistinct. Raw materials suitable for use with little or no modification were selected. An exception to this, of course, is the small number of full-grooved, ground stone and specular hematite axes that appear in the Early or Middle Archaic horizons 5-7.

With the exception of the axes, ground stone tool classes remain, when considered individually, fairly consistent through time. An exception is the ground stone slabs, many of which are hematite stained. These tools used in hematite processing are mainly in the Early and Middle Archaic components and this is consistent with the occurrence of hematite. Hematite impregnation also occurs on hand held and stationary tools which indicates that these also were integrally involved in hematite processing.

The ground sandstone slabs in the sample present somewhat of a problem when one considers function other than hematite processing. Ahler and McMillan (1976) inferred that they are whetstones. This tool class does show minor evidence of having been resharpened which may indicate that they served as slab metates as well. This hypothesis is also suggested when the number of stationary ground stone tools are compared with the number of grinding and rubbing stones which compose the majority of the hand held sample. Winters (1969:62-64) notes a similar discrepancy between grinding and rubbing implements in the Riverton materials. We are also unable to account for metates or plant processing slabs that may have been constructed of wood at Rodgers Shelter.

The function of pitted hand held tools is still a vexing problem at Rodgers Shelter as it is at other sites. Pounding, grinding and anvil activities are indicated. We are able to discount the suggestion that they are anvils specifically used for bipolar flint knapping because there is no evidence of this technique in the waste flakes and cores from the site. A large number of the pits in these hand held tools do show use wear and are associated with the larger working face of tools. This may indicate that their projected function as finger grips should be discounted as well because not all of them are associated with battered edges and they would not be functional on a face that was being used for grinding or rubbing activities. Among the pitted specimens that could be classified are grinding and rubbing tools as well as anvils and ground abraders.

VII. PRINCIPAL COMPONENT ANALYSIS OF GROUND STONE

Marvin Kay

In sum, chi-square contingency tabulations confirm the general integrity among ground stone techno-functional categories. However, these univariate analyses are unsuitable for a detailed assessment of ground stone tools as part of functionally-specific tool kits. Intuitively, it would seem extremely doubtful that the individual categories of ground stone were all involved in different grinding tasks. More plausible would be the idea that several categories were used in concert in various extractive, industrial and maintenance activities. R-Mode principal components, a form of multivariate factor analysis (Rummel 1970), is suited to test these ideas because it allows for reduction of the techno-functional classes (i.e., variables) into independent groups of ground stone functional categories (i.e., principal components, or factors) while also defining diachronic relationships among factors (i.e., factor scores for each case, or cultural horizon).

The data matrix (Table 10.32) used as input for principal components anslysis consists of all techno-functional classes that occurred in more than one cultural horizon, axes excluded, or 19 of the categories for 11 horizons. Although it is mathematically desirable to have fewer variables (i.e., techno-functional classes) than cases (i.e., horizons) in a principal components analysis, interpretation of factor results is often not impaired by having more variables than cases; and it is not in this instance.

Principal components analysis (PA1; Kim 1975) defined four unrotated factors with eigenvalues greater than one, respectively, accounting for

TABLE 10.32

Techno-Functional Class by Horizon

	Horizons										
Techno-Functional Class*	1	2	3	4	5	6	7a+	7b+	8	9	10
2 Hematite processing slab			1		21	15	18		4		1
3 Metate		1	1						1		
4 Cupstone	1				1	4	2				
5 Ground slab-metate						3	1	1	1		
6 Ground slab-cupstone							3		2		
7 Undetermined stationary			1		4	8	1	4	4		
8 Whetstone-ground slab fragment	2	2	1		30	25	2	8	3		2
9 Undetermined hand held or stationary fragment	1	1	1		10	8	2		1		
10 Undetermined hematite stained hand held or stationary fragment			1		1	3	5	1			
11 Undetermined ground stone fragment		1	1		8	4	5	2	2		1
12 Undetermined hand held	2	3	2		2	1	1	2	1		
13 Grinding stone/mano	4	4	3		4	2	2	1	1		
14 Rubbing stone	6	18	11	2	10	23	11	4	3	1	1
15 Anvil		1	1		3			2		1	
16 Hammerstone		1	1		1	1	1				
17 Abrader	1				3	3	2	2			
18 Grinding stone-hammerstone		2				1	1	1			
19 Rubbing stone-hammerstone	1	1	1		2	5	3	1	1		
20 Hematite slab cupstone		1					1				
21 Large grinding slab					2						
22 Mortar							1				
23 Hematite stained slab mortar							1				
24 Fragmentary abrader-cupstone								1			
25 Grinding stone-anvil					1						
26 Rubbing stone-anvil-hammerstone									1		
27 Resharpening flakes					2	2					

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*21-27 deleted from principal components analysis
+a-beneath overhang; b-area in front of overhang

46.6%, 17.5%, 14.1% and 8.2% or, cumulatively, 86.4% of the total variance. The four orthogonal or varimax rotated factors have positive high (above 0.65) loadings on all but one of the variables (Table 10.33), which has a positive moderate correlation (above 0.55) with the first factor.

Factor 1 has high positive loadings on six variables; including the techno-functional classes, hematite processing slab, cupstone, whetstone-ground slab fragment, undetermined hand held or stationary fragment, undetermined ground stone fragment and abrader. Factor 1 also has a

TABLE 10.33

Varimax Rotated Factor Matrix*

Techno-Functional Class	Factor 1	Factor 2	Factor 3	Factor 4
2 Hematite processing slab	*0.906*	0.036	0.174	0.363
3 Metate	-0.448	*0.616*	-0.002	-0.059
4 Cupstone	*0.894*	0.088	0.328	0.071
5 Ground slab-metate	0.294	-0.038	*0.924*	0.152
6 Ground slab-cupstone	0.022	-0.095	0.055	*0.864*
7 Undetermined stationary	0.577	0.012	*0.704*	-0.179
8 Whetstone-ground slab fragment	*0.897*	0.107	0.288	-0.273
9 Undetermined hand held or stationary fragment	*0.876*	0.252	0.245	-0.131
10 Undetermined hematite stained hand held or stationary	0.463	0.060	0.379	-*.734*
11 Undetermined ground stone fragment	*0.923*	0.129	0.020	0.256
12 Undetermined hand held	0.160	*0.886*	-0.120	-0.140
13 Grinding stone/mano	0.357	*0.801*	-0.146	-0.071
14 Rubbing stone	0.331	*0.711*	0.556	0.107
15 Anvil	0.581	0.271	-0.461	-0.361
16 Hammerstone	0.481	*0.688*	0.164	0.287
17 Abrader	*0.890*	0.055	0.312	0.094
18 Grinding stone-hammerstone	-0.038	*0.674*	0.325	0.327
19 Rubbing stone-hammerstone	0.592	0.241	*0.698*	0.284
20 Hematite slab cupstone	-0.098	0.576	-0.085	0.745

---

*High loadings in italics

positive moderate loading on the techno-functional class, anvil. We interpret this factor as a primary pigment processing tool kit. A plot of its factor scores (Table 10.34, Fig. 10.27) shows clearly that this is exclusively an Early and Middle Archaic tool kit and is most important during Horizon 5.

Factor 4 has high positive loadings on three variables, ground slab cupstone, undetermined hand held or stationary hematite stained fragments, and hematite processing slab-cupstone; and is similarly interpreted as a second primary pigment processing tool kit. Factor 4 scores indicate that the primary expression of this tool kit is in Horizon 7a (Early Archaic, ca. 8100-7500 B.P.) from beneath the overhang and at least some of the items also occur much later in Horizon 2 (Late Archaic-Woodland).

These two factors that express mainly industrial activities associated with extensive hematite processing during the Early and Middle Archaic counterpoint presumably food vegetal extractive tasks defined by Factors 2 and 3.

Factor 2 has positive high variable loadings on techno-functional classes, metate, undetermined hand held (pitted) tools, grinding stone/mano,

TABLE 10.34

Varimax Rotated Factor Scores

Horizon	Factor 1	Factor 2	Factor 3	Factor 4
1	-0.320	0.086	-0.358	-0.539
2	-0.918	2.391	-0.219	0.096
3	-0.515	0.897	-0.268	-0.475
4	-0.657	-1.025	-0.215	-0.171
5	2.504	0.167	-1.261	-0.670
6	0.922	0.096	2.738	-0.366
7a*	0.518	-0.058	-0.127	2.918
7b+	0.131	-0.180	0.067	-0.494
8	0.663	-0.408	0.477	0.100
9	-0.474	-0.990	-0.513	-0.267
10	-0.527	-1.074	-0.318	-0.128

* shelter
\+ main excavation

rubbing stone-hammerstone. Included in this food processing tool kit are obviously mainly hand held implements which, traditionally, have been classed as pitted or unpitted manos. Factor 2 represents primarily a Late Archaic or Woodland tool kit, although there is a minor expression of this tool kit in the Middle Archaic Horizon 5 (Fig. 10.27).

In contrast, Factor 3, also a food processing tool kit consisting principally of ground slab metates, undetermined stationary fragments, and rubbing stone-hammerstones, is primarily a Middle (Horizon 6) or Early (Horizons 7b and 8) Archaic tool kit.

DISCUSSION

As a final summary, it is clear that principal components factor analysis is a particularly appropriate technique to define not only tool kits but diachronic trends in the usages of Rodgers Shelter ground stone. Although there are a myriad of functional types, the ground stone industry (excluding axes) expresses convincingly but two basic activities, hematite pigment processing and food processing. Though Rodgers ground stone is stylistically undiagnostic, these tool kits and inferred activities are highly correlated with individual horizons or cultural periods.

VIII. BIFACIAL ARTIFACTS

Marvin Kay

Chipped stone or its manufacturing by-products constitute the two largest categories of artifacts from Rodgers Shelter. Previous studies by Ahler (1971), McMillan (1971) or Ahler and McMillan (1976) have dealt with small subsamples of mainly utilitarian bifacial implements including

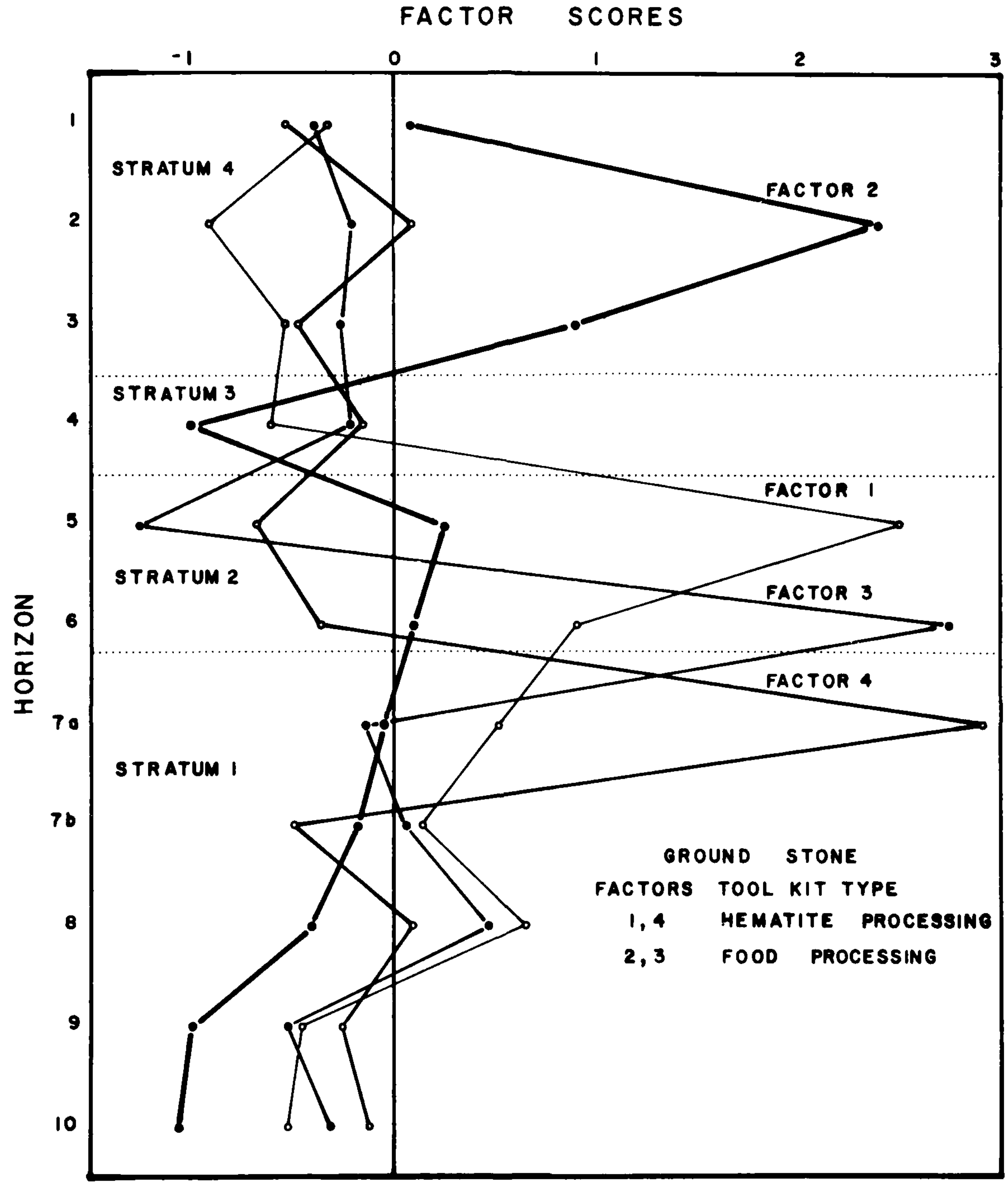

Figure 10.27. Diachronic trends in ground stone industrial and extractive activities at Rodgers Shelter. Factors 1 and 4 are hematite processing tool kits that document predominate industrial activity in the Early and Middle Archaic; factors 2 and 3 are food processing tool kits that became important during different cultural periods. (7a is beneath the overhang, 7b to its front.)

particularly chipped stone points, and have been oriented toward differentiating tool function of whole or nearly whole implements. Much of the chipped stone sample, however, consists of nebulous, fragmentary artifacts as well as an assortment of variably shaped whole bifaces having no obvious haft, and largely has been unstudied. Other studies often characterize these as general bifacial implements, perhaps divided into components by thickness and/or shape, or assign specific functional designations by shape, size, and flaking. Winters (1969:32-36), for instance, under the heading of general utility tools, includes knives, triangular knives, leaf shaped knives, lanceolate knives, pentagonal knives and choppers. Lewis and Lewis (1961:47-48) describe similar forms as bifacial blades, scrapers or choppers of variable size, shape and thickness. There is a general tendency in these and other studies to implicitly lump these artifacts into functional categories, primarily as cutting tools. Ahler and McMillan (1976:170) offer an explicit definition: "Chipped stone bifaces of every size and shape that lacked features of specialized functional significance and that lacked facility for hafting were placed in the functional category *generalized cutting implements.*" Little attention has been given to the possibility that many, if not all, of these artifacts are no more than bifacial preforms of core (ie.e., items flaked from a block) tools though Klippel (1969:Fig. 13) illustrates probable stages in bifacial reduction going from crude, thick preforms to finished hafted implements. (As used in this study, *preform* refers to any flaked but unfinished artifact that would require subsequent modification prior to use; *blank*, to the original kind of flaked block , i.e., core, flake, amorphous; *implement*, to a functionally generalized or specific tool.)

One of my objectives will be to show that this second alternative is the more likely proposition for at least Rodgers Shelter. A second objective will be the description of stylistically distinctive bifacial artifacts. Here I am speaking primarily of chipped stone projectiles, hafted cutting and scraping tools. These are recognized as horizon markers throughout the midwest and eastern North America; their common occurrence at Rodgers Shelter and other sites in the lower Pomme de Terre River valley in dated, multilayered deposits that formed over the past 10,500 years make them almost uniquely attractive for chronological purposes. Ahler's (1971) study of hafted bifacial implements (points) further allows for their functional subdivision and, thereby, provides a baseline for typological classification. These data are presented in Chapter 11.

THE SAMPLE

Including chipped stone points, Rodgers Shelter bifaces or bifacial fragments consist of 5666 tabulated specimens. There are still an uncounted number of surface specimens that are not considered, other than those used in point classification. Artifacts provenienced by both horizon and main excavation area grid units, amounting to 4975 specimens (or 87.80% of the total), are my main concern. The 4975 items consist of 784 (15.75%) small bifacial fragments that could not be further classified as well as 2244 (45.1%) bifacial preforms or preform fragments and 1924 (38.73%) artifacts assigned to techno-functional classes originally conceived by or modeled after Ahler and McMillan (1976:167-179). The majority of utilitarian artifacts are either whole or fragmentary chipped stone points (1318, or 68.39%), which constitute the most extensively studied artifact group from Rodgers Shelter. As with other material debris categories, the bifaces are bimodally distributed (Fig. 10.28) between the Late Archaic and Woodland Horizons 1-3 and the Middle Archaic Horizons 5-7.

A significant but relatively small number of bifacially flaked fragments have been pieced together. Not including mended bifaces broken in excavating, there are 84 specimens which were broken in manufacture or subsequent use. These are of paramount importance in the evaluation of fracture mechanics and serve as prime criteria in differentiating bifacial preforms from finished utilitarian implements. They have also been used to reconstruct stratigraphic contacts.

DATA DESCRIPTION AND ANALYSIS

Collins (1975:16), in introducing a general model of chipped stone tool manufacture, notes that, "The manufacture of chipped stone tools is a reductive technology...bounded by rather stringent limitations imposed by the behavior of the concoidal fracture, the nature of rocks and minerals possessing chippable properties, and the capacities of primitive cultures for exerting and controlling forces..." Collins observes that this process is linear in form; though he and others (Bradley 1975, Callahan 1974, Newcomer 1971), for purposes of analysis, define a chain of stages in chipped stone tool manufacture beginning with material acquisition and ending with, in Collins' framework, optional maintenance and modification. Drawing on Schiffer (1972), Collins further observes that the material remains represent a product of behavioral processes that define tool manufacture, use and maintenance. His model is applicable to Rodgers Shelter and, given the idiosyncracies of the bifacial data and their archaeological contexts, is followed in organizing this analysis.

Figure 10.29 is a flow diagram illustrating the overall sequence of chipped stone tool reduction, use, maintenance and recycling for Rodgers Shelter. Product groups 3, 6, 7 and 8 include unifacially as well as bifacially flaked artifacts; the unifacial artifacts, and lithic debitage are not included in this analysis. Definition of the various stages in bifacial reduction, from initial roughing out to recycling, has been attempted mainly by inspection of the broken and mended bifaces which, along with the debitage, are largely discard items of bifacial preforming. Supplementary studies were attempted also to replicate tool forms and manufacturing errors leading to breakage. Although more work is needed, these generally confirmed conclusions on bifacial fracture from observations of mended artifacts.

Using mended bifaces as a general guide, nominal observations were taken on fracture type, flaking, heat treatment for three basic biface geometric forms; amorphous or undifferentiated, ovate and rectanguloid or triangular. Differentiated by flaking, these general biface forms are illustrated in Figure 10.30. Interval scale measures of mass, size, edge angles and shape (involving a standardized polar co-ordinate system of data recording) were also tabulated for whole or nearly complete specimens. Excepting the chipped stone points, these interval scale data are not sum-

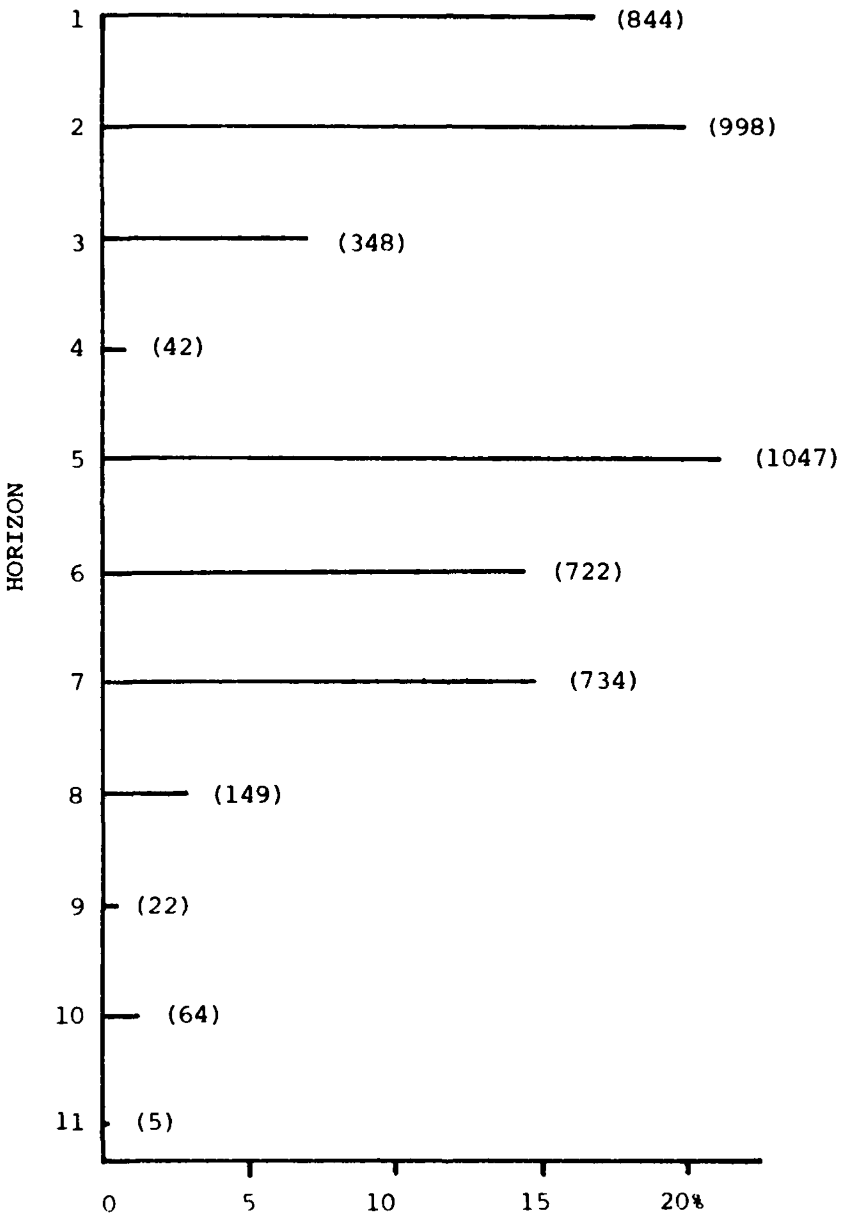

Figure 10.28. Temporal distribution of bifaces.

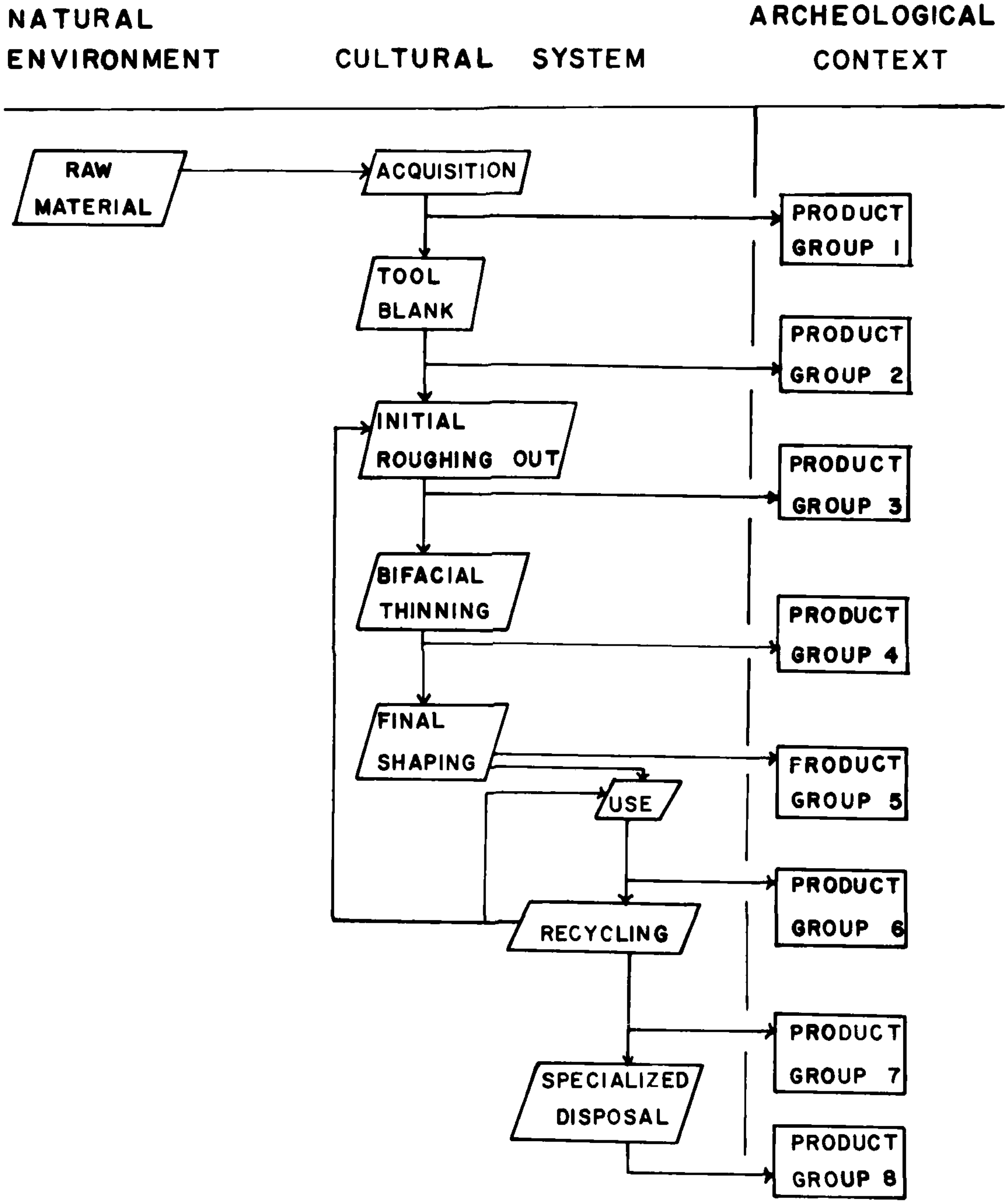

Figure 10.29. Bifacial reduction model (after Collins 1975:25).

Figure 10.30. Bifacial preforms: a-c, amorphous or undifferentiated; e, g-k, ovate; d, f, l-p, rectanguloid. Note difference in quality of flaking correlated with size and shape definition. e and k illustrate outre passe fractures. Scale in cm.

marized in this study but may be used in future intersite analyses where systematic comparison of general biface forms is needed. Similar observations or procedures were followed in the other techno-functional studies.

Similar observations were taken on the subsample of 954 points for typologic classification. These will be described in more detail in the next chapter. In addition, all points were classed according to techno-functional groupings established by Ahler (1971).

Thus, in a stepwise, or cummulative fashion the analysis deals with: (1) breakage patterns; (2) bifacial reduction: the manufacture and tool maintenance technology; (3) the partitioning of artifacts into bifacial preform and use cycles; and (4 in Chapter 11) typological characterization of point groups or categories.

BREAKAGE PATTERNS

The mechanics of chipped stone manufacture (Speth 1972, Faulkner 1972) involved both the magnitude and manner in which stress (loading) is applied to brittle flintworking materials, and is well documented and understood. Field (1965) describes general processes of fracture of brittle materials; Faulkner (1974) discusses these with respect to fracture morphology and process; and Purdy (1975) explains many peculiarities of thermal stress and fracture. The reader is referred to these for a general discussion.

What is important in this analysis is that fracture morphology be minimally understood as to cause, or fracture mechanism. However, a detailed analysis of fracture mechanisms, such as attempted by Faulkner (1974), was beyond the means of this project. But by examining the fractures, surfaces and flaking characteristics of mended bifaces it became clear that breakage occurred during the manufacturing process and use.

Figure 10.31 shows several mended preforms (Product Group 4), broken in bifacial thinning (a, d-f) or as a product of thermal stress (b-c). Breakage in bifacial thinning occurred when an inappropriate load, in the form of a percussion blow, was applied to either a poorly prepared platform surface (i.e., area of flake detachment) or to a surface protruberance or interior flaw. Morphology of the fractured surfaces is not necessarily consistent and simultaneous multiple fractures, apparently occurring along pre-existing internal flaws, are common as well. As a consequence, attention to a single fracture morphology without reference to the originating blow would have accorded an imperfect, if not wholely misleading, assessment of breakage patterns; on mended preforms, breakage generally is traceable to an inward-hinging fracture. We have used the term *outre passe* as a general description of this basic fracture where the cone of percussion is deflected either horizontally or transversely, resulting in uncontrolled breakage.

Often whole preforms (i.e., Fig. 10.30d,f) exhibit massive protruberances and were discarded (Product Group 3) prior to any other attempts at thinning. Others (i.e., Fig. 10.30a-c), also Product Group 3, have a combination of interior flaws or haphazardly fashioned platforms that made further thinning impossible and were similarly discarded.

Thermal stress (Figs. 10.31b,c and 10.32h,i) is a second major cause of fracture among bifacial implements. These fractures have curvilinear

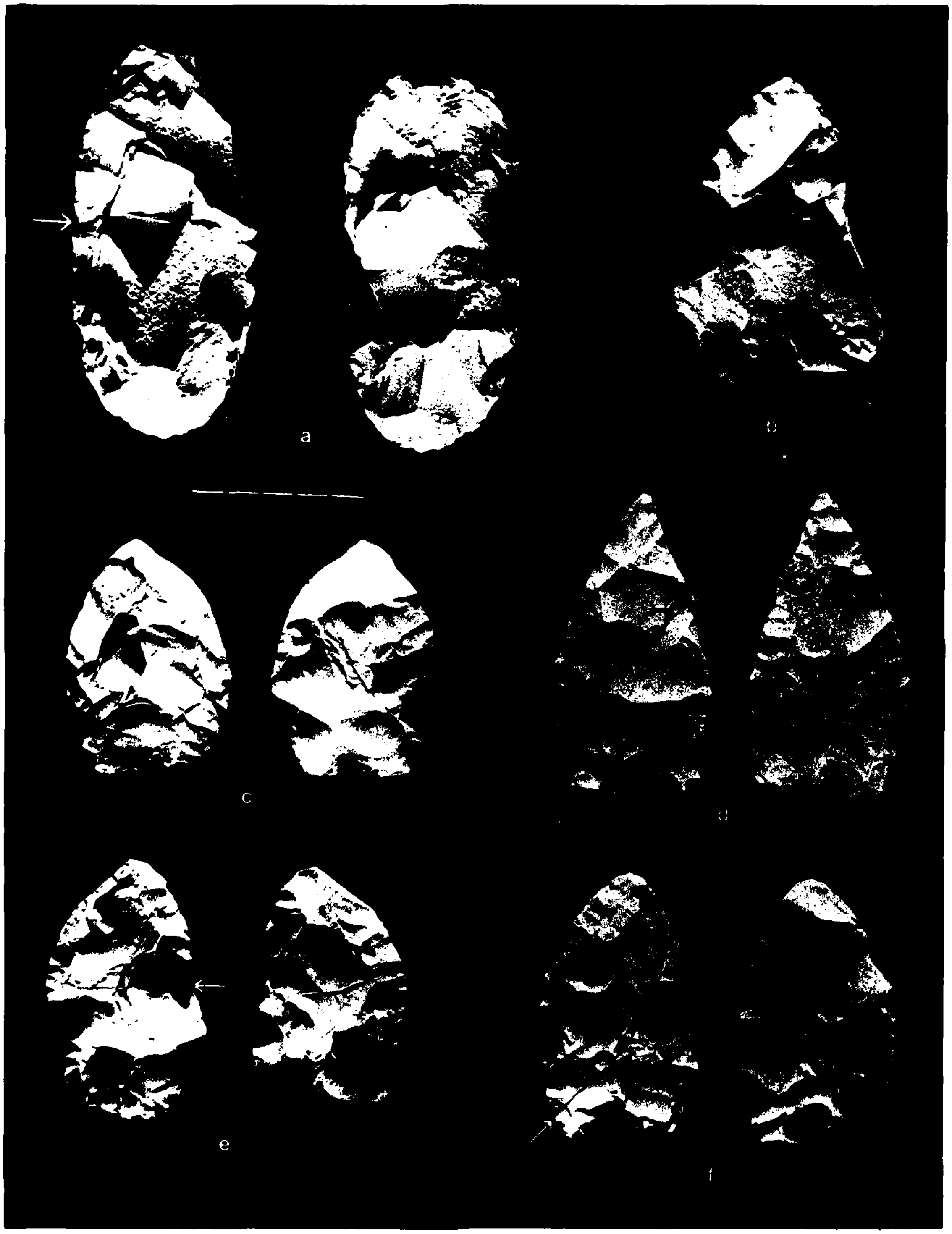

Figure 10.31. Mended bifacial preforms: a, d-f, broken during bifacial thinning, arrow points to originating point of breakage; b-c, heat fractures. Scale in cm.

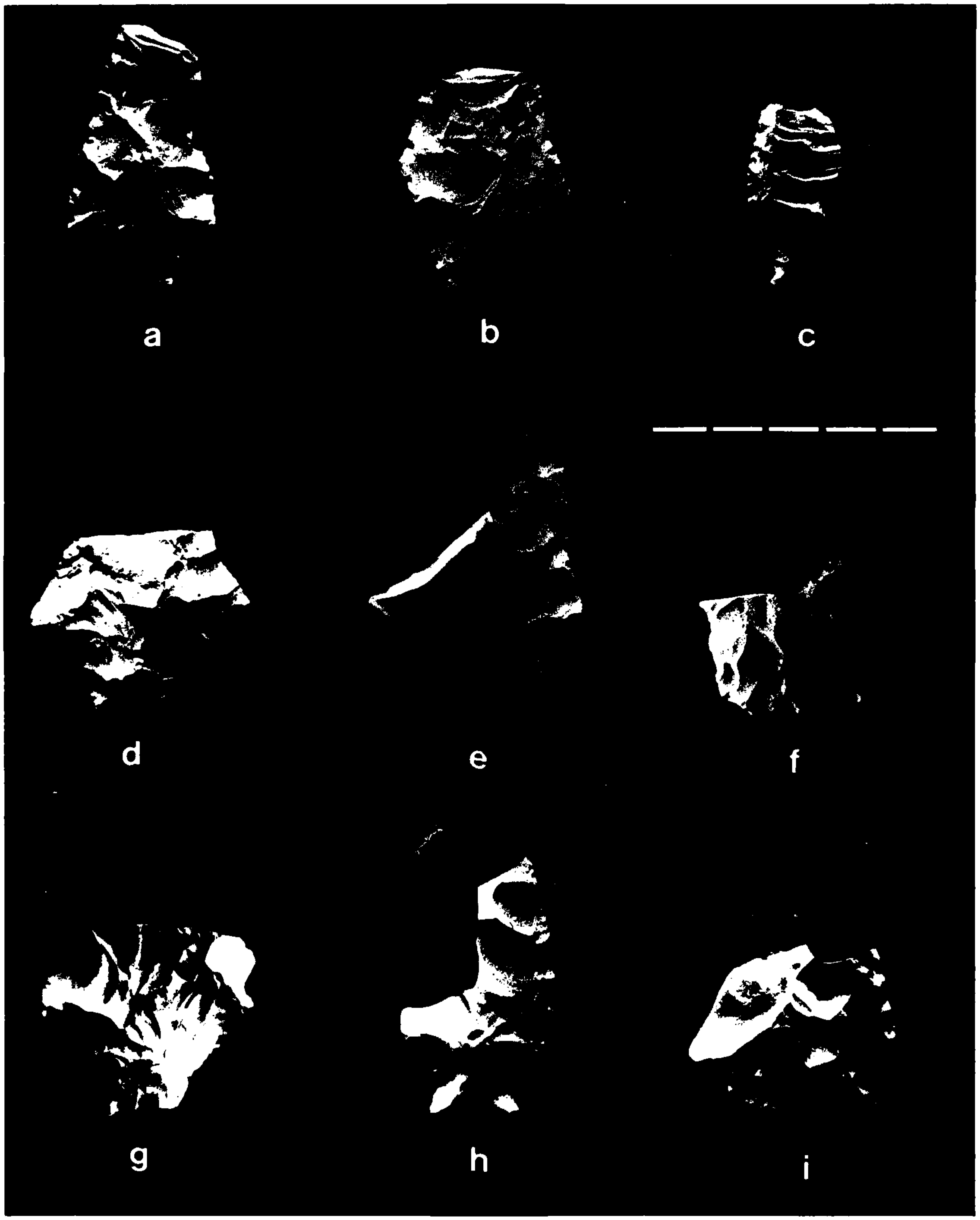

Figure 10.32. Blade fracture: a-c, impact; d, transverse; e, oblique; f-g, irregular; h-i, thermal. Scale in cm.

surfaces, accompanied by crazed and/or potlid-pocked surfaces. They are readily identifiable and generally do not require bifacial mending for fracture definition. However, they also occur as a post-depositional feature of successfully heat treated artifacts, making their evaluation difficult but not impossible. Because of this, it has been helpful to plot the distribution of mended heat fractured fragments. Post-depositional fractures are generally found to be in close proximity. Where heat fracture is not related to subsequent flaking, it is assumed the fracture is not post-depositional. In those cases where subsequent flaking occurs on a heated and fractured biface, the possibility of post-depositional breakage cannot be as easily eliminated. But for most examples where heat fracturing occurs on a specimen flaked subsequent to heating, it is possible to determine if the flaking resulted in fracture of a heat-flawed block.

A second class of fractures occurred during tool use and are represented by Product Group 6. Their morphology is generally little different from those occurring in bifacial thinning, with the possible exception of "impact" fractures (Fig. 10.32a-c) on projectiles (Ahler 1971:52) or burin-like facets detached in various cutting operations. In experimental studies, Ahler (personal communication) has inadvertently fractured chipped stone cutting tools in butchering game; "burin faceting" occurred as the blade of the tool either struck or lodged against a bone or tendon. A similar process may explain the occurrence of burin-faceted points commonly found on eastern North American sites (Epstein 1963). Impact fractures, originating at the distal end of projectiles have a similar appearance to burin facets. Distal compression on impact often results in more than a single fracture and occasionally causes other simultaneous fracture(s) of either the blade or haft elements of chipped stone projectiles (Frison 1974:95 and Fig. 1.53). Numerous examples occur in the Rodgers Shelter collection of medial, distal and lateral point segments. Proximal point fragments may or may not terminate in a characteristic, distal originating hinge fracture or impact scar (Fig. 10.32d-g). However the fracture morphology on chipped stone points, the ultimate cause may well be due to compression on impact. Faulkner (1974) notes other prime causes of fracture are due to unequal application of force either o the end or body of an implement. While the exact causes of fractures may never be known on many tools from archeological sites, the fact that these fractures can be a product of tool use as well as manufacture is clear.

Tool maintenance, in the form of resharpening dulled edges or reshaping a broken implement, also can be seen to result in other fractures, occurring on Product Group 7 artifacts. As before the mechanics of fracture may be similar in all three classes (i.e., manufacture, use, maintenance), though one exception is purposeful burin faceting along a break (Fig. 10.5). In cases of mended bifaces where burin facets on breaks occur, microscopic examination does not necessarily show abrasion, blunting, striations or polish indicative of burin use. It well may be that the burin facet having a sharp bifacially flaked dorsal surface may have been a desired product. In this case a composite tool of burin facets mounted on either a wood, bone or antler shaft may have been the ultimate implement. Frustration at breaking a finished and seemingly valuable cutting tool or projectile in resharpening may also have been vented by further breakage of the specimen, resulting in burin faceting.

In sum, the study of bifacial breakage is a complicated one. Multiple hypotheses about manufacture, use and tool maintenance must be weighed against all available evidence. We would not minimize the difficulty in assessing the causes of fracture, to say nothing of mechanics. Nonetheless, through the examination of other lines of evidence in concert with breakage patterns, both the technology of tool manufacture and the overall cycles of manufacture and tool use can be established for Rodgers Shelter.

BIFACIAL REDUCTION

Chipped stone tool manufacture at Rodgers Shelter involved several steps, or processes. These can be outlined, in the main, as (1) blank or material acquisition; (3) optional preform modification through heat treatment and edge, or platform, preparation; and (3) bifacial flaking until a desired tool form results.

Data on these three processes are most complete for the latter two and stem from observation of mended, broken or otherwise flawed bifaces that were discarded as Product Groups 3 through 5. Information on blank or material acquisition is more limited but does afford insight into availability of raw materials through time and use of varied sized or shaped blocks of stone.

Small nodules of Jefferson City chert were selected for reduction into single core bifacial blanks but data are insufficient to correlate this with specific preform shape or cultural period. It would be expected also that several bifaces were made from a single large block of chert. Direct evidence for this will be presented in the description of Smith points but one can only guess at the overall use, or selection, of large blocks as opposed to smaller nodules for bifacial reduction.

Raw materials (Table 10.35) are almost entirely of local origin and, as seen with the chert cores, acquisition emphasized local hillslope bedrock exposures or residual cherts. Dalton Horizon 10 is an exception in that cortex remnants are often patinated, indicative of a river source for the chert.

A logical sequence of bifacial flaking is exhibited by the preforms, represented by three preform categories, or product groups. These are discussed in terms of their flaking and optional preform modifications.

Product Group 3 preforms are crudely percussion flaked objects (Fig. 10.30a-c) having jagged, sinuous edges and irregular but thick sections; faces may have large areas of nodular cortex, flaking is random.

Product Group 4 preforms (Figs. 10.30d-k, m and 10.31) are more regularly percussion flaked bifaces with thinner sections; edges are still sinuous but are less so than with Product Group 3. Flake scars tend to be flat, expand from the striking platform, and as often as not are systematically oriented across from one-third to two-thirds of the preform width.

Product Group 5 preforms (Fig. 10.301, n-p) represent a final stage in bifacial manufacture that is, to a degree, traceable to specific tools, are thin in section, have nearly straight to straight edges and regular if not symmetric shape. Flaking is a combination of controlled percussion and/or pressure flaking that obliterates previous flake scars.

These preforms can be divided into those that clearly belong to specific point types as opposed to those that are not so easily identified.

TABLE 10.35

Distribution of Bifacially Flaked Materials other than Points

Material	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	EIGHT	NINE	TEN	ELEVEN	Row Total
	Horizon											
Quartzite	0	0	3	0	0	0	1	0	0	0	0	4
Oolitic	238	333	118	10	388	244	233	55	6	29	0	1654
Banded	307	348	95	26	477	325	308	55	8	25	3	1977
Crossbanded	17	22	12	1	22	27	16	7	2	0	0	126
Burlington	89	89	38	3	99	76	49	9	0	1	0	453
River Gravel	5	9	5	2	2	4	4	0	1	5	2	39
Other	29	23	7	0	6	6	5	0	0	0	0	76
Choteau	6	8	3	0	24	16	16	4	1	1	0	79
Dolomite	0	1	0	0	1	0	0	0	0	0	0	2
Column Total	691	833	281	42	1019	698	632	130	18	61	5	4410

Raw chi square = 311.8 with 80 degrees of freedom   Significance = 0.0

Number of missing observations = 1256

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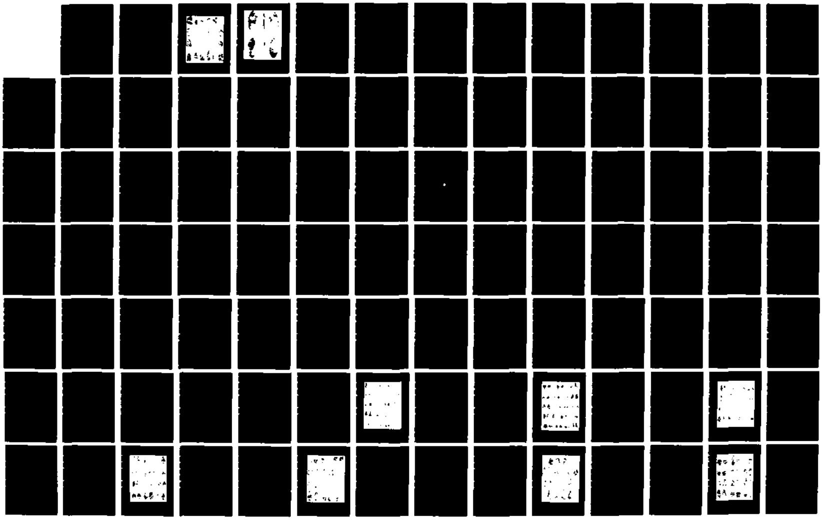

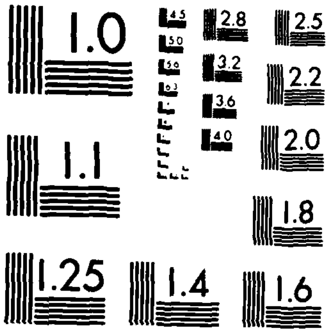
1.0
4.5
5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

Of the former, the Etley (Figs. 11.23a and 10.33a-b) or Smith (Figs. 11.18f and 10.33d) preforms show basal notching was last, as do other undifferentiated Late Archaic (Fig. 10.33k) or Middle Archaic (Fig. 10.33r) preforms. Other Late Archaic notched preforms (Fig. 10.33e-f) or Early Archaic (Fig. 10.33w-y) lanceolate preforms illustrate basal preparation prior to final flaking of the blade element. Of the undifferentiated preforms (Fig. 10.33g-y), the Late Archaic specimens are rectanguloid (Fig. 10.33g-k) or ovate (Fig. 10.33l-m); Middle Archaic ones are triangular (Fig. 10.33r) or concave based with excurvate blade edges (Fig. 10.33s-u). The latter were broken in attempts to further thin the blade (Fig. 10.33s-t) or during heating (Fig. 10.33u) prior to further blade thinning. The Early Archaic lanceolate preforms were broken in attempts to thin the blade (Fig. 10.33 w,y) or to remove a distal flake platform (Fig, 10.33x). Heat treatment is apparent for most Middle Archaic (Fig. 10.33 n-o, q, s-u) and several Late Archaic (Fig. 10.33a-b, f, j, m) preforms.

Flaking on these three preform groups was coded into five overall categories. Crude percussion flaking (Product Group 3) is irregular or haphazard and is dichotomized by presence or absence of cortex (coded values, 1 and 2, respectively). Flake removals probably were by direct hard hammer percussion in most cases but some soft hammer, or baton percussion work (see next) should not be ruled out. Flake scars are large, generally exhibit a prominent negative bulb of percussion, often terminate in distal hinge fractures, and are irregular in orientation. Coded value 3 refers to flaking commonly seen on Product Group 4 preforms, or percussion bifacial thinning. Thinning flakes have been infrequently matched to their respective biface but generally have a ventral platform lip and diffuse bulb of percussion. Newcomer's (1971:88) experimental studies indicate this flake platform and bulbar morphology correlates with soft hammer, or baton percussion flaking. Thinning flakes were repeatedly removed until either a final, regularly shaped biface resulted or a percussion blow inadvertently broke the preform. Figure 10.34 illustrates this bifacial thinning stage. Controlled percussion and/or pressure flaking (coded values 4 and 5 respectively) are commonly seen on Product Group 5 preforms or tools made from them. The percussion flaking is again thought to be mainly soft hammer. Percussion and pressure flaking on hafted tools initially was subdivided further into eleven types, which will be of primary interest in the descriptions of chipped stone point typologies (Chapter 11).

Two attendant processes, heat treatment and platform preparation by grinding, are important in bifacial preforming as well as subsequent "optional" maintenance and modification.

For purposes of this study, heat treatment, as opposed to random firing of chert, is dichotomized between heated but not subsequently flaked bifacial artifacts and those that exhibit post-heating flaking, using criteria of Collins and Fenwick (1974). Heated but not flaked artifacts were generally fractured during heating and for the most part are representative of unsuccessful but intentional firing. Heated and flaked artifacts survived the firing process and exhibit various forms of fracture as well as evidence of continued preforming, tool maintenance or recycling as either the same or a different tool or preform.

Figure 10.35 shows diachronic differences in heating with various bifacial preform categories. With reference to this figure, heat treat-

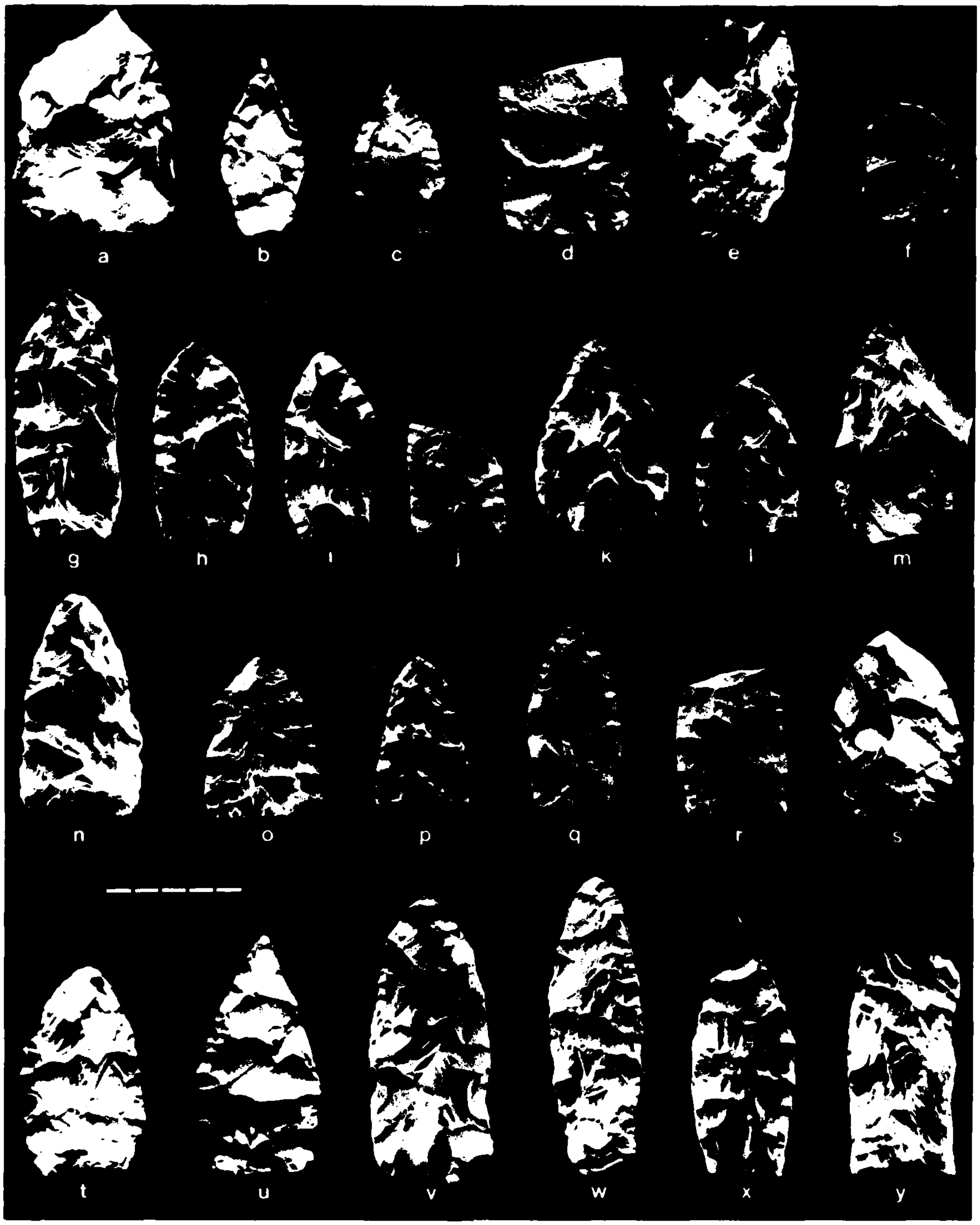

Figure 10.33. Point preforms (c is a finished point of preforms a and b). Scale in cm.

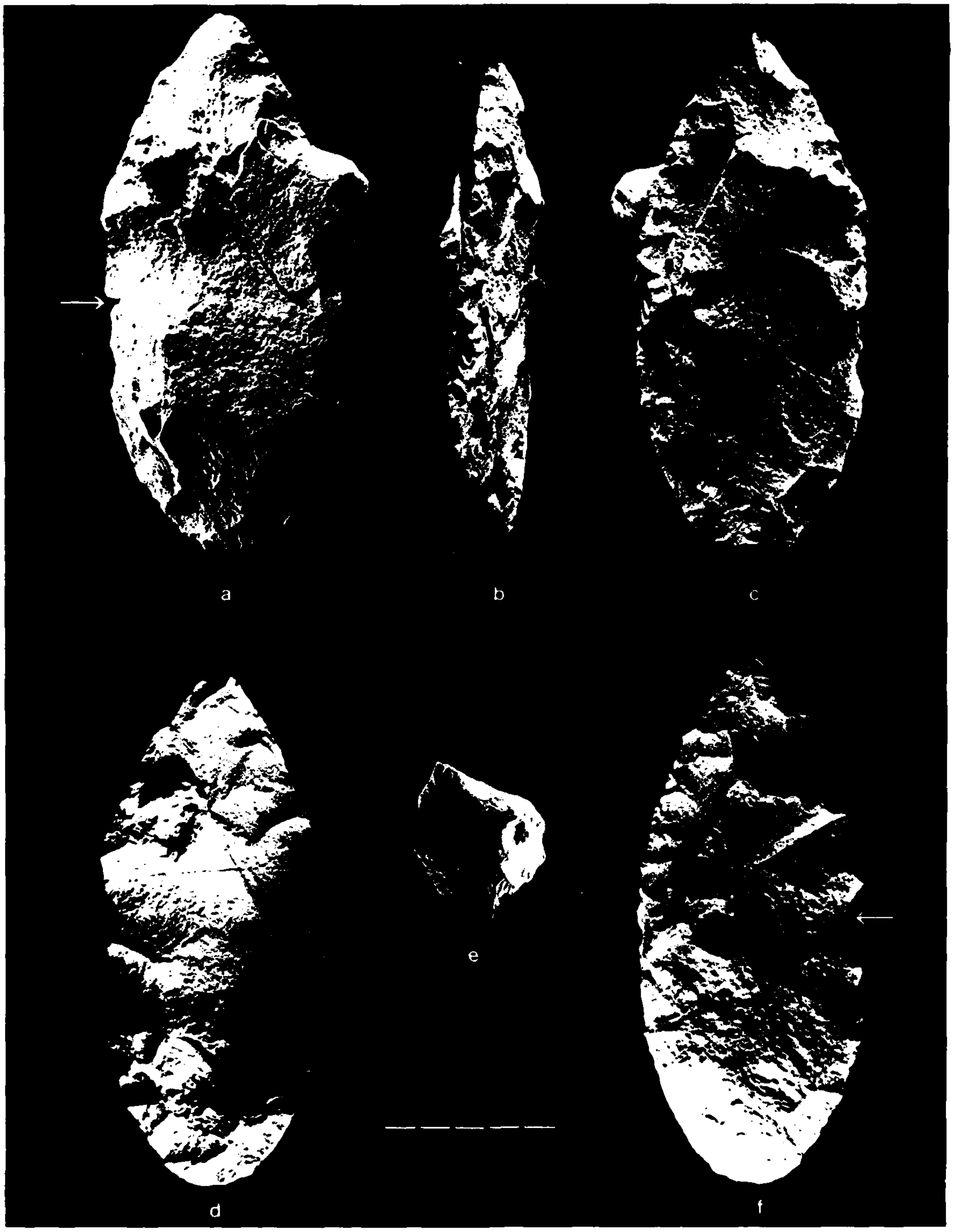

Figure 10.34. Biface 57, a mended Product Group 4 Preform; arrow indicates final baton percussion blow which fractured specimen: a-c, obverse, longitudinal section and reverse views of preform with thinning flakes in place; d, f, obverse and reverse views after detachment of final flake removal (arrow). Scale in cm.

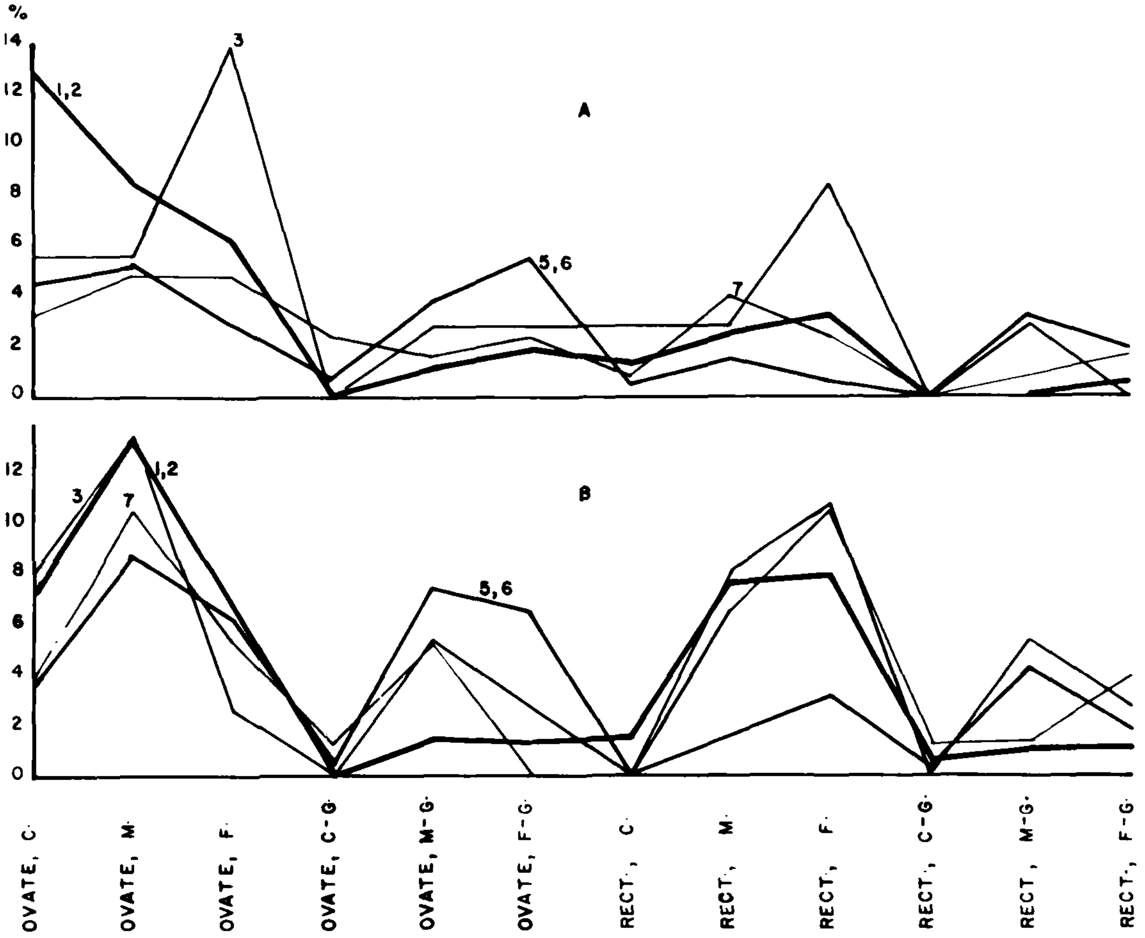

Figure 10.35. Trends in heat treatment of bifacial preforms for Horizons 1-3, 5-7; for illustrative purposes only, Horizons 1, 2, 5 and 6 are graphed as mean percentages. A, heated but not subsequently flaked; B, post-heating flaking. Grinding occurs predominately in Horizons 5-7 only. (Preform suffix: c, initial roughed out; m, bifacially thinned; f, finely shaped; g, laterally ground.)

ment of bifacial preforms is reasonably uniform through time (the major temporal differences have to do with presence or absence of platform grinding, not heat treatment). As a rule, heating occurs after the initial roughing out stage, regardless of preform shape.

Sheets (1971) discusses experimental observations on platform grinding, and along with other flintknappers, argues that platform grinding contributes significantly to controlled bifacial reduction, and that lateral grinding associated with manufacture can be differentiated from that found with tool use. His criteria for differentiating between the two depend on microscopic examination. Given the sample size of the Rodgers collection, such an approach was not practical. Instead, macroscopic observations were made on edge abrasion of bifacially flaked artifacts. Edges were also felt by hand and, with practice, it proved possible to accurately gauge grinding by this method as well. This may seem to lack analytical rigor but, in fact, it is by feel and visual inspection that many flintknappers evaluate their own attempts at preparing platforms through edge grinding. Obviously then, these procedures allow for but a gross assessment of edge grinding: those items with macroscopically visible, tactilely verified edge grinding are classed as laterally ground.

Many of the mended bifacial preforms, broken in thinning, were found by these methods to be laterally ground (Table 10.36). By extension, other fragments and whole bifaces were then evaluated with respect to lateral grinding and other bifacial attributes such as flaking, size and shape. These data when crosstabulated with time for the bifacial preforms (Table 10.37) establish that platform preparation is temporally distinctive. Lateral grinding as platform preparation is predominate only in the Early and Middle Archaic Horizons 5-7, though it also occurs in the more sparsely occupied Dalton Horizon 10. We have also found that lateral grinding is a basal, or haft, attribute of many Dalton, Early and Middle Archaic points (Chapter 11) and this may well be a stylistic carry-over of the platform preparation process. There are also occasional Middle Archaic broken chipped stone points which are extensively ground on both blade and blade element fractures. This indicates that part of the recycling technology involved platform preparation of the same magnitude as found on the preforms.

As a brief summary, what seems to be true of the processes attendant to bifacial preforming are also true of the optional maintenance and modification technologies. Heat treatment and platform preparation figured prominently in both phases of the life cycles of bifacial artifacts at Rodgers Shelter.

BIFACIAL PREFORM AND USE CYCLES

To this point, we have demonstrated chiefly that (1) bifacial preforms constitute a major subset of Rodgers chipped stone artifacts and (2) that they and tools ultimately fashioned from them underwent systematic alterations. To reiterate, the cycle of bifacial preforming involves initial roughing out of a general form, subsequent thinning and final bifacial shaping into a chipped stone implement. Primarily as discard items, these are seen archaeologically as Product Groups 3-5. What then can be said of chipped stone tool use cycles?

TABLE 10.36

Diachronic Distribution of Mended Bifacial Fragments

Horizon	Ovate preform	Ovate preform edges ground	Rectanguloid preform	Rectanguloid preform edges ground	Undifferentiated preform	Undifferentiated preform, edges ground	Chipped stone point	Unhafted (?) *cutting tool*	Lanceolate preform	Barrel shaped preform	Notched preform
1			1				2				1
2	3						1				1
3							1				
4											
5	2	2		3	1	1	7		2	1	
6	1	3	1	1			2			1	
7							3	1			
8		2					1		1		
9				1			1		1		
10							1	1			
Mixed Horizons											
1-2	1		1			1					
2-3							2				
5-6		3			2	2	6	1			
5-7		1				1	2				
5-8							1			1	
6-7		1				2	1		1		
6-8										1	
7-8						1	1			1	

There are a number of functionally discrete Rodgers Shelter chipped stone tool categories identified initially by Ahler and McMillan. Much of the generalized cutting tool category can be discounted as being largely biface preforms. Yet, there are still certain items that evidently were used as cutting tools and which cannot be easily defined as another use classification. So even this category is of value in thinking of tool use or use cycles. Without benefit of further concentrated study, however, it will be impossible to elaborate on specific details and nuances of the chipped stone tool use phases for most of the recognized categories. Here we use the terms "use phases" advisedly as constituting the entire cycle of initial use combined with any subsequent episodes of recycling. Because there is but minimal evidence of specialized disposal (Product Group 8) as burial accountrement or other caching for later use, we are largely discounting interpretation of these tools

TABLE 10.37

Bifacial Preform Categories by Horizon

Bifacial Preform Categories	Horizon																					
	Whole											Fragments										
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Ovate crude flaking	10	17	6		7	5	9	2		2		16	36	11		16	16	7	3	1		
Ovate medium flaking	7	13	7		11	7	11	1		2		11	29	6		21	15	15	2		2	
Ovate fine flaking	5	2			1	2	1					12	19	6	1	14	13	12	2			
Ovate crude flaking laterally ground	3		3		2	1	2	1		1						5	2	5	2			
Ovate medium flaking laterally ground	2	6	3		5	4	2	1					3	1		30	21	8	3	1		
Ovate fine flaking laterally ground		1	1									2	6	2		24	20	3	2			
Rectanguloid crude flaking	2	3	2				3					4	4	2		4	1	2				
Rectanguloid medium flaking	4	5	7		3	1	5	2		1		4	20	4		7	9	9	4	2	1	
Rectanguloid fine flaking	2	1	1		2	1	3	2		1		16	16	14	1	6	2	9				
Rectanguloid crude flaking laterally ground	1	1					1									1	1					
Rectanguloid medium flaking laterally ground		1			1					1			1	2		18	10	4	1	1	2	

TABLE 10.37 (concluded).

Bifacial Preform Categories	Horizon																					
	Whole											Fragments										
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Rectanguloid fine flaking laterally ground	1				1		1		1			2	2	1		16	9	6	3		2	
Undifferentiated crude flaking	24	28	15	1	23	24	11	8	3		1	17	34	11	4	30	20	18	8			
Undifferentiated medium flaking	3	7	1		6	4	2	1		1		36	51	7	2	58	36	33	8		1	
Undifferentiated fine flaking	1	1	1					1				36	68	21	2	51	29	28	5		1	1
Undifferentiated crude flaking laterally ground	1		2			2	2						4	2		9	3	5	1			
Undifferentiated medium flaking laterally ground												3	6	3		55	47	36	7	2	1	
Undifferentiated fine flaking laterally ground					1							8	13	5	1	84	49	45	4		2	

Flaking: 1-2, crude; 3, medium; 4-5, fine as being more than implements employed in normal extractive or maintenance activities. Binford (1962) refers to this category of tools as technomic, or of primary utilitarian function. Bearing in mind that a final synthesis is not possible now, preliminary comments can be made on bifacial tool use cycles.

We should preface our remarks with what may, with further study, become axioms of Rodgers Shelter tool use phases. First, we would agree with Miller's (1977) observation that "stylistic" variation among many chipped stone points is, in fact, little more than the pregressive recording of changes in form due to repeated use, breakage, reworking and recycling. A second idea, a corollary of the first, is that recycling of bifacial tools is roughly proportional to the care initially invested in manufacture. Third, there are two qualitative differences in recycling: (1) in the first, tool maintenance in the form of resharpening dulled or damaged edges leads to reuse in the same fashion as before; (2) in the second, tool maintenance after initial use leads to a divergence in subsequent function, or functions.

The simplest bifacial tools, cleaver/choppers, wedge-hammerstones, burins and spoke-shaves, require little in the way of manufacture beyond the initial roughing out stage. Our data on tool recycling are at best sketchy but do suggest that reuse was mainly as the same tool.

The other bifacial implements (Table 10.38) require more elaborate preform preparation, with the greatest care exercised in manufacture of implements having an obvious hafting element. Both kinds of recycling occur.

Ahler (1971:102), in his analysis of Rodgers Shelter Rice Lobed points, convincingly describes an example of recycling of the first kind, "...while haft element and blade width measurements are quite uniform, blade shape, length and blade edge angles vary widely. This information, together with the consistent use of edge serration, the general lack of severe edge wear with surface wear occurring only on the shoulder tips, indicates that these tools may have been periodically resharpened by regular pressure retouch to maintain a delicate serrated cutting edge. *There is a continuum from an unused tool to a well-worn, resharpened specimen in the small sample at hand...*" (italics added).

The second kind of recycling is apparent from inspection also of certain hafted bifacial implements discussed in detail later, and is expected to occur with other, less stylistically distinctive tools. Either due to blade element breakage or progressive alteration by resharpening, these hafted tools which initially functioned as projectiles and/or cutting tools were recycled as scrapers or perforators.

DIACHRONIC TRENDS

Potentially complex spatial and diachronic relationships or patterns are expressed by these data on biface manufacture and use. For now, the question of spatial configurations will be deferred. However, it will be valuable to assess temporal variation, if not patterns, in biface manufacture and use. A basic premise of these studies will be that manufacture or use classifications tabulated by horizon in Tables 10.37 and 10.38 represent terminal stages in manufacture or use of individual artifacts. A second assumption will be that though recycling occurred, the frequencies

TABLE 10.38

Bifacial Functional Categories by Horizon

Bifacial Functional Categories	Horizon 1	2	3	4	5	6	7	8	9	10	11
Hafted perforator	4	3	1		2	5	2	1			
Perforator	5	8	3		19	10	8	2		1	
Adz	5	15	6		12	7	15	2		5	
Unhafted cutting tool	54	56	18	1	59	38	40	8	1	6	1
Burin					1		2				
Cleaver/chopper		1	1		2		2			1	
Wedge/hammerstone	2	1	1			2					
Spoke-shave		2						1			
Projectile point fragment	43	46	5		22	14	17	5		3	
Projectile point whole	16	18	3		8	11	8	2	1		
Hafted cutting tool, fragment	5	2	13		13	4	7	3	1	2	
Hafted cutting tool, whole	2	3	11		5	3	10	3	1	3	
Hafted multipurpose tool, fragment	42	58	14		43	32	36	9	1		
Hafted multipurpose tool, whole	14	19	5		13	7	9	7			
Undifferentiated point, fragment	16	105	19	2	128	78	85	7	1	11	
Undifferentiated point, whole	1	3	2		1		4				
Hafted scraper	1	1	2		8	8	11				
Unhafted scraper	9	1	4		29	32	35	5	2		

of bifacial tools are representative of the range of activities to which chipped stone tools were put. Stated differently, it is assumed that sampling largely accounts for variation in spatially defineable activity at Rodgers Shelter and that tool frequencies are a general reflection of these activities. This subject will be developed fully in Chapter 12.

Principal components factor analysis as previously discussed for ground stone will be the primary technique for assessing diachronic trends in biface manufacture or use. Also, because it has been possible to partition the assemblages of bifacial artifacts according to manufacturing stage or (at least) terminal use, this study takes advantage of this logical division. Indeed, this partitioning is a critical feature as it insures that heuristically valuable divisions within the data are maintained in the analysis.

Manufacture

Data on preform fragments presented in Table 10.37 were used as input for a principal components analysis of biface manufacture. Inspection of this table shows that flaking, preform shape, presence or absence of lateral grinding were prime considerations. Heat treatment correlates with the later stages of bifacial preforming and, as such, would have been redundant; that is, little meaningful information would have been conveyed by further division of these preforms by heat treatment.

Two unrotated factors, respectively, accounting for 67.4% and 23.4% of the variance have eigenvalues greater than 1.0 and were orthogonally (varimax) rotated. Inspection of the rotated factor loadings (Table 10.39) shows that the main difference between the two factors is in terms of lateral grinding. Factor 1 has high positive loadings for laterally ground preforms, regardless of flaking or shape, and the converse is true for Factor 2. A plotting (Fig. 10.36) of factor scores (Table 10.40) shows that lateral grinding is time-specific to the Early and Middle Archaic Horizons 5-7 and that platform preparation (lateral grinding) is not a major factor in the Late Archaic and Woodland Horizons 1-3. Exactly what occurred in Dalton Horizon 10 is not well defined by this analysis, however, due to the small sample of preforms. Even so, lateral grinding occurs as an attribute of Dalton preforms and tools. Platform preparation of Dalton bifacial preforms probably was important but in this analysis it is outweighed by the numerically superior sample from other horizons.

TABLE 10.39

Varimax Rotated Factor Matrix

Variable	Factor 1	Factor 2
Ovate, crude flaking*	0.11507	*0.95622*
Ovate, medium flaking	0.39966	*0.90082*
Ovate, fine flaking	0.38066	*0.90742*
Ovate, crude flaking, laterally ground	*0.81816*	0.11636
Ovate, medium flaking, laterally ground	*0.95145*	0.18408
Ovate, fine flaking, laterally ground	*0.90468*	0.30026
Rectanguloid, crude flaking	0.21266	*0.89701*
Rectanguloid, medium flaking	0.16272	*0.87483*
Rectanguloid, fine flaking	-0.23062	*0.87097*
Rectanguloid, crude flaking, laterally ground	*0.91513*	0.09835
Rectanguloid, medium flaking, laterally ground	*0.96034*	0.14816
Rectanguloid, fine flaking, laterally ground	*0.95656*	0.23341
Undifferentiated, crude flaking	0.45258	*0.88198*
Undifferentiated, medium flaking	0.55260	*0.80994*
Undifferentiated, fine flaking	0.30827	*0.94674*
Undifferentiated, crude flaking, laterally ground	*0.77995*	0.49872
Undifferentiated, medium flaking, laterally ground	*0.95561*	0.20922
Undifferentiated, fine flaking, laterally ground	*0.93953*	0.29706

*Flaking: 1-2, crude; 3, medium; 4-5, fine

In sum, this analysis defines dichotomous biface manufacturing technologies that are time-specific to either the Early and Middle Archaic or

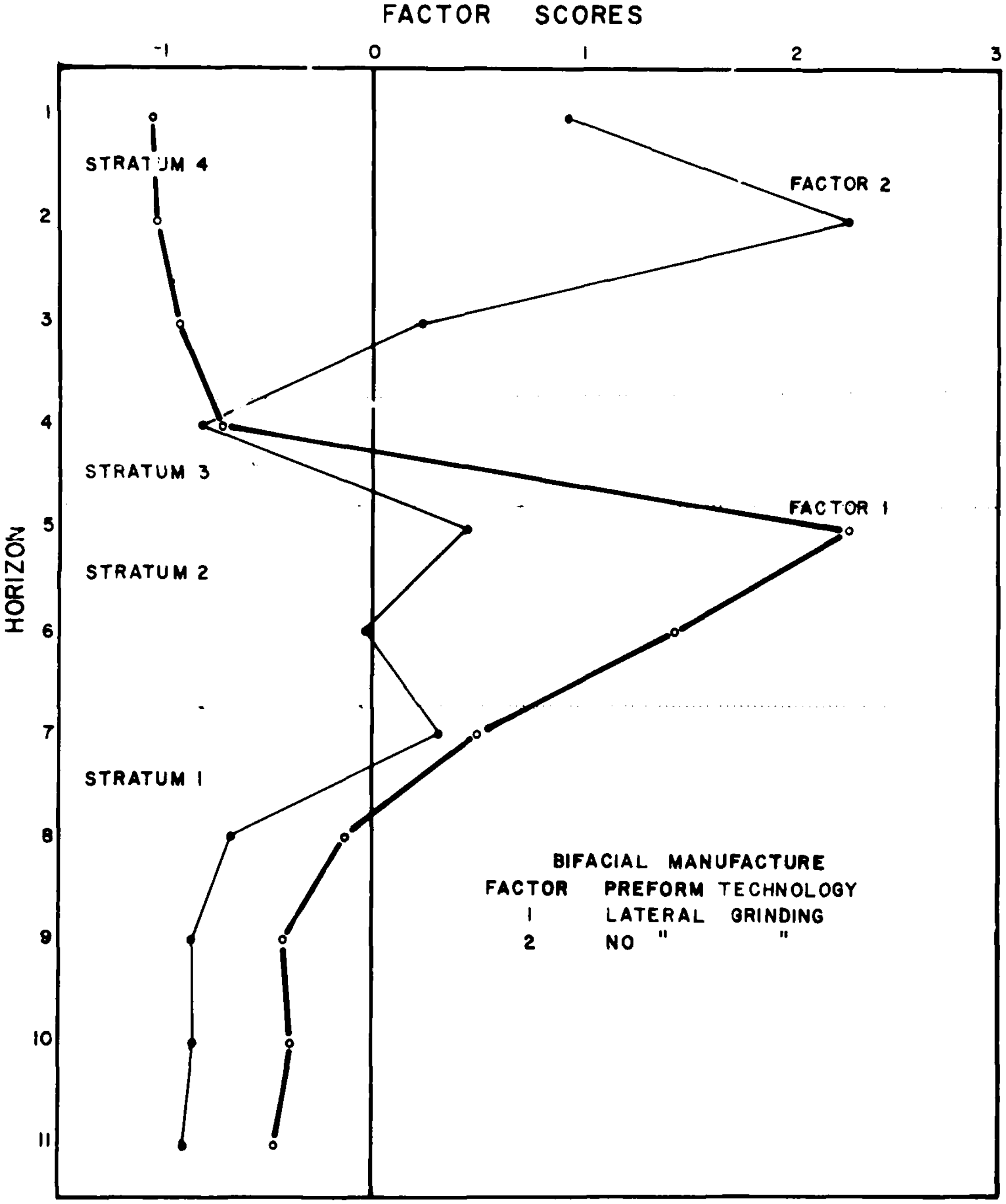

Figure 10.36. Trends in biface preforming technologies defined by principal components analysis of preform fragments. Note that positive scores express important temporal relationships; temporally dichotomous technologies are readily apparent.

TABLE 10.40

Varimax Rotated Factor Scores

Horizon	Factor 1	Factor 2
1	-0.818	0.923
2	-0.805	2.301
3	-0.635	0.225
4	-0.486	-0.820
5	2.270	0.447
6	1.430	-0.050
7	0.490	0.315
8	-0.135	-0.692
9	-0.439	-0.877
10	-0.397	-0.860
11	-0.474	-0.913

the Late Archaic/Woodland. It will be of interest to see if other Early and Middle Archaic Plains and Ozark Highland sites also exhibit a similar emphasis in bifacial preform platform preparation through extensive grinding or abrasion.

Use

Input data for analysis of bifacial implements are presented in Table 10.38. Most functional categories are as stated by Ahler and McMillan (1976:165-179) though the category *transverse scraper/grinder* has been excluded due to small sample size (n = 4) and restricted occurrence in Early and Middle Archaic Horizons 5-7 (one also occurs in Horizon 1). *Undifferentiated point* is a morphological, not functional designation. *Burin* refers to tools presumably used for slotting softer materials such as wood, bone or antler and usage follows Semenov (1964:90-100). *Cleaver/chopper* refers to heavy-duty cutting or hacking tools made from large flakes or oblong chert nodules. One edge is bifacially worked only. Frison (1974:92-95) describes functionally similar though morphologically different tools and regards them as butchering implements. *Wedge-hammerstone* refers to a bifacially flaked wedge-shaped implement with extensive battering indicative of hammerstone use as previously discussed. Ranere (1975:190-192) describes similarly shaped and worn tools as tabular and broad-based wedges, which he experimentally employed in splitting wood; they may have had a similar function at Rodgers Shelter. *Spokeshaves* have a retouched concavity generally considered to be used to shave wood. The sample of bifacially flaked spokeshaves is small and is probably not representative of their overall importance as others were probably prepared by unifacial flaking.

Four unrotated factors, respectively accounting for 56.7%, 20.5%, 8.9% and 6.1% of the variance have eigenvalues greater than 1.0 and were rotated. Factor loadings for the four orthogonal, or varimax rotated factors are represented in Table 10.41; scores in Table 10.42.

TABLE 10.41

Bifacial Implements Varimax Rotated Factor Matrix*

Functional Categories	Factor 1	Factor 2	Factor 3	Factor 4
Hafted Perforator	*0.92906*	0.09201	-0.01624	0.07973
Perforator	0.43819	*0.80032*	0.17612	0.06496
Adz	0.37647	0.61335	0.46946	0.46894
Unhafted Cutting Tool	*0.75038*	0.51831	0.23367	0.26916
Burin	-0.18423	*0.77639*	0.45511	0.09610
Cleaver/Chopper	-0.11410	0.63561	0.64573	0.29097
Wedge-hammerstone	*0.93692*	-0.16901	0.02809	-0.24031
Spoke-shave	0.26217	-0.13947	-0.10903	*0.86548*
Projectile point, fragment	*0.80230*	0.16900	0.08768	0.49373
Projectile point, whole	*0.88540*	0.23968	0.06689	0.36327
Hafted cutting tool, fragment	0.21662	0.33478	*0.76906*	-0.21184
Hafted cutting tool, whole	0.03575	0.22401	*0.94834*	-0.04466
Hafted multipurpose tool, fragment	*0.75224*	0.46329	0.21439	0.40825
Hafted multipurpose tool, whole	*0.73294*	0.30915	0.20680	0.52411
Undifferentiated point, fragment	0.39374	*0.79270*	0.19434	0.32461
Undifferentiated point, whole	0.20681	0.29785	*0.63069*	0.50097
Hafted scraper	0.19001	*0.86793*	0.33969	-0.19554
Unhafted scraper	0.30521	*0.86985*	0.21173	-0.12214

*High loadings in italics

TABLE 10.42

Bifacial Implements Varimax Rotated Factor Scores

Horizon	Factor 1	Factor 2	Factor 3	Factor 4
1	1.851	-0.785	-0.063	-0.399
2	1.087	-0.177	-0.153	2.560
3	0.099	-1.280	2.303	-0.751
4	-8.33	-0.358	-0.832	-0.191
5	0.005	1.950	0.200	-0.063
6	1.397	0.821	-0.896	-1.490
7	-0.598	1.535	1.371	0.342
8	-0.479	-0.547	-0.397	0.475
9	-0.773	-0.417	-0.636	-0.274
10	-0.923	-0.371	-0.068	-0.013
11	-0.832	-0.368	-0.826	-0.194

Factor 1 is interpreted as a game hunting tool kit and has high positive loadings on seven categories, hafted perforator, unhafted cutting tool, wedge-hammerstone, projectile points (whole and fragments) and hafted multipurpose tools (whole and fragments). Wilson (1899:957-959) illustrates several "hafted perforators" imbedded in human skeletons, and it well may be that several of the Rodgers Shelter hafted perforators were similarly used as projectiles.

Plotting of Factor 1 scores (Fig. 10.37) shows that hunting is prominent in the Middle Archaic Horizon 6 and becomes increasingly important in the Late Archaic and Woodland horizons 1-3.

Factor 2 has positive high loadings on five categories, perforator, burin, undifferentiated point fragment, hafted and unhafted scrapers. Two categories, adz and cleaver/chopper, have moderate positive loadings as well; of these, cleaver/chopper also has a moderate positive loading on Factor 3. Factor 2 is interpreted as basic maintenance tool kits involved in wood, bone and antler working and scraping of hides(?). Factor 2 scores (Fig. 10.37) are positive only for the Early and Middle Archaic horizons 5-7, though both the Dalton Horizon 10 and Late Archaic/Woodland Horizon 2 have near-positive scores as well. Factor 2 is a prime diachronic differentiator of site activity.

Factor 3, in addition to the moderate loading on cleaver/chopper, has high positive loadings on hafted cutting tools (whole and fragments) and whole undifferentiated points, interpreted as butchering tool kits. Its scores show several peaks (Fig. 10.37) in importance during the Archaic, and largely an inverse relationship to Factor 1: Butchering activities represented by Factor 3 are prominent specifically in the Early Archaic Horizon 7, Middle Archaic Horizon 5 and the late Archaic Horizon 3.

Factor 4 has only a high positive loading on the category, spokeshave, and is not further considered in this discussion.

IX. SUMMARY AND COMMENTS

Marvin Kay

These studies, and those presented in Chapter 11, indicate where basic differences in usage of tools, raw materials, manufacturing technologies exist for Rodgers Shelter components. Summary comments follow.

RAW MATERIALS

Exploited natural resources such as chert, dolomite, sandstone and probably the minerals hematite or galena are predominately of local origin. Inter-horizon differences in usage of chert are few. Significant differences in material occur with the hand held ground stone implements, of which the Early and Middle Archaic horizons 5-7 are mainly of dolomite or sandstone and the Late Archaic or Woodland horizons 2-3 includes these materials and a significant number of chert. Then too, Dalton Horizon 10 does exhibit a reliance on chert nodules derived from river gravels (i.e., cores, bifaces); this selectivity is hypothe-

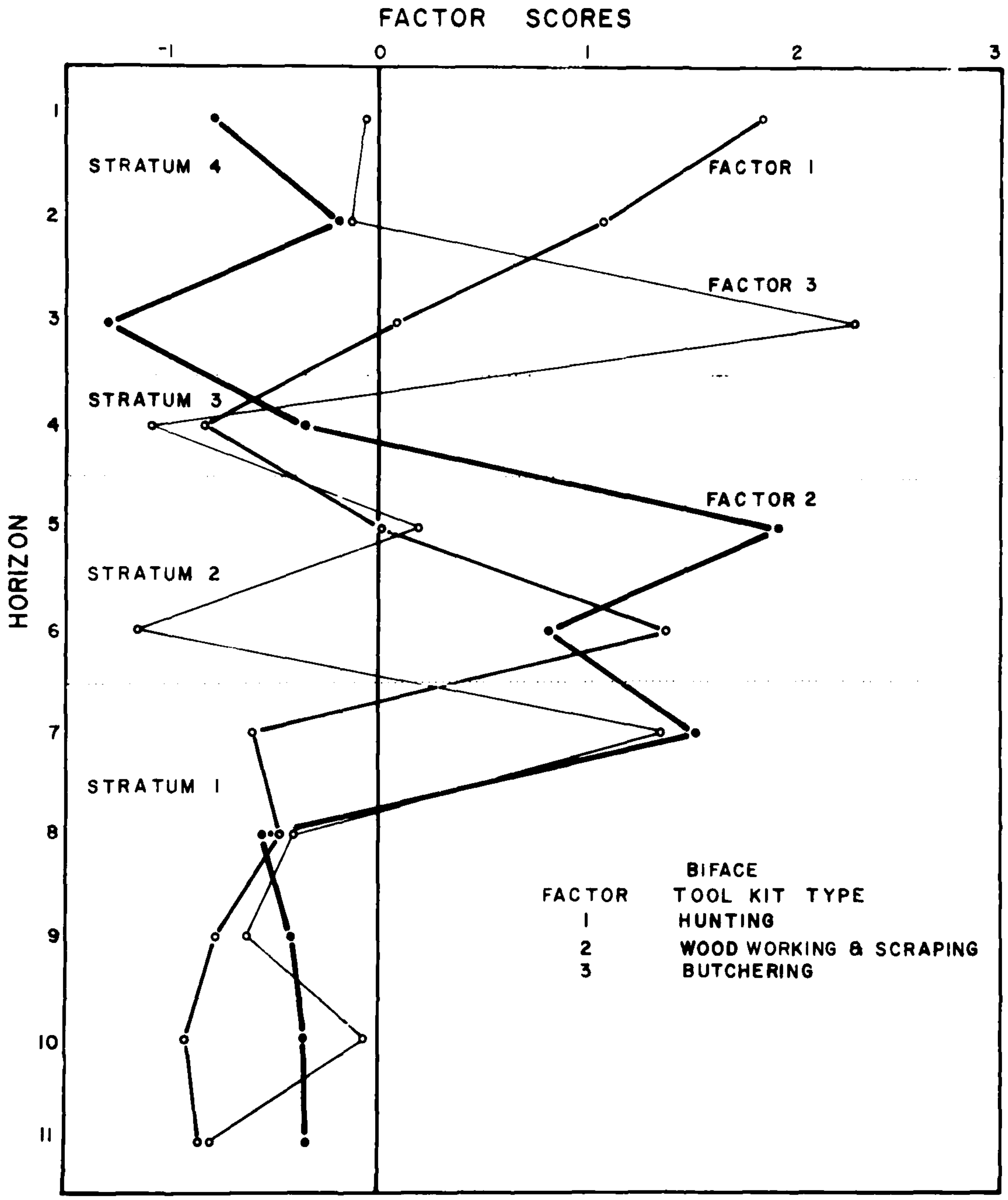

Figure 10.37. Trends in activity expressed by principal components analysis of bifacial implements.

sized to have been in response to then-existing geomorphic conditions which favored use of river gravels for flintworking materials. As hillslopes eroded, other exposures of suitable flintworking materials became more accessible; post-Dalton horizons manifest a primary reliance on hillslope-derived chert.

Possibly influenced by landscape changes as well was use of hematite which peaks in the Early and Middle Archaic horizons 5-7. However, at ca. 8000 B.P. hematite became an important resource at other sites in the Eastern Woodlands also. It may be that the parallel exploitation of hematite at Rodgers Shelter may have been conditioned in part by undefined interaction among these groups. Usage of galena, ca. 8000 B.P., appears to be without precadence in the Eastern Woodlands.

MANUFACTURING TECHNOLOGIES

Ground stone manufacture was primarily by minimal pecking and grinding, though exceptions exist. Other ground stone implements were not modified by design but rather through repeated use in grinding or rubbing became characteristically worn.

A related technology is pigment production, which depended upon abrasion or grinding of lumps of hematite or galena to produce powder. Differences in the geometry of ground hematite correlate with hardness of individual pieces.

Chipped stone manufacture varies diachronically. In addition to extensive platform preparation of bifacial preforms during the Early and Middle Archaic horizons 5-7 (and probably Dalton Horizon 10), these units have a high incidence of well-worn spheroidal hammerstones that probably correlated with bifacial reduction, and axe manufacture. Similar attention to platform preparation is not evident in the Late Archaic and Woodland horizons 1-3.

ACTIVITY INDICATORS AND TOOL KITS

Dealing strictly with the implements themselves, there are but six basic forms of activity indicated at Rodgers Shelter. The first, tool manufacture and maintenance, resulted in the production of the bulk of the cultural inventory from Rodgers Shelter, including the majority of the biface artifacts. Extractive and industrial activities are represented by chipped and ground stone tools. Although there are technological differences within ground stone tool kits that correlate with individual horizons, only two activities are defined: hematite (pigment) processing, and food processing. Similar relationships adhere with the biface tool kits, which minimally represent hunting, butchering, and wood-bone-antler working/hide(?) scraping. Although not included in the principal components analyses, the presence of axes in the Early and Middle Archaic horizons is independent confirmation of the importance woodworking had at these times.

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CHAPTER 11

STYLISTIC STUDY OF CHIPPED STONE POINTS FROM RODGERS SHELTER

Marvin Kay

I. INTRODUCTION

This study describes stylistic variation of Rodgers Shelter chipped stone projectiles, hafted cutting and scraping tools. These bifacially flaked implements are recognized as horizon markers throughout the midwest and eastern United States; their common occurrence at Rodgers Shelter in dated, well delineated strata which formed over the past 10,500 years make them almost uniquely attractive for chronological purposes. Our primary objective is to establish a chronological framework for Rodgers Shelter, which while it will have an immediate application to on-going research in the western Ozark Highland of Missouri will also serve as a primary reference for the midwest.

Previous research, primarily by Stanley A. Ahler (1971; Ahler and McMillan 1976), has allowed for the functional subdivision of these tools according to macro or microscopic edge wear and evidence of tool maintenance, and has provided a baseline for stylistic subdivision according to tool form. The classification herein proposed is, in many ways, a sequel to Ahler's efforts but differs significantly in approach and goals. *What is important for our* purposes is the systematic delineation of diachronic variation in shapes, flaking characteristics, material selection and subsequent thermal alteration--if any--for functionally specific and/or general tools, their unfinished preforms or reworked forms. Relevant to this goal is Benfer's (1967) four part design for the study of archaeological characters, which in modified form is followed here.

Benfer's thesis is that a variable portion of an archaeological characteristic is knowable from its position in time and/or space. And where such knowledge exists (and depending upon other circumstances), it may be a means to estimate either cultural variability through time or the boundaries of a culture area. These ideas and expectations are often intuitive aspects of classificatory schemes. What is notable about Benfer's statement is its rigorous methodology which, if only in part, has been integral to subsequent studies (cf., Ahler 1971; Calabrese 1972; Kay 1975). Benfer (1967:719) succinctly proposes:

(1) Factor analysis to develop the descriptive characteristics of artifacts.
(2) Analysis of sources of variance to validate the archaeological usefulness of the characteristics found in (1).
(3) Grouping analysis and factor analysis to develop artifact types based on the characteristics found in (1) and validated in (2).
(4) Multivariate analysis to test the validity and usefulness of the types developed in step (3).

Cumbersome though this method may appear, for Rodgers Shelter it has several advantages, not the least of which is its replicability. But we would not argue that conventional classifications cannot produce "valid" types such as Dalton or Folsom points. Obviously, there is little disagreement about what each is or the fact that while both are lanceolates they are dissimilar. What is known to a lesser degree, if at all, is geographic or temporal variation of Dalton or Folsom points--systematic relationships which could be determined by multivariate techniques. One might further note that numerical taxonomic approaches often provide new insight into old but unresolved problems. For instance, the presence or absence, of notches on Cahokia triangular points has been found to be insignificant (Benfer 1972:549), whereas the blade configuration of Texas Archaic points (Benfer 1967) is important for their classification. Indeed, because of these advantages, there has been a recent proliferation of multivariate classifications of mainly midwest point types (Luchterhand 1970; White 1974; Gunn and Prewitt 1975) as well as other artifacts (Adovasio and Gunn 1977).

II. THE METHODOLOGY OF POINT CHARACTERIZATION

> *...let me assess what archaeologists have traditionally expected of their types. First, types are abstractions from reality and not the artifacts themselves (Rouse 1939; Chang 1967a:4). In addition, types are often considered as reflections of the "mental template" of the maker (Deetz 1967, 1967), as "mental patterns" (Krieger 1944:272), as "fossilized ideas (Deetz 1967:45), as "intellectual ideas" (Rouse 1939: 20), and comprised of a series of "cognitively significant modes" (Chang 1967a, 1967b)...Finally, types also possess temporal and/or spatial significance (Krieger 1944; Steward 1954; Sears 1960; Smith, Willey and Gifford 1960; Rouse 1960). This most salient characteristic of types provides a refreshing area of general agreement in an otherwise quite controversial topic...* [Thomas 1972:38]

My purpose here is not to add to what may be an existing controversy over the meaning of archaeological types. As we would use the term, a type refers to an *analytical construct which embodies a set or sets of interrelated attributes however defined, and which has been established for a particular purpose or purposes.* Our emphasis here is on the usage and explicit definition of archaeological types, specifically point types. We would agree with Thomas (1972) that definition of archaeological types is little different in method from that of any other discipline; and that while "feel" or "intuition" is often a valid approach, numerical taxonomy is an objective--if less economical--basis for at least the first phase of classification, the construction of phenetic units or homogeneous groups.

How one might gauge differences among similar point forms and their expression as point typologies is the crux of the matter. For intuitively defined types confirmation of type examples is generally dependent upon the individual responsible for the typology or is by reference to direct comparison with type examples, their conventional descriptions and/or photographs. This is not possible in all cases. And even if it were, resolution would still be less than perfect. Similarly, different multivariate clustering procedures using the same data will produce varying results. Even so, because types are no more than abstractions that model "reality" for one purpose or another, the fact that numerical taxonomic groups differ depending upon which procedure is used is of no greater significance than the differences repeatedly found in applying conventional typological methods. The salient distinction between the two is that on the one hand numerical taxonomies are objective and reproducible, whereas on the other hand, conventional typologies are neither objective nor reproducible. Clearly, numerical taxonomy is methodologically the better choice and it does not exclude use of intuition in determining attributes which are explicitly considered in a phenetic analysis. Indeed, the selection of attributes rather than the mechanics of the analysis is pivotal; stated in contemporary terms: garbage in, garbage out.

In American studies a primary predisposition that is at least as old as the research of Dr. Charles Rau (cf., Wilson 1899) is to characterize point types by similarities in form and size. Subsequent efforts differ primarily in measurement or attention to flaking characteristics, functional indicators, material selection or its thermal alteration. But the reliance on point form and size remains axiomatic whether or not classification considers only nominal observation (presence or absence), ordinal or interval scaled measurement. And they are focal attributes of this study.

A second consideration is isolation of independent sources of variation that influence the form and size of chipped stone points. Prime among these would be the tool fabricator's ability as a flint knapper, the technological tradition in which he operates and environmental constraints in resource selection or acquisition. Other limitations such as variable tool use or post depositional history might equally be applied to specific assemblages. Regardless, what is important in this, the first phase of classification is that seminal attributes which limit form or size be evaluated as part of the initial process of characterizing point types.

It should be apparent as well that the faculty to measure all of these attributes is at best imperfect, even considering recent advances in defining idiosyncratic patterns in flint knapping (Gunn 1975) or in understanding tool use (Ahler 1971). A pragmatic solution to this dilemma would be to select a battery of variables (measureable characteristics) which pertain to these attributes, if only minimally. For illustration, the technology of point manufacture and identification of lithic resources are two of the more quantifiable aspects of the Rodgers Shelter point sample; to a much lesser degree is it possible to assess individual variation in manufacturing skill, progressive changes in blade element shape or flaking patterns which correlate with tool use.

Given these observations, matrices of similarity can be computed for some or all of the attributes under consideration and ultimately through the use of one clustering procedure or another homogeneous point groups, or types, can be derived. To quote Thomas (1972:42), this approach would be analogous to the conventional method of comparing "each artifact on the lab table with others" and then sorting them into "taxonomic piles." As a final caveat, we should note that slavish adherence to objective measurement followed by consistent usage of one or perhaps several multivariate techniques is not enough for entirely pragmatic reasons. Conventional point types remain the most widely used and accepted characterization of variability in point assemblages. A numerical taxonomic classification which fails to consider conventional point typologies or, worse, that merely demonstrates that widely divergent forms are measurably discrete (cf., Luchterhand 1970) is no more than an exercise of pedantry.

The approach we propose then is one that would (a) efficiently characterize point groups in an objective, replicable manner and (b) concurrently evaluate conventional methods as applied to specific point assemblages by known typologies.

Discriminant function analysis, a multivariate statistical technique, is suitable for measuring similarity among chipped stone points because it attempts to minimize intragroup variation (i.e., variation among points from a single proposed type), while maximizing the Euclidean distance among groups (i.e., several point types of similar shape) (Cooley and Lohnes 1971:243-250). In this study discriminant function analysis tests the null hypothesis: no statistically significant variation occurs among conventional point types having similar form and size from Rodgers Shelter.

We should underscore as well that point type definition is independent of discriminant function analysis, although classification of specimens into one of several predetermined groups or types is one of the main uses of the technique. Our choice of conventionally defined point types as criterion groups was a matter of convenience with practical application to other studies. Nonetheless, we would not wish to minimize the heuristic potential of numerical taxonomy to generate point types; for this, included also are the results of multivariate, hierarchial cluster analyses which can be directly compared with the conventionally defined point types.

THE STUDY SAMPLE

The major Rodgers Shelter excavations were conducted during the summers of 1963-1968 and subsequent small scale excavations continued in the summers of 1974 and 1976. This study considers only artifacts recovered from the 1960's with the exception of a few specimens from the later excavations. The latter consists of point preforms or complete points illustrative of either stages of manufacture or the finished product where previous specimens are fragmentary. The exclusion of the 1970's specimens was predicated by their being unsorted or unexcavated when this study was started in 1975. Nonetheless, the 1970's samples are small and consist of similar point categories to those considered here. Their inclusion would not, in any event, have appreciably affected either type descriptions or the relative frequencies of point types. They are included in tabulations presented in the previous chapter, however.

The 1960's sample consists of 954 complete points or proximal fragments, and medial and distal point segments or point preforms. Of the 954 tabulated specimens, 862 (90.4%) are classified into one or another of fifty-four point categories (a reduction of three from an original listing of 57). The remainder are either too fragmentary or amorphous for classification. Of the conventionally typed points, 726 (84.2%) are provenienced to a correlative level, of which the majority (657 specimens, or 90.5%) are from the excavation beneath the shelter or to its immediate front (i.e., the main excavation area) and are used for diachronic frequency distributions (Tables 11.1, 11.2).

As a whole, the sample represents a multiplicity of forms and illustrates varying flaking techniques, raw material selection and subsequent heat treatment for functionally discrete categories (cf., Ahler and McMillan 1976) for a period of some 10,000 years. Succinctly stated, the sample is of a size and complexity to warrant standardized coding for the discriminant and other analyses used in this study.

CODING PROCEDURE

Polar Co-ordinate Measurement of Shape

To our knowledge, polar co-ordinate measurement of shape (i.e., form *and* size) has been attempted only for Archaic points from northwest Missouri counties near Kansas City (White 1974), although its use for other unifacial or bifacial implements is reasonably well established in Old and New World studies (cf., Sackett 1966; Wilmsen 1970; Tringham *et al.* 1974; White 1973). White (1974:18) concisely describes the method as "measuring from a centroid the coordinates of peripheral points, describing the outline of any irregularly shaped object" and its primary purpose as being an attempt "to minimize the loss of information encountered when continuous data in the form of lines or surfaces are transformed into discrete (interval scale) measurements compatible with statistical manipulations." Our use of this technique was conditioned indirectly by White's work and it was only after our study was well under way that her 1974 article was read. Her selection of 18 sets of coordinates and our similar usage of 19 to inscribe point outlines is perhaps all the more surprising and would suggest that there are relatively a small number of observations needed to optimally describe the shapes of many different points. There are, however, significant differences in the way her study and ours measured points.

Chief among these are the initial orientation of specimens and our omission of coordinates dependent upon a particular haft element morphology. Specimen orientation in this study is with reference to the proximal (i.e., basal) end of the artifact, longitudinally bisected on the 0° axis at a distance from the centroid of 0.5 inch, as shown in Figure 11.1. Symmetry was not considered in orienting specimens and often the distal end, or tip, of complete specimens was not precisely aligned with the 180° axis but would be to one side. Coordinates 1 - 8 and 12 - 19 are at 20° intervals, starting at the 170° axis. This system insured that consistent measurement would be possible for any complete specimen or proximal point fragment of greater than 0.5 inch (12.7 mm) length.

In practice, specimens were rigidly held against a sheet of polar co-ordinate paper and a tick mark was made on the paper corresponding to the point outline for each coordinate. Specific coordinates were omitted as needed for fragmented or incomplete specimens; that is to say, were a lateral sector missing for one coordinate and it was not

TABLE 11.1

Crosstabulation of Point Group by Horizon

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* * * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * * * * * * * * * * * * *
     V10        PT GROUP                                          BY  V8        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  PAGE  1 OF  8

                    V8
             COUNT I
           ROW PCT IONE      TWO      THREE    FIVE     SIX      SEVEN    EIGHT    NINE     TEN           ROW
           COL PCT I                                                                                   TOTAL
           TOT PCT I      1 I      2 I      3 I      5 I      6 I      7 I      8 I      9 I     10 I
V10      ----------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 1 I     10 I      3 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I     13
  SCALLORN         I   76.9 I   23.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    2.0
                   I    7.0 I    2.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    1.5 I    0.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 2 I     10 I      1 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I     12
                   I   83.3 I    8.3 I    0.0 I    0.0 I    8.3 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8
                   I    7.0 I    0.7 I    0.0 I    0.0 I    1.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    1.5 I    0.2 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 3 I      2 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      3
  SCALLORN LIKE    I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                   I    1.4 I    0.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.3 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 5 I      1 I      0 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      2
                   I   50.0 I    0.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                   I    0.7 I    0.0 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.2 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 6 I     32 I     17 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I     50
RICE SIDE NOTCH    I   64.0 I   34.0 I    2.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    7.6
                   I   22.4 I   12.1 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    4.9 I    2.6 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 7 I      1 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      3
  GARY             I   33.3 I   66.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                   I    0.7 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.2 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 8 I     13 I     10 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I     23
  LANGTRY          I   56.5 I   43.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    3.5
                   I    9.1 I    7.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    2.0 I    1.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 9 I      4 I      8 I      5 I      0 I      0 I      0 I      0 I      0 I      0 I     17
  SMITH            I   23.5 I   47.1 I   29.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    2.6
                   I    2.8 I    5.7 I    8.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.6 I    1.2 I    0.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                10 I      0 I      0 I      0 I      0 I      0 I      1 I      0 I      1 I      1 I      3
  FLUTED LANCE     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   33.3 I    0.0 I   33.3 I   33.3 I    0.5
                   I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.2 I    0.0 I   25.0 I   10.0 I
                   I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I    0.2 I    0.2 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                11 I      2 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      3
  AFTON            I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                   I    1.4 I    0.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.3 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                12 I      1 I      3 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      5
  TABLE ROCK       I   20.0 I   60.0 I   20.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.8
                   I    0.7 I    2.1 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.2 I    0.5 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                13 I      6 I     16 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I     22
                   I   27.3 I   72.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    3.3
                   I    4.2 I   11.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.9 I    2.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                14 I      6 I     10 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I     17
                   I   35.3 I   58.8 I    5.9 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    2.6
                   I    4.2 I    7.1 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.9 I    1.5 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                15 I      0 I      2 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      3
                   I    0.0 I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                   I    0.0 I    1.4 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    0.0 I    0.3 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
            COLUMN      143      140       61      104       81       85       29        4       10     657
             TOTAL     21.8     21.3      9.3     15.8     12.3     12.9      4.4      0.6      1.5   100.0
(CONTINUED)
```

TABLE 11.1 (continued)

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * * * *
   V10        PT GROUP                                           BY  V8          HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  PAGE  3 OF  8

                 V8
        COUNT   I
        ROW PCT IONE      TWO      THREE    FIVE     SIX      SEVEN    EIGHT    NINE     TEN          ROW
        COL PCT I                                                                                     TOTAL
        TOT PCT I      1 I      2 I      3 I      5 I      6 I      7 I      8 I      9 I     10 I
V10     --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             16 I      5 I      3 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      9
                I   55.6 I   33.3 I   11.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.4
                I    3.5 I    2.1 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                I    0.8 I    0.5 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             17 I      0 I      4 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      6
  SEDALIA       I    0.0 I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9
                I    0.0 I    2.9 I    3.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                I    0.0 I    0.6 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             18 I      0 I      2 I      0 I     12 I     11 I     21 I     12 I      1 I      0 I     59
  RICE LANCE    I    0.0 I    3.4 I    0.0 I   20.3 I   18.6 I   35.6 I   20.3 I    1.7 I    0.0 I    9.0
                I    0.0 I    1.4 I    0.0 I   11.5 I   13.6 I   24.7 I   41.4 I   25.0 I    0.0 I
                I    0.0 I    0.3 I    0.0 I    1.8 I    1.7 I    3.2 I    1.8 I    0.2 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             19 I      0 I      0 I      0 I      6 I      8 I      3 I      2 I      0 I      0 I     19
                I    0.0 I    0.0 I    0.0 I   31.6 I   42.1 I   15.8 I   10.5 I    0.0 I    0.0 I    2.9
                I    0.0 I    0.0 I    0.0 I    5.8 I    9.9 I    3.5 I    6.9 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    0.9 I    1.2 I    0.5 I    0.3 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             20 I      0 I      0 I      0 I      4 I      5 I      4 I      0 I      0 I      0 I     13
                I    0.0 I    0.0 I    0.0 I   30.8 I   38.5 I   30.8 I    0.0 I    0.0 I    0.0 I    2.0
                I    0.0 I    0.0 I    0.0 I    3.8 I    6.2 I    4.7 I    0.0 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    0.6 I    0.8 I    0.6 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             21 I      0 I      0 I      0 I      1 I      1 I      2 I      0 I      0 I      0 I      4
  DALTON LIKE   I    0.0 I    0.0 I    0.0 I   25.0 I   25.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.6
                I    0.0 I    0.0 I    0.0 I    1.0 I    1.2 I    2.4 I    0.0 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    0.2 I    0.2 I    0.3 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             22 I      0 I      0 I      0 I      0 I      0 I      0 I      1 I      0 I      6 I      7
  DALTON        I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   14.3 I    0.0 I   85.7 I    1.1
                I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    3.4 I    0.0 I   60.0 I
                I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I    0.9 I
        --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             23 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      3 I      3
  PLAINVIEW     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I  100.0 I    0.5
                I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   30.0 I
                I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             24 I      0 I      0 I      0 I      1 I      2 I      3 I      5 I      1 I      0 I     12
  RICE LOBED    I    0.0 I    0.0 I    0.0 I    8.3 I   16.7 I   25.0 I   41.7 I    8.3 I    0.0 I    1.8
                I    0.0 I    0.0 I    0.0 I    1.0 I    2.5 I    3.5 I   17.2 I   25.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    0.2 I    0.3 I    0.5 I    0.8 I    0.2 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             25 I      0 I      0 I      1 I     11 I     11 I      9 I      1 I      0 I      0 I     33
  HIDDEN VALLEY I    0.0 I    0.0 I    3.0 I   33.3 I   33.3 I   27.3 I    3.0 I    0.0 I    0.0 I    5.0
                I    0.0 I    0.0 I    1.6 I   10.6 I   13.6 I   10.6 I    3.4 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.2 I    1.7 I    1.7 I    1.4 I    0.2 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             26 I      0 I      0 I      1 I      6 I      2 I      4 I      2 I      0 I      0 I     15
  RODGERS FLARED I   0.0 I    0.0 I    6.7 I   40.0 I   13.3 I   26.7 I   13.3 I    0.0 I    0.0 I    2.3
                I    0.0 I    0.0 I    1.6 I    5.8 I    2.5 I    4.7 I    6.9 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.2 I    0.9 I    0.3 I    0.6 I    0.3 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             27 I      0 I      0 I      0 I      5 I      3 I      5 I      0 I      0 I      0 I     13
                I    0.0 I    0.0 I    0.0 I   38.5 I   23.1 I   38.5 I    0.0 I    0.0 I    0.0 I    2.0
                I    0.0 I    0.0 I    0.0 I    4.8 I    3.7 I    5.9 I    0.0 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    0.8 I    0.5 I    0.8 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             28 I      0 I      0 I      0 I      9 I      4 I      4 I      0 I      0 I      0 I     17
  KIRK-LIKE     I    0.0 I    0.0 I    0.0 I   52.9 I   23.5 I   23.5 I    0.0 I    0.0 I    0.0 I    2.6
                I    0.0 I    0.0 I    0.0 I    8.7 I    4.9 I    4.7 I    0.0 I    0.0 I    0.0 I
                I    0.0 I    0.0 I    0.0 I    1.4 I    0.6 I    0.6 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             29 I      1 I      0 I      0 I     16 I     13 I      7 I      0 I      0 I      0 I     37
  WILLIAMS      I    2.7 I    0.0 I    0.0 I   43.2 I   35.1 I   18.9 I    0.0 I    0.0 I    0.0 I    5.6
                I    0.7 I    0.0 I    0.0 I   15.4 I   16.0 I    8.2 I    0.0 I    0.0 I    0.0 I
                I    0.2 I    0.0 I    0.0 I    2.4 I    2.0 I    1.1 I    0.0 I    0.0 I    0.0 I
               -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
         COLUMN      143      140       61      104       81       85       29        4       10      657
          TOTAL     21.8     21.3      9.3     15.8     12.3     12.9      4.4      0.6      1.5    100.0
(CONTINUED)
```

TABLE 11.1 (continued)

```
* * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * *
   V10        PT GROUP                                              BY  V8          HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  PAGE  5 OF  8

                   V8
          COUNT  I
        ROW PCT  IONE      TWO      THREE    FIVE     SIX      SEVEN    EIGHT    NINE     TEN         ROW
        COL PCT  I                                                                                    TOTAL
        TOT PCT  I      1 I      2 I      3 I      5 I      6 I      7 I      8 I      9 I     10 I
V10      --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             30  I      0 I      0 I      1 I     16 I     12 I      6 I      0 I      0 I      0 I     35
  MARCOS         I    0.0 I    0.0 I    2.9 I   45.7 I   34.3 I   17.1 I    0.0 I    0.0 I    0.0 I    5.3
                 I    0.0 I    0.0 I    1.6 I   15.4 I   14.8 I    7.1 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.2 I    2.4 I    1.8 I    0.9 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             31  I      1 I      3 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      4
                 I   25.0 I   75.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6
                 I    0.7 I    2.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.2 I    0.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             32  I      0 I      0 I      0 I      1 I      1 I      0 I      0 I      0 I      0 I      2
                 I    0.0 I    0.0 I    0.0 I   50.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                 I    0.0 I    0.0 I    0.0 I    1.0 I    1.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.2 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             33  I      0 I      0 I      0 I      2 I      1 I      1 I      1 I      0 I      0 I      5
                 I    0.0 I    0.0 I    0.0 I   40.0 I   20.0 I   20.0 I   20.0 I    0.0 I    0.0 I    0.8
                 I    0.0 I    0.0 I    0.0 I    1.9 I    1.2 I    1.2 I    3.4 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.3 I    0.2 I    0.2 I    0.2 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             34  I      0 I      0 I      0 I      3 I      0 I      0 I      0 I      0 I      0 I      3
  LECROY         I    0.0 I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                 I    0.0 I    0.0 I    0.0 I    2.9 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             35  I      0 I      0 I      0 I      1 I      0 I      0 I      0 I      1 I      0 I      2
  JACKIE STEMMED I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    0.3
                 I    0.0 I    0.0 I    0.0 I    1.0 I    0.0 I    0.0 I    0.0 I   25.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             36  I      0 I      0 I      0 I      1 I      2 I      3 I      4 I      0 I      0 I     10
  GRAHAM CAVE    I    0.0 I    0.0 I    0.0 I   10.0 I   20.0 I   30.0 I   40.0 I    0.0 I    0.0 I    1.5
                 I    0.0 I    0.0 I    0.0 I    1.0 I    2.5 I    3.5 I   13.8 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.2 I    0.3 I    0.5 I    0.6 I    0.0 I    0.0 I
         --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             37  I      0 I      1 I      0 I      2 I      1 I      6 I      0 I      0 I      0 I     10
  FRIO           I    0.0 I   10.0 I    0.0 I   20.0 I   10.0 I   60.0 I    0.0 I    0.0 I    0.0 I    1.5
                 I    0.0 I    0.7 I    0.0 I    1.9 I    1.2 I    7.1 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.2 I    0.0 I    0.3 I    0.2 I    0.9 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             38  I      0 I      1 I      0 I      2 I      1 I      1 I      0 I      0 I      0 I      5
                 I    0.0 I   20.0 I    0.0 I   40.0 I   20.0 I   20.0 I    0.0 I    0.0 I    0.0 I    0.8
                 I    0.0 I    0.7 I    0.0 I    1.9 I    1.2 I    1.2 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.2 I    0.0 I    0.3 I    0.2 I    0.2 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             40  I      0 I      0 I      0 I      2 I      1 I      3 I      1 I      0 I      0 I      7
                 I    0.0 I    0.0 I    0.0 I   28.6 I   14.3 I   42.9 I   14.3 I    0.0 I    0.0 I    1.1
                 I    0.0 I    0.0 I    0.0 I    1.9 I    1.2 I    3.5 I    3.4 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.3 I    0.2 I    0.5 I    0.2 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             41  I      0 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      1
  CUPP           I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2
                 I    0.0 I    0.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             42  I      5 I      7 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I     12
  MARCUS         I   41.7 I   58.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8
                 I    3.5 I    5.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.8 I    1.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             43  I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      2
                 I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
             44  I      0 I      1 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      3
                 I    0.0 I   33.3 I   66.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5
                 I    0.0 I    0.7 I    3.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.2 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
         COLUMN       143      140       61      104       81       85       29        4       10        657
          TOTAL      21.8     21.3      9.3     15.8     12.3     12.9      4.4      0.6      1.5      100.0
(CONTINUED)
```

TABLE 11.1 (concluded)

```
* * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * * * * * * * * * * * *
   V10       PT GROUP                                          BY  V8        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE  7 OF  8

                          V8
                 COUNT  I
                ROW PCT IONE      TWO      THREE    FIVE     SIX      SEVEN    EIGHT    NINE     TEN         ROW
                COL PCT I                                                                                   TOTAL
                TOT PCT I      1 I      2 I      3 I      5 I      6 I      7 I      8 I      9 I     10 I
V10             --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     45 I      0 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      2
                        I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                        I    0.0 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.0 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     46 I      4 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      6
                        I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9
                        I    2.8 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.6 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     47 I      1 I      0 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      2
                        I   50.0 I    0.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                        I    0.7 I    0.0 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.2 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     48 I     12 I     14 I      8 I      0 I      0 I      0 I      0 I      0 I      0 I     34
                        I   35.3 I   41.2 I   23.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    5.2
                        I    8.4 I   10.0 I   13.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    1.8 I    2.1 I    1.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     49 I     10 I     14 I      5 I      1 I      0 I      0 I      0 I      0 I      0 I     30
   STONE                I   33.3 I   46.7 I   16.7 I    3.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    4.6
                        I    7.0 I   10.0 I    8.2 I    1.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    1.5 I    2.1 I    0.8 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     50 I      6 I      4 I     21 I      1 I      0 I      0 I      0 I      0 I      0 I     32
   ETLEY                I   18.8 I   12.5 I   65.6 I    3.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    4.9
                        I    4.2 I    2.9 I   34.4 I    1.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.9 I    0.6 I    3.2 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     51 I      1 I      1 I      4 I      0 I      0 I      0 I      0 I      0 I      0 I      6
   CASTORVILLE          I   16.7 I   16.7 I   66.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9
                        I    0.7 I    0.7 I    6.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.2 I    0.2 I    0.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     52 I      5 I      6 I      2 I      0 I      0 I      1 I      0 I      0 I      0 I     14
                        I   35.7 I   42.9 I   14.3 I    0.0 I    0.0 I    7.1 I    0.0 I    0.0 I    0.0 I    2.1
                        I    3.5 I    4.3 I    3.3 I    0.0 I    0.0 I    1.2 I    0.0 I    0.0 I    0.0 I
                        I    0.8 I    0.9 I    0.3 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     54 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      1
                        I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2
                        I    0.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     55 I      1 I      0 I      2 I      1 I      0 I      0 I      0 I      0 I      0 I      4
                        I   25.0 I    0.0 I   50.0 I   25.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6
                        I    0.7 I    0.0 I    3.3 I    1.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                        I    0.2 I    0.0 I    0.3 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                     57 I      0 I      0 I      0 I      0 I      1 I      1 I      0 I      0 I      0 I      2
                        I    0.0 I    0.0 I    0.0 I    0.0 I   50.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.3
                        I    0.0 I    0.0 I    0.0 I    0.0 I    1.2 I    1.2 I    0.0 I    0.0 I    0.0 I
                        I    0.0 I    0.0 I    0.0 I    0.0 I    0.2 I    0.2 I    0.0 I    0.0 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 COLUMN      143      140       61      104       81       85       29        4       10      657
                  TOTAL     21.8     21.3      9.3     15.8     12.3     12.9      4.4      0.6      1.5    100.0

RAW CHI SQUARE =  1805.30566 WITH   416 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =    262
```

TABLE 11.2

Crosstabulation of Point Group by Horizons 5-8

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N
   V10        PT GROUP
                                                          BY  V8
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      V8
             COUNT   I
           ROW PCT   IFIVE       SIX       SEVEN       ROW
           COL PCT   I                                 TOTAL
           TOT PCT   I      5  I      6  I      7  I
V10        ----------I---------I---------I---------I
                   2 I      0  I      1  I      0  I       1
                     I    0.0  I  100.0  I    0.0  I     0.4
                     I    0.0  I    1.2  I    0.0  I
                     I    0.0  I    0.4  I    0.0  I
                    -I---------I---------I---------I
                  10 I      0  I      0  I      1  I       1
  FLUTED LANCE       I    0.0  I    0.0  I  100.0  I     0.4
                     I    0.0  I    0.0  I    1.2  I
                     I    0.0  I    0.0  I    0.4  I
                    -I---------I---------I---------I
                  18 I     12  I     11  I     21  I      44
  RICE LANCE         I   27.3  I   25.0  I   47.7  I    16.3
                     I   11.5  I   13.6  I   24.7  I
                     I    4.4  I    4.1  I    7.8  I
                    -I---------I---------I---------I
                  19 I      6  I      8  I      3  I      17
                     I   35.3  I   47.1  I   17.6  I     6.3
                     I    5.8  I    9.9  I    3.5  I
                     I    2.2  I    3.0  I    1.1  I
                    -I---------I---------I---------I
                  20 I      4  I      5  I      4  I      13
                     I   30.8  I   38.5  I   30.8  I     4.8
                     I    3.8  I    6.2  I    4.7  I
                     I    1.5  I    1.9  I    1.5  I
                    -I---------I---------I---------I
                  21 I      1  I      1  I      2  I       4
  DALTON LIKE        I   25.0  I   25.0  I   50.0  I     1.5
                     I    1.0  I    1.2  I    2.4  I
                     I    0.4  I    0.4  I    0.7  I
                    -I---------I---------I---------I
                  24 I      1  I      2  I      3  I       6
  RICE LOBED         I   16.7  I   33.3  I   50.0  I     2.2
                     I    1.0  I    2.5  I    3.5  I
                     I    0.4  I    0.7  I    1.1  I
           ----------I---------I---------I---------I
                  25 I     11  I     11  I      9  I      31
  HIDDEN VALLEY      I   35.5  I   35.5  I   29.0  I    11.5
                     I   10.6  I   13.6  I   10.6  I
                     I    4.1  I    4.1  I    3.3  I
                    -I---------I---------I---------I
                  26 I      6  I      2  I      4  I      12
  RODGERS FLARED     I   50.0  I   16.7  I   33.3  I     4.4
                     I    5.8  I    2.5  I    4.7  I
                     I    2.2  I    0.7  I    1.5  I
                    -I---------I---------I---------I
                  27 I      5  I      3  I      5  I      13
                     I   38.5  I   23.1  I   38.5  I     4.8
                     I    4.8  I    3.7  I    5.9  I
                     I    1.9  I    1.1  I    1.9  I
                    -I---------I---------I---------I
                  28 I      9  I      4  I      4  I      17
  KIRK-LIKE          I   52.9  I   23.5  I   23.5  I     6.3
                     I    8.7  I    4.9  I    4.7  I
```

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N
   V10        PT GROUP
                                                          BY  V8        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      V8
             COUNT   I
           ROW PCT   IFIVE       SIX       SEVEN       ROW
           COL PCT   I                                 TOTAL
           TOT PCT   I      5  I      6  I      7  I
V10        ----------I---------I---------I---------I
                  33 I      2  I      1  I      1  I       4
                     I   50.0  I   25.0  I   25.0  I     1.5
                     I    1.9  I    1.2  I    1.2  I
                     I    0.7  I    0.4  I    0.4  I
                    -I---------I---------I---------I
                  34 I      3  I      0  I      0  I       3
  LECROY             I  100.0  I    0.0  I    0.0  I     1.1
                     I    2.9  I    0.0  I    0.0  I
                     I    1.1  I    0.0  I    0.0  I
                    -I---------I---------I---------I
                  35 I      1  I      0  I      0  I       1
  JACKIE STEMMED     I  100.0  I    0.0  I    0.0  I     0.4
                     I    1.0  I    0.0  I    0.0  I
                     I    0.4  I    0.0  I    0.0  I
                    -I---------I---------I---------I
                  36 I      1  I      2  I      3  I       6
  GRAHAM CAVE        I   16.7  I   33.3  I   50.0  I     2.2
                     I    1.0  I    2.5  I    3.5  I
                     I    0.4  I    0.7  I    1.1  I
                    -I---------I---------I---------I
                  37 I      2  I      1  I      6  I       9
  FRIO               I   22.2  I   11.1  I   66.7  I     3.3
                     I    1.9  I    1.2  I    7.1  I
                     I    0.7  I    0.4  I    2.2  I
                    -I---------I---------I---------I
                  38 I      2  I      1  I      1  I       4
                     I   50.0  I   25.0  I   25.0  I     1.5
                     I    1.9  I    1.2  I    1.2  I
                     I    0.7  I    0.4  I    0.4  I
                    -I---------I---------I---------I
                  40 I      2  I      1  I      3  I       6
                     I   33.3  I   16.7  I   50.0  I     2.2
                     I    1.9  I    1.2  I    3.5  I
                     I    0.7  I    0.4  I    1.1  I
           ----------I---------I---------I---------I
                  49 I      1  I      0  I      0  I       1
  STONE              I  100.0  I    0.0  I    0.0  I     0.4
                     I    1.0  I    0.0  I    0.0  I
                     I    0.4  I    0.0  I    0.0  I
                    -I---------I---------I---------I
                  50 I      1  I      0  I      0  I       1
  ETLEY              I  100.0  I    0.0  I    0.0  I     0.4
                     I    1.0  I    0.0  I    0.0  I
                     I    0.4  I    0.0  I    0.0  I
                    -I---------I---------I---------I
                  52 I      0  I      0  I      1  I       1
                     I    0.0  I    0.0  I  100.0  I     0.4
                     I    0.0  I    0.0  I    1.2  I
                     I    0.0  I    0.0  I    0.4  I
                    -I---------I---------I---------I
                  55 I      1  I      0  I      0  I       1
                     I  100.0  I    0.0  I    0.0  I     0.4
                     I    1.0  I    0.0  I    0.0  I
```

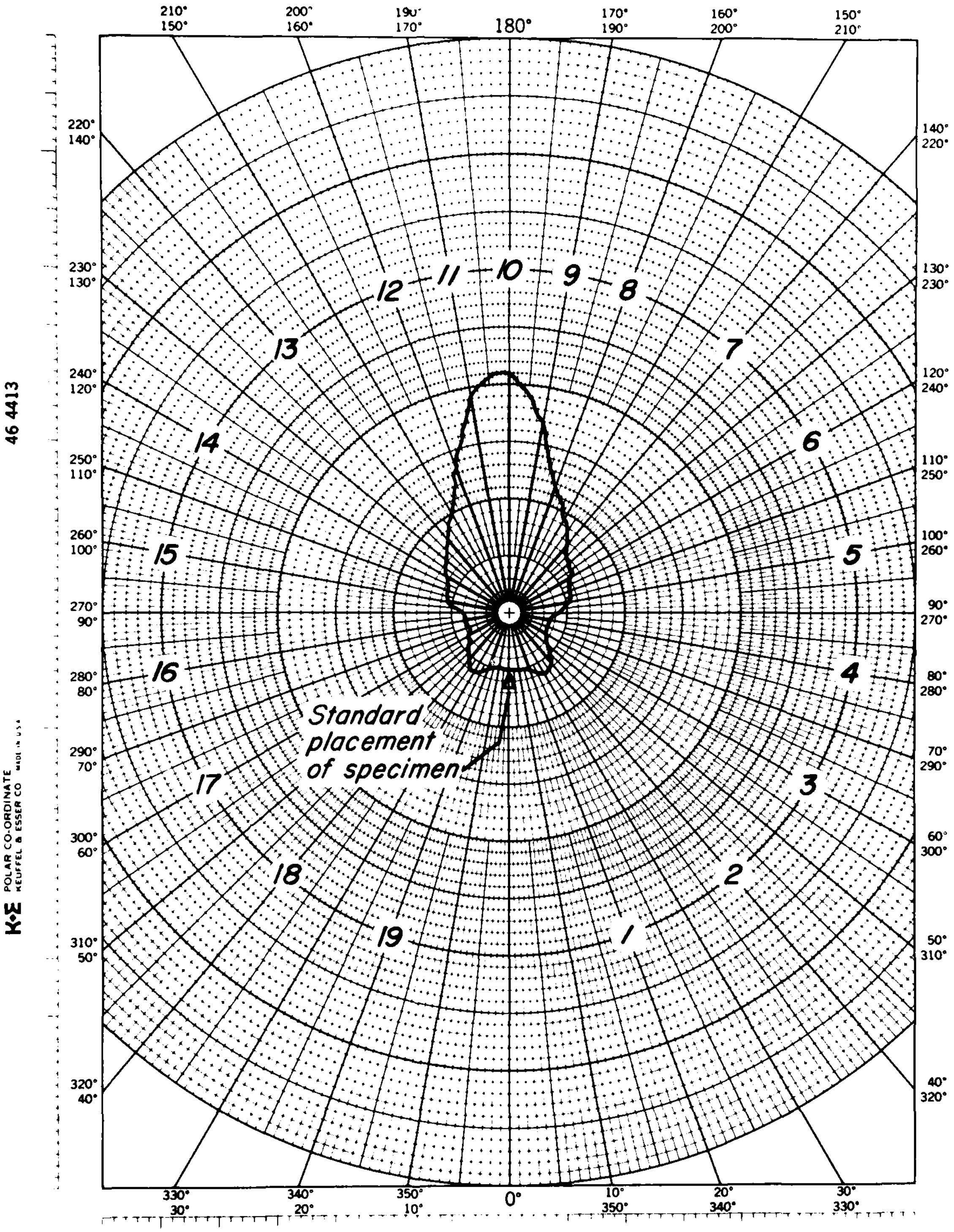

Figure 11.1. Polar coordinate measurements.

possible to interpolate the edge from two coordinates on either side, that coordinate would not be recorded. It also proved useful to note which side was facing the paper so the accuracy of individual coding attempts could be independently verified.

Measurement accuracy was determined to be ±0.1 inch (2.54 mm); for coordinate plots located between two concentric arcs, the measurement recorded was rounded to the arc closest to the centroid.

Although the technique is contingent on neither a specific form such as White's (1974) stemmed point series nor on conventional subdivisions of point morphology (cf., Binford 1963), discrimination among diverse point forms and identification of point morphological subdivisions can be demonstrated readily. Figure 11.2 unequivocally illustrates the power of the 19 coordinate measurement battery to discriminate among diverse forms; more will be said later about the particulars of discriminant function analysis. Conventional aspects of point morphology are also clearly apparent from factor analyses using but 15 of the coordinates. A summary of two principal component factor analyses follows.

Factor analysis, a primary multivariate technique, is equally well suited to assessing conventional aspects of point morphology because it attempts to reduce a set of variables to a smaller number (i.e., factors) that describe the original subject (i.e., point morphology) at a higher level of abstraction (Rummel 1970; Veldman 1967:206). Principal components is one of the most commonly used factor models and it makes no assumptions about the underlying structure of a data set. The two analyses discussed are little different in application but do vary in the method of factor rotation--one being an orthagonal or varimax rotated solution; the other, an oblique rotated solution--and the degree of correlation among the rotated factors. The orthagonal solution computes uncorrelated and thus independent factors, while the oblique solution computes potentially correlated factors. Even though point morphology is generally thought to consist of discrete blade and haft elements, it is doubtful that either could be termed independent of the other. The distinction between the two should be clarified by comparing the rotated solutions.

Subprogram FACTOR (SPSS; Kim 1975) was used for both rotated solutions. For the two, the input matrix consisted of fifteen variables (coordinates 1 - 8 and 13 - 19) for 372 specimens, which represents the total number from our sample which could be measured for the fifteen coordinates. Both solutions produced three rotated factors having eigenvalues greater than 1.0; the three unrotated, principal axis factors are the same for the two analyses and respectively account for 51.7 percent, 14.6 percent and 8.6 percent of the total variance, or a cumulative percentage of 74.8. Inspection of the factor loading matrix of the orthagonal rotated factors, and the oblique pattern and structure matrices (Kim 1975:473-474) together with the oblique factor correlation matrix (Table 11.4) provides clear measures of the correlation of the fifteen coordinates with the rotated factors as well as the strength of correlation among the three oblique factors. The two solutions illustrate the same structuring of the original data, with the exception of showing partial correlations among the three oblique factors, particularly among the first two factors. For either solution Figure 11.3 diagrams the

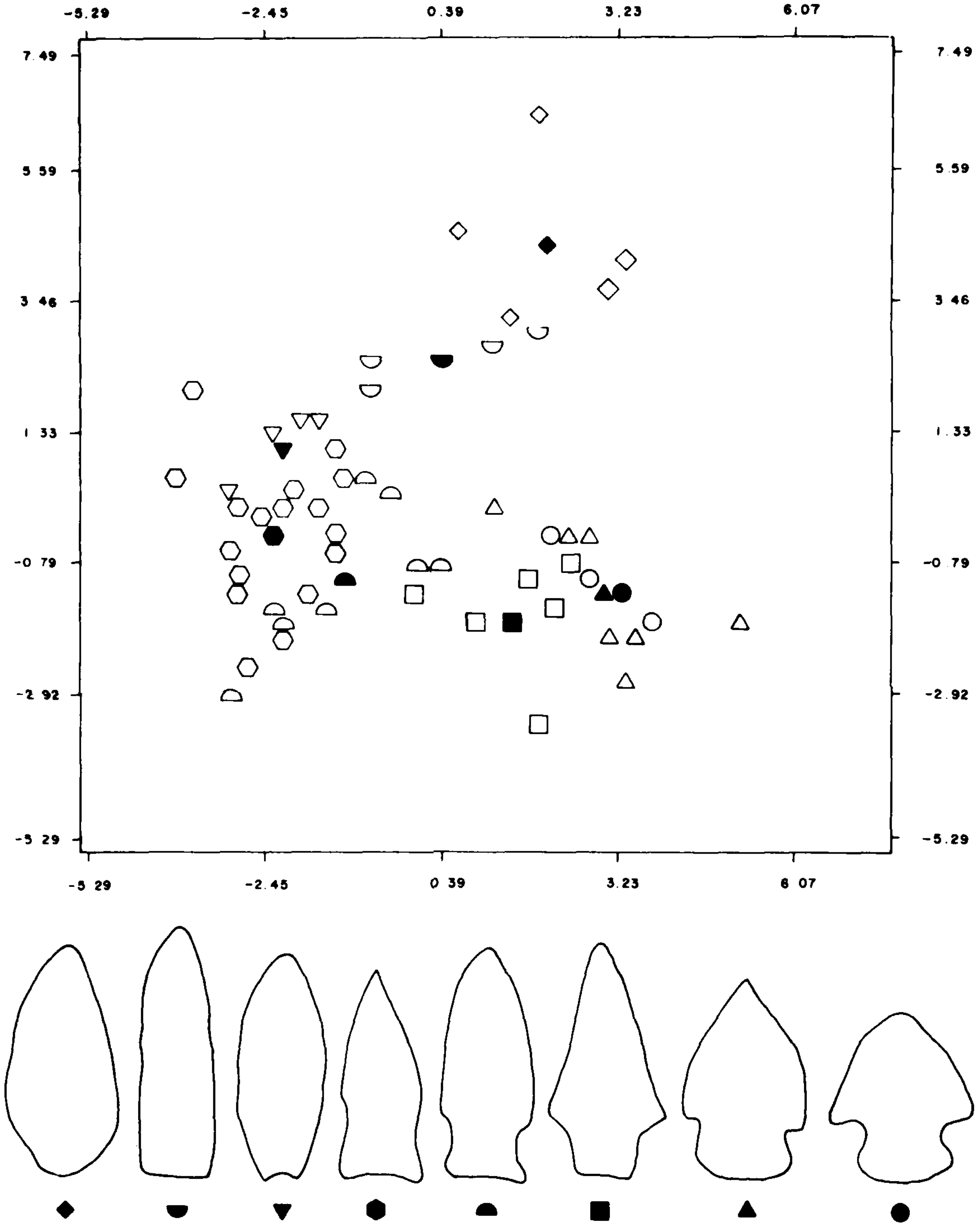

Figure 11.2. Discriminant plots of measured point types. Solid figures denote group centroids.

TABLE 11.3

Comparison of Orthagonal and Oblique Rotated Factors*

	Orthagonal			Oblique					
	Factor Loading			Factor Pattern			Factor Structure		
Variable	One	Two	Three	One	Two	Three	One	Two	Three
v01	0.07	0.12	*0.90*	0.08	-0.01	*0.91*	0.12	0.24	*0.91*
v02	0.18	*0.81*	0.26	-0.04	*0.84*	0.17	0.39	*0.85*	0.37
v03	0.39	*0.73*	0.00	0.19	*0.72*	-0.08	0.57	*0.81*	0.09
v04	0.52	0.48	0.13	0.43	0.37	0.08	0.63	0.62	0.19
v05	*0.79*	0.33	-0.02	*0.78*	0.14	-0.05	*0.85*	0.53	0.01
v06	*0.89*	0.24	0.00	*0.92*	0.00	-0.00	*0.92*	0.47	0.03
v07	*0.92*	0.17	0.04	*0.98*	-0.09	0.04	*0.93*	0.42	0.06
v08	*0.85*	0.12	0.08	*0.93*	-0.13	0.08	*0.86*	0.36	0.09
v13	*0.84*	0.22	0.02	*0.87*	-0.00	0.01	*0.87*	0.44	0.05
v14	*0.86*	0.26	-0.02	*0.88*	0.04	-0.04	*0.89*	0.48	0.00
v15	*0.76*	0.37	-0.03	*0.73*	0.19	-0.07	*0.83*	0.55	0.00
v16	0.48	0.53	0.08	0.37	0.45	0.03	0.60	0.65	0.15
v17	0.26	*0.80*	-0.01	0.02	*0.84*	-0.11	0.46	*0.83*	0.08
v18	0.14	*0.84*	0.20	-0.10	*0.90*	0.10	0.36	*0.87*	0.31
v19	-0.04	0.15	*0.89*	-0.05	0.06	*0.89*	0.01	0.23	*0.91*

Oblique Factor Corrections

Factor	One	Two	Three
One	1.00	0.51	0.04
Two	0.51	1.00	0.23
Three	0.04	0.23	1.00

* Significant correlations of variables are italicized.

high correlations among the fifteen coordinates; showing that Factor 1 identifies the blade element, Factors 2 and 3 the haft element. Not surprisingly, the blade and haft elements, as shown by the oblique rotation, represent polarities in a continuum rather than independent morphological subdivisions.

A final observation about this analysis further substantiates the utility of the polar co-ordinate technique. Coordinates 4 and 16, which in this study measure the distal haft/blade juncture, have but low to moderate factor correlations (Table 11.3) and do not isolate significant variation in point morphology. Measures of the distal haft/blade juncture and associated shoulder/stem angles are common to many point classifications and often are important in distinguishing point types (Luchterhand 1970; White 1974; Gunn and Prewitt 1975; Thomas and Bettinger 1976:282-295). However, the results of this analysis differ in as much as the description of point shape with this polar co-ordinate technique is simpler and more efficient, requiring no prior assumptions about point shape.

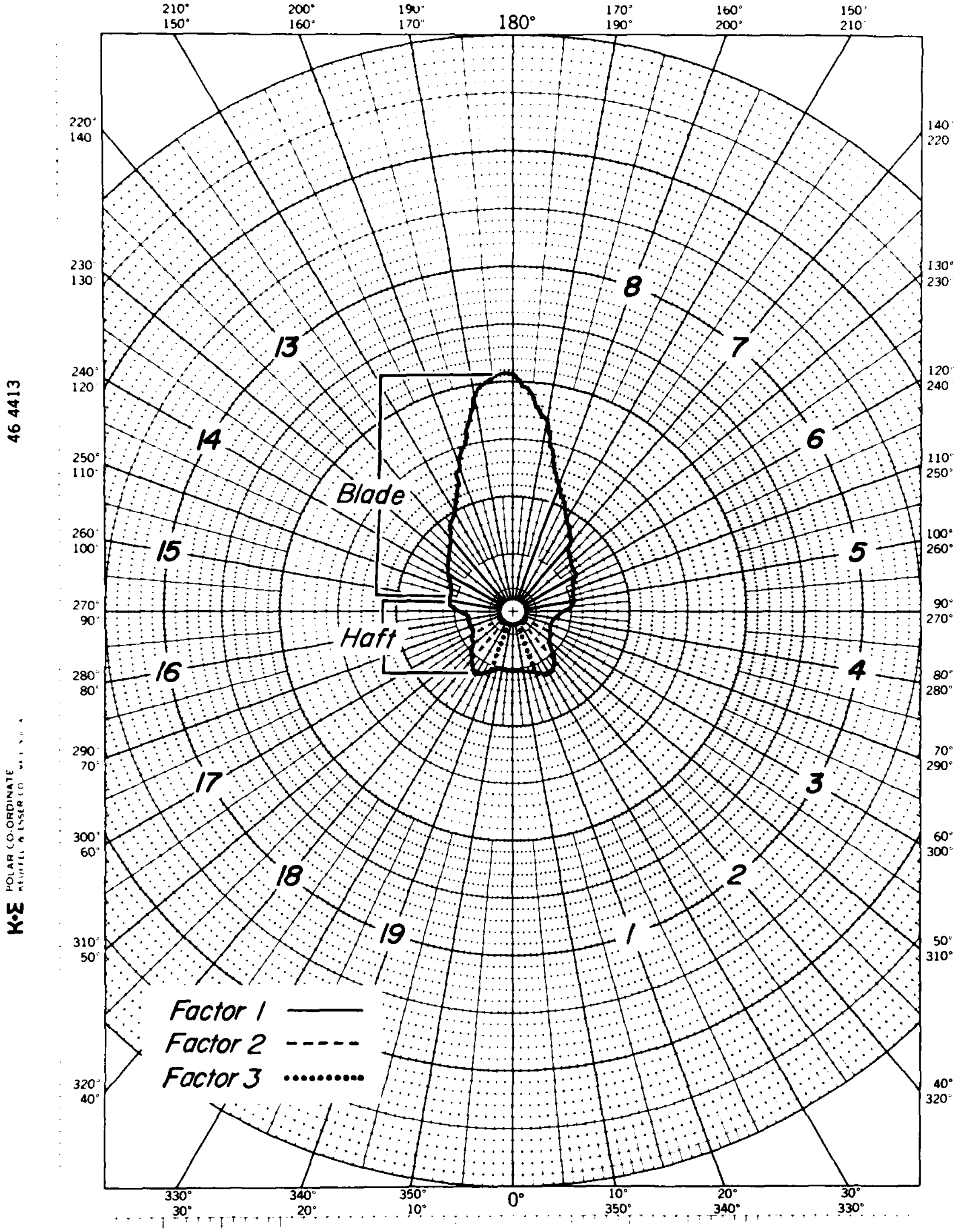

Figure 11.3. Factor analysis results of measured point types.

TABLE 11.4

Point Group Specimen Condition

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * *
   V10       PT GROUP                                    BY  V20       SPECIMEN CONDITION
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE  1 OF  8

                        V20
                COUNT   I
              ROW PCT   IWHOLE     FRAGMENT PIECED    LOST           ROW
              COL PCT   I                   TOGETHER                 TOTAL
              TOT PCT   I       1  I      2  I      3  I      4  I
V10           --------I--------I--------I--------I--------I
                     1  I      9  I     14  I      0  I      0  I       23
  SCALLORN              I   39.1  I   60.9  I    0.0  I    0.0  I      2.7
                        I    3.5  I    2.4  I    0.0  I    0.0  I
                        I    1.1  I    1.6  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     2  I      7  I      8  I      0  I      0  I       15
                        I   46.7  I   53.3  I    0.0  I    0.0  I      1.8
                        I    2.8  I    1.4  I    0.0  I    0.0  I
                        I    0.8  I    0.9  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     3  I      4  I      2  I      0  I      0  I        6
  SCALLORN LIKE         I   66.7  I   33.3  I    0.0  I    0.0  I      0.7
                        I    1.6  I    0.3  I    0.0  I    0.0  I
                        I    0.5  I    0.2  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     4  I      0  I      3  I      0  I      0  I        3
  CAHOKIA NOTCHED       I    0.0  I  100.0  I    0.0  I    0.0  I      0.4
                        I    0.0  I    0.5  I    0.0  I    0.0  I
                        I    0.0  I    0.4  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     5  I      1  I      1  I      0  I      0  I        2
                        I   50.0  I   50.0  I    0.0  I    0.0  I      0.2
                        I    0.4  I    0.2  I    0.0  I    0.0  I
                        I    0.1  I    0.1  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     6  I     21  I     50  I      1  I      0  I       72
  RICE SIDE NOTCH       I   29.2  I   69.4  I    1.4  I    0.0  I      8.4
                        I    8.3  I    8.7  I    4.3  I    0.0  I
                        I    2.5  I    5.8  I    0.1  I    0.0  I
                       -I--------I--------I--------I--------I
                     7  I      3  I      3  I      0  I      0  I        6
  GARY                  I   50.0  I   50.0  I    0.0  I    0.0  I      0.7
                        I    1.2  I    0.5  I    0.0  I    0.0  I
                        I    0.4  I    0.4  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    15  I      2  I      3  I      0  I      0  I        5
                        I   40.0  I   60.0  I    0.0  I    0.0  I      0.6
                        I    0.8  I    0.5  I    0.0  I    0.0  I
                        I    0.2  I    0.4  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    16  I      5  I      8  I      0  I      0  I       13
                        I   38.5  I   61.5  I    0.0  I    0.0  I      1.5
                        I    2.0  I    1.4  I    0.0  I    0.0  I
                        I    0.6  I    0.9  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    17  I      3  I      7  I      0  I      0  I       10
  SEDALIA               I   30.0  I   70.0  I    0.0  I    0.0  I      1.2
                        I    1.2  I    1.2  I    0.0  I    0.0  I
                        I    0.4  I    0.8  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    18  I     10  I     52  I      3  I      0  I       65
  RICE LANCE            I   15.4  I   80.0  I    4.6  I    0.0  I      7.6
                        I    3.9  I    9.1  I   13.0  I    0.0  I
                        I    1.2  I    6.1  I    0.4  I    0.0  I
                       -I--------I--------I--------I--------I
                    19  I      5  I     16  I      0  I      0  I       21
  AGATE BASIN           I   23.8  I   76.2  I    0.0  I    0.0  I      2.5
                        I    2.0  I    2.8  I    0.0  I    0.0  I
                        I    0.6  I    1.9  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    20  I      8  I      4  I      2  I      0  I       14
                        I   57.1  I   28.6  I   14.3  I    0.0  I      1.6
                        I    3.1  I    0.7  I    8.7  I    0.0  I
                        I    0.9  I    0.5  I    0.2  I    0.0  I
                       -I--------I--------I--------I--------I
                    21  I      3  I      2  I      0  I      0  I        5
  DALTON LIKE           I   60.0  I   40.0  I    0.0  I    0.0  I      0.6
                        I    1.2  I    0.3  I    0.0  I    0.0  I
                        I    0.4  I    0.2  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
               COLUMN        254       573        23         6       856
                TOTAL       29.7      66.9       2.7       0.7     100.0
(CONTINUED)

                        V20
                COUNT   I
              ROW PCT   IWHOLE     FRAGMENT PIECED    LOST           ROW
              COL PCT   I                   TOGETHER                 TOTAL
              TOT PCT   I       1  I      2  I      3  I      4  I
V10           --------I--------I--------I--------I--------I
                     8  I     12  I     18  I      0  I      0  I       30
  LANGTRY               I   40.0  I   60.0  I    0.0  I    0.0  I      3.5
                        I    4.7  I    3.1  I    0.0  I    0.0  I
                        I    1.4  I    2.1  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                     9  I      5  I     20  I      2  I      0  I       27
  SMITH                 I   18.5  I   74.1  I    7.4  I    0.0  I      3.2
                        I    2.0  I    3.5  I    8.7  I    0.0  I
                        I    0.6  I    2.3  I    0.2  I    0.0  I
                       -I--------I--------I--------I--------I
                    10  I      2  I      1  I      0  I      0  I        3
  FLUTED LANCE          I   66.7  I   33.3  I    0.0  I    0.0  I      0.4
                        I    0.8  I    0.2  I    0.0  I    0.0  I
                        I    0.2  I    0.1  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    11  I      1  I      3  I      0  I      0  I        4
  AFTON                 I   25.0  I   75.0  I    0.0  I    0.0  I      0.5
                        I    0.4  I    0.5  I    0.0  I    0.0  I
                        I    0.1  I    0.4  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    12  I      0  I      7  I      0  I      0  I        7
  TABLE ROCK            I    0.0  I  100.0  I    0.0  I    0.0  I      0.8
                        I    0.0  I    1.2  I    0.0  I    0.0  I
                        I    0.0  I    0.8  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    13  I     14  I     14  I      0  I      0  I       28
                        I   50.0  I   50.0  I    0.0  I    0.0  I      3.3
                        I    5.5  I    2.4  I    0.0  I    0.0  I
                        I    1.6  I    1.6  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    14  I      3  I     22  I      0  I      0  I       25
                        I   12.0  I   88.0  I    0.0  I    0.0  I      2.9
                        I    1.2  I    3.8  I    0.0  I    0.0  I
                        I    0.4  I    2.6  I    0.0  I    0.0  I
V10                     I--------I--------I--------I--------I
                    22  I      3  I      3  I      1  I      0  I        7
  DALTON                I   42.9  I   42.9  I   14.3  I    0.0  I      0.8
                        I    1.2  I    0.5  I    4.3  I    0.0  I
                        I    0.4  I    0.4  I    0.1  I    0.0  I
                       -I--------I--------I--------I--------I
                    23  I      0  I      3  I      0  I      0  I        3
  PLAINVIEW             I    0.0  I  100.0  I    0.0  I    0.0  I      0.4
                        I    0.0  I    0.5  I    0.0  I    0.0  I
                        I    0.0  I    0.4  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    24  I      4  I      5  I      2  I      2  I       13
  RICE LOBED            I   30.8  I   38.5  I   15.4  I   15.4  I      1.5
                        I    1.6  I    0.9  I    8.7  I   33.3  I
                        I    0.5  I    0.6  I    0.2  I    0.2  I
                       -I--------I--------I--------I--------I
                    25  I      4  I     28  I      4  I      0  I       36
  HIDDEN VALLEY         I   11.1  I   77.8  I   11.1  I    0.0  I      4.2
                        I    1.6  I    4.9  I   17.4  I    0.0  I
                        I    0.5  I    3.3  I    0.5  I    0.0  I
                       -I--------I--------I--------I--------I
                    26  I      7  I     17  I      0  I      0  I       24
  RODGERS FLARED        I   29.2  I   70.8  I    0.0  I    0.0  I      2.8
                        I    2.8  I    3.0  I    0.0  I    0.0  I
                        I    0.8  I    2.0  I    0.0  I    0.0  I
                       -I--------I--------I--------I--------I
                    27  I      5  I     12  I      1  I      0  I       18
                        I   27.8  I   66.7  I    5.6  I    0.0  I      2.1
                        I    2.0  I    2.1  I    4.3  I    0.0  I
                        I    0.6  I    1.4  I    0.1  I    0.0  I
                       -I--------I--------I--------I--------I
                    28  I      8  I     14  I      0  I      1  I       23
  KIRK-LIKE             I   34.8  I   60.9  I    0.0  I    4.3  I      2.7
                        I    3.1  I    2.4  I    0.0  I   16.7  I
                        I    0.9  I    1.6  I    0.0  I    0.1  I
                       -I--------I--------I--------I--------I
               COLUMN        254       573        23         6       856
                TOTAL       29.7      66.9       2.7       0.7     100.0
(CONTINUED)
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TABLE 11.4 (concluded)

```
* * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * *
   V10        PT GROUP                                           BY  V20        SPECIMEN CONDITION
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  PAGE  5 OF  8

                     V20
            COUNT   I
          ROW PCT   IWHOLE    FRAGMENT PIECED   LOST      ROW
          COL PCT   I                  TOGETHER           TOTAL
          TOT PCT   I      1 I      2 I      3 I      4 I
V10       --------I--------I--------I--------I--------I
               29 I     13 I     27 I      2 I      0 I     42
  WILLIAMS        I   31.0 I   64.3 I    4.8 I    0.0 I    4.9
                  I    5.1 I    4.7 I    8.7 I    0.0 I
                  I    1.5 I    3.2 I    0.2 I    0.0 I
                 -I--------I--------I--------I--------I
               30 I      5 I     40 I      2 I      0 I     47
  MARCOS          I   10.6 I   35.1 I    4.3 I    0.0 I    5.5
                  I    2.0 I    7.0 I    8.7 I    0.0 I
                  I    0.6 I    4.7 I    0.2 I    0.0 I
                 -I--------I--------I--------I--------I
               31 I      1 I      3 I      0 I      0 I      4
                  I   25.0 I   75.0 I    0.0 I    0.0 I    0.5
                  I    0.4 I    0.5 I    0.0 I    0.0 I
                  I    0.1 I    0.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               32 I      1 I      1 I      0 I      0 I      2
                  I   50.0 I   50.0 I    0.0 I    0.0 I    0.2
                  I    0.4 I    0.2 I    0.0 I    0.0 I
                  I    0.1 I    0.1 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               33 I      2 I      3 I      0 I      0 I      5
                  I   40.0 I   60.0 I    0.0 I    0.0 I    0.6
                  I    0.8 I    0.5 I    0.0 I    0.0 I
                  I    0.2 I    0.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               34 I      1 I      2 I      0 I      0 I      3
  LECROY          I   33.3 I   66.7 I    0.0 I    0.0 I    0.4
                  I    0.4 I    0.3 I    0.0 I    0.0 I
                  I    0.1 I    0.2 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               35 I      3 I      0 I      0 I      0 I      3
  JACKIE STEMMED  I  100.0 I    0.0 I    0.0 I    0.0 I    0.4
                  I    1.2 I    0.0 I    0.0 I    0.0 I
                  I    0.4 I    0.0 I    0.0 I    0.0 I
                  I========I========I========I========I
               44 I      2 I      1 I      0 I      0 I      3
                  I   66.7 I   33.3 I    0.0 I    0.0 I    0.4
                  I    0.8 I    0.2 I    0.0 I    0.0 I
                  I    0.2 I    0.1 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               45 I      2 I      0 I      0 I      0 I      2
                  I  100.0 I    0.0 I    0.0 I    0.0 I    0.2
                  I    0.8 I    0.0 I    0.0 I    0.0 I
                  I    0.2 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               46 I      4 I      2 I      0 I      0 I      6
                  I   66.7 I   33.3 I    0.0 I    0.0 I    0.7
                  I    1.6 I    0.3 I    0.0 I    0.0 I
                  I    0.5 I    0.2 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               47 I      0 I      3 I      0 I      0 I      3
                  I    0.0 I  100.0 I    0.0 I    0.0 I    0.4
                  I    0.0 I    0.5 I    0.0 I    0.0 I
                  I    0.0 I    0.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               48 I     13 I     29 I      0 I      0 I     42
                  I   31.0 I   69.0 I    0.0 I    0.0 I    4.9
                  I    5.1 I    5.1 I    0.0 I    0.0 I
                  I    1.5 I    3.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               49 I      6 I     29 I      1 I      0 I     36
  STONE           I   16.7 I   80.6 I    2.8 I    0.0 I    4.2
                  I    2.4 I    5.1 I    4.3 I    0.0 I
                  I    0.7 I    3.4 I    0.1 I    0.0 I
                 -I--------I--------I--------I--------I
               50 I     17 I     25 I      0 I      0 I     42
  ETLEY           I   40.5 I   59.5 I    0.0 I    0.0 I    4.9
                  I    6.7 I    4.4 I    0.0 I    0.0 I
                  I    2.0 I    2.9 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
           COLUMN      254      573       23        6      856
            TOTAL     29.7     66.9      2.7      0.7    100.0
(CONTINUED)
```

```
                     V20
            COUNT   I
          ROW PCT   IWHOLE    FRAGMENT PIECED   LOST      ROW
          COL PCT   I                  TOGETHER           TOTAL
          TOT PCT   I      1 I      2 I      3 I      4 I
V10       --------I--------I--------I--------I--------I
               36 I      5 I      5 I      0 I      2 I     12
  GRAHAM CAVE     I   41.7 I   41.7 I    0.0 I   16.7 I    1.4
                  I    2.0 I    0.9 I    0.0 I   33.3 I
                  I    0.6 I    0.6 I    0.0 I    0.2 I
                 -I--------I--------I--------I--------I
               37 I      4 I     10 I      0 I      0 I     14
  FRIO            I   28.6 I   71.4 I    0.0 I    0.0 I    1.6
                  I    1.6 I    1.7 I    0.0 I    0.0 I
                  I    0.5 I    1.2 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               38 I      2 I      3 I      0 I      0 I      5
                  I   40.0 I   60.0 I    0.0 I    0.0 I    0.6
                  I    0.8 I    0.5 I    0.0 I    0.0 I
                  I    0.2 I    0.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               40 I      5 I      3 I      0 I      1 I      9
                  I   55.6 I   33.3 I    0.0 I   11.1 I    1.1
                  I    2.0 I    0.5 I    0.0 I   16.7 I
                  I    0.6 I    0.4 I    0.0 I    0.1 I
                 -I--------I--------I--------I--------I
               41 I      1 I      0 I      0 I      0 I      1
  CUPP            I  100.0 I    0.0 I    0.0 I    0.0 I    0.1
                  I    0.4 I    0.0 I    0.0 I    0.0 I
                  I    0.1 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               42 I      2 I     15 I      1 I      0 I     18
  MARCUS          I   11.1 I   83.3 I    5.6 I    0.0 I    2.1
                  I    0.8 I    2.6 I    4.3 I    0.0 I
                  I    0.2 I    1.8 I    0.1 I    0.0 I
                 -I--------I--------I--------I--------I
               43 I      2 I      1 I      0 I      0 I      3
                  I   66.7 I   33.3 I    0.0 I    0.0 I    0.4
                  I    0.8 I    0.2 I    0.0 I    0.0 I
                  I    0.2 I    0.1 I    0.0 I    0.0 I
                  I--------I--------I--------I--------I
               51 I      4 I      3 I      1 I      0 I      8
  CASTORVILLE     I   50.0 I   37.5 I   12.5 I    0.0 I    0.9
                  I    1.6 I    0.5 I    4.3 I    0.0 I
                  I    0.5 I    0.4 I    0.1 I    0.0 I
                 -I--------I--------I--------I--------I
               52 I      5 I     23 I      0 I      0 I     28
                  I   17.9 I   82.1 I    0.0 I    0.0 I    3.3
                  I    2.0 I    4.0 I    0.0 I    0.0 I
                  I    0.6 I    2.7 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               54 I      2 I      1 I      0 I      0 I      3
                  I   66.7 I   33.3 I    0.0 I    0.0 I    0.4
                  I    0.8 I    0.2 I    0.0 I    0.0 I
                  I    0.2 I    0.1 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               55 I      3 I      3 I      0 I      0 I      6
                  I   50.0 I   50.0 I    0.0 I    0.0 I    0.7
                  I    1.2 I    0.5 I    0.0 I    0.0 I
                  I    0.4 I    0.4 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
               57 I      0 I      1 I      0 I      0 I      1
                  I    0.0 I  100.0 I    0.0 I    0.0 I    0.1
                  I    0.0 I    0.2 I    0.0 I    0.0 I
                  I    0.0 I    0.1 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I
           COLUMN      254      573       23        6      856
            TOTAL     29.7     66.9      2.7      0.7    100.0

RAW CHI SQUARE =   261.00781 WITH   159 DEGREES OF FREEDOM.

NUMBER OF MISSING OBSERVATIONS =    98

 SIGNIFICANCE =  0.0000
```

NOMINAL OBSERVATIONS OF FLAKING, HEAT TREATMENT BLADE AND HAFT ELEMENT

Flaking

In spite of recent advances in flaking description (cf., Binford 1963; Crabtree 1972), no single method or terminology seemed appropriate for the Rodgers Shelter point sample. Binford's (1963:202-207) distinction among primary and secondary chipping and placement of flake scars had a certain ring of truth about them, as did Crabtree's (1972:87) terminology for pressure flaking such as collateral or parallel flaking. In practice it was difficult to apply either because many of the clear-cut idealized flaking patterns had no actual analogue or were confused by flaking subsequent to manufacture. The coding procedure finally developed is nominally appropriate for Rodgers Shelter but may not apply as well to other point samples. Because of these limitations, specimens were photographed so as to optimally portray flaking and may more closely satisfy comparative needs. Flaking categories follow:

1. MARGINAL PRESSURE: random pressure flaking restricted to point edges.
2. TYPE 2 PRESSURE: controlled pressure flaking on one surface only; flake scars are generally parallel, oblique or collateral.
3. TYPE 3 PRESSURE: similar to 2, but with pressure flaking on both faces and portions of the preform surfaces or surfaces remaining on one or both faces.
4. TYPE 4 PRESSURE: similar to 3, but with no preform surfaces remaining.
5. RANDOM PRESSURE: random pressure flaking over one or both surfaces.
6. RANDOM PERCUSSION: random bifacial percussion flaking
7. TYPE 5 PERCUSSION: bilateral percussion flaking with parallel or oblique flake scars terminating in a midline ridge, often preform remnant surfaces are present at the midline.
8. TYPE 6 PERCUSSION: alternating lateral percussion flaking with flake scars spanning the blade width.
9. TYPE 7 PERCUSSION: unifacial percussion flaking with collateral flake scars.
10. COMBINED: combination of percussion and pressure flaking.
11. FLUTING: fluting present on one or both sides of the point base.

The bold face labels given above are used as tabular headings for flaking. Similar labels for other nominal observations refer to their respective tabular headings. In Chapter 10, these flaking categories are grouped as numbers 4 and 5.

Heat Treatment

Heat treatment, or thermal alteration (Purdy and Brooks 1971), was an important step in the manufacturing or maintenance processes of points from Rodgers Shelter. Evaluation of heat treatment is with reference to experimentally controlled heating of Jefferson City as well as the less common Chouteau and Burlington formation cherts, as discussed in Chapter 10. In general, the observations of Collins and Fenwick (1974) on changes in color, luster, wavy ripple marks, crazing and potlid fractures apply to an assessment of heat treatment of the Rodgers Shelter points for a specific material. Even so, our estimates of heating are probably still somewhat conservative. Five values for heat treatment were recorded:

1. UNHEATED: no evidence of heating.
2. PRIOR: heat treatment was intentionally done prior to point manufacture.
3. AFTER: as determined by truncation of flake scars by heat fractures, heating occurred after point manufacture and is presumed to be accidental or unintentional.
4. UNKNOWN: cannot evaluate for lithology.
5. HEATED AND REWORKED: heat treatment after point preform manufacture or completion of point manufacture and with subsequent evidence of point reuse.

Cross Section

Transverse sections of the blade element include:

1. BIPLANO (Fig. 11.4a)
2. TRIANGULAR (Fig. 11.4b)
3. TRAPEZOID (Fig. 11.4c)
4. BICONVEX (Fig. 11.4d)
5. LENTICULAR (Fig. 11.4e)
6. PLANO-CONVEX (Fig. 11.4f)
7. CONCAVO-CONVEX (Fig. 11.4g)
8. BEVELED (Fig. 11.4h)
9. ALTERNATE BEVEL (Fig. 11.4i)
10. BEVELED (Fig. 11.4j)
11. IRREGULAR (Fig. 11.4k)

Blade Fracture

Five blade fractures were coded:

1. IMPACT: described initially by Ahler (1971:52) as "longitudinally oriented flake scars derived from the distal end of the blade, possibly indicative of impact..." Frison (1974:95-98) describes impact fractured projectiles and impact flakes for the Casper site and his analysis further substantiates Ahler's (1971) contention that impact fractures are indicative of use as projectiles (Fig. 10.33a-c).
2. TRANSVERSE (Fig. 10.33d)
3. OBLIQUE (Fig. 10.33e)
4. IRREGULAR (Fig. 10.33f,g)
5. THERMAL: described by Purdy (1975:137, and Plate 4a) as a "crenated" fracture resulting from rapid cooling of a heated piece of stone or as a product of attempting to flake a specimen heated to too high a temperature (Fig. 10.33h,i)

Serration and Grinding

Eight potential combinations of blade serration and basal grinding were coded:

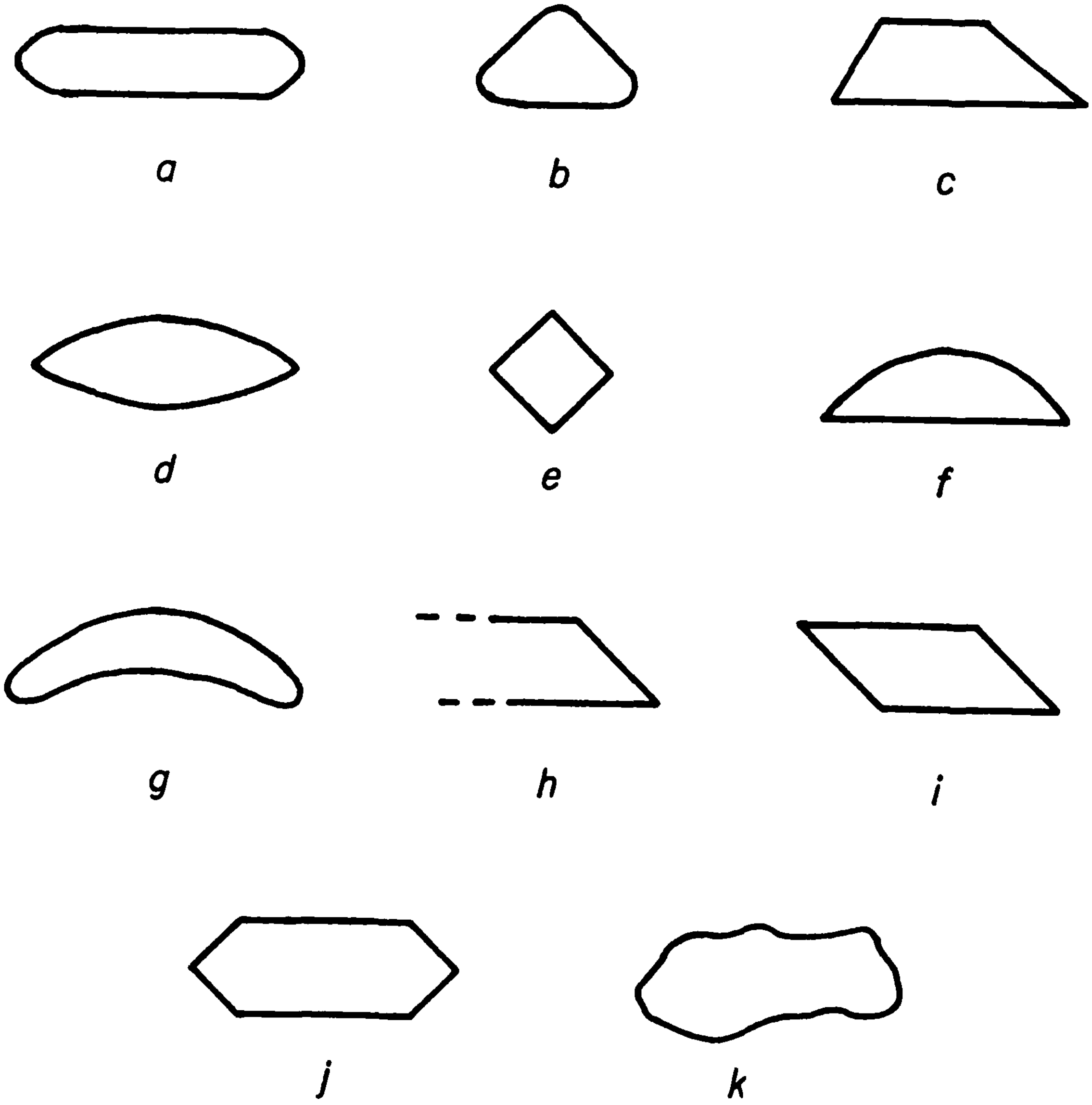

Figure 11.4. Blade element transverse sections.

1. SERRATED AND GROUND: blade element serrated; haft element ground.
2. SERRATED STGROUND: blade element serrated; the lateral edges of the haft element ground.
3. SERRATED BSGROUND: blade element serrated; proximal haft element edge ground.
4. SERRATED BLADE: blade element serrated, no basal grinding.
5. GROUND HAFT: blade element unserrated, haft ground.
6. STEM GROUND: blade element unserrated, lateral edges of haft ground.
7. BASE GROUND: blade element unserrated, proximal haft element edge ground.
8. NEITHER OBSERVED: neither blade element serration nor haft element grinding.

Material

The predominant lithology of Rodgers Shelter chipped stone points is chert, most of which occurs locally and is identifiable to the Jefferson City, Chouteau or Burlington formations; a quartzite from the Jefferson City formation also was used. Eight materials were coded; divisions within the Jefferson City cherts and quartzite account for the first four.

1. QUARTZITE: a white granular material with a sugary texture composed of faceted sand grains in a silica matrix.
2. OOLITIC CHERT: chert of varying colors but shades of gray or blue predominate, is banded and/or mottled and contains oolites as the defining feature.
3. BANDED CHERT: similar to 2, but without oolites.
4. X-BANDED CHERT: a banded chert having two sets of bands which cross cut usually at an angle approaching 90°; oolites occur infrequently.
5. BURLINGTON CHERT: chert from the Burlington formation; it is fossiliferous and generally off-white in color.
6. RIVER GRAVEL: chert from various formations collected from stream beds, typically the cortex is highly patinated.
7. OTHER CHERT: chert either of unknown derivation or which occurs in such low frequency as to not warrant further identification.
8. CHOUTEAU CHERT: chert from the Chouteau formation, which underlies the Burlington; the chert is typically dark gray and has a few white flecks as well as a distinctive net-like fossil.

Observations described in this section were entered onto standard Fortran coding forms along with appropriate provenience and other catalog information. Numerical values of nominal observations are, in most cases, those listed. Tables 11.4 to 11.14 crosstabulate the nominal observations by point categories or horizons.

ANALYSIS

Analysis of these data is in four parts. First, point attributes potentially relating to either style or function are assessed by chi square crosstabulations which test the null hypothesis: variation ob-

TABLE 11.5

Crosstabulation of Point Group by Material

V10	V18 COUNT ROW PCT COL PCT TOT PCT	QUARTZITE 1	OOLITIC CHERT 2	BANDED CHERT 3	X-BANDEC CHERT 4	BURLNGTN CHERT 5	RIVER GRAVEL 6	OTHER CHERT 7	CHOTEAU CHERT 8	ROW TOTAL
SCALLORN	1	0 0.0 0.0 0.0	3 12.5 1.2 0.4	15 62.5 3.8 1.8	0 0.0 0.0 0.0	5 20.8 3.4 0.6	1 4.2 20.0 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	24 2.8
	2	0 0.0 0.0 0.0	3 18.8 1.2 0.4	12 75.0 3.0 1.4	0 0.0 0.0 0.0	1 6.3 0.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	16 1.9
SCALLORN LIKE	3	0 0.0 0.0 0.0	1 16.7 0.4 0.1	5 83.3 1.3 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 0.7
CAHOKIA NOTCHED	4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 100.0 2.0 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.4
	5	0 0.0 0.0 0.0	1 50.0 0.4 0.1	1 50.0 0.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 0.2
RICE SIDE NOTCH	6	1 1.4 100.0 0.1	16 21.9 6.6 1.9	19 26.0 4.8 2.2	2 2.7 6.9 0.2	33 45.2 22.4 3.9	0 0.0 0.0 0.0	1 1.4 50.0 0.1	1 1.4 3.0 0.1	73 8.5
GARY	7	0 0.0 0.0 0.0	3 50.0 1.2 0.4	2 33.3 0.5 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 16.7 20.0 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 0.7
LANGTRY	8	0 0.0 0.0 0.0	5 16.7 2.1 0.6	19 63.3 4.8 2.2	1 3.3 3.4 0.1	2 6.7 1.4 0.2	2 6.7 40.0 0.2	0 0.0 0.0 0.0	1 3.3 3.0 0.1	30 3.5
SMITH	9	0 0.0 0.0 0.0	4 14.8 1.6 0.5	17 63.0 4.3 2.0	1 3.7 3.4 0.1	5 18.5 3.4 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	27 3.2
FLUTED LANCE	10	0 0.0 0.0 0.0	1 33.3 0.4 0.1	1 33.3 0.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 3.0 0.1	3 0.4
AFTON	11	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 75.0 0.8 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 25.0 3.0 0.1	4 0.5
TABLE ROCK	12	0 0.0 0.0 0.0	4 57.1 1.6 0.5	3 42.9 0.8 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 0.8
	13	0 0.0 0.0 0.0	4 14.3 1.6 0.5	21 75.0 5.3 2.5	0 0.0 0.0 0.0	1 3.6 0.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 7.1 6.1 0.2	28 3.3
	14	0 0.0 0.0 0.0	8 30.8 3.3 0.9	12 46.2 3.0 1.4	0 0.0 0.0 0.0	6 23.1 4.1 0.7	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	26 3.0
COLUMN TOTAL		1 0.1	243 28.4	397 46.3	29 3.4	147 17.2	5 0.6	2 0.2	33 3.9	857 100.0

(CONTINUED)

TABLE 11.5 (continued)

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                         V18
               COUNT   I
               RCW PCT IQUARTZ-  OOLITIC  BANDEL   X-BANDEC BURLNGTN RIVER    OTHER    CHOTEAU    ROW
               COL PCT IITE      CHERT    CHERT    CHERT    CHERT    GRAVEL   CHERT    CHERT     TOTAL
               TOT PCT I      1 I      2 I      3 I      4 I      5 I      6 I      7 I      8 I
V10            --------I--------I--------I--------I--------I--------I--------I--------I--------I
                    15 I      0 I      1 I      4 I      0 I      0 I      0 I      0 I      0 I      5
                       I    0.0 I   20.0 I   80.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6
                       I    0.0 I    0.4 I    1.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       I    0.0 I    0.1 I    0.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    16 I      0 I      5 I      7 I      0 I      0 I      0 I      0 I      1 I     13
                       I    0.0 I   38.5 I   53.8 I    0.0 I    0.0 I    0.0 I    0.0 I    7.7 I    1.5
                       I    0.0 I    2.1 I    1.8 I    0.0 I    0.0 I    0.0 I    0.0 I    3.0 I
                       I    0.0 I    0.6 I    0.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    17 I      0 I      3 I      3 I      1 I      2 I      0 I      0 I      1 I     10
  SEDALIA              I    0.0 I   30.0 I   30.0 I   10.0 I   20.0 I    0.0 I    0.0 I   10.0 I    1.2
                       I    0.0 I    1.2 I    0.8 I    3.4 I    1.4 I    0.0 I    0.0 I    3.0 I
                       I    0.0 I    0.4 I    0.4 I    0.1 I    0.2 I    0.0 I    0.0 I    0.1 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    18 I      0 I     15 I     27 I      4 I     17 I      0 I      0 I      2 I     65
  RICE LANCE           I    0.0 I   23.1 I   41.5 I    6.2 I   26.2 I    0.0 I    0.0 I    3.1 I    7.6
                       I    0.0 I    6.2 I    6.8 I   13.8 I   11.6 I    0.0 I    0.0 I    6.1 I
                       I    0.0 I    1.8 I    3.2 I    0.5 I    2.0 I    0.0 I    0.0 I    0.2 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    19 I      0 I      6 I      9 I      1 I      4 I      0 I      0 I      1 I     21
  AGATE BASIN          I    0.0 I   28.6 I   42.9 I    4.8 I   19.0 I    0.0 I    0.0 I    4.8 I    2.5
                       I    0.0 I    2.5 I    2.3 I    3.4 I    2.7 I    0.0 I    0.0 I    3.0 I
                       I    0.0 I    0.7 I    1.1 I    0.1 I    0.5 I    0.0 I    0.0 I    0.1 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    20 I      0 I      7 I      3 I      0 I      2 I      0 I      0 I      2 I     14
                       I    0.0 I   50.0 I   21.4 I    0.0 I   14.3 I    0.0 I    0.0 I   14.3 I    1.6
                       I    0.0 I    2.9 I    0.8 I    0.0 I    1.4 I    0.0 I    0.0 I    6.1 I
                       I    0.0 I    0.8 I    0.4 I    0.0 I    0.2 I    0.0 I    0.0 I    0.2 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    21 I      0 I      1 I      1 I      0 I      3 I      0 I      0 I      0 I      5
  DALTCN LIKE          I    0.0 I   20.0 I   20.0 I    0.0 I   60.0 I    0.0 I    0.0 I    0.0 I    0.6
                       I    0.0 I    0.4 I    0.3 I    0.0 I    2.0 I    0.0 I    0.0 I    0.0 I
                       I    0.0 I    0.1 I    0.1 I    0.0 I    0.4 I    0.0 I    0.0 I    0.0 I
               --------I--------I--------I--------I--------I--------I--------I--------I--------I
                    22 I      0 I      1 I      3 I      0 I      2 I      0 I      0 I      1 I      7
  DALTON               I    0.0 I   14.3 I   42.9 I    0.0 I   28.6 I    0.0 I    0.0 I   14.3 I    0.8
                       I    0.0 I    0.4 I    0.8 I    0.0 I    1.4 I    0.0 I    0.0 I    3.0 I
                       I    0.0 I    0.1 I    0.4 I    0.0 I    0.2 I    0.0 I    0.0 I    0.1 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    23 I      0 I      2 I      1 I      0 I      0 I      0 I      0 I      0 I      3
  PLAINVIEW            I    0.0 I   66.7 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.4
                       I    0.0 I    0.8 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                       I    0.0 I    0.2 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    24 I      0 I      3 I      5 I      1 I      2 I      0 I      0 I      0 I     11
  RICE LOBED           I    0.0 I   27.3 I   45.5 I    9.1 I   18.2 I    0.0 I    0.0 I    0.0 I    1.3
                       I    0.0 I    1.2 I    1.3 I    3.4 I    1.4 I    0.0 I    0.0 I    0.0 I
                       I    0.0 I    0.4 I    0.6 I    0.1 I    0.2 I    0.0 I    0.0 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    25 I      0 I      6 I     27 I      1 I      1 I      0 I      0 I      2 I     37
  HIDDEN VALLEY        I    0.0 I   16.2 I   73.0 I    2.7 I    2.7 I    0.0 I    0.0 I    5.4 I    4.3
                       I    0.0 I    2.5 I    6.8 I    3.4 I    0.7 I    0.0 I    0.0 I    6.1 I
                       I    0.0 I    0.7 I    3.2 I    0.1 I    0.1 I    0.0 I    0.0 I    0.2 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    26 I      0 I      6 I     12 I      1 I      1 I      0 I      1 I      3 I     24
  RODGERS FLARED       I    0.0 I   25.0 I   50.0 I    4.2 I    4.2 I    0.0 I    4.2 I   12.5 I    2.8
                       I    0.0 I    2.5 I    3.0 I    3.4 I    0.7 I    0.0 I   50.0 I    9.1 I
                       I    0.0 I    0.7 I    1.4 I    0.1 I    0.1 I    0.0 I    0.1 I    0.4 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    27 I      0 I      6 I      5 I      0 I      5 I      0 I      0 I      2 I     18
                       I    0.0 I   33.3 I   27.8 I    0.0 I   27.8 I    0.0 I    0.0 I   11.1 I    2.1
                       I    0.0 I    2.5 I    1.3 I    0.0 I    3.4 I    0.0 I    0.0 I    6.1 I
                       I    0.0 I    0.7 I    0.6 I    0.0 I    0.6 I    0.0 I    0.0 I    0.2 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                    28 I      0 I      8 I      6 I      2 I      5 I      0 I      0 I      1 I     22
  KIRK-LIKE            I    0.0 I   36.4 I   27.3 I    9.1 I   22.7 I    0.0 I    0.0 I    4.5 I    2.6
                       I    0.0 I    3.3 I    1.5 I    6.9 I    3.4 I    0.0 I    0.0 I    3.0 I
                       I    0.0 I    0.9 I    0.7 I    0.2 I    0.6 I    0.0 I    0.0 I    0.1 I
                      -I--------I--------I--------I--------I--------I--------I--------I--------I
                CCLUMN        1      243      397       29      147        5        2       33      857
                 TOTAL      0.1     28.4     46.3      3.4     17.2      0.6      0.2      3.9    100.0
(CONTINUED)
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TABLE 11.5 (continued)

```
                          V18
                 COUNT  I
               ROW PCT  IQUARTZ-  OOLITIC   BANDED   X-BANDED BURLNGTN RIVER    OTHER    CHOTEAU    ROW
               COL PCT  IITE      CHERT     CHERT     CHERT    CHERT   GRAVEL   CHERT    CHERT      TOTAL
               TOT PCT  I       1 I       2 I       3 I       4 I       5 I       6 I       7 I       8 I
V10                     --------I--------I--------I--------I--------I--------I--------I--------I
                     29 I       0 I      16 I      18 I       2 I       4 I       0 I       0 I       2 I      42
  WILLIAMS              I     0.0 I    38.1 I    42.9 I     4.8 I     9.5 I     0.0 I     0.0 I     4.8 I     4.9
                        I     0.0 I     6.6 I     4.5 I     6.9 I     2.7 I     0.0 I     0.0 I     6.1 I
                        I     0.0 I     1.9 I     2.1 I     0.2 I     0.5 I     0.0 I     0.0 I     0.2 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     30 I       0 I      20 I      20 I       2 I       4 I       0 I       0 I       1 I      47
  MARCOS                I     0.0 I    42.6 I    42.6 I     4.3 I     8.5 I     0.0 I     0.0 I     2.1 I     5.5
                        I     0.0 I     8.2 I     5.0 I     6.9 I     2.7 I     0.0 I     0.0 I     3.0 I
                        I     0.0 I     2.3 I     2.3 I     0.2 I     0.5 I     0.0 I     0.0 I     0.1 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     31 I       0 I       2 I       2 I       0 I       0 I       0 I       0 I       0 I       4
                        I     0.0 I    50.0 I    50.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.5
                        I     0.0 I     0.8 I     0.5 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.2 I     0.2 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     32 I       0 I       0 I       2 I       0 I       0 I       0 I       0 I       0 I       2
                        I     0.0 I     0.0 I   100.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.2
                        I     0.0 I     0.0 I     0.5 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.0 I     0.2 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     33 I       0 I       2 I       3 I       0 I       0 I       0 I       0 I       0 I       5
                        I     0.0 I    40.0 I    60.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.6
                        I     0.0 I     0.8 I     0.8 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.2 I     0.4 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     34 I       0 I       0 I       3 I       0 I       0 I       0 I       0 I       0 I       3
  LECROY                I     0.0 I     0.0 I   100.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.4
                        I     0.0 I     0.0 I     0.8 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.0 I     0.4 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     35 I       0 I       0 I       2 I       0 I       1 I       0 I       0 I       0 I       3
  JACKIE STEMMED        I     0.0 I     0.0 I    66.7 I     0.0 I    33.3 I     0.0 I     0.0 I     0.0 I     0.4
                        I     0.0 I     0.0 I     0.5 I     0.0 I     0.7 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.0 I     0.2 I     0.0 I     0.1 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     36 I       0 I       2 I       7 I       1 I       1 I       0 I       0 I       0 I      11
  GRAHAM CAVE           I     0.0 I    18.2 I    63.6 I     9.1 I     9.1 I     0.0 I     0.0 I     0.0 I     1.3
                        I     0.0 I     0.8 I     1.8 I     3.4 I     0.7 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.2 I     0.8 I     0.1 I     0.1 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     37 I       0 I       4 I       8 I       0 I       2 I       0 I       0 I       0 I      14
  FRIO                  I     0.0 I    28.6 I    57.1 I     0.0 I    14.3 I     0.0 I     0.0 I     0.0 I     1.6
                        I     0.0 I     1.6 I     2.0 I     0.0 I     1.4 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.5 I     0.9 I     0.0 I     0.2 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     38 I       0 I       3 I       2 I       0 I       0 I       0 I       0 I       0 I       5
                        I     0.0 I    60.0 I    40.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.6
                        I     0.0 I     1.2 I     0.5 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.4 I     0.2 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     40 I       0 I       5 I       2 I       0 I       1 I       0 I       0 I       0 I       8
                        I     0.0 I    62.5 I    25.0 I     0.0 I    12.5 I     0.0 I     0.0 I     0.0 I     0.9
                        I     0.0 I     2.1 I     0.5 I     0.0 I     0.7 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.6 I     0.2 I     0.0 I     0.1 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     41 I       0 I       1 I       0 I       0 I       0 I       0 I       0 I       0 I       1
  CUPP                  I     0.0 I   100.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.1
                        I     0.0 I     0.4 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.1 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     42 I      .. I       4 I      10 I       2 I       1 I       0 I       0 I       1 I      18
  MARCUS                I     0.0 I    22.2 I    55.6 I    11.1 I     5.6 I     0.0 I     0.0 I     5.6 I     2.1
                        I     0.0 I     1.6 I     2.5 I     6.9 I     0.7 I     0.0 I     0.0 I     3.0 I
                        I     0.0 I     0.5 I     1.2 I     0.2 I     0.1 I     0.0 I     0.0 I     0.1 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                     43 I       0 I       0 I       2 I       0 I       1 I       0 I       0 I       0 I       3
                        I     0.0 I     0.0 I    66.7 I     0.0 I    33.3 I     0.0 I     0.0 I     0.0 I     0.4
                        I     0.0 I     0.0 I     0.5 I     0.0 I     0.7 I     0.0 I     0.0 I     0.0 I
                        I     0.0 I     0.0 I     0.2 I     0.0 I     0.1 I     0.0 I     0.0 I     0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I--------I
                COLUMN          1       243       357        29       147         5         2        33       857
                 TOTAL        0.1      28.4      46.3       3.4      17.2       0.6       0.2       3.9     100.0
(CONTINUED)
```

TABLE 11.5 (concluded)

```
                         V18
                COUNT   I
                ROW PCT IQUARTZ-  OOLITIC   BANDED    X-BANDED BURLNGTN RIVER     OTHER     CHUTEAU     ROW
                COL PCT IITE      CHERT     CHERT     CHERT    CHERT    GRAVEL    CHERT     CHERT       TOTAL
                TOT PCT I      1  I      2  I      3  I      4  I      5  I      6  I      7  I      8  I
V10             --------I---------I---------I---------I---------I---------I---------I---------I---------I
                     44 I      0  I      3  I      0  I      0  I      0  I      0  I      0  I      0  I        3
                        I    0.0  I  100.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I      0.4
                        I    0.0  I    1.2  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.4  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     45 I      0  I      1  I      0  I      0  I      1  I      0  I      0  I      0  I        2
                        I    0.0  I   50.0  I    0.0  I    0.0  I   50.0  I    0.0  I    0.0  I    0.0  I      0.2
                        I    0.0  I    0.4  I    0.0  I    0.0  I    0.7  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.1  I    0.0  I    0.0  I    0.1  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     46 I      0  I      0  I      3  I      0  I      3  I      0  I      0  I      0  I        6
                        I    0.0  I    0.0  I   50.0  I    0.0  I   50.0  I    0.0  I    0.0  I    0.0  I      0.7
                        I    0.0  I    0.0  I    0.8  I    0.0  I    2.0  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.0  I    0.4  I    0.0  I    0.4  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     47 I      0  I      1  I      2  I      0  I      0  I      0  I      0  I      0  I        3
                        I    0.0  I   33.3  I   66.7  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I      0.4
                        I    0.0  I    0.4  I    0.5  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.1  I    0.2  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     48 I      0  I      8  I     18  I      2  I     13  I      0  I      0  I      1  I       42
                        I    0.0  I   19.0  I   42.9  I    4.8  I   31.0  I    0.0  I    0.0  I    2.4  I      4.9
                        I    0.0  I    3.3  I    4.5  I    6.9  I    8.8  I    0.0  I    0.0  I    3.0  I
                        I    0.0  I    0.9  I    2.1  I    0.2  I    1.5  I    0.0  I    0.0  I    0.1  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     49 I      0  I     17  I     15  I      0  I      3  I      0  I      0  I      1  I       36
  STONE                 I    0.0  I   47.2  I   41.7  I    0.0  I    8.3  I    0.0  I    0.0  I    2.8  I      4.2
                        I    0.0  I    7.0  I    3.8  I    0.0  I    2.0  I    0.0  I    0.0  I    3.0  I
                        I    0.0  I    2.0  I    1.8  I    0.0  I    0.4  I    0.0  I    0.0  I    0.1  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     50 I      0  I     19  I     12  I      4  I      3  I      1  I      0  I      3  I       42
  ETLEY                 I    0.0  I   45.2  I   28.6  I    9.5  I    7.1  I    2.4  I    0.0  I    7.1  I      4.9
                        I    0.0  I    7.8  I    3.0  I   13.8  I    2.0  I   20.0  I    0.0  I    9.1  I
                        I    0.0  I    2.2  I    1.4  I    0.5  I    0.4  I    0.1  I    0.0  I    0.4  I
              --- -----I---------I---------I---------I---------I---------I---------I---------I---------I
                     51 I      0  I      0  I      4  I      0  I      3  I      0  I      0  I      1  I        8
  CASTORVILLE           I    0.0  I    0.0  I   50.0  I    0.0  I   37.5  I    0.0  I    0.0  I   12.5  I      0.9
                        I    0.0  I    0.0  I    1.0  I    0.0  I    2.0  I    0.0  I    0.0  I    3.0  I
                        I    0.0  I    0.0  I    0.5  I    0.0  I    0.4  I    0.0  I    0.0  I    0.1  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     52 I      0  I      9  I     12  I      1  I      6  I      0  I      0  I      0  I       28
                        I    0.0  I   32.1  I   42.9  I    3.6  I   21.4  I    0.0  I    0.0  I    0.0  I      3.3
                        I    0.0  I    3.7  I    3.0  I    3.4  I    4.1  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    1.1  I    1.4  I    0.1  I    0.7  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     54 I      0  I      1  I      2  I      0  I      0  I      0  I      0  I      0  I        3
                        I    0.0  I   33.3  I   66.7  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I      0.4
                        I    0.0  I    0.4  I    0.5  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.1  I    0.2  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     55 I      0  I      2  I      3  I      0  I      0  I      0  I      0  I      1  I        6
                        I    0.0  I   33.3  I   50.0  I    0.0  I    0.0  I    0.0  I    0.0  I   16.7  I      0.7
                        I    0.0  I    0.8  I    0.8  I    0.0  I    0.0  I    0.0  I    0.0  I    3.0  I
                        I    0.0  I    0.2  I    0.4  I    0.0  I    0.0  I    0.0  I    0.0  I    0.1  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                     57 I      0  I      0  I      2  I      0  I      0  I      0  I      0  I      0  I        2
                        I    0.0  I    0.0  I  100.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I      0.2
                        I    0.0  I    0.0  I    0.5  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                        I    0.0  I    0.0  I    0.2  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I
                       -I---------I---------I---------I---------I---------I---------I---------I---------I
                 COLUMN        1        243       357        29       147         5         2        33        857
                  TOTAL      0.1       28.4      46.3       3.4      17.2       0.6       0.2       3.9      100.0

RAW CHI SQUARE =    378.53735 WITH   371 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.3845
```

TABLE 11.6

Crosstabulation of Point Group by Heat Treatment

```
                     V19
            COUNT   I
            ROW PCT IUNHEATED PRIOR      AFTER     UNKNOWN   HEATED &    ROW
            COL PCT I                                        REWORKED    TOTAL
            TOT PCT I       1 I       2 I       3 I       4 I       5 I
0           --------I--------I--------I--------I--------I--------I
                  1 I       1 I      14 I       8 I       1 I       0 I      24
SCALLORN            I     4.2 I    58.3 I    33.3 I     4.2 I     0.0 I     2.8
                    I     2.6 I     2.4 I     8.2 I     1.0 I     0.0 I
                    I     0.1 I     1.6 I     0.9 I     0.1 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                  2 I       6 I       8 I       0 I       2 I       0 I      16
                    I    37.5 I    50.0 I     0.0 I    12.5 I     0.0 I     1.9
                    I    15.4 I     1.4 I     0.0 I     1.9 I     0.0 I
                    I     0.7 I     0.9 I     0.0 I     0.2 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                  3 I       1 I       4 I       1 I       0 I       0 I       6
SCALLORN LIKE       I    16.7 I    66.7 I    16.7 I     0.0 I     0.0 I     0.7
                    I     2.6 I     0.7 I     1.0 I     0.0 I     0.0 I
                    I     0.1 I     0.5 I     0.1 I     0.0 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                  4 I       0 I       3 I       0 I       0 I       0 I       3
CAHOKIA NOTCHED     I     0.0 I   100.0 I     0.0 I     0.0 I     0.0 I     0.4
                    I     0.0 I     0.5 I     0.0 I     0.0 I     0.0 I
                    I     0.0 I     0.4 I     0.0 I     0.0 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                  5 I       0 I       1 I       1 I       0 I       0 I       2
                    I     0.0 I    50.0 I    50.0 I     0.0 I     0.0 I     0.2
                    I     0.0 I     0.2 I     1.0 I     0.0 I     0.0 I
                    I     0.0 I     0.1 I     0.1 I     0.0 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                  6 I       0 I      52 I       9 I      10 I       2 I      73
RICE SIDE NOTCH     I     0.0 I    71.2 I    12.3 I    13.7 I     2.7 I     8.5
                    I     0.0 I     9.0 I     9.3 I     9.7 I     5.3 I
                    I     0.0 I     6.1 I     1.1 I     1.2 I     0.2 I
                   -I--------I--------I--------I--------I--------I
                  7 I       1 I       2 I       1 I       2 I       0 I       6
GARY                I    16.7 I    33.3 I    16.7 I    33.3 I     0.0 I     0.7
                    I     2.6 I     0.3 I     1.0 I     1.9 I     0.0 I
                    I     0.1 I     0.2 I     0.1 I     0.2 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 15 I       1 I       1 I       1 I       2 I       0 I       5
                    I    20.0 I    20.0 I    20.0 I    40.0 I     0.0 I     0.6
                    I     2.6 I     0.2 I     1.0 I     1.9 I     0.0 I
                    I     0.1 I     0.1 I     0.1 I     0.2 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 16 I       1 I       7 I       3 I       2 I       0 I      13
                    I     7.7 I    53.8 I    23.1 I    15.4 I     0.0 I     1.5
                    I     2.6 I     1.2 I     3.1 I     1.9 I     0.0 I
                    I     0.1 I     0.8 I     0.4 I     0.2 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 17 I       4 I       1 I       3 I       2 I       0 I      10
SEDALIA             I    40.0 I    10.0 I    30.0 I    20.0 I     0.0 I     1.2
                    I    10.3 I     0.2 I     3.1 I     1.9 I     0.0 I
                    I     0.5 I     0.1 I     0.4 I     0.2 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 18 I       0 I      52 I       3 I       8 I       2 I      65
RICE LANCE          I     0.0 I    80.0 I     4.6 I    12.3 I     3.1 I     7.6
                    I     0.0 I     9.0 I     3.1 I     7.8 I     5.3 I
                    I     0.0 I     6.1 I     0.4 I     0.9 I     0.2 I
                   -I--------I--------I--------I--------I--------I
                 19 I       0 I      18 I       2 I       1 I       0 I      21
AGATE BASIN         I     0.0 I    85.7 I     9.5 I     4.8 I     0.0 I     2.5
                    I     0.0 I     3.1 I     2.1 I     1.0 I     0.0 I
                    I     0.0 I     2.1 I     0.2 I     0.1 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 20 I       0 I      13 I       1 I       0 I       0 I      14
                    I     0.0 I    92.9 I     7.1 I     0.0 I     0.0 I     1.6
                    I     0.0 I     2.2 I     1.0 I     0.0 I     0.0 I
                    I     0.0 I     1.5 I     0.1 I     0.0 I     0.0 I
                   -I--------I--------I--------I--------I--------I
                 21 I       0 I       4 I       1 I       0 I       0 I       5
DALTON LIKE         I     0.0 I    80.0 I    20.0 I     0.0 I     0.0 I     0.6
                    I     0.0 I     0.7 I     1.0 I     0.0 I     0.0 I
                    I     0.0 I     0.5 I     0.1 I     0.0 I     0.0 I
                   -I--------I--------I--------I--------I--------I
             COLUMN        39       580        97       103        38       857
              TOTAL       4.6      67.7      11.3      12.0       4.4     100.0
ONTINUED)
```

TABLE 11.6 (continued)

```
                            V19
                   COUNT  I
                  ROW PCT IUNHEATED PRIOR     AFTER     UNKNOWN   HEATED &   ROW
                  COL PCT I                                       REWORKED   TOTAL
                  TOT PCT I      1  I      2  I      3  I      4  I      5  I
V10               --------I---------I---------I---------I---------I---------I
                       8  I      1  I     25  I      3  I      1  I      0  I     30
  LANGTRY                 I    3.3  I   83.3  I   10.0  I    3.3  I    0.0  I    3.5
                          I    2.6  I    4.3  I    3.1  I    1.0  I    0.0  I
                          I    0.1  I    2.9  I    0.4  I    0.1  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                       9  I      4  I     14  I      6  I      3  I      0  I     27
  SMITH                   I   14.8  I   51.9  I   22.2  I   11.1  I    0.0  I    3.2
                          I   10.3  I    2.4  I    6.2  I    2.9  I    0.0  I
                          I    0.5  I    1.6  I    0.7  I    0.4  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      10  I      0  I      1  I      1  I      1  I      0  I      3
  FLUTED LANCE            I    0.0  I   33.3  I   33.3  I   33.3  I    0.0  I    0.4
                          I    0.0  I    0.2  I    1.0  I    1.0  I    0.0  I
                          I    0.0  I    0.1  I    0.1  I    0.1  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      11  I      2  I      2  I      0  I      0  I      0  I      4
  AFTON                   I   50.0  I   50.0  I    0.0  I    0.0  I    0.0  I    0.5
                          I    5.1  I    0.3  I    0.0  I    0.0  I    0.0  I
                          I    0.2  I    0.2  I    0.0  I    0.0  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      12  I      0  I      6  I      0  I      1  I      0  I      7
  TABLE ROCK              I    0.0  I   85.7  I    0.0  I   14.3  I    0.0  I    0.8
                          I    0.0  I    1.0  I    0.0  I    1.0  I    0.0  I
                          I    0.0  I    0.7  I    0.0  I    0.1  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      13  I      0  I     22  I      2  I      4  I      0  I     28
                          I    0.0  I   78.6  I    7.1  I   14.3  I    0.0  I    3.3
                          I    0.0  I    3.8  I    2.1  I    3.9  I    0.0  I
                          I    0.0  I    2.6  I    0.2  I    0.5  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      14  I      1  I     21  I      1  I      1  I      2  I     26
                          I    3.8  I   80.8  I    3.8  I    3.8  I    7.7  I    3.0
                          I    2.6  I    3.6  I    1.0  I    1.0  I    5.3  I
                          I    0.1  I    2.5  I    0.1  I    0.1  I    0.2  I
                  --------I---------I---------I---------I---------I---------I
                      22  I      0  I      2  I      1  I      4  I      0  I      7
  DALTON                  I    0.0  I   28.6  I   14.3  I   57.1  I    0.0  I    0.8
                          I    0.0  I    0.3  I    1.0  I    3.9  I    0.0  I
                          I    0.0  I    0.2  I    0.1  I    0.5  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      23  I      0  I      1  I      0  I      2  I      0  I      3
  PLAINVIEW               I    0.0  I   33.3  I    0.0  I   66.7  I    0.0  I    0.4
                          I    0.0  I    0.2  I    0.0  I    1.9  I    0.0  I
                          I    0.0  I    0.1  I    0.0  I    0.2  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      24  I      0  I      9  I      0  I      1  I      1  I     11
  RICE LOBED              I    0.0  I   81.8  I    0.0  I    9.1  I    9.1  I    1.3
                          I    0.0  I    1.6  I    0.0  I    1.0  I    2.6  I
                          I    0.0  I    1.1  I    0.0  I    0.1  I    0.1  I
                         -I---------I---------I---------I---------I---------I
                      25  I      0  I     26  I      2  I      7  I      2  I     37
  HIDDEN VALLEY           I    0.0  I   70.3  I    5.4  I   18.9  I    5.4  I    4.3
                          I    0.0  I    4.5  I    2.1  I    6.8  I    5.3  I
                          I    0.0  I    3.0  I    0.2  I    0.8  I    0.2  I
                         -I---------I---------I---------I---------I---------I
                      26  I      0  I     23  I      1  I      0  I      0  I     24
  RODGERS FLARED          I    0.0  I   95.8  I    4.2  I    0.0  I    0.0  I    2.8
                          I    0.0  I    4.0  I    1.0  I    0.0  I    0.0  I
                          I    0.0  I    2.7  I    0.1  I    0.0  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                      27  I      0  I     12  I      2  I      2  I      2  I     18
                          I    0.0  I   66.7  I   11.1  I   11.1  I   11.1  I    2.1
                          I    0.0  I    2.1  I    2.1  I    1.9  I    5.3  I
                          I    0.0  I    1.4  I    0.2  I    0.2  I    0.2  I
                         -I---------I---------I---------I---------I---------I
                      28  I      0  I     20  I      1  I      1  I      0  I     22
  KIRK-LIKE               I    0.0  I   90.9  I    4.5  I    4.5  I    0.0  I    2.6
                          I    0.0  I    3.4  I    1.0  I    1.0  I    0.0  I
                          I    0.0  I    2.3  I    0.1  I    0.1  I    0.0  I
                         -I---------I---------I---------I---------I---------I
                  COLUMN         39       580        97       103        38       857
                   TOTAL        4.6      67.7      11.3      12.0       4.4     100.0
CONTINUED)
```

TABLE 11.6 (continued)

```
                        V19
              COUNT    I
              ROW PCT  IUNHEATED PRIOR      AFTER     UNKNOWN   HEATED &   ROW
              COL PCT  I                                        REWORKED   TOTAL
              TOT PCT  I     1    I     2    I     3    I     4    I     5    I
 10            --------I----------I----------I----------I----------I----------I
                   29  I     1    I    24    I     3    I     0    I    14    I     42
  WILLIAMS             I   2.4    I  57.1    I   7.1    I   0.0    I  33.3    I    4.9
                       I   2.6    I   4.1    I   3.1    I   0.0    I  36.8    I
                       I   0.1    I   2.8    I   0.4    I   0.0    I   1.6    I
                      -I----------I----------I----------I----------I----------I
                   30  I     1    I    33    I     6    I     5    I     2    I     47
  MARCOS               I   2.1    I  70.2    I  12.8    I  10.6    I   4.3    I    5.5
                       I   2.6    I   5.7    I   6.2    I   4.9    I   5.3    I
                       I   0.1    I   3.9    I   0.7    I   0.6    I   0.2    I
                      -I----------I----------I----------I----------I----------I
                   31  I     2    I     1    I     1    I     0    I     0    I      4
                       I  50.0    I  25.0    I  25.0    I   0.0    I   0.0    I    0.5
                       I   5.1    I   0.2    I   1.0    I   0.0    I   0.0    I
                       I   0.2    I   0.1    I   0.1    I   0.0    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   32  I     0    I     0    I     0    I     2    I     0    I      2
                       I   0.0    I   0.0    I   0.0    I 100.0    I   0.0    I    0.2
                       I   0.0    I   0.0    I   0.0    I   1.9    I   0.0    I
                       I   0.0    I   0.0    I   0.0    I   0.2    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   33  I     0    I     2    I     0    I     3    I     0    I      5
                       I   0.0    I  40.0    I   0.0    I  60.0    I   0.0    I    0.6
                       I   0.0    I   0.3    I   0.0    I   2.9    I   0.0    I
                       I   0.0    I   0.2    I   0.0    I   0.4    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   34  I     0    I     2    I     0    I     0    I     1    I      3
  LECROY               I   0.0    I  66.7    I   0.0    I   0.0    I  33.3    I    0.4
                       I   0.0    I   0.3    I   0.0    I   0.0    I   2.6    I
                       I   0.0    I   0.2    I   0.0    I   0.0    I   0.1    I
                      -I----------I----------I----------I----------I----------I
                   35  I     0    I     2    I     0    I     1    I     0    I      3
  JACKIE STEMMED       I   0.0    I  66.7    I   0.0    I  33.3    I   0.0    I    0.4
                       I   0.0    I   0.3    I   0.0    I   1.0    I   0.0    I
                       I   0.0    I   0.2    I   0.0    I   0.1    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   44  I     0    I     3    I     0    I     0    I     0    I      3
                       I   0.0    I 100.0    I   0.0    I   0.0    I   0.0    I    0.4
                       I   0.0    I   0.5    I   0.0    I   0.0    I   0.0    I
                       I   0.0    I   0.4    I   0.0    I   0.0    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   45  I     1    I     1    I     0    I     0    I     0    I      2
                       I  50.0    I  50.0    I   0.0    I   0.0    I   0.0    I    0.2
                       I   2.6    I   0.2    I   0.0    I   0.0    I   0.0    I
                       I   0.1    I   0.1    I   0.0    I   0.0    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   46  I     0    I     4    I     0    I     0    I     2    I      6
                       I   0.0    I  66.7    I   0.0    I   0.0    I  33.3    I    0.7
                       I   0.0    I   0.7    I   0.0    I   0.0    I   5.3    I
                       I   0.0    I   0.5    I   0.0    I   0.0    I   0.2    I
                      -I----------I----------I----------I----------I----------I
                   47  I     1    I     2    I     0    I     0    I     0    I      3
                       I  33.3    I  66.7    I   0.0    I   0.0    I   0.0    I    0.4
                       I   2.6    I   0.3    I   0.0    I   0.0    I   0.0    I
                       I   0.1    I   0.2    I   0.0    I   0.0    I   0.0    I
                      -I----------I----------I----------I----------I----------I
                   48  I     0    I    29    I     9    I     1    I     3    I     42
                       I   0.0    I  69.0    I  21.4    I   2.4    I   7.1    I    4.9
                       I   0.0    I   5.0    I   9.3    I   1.0    I   7.9    I
                       I   0.0    I   3.4    I   1.1    I   0.1    I   0.4    I
                      -I----------I----------I----------I----------I----------I
                   49  I     1    I    16    I    10    I     6    I     3    I     36
  STONE                I   2.8    I  44.4    I  27.8    I  16.7    I   8.3    I    4.2
                       I   2.6    I   2.8    I  10.3    I   5.8    I   7.9    I
                       I   0.1    I   1.9    I   1.2    I   0.7    I   0.4    I
                      -I----------I----------I----------I----------I----------I
                   50  I     6    I    21    I     6    I     9    I     0    I     42
  ETLEY                I  14.3    I  50.0    I  14.3    I  21.4    I   0.0    I    4.9
                       I  15.4    I   3.6    I   6.2    I   8.7    I   0.0    I
                       I   0.7    I   2.5    I   0.7    I   1.1    I   0.0    I
                      -I----------I----------I----------I----------I----------I
               COLUMN         39        580         97        103         38       857
                TOTAL        4.6       67.7       11.3       12.0        4.4     100.0
 CONTINUED)
```

TABLE 11.6 (concluded)

```
                       V19
           CCUNT    I
           ROW PCT  IUNHEATED PRIOR      AFTER     UNKNOWN   HEATED &   ROW
           COL PCT  I                                         REWORKED   TOTAL
           TOT PCT  I      1  I      2  I      3  I      4  I      5  I
V10        ---------I---------I---------I---------I---------I---------I
                36  I      0  I      7  I      0  I      4  I      0  I     11
  GRAHAM CAVE       I    0.0  I   63.6  I    0.0  I   36.4  I    0.0  I    1.3
                    I    0.0  I    1.2  I    0.0  I    3.9  I    0.0  I
                    I    0.0  I    0.8  I    0.0  I    0.5  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                37  I      0  I     12  I      0  I      2  I      0  I     14
  FRIO              I    0.0  I   85.7  I    0.0  I   14.3  I    0.0  I    1.6
                    I    0.0  I    2.1  I    0.0  I    1.9  I    0.0  I
                    I    0.0  I    1.4  I    0.0  I    0.2  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                38  I      0  I      2  I      1  I      2  I      0  I      5
                    I    0.0  I   40.0  I   20.0  I   40.C  I    0.0  I    0.6
                    I    0.0  I    0.3  I    1.0  I    1.9  I    0.0  I
                    I    0.0  I    0.2  I    0.1  I    0.2  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                40  I      0  I      7  I      1  I      0  I      0  I      8
                    I    0.0  I   87.5  I   12.5  I    0.0  I    0.0  I    0.9
                    I    0.0  I    1.2  I    1.0  I    0.0  I    0.0  I
                    I    0.0  I    0.8  I    0.1  I    0.0  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                41  I      0  I      1  I      0  I      0  I      0  I      1
  CUPP              I    0.0  I  100.0  I    0.0  I    0.C  I    0.0  I    0.1
                    I    0.0  I    0.2  I    0.0  I    0.0  I    0.0  I
                    I    0.0  I    0.1  I    0.0  I    0.0  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                42  I      0  I     16  I      1  I      1  I      0  I     18
  MARCUS            I    0.0  I   88.9  I    5.6  I    5.6  I    0.0  I    2.1
                    I    0.0  I    2.8  I    1.0  I    1.0  I    0.0  I
                    I    0.0  I    1.9  I    0.1  I    0.1  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                43  I      0  I      2  I      1  I      0  I      0  I      3
                    I    0.0  I   66.7  I   33.3  I    0.0  I    0.0  I    0.4
                    I    0.0  I    0.3  I    1.0  I    0.0  I    0.0  I
                    I    0.0  I    0.2  I    0.1  I    0.0  I    0.0  I
...        ---------I---------I---------I---------I---------I---------I
                51  I      0  I      6  I      C  I      1  I      1  I      8
  CASTORVILLE       I    0.0  I   75.0  I    0.0  I   12.5  I   12.5  I    0.9
                    I    0.0  I    1.0  I    0.0  I    1.0  I    2.6  I
                    I    0.0  I    0.7  I    0.0  I    0.1  I    0.1  I
                   -I---------I---------I---------I---------I---------I
                52  I      1  I     17  I      4  I      5  I      1  I     28
                    I    3.6  I   60.7  I   14.3  I   17.9  I    3.6  I    3.3
                    I    2.6  I    2.9  I    4.1  I    4.9  I    2.6  I
                    I    0.1  I    2.0  I    0.5  I    0.6  I    0.1  I
                   -I---------I---------I---------I---------I---------I
                54  I      2  I      1  I      0  I      0  I      0  I      3
                    I   66.7  I   33.3  I    0.0  I    0.0  I    0.0  I    0.4
                    I    5.1  I    0.2  I    0.0  I    0.0  I    0.0  I
                    I    0.2  I    0.1  I    0.0  I    0.0  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                55  I      0  I      4  I      0  I      2  I      0  I      6
                    I    0.0  I   66.7  I    0.0  I   33.3  I    0.0  I    0.7
                    I    0.0  I    0.7  I    0.0  I    1.9  I    0.0  I
                    I    0.0  I    0.5  I    0.0  I    C.2  I    0.0  I
                   -I---------I---------I---------I---------I---------I
                57  I      0  I      1  I      0  I      1  I      0  I      2
                    I    0.0  I   50.0  I    0.0  I   50.0  I    0.0  I    0.2
                    I    0.0  I    0.2  I    0.0  I    1.0  I    0.0  I
                    I    0.0  I    0.1  I    0.0  I    0.1  I    0.0  I
                   -I---------I---------I---------I---------I---------I
            COLUMN        39       580        57       103        38       857
             TOTAL       4.6      67.7      11.3      12.0       4.4     100.0

RAW CHI SQUARE =    503.75586 WITH   212 DEGREES CF FREEDOM.

NUMBER OF MISSING OBSERVATIONS =     97

 SIGNIFICANCE =  0.0
```

TABLE 11.7

Crosstabulation of Point Group by Flaking

```
               V17                                                                                    V17
        COUNT  I                                                                                      I
      ROW PCT  IMARGINAL TYPE 2   TYPE 3   TYPE 4   RANDOM   RANDOM   TYPE 5   TYPE 6   TYPE 7   COMBINEDIFLUTING    ROW
      COL PCT  IPRESSURE PRESSURE PRESSURE PRESSURE PRESSURE PERCUSN  PERCUSN  PERCUSN  PERCUSN           I          TOTAL
      TOT PCT  I     1  I     2  I     3  I     4  I     5  I     6  I     7  I     8  I     9  I    10  I    11  I
V10            --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  1  I      4 I      5 I      5 I      6 I      4 I      0 I      0 I      0 I      0 I      0 I      0 I     24
  SCALLORN           I   16.7 I   20.8 I   20.8 I   25.0 I   16.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    3.3
                     I   50.0 I   31.3 I    3.5 I    9.5 I    7.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    0.6 I    0.7 I    0.7 I    0.8 I    0.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  2  I      1 I      1 I      2 I      2 I      5 I      1 I      0 I      0 I      0 I      4 I      0 I     16
                     I    6.3 I    6.3 I   12.5 I   12.5 I   31.3 I    6.3 I    0.0 I    0.0 I    0.0 I   25.0 I    0.0 I    2.2
                     I   12.5 I    6.3 I    1.4 I    3.2 I    8.8 I    4.2 I    0.0 I    0.0 I    0.0 I    1.8 I    0.0 I
                     I    0.1 I    0.1 I    0.3 I    0.3 I    0.7 I    0.1 I    0.0 I    0.0 I    0.0 I    0.6 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  3  I      1 I      0 I      1 I      3 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      6
  SCALLORN LIKE      I   16.7 I    0.0 I   16.7 I   50.0 I   16.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.8
                     I   12.5 I    0.0 I    0.7 I    4.8 I    1.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    0.1 I    0.0 I    0.1 I    0.4 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  4  I      1 I      0 I      0 I      0 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      3
  CAHOKIA NOTCHED    I   33.3 I    0.0 I    0.0 I    0.0 I   66.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.4
                     I   12.5 I    0.0 I    0.0 I    0.0 I    3.5 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    0.1 I    0.0 I    0.0 I    0.0 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  5  I      0 I      0 I      0 I      0 I      1 I      1 I      0 I      0 I      0 I      0 I      0 I      2
                     I    0.0 I    0.0 I    0.0 I    0.0 I   50.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3
                     I    0.0 I    0.0 I    0.0 I    0.0 I    1.8 I    4.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  6  I      0 I      1 I     13 I     11 I      2 I      4 I     21 I      0 I      1 I     15 I      0 I     68
  RICE SIDE NOTCH    I    0.0 I    1.5 I   19.1 I   16.2 I    2.9 I    5.9 I   30.9 I    0.0 I    1.5 I   22.1 I    0.0 I    9.4
                     I    0.0 I    6.3 I    9.1 I   17.5 I    3.5 I   16.7 I   14.6 I    0.0 I   11.1 I    6.8 I    0.0 I
                     I    0.0 I    0.1 I    1.8 I    1.5 I    0.3 I    0.6 I    2.9 I    0.0 I    0.1 I    2.1 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  7  I      0 I      0 I      0 I      0 I      0 I      0 I      4 I      0 I      0 I      1 I      0 I      5
  GARY               I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   80.0 I    0.0 I    0.0 I   20.0 I    0.0 I    0.7
                     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    2.8 I    0.0 I    0.0 I    0.5 I    0.0 I
                     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6 I    0.0 I    0.0 I    0.1 I    0.0 I
               ------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  8  I      0 I      0 I      8 I      1 I      0 I      3 I      4 I      0 I      1 I     10 I      0 I     27
  LANGTRY            I    0.0 I    0.0 I   29.6 I    3.7 I    0.0 I   11.1 I   14.8 I    0.0 I    3.7 I   37.0 I    0.0 I    3.7
                     I    0.0 I    0.0 I    5.6 I    1.6 I    0.0 I   12.5 I    2.8 I    0.0 I   11.1 I    4.5 I    0.0 I
                     I    0.0 I    0.0 I    1.1 I    0.1 I    0.0 I    0.4 I    0.6 I    0.0 I    0.1 I    1.4 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                  9  I      0 I      0 I      1 I      0 I      0 I      6 I     14 I      0 I      4 I      1 I      0 I     26
  SMITH              I    0.0 I    0.0 I    3.8 I    0.0 I    0.0 I   23.1 I   53.8 I    0.0 I   15.4 I    3.8 I    0.0 I    3.6
                     I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I   25.0 I    9.7 I    0.0 I   44.4 I    0.5 I    0.0 I
                     I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.8 I    1.9 I    0.0 I    0.6 I    0.1 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 10  I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      3 I      3
  FLUTED LANCE       I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I  100.0 I    0.4
                     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   12.0 I
                     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.4 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 11  I      0 I      0 I      1 I      1 I      0 I      0 I      1 I      0 I      0 I      1 I      0 I      4
  AFTON              I    0.0 I    0.0 I   25.0 I   25.0 I    0.0 I    0.0 I   25.0 I    0.0 I    0.0 I   25.0 I    0.0 I    0.6
                     I    0.0 I    0.0 I    0.7 I    1.6 I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I    0.5 I    0.0 I
                     I    0.0 I    0.0 I    0.1 I    0.1 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.1 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 12  I      0 I      0 I      1 I      4 I      0 I      0 I      1 I      0 I      0 I      1 I      0 I      7
  TABLE ROCK         I    0.0 I    0.0 I   14.3 I   57.1 I    0.0 I    0.0 I   14.3 I    0.0 I    0.0 I   14.3 I    0.0 I    1.0
                     I    0.0 I    0.0 I    0.7 I    6.3 I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I    0.5 I    0.0 I
                     I    0.0 I    0.0 I    0.1 I    0.6 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.1 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 13  I      1 I      1 I      0 I      4 I     20 I      0 I      0 I      0 I      0 I      2 I      0 I     28
                     I    3.6 I    3.6 I    0.0 I   14.3 I   71.4 I    0.0 I    0.0 I    0.0 I    0.0 I    7.1 I    0.0 I    3.9
                     I   12.5 I    6.3 I    0.0 I    6.3 I   35.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9 I    0.0 I
                     I    0.1 I    0.1 I    0.0 I    0.6 I    2.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 14  I      0 I      2 I      4 I      5 I     13 I      0 I      0 I      0 I      0 I      2 I      0 I     26
                     I    0.0 I    7.7 I   15.4 I   19.2 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I    7.7 I    0.0 I    3.6
                     I    0.0 I   12.5 I    2.8 I    7.9 I   22.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9 I    0.0 I
                     I    0.0 I    0.3 I    0.6 I    0.7 I    1.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               COLUMN        8       16      143       63       57       24      144       13        9      220       25      722
                TOTAL      1.1      2.2     19.8      8.7      7.9      3.3     19.9      1.8      1.2     30.5      3.5    100.0
(CONTINUED)
```

TABLE 11.7 (continued)

```
                      V17                                                                                                  V17
             COUNT   I                                                                                                     I
           ROW PCT   IMARGINAL  TYPE 2    TYPE 3    TYPE 4    RANDOM    RANDOM    TYPE 5    TYPE 6    TYPE 7    COMBINE  IFLUTING     ROW
           COL PCT   IPRESSURE  PRESSURE  PRESSURE  PRESSURE  PRESSURE  PERCUSN   PERCUSN   PERCUSN   PERCUSN            I           TOTAL
           TOT PCT   I      1  I      2  I      3  I      4  I      5  I      6  I      7  I      8  I      9  I     10  I     11  I
V10                 -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 22  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      7  I      7
DALTON               I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I  100.0  I    1.0
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I   28.0  I
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    1.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 23  I      0  I      0  I      0  I      1  I      0  I      0  I      0  I      0  I      0  I      1  I      1  I      3
PLAINVIEW            I    0.0  I    0.0  I    0.0  I   33.3  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I   33.3  I   33.3  I    0.4
                     I    0.0  I    0.0  I    0.0  I    1.6  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.5  I    4.0  I
                     I    0.0  I    0.0  I    0.0  I    0.1  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.1  I    0.1  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 24  I      0  I      0  I      0  I      0  I      0  I      0  I      1  I      8  I      0  I      1  I      0  I     10
RICE LOBED           I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I   10.0  I   80.0  I    0.0  I   10.0  I    0.0  I    1.4
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.7  I   61.5  I    0.0  I    0.5  I    0.0  I
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.1  I    1.1  I    0.0  I    0.1  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 25  I      0  I      1  I      8  I      0  I      0  I      0  I      5  I      0  I      0  I      8  I      0  I     22
HIDDEN VALLEY        I    0.0  I    4.5  I   36.4  I    0.0  I    0.0  I    0.0  I   22.7  I    0.0  I    0.0  I   36.4  I    0.0  I    3.0
                     I    0.0  I    6.3  I    5.6  I    0.0  I    0.0  I    0.0  I    3.5  I    0.0  I    0.0  I    3.6  I    0.0  I
                     I    0.0  I    0.1  I    1.1  I    0.0  I    0.0  I    0.0  I    0.7  I    0.0  I    0.0  I    1.1  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 26  I      0  I      0  I      7  I      3  I      0  I      0  I      1  I      1  I      0  I      7  I      1  I     20
RODGERS FLARED       I    0.0  I    0.0  I   35.0  I   15.0  I    0.0  I    0.0  I    5.0  I    5.0  I    0.0  I   35.0  I    5.0  I    2.8
                     I    0.0  I    0.0  I    4.9  I    4.8  I    0.0  I    0.0  I    0.7  I    7.7  I    0.0  I    3.2  I    4.0  I
                     I    0.0  I    0.0  I    1.0  I    0.4  I    0.0  I    0.0  I    0.1  I    0.1  I    0.0  I    1.0  I    0.1  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 27  I      0  I      0  I      1  I      0  I      0  I      0  I      3  I      0  I      0  I      9  I      1  I     14
                     I    0.0  I    0.0  I    7.1  I    0.0  I    0.0  I    0.0  I   21.4  I    0.0  I    0.0  I   64.3  I    7.1  I    1.9
                     I    0.0  I    0.0  I    0.7  I    0.0  I    0.0  I    0.0  I    2.1  I    0.0  I    0.0  I    4.1  I    4.0  I
                     I    0.0  I    0.0  I    0.1  I    0.0  I    0.0  I    0.0  I    0.4  I    0.0  I    0.0  I    1.2  I    0.1  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 28  I      0  I      0  I      2  I      0  I      0  I      0  I      4  I      1  I      0  I      9  I      0  I     16
KIRK-LIKE            I    0.0  I    0.0  I   12.5  I    0.0  I    0.0  I    0.0  I   25.0  I    6.3  I    0.0  I   56.3  I    0.0  I    2.2
                     I    0.0  I    0.0  I    1.4  I    0.0  I    0.0  I    0.0  I    2.8  I    7.7  I    0.0  I    4.1  I    0.0  I
                     I    0.0  I    0.0  I    0.3  I    0.0  I    0.0  I    0.0  I    0.6  I    0.1  I    0.0  I    1.2  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 15  I      0  I      0  I      0  I      1  I      1  I      0  I      0  I      0  I      0  I      3  I      0  I      5
                     I    0.0  I    0.0  I    0.0  I   20.0  I   20.0  I    0.0  I    0.0  I    0.0  I    0.0  I   60.0  I    0.0  I    0.7
                     I    0.0  I    0.0  I    0.0  I    1.6  I    1.8  I    0.0  I    0.0  I    0.0  I    0.0  I    1.4  I    0.0  I
                     I    0.0  I    0.0  I    0.0  I    0.1  I    0.1  I    0.0  I    0.0  I    0.0  I    0.0  I    0.4  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 16  I      0  I      0  I      1  I      3  I      3  I      2  I      0  I      0  I      0  I      1  I      0  I     10
                     I    0.0  I    0.0  I   10.0  I   30.0  I   30.0  I   20.0  I    0.0  I    0.0  I    0.0  I   10.0  I    0.0  I    1.4
                     I    0.0  I    0.0  I    0.7  I    4.8  I    5.3  I    8.3  I    0.0  I    0.0  I    0.0  I    0.5  I    0.0  I
                     I    0.0  I    0.0  I    0.1  I    0.4  I    0.4  I    0.3  I    0.0  I    0.0  I    0.0  I    0.1  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 17  I      0  I      0  I      2  I      0  I      0  I      0  I      8  I      0  I      0  I      0  I      0  I     10
SEDALIA              I    0.0  I    0.0  I   20.0  I    0.0  I    0.0  I    0.0  I   80.0  I    0.0  I    0.0  I    0.0  I    0.0  I    1.4
                     I    0.0  I    0.0  I    1.4  I    0.0  I    0.0  I    0.0  I    5.6  I    0.0  I    0.0  I    0.0  I    0.0  I
                     I    0.0  I    0.0  I    0.3  I    0.0  I    0.0  I    0.0  I    1.1  I    0.0  I    0.0  I    0.0  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 18  I      0  I      0  I     13  I      1  I      0  I      0  I      3  I      0  I      0  I     31  I      0  I     48
RICE LANCE           I    0.0  I    0.0  I   27.1  I    2.1  I    0.0  I    0.0  I    6.3  I    0.0  I    0.0  I   64.6  I    0.0  I    6.6
                     I    0.0  I    0.0  I    9.1  I    1.6  I    0.0  I    0.0  I    2.1  I    0.0  I    0.0  I   14.1  I    0.0  I
                     I    0.0  I    0.0  I    1.8  I    0.1  I    0.0  I    0.0  I    0.4  I    0.0  I    0.0  I    4.3  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 19  I      0  I      0  I      3  I      0  I      0  I      0  I      1  I      0  I      0  I      5  I      0  I      9
                     I    0.0  I    0.0  I   33.3  I    0.0  I    0.0  I    0.0  I   11.1  I    0.0  I    0.0  I   55.6  I    0.0  I    1.2
                     I    0.0  I    0.0  I    2.1  I    0.0  I    0.0  I    0.0  I    0.7  I    0.0  I    0.0  I    2.3  I    0.0  I
                     I    0.0  I    0.0  I    0.4  I    0.0  I    0.0  I    0.0  I    0.1  I    0.0  I    0.0  I    0.7  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 20  I      0  I      0  I      6  I      0  I      0  I      0  I      3  I      0  I      0  I      4  I      0  I     13
                     I    0.0  I    0.0  I   46.2  I    0.0  I    0.0  I    0.0  I   23.1  I    0.0  I    0.0  I   30.8  I    0.0  I    1.8
                     I    0.0  I    0.0  I    4.2  I    0.0  I    0.0  I    0.0  I    2.1  I    0.0  I    0.0  I    1.8  I    0.0  I
                     I    0.0  I    0.0  I    0.8  I    0.0  I    0.0  I    0.0  I    0.4  I    0.0  I    0.0  I    0.6  I    0.0  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                 21  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      0  I      4  I      4
DALTON LIKE          I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I  100.0  I    0.6
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I   16.0  I
                     I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.0  I    0.6  I
                    -I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
            COLUMN          8        16       143        63        57        24       144        13         9       220        25        722
             TOTAL        1.1       2.2      19.8       8.7       7.9       3.3      19.9       1.8       1.2      30.5       3.5      100.0
```

TABLE 11.7 (continued)

```
                 V17                                                                                        V17
           COUNT I                                                                                          I
         ROW PCT IMARGINAL TYPE 2   TYPE 3   TYPE 4   RANDOM   RANDOM   TYPE 5   TYPE 6   TYPE 7   COMBINEDIFLUTING    ROW
         COL PCT IPRESSURE PRESSURE PRESSURE PRESSURE PRESSURE PERCUSN  PERCUSN  PERCUSN  PERCUSN           I           TOTAL
         TOT PCT I      1 I      2 I      3 I      4 I      5 I      6 I      7 I      8 I      9 I     10 I     11 I
10       --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              29 I      0 I      2 I     10 I      3 I      0 I      1 I      5 I      0 I      0 I     16 I      0 I     37
 WILLIAMS        I    0.0 I    5.4 I   27.0 I    8.1 I    0.0 I    2.7 I   13.5 I    0.0 I    0.0 I   43.2 I    0.0 I    5.1
                 I    0.0 I   12.5 I    7.0 I    4.8 I    0.0 I    4.2 I    3.5 I    0.0 I    0.0 I    7.3 I    0.0 I
                 I    0.0 I    0.3 I    1.4 I    0.4 I    0.0 I    0.1 I    0.7 I    0.0 I    0.0 I    2.2 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              30 I      0 I      0 I      2 I      1 I      0 I      0 I      7 I      0 I      0 I     16 I      4 I     30
 MARCOS          I    0.0 I    0.0 I    6.7 I    3.3 I    0.0 I    0.0 I   23.3 I    0.0 I    0.0 I   53.3 I   13.3 I    4.2
                 I    0.0 I    0.0 I    1.4 I    1.6 I    0.0 I    0.0 I    4.9 I    0.0 I    0.0 I    7.3 I   16.0 I
                 I    0.0 I    0.0 I    0.3 I    0.1 I    0.0 I    0.0 I    1.0 I    0.0 I    0.0 I    2.2 I    0.6 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              31 I      0 I      0 I      0 I      0 I      0 I      1 I      3 I      0 I      0 I      0 I      0 I      4
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I   75.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    4.2 I    2.1 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I    0.4 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              32 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      2 I      2
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I  100.0 I    0.3
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    8.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              33 I      0 I      0 I      2 I      0 I      0 I      0 I      0 I      0 I      0 I      3 I      0 I      5
                 I    0.0 I    0.0 I   40.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   60.0 I    0.0 I    0.7
                 I    0.0 I    0.0 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.4 I    0.0 I
                 I    0.0 I    0.0 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.4 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              34 I      0 I      0 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I      1 I      0 I      2
 LECROY          I    0.0 I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    0.3
                 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              35 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      2 I      0 I      3
 JACKIE STEMMED  I    0.0 I    0.0 I   33.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   66.7 I    0.0 I    0.4
                 I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9 I    0.0 I
                 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3 I    0.0 I
V10     --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              36 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      2 I      0 I      8 I      1 I     11
 GRAHAM CAVE     I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   18.2 I    0.0 I   72.7 I    9.1 I    1.5
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   15.4 I    0.0 I    3.6 I    4.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.3 I    0.0 I    1.1 I    0.1 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              37 I      0 I      0 I      4 I      3 I      1 I      0 I      0 I      0 I      0 I      4 I      0 I     12
 FRIO            I    0.0 I    0.0 I   33.3 I   25.0 I    8.3 I    0.0 I    0.0 I    0.0 I    0.0 I   33.3 I    0.0 I    1.7
                 I    0.0 I    0.0 I    2.8 I    4.8 I    1.8 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8 I    0.0 I
                 I    0.0 I    0.0 I    0.6 I    0.4 I    0.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              39 I      0 I      0 I      3 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      1 I      4
                 I    0.0 I    0.0 I   75.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I    0.6
                 I    0.0 I    0.0 I    2.1 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    4.0 I
                 I    0.0 I    0.0 I    0.4 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              40 I      0 I      0 I      2 I      2 I      0 I      0 I      0 I      0 I      0 I      4 I      0 I      8
                 I    0.0 I    0.0 I   25.0 I   25.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    1.1
                 I    0.0 I    0.0 I    1.4 I    3.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    1.8 I    0.0 I
                 I    0.0 I    0.0 I    0.3 I    0.3 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.6 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              41 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      0 I      1 I      0 I      1
 CUPP            I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I  100.0 I    0.0 I    0.1
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5 I    0.0 I
                 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.1 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              42 I      0 I      0 I      2 I      3 I      0 I      1 I     10 I      0 I      0 I      0 I      0 I     16
 MARCUS          I    0.0 I    0.0 I   12.5 I   18.8 I    0.0 I    6.3 I   62.5 I    0.0 I    0.0 I    0.0 I    0.0 I    2.2
                 I    0.0 I    0.0 I    1.4 I    4.8 I    0.0 I    4.2 I    6.9 I    0.0 I    0.0 I    0.0 I    0.0 I
                 I    0.0 I    0.0 I    0.3 I    0.4 I    0.0 I    0.1 I    1.4 I    0.0 I    0.0 I    0.0 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
              43 I      0 I      0 I      1 I      0 I      0 I      0 I      1 I      0 I      0 I      1 I      0 I      3
                 I    0.0 I    0.0 I   33.3 I    0.0 I    0.0 I    0.0 I   33.3 I    0.0 I    0.0 I   33.3 I    0.0 I    0.4
                 I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I    0.0 I    0.7 I    0.0 I    0.0 I    0.5 I    0.0 I
                 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.1 I    0.0 I
                -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          COLUMN        8       16      143       63       57       24      144       13        9      220       25     722
           TOTAL      1.1      2.2     19.8      8.7      7.9      3.3     19.9      1.8      1.2     30.5      3.5   100.0
(CONTINUED)
```

TABLE 11.7 (concluded)

COUNT ROW PCT COL PCT TOT PCT	VI7 MARGINAL PRESSURE 1	TYPE 2 PRESSURE 2	TYPE 3 PRESSURE 3	TYPE 4 PRESSURE 4	RANDOM PRESSURE 5	RANDOM PERCUSN 6	TYPE 5 PERCUSN 7	TYPE 6 PERCUSN 8	TYPE 7 PERCUSN 9	COMBINE 10	VI7 FLUTING 11	ROW TOTAL
V10 44	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 0.7 0.1	1 33.3 1.6 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 0.5 0.1	0 0.0 0.0 0.0	3 0.4
45	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 50.0 1.6 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 50.0 0.5 0.1	0 0.0 0.0 0.0	2 0.3
46	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 100.0 1.8 0.6	0 0.0 0.0 0.0	4 0.6
47	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 0.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 4.2 0.1	1 33.3 0.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.4
48	0 0.0 0.0 0.0	1 3.3 6.3 0.1	14 46.7 9.8 1.9	2 6.7 3.2 0.3	1 3.3 1.8 0.1	2 6.7 8.3 0.3	7 23.3 4.9 1.0	0 0.0 0.0 0.0	1 3.3 11.1 0.1	2 6.7 0.9 0.3	0 0.0 0.0 0.0	30 4.2
49 STONE	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 22.2 4.2 0.8	0 0.0 0.0 0.0	1 3.7 1.8 0.1	0 0.0 0.0 0.0	12 44.4 8.3 1.7	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 29.6 3.6 1.1	0 0.0 0.0 0.0	27 3.7
50 [illegible]LEY	0 0.0 0.0 0.0	2 4.8 12.5 0.3	7 16.7 4.9 1.0	1 2.4 1.6 0.1	0 0.0 0.0 0.0	1 2.4 4.2 0.1	14 33.3 9.7 1.9	1 2.4 7.7 0.1	2 4.8 22.2 0.3	14 33.3 6.4 1.9	0 0.0 0.0 0.0	42 5.8
V10 51 CASTORVILLE	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 25.0 1.4 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 12.5 0.7 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	5 62.5 2.3 0.7	0 0.0 0.0 0.0	8 1.1
52	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 20.0 2.8 0.6	0 0.0 0.0 0.0	1 5.0 1.8 0.1	0 0.0 0.0 0.0	4 20.0 2.8 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	11 55.0 5.0 1.5	0 0.0 0.0 0.0	20 2.8
54	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 100.0 2.1 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.4
55	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 33.3 1.4 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 33.3 1.4 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 33.3 0.9 0.3	0 0.0 0.0 0.0	6 0.8
COLUMN TOTAL	8 1.1	16 2.2	143 19.8	63 8.7	57 7.9	24 3.3	144 19.9	13 1.8	9 1.2	220 30.5	25 3.5	722 100.0

RAW CHI SQUARE = 1853.71802 WITH 520 DEGREES OF FREEDOM. SIGNIFICANCE = 0.0

TABLE 11.8

Crosstabulation of Point Group by Serration-grinding

```
                       V24
              COUNT   I
            ROW PCT   ISERATEDC SERATED  SERATED  GROUND H STEM     BASE     NEITHER   ROW
            COL PCT   IGROUND   STGROUND BLADE    AFT      GROUND   GROUND   OBSERVED  TOTAL
            TOT PCT   I     1   I     2  I     4  I     5  I     6  I     7  I     9  I
V10         ----------I---------I--------I--------I--------I--------I--------I--------I
                   1  I     0   I     0  I     6  I     0  I     0  I     0  I    19  I
   SCALLORN           I   0.0   I   0.0  I  25.0  I   0.0  I   0.0  I   0.0  I  75.0  I    2.
                      I   0.0   I   0.0  I  31.6  I   0.0  I   0.0  I   0.0  I   3.6  I
                      I   0.0   I   0.0  I   0.7  I   0.0  I   0.0  I   0.0  I   2.1  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   2  I     0   I     0  I     0  I     0  I     0  I     0  I    16  I     16
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    1.9
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   3.2  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.9  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   3  I     0   I     0  I     0  I     0  I     0  I     0  I     6  I      6
   SCALLORN LIKE      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.7
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.2  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.7  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   4  I     0   I     0  I     0  I     0  I     0  I     0  I     3  I      3
   CAHOKIA NOTCHED    I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.6  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.3  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   5  I     0   I     0  I     0  I     0  I     0  I     0  I     2  I      2
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.2
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.4  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.2  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   6  I     0   I     0  I     0  I     4  I     4  I     2  I    63  I     73
   RICE SIDE NOTCH    I   0.0   I   0.0  I   0.0  I   5.5  I   5.5  I   2.7  I  86.3  I    8.5
                      I   0.0   I   0.0  I   0.0  I   2.5  I   5.1  I   3.1  I  12.7  I
                      I   0.0   I   0.0  I   0.0  I   0.5  I   0.5  I   0.2  I   7.3  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   7  I     0   I     0  I     0  I     2  I     2  I     0  I     2  I      6
   GARY               I   0.0   I   0.0  I   0.0  I  33.3  I  33.3  I   0.0  I  33.3  I    0.7
                      I   0.0   I   0.0  I   0.0  I   1.2  I   2.6  I   0.0  I   0.4  I
                      I   0.0   I   0.0  I   0.0  I   0.2  I   0.2  I   0.0  I   0.2  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   8  I     0   I     0  I     0  I     5  I     7  I     2  I    16  I     30
                      I   0.0   I   0.0  I   0.0  I  16.7  I  23.3  I   6.7  I  53.3  I    3.5
   LANGTRY            I   0.0   I   0.0  I   0.0  I   3.1  I   9.0  I   3.1  I   3.2  I
                      I   0.0   I   0.0  I   0.0  I   0.6  I   0.9  I   0.2  I   1.9  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                   9  I     0   I     0  I     0  I     2  I     3  I     5  I    17  I     27
                      I   0.0   I   0.0  I   0.0  I   7.4  I  11.1  I  18.5  I  63.0  I    3.1
   SMITH              I   0.0   I   0.0  I   0.0  I   1.2  I   3.8  I   7.8  I   3.4  I
                      I   0.0   I   0.0  I   0.0  I   0.2  I   0.3  I   0.6  I   2.0  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                  10  I     1   I     0  I     0  I     2  I     0  I     0  I     0  I      3
                      I  33.3   I   0.0  I   0.0  I  66.7  I   0.0  I   0.0  I   0.0  I    0.3
   FLUTED LANCE       I   2.9   I   0.0  I   0.0  I   1.2  I   0.0  I   0.0  I   0.0  I
                      I   0.1   I   0.0  I   0.0  I   0.2  I   0.0  I   0.0  I   0.0  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                  11  I     0   I     0  I     0  I     0  I     0  I     0  I     4  I      4
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.5
   AFTON              I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.8  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.5  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                  12  I     0   I     0  I     0  I     5  I     0  I     0  I     2  I      7
                      I   0.0   I   0.0  I   0.0  I  71.4  I   0.0  I   0.0  I  28.6  I    0.8
   TABLE ROCK         I   0.0   I   0.0  I   0.0  I   3.1  I   0.0  I   0.0  I   0.4  I
                      I   0.0   I   0.0  I   0.0  I   0.6  I   0.0  I   0.0  I   0.2  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                  13  I     0   I     0  I     0  I     0  I     0  I     8  I    20  I     28
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I  28.6  I  71.4  I    3.3
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I  12.5  I   4.0  I
                      I   0.0   I   0.0  I   0.0  I   0.0  I   0.0  I   0.9  I   2.3  I
                     -I---------I--------I--------I--------I--------I--------I--------I
                  14  I     0   I     0  I     1  I     0  I     0  I     6  I    18  I     25
                      I   0.0   I   0.0  I   4.0  I   0.0  I   0.0  I  24.0  I  72.0  I    2.9
                      I   0.0   I   0.0  I   5.3  I   0.0  I   0.0  I   9.4  I   3.6  I
                      I   0.0   I   0.0  I   0.1  I   0.0  I   0.0  I   0.7  I   2.1  I
                     -I---------I--------I--------I--------I--------I--------I--------I
             COLUMN          35         5       19      163       78       64      497      861
              TOTAL         4.1       0.6      2.2     19.9      9.1      7.4     57.7    100.0
(CONTINUED)
```

TABLE 11.8 (continued)

V13	COUNT ROW PCT COL PCT TOT PCT	V14 SERATED GROUND 1	SERATED STGROUND 2	SERATED BLADE 4	GROUND HAFT 5	STEM GROUND 6	BASE GROUND 7	NEITHER OBSERVED 8	ROW TOTAL
	15	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 20.0 5.3 0.1	2 40.0 1.2 0.2	1 20.0 1.3 0.1	1 20.0 1.6 0.1	0 0.0 0.0 0.0	5 0.6
	16	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 7.7 0.6 0.1	0 0.0 0.0 0.0	4 30.8 6.3 0.5	9 61.5 1.6 0.9	13 1.5
SEDALIA	17	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 40.0 2.5 0.5	1 10.0 1.3 0.1	0 0.0 0.0 0.0	5 50.0 1.0 0.6	10 1.2
RICE LANCE	18	6 9.4 17.1 0.7	3 4.7 60.0 0.3	3 4.7 15.8 0.3	23 35.9 14.1 2.7	13 20.3 16.7 1.5	1 1.6 1.6 0.1	15 23.4 3.0 1.7	64 7.4
	19	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	10 47.6 6.1 1.2	9 42.9 11.5 1.0	0 0.0 0.0 0.0	2 9.5 0.4 0.2	21 2.4
	20	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 7.1 5.3 0.1	1 7.1 0.6 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	12 85.7 2.4 1.4	14 1.6
DALTON LIKE	21	1 20.0 2.9 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 40.0 1.2 0.2	0 0.0 0.0 0.0	1 20.0 1.6 0.1	1 20.0 0.2 0.1	5 0.6
DALTON	22	4 57.1 11.4 0.5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 42.9 1.8 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 0.8
PLAINVIEW	23	1 33.3 2.9 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 0.6 0.1	0 0.0 0.0 0.0	1 33.3 1.6 0.1	0 0.0 0.0 0.0	3 0.3
RICE LOBED	24	6 46.2 17.1 0.7	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 7.7 0.6 0.1	0 0.0 0.0 0.0	1 7.7 1.6 0.1	5 38.5 1.0 0.6	13 1.5
HIDDEN VALLEY	25	1 2.7 2.9 0.1	2 5.4 40.0 0.2	0 0.0 0.0 0.0	9 24.3 5.5 1.0	15 40.5 19.2 1.7	0 0.0 0.0 0.0	10 27.0 2.0 1.2	37 4.3
RODGERS FLARED	26	3 12.5 8.6 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	14 58.3 8.6 1.6	3 12.5 3.8 0.3	0 0.0 0.0 0.0	4 16.7 0.8 0.5	24 2.8
	27	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 22.2 2.5 0.5	1 5.6 1.3 0.1	3 16.7 4.7 0.3	10 55.6 2.0 1.2	18 2.1
KIRK-LIKE	28	3 13.0 8.6 0.3	0 0.0 0.0 0.0	1 4.3 5.3 0.1	14 60.9 8.6 1.6	0 0.0 0.0 0.0	2 8.7 3.1 0.2	3 13.0 0.6 0.3	23 2.7
	COLUMN TOTAL	35 4.1	5 0.6	19 2.2	163 18.9	78 9.1	64 7.4	497 57.7	861 100.0

(CONTINUED)

TABLE 11.8 (continued)

```
                    V14
           COUNT   I
         ROW PCT  ISERRATEDL SERRATED  SERRATED  GROUND H  STEM      BASE      NEITHER    ROW
         COL PCT  IGROUND    STGROUND  BLADE     AFT       GROUND    GROUND    OBSERVED   TOTAL
         TOT PCT  I       1 I       2 I       4 I       5 I       6 I       7 I       8 I
V10      ---------I---------I---------I---------I---------I---------I---------I---------I
              29  I       0 I       0 I       0 I       7 I       2 I       0 I      33 I     42
  WILLIAMS        I     0.0 I     0.0 I     0.0 I    16.7 I     4.8 I     0.0 I    78.6 I    4.9
                  I     0.0 I     0.0 I     0.0 I     4.3 I     2.6 I     0.0 I     6.6 I
                  I     0.0 I     0.0 I     0.0 I     0.8 I     0.2 I     0.0 I     3.8 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              30  I       0 I       0 I       0 I      19 I       2 I       7 I      19 I     47
  MARCOS          I     0.0 I     0.0 I     0.0 I    40.4 I     4.3 I    14.9 I    40.4 I    5.5
                  I     0.0 I     0.0 I     0.0 I    11.7 I     2.6 I    10.9 I     3.8 I
                  I     0.0 I     0.0 I     0.0 I     2.2 I     0.2 I     0.8 I     2.2 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              31  I       0 I       0 I       0 I       0 I       0 I       0 I       4 I      4
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I   100.0 I    0.5
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.8 I
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.5 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              32  I       0 I       0 I       0 I       2 I       0 I       0 I       0 I      2
                  I     0.0 I     0.0 I     0.0 I   100.0 I     0.0 I     0.0 I     0.0 I    0.2
                  I     0.0 I     0.0 I     0.0 I     1.2 I     0.0 I     0.0 I     0.0 I
                  I     0.0 I     0.0 I     0.0 I     0.2 I     0.0 I     0.0 I     0.0 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              33  I       1 I       0 I       1 I       1 I       1 I       0 I       1 I      5
                  I    20.0 I     0.0 I    20.0 I    20.0 I    20.0 I     0.0 I    20.0 I    0.6
                  I     2.9 I     0.0 I     5.3 I     0.6 I     1.3 I     0.0 I     0.2 I
                  I     0.1 I     0.0 I     0.1 I     0.1 I     0.1 I     0.0 I     0.1 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              34  I       1 I       0 I       0 I       0 I       0 I       1 I       1 I      3
  LEDROY          I    33.3 I     0.0 I     0.0 I     0.0 I     0.0 I    33.3 I    33.3 I    0.3
                  I     2.9 I     0.0 I     0.0 I     0.0 I     0.0 I     1.6 I     0.2 I
                  I     0.1 I     0.0 I     0.0 I     0.0 I     0.0 I     0.1 I     0.1 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              35  I       1 I       0 I       0 I       0 I       0 I       0 I       2 I      3
  JACKIE STEMMED  I    33.3 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I    66.7 I    0.3
                  I     2.9 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.4 I
                  I     0.1 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.2 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              36  I       5 I       0 I       1 I       4 I       0 I       0 I       3 I     13
  GRAHAM CAVE     I    38.5 I     0.0 I     7.7 I    30.8 I     0.0 I     0.0 I    23.1 I    1.5
                  I    14.3 I     0.0 I     5.3 I     2.5 I     0.0 I     0.0 I     0.6 I
                  I     0.6 I     0.0 I     0.1 I     0.5 I     0.0 I     0.0 I     0.3 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              37  I       0 I       0 I       0 I      11 I       0 I       0 I       3 I     14
  FRIO            I     0.0 I     0.0 I     0.0 I    78.6 I     0.0 I     0.0 I    21.4 I    1.6
                  I     0.0 I     0.0 I     0.0 I     6.7 I     0.0 I     0.0 I     0.6 I
                  I     0.0 I     0.0 I     0.0 I     1.3 I     0.0 I     0.0 I     0.3 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              38  I       1 I       0 I       0 I       2 I       0 I       0 I       2 I      5
                  I    20.0 I     0.0 I     0.0 I    40.0 I     0.0 I     0.0 I    40.0 I    0.6
                  I     2.9 I     0.0 I     0.0 I     1.2 I     0.0 I     0.0 I     0.4 I
                  I     0.1 I     0.0 I     0.0 I     0.2 I     0.0 I     0.0 I     0.2 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              40  I       0 I       0 I       2 I       1 I       1 I       0 I       5 I      9
                  I     0.0 I     0.0 I    22.2 I    11.1 I    11.1 I     0.0 I    55.6 I    1.0
                  I     0.0 I     0.0 I    10.5 I     0.6 I     1.3 I     0.0 I     1.0 I
                  I     0.0 I     0.0 I     0.2 I     0.1 I     0.1 I     0.0 I     0.6 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              41  I       0 I       0 I       0 I       0 I       0 I       0 I       1 I      1
  CUPP            I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I   100.0 I    0.1
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.2 I
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.1 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              42  I       0 I       0 I       0 I       0 I       0 I       9 I       9 I     18
  MARCOS          I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I    50.0 I    50.0 I    2.1
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I    14.1 I     1.8 I
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     1.0 I     1.0 I
                 -I---------I---------I---------I---------I---------I---------I---------I
              43  I       0 I       0 I       0 I       0 I       0 I       0 I       3 I      3
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I   100.0 I    0.3
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.6 I
                  I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.0 I     0.3 I
                 -I---------I---------I---------I---------I---------I---------I---------I
          COLUMN        35         5        19       163        78        64       497      861
           TOTAL       4.1       0.6       2.2      18.9       9.1       7.4      57.7    100.0
(CONTINUED)
```

TABLE 11.8 (concluded)

```
                   V24
           COUNT  I
         ROW PCT  ISERATEDE SERATED  SERATED  GROUND H STEM     BASE     NEITHER   ROW
         COL PCT  IGROUND   STGROUND BLADE    AFT      GROUND   GROUND   OBSERVED  TOTAL
         TOT PCT  I     1  I     2  I     4  I     5  I     6  I     7  I     8  I
V10      --------I--------I--------I--------I--------I--------I--------I--------I
              44  I     0  I     0  I     0  I     0  I     0  I     0  I     3  I      3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.6  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.3  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              45  I     0  I     0  I     0  I     0  I     0  I     0  I     2  I      2
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.2
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.4  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.2  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              46  I     0  I     0  I     0  I     0  I     0  I     0  I     6  I      6
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.7
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.2  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.7  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              47  I     0  I     0  I     0  I     0  I     0  I     0  I     3  I      3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.6  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.3  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              48  I     0  I     0  I     0  I     1  I     4  I     0  I    37  I     42
                  I   0.0  I   0.0  I   0.0  I   2.4  I   9.5  I   0.0  I  88.1  I    4.9
                  I   0.0  I   0.0  I   0.0  I   0.6  I   5.1  I   0.0  I   7.4  I
                  I   0.0  I   0.0  I   0.0  I   0.1  I   0.5  I   0.0  I   4.3  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              49  I     0  I     0  I     0  I     4  I     5  I     1  I    26  I     36
STONE             I   0.0  I   0.0  I   0.0  I  11.1  I  13.9  I   2.8  I  72.2  I    4.2
                  I   0.0  I   0.0  I   0.0  I   2.5  I   6.4  I   1.6  I   5.2  I
                  I   0.0  I   0.0  I   0.0  I   0.5  I   0.6  I   0.1  I   3.0  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              50  I     0  I     0  I     1  I     1  I     0  I     6  I    34  I     42
ETLEY             I   0.0  I   0.0  I   2.4  I   2.4  I   0.0  I  14.3  I  81.0  I    4.9
                  I   0.0  I   0.0  I   5.3  I   0.6  I   0.0  I   9.4  I   6.8  I
                  I   0.0  I   0.0  I   0.1  I   0.1  I   0.0  I   0.7  I   3.9  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              51  I     0  I     0  I     0  I     0  I     0  I     0  I     8  I      8
CASTROVILLE       I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.9
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.6  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.9  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              52  I     0  I     0  I     1  I     0  I     3  I     0  I    24  I     28
                  I   0.0  I   0.0  I   3.6  I   0.0  I  10.7  I   0.0  I  85.7  I    3.3
                  I   0.0  I   0.0  I   5.3  I   0.0  I   3.8  I   0.0  I   4.8  I
                  I   0.0  I   0.0  I   0.1  I   0.0  I   0.3  I   0.0  I   2.8  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              54  I     0  I     0  I     0  I     0  I     0  I     1  I     2  I      3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I  33.3  I  66.7  I    0.3
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.6  I   0.4  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.1  I   0.2  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              55  I     0  I     0  I     0  I     0  I     1  I     2  I     3  I      6
                  I   0.0  I   0.0  I   0.0  I   0.0  I  16.7  I  33.3  I  50.0  I    0.7
                  I   0.0  I   0.0  I   0.0  I   0.0  I   1.3  I   3.1  I   0.6  I
                  I   0.0  I   0.0  I   0.0  I   0.0  I   0.1  I   0.2  I   0.3  I
                 -I--------I--------I--------I--------I--------I--------I--------I
              57  I     0  I     0  I     0  I     1  I     0  I     0  I     1  I      2
                  I   0.0  I   0.0  I   0.0  I  50.0  I   0.0  I   0.0  I  50.0  I    0.2
                  I   0.0  I   0.0  I   0.0  I   0.6  I   0.0  I   0.0  I   0.2  I
                  I   0.0  I   0.0  I   0.0  I   0.1  I   0.0  I   0.0  I   0.1  I
                 -I--------I--------I--------I--------I--------I--------I--------I
          COLUMN        35         5        19       163        79        64       497      861
           TOTAL       4.1       0.6       2.2      18.9       9.1       7.4      57.7    100.0

RAW CHI SQUARE = [illegible]2.43262 WITH  319 DEGREES OF FREEDOM.  SIGNIFICANCE = 0.0
```

TABLE 11.9

Crosstabulation of Point Group by Blade Element Fracture

10	V14 COUNT ROW PCT COL PCT TOT PCT	IMPACT 1	TRANS-VERSE 2	OBLIGUE 3	IRREG-ULAR 4	THERMAL 5	ROW TOTAL
SCALLORN	1	8 57.1 3.6 1.3	5 35.7 2.7 0.8	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 7.1 1.3 0.2	14 2.3
	2	1 12.5 0.4 0.2	5 62.5 2.7 0.8	2 25.0 3.5 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 1.3
SCALLORN LIKE	3	3 100.0 1.3 0.5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.5
CAHOKIA NOTCHED	4	2 66.7 0.9 0.3	1 33.3 0.5 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 0.5
	5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 1.8 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.2
RICE SIDE NOTCH	6	29 63.0 12.9 4.8	12 26.1 6.5 2.0	1 2.2 1.8 0.2	2 4.3 3.3 0.3	2 4.3 2.5 0.3	46 7.6
GARY	7	2 50.0 0.9 0.3	1 25.0 0.5 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 25.0 1.3 0.2	4 0.7
LANGTRY	8	10 50.0 4.5 1.7	5 25.0 2.7 0.8	1 5.0 1.8 0.2	2 10.0 3.3 0.3	2 10.0 2.5 0.3	20 3.3
SMITH	9	7 31.8 3.1 1.2	5 22.7 2.7 0.8	4 18.2 7.0 0.7	1 4.5 1.7 0.2	5 22.7 6.3 0.8	22 3.6
FLUTED LANCE	10	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 1.3 0.2	1 0.2
AFTON	11	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 33.3 1.8 0.2	2 66.7 3.3 0.3	0 0.0 0.0 0.0	3 0.5
TABLE ROCK	12	3 42.9 1.3 0.5	1 14.3 0.5 0.2	0 0.0 0.0 0.0	1 14.3 1.7 0.2	2 28.6 2.5 0.3	7 1.2
	13	6 37.5 2.7 1.0	5 31.3 2.7 0.8	3 18.8 5.3 0.5	0 0.0 0.0 0.0	2 12.5 2.5 0.3	16 2.6
	14	9 50.0 4.0 1.5	4 22.2 2.2 0.7	4 22.2 7.0 0.7	0 0.0 0.0 0.0	1 5.6 1.3 0.2	18 3.0
	COLUMN TOTAL	224 37.0	185 30.6	57 9.4	60 9.9	79 13.1	605 100.0

TABLE 11.9 (continued)

```
                      V14
               COUNT  I
             ROW PCT  IIMPACT    TRANS-    OBLIQUE   IRREG-    THERMAL     ROW
             COL PCT  I          VERSE               ULAR                  TOTAL
             TOT PCT  I      1  I      2  I      3  I      4  I      5  I
V10          --------I--------I--------I--------I--------I--------I
                   15 I      3 I      0 I      1 I      0 I      0 I       4
                      I   75.0 I    0.0 I   25.0 I    0.0 I    0.0 I     0.7
                      I    1.3 I    0.0 I    1.8 I    0.0 I    0.0 I
                      I    0.5 I    0.0 I    0.2 I    0.0 I    0.0 I
                     -I--------I--------I--------I--------I--------I
                   16 I      4 I      3 I      0 I      1 I      2 I      10
                      I   40.0 I   30.0 I    0.0 I   10.0 I   20.0 I     1.7
                      I    1.8 I    1.6 I    0.0 I    1.7 I    2.5 I
                      I    0.7 I    0.5 I    0.0 I    0.2 I    0.3 I
                     -I--------I--------I--------I--------I--------I
                   17 I      2 I      4 I      0 I      2 I      1 I       9
  SEDALIA             I   22.2 I   44.4 I    0.0 I   22.2 I   11.1 I     1.5
                      I    0.9 I    2.2 I    0.0 I    3.3 I    1.3 I
                      I    0.3 I    0.7 I    0.0 I    0.3 I    0.2 I
                     -I--------I--------I--------I--------I--------I
                   18 I     15 I     25 I      6 I      0 I      8 I      54
  RICE LANCE          I   27.8 I   46.3 I   11.1 I    0.0 I   14.8 I     8.9
                      I    6.7 I   13.5 I   10.5 I    0.0 I   10.1 I
                      I    2.5 I    4.1 I    1.0 I    0.0 I    1.3 I
                     -I--------I--------I--------I--------I--------I
                   19 I      6 I      8 I      0 I      1 I      1 I      16
  [illegible]         I   37.5 I   50.0 I    0.0 I    6.3 I    6.3 I     2.6
                      I    2.7 I    4.3 I    0.0 I    1.7 I    1.3 I
                      I    1.0 I    1.3 I    0.0 I    0.2 I    0.2 I
                     -I--------I--------I--------I--------I--------I
                   20 I      5 I      2 I      0 I      2 I      1 I      10
                      I   50.0 I   20.0 I    0.0 I   20.0 I   10.0 I     1.7
                      I    2.2 I    1.1 I    0.0 I    3.3 I    1.3 I
                      I    0.8 I    0.3 I    0.0 I    0.3 I    0.2 I
                     -I--------I--------I--------I--------I--------I
                   21 I      1 I      1 I      0 I      1 I      0 I       3
  DALTON LIKE         I   33.3 I   33.3 I    0.0 I   33.3 I    0.0 I     0.5
                      I    0.4 I    0.5 I    0.0 I    1.7 I    0.0 I
                      I    0.2 I    0.2 I    0.0 I    0.2 I    0.0 I
                      I--------I--------I--------I--------I--------I
                   22 I      0 I      3 I      0 I      0 I      1 I       4
  DALTON              I    0.0 I   75.0 I    0.0 I    0.0 I   25.0 I     0.7
                      I    0.0 I    1.6 I    0.0 I    0.0 I    1.3 I
                      I    0.0 I    0.5 I    0.0 I    0.0 I    0.2 I
                     -I--------I--------I--------I--------I--------I
                   23 I      1 I      0 I      1 I      0 I      0 I       2
  PLAINVIEW           I   50.0 I    0.0 I   50.0 I    0.0 I    0.0 I     0.3
                      I    0.4 I    0.0 I    1.8 I    0.0 I    0.0 I
                      I    0.2 I    0.0 I    0.2 I    0.0 I    0.0 I
                     -I--------I--------I--------I--------I--------I
                   24 I      2 I      5 I      1 I      0 I      0 I       8
  RICE LOBED          I   25.0 I   62.5 I   12.5 I    0.0 I    0.0 I     1.3
                      I    0.9 I    2.7 I    1.8 I    0.0 I    0.0 I
                      I    0.3 I    0.8 I    0.2 I    0.0 I    0.0 I
                     -I--------I--------I--------I--------I--------I
                   25 I      9 I     14 I      2 I      7 I      0 I      32
  HIDDEN VALLEY       I   28.1 I   43.8 I    6.3 I   21.9 I    0.0 I     5.3
                      I    4.0 I    7.6 I    3.5 I   11.7 I    0.0 I
                      I    1.5 I    2.3 I    0.3 I    1.2 I    0.0 I
                     -I--------I--------I--------I--------I--------I
                   26 I      8 I      1 I      2 I      2 I      2 I      15
  RODGERS FLARED      I   53.3 I    6.7 I   13.3 I   13.3 I   13.3 I     2.5
                      I    3.6 I    0.5 I    3.5 I    3.3 I    2.5 I
                      I    1.3 I    0.2 I    0.3 I    0.3 I    0.3 I
                     -I--------I--------I--------I--------I--------I
                   27 I      5 I      2 I      1 I      2 I      2 I      12
                      I   41.7 I   16.7 I    8.3 I   16.7 I   16.7 I     2.0
                      I    2.2 I    1.1 I    1.8 I    3.3 I    2.5 I
                      I    0.8 I    0.3 I    0.2 I    0.3 I    0.3 I
                     -I--------I--------I--------I--------I--------I
                   28 I      8 I      5 I      0 I      0 I      2 I      15
  KIRK-LIKE           I   53.3 I   33.3 I    0.0 I    0.0 I   13.3 I     2.5
                      I    3.6 I    2.7 I    0.0 I    0.0 I    2.5 I
                      I    1.3 I    0.8 I    0.0 I    0.0 I    0.3 I
                     -I--------I--------I--------I--------I--------I
               COLUMN      224      185       57       60       79     605
                TOTAL     37.0     30.6      9.4      9.9     13.1   100.0
(CONTINUED)
```

TABLE 11.9 (continued)

```
                          V14
               COUNT  I
              ROW PCT IIMPACT   TRANS-   OBLIQUE  IRREG-   THERMAL    ROW
              COL PCT I         VERSE             ULAR                TOTAL
              TOT PCT I     1  I     2  I     3  I     4  I     5  I
  10          --------I--------I--------I--------I--------I--------I
                   29 I     7  I     7  I     5  I     3  I     9  I     31
   WILLIAMS           I  22.6  I  22.6  I  16.1  I   9.7  I  29.0  I    5.1
                      I   3.1  I   3.8  I   8.8  I   5.0  I  11.4  I
                      I   1.2  I   1.2  I   0.8  I   0.5  I   1.5  I
                     -I--------I--------I--------I--------I--------I
                   30 I    12  I    15  I     2  I     5  I     8  I     42
   MARCOS             I  28.6  I  35.7  I   4.8  I  11.9  I  19.0  I    6.9
                      I   5.4  I   8.1  I   3.5  I   8.3  I  10.1  I
                      I   2.0  I   2.5  I   0.3  I   0.8  I   1.3  I
                     -I--------I--------I--------I--------I--------I
                   31 I     2  I     0  I     2  I     0  I     0  I      4
                      I  50.0  I   0.0  I  50.0  I   0.0  I   0.0  I    0.7
                      I   0.9  I   0.0  I   3.5  I   0.0  I   0.0  I
                      I   0.3  I   0.0  I   0.3  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   32 I     0  I     1  I     0  I     0  I     0  I      1
                      I   0.0  I 100.0  I   0.0  I   0.0  I   0.0  I    0.2
                      I   0.0  I   0.5  I   0.0  I   0.0  I   0.0  I
                      I   0.0  I   0.2  I   0.0  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   33 I     1  I     0  I     0  I     1  I     2  I      4
                      I  25.0  I   0.0  I   0.0  I  25.0  I  50.0  I    0.7
                      I   0.4  I   0.0  I   0.0  I   1.7  I   2.5  I
                      I   0.2  I   0.0  I   0.0  I   0.2  I   0.3  I
                     -I--------I--------I--------I--------I--------I
                   34 I     1  I     0  I     0  I     1  I     0  I      2
   LECRCY             I  50.0  I   0.0  I   0.0  I  50.0  I   0.0  I    0.3
                      I   0.4  I   0.0  I   0.0  I   1.7  I   0.0  I
                      I   0.2  I   0.0  I   0.0  I   0.2  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   36 I     3  I     2  I     0  I     0  I     1  I      6
   GRAHAM CAVE        I  50.0  I  33.3  I   0.0  I   0.0  I  16.7  I    1.0
                      I   1.3  I   1.1  I   0.0  I   0.0  I   1.3  I
                      I   0.5  I   0.3  I   0.0  I   0.0  I   0.2  I
                     -I--------I--------I--------I--------I--------I
                   37 I     9  I     1  I     2  I     0  I     0  I     12
   FRIO               I  75.0  I   8.3  I  16.7  I   0.0  I   0.0  I    2.0
                      I   4.0  I   0.5  I   3.5  I   0.0  I   0.0  I
                      I   1.5  I   0.2  I   0.3  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   38 I     0  I     0  I     0  I     0  I     1  I      1
                      I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    0.2
                      I   0.0  I   0.0  I   0.0  I   0.0  I   1.3  I
                      I   0.0  I   0.0  I   0.0  I   0.0  I   0.2  I
                     -I--------I--------I--------I--------I--------I
                   40 I     2  I     0  I     0  I     0  I     0  I      2
                      I 100.0  I   0.0  I   0.0  I   0.0  I   0.0  I    0.3
                      I   0.9  I   0.0  I   0.0  I   0.0  I   0.0  I
                      I   0.3  I   0.0  I   0.0  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   42 I     1  I     3  I     3  I     5  I     4  I     16
   MARCUS             I   6.3  I  18.8  I  18.8  I  31.3  I  25.0  I    2.6
                      I   0.4  I   1.6  I   5.3  I   8.3  I   5.1  I
                      I   0.2  I   0.5  I   0.5  I   0.8  I   0.7  I
                     -I--------I--------I--------I--------I--------I
                   43 I     0  I     0  I     0  I     1  I     0  I      1
                      I   0.0  I   0.0  I   0.0  I 100.0  I   0.0  I    0.2
                      I   0.0  I   0.0  I   0.0  I   1.7  I   0.0  I
                      I   0.0  I   0.0  I   0.0  I   0.2  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   44 I     0  I     1  I     1  I     0  I     0  I      2
                      I   0.0  I  50.0  I  50.0  I   0.0  I   0.0  I    0.3
                      I   0.0  I   0.5  I   1.8  I   0.0  I   0.0  I
                      I   0.0  I   0.2  I   0.2  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
                   46 I     0  I     2  I     0  I     0  I     0  I      2
                      I   0.0  I 100.0  I   0.0  I   0.0  I   0.0  I    0.3
                      I   0.0  I   1.1  I   0.0  I   0.0  I   0.0  I
                      I   0.0  I   0.3  I   0.0  I   0.0  I   0.0  I
                     -I--------I--------I--------I--------I--------I
               COLUMN     224      185       57       60       77       605
                TOTAL    37.0     30.6      9.4      9.5     13.1     100.0
 (CONTINUED)
```

TABLE 11.9 (concluded)

```
                        V14
               COUNT   I
               ROW PCT IIMPACT   TRANS-   OBLIQUE  IRREG-   THERMAL    ROW
               COL PCT I         VERSE             ULAR               TOTAL
               TOT PCT I    1  I    2  I    3  I    4  I    5  I
V10            --------I-------I-------I-------I-------I-------I
                    47 I     0 I     3 I     0 I     0 I     0 I      3
                       I   0.0 I 100.0 I   0.0 I   0.0 I   0.0 I    0.5
                       I   0.0 I   1.6 I   0.0 I   0.0 I   0.0 I
                       I   0.0 I   0.5 I   0.0 I   0.0 I   0.0 I
                      -I-------I-------I-------I-------I-------I
                    48 I    11 I     3 I     3 I     6 I     7 I     30
                       I  36.7 I  10.0 I  10.0 I  20.0 I  23.3 I    5.0
                       I   4.9 I   1.6 I   5.3 I  10.0 I   8.9 I
                       I   1.8 I   0.5 I   0.5 I   1.0 I   1.2 I
                      -I-------I-------I-------I-------I-------I
                    49 I     6 I    13 I     3 I     2 I     7 I     31
  STONE                I  19.4 I  41.9 I   9.7 I   6.5 I  22.6 I    5.1
                       I   2.7 I   7.0 I   5.3 I   3.3 I   8.9 I
                       I   1.0 I   2.1 I   0.5 I   0.3 I   1.2 I
                      -I-------I-------I-------I-------I-------I
                    50 I     6 I     5 I     4 I     4 I     0 I     19
  ETLEY                I  31.6 I  26.3 I  21.1 I  21.1 I   0.0 I    3.1
                       I   2.7 I   2.7 I   7.0 I   6.7 I   0.0 I
                       I   1.0 I   0.8 I   0.7 I   0.7 I   0.0 I
                      -I-------I-------I-------I-------I-------I
                    51 I     2 I     1 I     1 I     1 I     0 I      5
  CASTORVILLE          I  40.0 I  20.0 I  20.0 I  20.0 I   0.0 I    0.8
                       I   0.9 I   0.5 I   1.8 I   1.7 I   0.0 I
                       I   0.3 I   0.2 I   0.2 I   0.2 I   0.0 I
                      -I-------I-------I-------I-------I-------I
                    52 I     9 I     9 I     0 I     4 I     3 I     25
                       I  36.0 I  36.0 I   0.0 I  16.0 I  12.0 I    4.1
                       I   4.0 I   4.9 I   0.0 I   6.7 I   3.8 I
                       I   1.5 I   1.5 I   0.0 I   0.7 I   0.5 I
                      -I-------I-------I-------I-------I-------I
                    55 I     3 I     1 I     0 I     0 I     0 I      4
                       I  75.0 I  25.0 I   0.0 I   0.0 I   0.0 I    0.7
                       I   1.3 I   0.5 I   0.0 I   0.0 I   0.0 I
                       I   0.5 I   0.2 I   0.0 I   0.0 I   0.0 I
                       I-------I-------I-------I-------I-------I
                    57 I     0 I     1 I     0 I     1 I     0 I      2
                       I   0.0 I  50.0 I   0.0 I  50.0 I   0.0 I    0.3
                       I   0.0 I   0.5 I   0.0 I   1.7 I   0.0 I
                       I   0.0 I   0.2 I   0.0 I   0.2 I   0.0 I
                      -I-------I-------I-------I-------I-------I
                COLUMN     224     185      57      60      79      605
                 TOTAL    37.0    30.6     9.4     9.9    13.1    100.0

RAW CHI SQUARE =   287.60010 WITH   196 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000
```

TABLE 11.10

Crosstabulation of Horizon by Flaking

```
* * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * * * * * * * * * * * * * * * * * * *
   V8      HORIZON                                         BY  V17      FLAKING
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE  1 OF * * * * * * * * * *

               V17                                                                                    V17
     COUNT  I                                                                                          I
   ROW PCT  IMARGINAL TYPE 2   TYPE 3   TYPE 4   RANDOM   RANDOM   TYPE 5   TYPE 6   TYPE 7   COMBINECIFLUTING      ROW
   COL PCT  IPRESSURE PRESSURE PRESSURE PRESSURE PRESSURE PERCUSN  PERCUSN  PERCUSN  PERCUSN           I             TOTAL
   TOT PCT  I      1 I      2 I      3 I      4 I      5 I      6 I      7 I      8 I      9 I     10 I     11 I
V8          --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          1 I      4 I      6 I     27 I     13 I     13 I      1 I     36 I      0 I      1 I     31 I      0 I   132
  ONE       I    3.0 I    4.5 I   20.5 I    9.8 I    9.8 I    0.8 I   27.3 I    0.0 I    0.8 I   23.5 I    0.0 I  23.5
            I   80.0 I   46.2 I   23.1 I   34.2 I   35.1 I    7.7 I   31.9 I    0.0 I   14.3 I   16.7 I    0.0 I
            I    0.7 I    1.1 I    4.8 I    2.3 I    2.3 I    0.2 I    6.4 I    0.0 I    0.2 I    5.5 I    0.0 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          2 I      1 I      3 I     22 I     13 I     20 I      8 I     32 I      0 I      4 I     24 I      0 I   127
  TWO       I    0.8 I    2.4 I   17.3 I   10.2 I   15.7 I    6.3 I   25.2 I    0.0 I    3.1 I   18.9 I    0.0 I  22.6
            I   20.0 I   23.1 I   18.8 I   34.2 I   54.1 I   61.5 I   28.3 I    0.0 I   57.1 I   12.9 I    0.0 I
            I    0.2 I    0.5 I    3.9 I    2.3 I    3.6 I    1.4 I    5.7 I    0.0 I    0.7 I    4.3 I    0.0 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          3 I      0 I      1 I     13 I      2 I      2 I      4 I     14 I      0 I      2 I     18 I      0 I    56
  THREE     I    0.0 I    1.8 I   23.2 I    3.6 I    3.6 I    7.1 I   25.0 I    0.0 I    3.6 I   32.1 I    0.0 I  10.0
            I    0.0 I    7.7 I   11.1 I    5.3 I    5.4 I   30.8 I   12.4 I    0.0 I   28.6 I    9.7 I    0.0 I
            I    0.0 I    0.2 I    2.3 I    0.4 I    0.4 I    0.7 I    2.5 I    0.0 I    0.4 I    3.2 I    0.0 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          5 I      0 I      2 I     15 I      3 I      1 I      0 I     17 I      1 I      0 I     41 I      4 I    84
  FIVE      I    0.0 I    2.4 I   17.9 I    3.6 I    1.2 I    0.0 I   20.2 I    1.2 I    0.0 I   48.8 I    4.8 I  14.9
            I    0.0 I   15.4 I   12.8 I    7.9 I    2.7 I    0.0 I   15.0 I    9.1 I    0.0 I   22.0 I   18.2 I
            I    0.0 I    0.4 I    2.7 I    0.5 I    0.2 I    0.0 I    3.0 I    0.2 I    0.0 I    7.3 I    0.7 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          6 I      0 I      1 I     19 I      1 I      0 I      0 I      8 I      2 I      0 I     23 I      3 I    57
  SIX       I    0.0 I    1.8 I   33.3 I    1.8 I    0.0 I    0.0 I   14.0 I    3.5 I    0.0 I   40.4 I    5.3 I  10.1
            I    0.0 I    7.7 I   16.2 I    2.6 I    0.0 I    0.0 I    7.1 I   18.2 I    0.0 I   12.4 I   13.6 I
            I    0.0 I    0.2 I    3.4 I    0.2 I    0.0 I    0.0 I    1.4 I    0.4 I    0.0 I    4.1 I    0.5 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          7 I      0 I      0 I     15 I      5 I      1 I      0 I      6 I      2 I      0 I     38 I      5 I    72
  SEVEN     I    0.0 I    0.0 I   20.8 I    6.9 I    1.4 I    0.0 I    8.3 I    2.8 I    0.0 I   52.8 I    6.9 I  12.8
            I    0.0 I    0.0 I   12.8 I   13.2 I    2.7 I    0.0 I    5.3 I   18.2 I    0.0 I   20.4 I   22.7 I
            I    0.0 I    0.0 I    2.7 I    0.9 I    0.2 I    0.0 I    1.1 I    0.4 I    0.0 I    6.8 I    0.9 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          8 I      0 I      0 I      5 I      0 I      0 I      0 I      0 I      5 I      0 I      9 I      1 I    20
  EIGHT     I    0.0 I    0.0 I   25.0 I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I    0.0 I   45.0 I    5.0 I   3.6
            I    0.0 I    0.0 I    4.3 I    0.0 I    0.0 I    0.0 I    0.0 I   45.5 I    0.0 I    4.8 I    4.5 I
            I    0.0 I    0.0 I    0.9 I    0.0 I    0.0 I    0.0 I    0.0 I    0.9 I    0.0 I    1.6 I    0.2 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
          9 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I      1 I      0 I      1 I      1 I     4
  NINE      I    0.0 I    0.0 I   25.0 I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I    0.0 I   25.0 I   25.0 I   0.7
            I    0.0 I    0.0 I    0.9 I    0.0 I    0.0 I    0.0 I    0.0 I    9.1 I    0.0 I    0.5 I    4.5 I
            I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I    0.2 I    0.2 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
         10 I      0 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I      0 I      1 I      8 I    10
  TEN       I    0.0 I    0.0 I    0.0 I   10.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I   10.0 I   80.0 I   1.8
            I    0.0 I    0.0 I    0.0 I    2.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.5 I   36.4 I
            I    0.0 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.2 I    1.4 I
           -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
     COLUMN        5       13      117       38       37       13      113       11        7      186       22      562
      TOTAL      0.9      2.3     20.8      6.8      6.6      2.3     20.1      2.0      1.2     33.1      3.9    100.0

RAW CHI SQUARE =   383.29639 WITH    80 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING CBSERVATIONS =    357
```

TABLE 11.11

Crosstabulation of Horizon by Serration-grinding

```
                                        - - - - C R O S S T A B U L A T I O N   O F - - - - - - - - - -
      V8          HORIZON                                                  BY  V24        SERATION-GRINDING
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                          V24
                  COUNT   I
                ROW PCT   ISERATEDG SERATED  SERATED  GROUND H STEM     BASE     NEITHER   ROW
                COL PCT   IGROUND   STGROUND BLADE    AFT      GROUND   GROUND   OBSERVED  TOTAL
                TOT PCT   I       1 I      2 I      4 I      5 I      6 I      7 I      8 I
V8              --------I--------I--------I--------I--------I--------I--------I--------I
                      1 I      0 I      0 I      2 I     10 I      6 I      9 I    122 I    149
  ONE                   I    0.0 I    0.0 I    1.3 I    6.7 I    4.0 I    6.0 I   81.9 I   21.4
                        I    0.0 I    0.0 I   13.3 I    7.6 I    9.0 I   17.6 I   30.8 I
                        I    0.0 I    0.0 I    0.3 I    1.4 I    0.9 I    1.3 I   17.5 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      2 I      0 I      0 I      5 I      9 I     10 I     17 I    105 I    146
  TWO                   I    0.0 I    0.0 I    3.4 I    6.2 I    6.8 I   11.6 I   71.9 I   21.0
                        I    0.0 I    0.0 I   33.3 I    6.9 I   14.9 I   33.3 I   26.5 I
                        I    0.0 I    0.0 I    0.7 I    1.3 I    1.4 I    2.4 I   15.1 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      3 I      0 I      0 I      1 I      6 I      5 I      6 I     44 I     62
  THREE                 I    0.0 I    0.0 I    1.6 I    9.7 I    8.1 I    9.7 I   71.0 I    8.9
                        I    0.0 I    0.0 I    6.7 I    4.6 I    7.5 I   11.8 I   11.1 I
                        I    0.0 I    0.0 I    0.1 I    0.9 I    0.7 I    0.9 I    6.3 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      5 I      4 I      1 I      0 I     36 I     17 I      8 I     49 I    115
  FIVE                  I    3.5 I    0.9 I    0.0 I   31.3 I   14.8 I    7.0 I   42.6 I   16.5
                        I   12.9 I   20.0 I    0.0 I   27.5 I   25.4 I   15.7 I   12.4 I
                        I    0.6 I    0.1 I    0.0 I    5.2 I    2.4 I    1.1 I    7.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      6 I      6 I      1 I      3 I     31 I     13 I      3 I     29 I     86
  SIX                   I    7.0 I    1.2 I    3.5 I   36.0 I   15.1 I    3.5 I   33.7 I   12.4
                        I   19.4 I   20.0 I   20.0 I   23.7 I   19.4 I    5.9 I    7.3 I
                        I    0.9 I    0.1 I    0.4 I    4.5 I    1.9 I    0.4 I    4.2 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      7 I      8 I      3 I      1 I     24 I     14 I      7 I     38 I     95
  SEVEN                 I    9.4 I    3.2 I    1.1 I   25.3 I   14.7 I    7.4 I   40.0 I   13.6
                        I   25.8 I   60.0 I    6.7 I   18.3 I   20.9 I   13.7 I    9.6 I
                        I    1.1 I    0.4 I    0.1 I    3.4 I    2.0 I    1.0 I    5.5 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                      8 I      6 I      0 I      3 I     10 I      2 I      0 I      8 I     29
  EIGHT                 I   20.7 I    0.0 I   10.3 I   34.5 I    6.9 I    0.0 I   27.6 I    4.2
                        I   19.4 I    0.0 I   20.0 I    7.6 I    3.0 I    0.0 I    2.0 I
                        I    0.9 I    0.0 I    0.4 I    1.4 I    0.3 I    0.0 I    1.1 I
                --------I--------I--------I--------I--------I--------I--------I--------I
                      9 I      2 I      0 I      0 I      1 I      0 I      0 I      1 I      4
  NINE                  I   50.0 I    0.0 I    0.0 I   25.0 I    0.0 I    0.0 I   25.0 I    0.6
                        I    6.5 I    0.0 I    0.0 I    0.8 I    0.0 I    0.0 I    0.3 I
                        I    0.3 I    0.0 I    0.0 I    0.1 I    0.0 I    0.0 I    0.1 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                     10 I      5 I      0 I      0 I      4 I      0 I      1 I      0 I     10
  TEN                   I   50.0 I    0.0 I    0.0 I   40.0 I    0.0 I   10.0 I    0.0 I    1.4
                        I   16.1 I    0.0 I    0.0 I    3.1 I    0.0 I    2.0 I    0.0 I
                        I    0.7 I    0.0 I    0.0 I    0.6 I    0.0 I    0.1 I    0.0 I
                       -I--------I--------I--------I--------I--------I--------I--------I
                 COLUMN       31        5       15      131       67       51      396      696
                  TOTAL      4.5      0.7      2.2     18.8      9.6      7.3     56.9    100.0

RAW CHI SQUARE =   264.07251 WITH    48 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =    223
```

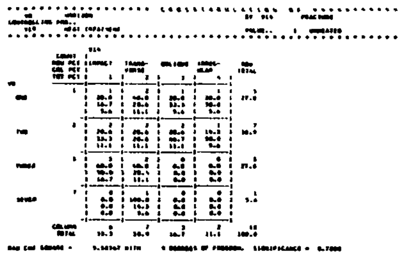
TABLE 11.12

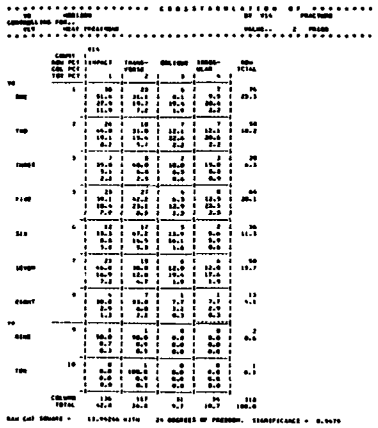
Crosstabulation of Serration-grinding by Blade Cross Section

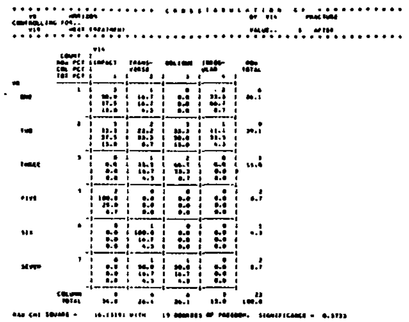
```
                    V11
            COUNT  I
          ROW PCT  IBIPLANO  TRIANGUL TRAPEZOI BICONVEX LENTICUL PLANO-CO CONCAVO- BEVELED  BIBEVELE IRREGULA   ROW
          COL PCT  I         AR       D                 AR       NVEX     CONVEX            D        R         TOTAL
          TOT PCT  I     1  I     2  I     3  I     4  I     5  I     6  I     7  I     8  I    10  I    11  I
V24        --------I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 4 I     0  I     1  I     0  I     0  I     0  I     1  I     0  I     0  I     0  I     0  I     2
  SERRATED BLADE   I   0.0  I  50.0  I   0.0  I   0.0  I   0.0  I  50.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.6
                   I   0.0  I  50.0  I   0.0  I   0.0  I   0.0  I   2.8  I   0.0  I   0.0  I   0.0  I   0.0  I
                   I   0.0  I   0.8  I   0.0  I   0.0  I   0.0  I   0.8  I   0.0  I   0.0  I   0.0  I   0.0  I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 5 I     4  I     0  I     0  I     2  I     0  I     2  I     0  I     0  I     0  I     0  I     8
  GROUND HAFT      I  50.0  I   0.0  I   0.0  I  25.0  I   0.0  I  25.0  I   0.0  I   0.0  I   0.0  I   0.0  I   6.3
                   I  13.9  I   0.0  I   0.0  I   6.5  I   0.0  I   5.6  I   0.0  I   0.0  I   0.0  I   0.0  I
                   I   3.2  I   0.0  I   0.0  I   1.6  I   0.0  I   1.6  I   0.0  I   0.0  I   0.0  I   0.0  I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 6 I     1  I     0  I     0  I     0  I     0  I     1  I     0  I     0  I     0  I     2  I     4
  STEM     GROUND  I  25.0  I   0.0  I   0.0  I   0.0  I   0.0  I  25.0  I   0.0  I   0.0  I   0.0  I  50.0  I   3.2
                   I   3.4  I   0.0  I   0.0  I   0.0  I   0.0  I   2.9  I   0.0  I   0.0  I   0.0  I  16.7  I
                   I   0.9  I   0.0  I   0.0  I   0.0  I   0.0  I   0.8  I   0.0  I   0.0  I   0.0  I   1.6  I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 7 I     1  I     0  I     0  I     1  I     0  I     1  I     0  I     0  I     1  I     2  I     6
  BASE     GROUND  I  16.7  I   0.0  I   0.0  I  16.7  I   0.0  I  16.7  I   0.0  I   0.0  I  16.7  I  33.3  I   4.8
                   I   3.4  I   0.0  I   0.0  I   3.2  I   0.0  I   2.8  I   0.0  I   0.0  I  50.0  I  16.7  I
                   I   0.8  I   0.0  I   0.0  I   0.8  I   0.0  I   0.8  I   0.0  I   0.0  I   0.8  I   1.6  I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                 8 I    23  I     1  I     2  I    28  I     6  I    31  I     5  I     1  I     1  I     8  I   106
  NEITHER OBSERVED I  21.7  I   0.9  I   1.9  I  26.4  I   5.7  I  29.2  I   4.7  I   0.9  I   0.9  I   7.5  I  84.1
                   I  79.3  I  50.0  I 100.0  I  70.3  I 100.0  I  86.1  I 100.0  I 100.0  I  50.0  I  66.7  I
                   I  19.3  I   0.8  I   1.6  I  22.2  I   4.8  I  24.6  I   4.0  I   0.9  I   0.8  I   5.3  I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
           COLUMN       29        2        2       41        6       36        5        1        2       12      126
           TOTAL      23.0      1.6      1.6     32.5      4.8     28.6      4.0      0.8      1.6      9.5    100.0

RAW CHI SQUARE     [illegible] WITH     [illegible] DEGREES OF FREEDOM.  SIGNIFICANCE     [illegible]
```

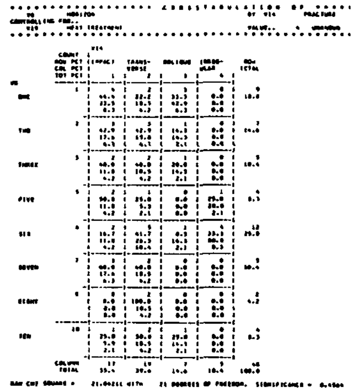
TABLE 11.13

Crosstabulation of Horizon by Fracture Controlled for Heat Treatment









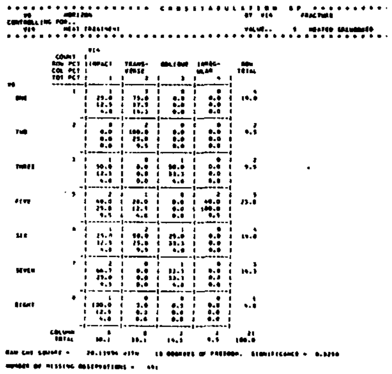


TABLE 11.14

Crosstabulation of Horizon by Material Controlled for Heat Treatment

```
* * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * *
   V8       HORIZON                                          BY V18      MATERIAL
CONTROLLING FOR..
   V19      HEAT TREATMENT                                   VALUE..   1  UNHEATED
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
           COUNT   I
           ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN CHOTEAU    ROW
           COL PCT ICHERT    CHERT    CHERT    CHERT    CHERT      TOTAL
           TOT PCT I      2 I      3 I      4 I      5 I      6 I
V8         --------I--------I--------I--------I--------I--------I
                 1 I      2 I      4 I      0 I      1 I      0 I      7
  ONE              I   28.6 I   57.1 I    0.0 I   14.3 I    0.0 I   28.0
                   I   22.2 I   36.4 I    0.0 I   33.3 I    0.0 I
                   I    8.0 I   16.0 I    0.0 I    4.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 2 I      5 I      3 I      1 I      1 I      0 I     10
  TWO              I   50.0 I   30.0 I   10.0 I   10.0 I    0.0 I   40.0
                   I   55.6 I   27.3 I  100.0 I   33.3 I    0.0 I
                   I   20.0 I   12.0 I    4.0 I    4.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 3 I      1 I      4 I      0 I      1 I      1 I      7
  THREE            I   14.3 I   57.1 I    0.0 I   14.3 I   14.3 I   28.0
                   I   11.1 I   36.4 I    0.0 I   33.3 I  100.0 I
                   I    4.0 I   16.0 I    0.0 I    4.0 I    4.0 I
                  -I--------I--------I--------I--------I--------I
                 7 I      1 I      0 I      0 I      0 I      0 I      1
  SEVEN            I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    4.0
                   I   11.1 I    0.0 I    0.0 I    0.0 I    0.0 I
                   I    4.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
            COLUMN        9       11        1        3        1       25
             TOTAL     36.0     44.0      4.0     12.0      4.0    100.0

RAW CHI SQUARE =    8.42712 WITH   12 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.7504
```

```
* * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * * * * *
   V8       HORIZON                                          BY V18      MATERIAL
CONTROLLING FOR..
   V19      HEAT TREATMENT                                   VALUE..   2  PRIOR
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
           COUNT   I
           ROW PCT IQUARTZ-  OOLITIC  BANDED   X-BANDED BURLNGTN RIVER    OTHER    CHOTEAU    ROW
           COL PCT IITE      CHERT    CHERT    CHERT    CHERT    GRAVEL   CHERT    CHERT      TOTAL
           TOT PCT I      1 I      2 I      3 I      4 I      5 I      6 I      7 I      8 I
V8         --------I--------I--------I--------I--------I--------I--------I--------I--------I
                 1 I      0 I     19 I     50 I      8 I     16 I      1 I      0 I      3 I     97
  ONE              I    0.0 I   19.6 I   51.5 I    8.2 I   16.5 I    1.0 I    0.0 I    3.1 I   20.7
                   I    0.0 I   14.8 I   22.8 I   47.1 I   19.3 I   50.0 I    0.0 I   16.7 I
                   I    0.0 I    4.1 I   10.7 I    1.7 I    3.4 I    0.2 I    0.0 I    0.6 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 2 I      1 I     18 I     53 I      2 I     17 I      1 I      0 I      0 I     92
  TWO              I    1.1 I   19.6 I   57.6 I    2.2 I   18.5 I    1.1 I    0.0 I    0.0 I   19.6
                   I  100.0 I   14.1 I   24.2 I   11.8 I   20.5 I   50.0 I    0.0 I    0.0 I
                   I    0.2 I    3.8 I   11.3 I    0.4 I    3.6 I    0.2 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 3 I      0 I     18 I     10 I      1 I      5 I      0 I      0 I      1 I     35
  THREE            I    0.0 I   51.4 I   28.6 I    2.9 I   14.3 I    0.0 I    0.0 I    2.9 I    7.5
                   I    0.0 I   14.1 I    4.6 I    5.9 I    6.0 I    0.0 I    0.0 I    5.6 I
                   I    0.0 I    3.8 I    2.1 I    0.2 I    1.1 I    0.0 I    0.0 I    0.2 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 5 I      0 I     28 I     37 I      3 I     13 I      0 I      1 I      8 I     90
  FIVE             I    0.0 I   31.1 I   41.1 I    3.3 I   14.4 I    0.0 I    1.1 I    8.9 I   19.2
                   I    0.0 I   21.9 I   16.9 I   17.6 I   15.7 I    0.0 I  100.0 I   44.4 I
                   I    0.0 I    6.0 I    7.9 I    0.6 I    2.8 I    0.0 I    0.2 I    1.7 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 6 I      0 I     16 I     30 I      2 I     10 I      0 I      0 I      1 I     59
  SIX              I    0.0 I   27.1 I   50.8 I    3.4 I   16.9 I    0.0 I    0.0 I    1.7 I   12.6
                   I    0.0 I   12.5 I   13.7 I   11.8 I   12.0 I    0.0 I    0.0 I    5.6 I
                   I    0.0 I    3.4 I    6.4 I    0.4 I    2.1 I    0.0 I    0.0 I    0.2 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 7 I      0 I     17 I     32 I      1 I     15 I      0 I      0 I      4 I     69
  SEVEN            I    0.0 I   24.6 I   46.4 I    1.4 I   21.7 I    0.0 I    0.0 I    5.8 I   14.7
                   I    0.0 I   13.3 I   14.6 I    5.9 I   18.1 I    0.0 I    0.0 I   22.2 I
                   I    0.0 I    3.6 I    6.8 I    0.2 I    3.2 I    0.0 I    0.0 I    0.9 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                 8 I      0 I      9 I      6 I      0 I      5 I      0 I      0 I      0 I     20
  EIGHT            I    0.0 I   45.0 I   30.0 I    0.0 I   25.0 I    0.0 I    0.0 I    0.0 I    4.3
                   I    0.0 I    7.0 I    2.7 I    0.0 I    6.0 I    0.0 I    0.0 I    0.0 I
                   I    0.0 I    1.9 I    1.3 I    0.0 I    1.1 I    0.0 I    0.0 I    0.0 I
V8         --------I--------I--------I--------I--------I--------I--------I--------I--------I
                 9 I      0 I      2 I      1 I      0 I      1 I      0 I      0 I      0 I      4
  NINE             I    0.0 I   50.0 I   25.0 I    0.0 I   25.0 I    0.0 I    0.0 I    0.0 I    0.9
                   I    0.0 I    1.6 I    0.5 I    0.0 I    1.2 I    0.0 I    0.0 I    0.0 I
                   I    0.0 I    0.4 I    0.2 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
                10 I      0 I      1 I      0 I      0 I      1 I      0 I      0 I      1 I      3
  TEN              I    0.0 I   33.3 I    0.0 I    0.0 I   33.3 I    0.0 I    0.0 I   33.3 I    0.6
                   I    0.0 I    0.8 I    0.0 I    0.0 I    1.2 I    0.0 I    0.0 I    5.6 I
                   I    0.0 I    0.2 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.2 I
                  -I--------I--------I--------I--------I--------I--------I--------I--------I
            COLUMN        1      128      219       17       83        2        1       18      469
             TOTAL      0.2     27.3     46.7      3.6     17.7      0.4      0.2      3.8    100.0

RAW CHI SQUARE =   65.44825 WITH   56 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.1807
```

```
* * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * *
   V8       HORIZON                                          BY V18      MATERIAL
CONTROLLING FOR..
   V19      HEAT TREATMENT                                   VALUE..   3  AFTER
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
           COUNT   I
           ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN CHOTEAU    ROW
           COL PCT ICHERT    CHERT    CHERT    CHERT    CHERT      TOTAL
           TOT PCT I      2 I      3 I      4 I      5 I      6 I
V8         --------I--------I--------I--------I--------I--------I
                 1 I      3 I     13 I      1 I      7 I      1 I     25
  ONE              I   12.0 I   52.0 I    4.0 I   28.0 I    4.0 I   31.3
                   I   16.7 I   31.7 I   33.3 I   50.0 I   25.0 I
                   I    3.7 I   16.2 I    1.2 I    8.7 I    1.2 I
                  -I--------I--------I--------I--------I--------I
                 2 I      6 I     15 I      1 I      3 I      1 I     26
  TWO              I   23.1 I   57.7 I    3.8 I   11.5 I    3.8 I   32.5
                   I   33.3 I   36.6 I   33.3 I   21.4 I   25.0 I
                   I    7.5 I   18.8 I    1.2 I    3.7 I    1.2 I
                  -I--------I--------I--------I--------I--------I
                 3 I      2 I      2 I      0 I      2 I      1 I      7
  THREE            I   28.6 I   28.6 I    0.0 I   28.6 I   14.3 I    8.8
                   I   11.1 I    4.9 I    0.0 I   14.3 I   25.0 I
                   I    2.5 I    2.5 I    0.0 I    2.5 I    1.2 I
                  -I--------I--------I--------I--------I--------I
                 5 I      2 I      4 I      0 I      1 I      0 I      7
  FIVE             I   28.6 I   57.1 I    0.0 I   14.3 I    0.0 I    8.8
                   I   11.1 I    9.8 I    0.0 I    7.1 I    0.0 I
                   I    2.5 I    5.0 I    0.0 I    1.2 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 6 I      2 I      2 I      1 I      0 I      0 I      5
  SIX              I   40.0 I   40.0 I   20.0 I    0.0 I    0.0 I    6.3
                   I   11.1 I    4.9 I   33.3 I    0.0 I    0.0 I
                   I    2.5 I    2.5 I    1.2 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 7 I      3 I      4 I      0 I      1 I      0 I      8
  SEVEN            I   37.5 I   50.0 I    0.0 I   12.5 I    0.0 I   10.0
                   I   16.7 I    9.8 I    0.0 I    7.1 I    0.0 I
                   I    3.7 I    5.0 I    0.0 I    1.2 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 8 I      0 I      1 I      0 I      0 I      0 I      1
  EIGHT            I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    1.3
                   I    0.0 I    2.4 I    0.0 I    0.0 I    0.0 I
                   I    0.0 I    1.2 I    0.0 I    0.0 I    0.0 I
           --------I--------I--------I--------I--------I--------I
                10 I      0 I      0 I      0 I      0 I      1 I      1
  TEN              I    0.0 I    0.0 I    0.0 I    0.0 I  100.0 I    1.3
                   I    0.0 I    0.0 I    0.0 I    0.0 I   25.0 I
                   I    0.0 I    0.0 I    0.0 I    0.0 I    1.2 I
                  -I--------I--------I--------I--------I--------I
            COLUMN       18       41        3       14        4       80
             TOTAL     22.5     51.3      3.8     17.5      5.0    100.0

RAW CHI SQUARE =   34.29001 WITH   28 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.1918
```

```
* * * * * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * *
TERIAL     V8       HORIZON                                          BY V18      MATERIAL
           CONTROLLING FOR..
AFTER         V19      HEAT TREATMENT                                VALUE..   4  UNKNOWN
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
           COUNT   I
           ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN CHOTEAU    ROW
           COL PCT ICHERT    CHERT    CHERT    CHERT    CHERT      TOTAL
           TOT PCT I      2 I      3 I      4 I      5 I      6 I
V8         --------I--------I--------I--------I--------I--------I
                 1 I      5 I      9 I      0 I      1 I      0 I     15
  ONE              I   33.3 I   60.0 I    0.0 I    6.7 I    0.0 I   18.8
                   I   19.2 I   20.0 I    0.0 I   25.0 I    0.0 I
                   I    6.3 I   11.2 I    0.0 I    1.2 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 2 I      7 I      7 I      1 I      0 I      0 I     15
  TWO              I   46.7 I   46.7 I    6.7 I    0.0 I    0.0 I   18.8
                   I   26.9 I   15.6 I   25.0 I    0.0 I    0.0 I
                   I    8.7 I    8.7 I    1.2 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 3 I      4 I      5 I      0 I      1 I      1 I     11
  THREE            I   36.4 I   45.5 I    0.0 I    9.1 I    9.1 I   13.8
                   I   15.4 I   11.1 I    0.0 I   25.0 I  100.0 I
                   I    5.0 I    6.3 I    0.0 I    1.2 I    1.2 I
                  -I--------I--------I--------I--------I--------I
                 5 I      2 I      5 I      0 I      0 I      0 I      7
  FIVE             I   28.6 I   71.4 I    0.0 I    0.0 I    0.0 I    8.8
                   I    7.7 I   11.1 I    0.0 I    0.0 I    0.0 I
                   I    2.5 I    6.3 I    0.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 6 I      3 I      9 I      1 I      1 I      0 I     14
  SIX              I   21.4 I   64.3 I    7.1 I    7.1 I    0.0 I   17.5
                   I   11.5 I   20.0 I   25.0 I   25.0 I    0.0 I
                   I    3.7 I   11.2 I    1.2 I    1.2 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 7 I      3 I      4 I      1 I      0 I      0 I      8
  SEVEN            I   37.5 I   50.0 I   12.5 I    0.0 I    0.0 I   10.0
                   I   11.5 I    8.9 I   25.0 I    0.0 I    0.0 I
                   I    3.7 I    5.0 I    1.2 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 8 I      0 I      3 I      1 I      0 I      0 I      4
  EIGHT            I    0.0 I   75.0 I   25.0 I    0.0 I    0.0 I    5.0
                   I    0.0 I    6.7 I   25.0 I    0.0 I    0.0 I
                   I    0.0 I    3.7 I    1.2 I    0.0 I    0.0 I
           --------I--------I--------I--------I--------I--------I
                10 I      2 I      3 I      0 I      1 I      0 I      6
  TEN              I   33.3 I   50.0 I    0.0 I   16.7 I    0.0 I    7.5
                   I    7.7 I    6.7 I    0.0 I   25.0 I    0.0 I
                   I    2.5 I    3.7 I    0.0 I    1.2 I    0.0 I
                  -I--------I--------I--------I--------I--------I
            COLUMN       26       45        4        4        1       80
             TOTAL     32.5     56.3      5.0      5.0      1.3    100.0

0.1918     RAW CHI SQUARE =   20.65704 WITH   28 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.8396
```

```
* * * * * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * * * * *
ERIAL      V8       HORIZON                                          BY V18      MATERIAL
           CONTROLLING FOR..
UNKNOWN       V19      HEAT TREATMENT                                VALUE..   5  HEATED [illegible]
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
           COUNT   I
           ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN CHOTEAU    ROW
           COL PCT ICHERT    CHERT    CHERT    CHERT    CHERT      TOTAL
           TOT PCT I      2 I      3 I      4 I      5 I      6 I
V8         --------I--------I--------I--------I--------I--------I
                 1 I      1 I      0 I      0 I      4 I      0 I      5
  ONE              I   20.0 I    0.0 I    0.0 I   80.0 I    0.0 I   15.2
                   I   10.0 I    0.0 I    0.0 I   50.0 I    0.0 I
                   I    3.0 I    0.0 I    0.0 I   12.1 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 2 I      0 I      2 I      0 I      1 I      0 I      3
  TWO              I    0.0 I   66.7 I    0.0 I   33.3 I    0.0 I    9.1
                   I    0.0 I   15.4 I    0.0 I   12.5 I    0.0 I
                   I    0.0 I    6.1 I    0.0 I    3.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 3 I      1 I      0 I      0 I      1 I      0 I      2
  THREE            I   50.0 I    0.0 I    0.0 I   50.0 I    0.0 I    6.1
                   I   10.0 I    0.0 I    0.0 I   12.5 I    0.0 I
                   I    3.0 I    0.0 I    0.0 I    3.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 5 I      4 I      5 I      0 I      1 I      0 I     10
  FIVE             I   40.0 I   50.0 I    0.0 I   10.0 I    0.0 I   30.3
                   I   40.0 I   38.5 I    0.0 I   12.5 I    0.0 I
                   I   12.1 I   15.2 I    0.0 I    3.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 6 I      3 I      3 I      0 I      0 I      1 I      7
  SIX              I   42.9 I   42.9 I    0.0 I    0.0 I   14.3 I   21.2
                   I   30.0 I   23.1 I    0.0 I    0.0 I  100.0 I
                   I    9.1 I    9.1 I    0.0 I    0.0 I    3.0 I
                  -I--------I--------I--------I--------I--------I
                 7 I      1 I      3 I      0 I      1 I      0 I      5
  SEVEN            I   20.0 I   60.0 I    0.0 I   20.0 I    0.0 I   15.2
                   I   10.0 I   23.1 I    0.0 I   12.5 I    0.0 I
                   I    3.0 I    9.1 I    0.0 I    3.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
                 8 I      0 I      0 I      1 I      0 I      0 I      1
  EIGHT            I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I    3.0
                   I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I
                   I    0.0 I    0.0 I    3.0 I    0.0 I    0.0 I
                  -I--------I--------I--------I--------I--------I
            COLUMN       10       13        1        8        1       33
             TOTAL     30.3     39.4      3.0     24.2      3.0    100.0

RAW CHI SQUARE =   72.64570 WITH   24 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =    232

0.8396
```

served in a combination of attributes is no greater than could be explained by chance alone. These crosstabulations are summarized for each point type, or category, in Part III. Function, based on attributes initially presented by Ahler (1971), is summarized as well. Second, discriminant function analysis is used as an empirical measure of the integrity of conventional point types, with the results presented for formal point series (i.e., darts, lanceolates, etc.) in Part IV. Third, multivariate types are delineated for the formal point series using suitably transformed polar co-ordinate data and hierarchial clustering. Lastly, chronological relationships are explored.

III. DESCRIPTION OF POINT CATEGORIES

Category descriptions in this and subsequent parts are organized according to specific point series (Figs 11.5, 11.6). Descriptive terminology is keyed to Figure 11.7 and nominal observations for each category were crosstabulated, and are summarized below. Tables having significant chi square values are included. Crosstabulations included:

1. Fracture by material.
2. Blade cross section by fracture.
3. Heat treatment by material
4. Flaking by material
5. Serration - grinding by blade cross section.

ARROWS

Category 1: Scallorn

FUNCTION:	Projectile point	
FORM:	Small, triangular corner-notched point	
	Blade edges:	straight, occasionally finely serrated
	Shoulders:	very angular and often barbed; maximum width and thickness at shoulders
	Notches:	deeply U-shaped
	Stem:	expanding
	Base:	varies: subconvex, straight and concave are the main shapes but some are the unmodified proximal or distal ends of flake preforms
FLAKING:	Blade:	varies from marginal pressure flaking of flake preform ventral surfaces with the dorsal surface having either no pressure flaking or finely directed parallel and oblique pressure flaking to specimens having controlled bifacial pressure flaking
	Base:	generally pressure flaked into final form
HEAT TREATMENT:		the majority of the specimens appear to have been intentionally heated as part of the manufacturing process; however, several were heated prior to manufacture.

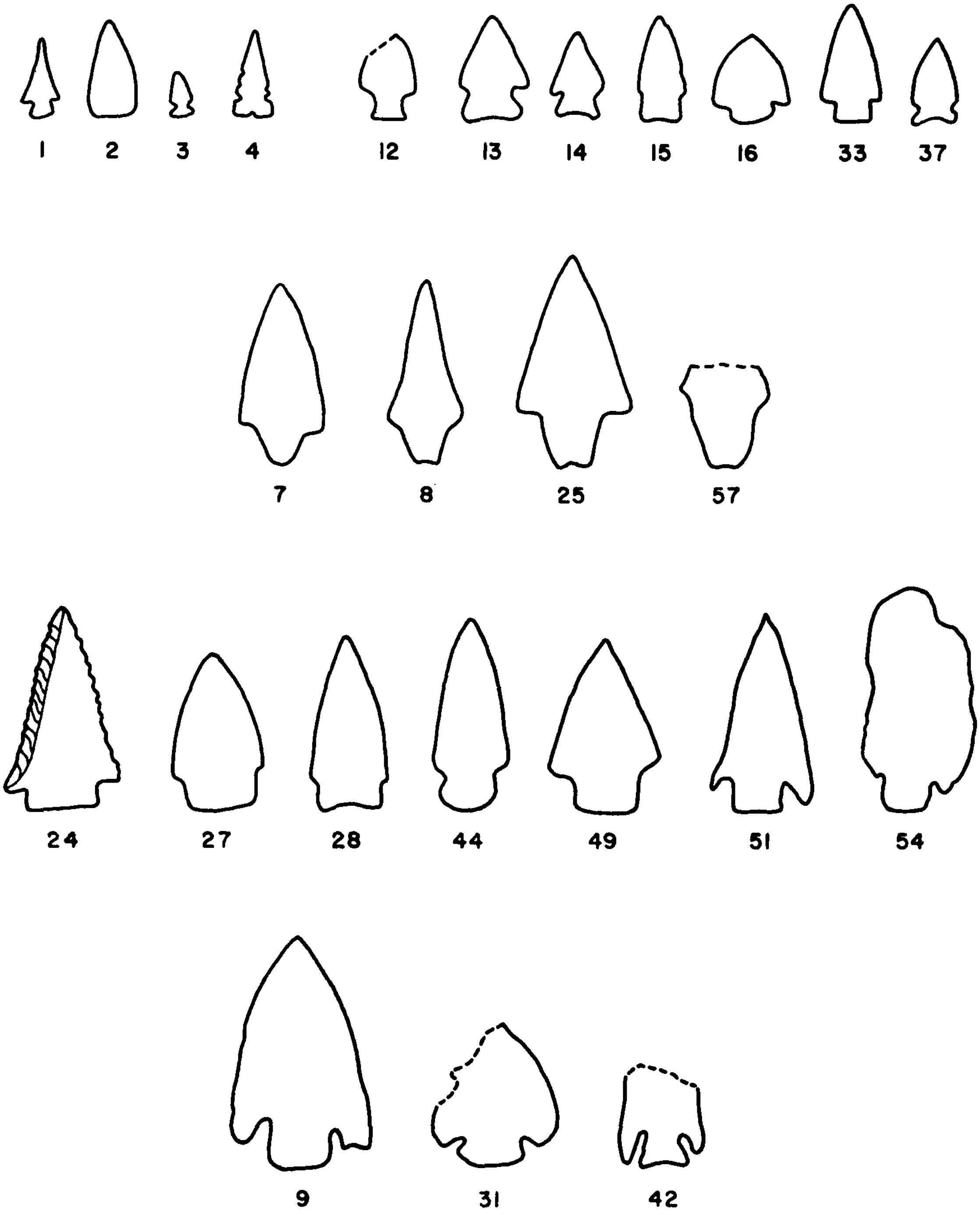


Figure 11.5. Point series, a. Top row: arrows, small darts; Second row: straight items; Third row: contracting stem; Fourth row: basal notch.

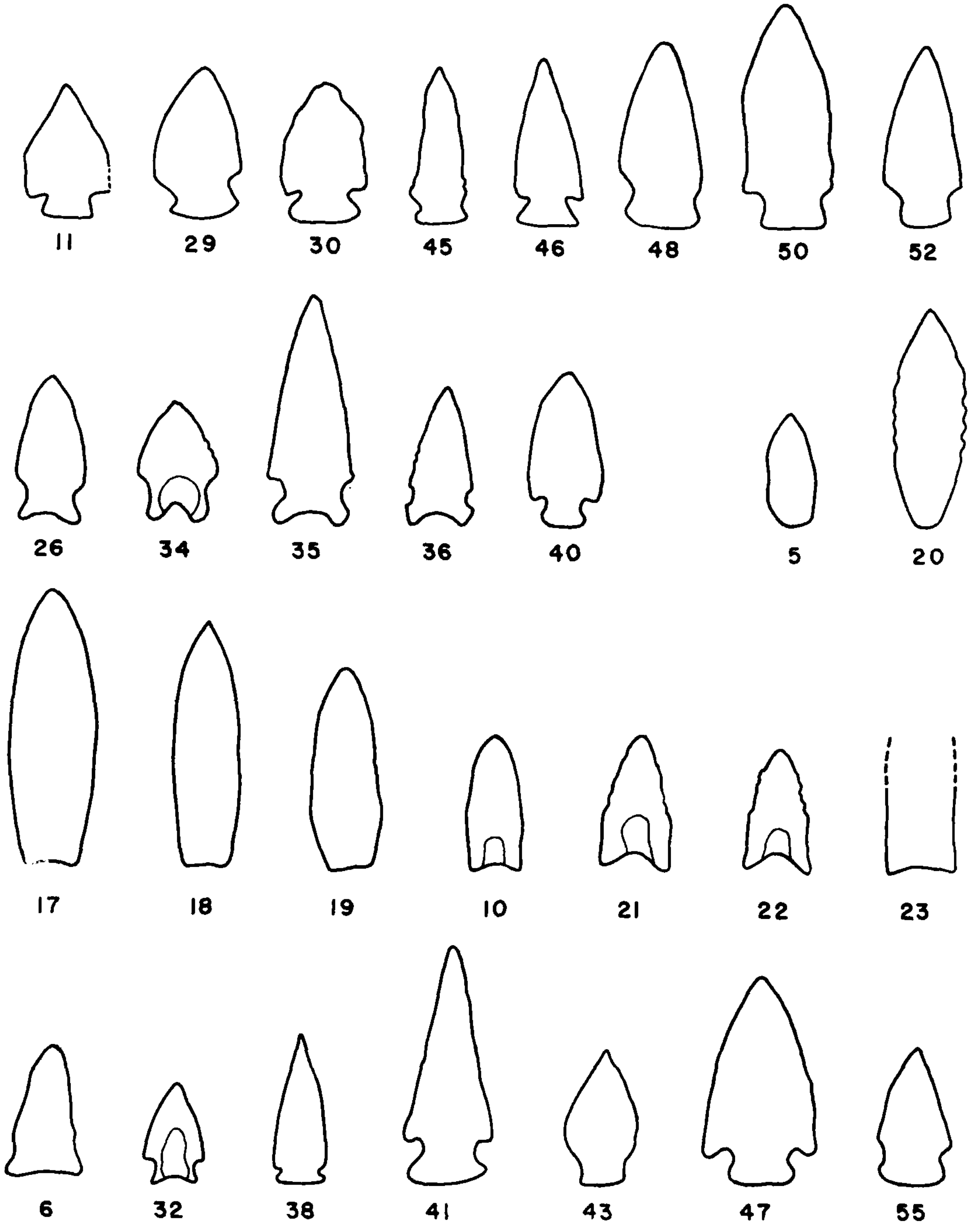
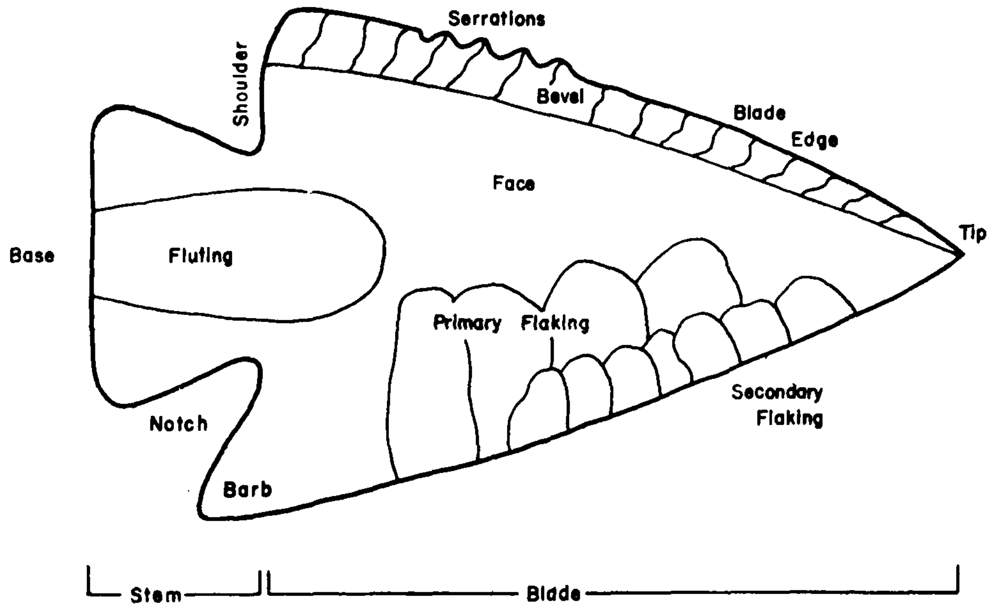


Figure 11.6. Point series, b. Top row: corner notched; Second row: flared base and ovate; Third row: lanceolates; Fourth row: miscellaneous.



(adapted from Chapman 1975:240)

Figure 11.7. Point terminology.

DIMENSIONS: Length: 19-41 mm
Width: 7-24 mm
Thickness: 2- 4 mm

AGE OR HORIZON: Late Woodland

REFERENCES: Kelly 1947, cited by Bell 1960:84-85.

Chi square and associated probabilities are insignificant confirming the null hypothesis that differences in fracture, material selection, transverse blade section, heat treatment, flaking and blade serration are explainable by chance alone. Stated differently, Scallorn points from Rodgers Shelter represent a uniform class of arrow points; where differences exist, those can best be thought to reflect minor variations in material selection and manufacturing technology. Specimens were fashioned from one of several locally available cherts, the majority being Jefferson City chert. While no meaningful differences in style were denoted, the quality of flaking varies strikingly from the merest edge shaping of flake preforms to meticulous pressure work. Impact fracturing is common. Representative examples are illustrated in Figure 11.8a-h.

Category 2

FUNCTION: Projectile point

FORM: Triangular
Blade edges: straight or slightly excurvate
Base: straight but generally rounded at juncture with blade.

FLAKING: varies from random percussion and pressure flaking to well controlled bifacial pressure flaking.

HEAT TREATMENT: 8 of the 16 specimens were heated prior to manufacture; the remainder are either unheated or heat treatment could not be determined.

DIMENSIONS: Length: 28-64 mm
Width: 7-26 mm
Thickness: 3-17 mm

AGE OR HORIZON: Woodland or Archaic

Chi squares and associated probabilities are insignificant, confirming the null hypothesis that differences in material selection, the manufacturing technology and use are no more than would be expected by chance. Jefferson City chert flakes were primarily used for point preforms; and the range in quality of flaking, the fact that only a single specimen has an impact fracture, and that a single specimen strongly resembles an unnotched Scallorn point all suggest that as a whole these may be more unfinished arrows rather than utilitarian implements. Representative examples are illustrated in Figure 11.8i-n.

Category 3

FUNCTION: Projectile points

FORM: Small, triangular side notched Scallorn variant
Blade edges: straight
Shoulders: acutely angular but not barbed
Notches: U-shaped
Base: straight to slightly incurvate; maximum width of point

FLAKING: pressure flaking similar to other Scallion points

HEAT TREATMENT: 6 or the 8 specimens were heated prior to manufacture; the other 2 are unheated or heat treatment could not be determined.

DIMENSIONS: Length: indeterminate
Width: 12-15 mm
Thickness: 1- 2 mm

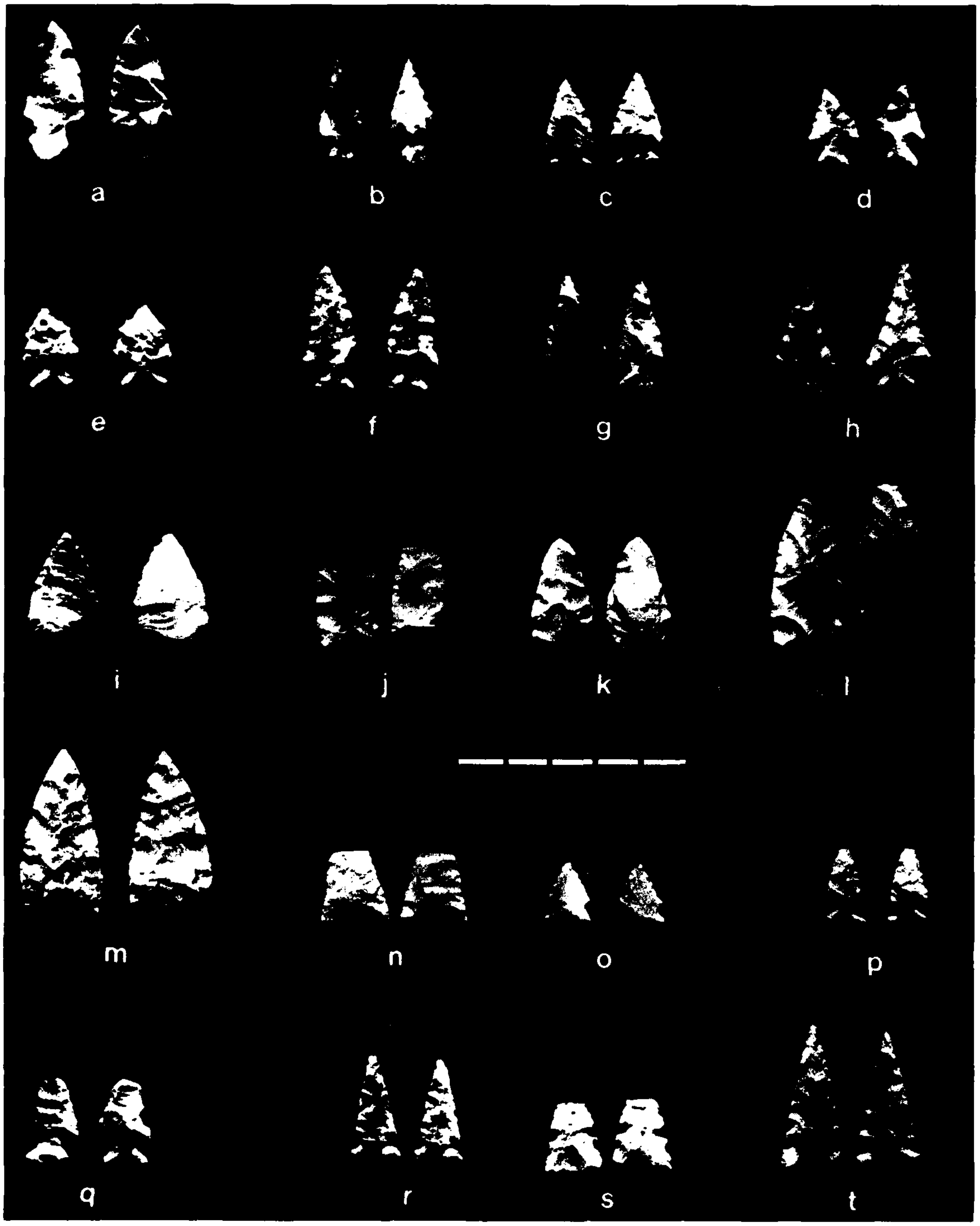


Figure 11.8. Arrows: a-h, Category 1 (Scallorn); i-n, Category 2; o-q, Category 3; r-t, Category 4 (Cahokia Notched). Scale in cm.

AGE OR HORIZON: Late Woodland

The crosstabulations are similar to those of the other Scallorn points, and again confirm the null hypothesis. Representative samples are illustrated in Figure 11.8o-q.

Category 4, Cahokia Notched

FUNCTION: Projectile point

FORM: Small, triangular multiple notches
Blade edges: straight with one or two narrow V-shaped notches near base
Base: straight, occasional small V-shaped notch; point maximum width

FLAKING: random or marginal pressure flaking of flake preforms

HEAT TREATMENT: All 3 specimens are from Burlington chert flakes heated prior to manufacture

DIMENSIONS: Length: indeterminate
Width: 12-15 mm
Thickness: 1- 2 mm

AGE OR HORIZON: Mississippian

REFERENCES: Titterington 1938, cited by Scully 1951:15

Representative examples including some from the 1974 excavations are illustrated in Figure 11.8r-t.

DARTS

Category 12, Table Rock

FUNCTION: Projectile point

FORM: Symmetrical expanding stem point with a parallel sided blade
Blade edges: straight to slightly excurvate
Shoulders: angular but not barbed; maximum point width
Notches: broadly rounded or U-shaped
Base: straight and from 1/3 to 1/2 the maximum point width

FLAKING: controlled percussion and pressure flaking that obscures all remnant flake preform surfaces; bases are bifacially thinned

HEAT TREATMENT: 6 of the 7 specimens were heated prior to manufacture

DIMENSIONS: Length: indeterminate
Width: 23-24 mm
Thickness: 6-10 mm

AGE OR HORIZON: Late Archaic, possibly Woodland

REFERENCES: Bray 1956:127; Perino 1968:96-97c; C. Chapman 1975:257-258.

Chi squares and associated probabilities are insignificant confirming the null hypothesis that differences in material selection, manufacturing technology and use are no more than would be expected by chance. The style and function of Table Rock points is reasonably uniform: they are a basally ground, expanding stem dart that illustrates care in craftsmanship. All Rodgers Shelter specimens have blade fractures, the majority from impact. Representative examples are illustrated in Figure 11.9a-c.

Category 13

FUNCTION: Projectile point

FORM: Symmetrical side notched point with triangular blade
Blade edges: straight
Shoulders: angular and barbed; maximum point width
Notches: rounded or broadly U-shaped
Base: slightly convex
Grinding: infrequent basal grinding

FLAKING: the majority of specimens are randomly pressure flaked. But several illustrate controlled pressure flaking also. Bases are bifacially thinned by percussion flaking.

HEAT TREATMENT: 22 of the 28 specimens were heated prior to manufacture

DIMENSIONS: Length: 22-45 mm
Width: 15-27 mm
Thickness: 4- 7 mm

AGE OR HORIZON: Late Archaic and Woodland

Category 13 contingency tables indicate a systematic relationship between material selection and subsequent heat treatment (P = 0.02); Burlington and Chouteau cherts were consistently heated as were most Jefferson City cherts. The other crosstabulations have insignificant chi squares, confirming the null hypothesis for other attributes related to manufacture or use. But it should be noted that the probability for basal grinding compared to blade transverse section (P = 0.1004) suggests that these relationships may also have stylistic or functional importance, if not statistical relevance. Representative examples are illustrated in Figure 11.9d-h.

Category 14

FUNCTION: Projectile point

FORM: Symmetrical side notched point with triangular blade

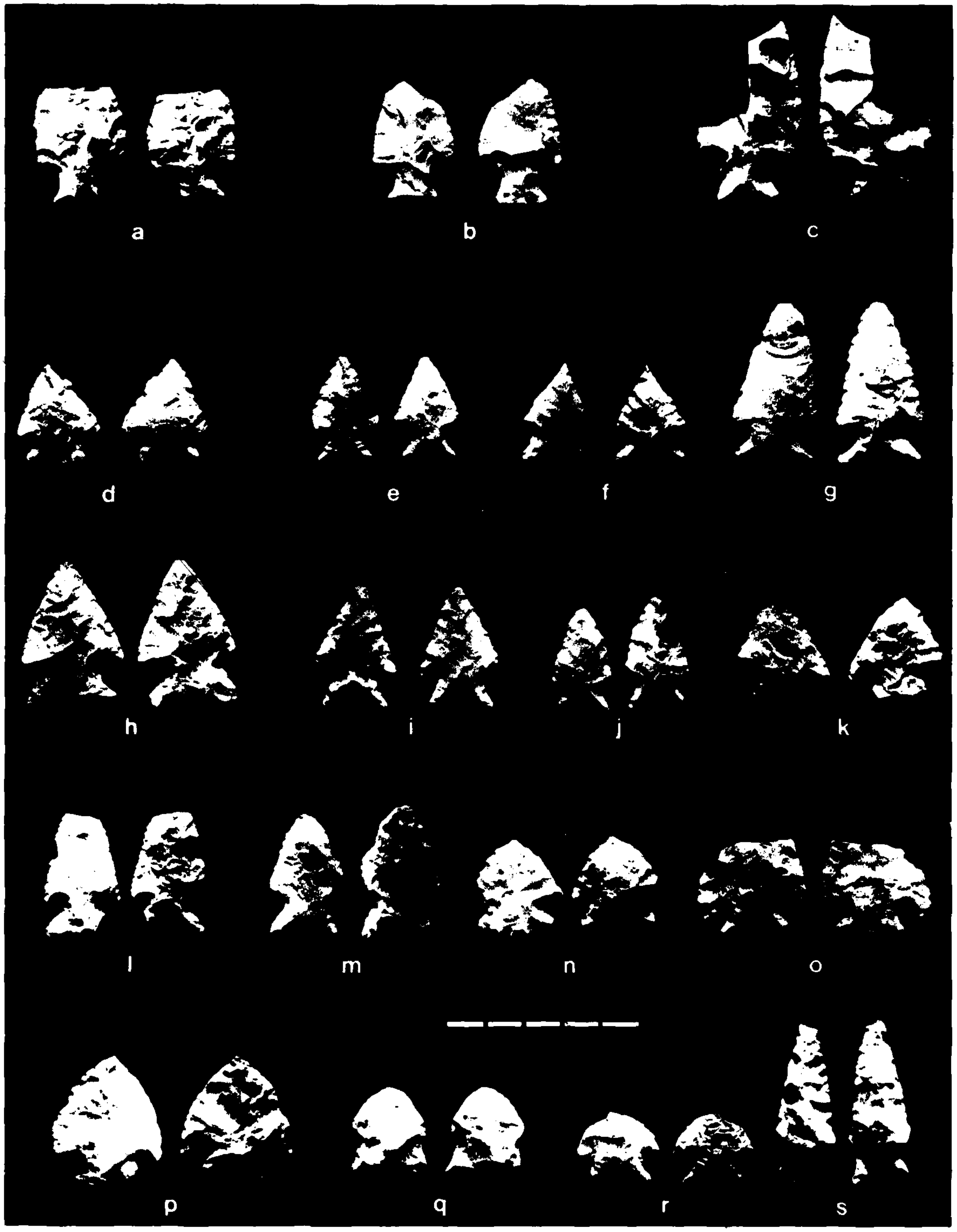


Figure 11.9. Darts: a-c, Category 12 (Table Rock); d-h, Category 13; i-m, Category 14; n-s, Category 16. Scale in cm.

Blade edges: straight
Shoulders: angular and barbed; maximum point width
Base: concave
Grinding: infrequent basal grinding

FLAKING: roughly equal numbers show either random or controlled pressure flaking with bifacially thinned bases. Basal thinning flake scars are mainly parallel and perpendicular to the base.

HEAT TREATMENT: of the 26 specimens, 21 were heated prior to manufacture and two others were heated and then reworked

DIMENSIONS: Length: 27-34 mm
Width: 17-25 mm
Thickness: 4- 7 mm

AGE OR HORIZON: Late Archaic and Woodland

Chi squares and associated probabilities are insignificant confirming the null hypothesis that differences in material selection, manufacturing technology and use are no more than would be expected by chance. But the probability for comparing heat treatment by material (P = 0.0984) does suggest that selection of material either prior to manufacture or after point use may have been an important consideration in heat treatment. Representative examples are illustrated in Figure 11.9i-m.

Category 15

FUNCTION: Projectile point

FORM: Square stemmed point with triangular base
Blade edges: straight to incurvate
Shoulders: angular but not barbed; maximum point width
Stem: straight to slightly expanding
Base: straight, square shaped

FLAKING: varies from controlled bifacial percussion or pressure flaking to random pressure flaking; bases are bifacially thinned

HEAT TREATMENT: only 1 of 5 specimens was heat treated prior to manufacture

DIMENSIONS: Length: 28-43 mm
Width: 25-28 mm
Thickness: 5- 7 mm

AGE OR HORIZON: Late Archaic and Woodland

Chi squares and associated probabilities are insignificant, thus confirming the null hypothesis. But the probability for comparing flaking by material (P = 0.0824) nonetheless suggests importance in preselection of banded or oolitic Jefferson City chert for flaking. Representative examples are illustrated in Figure 11.10a-d.

Category 16

FUNCTION: Projectile point

FORM: Expanding stem point with triangular blade
Blade edges: straight to excurvate
Shoulder: angular but not barbed
Notches: varies from narrow V-shaped to rounded U-shaped
Base: straight to convex
Grinding: infrequent basal grinding

FLAKING: varies from random percussion or pressure flaking to controlled bifacial pressure flaking. Bases are bifacially thinned and flake scars are parallel and perpendicular to the base.

HEAT TREATMENT: 7 of the 13 specimens were heated prior to point manufacture

DIMENSIONS: Length: 20-44 mm
Width: 17-30 mm
Thickness: 5- 8 mm

AGE OR HORIZON: Late Archaic and Woodland

Chi square values and associated probabilities are all insignificant, thus confirming the null hypothesis that differences in material selection, manufacturing technology and use of these points are no more than would be expected by chance alone. In sum, these darts are reasonably uniform and illustrate selection of Jefferson City and Chouteau chert flake blanks which generally were pressure flaked into final form. Subsequent blade manufacturing is common; and although not all are impact fractures, most probably are the product of tool use as projectiles. Representative examples are illustrated in Figure 11.9n-s.

Category 33

FUNCTION: Projectile point

FORM: Square stemmed point with symmetrical triangular blade
Blade edges: straight, occasionally serrated
Shoulders: angular with dimunitive barbs; maximum point width
Base: straight to slightly concave with square stem
Grinding: 2 specimens are basally ground

FLAKING: either a combination of percussion and pressure flaking or extremely well controlled bifacial pressure flaking with flake scars extending across approximately 2/3 of the

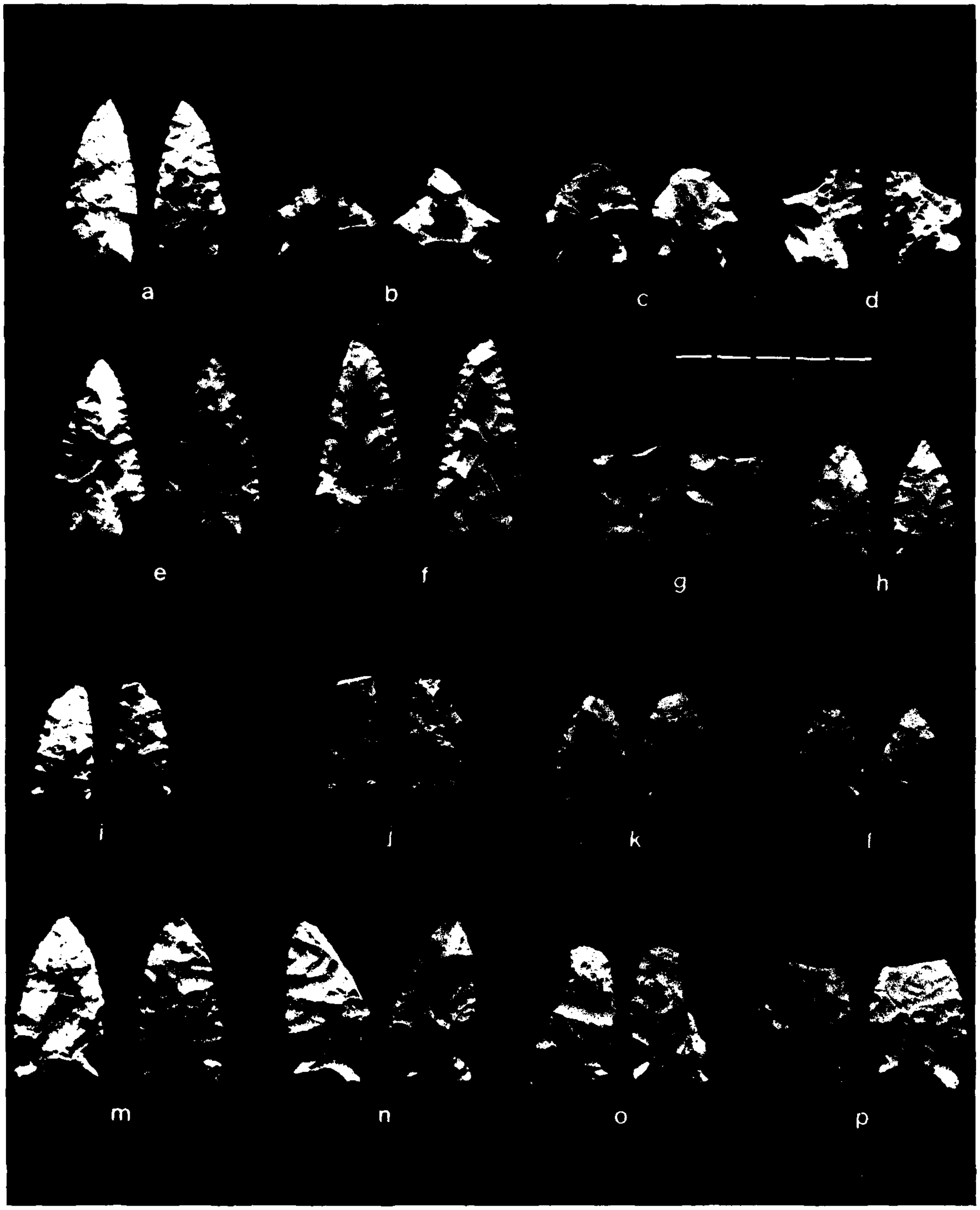


Figure 11.10. Darts: a-d, Category 15; e-g, Category 33; h-p, Category 37 (Frio). Scale in cm.

	blade width. Bases are bifacially thinned by either percussion or minor pressure flaking.
HEAT TREATMENT:	2 of the 5 specimens were heated prior to manufacture
DIMENSIONS: Length:	50-53 mm
Width:	21-25 mm
Thickness:	5- 6 mm
AGE OR HORIZON:	Middle Archaic

Chi square values and associated probabilities are insignificant and the null hypothesis is accepted. But because the sample is small (N = 5), it is difficult to place any great significance in these results. On a more intuitive level, the sample has two specimens with alternate beveling of the blade element, which probably indicates blade resharpening or use maintenance, as well as one impact fractured specimen. A plausible suggestion would be that several different use phases are represented, although it would be difficult to determine if differences in function actually existed. Representative examples are illustrated in Figure 11.10 and should be compared with those for Category 15.

Category 37: Frio

FUNCTION:	Projectile point	
FORM:	Side notched point	
	Blade edges:	straight to excurvate
	Shoulders:	angular but unbarbed, maximum point width
	Notches:	open U-shaped
	Base:	straight to concave with square stem below notches
	Grinding:	generally basally ground
FLAKING:		varies from random pressure flaking and combined percussion and pressure flaking to well executed pressure flaking; bases are bifacially thinned by pressure flaking
HEAT TREATMENT:		12 of the 14 specimens were heat treated prior to manufacture
DIMENSIONS:	Length:	26-44 mm
	Width:	14-22 mm
	Thickness:	5- 9 mm
AGE OR HORIZON:		Middle Archaic
REFERENCES:		Kelly 1947, cited by Bell 1960:48-49

Crosstabulations indicate a highly significant (P = 0.0009) relationship between material selection and heat treatment, with Jefferson City cherts being exclusively heated (Table 11.15). This conclusively rejects the null hypothesis as it pertains to this aspect of the manu-

TABLE 11.15

Crosstabulation of Heat Treatment by Material for Point Group 37

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
   V19       HEAT TREATMENT                                       BY  V18         MATERIAL
CONTROLLING FOR..
   V10       PT GROUP                                             VALUE..    37   FRIO
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                        V18
               COUNT   I
               ROW PCT IOOLITIC  BANDED    BURLNGTN   ROW
               COL PCT ICHERT    CHERT     CHERT      TOTAL
               TOT PCT I      2  I      3  I      5  I
V19            --------I--------I--------I--------I
                     2 I      4 I      8 I      0 I     12
  PRIOR                I   33.3 I   66.7 I    0.0 I   85.7
                       I  100.0 I  100.0 I    0.0 I
                       I   28.6 I   57.1 I    0.0 I
                      -I--------I--------I--------I
                     4 I      0 I      0 I      2 I      2
  UNKNOWN              I    0.0 I    0.0 I  100.0 I   14.3
                       I    0.0 I    0.0 I  100.0 I
                       I    0.0 I    0.0 I   14.3 I
                      -I--------I--------I--------I
               COLUMN         4        8        2       14
               TOTAL       28.6     57.1     14.3    100.0

RAW CHI SQUARE =    13.99998 WITH     2 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0009
```

TABLE 11.16

Crosstabulation of Heat Treatment by Material for Point Group 8

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * *
   V19       HEAT TREATMENT                                  BY  V18        MATERIAL
CONTROLLING FOR..
   V10       PT GROUP                                        VALUE..     8   LANGTRY
* * * * * * * * * * * *   * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                        V18
               COUNT   I
               ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN RIVER    CHOTEAU    ROW
               COL PCT ICHERT    CHERT     CHERT    CHERT   GRAVEL   CHERT      TOTAL
               TOT PCT I      2 I      3 I      4 I      5 I      6 I      8 I
V19            --------I--------I--------I--------I--------I--------I--------I
                     1 I      0 I      0 I      0 I      1 I      0 I      0 I      1
  UNHEATED             I    0.0 I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I    3.3
                       I    0.0 I    0.0 I    0.0 I   50.0 I    0.0 I    0.0 I
                       I    0.0 I    0.0 I    0.0 I    3.3 I    0.0 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I
                     2 I      4 I     17 I      1 I      1 I      2 I      0 I     25
  PRIOR                I   16.0 I   68.0 I    4.0 I    4.0 I    8.0 I    0.0 I   83.3
                       I   80.0 I   89.5 I  100.0 I   50.0 I  100.0 I    0.0 I
                       I   13.3 I   56.7 I    3.3 I    3.3 I    6.7 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I
                     3 I      1 I      1 I      0 I      0 I      0 I      1 I      3
  AFTER                I   33.3 I   33.3 I    0.0 I    0.0 I    0.0 I   33.3 I   10.0
                       I   20.0 I    5.3 I    0.0 I    0.0 I    0.0 I  100.0 I
                       I    3.3 I    3.3 I    0.0 I    0.0 I    0.0 I    3.3 I
                      -I--------I--------I--------I--------I--------I--------I
                     4 I      0 I      1 I      0 I      0 I      0 I      0 I      1
  UNKNOWN              I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    3.3
                       I    0.0 I    5.3 I    0.0 I    0.0 I    0.0 I    0.0 I
                       I    0.0 I    3.3 I    0.0 I    0.0 I    0.0 I    0.0 I
                      -I--------I--------I--------I--------I--------I--------I
                COLUMN        5       19        1        2        2        1       30
                TOTAL      16.7     63.3      3.3      6.7      6.7      3.3    100.0

RAW CHI SQUARE =    25.39783 WITH    15 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0449
```

facturing technology. In all other aspects of manufacture and use, the differences in blade shape or fracture, flaking or basal grinding are no more than would be expected by chance alone. The Rodgers Shelter specimens are commonly fractured, the most frequent form being from impact. Representative examples are illustrated in Figure 11.10n-p.

CONTRACTING STEM

Category 7: Gary

FUNCTION: Multipurpose

FORM: Symmetrical, rounded base contracting stem point with a triangular blade
Blade edges: straight or slightly excurvate
Shoulders: vary from acutely angular to subrounded, maximum point width
Stem: straight sided, contracting
Base: convex

FLAKING: Blade: bilaterial percussion flaking with parallel or oblique flake scars terminating in a midline ridge, often preform remnant surfaces are present at the midline. Edges were shaped or resharpened by pressure flaking.
Base: reduced into contracting form by short percussion and/or pressure flake removals along stem margins only.
Grinding: occasional basal grinding

HEAT TREATMENT: 2 of the 6 specimens were heated prior to manufacture

DIMENSIONS: Length: 48-70 mm
Width: 23-33 mm
Thickness: 7-18 mm

AGE OR HORIZON: Woodland

REFERENCES: Newell and Krieger 1949:164-165, cited by Bell 1958:28-29.

Chi squares and associated probabilities are insignificant and the null hypothesis that differences in material selection, point manufacture or use are no more than would be due to chance is accepted. Rodgers Shelter Gary points are almost uniformly Jefferson City chert; blade edges are use battered or abraded and several are resharpened; two have impact fractures. Representative examples are illustrated in Figure 11.11a-e.

Category 8: Langtry

FUNCTION: Multipurpose

FORM: Concave base, contracting stem point with a triangular blade

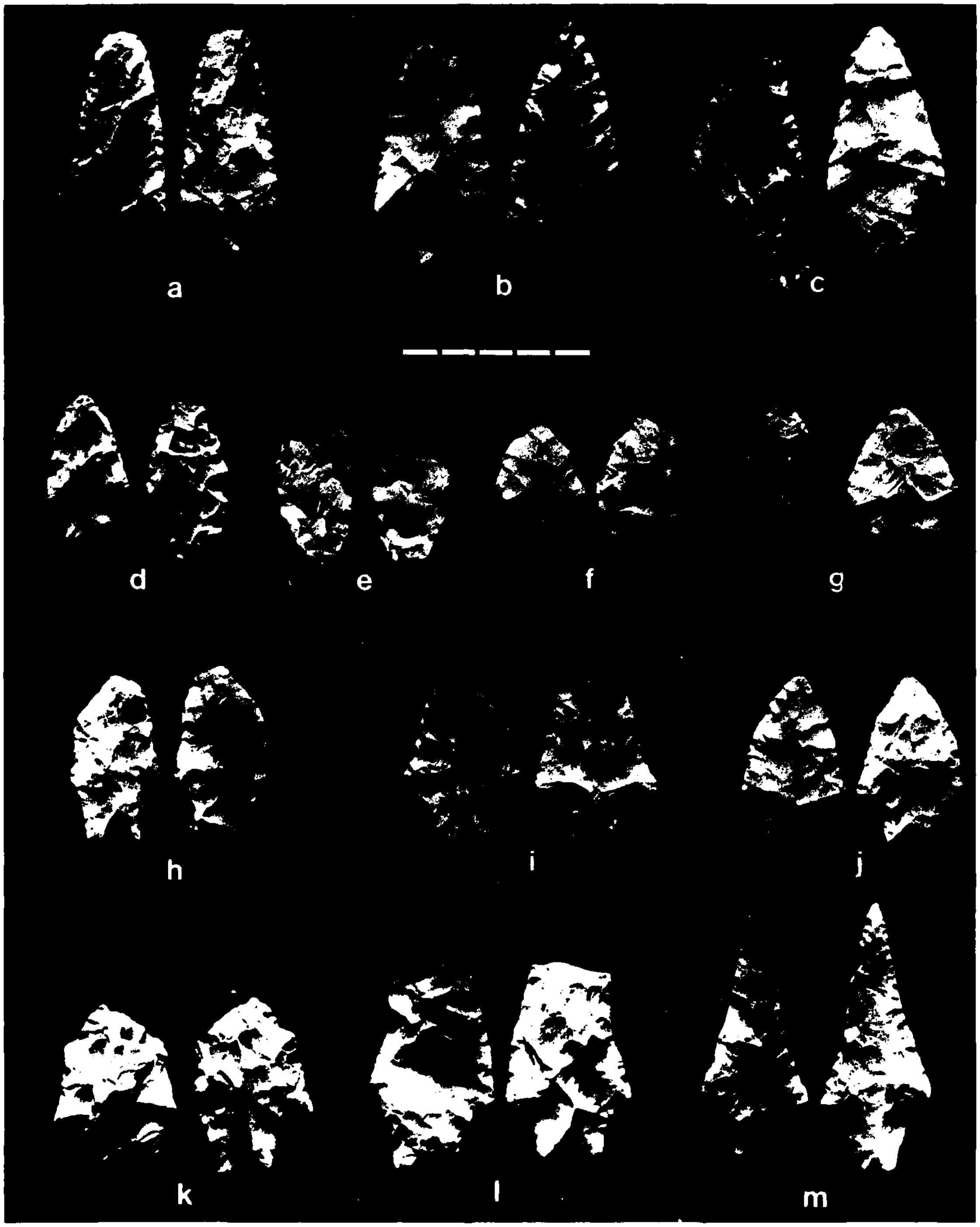


Figure 11.11. Contracting stem points. a-e, Category 7 (Gary); f-m, Category 8 (Langtry). Scale in cm.

Blade edges: straight to highly incurvate
Shoulders: acutely angular but unbarbed; point maximum width
Stem: contracting, straight to incurvate edges terminating abruptly in an angular basal juncture
Base: slightly concave
Grinding: basal grinding present for roughly a third of the sample

FLAKING: Blade: varies from poorly to well controlled bilateral percussion thinning, leaving on almost all specimens flake preform remnant surfaces on one or both faces; blade edges were shaped or reshaped by percussion and/or pressure flaking
Stem: demonstrates considerable variation in preparation including unifacial percussion or pressure flaking as well as bifacial flaking.
Base: the majority of specimens are basally thinned by finely directed parallel pressure flaking either on one or both sides of the base

HEAT TREATMENT: 25 of the 30 specimens were heated prior to manufacture

DIMENSIONS: Length: 38-111 mm
Width: 24- 49 mm
Thickness: 5- 19 mm

AGE OR HORIZON: Woodland

REFERENCES: Bell 1958:38-40

Chi squares and associated probabilities are insignificant with the exception of heat treatment by material (P = 0.0449; Table 11.16), which suggests a greater emphasis in selection of Jefferson City cherts for subsequent heating. In all other respects, the null hypothesis is confirmed and while there are differences in flaking, blade fractures and transverse sections as well as in serration or grinding, these are no more than would be expected by chance alone. Impact fractures are common but transverse and oblique blade fractures also occur on specimens having similar transverse sections; blade edges often are resharpened as well. Representative examples are illustrated in Figure 11.11f-m.

Category 25: Hidden Valley

FUNCTION: Hafted cutting tool

FORM: Contracting stem point with triangular blade
Blade edges: roughly symmetrical incurvate-excurvate (S-shaped) or straight, occasionally serrated
Shoulders: acutely angular with a distinctive but slight barb; maximum width of point

	Base:	concave with contracting stem; stem/shoulder juncture is roughly perpendicular. Sample is about equally divided among specimens having broad proximally excurvate stems and those with proportionately narrower and longer straight edged stems.
	Grinding:	basal grinding is frequent, the majority being on the stem.
FLAKING:	Blade:	variable but usually well controlled bifacial percussion flaking resulting in shallow oblique, transverse or parallel flake scars extending across from one half to two-thirds of the blade width. Shallow hinge fractures are present on most specimens as are flake preform remnant surfaces on one or both faces. Bifacial pressure flake blade edge resharpening also occurs on most specimens.
	Stem:	almost entirely bifacial pressure flaked into final form, with the exception of three specimens having alternating unifacial flaking.
	Base:	basal thinning varies from regularly patterned bifacial pressure flaking into bifacial percussion flaking resulting in flake removals extending across the haft element.
HEAT TREATMENT:		26 of the 37 specimens were heated prior to manufacture and 2 more were heated after manufacture and then reworked.
DIMENSIONS:	Length:	60-95 mm
	Width:	36-55 mm
	Thickness:	7-10 mm
AGE OR HORIZON:		Early to Middle Archaic
REFERENCES:		Adams 1941; Ahler 1971:15; C. Chapman 1975: 249-150; Scully 1951:5; Fowler 1959:36-37,66.

Chi squares and associated probabilities are insignificant and the null hypothesis that differences in material selection, point manufacture and use are no more than would be due to chance is accepted. In sum Rodgers Shelter Hidden Valley points were made from the entire range of Jefferson City chert, and two of these were heated after manufacture and then reworked. Thirty-two of the thirty-seven specimens have blade fractures and the relationship of fracture type to blade transverse section is statistically unimportant. The majority of fractured specimens are transverse; impact fractures also occur with less frequency. The five complete specimens have resharpened blade edges. Representative examples are illustrated in Figure 11.12a-k.

Category 57

FUNCTION: indeterminate

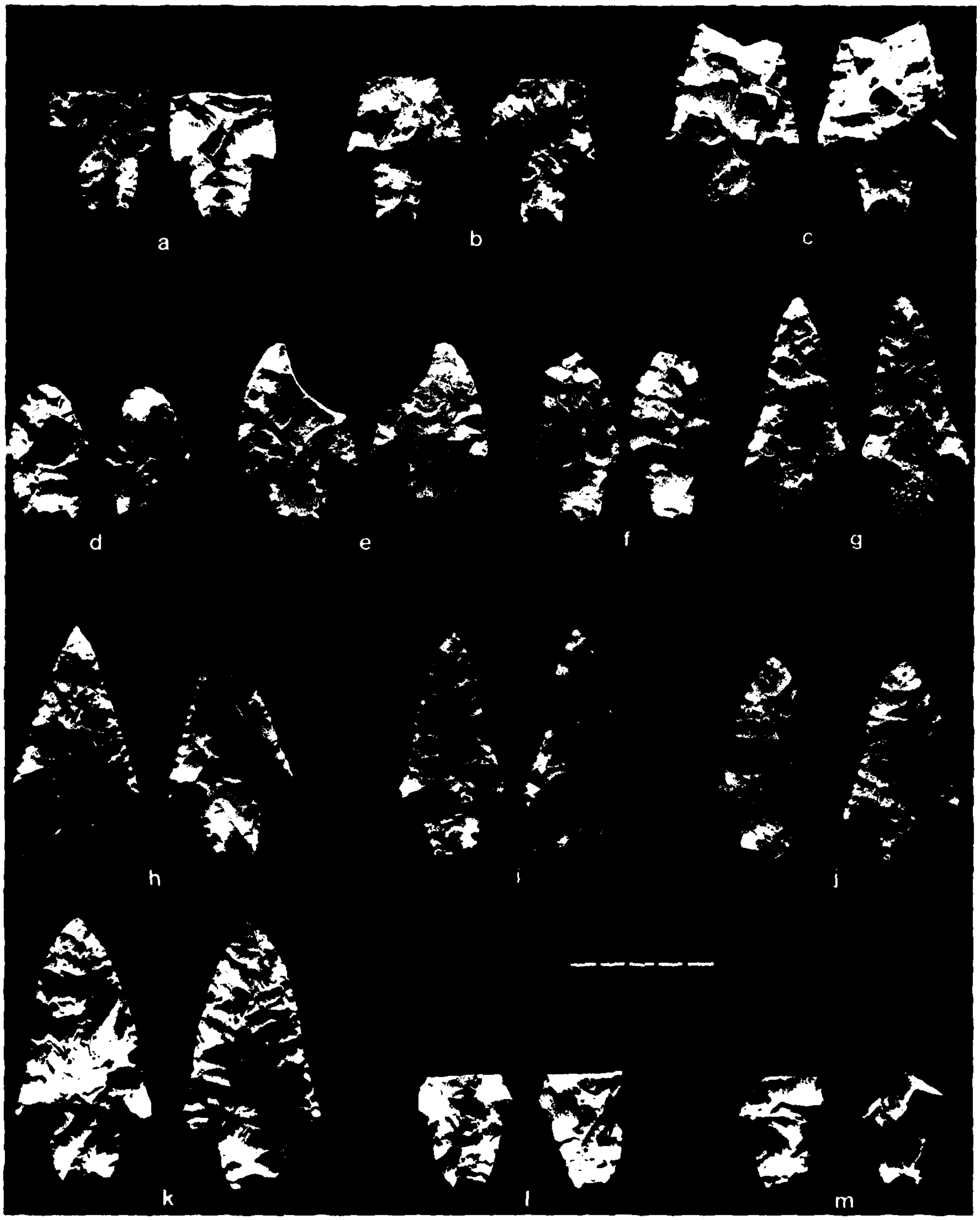


Figure 11.12. Contracting stem points: a-k, Category 25 (Hidden Valley); l-m, Category 57. Scale in cm.

FORM: Contracting stem point
Blade edges: indeterminate
Shoulders: angular but unbarbed
Base: concave with contracting stem

FLAKING: random percussion flaking on remaining portions of blade element; stem of one specimen is bifacially pressure flaked.

HEAT TREATMENT: 1 of the 2 specimens was heated prior to manufacture

DIMENSIONS: Length: indeterminate
Width: 30-35 mm
Thickness: 9-10 mm

AGE OR HORIZON: Middle Archaic

In general, the two proximal fragments are similar to unfinished Hidden Valley specimens and are illustrated in Figure 11.121-m.

STRAIGHT STEM

Category 24: Rice Lobed

FUNCTION: Hafted cutting tool

FORM: Bifurcated base point with a broad triangular blade
Blade edges: straight to highly incurvate, often with a pronounced alternating bevel and serrations.
Shoulders: angular and barbed; maximum width of point
Notches: broad V-shaped
Base: straight to slightly bifurcated with an expanding or straight stem
Grinding: usually basally ground

FLAKING: varies but is primarily alternating lateral percussion flaking with flake scars spanning the blade width. Blade edges are thinned and resharpened by meticulous transverse percussion and/or pressure flaking. Progressive or successive resharpening is evident on several specimens, resulting in an abruptly beveled, serrated blade edge. Bases are thinned by parallel pressure flaking.

HEAT TREATMENT: 9 of the 11 specimens (a twelfth specimen was stolen) were heated prior to manufacture, an additional specimen was heated after manufacture and reworked.

DIMENSIONS: Length: 55-97 mm
Width: 30-54 mm
Thickness: 6-17 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Bray 1956:128; Perino 1968:76-77; Ahler 1971: 8-10; C. Chapman 1975:254.

The crosstabulations confirm the null hypothesis for all but the relationship between material selection and heat treatment (P = 0.0144; Table 11.17), which primarily shows that selection of the cross-banded Jefferson City specimen for heat treatment after manufacture and with evidence of reuse cannot be explained by chance. As a whole, the category is reasonably uniform and examples are very distinctive: with respect to the blade element the haft is proportionately short and square in appearance; the blade is broad at the shoulders and on specimens in the beginning stages of use have nearly parallel sides. Most of the Rodgers Shelter Rice Lobed points were extensively used, and show progressive changes in blade form. Representative examples are illustrated in Figure 11.13.

Category 27

FUNCTION: Multipurpose

FORM: straight stem point with asymmetrical triangular blade
Blade edges: excurvate
Shoulders: angular but unbarbed; point maximum width
Base: slightly convex with a straight stem. A diagnostic feature is a distinct "keel", or a roughly plano-convex longitudinal section.
Grinding: basal grinding present on several specimens

FLAKING: Blade: variable but generally includes random bifacial percussion thinning and hinge fractures are common. Subsequent edge shaping or resharpening was by well controlled parallel or transverse pressure flaking, resulting in regularly spaced scars that extend to or across the blade midline. Large preform surface remnants also occur, suggesting that blade shaping was mainly utilitarian in design with a prime objective of assuring sharp edges.
Base: in contrast to the blade element, basal flaking is very uniform for the sample and consists of bifacial thinning by parallel pressure flaking. A single specimen is fluted on the flake preform dorsal surface. The flute hinge fracture scars truncate blade element scars and appear to be purposely executed.

HEAT TREATMENT: 12 of the 18 specimens were heated prior to manufacture; 2 others were heated after manufacture and have evidence of subsequent use.

DIMENSIONS: Length: 55-71 mm
Width: 29-41 mm
Thickness: 8-11 mm

TABLE 11.17

Crosstabulation of Heat Treatment by Material for Point Group 24

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
    V19       HEAT TREATMENT                                           BY  V18       MATERIAL
CONTROLLING FOR..
    V10       PT GROUP                                                 VALUE..    24  RICE LOBED
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                        V18
              COUNT   I
            ROW PCT   IOOLITIC   BANDED    X-BANDED BURLNGTN    ROW
            COL PCT   ICHERT     CHERT      CHERT    CHERT      TOTAL
            TOT PCT   I      2  I      3  I      4  I      5  I
V19         --------I--------I--------I--------I--------I
                   2  I      3  I      5  I      0  I      1  I      9
  PRIOR               I   33.3  I   55.6  I    0.0  I   11.1  I   81.8
                      I  100.0  I  100.0  I    0.0  I   50.0  I
                      I   27.3  I   45.5  I    0.0  I    9.1  I
                     -I--------I--------I--------I--------I
                   4  I      0  I      0  I      0  I      1  I      1
  UNKNOWN             I    0.0  I    0.0  I    0.0  I  100.0  I    9.1
                      I    0.0  I    0.0  I    0.0  I   50.0  I
                      I    0.0  I    0.0  I    0.0  I    9.1  I
                     -I--------I--------I--------I--------I
                   5  I      0  I      0  I      1  I      0  I      1
  HEATED &REWORKED    I    0.0  I    0.0  I  100.0  I    0.0  I    9.1
                      I    0.0  I    0.0  I  100.0  I    0.0  I
                      I    0.0  I    0.0  I    9.1  I    0.0  I
                     -I--------I--------I--------I--------I
             COLUMN          3        5        1        2         11
             TOTAL        27.3     45.5      9.1     18.2      100.0

RAW CHI SQUARE =     15.88889 WITH     6 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0144
```

TABLE 11.18

Crosstabulation of Serration-grinding by Blade Cross Section for Point Group 27

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
    V24       SERRATION-GRINDING                                      BY  V11       BLADE XSECTION
CONTROLLING FOR..
    V10       PT GROUP                                                VALUE..    27
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                        V11
              COUNT   I
            ROW PCT   IBICONVEX PLANO-CO IRREGULA    ROW
            COL PCT   I         NVEX     R           TOTAL
            TOT PCT   I      4  I      6  I     11  I
V24         --------I--------I--------I--------I
                   1  I      2  I      0  I      0  I      2
  GROUND HAFT         I  100.0  I    0.0  I    0.0  I   14.3
                      I   18.2  I    0.0  I    0.0  I
                      I   14.3  I    0.0  I    0.0  I
                     -I--------I--------I--------I
                   3  I      0  I      0  I      1  I      1
  STEM     GROUND     I    0.0  I    0.0  I  100.0  I    7.1
                      I    0.0  I    0.0  I  100.0  I
                      I    0.0  I    0.0  I    7.1  I
                     -I--------I--------I--------I
                   7  I      1  I      1  I      0  I      2
  PART     GROUND     I   50.0  I   50.0  I    0.0  I   14.3
                      I    9.1  I   50.0  I    0.0  I
                      I    7.1  I    7.1  I    0.0  I
                     -I--------I--------I--------I
                   9  I      8  I      1  I      0  I      9
  NEITHER OBSERVED    I   88.9  I   11.1  I    0.0  I   64.3
                      I   72.7  I   50.0  I    0.0  I
                      I   57.1  I    7.1  I    0.0  I
                     -I--------I--------I--------I
             COLUMN         11        2        1        14
             TOTAL        78.6     14.3      7.1     100.0

RAW CHI SQUARE =     15.51010 WITH     6 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0113
```

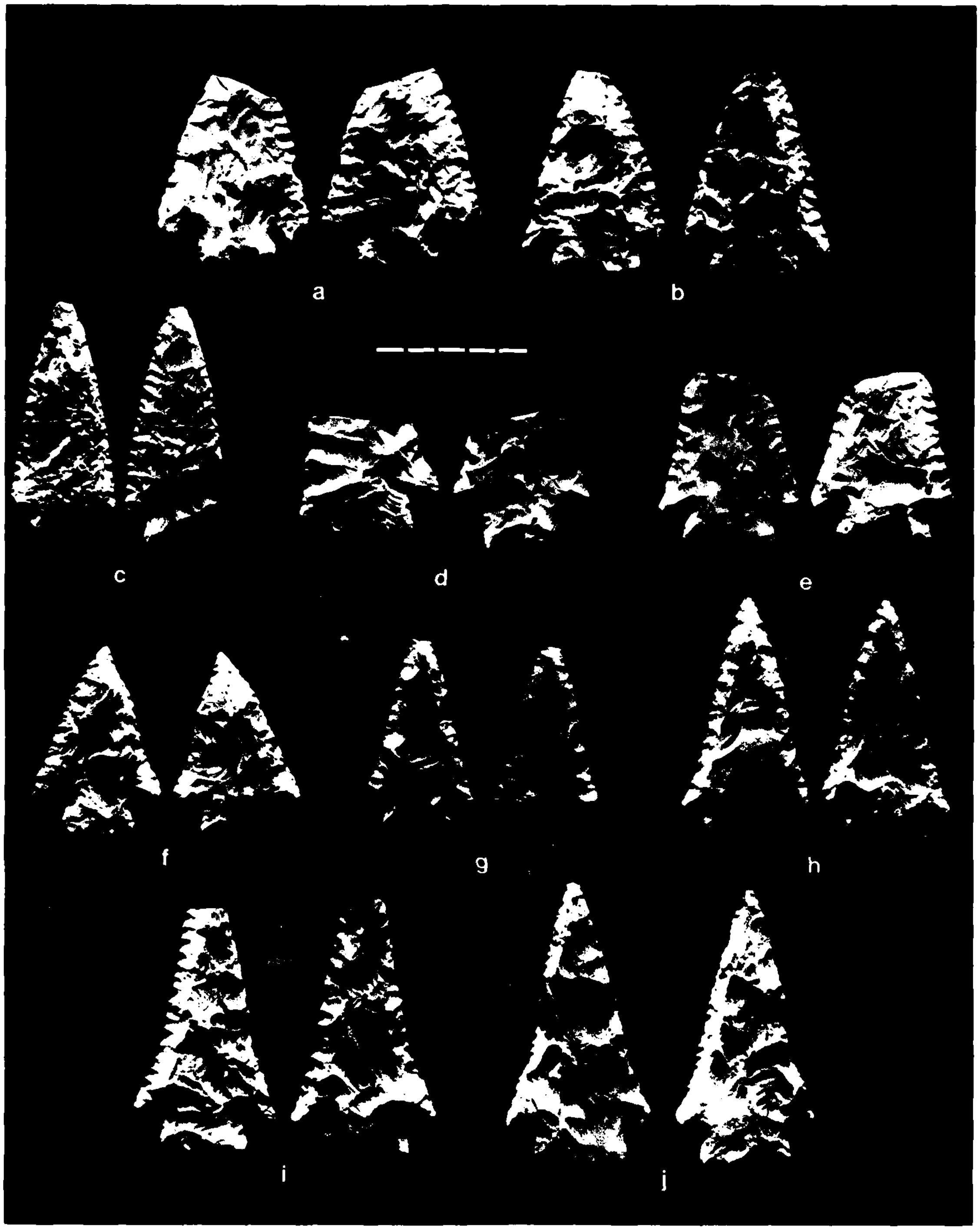


Figure 11.13. Rice Lobed, Category 24. Scale in cm.

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Ahler 1971:11

The crosstabulations confirm the null hypothesis for all but the relationship among basal grinding and blade transverse section ($P = 0.0113$; Table 11.18). While these relationships would not be expected by chance alone, it is difficult to associate them exclusively with either stylistic or functional differences, as may be judged from the crosstabulation between blade transverse section and fracture. At any rate, further thought would seem to be merited. Similarly, the crosstabulation between heat treatment and material deserves more attention primarily because it illustrates a higher but not significant probability ($P = 0.0966$) of heated and reworked specimens being either oolitic Jefferson City chert or Chouteau chert (Table 11.19). As a whole, the category has a distinctive appearance, mainly because of the rounded base, stubby square stem and diminutive shoulders. Representative examples are illustrated in Figure 11.14.

Category 28: Kirk-like

FUNCTION: multipurpose

FORM: square stem point
- Blade edges: asymmetric, excurvate, occasionally serrated
- Shoulders: angular and slightly barbed; maximum point width
- Base: straight to slightly concave
- Grinding: majority of specimens are basally ground

FLAKING:
- Blade: initial thinning was by bifacial percussion flaking, resulting in a random assortment of thin, occasionally hinged flake scars that extend across one-third to two-thirds of the blade width, only infrequently leaving remnants of the preform surfaces. Subsequent shaping or resharpening of blade edges was by controlled bifacial pressure flaking, often local to the immediate blade edge areas.
- Base: Meticulous bifacial pressure flake basal thinning is a regular feature, often obscuring prior percussion thinning. Pressure flake scars are mainly parallel and perpendicular to the base, while those originating on the stem are sometimes transverse and extend almost across the stem width.

HEAT TREATMENT: 20 of the 22 specimens were heated prior to manufacture.

DIMENSIONS:
- Length: 51-75 mm
- Width: 25-43 mm
- Thickness: 7-10 mm

TABLE 11.19

Crosstabulation of Heat Treatment by Material for Point Group 27

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F  * * * *
    V19          HEAT TREATMENT                                   BY  V18        MATERIAL
CONTROLLING FOR..
    V10          PT GROUP                                         VALUE..    27
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                  V18
         COUNT   I
        ROW PCT  IOOLITIC   BANDED    BURLNGTN CHOTEAU     ROW
        COL PCT  ICHERT     CHERT     CHERT    CHERT      TOTAL
        TOT PCT  I      2  I      3  I      5 I      8  I
V19     ---------I---------I---------I--------I---------I
              2  I      5  I      3  I      3 I      1  I    12
  PRIOR          I   41.7  I   25.0  I   25.0 I    8.3  I  66.7
                 I   83.3  I   60.0  I   60.0 I   50.0  I
                 I   27.8  I   16.7  I   16.7 I    5.6  I
                -I---------I---------I--------I---------I
              3  I      0  I      0  I      2 I      0  I     2
  AFTER          I    0.0  I    0.0  I  100.0 I    0.0  I  11.1
                 I    0.0  I    0.0  I   40.0 I    0.0  I
                 I    0.0  I    0.0  I   11.1 I    0.0  I
                -I---------I---------I--------I---------I
              4  I      0  I      2  I      0 I      0  I     2
  UNKNOWN        I    0.0  I  100.0  I    0.0 I    0.0  I  11.1
                 I    0.0  I   40.0  I    0.0 I    0.0  I
                 I    0.0  I   11.1  I    0.0 I    0.0  I
                -I---------I---------I--------I---------I
              5  I      1  I      0  I      0 I      1  I     2
  HEATED &REWORKED I   50.0  I    0.0  I    0.0 I   50.0  I  11.1
                 I   16.7  I    0.0  I    0.0 I   50.0  I
                 I    5.6  I    0.0  I    0.0 I    5.6  I
                -I---------I---------I--------I---------I
         COLUMN         6         5         5         2        18
         TOTAL       33.3      27.8      27.8      11.1     100.0

RAW CHI SQUARE =    14.79996 WITH     9 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0966
```

TABLE 11.20

Crosstabulation of Serration-grinding by Blade Cross Section for Point Group 28

```
                     V11
            COUNT   I
           ROW PCT  IBIPLANO   TRIANGUL BICONVEX PLANO-CO BIBEVELE    ROW
           COL PCT  I          AR                NVEX     D          TOTAL
           TOT PCT  I      1  I      2 I      4 I      5 I     10 I
V24        ---------I---------I--------I--------I--------I--------I
                 1  I      1  I      0 I      1 I      1 I      0 I      3
  SERATED&GROUND    I   33.3  I    0.0 I   33.3 I   33.3 I    0.0 I   15.0
                    I   25.0  I    0.0 I    8.3 I  100.0 I    0.0 I
                    I    5.0  I    0.0 I    5.0 I    5.0 I    0.0 I
                   -I---------I--------I--------I--------I--------I
                 4  I      0  I      1 I      0 I      0 I      0 I      1
  SERATED BLADE     I    0.0  I  100.0 I    0.0 I    0.0 I    0.0 I    5.0
                    I    0.0  I  100.0 I    0.0 I    0.0 I    0.0 I
                    I    0.0  I    5.0 I    0.0 I    0.0 I    0.0 I
                   -I---------I--------I--------I--------I--------I
                 5  I      2  I      0 I      8 I      0 I      2 I     12
  GROUND HAFT       I   16.7  I    0.0 I   66.7 I    0.0 I   16.7 I   50.0
                    I   50.0  I    0.0 I   66.7 I    0.0 I  100.0 I
                    I   10.0  I    0.0 I   40.0 I    0.0 I   10.0 I
                   -I---------I--------I--------I--------I--------I
                 7  I      1  I      0 I      1 I      0 I      0 I      2
  BASE    GROUND    I   50.0  I    0.0 I   50.0 I    0.0 I    0.0 I   10.0
                    I   25.0  I    0.0 I    8.3 I    0.0 I    0.0 I
                    I    5.0  I    0.0 I    5.0 I    0.0 I    0.0 I
                   -I---------I--------I--------I--------I--------I
                 9  I      0  I      0 I      2 I      0 I      0 I      2
  NEITHER OBSERVED  I    0.0  I    0.0 I  100.0 I    0.0 I    0.0 I   10.0
                    I    0.0  I    0.0 I   16.7 I    0.0 I    0.0 I
                    I    0.0  I    0.0 I   10.0 I    0.0 I    0.0 I
                   -I---------I--------I--------I--------I--------I
            COLUMN         4          1       12        1        2       20
            TOTAL       20.0        5.0     60.0      5.0     10.0    100.0

RAW CHI SQUARE =    20.44429 WITH    16 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0211
```

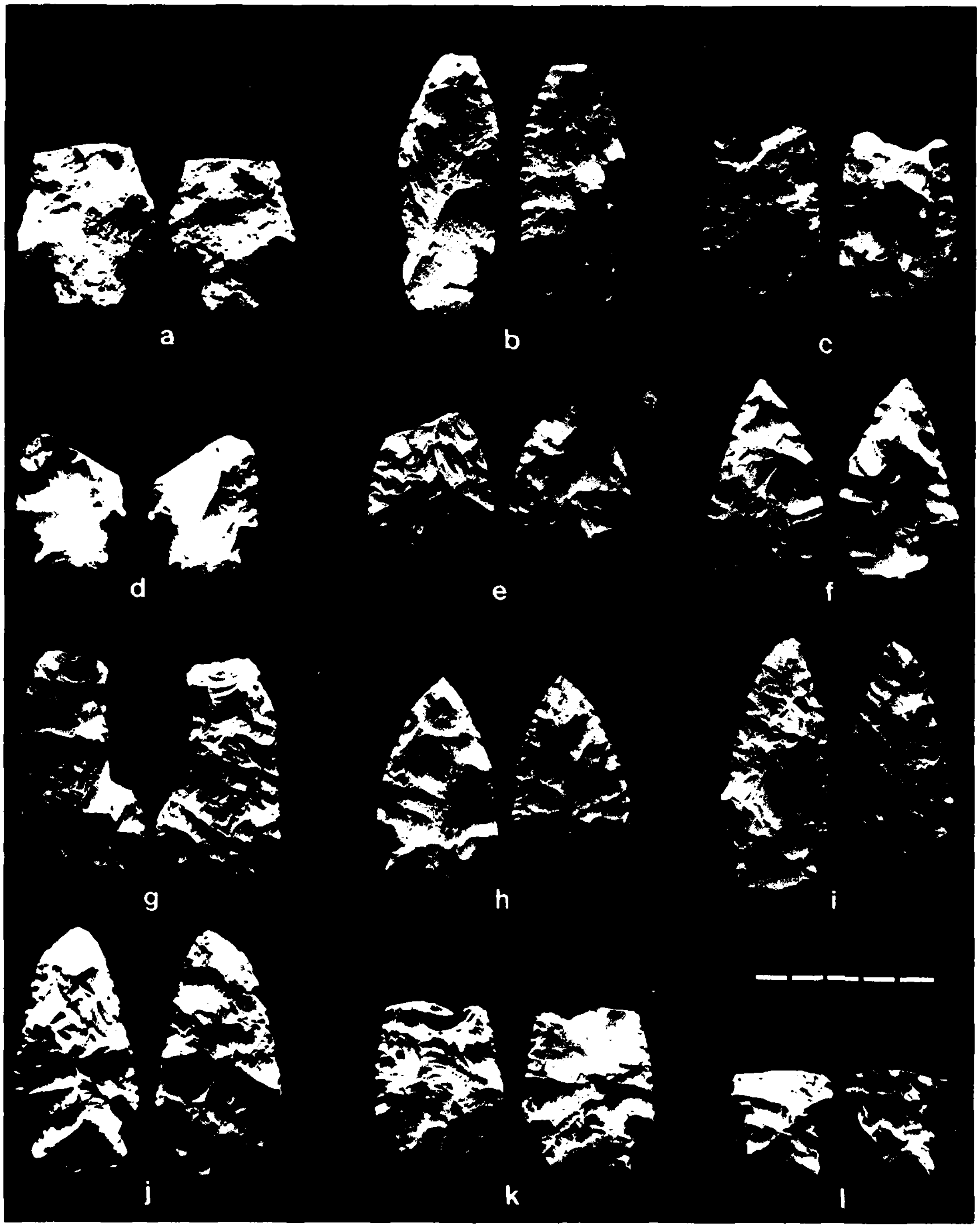


Figure 11.14. Category 27, straight stemmed points. Scale in cm.

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Bell 1960:62-63; Lewis and Lewis 1961:40,45; Ahler 1971:12

The crosstabulations confirm the null hypothesis for all but the relationship among blade serration-basal grinding and blade trasverse section (P = 0.0211; Table 11.20). Specimens with serrated blades and ground hafts and those having only ground hafts are mainly those with biplano or biconvex transverse blade sections and it may indicate that use has progressively obliterated blade serrations from specimens with ground hafts only. Specimens from Rodgers Shelter are almost uniformly heated, are basally ground and occasionally have serrated blades. Blade elements are generally asymmetrical and show evidence of resharpening on one or both edges, are often fractured by either transverse or impact fractures, and have square shoulders. Bases are short respective to the blade and almost square. Representative examples are illustrated in Figure 11.15.

Category 44

FUNCTION: indeterminate

FORM: straight stem point with asymmetrical blade
Blade edges: excurvate and incurvate
Shoulders: angular but unbarbed
Base: square but with rounded corners

FLAKING: Blade: initial shaping by bifacial percussion flaking with broad flake scars extending over one-half or more of the blade width. This flaking is generally crude and major preform surface irregularities were not removed to any great degree. Blade edges show progressive percussion or pressure flake resharpening, resulting in incurvate blades with trapezoidal or lenticular transverse sections.
Base: crudely thinned by bifacial percussion flake removals.

HEAT TREATMENT: All 3 specimens were heated prior to manufacture.

DIMENSIONS: Length: 70-90 mm
Width: 25-39 mm
Thickness: 9-12 mm

AGE OR HORIZON: Late Archaic

The three specimens are all of medium size with square shoulders and stubby square to sub-expanding stems and they are illustrated in Figure 11.16a-c.

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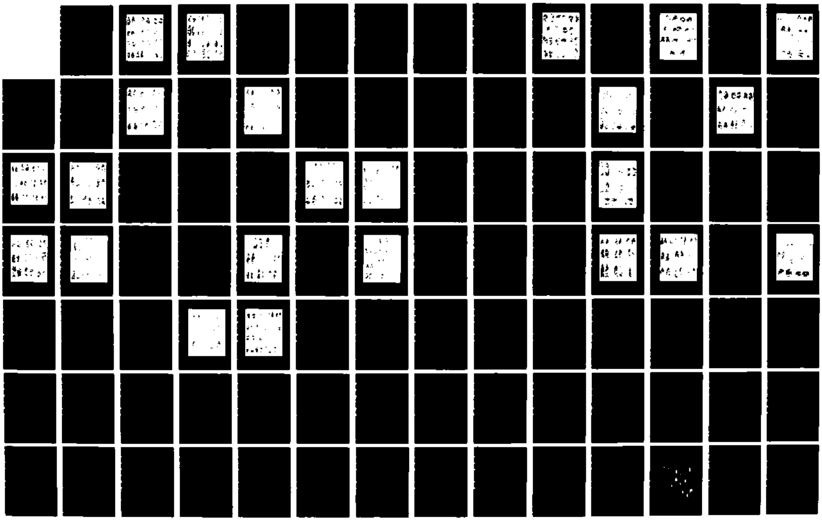

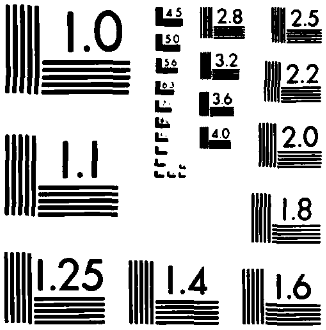

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Figure 11.15. Category 28, straight stemmed points. Scale in cm.

Figure 11.16. Straight stemmed points: a-c, Category 44; d-h, Category 49 (Stone); i-k, Category 51 (Castroville); l-n, Category 54. Scale in cm.

Category 49: Stone

FUNCTION:	multipurpose	
FORM:	square stem point with variable blade shape	
	Blade edges:	straight, either parallel or converging distally
	Shoulders:	angular, infrequently barbed; maximum point width
	Base:	straight, square stem
	Grinding:	basal grinding occurs infrequently
FLAKING:	Blade:	the majority of straight sided specimens were percussion flaked with large bilateral flake removals extending across the blade midline; occasionally these flake scars meet at the midline and form a subdued ridge. Remnant flake preform surfaces were often left. Other specimens with broad but distally converging blades exhibit equally rough bilateral percussion flaking. Flake scars extend across approximately one-third the blade width. Controlled pressure flaking also occurs.
	Stem:	bifacial percussion and/or pressure flaked, with the exception of three specimens that have alternate lateral unifacial flaking.
	Base:	Thinned by bifacial percussion and pressure flaking; flake scars are mostly short, parallel and oriented perpendicular to the base. Three specimens are not basally thinned, having the flake preform striking platform at the base.
HEAT TREATMENT:		16 of the 36 specimens were heated prior to manufacture; 3 others were heated after manufacture and subsequently reused.
DIMENSIONS:	Length:	59-82 mm
	Width:	26-44 mm
	Thickness:	6-12 mm
AGE OR HORIZON:		Late Archaic and Woodland
REFERENCES:		C. Chapman 1975:256

Chi squares and associated probabilities are insignificant, confirming the null hypothesis that differences in material selection, points manufacture and use are not more than would be expected by chance alone. Rodgers Shelter Stone points are as likely as not to be heated, to be made from a variety of locally available cherts, and to have been used as cutting tools or projectiles, which produced transverse or oblique or impact fractures as well as extensive abrasion of blade edges, which were subsequently resharpened. The points are of medium size, have square shoulders and short square stems. Representative examples are illustrated in Figure 11.16d-h.

Category 51: Castroville

FUNCTION:	Hafted cutting tool	
FORM:	straight or slightly expanding stem point with broad triangular blade	
	Blade edges:	asymmetric excurvate-incurvate
	Shoulders:	angular with pronounced barb; maximum point width
	Notches:	broad V- or U-shaped
	Base:	straight with expanding or square stem
FLAKING:	Blade:	bifacially shaped generally by parallel percussion flaking. Flake scars extend to the blade midline, leaving a subdued ridge and parts of the original preform surfaces. Edges are pressure flaked or resharpened.
	Notches:	bifacially flaked
	Base:	casually thinned by bifacial percussion or pressure flaking.
HEAT TREATMENT:		6 of the 8 specimens were heated prior to manufacture; an additional specimen was heated after manufacture and reworked.
DIMENSIONS:	Length:	72-84 mm
	Width:	39-48 mm
	Thickness:	8-11 mm
AGE OR HORIZON:		Late Archaic
REFERENCES:		Bell 1960:14-15

Chi squares and associated probabilities are insignificant, confirming the null hypothesis. Nonetheless, the relationship between material selection and subsequent flaking (Table 11.21) deserves additional comment even though the probability (P = 0.0892) is not statistically meaningful. It would appear that the greater care exercised in flaking the banded Jefferson City chert or Burlington chert is at least nominally important. As a whole, Rodgers Shelter Castroville points are massive with substantial blades having barbed shoulders. Notching is almost a basal characteristic. Representative examples are illustrated in Figure 11.16i-k.

Category 54

FUNCTION:	Hafted cutting tool	
FORM:	straight stem point with asymmetric blade	
	Blade edges:	markedly excurvate on one edge and incurvate on other
	Shoulders:	angular with pronounced barb

TABLE 11.21

Crosstabulation of Flaking by Material for Point Group 51

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * *
   V17       FLAKING                                                  BY  V13       MATERIAL
CONTROLLING FOR..
   V10       PT GROUP                                                 VALUE..    51   CASTORVILLE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V13
            COUNT  I
          ROW PCT  IBANDED    BURLNGTN CHOTEAU     ROW
          COL PCT  ICHERT      CHERT   CHERT       TOTAL
          TOT PCT  I     3  I      5  I      8  I
V17                --------I--------I--------I--------I
                 3  I     1  I      1  I      0  I      2
  TYPE 3  PRESSURE  I  50.0  I   50.0  I    0.0  I   25.0
                    I  25.0  I   33.3  I    0.0  I
                    I  12.5  I   12.5  I    0.0  I
                   -I--------I--------I--------I
                 7  I     0  I      0  I      1  I      1
  TYPE 5  PERCUSN   I   0.0  I    0.0  I  100.0  I   12.5
                    I   0.0  I    0.0  I  100.0  I
                    I   0.0  I    0.0  I   12.5  I
                   -I--------I--------I--------I
                10  I     3  I      2  I      0  I      5
  COMBINED          I  60.0  I   40.0  I    0.0  I   62.5
                    I  75.0  I   66.7  I    0.0  I
                    I  37.5  I   25.0  I    0.0  I
                   -I--------I--------I--------I
           COLUMN         4         3         1         8
            TOTAL      50.0      37.5      12.5     100.0

RAW CHI SQUARE =     8.06667 WITH     4 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0892
```

TABLE 11.22

Crosstabulation of Flaking by Material for Point Group 42

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * *
   V17       FLAKING                                               BY  V13       MATERIAL
CONTROLLING FOR..
   V10       PT GROUP                                              VALUE..    42
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                   V13
           COUNT  I
         ROW PCT  IOOLITIC   BANDED    X-BANDED BURLNGTN CHOTEAU     ROW
         COL PCT  ICHERT     CHERT      CHERT    CHERT   CHERT       TOTAL
         TOT PCT  I      2  I      3  I      4  I      5  I      8  I
V17               --------I--------I--------I--------I--------I
                3  I     1  I      1  I      0  I      0  I      0  I      2
  TYPE 3  PRESSURE I  50.0  I   50.0  I    0.0  I    0.0  I    0.0  I   12.5
                   I  25.0  I   12.5  I    0.0  I    0.0  I    0.0  I
                   I   6.3  I    6.3  I    0.0  I    0.0  I    0.0  I
                  -I--------I--------I--------I--------I--------I
                4  I     0  I      1  I      1  I      0  I      1  I      3
  TYPE 4  PRESSURE I   0.0  I   33.3  I   33.3  I    0.0  I   33.3  I   18.8
                   I   0.0  I   12.5  I   50.0  I    0.0  I  100.0  I
                   I   0.0  I    6.3  I    6.3  I    0.0  I    6.3  I
                  -I--------I--------I--------I--------I--------I
                6  I     0  I      0  I      0  I      1  I      0  I      1
  RANDOM  PERCUSN  I   0.0  I    0.0  I    0.0  I  100.0  I    0.0  I    6.3
                   I   0.0  I    0.0  I    0.0  I  100.0  I    0.0  I
                   I   0.0  I    0.0  I    0.0  I    6.3  I    0.0  I
                  -I--------I--------I--------I--------I--------I
                7  I     3  I      6  I      1  I      0  I      0  I     10
  TYPE 5  PERCUSN  I  30.0  I   60.0  I   10.0  I    0.0  I    0.0  I   62.5
                   I  75.0  I   75.0  I   50.0  I    0.0  I    0.0  I
                   I  18.8  I   37.5  I    6.3  I    0.0  I    0.0  I
                  -I--------I--------I--------I--------I--------I
          COLUMN         4         8         2         1         1        16
           TOTAL      25.0      50.0      12.5       6.3       6.3     100.0

RAW CHI SQUARE =    23.26663 WITH    12 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0255
```

Notches: almost basally oriented, broad U-shaped
Base: straight with square stem

FLAKING: bifacial bilateral percussion flaking with thin flake scars terminating in a midline ridge. Blade edges are pressure retouched. Basal thinning is restricted to a few bifacial percussion flake removals.

HEAT TREATMENT: 1 of the 3 specimens was heated prior to manufacture

DIMENSIONS: Length: 75-100 mm
Width: 30- 36 mm
Thickness: 10- 12 mm

AGE OR HORIZON: Late Archaic or Woodland?

The three specimens have a crude appearance and are of massive size, vaguely similar to basally notched Smith points (Category 9), which are discussed next. The three are illustrated in Figure 11.161-n.

BASAL NOTCHED

Category 9: Smith

FUNCTION: multipurpose

FORM: straight stem, basally notched point with an asymmetric blade
Blade edges: vary from straight with parallel sides to excurvate or excurvate and incurvate
Shoulders: parallel to the base and having a pronounced angular barb; point maximum width
Notches: at a perpendicular to the base, U-shaped
Base: straight with square stem
Grinding: basal grinding infrequent

FLAKING: Blade: bilateral percussion flaking was used to rough out the blade, producing large flake scars that extend across one-third to two-thirds of the blade width. Hinge fractures are common and usually only five or six flakes were removed in completing the process. Most specimens have flake preform remnant surfaces as either a medial ridge or as a remnant flake ventral surface. Due to this rough percussion flaking, the more extreme examples have asymmetrically thick blades with the point of maximum thickness near a blade edge. As a second step, finely controlled bilateral percussion flake finishing was also executed that produced parallel flake scars extending generally to the blade midline. Blade edges have continuous secondary pressure and percussion flake scars.

Notching: bifacial and was subsequent to blade flaking

Stem: bifacially pressure flaked into final straight form

Base: bifacially thinned by percussion flaking

HEAT TREATMENT: 14 of the 27 specimens were heated prior to manufacture

DIMENSIONS: Length: 69-93 mm

Width: 41-59 mm

Thickness: 9-14 mm

AGE OR HORIZON: Late Archaic

REFERENCES: Baerreis and Freeman 1959, cited by Perino 1968:90-91; C. Chapman 1975:256-257.

Crosstabulations all confirm the null hypothesis that differences in material selection, point manufacture and use are no more than would be true by chance alone. Smith points from Rodgers Shelter are among the most distinctive forms and present an easily recognized basally notched shape. Specimens tend to be massive and have considerable variation in kinds of blade fracture; impact fractures are reasonably common. Blade edge abrasion and subsequent attempts to resharpen dulled edges also occur with some regularity. And it would be difficult to characterize Smith points as being solely used for but one purpose. Representative examples are illustrated in Figure 11.17.

Category 31

FUNCTION: Projectile point

FORM: ovate basally notched point

Blade edges: highly excurvate

Shoulders: parallel to or on same arc as base; highly

Notches: straight, broad V-shaped; maximum point width is almost on a plane connecting the distal notch ends that would intersect the blade edges.

FLAKING: random bilateral and basal, bifacial percussion flake thinning of point with flake scars extending across one-third to one-half the blade width. Notches are bifacially flaked.

HEAT TREATMENT: 1 of the 4 specimens was heated prior to manufacture

DIMENSIONS: Length: 60 mm (one specimen only)

Width: 40-62 mm

Thickness: 8-10 mm

AGE OR HORIZON: Woodland

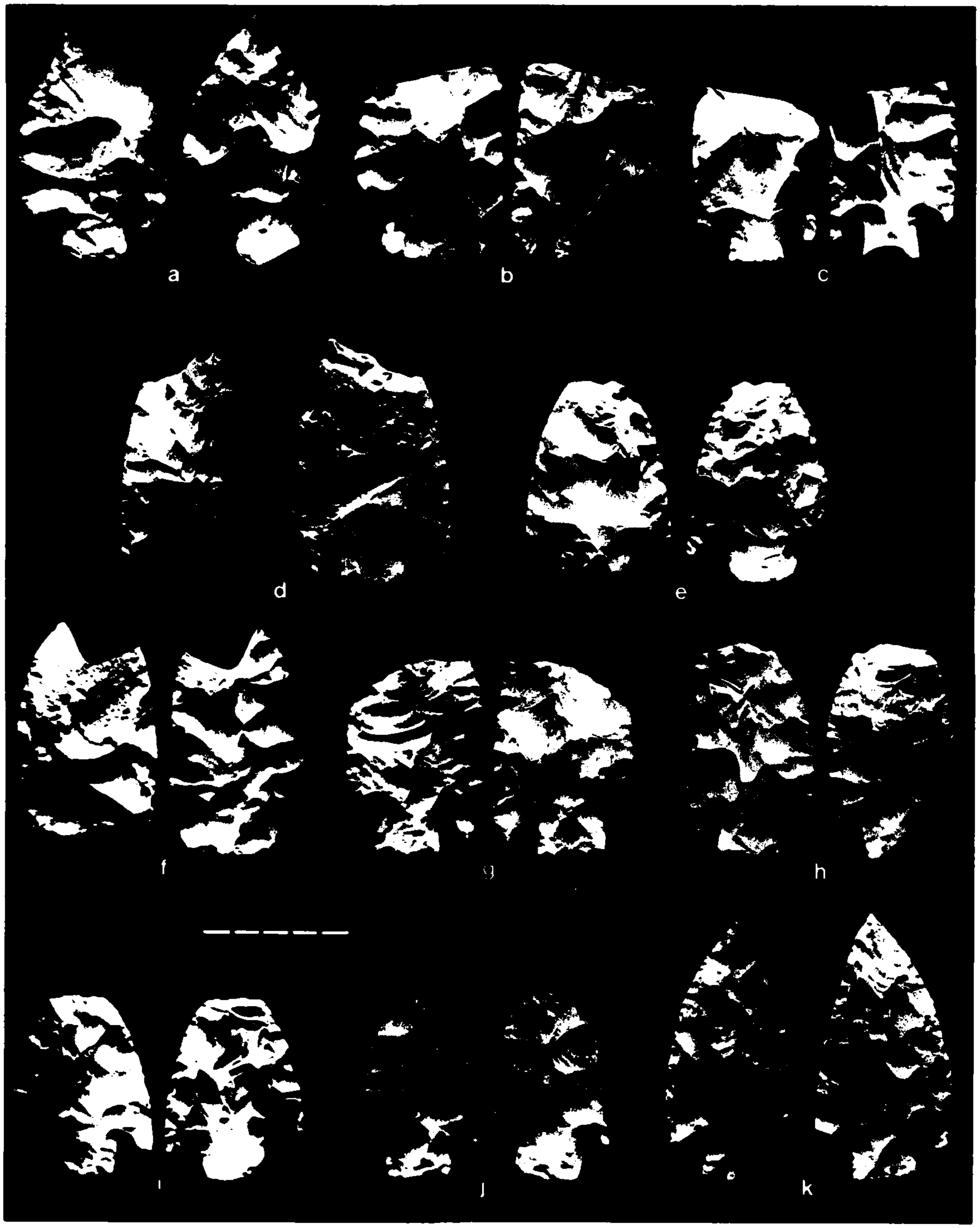

Figure 11.17. Smith points, Category 9: Note specimen f is an unnotched preform and is from same nodule as d. Scale in cm.

The four specimens have blade fractures; two are impact, and the others are oblique. In a very gross way, the specimens resemble Snyders points (Bell 1958:88-89) and are illustrated in Figure 11.18a-c.

Category 42

FUNCTION:	Projectile point	
FORM:	triangular basally notched point with accentuated barbs	
	Blade edges:	roughly parallel and straight to slightly incurvate
	Shoulders:	acutely angular with highly pronounced barbs on a plane with the base; maximum width of point
	Notches:	vary from narrow V-shaped to a wider U-shaped; most specimens are V-shaped
	Base:	generally straight but also slightly concave or convex with an expanding stem
	Grinding:	base is occasionally ground
FLAKING:	Blade:	bifacially thinned by well controlled percussion flaking that removed thin flakes extending across one-third to two-thirds the blade width and often producing a midline ridge. Blade edges were progressively resharpened by bifacial percussion or pressure flaking that removed very thin, occasionally hinged, flakes extending generally across no more than one-fifth of the blade width
	Notches:	bifacially flaked
	Base:	thinned bifacially by an initial phase of percussion flaking followed by discontinuous pressure flaking, that removed basal protrusions
HEAT TREATMENT:		16 of the 18 specimens were heated prior to point manufacture
DIMENSIONS:	Length:	51-57 mm (only two specimens)
	Width:	25-46 mm
	Thickness:	5-10 mm
AGE OR HORIZON:		Late Archaic and Woodland

Chi squares and associated probabilities demonstrate a significant (P = 0.0255) relationship between material selection and subsequent flaking (Table 11.22). The null hypothesis is accepted, however, for the other crosstabulations. And in general, the category represents a reasonably uniform class of heated, basally notched forms of medium size. Most specimens are fractured, only one of these is due to impact. The majority are irregular fractures which may be a product of heating. Representative examples are illustrated in Figure 11.18d-i.

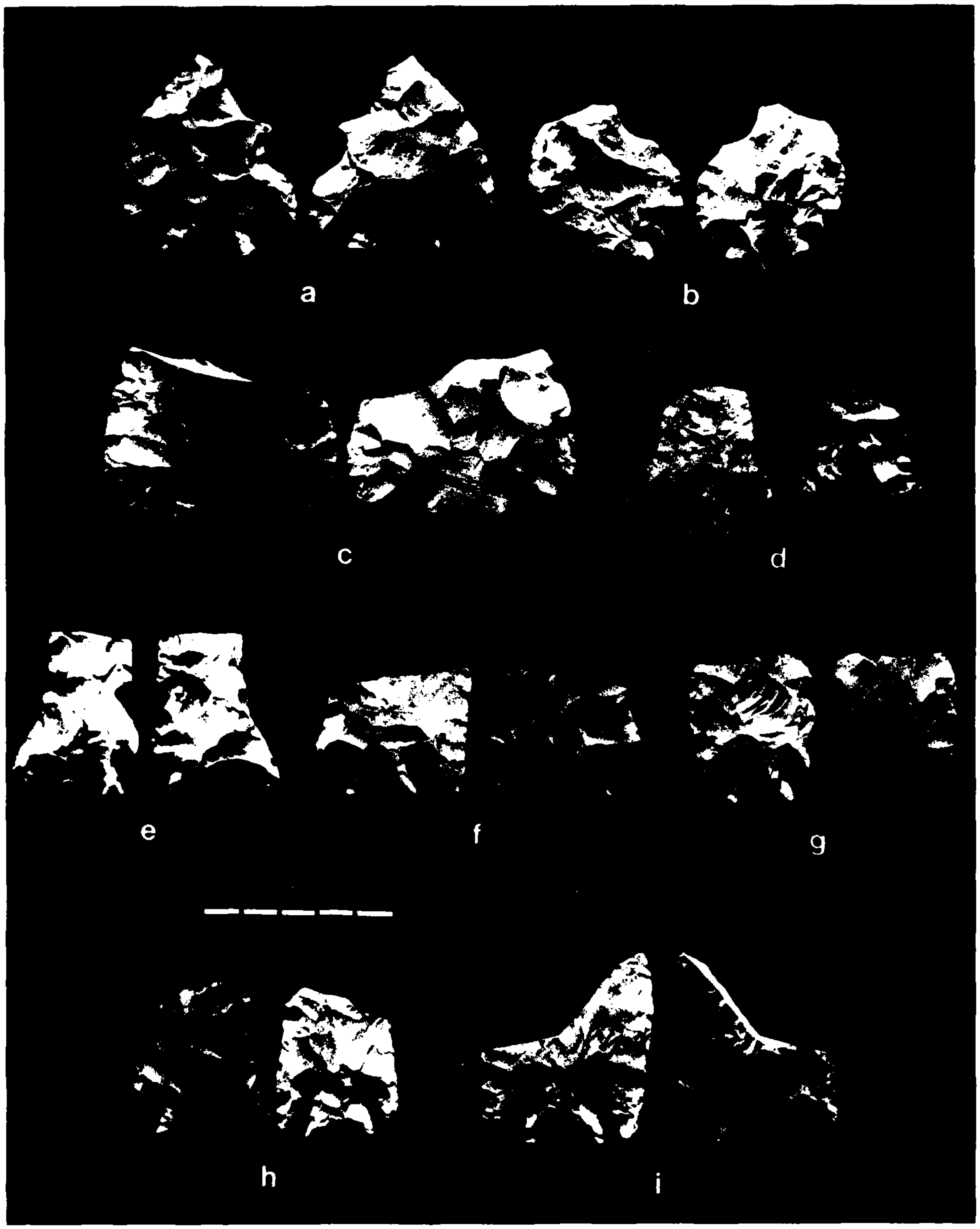

Figure 11.18. Basal notched points: a-c, Category 31; d-i, Category 42. Scale in cm.

CORNER NOTCHED

Category 11: Afton

FUNCTION: Projectile point

FORM: pentagonal corner notched point
Blade edges: parallel above shoulders to about one-half or two-thirds the blade length, then converging to the tip
Shoulders: angular with a pronounced barb
Notches: straight, narrow and V-shaped at roughly a 30° to 40° angle to the blade

FLAKING: finely controlled percussion or pressure flaking with flake scars generally parallel, colateral or transverse. Notches were produced by bifacial pressure flaking at the blade corners, and the base is thinned by pressure flaking

HEAT TREATMENT: 2 of the 4 specimens were heated prior to manufacture

DIMENSIONS: Length: 53-55 mm
Width: 28-40 mm
Thickness: 5- 7 mm

AGE OR HORIZON: Late Archaic

REFERENCES: Holmes 1903; Bell 1958:6-7; Wood 1960; C. Chapman 1975:240

The five-sided form, meticulous craftsmanship and wafer-like thinness make Afton points one of the most distinctive points from Rodgers Shelter. Examples are illustrated in Figure 11.19a-d.

Category 29: Williams

FUNCTION: multipurpose

FORM: corner notched point
Blade edges: roughly parallel and excurvate
Shoulders: angular with subdued barb; maximum point width
Notches: open, broad U-shaped
Base: convex
Grinding: infrequent basal grinding

FLAKING: Blade: initial preparation is amorphous but controlled bifacial percussion thinning that resulted in shallow generally broad flake scars extending across one-half to two-thirds of the blade width. Subsequent shaping is mainly restricted to pressure flaking of blade edges; remnant flake preform surfaces are common

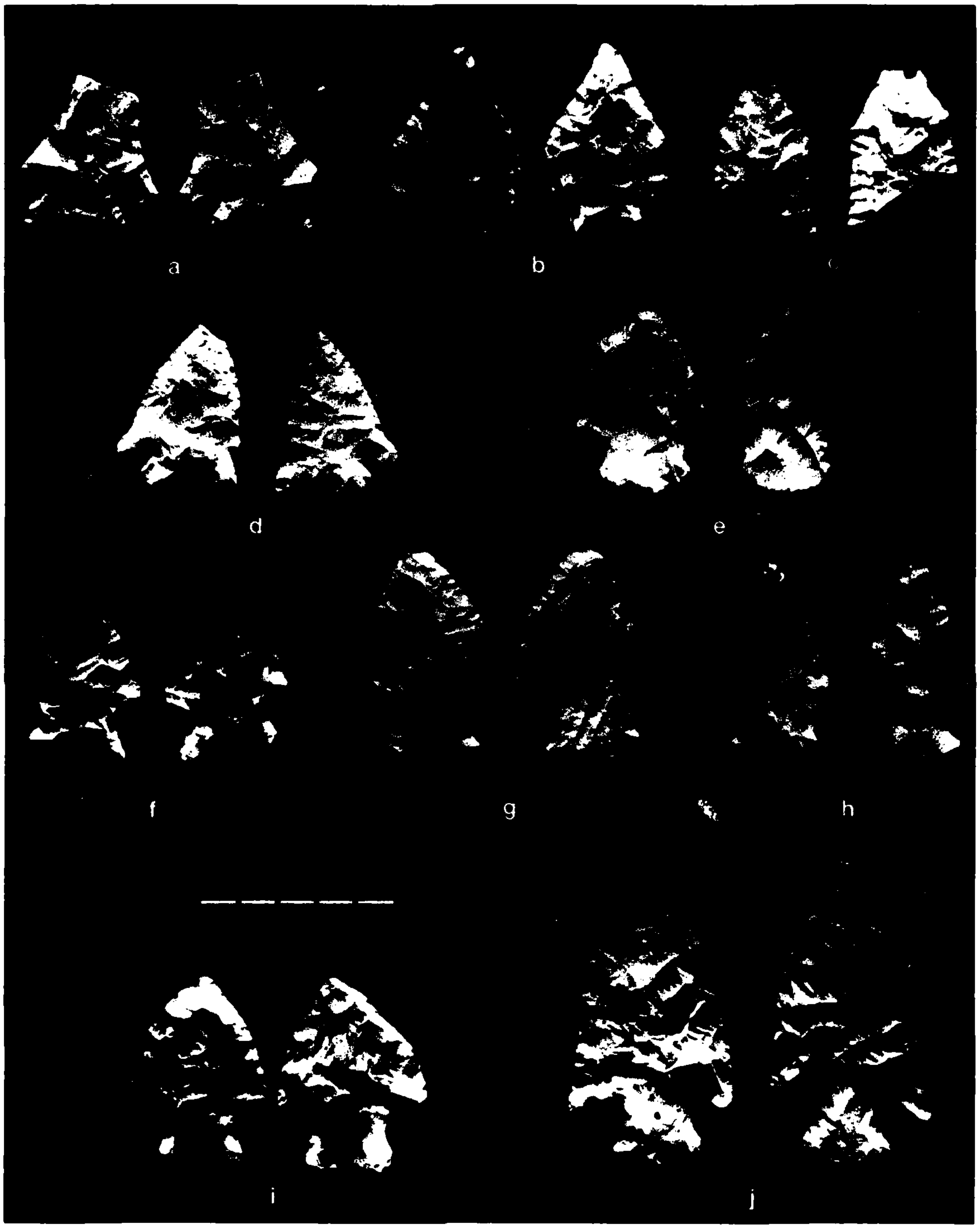

Figure 11.19. Corner notched points: a-d, Category 11 (Afton); e-j, Category 29 (Williams). Scale in cm.

Notches: mainly bifacially pressure flaked, a few are unifacially notched
Base: roughly thinned by a combination of percussion and pressure flaking

HEAT TREATMENT: of the 42 specimens, 24 were heated prior to manufacture; an additional 14 were heated after manufacture and reworked

DIMENSIONS: Length: 45-81 mm
Width: 25-43 mm
Thickness: 6-11 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Suhm and Krieger 1954:480, cited by Bell 1960: 96-97; Ahler 1971:8

Chi squares and associated probabilities are insignificant thus confirming the null hypothesis that differences in material selection, point manufacture and use are not greater than would be expected by chance alone. Nonetheless, while Rodgers Shelter Williams points are reasonably uniform, they are one of the more intriguing point types from the site. Most of the specimens are small and relatively thick with highly worn blade edges. A remarkably high percentage (33.3%) apparently were heated--perhaps reheated--after manufacture and then reworked. These points were used until the blade elements were all but exhausted. And it appears that this represents a conscious effort to conserve what were obviously considered to be valuable utilitarian implements. Exactly why this seems to be so is equally puzzling since the specimens are of primarily Jefferson City cherts and would seemingly have been the most readily obtainable of chert resources. Similarly, the points illustrate no greater care in workmanship, and often a good deal less, than other point categories of similar age from the site. Representative examples are illustrated in Figure 11.19e-j.

Category 30: Marcos or Cypress Creek I

FUNCTION: multipurpose

FORM: corner notched point
Blade edges: parallel to slightly excurvate; often with a bifacial bevel
Shoulders: angular with dimunitive barbs; maximum point width
Notches: U-shaped and broad
Base: straight to slightly convex and having an angular stem juncture; the base often equals the shoulder width
Grinding: basal grinding frequent

FLAKING: Blade: although variable in the degree of execution blade preparation is uniform and consists of initial blade thinning and primary shaping by controlled bifacial percussion flaking, with

	mainly parallel flake scars resulting that extend across the blade width. Hinge fractures and remnant flake preform surfaces are infrequent. The overall impression is that initial blade shaping was highly stylized and exceptionally well executed. Subsequent edge preparation or resharpening was by equally meticulous bifacial pressure flaking which resulted in diminutive parallel flake scars generally restricted to the immediate edge area.
Notches:	bifacially pressure flaked
Base:	thinned primarily by controlled bifacial pressure flaking resulting in parallel flake scars oriented perpendicular to the base. A few specimens were thinned by percussion flaking and have larger flake scars, occasionally terminating in a hinge fracture. Of these, four have basal fluting on one or both sides of the base that appears to be purposely executed
HEAT TREATMENT:	33 of the 47 specimens were heated prior to manufacture, 2 others were heated after manufacture and reworked
DIMENSIONS:Length:	52-78 mm
Width:	30-45 mm
Thickness:	5-10 mm
AGE OR HORIZON:	Early to Middle Archaic
REFERENCES:	Suhm and Krieger 1954:442, cited by Bell 1958:42-43; Ahler 1971:8; Lewis and Lewis 1961:37, 41

Crosstabulations confirm the null hypothesis that differences in material selection, point manufacture and use are no more than would be expected by chance. Marcos points from Rodgers Shelter are reasonably uniform and were fashioned mainly from heated Jefferson City cherts. In addition to differences in form, they contrast with the coeval Williams points (Category 29) in the percentage of heated and reworked specimens (4.3% compared to 33.3%), although both categories have roughly similar percentages of thermal and irregular fractures (30.9% and 38.7%) and are commonly impact fractured also. Three specimens have reworked blade fractures and several hafted scrapers have Marcos bases. Marcos blade elements seemingly were subject to variable use and stylistic variation is best reflected in the haft element and shoulders. Marcos points (Figure 11.20) are similar to Kirk Corner Notched points, Large Variety (Broyles 1966:20-21) and the latter name might well apply also. Lewis and Lewis (1961:37, 41) illustrate similar specimens from the Eva site also, termed Cypress Creek I.

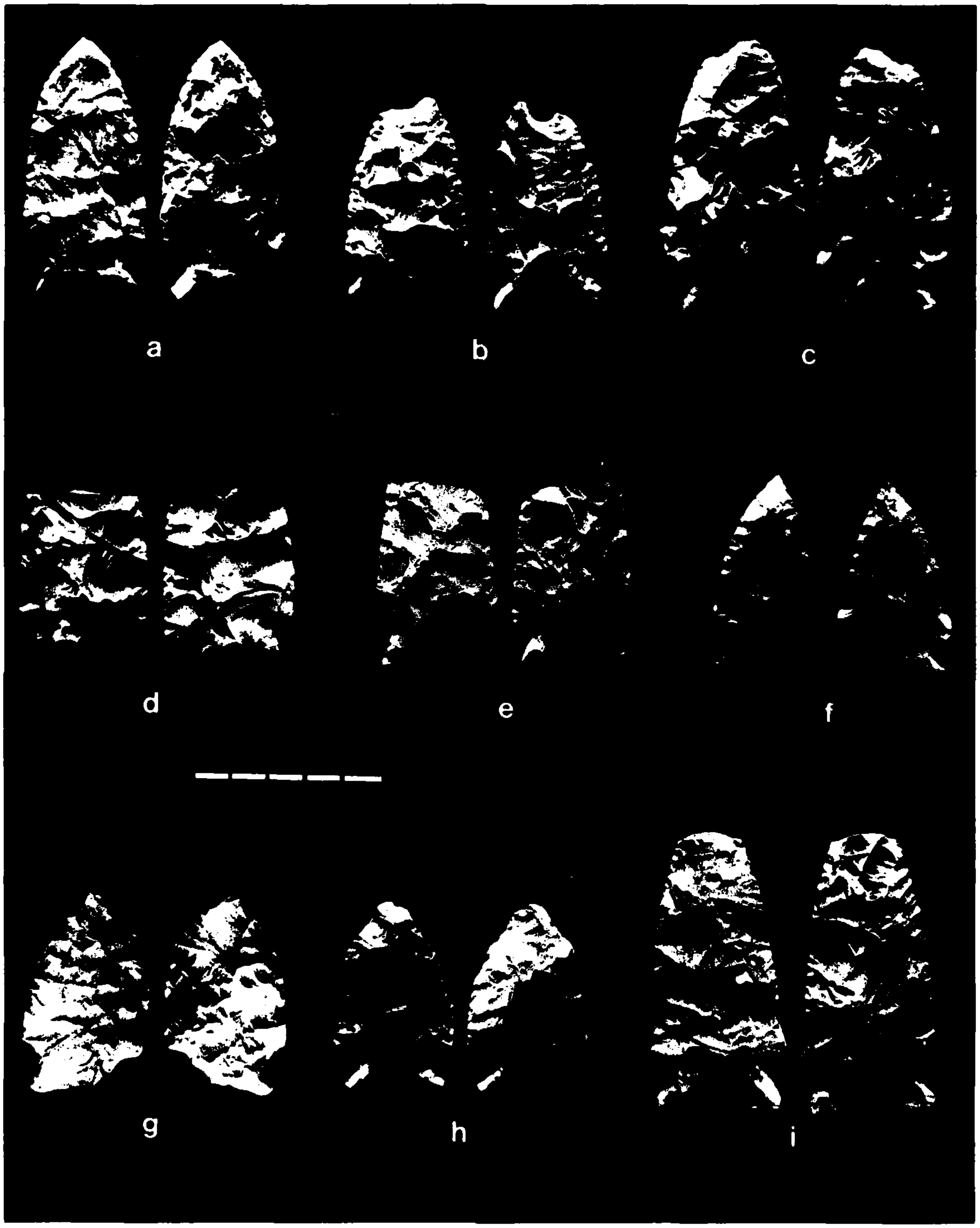

Figure 11.20. Marcos or Cypress Creek I points (Category 30). Scale in cm.

Category 45

FUNCTION: Projectile point

FORM: symmetrical corner notched point
Blade edges: incurvate and excurvate
Shoulders: angular but unbarbed, maximum point width
Notches: rounded U-shaped or broad V-shaped
Base: straight with expanding stem

FLAKING: Blade: initial shaping by bilateral percussion flaking, resulting in irregular flake removals that extend across the blade midline. Subsequent edge preparation or resharpening was by finely controlled pressure flaking, producing transverse flake scars that extend across the blade midline as well.
Notches: bifacially pressure flaked
Base: thinned by bifacial percussion flaking followed by more refined pressure retouching of the basal edge.

HEAT TREATMENT: 1 of the 2 specimens was heated prior to manufacture

DIMENSIONS: Length: 60-61 mm
Width: 22-25 mm
Thickness: 6- 7 mm

AGE OR HORIZON: Late Archaic or Woodland

The two specimens are illustrated in Figure 11.21a-b.

Category 46

FUNCTION: Projectile point

FORM: corner notched point with a symmetrical triangular base
Blade edges: straight or excurvate, converging distally
Shoulders: angular and barbed
Notches: V-shaped
Base: straight with expanding stem

FLAKING: Blade: finely flaked with initial bifacial thinning and shaping by bilateral percussion flaking, usually removing fewer than 5 or 6 paper thin transverse flakes. Resultant flake scars extend from one-half to entirely across the blade width. Subsequent edge shaping was by bifacial pressure flaking; flake scars are parallel and extend less than one-fifth across the blade width.
Notches: bifacially flaked
Base: bifacially thinned by simiarly well controlled percussion flaking followed by minor pressure flake retouching

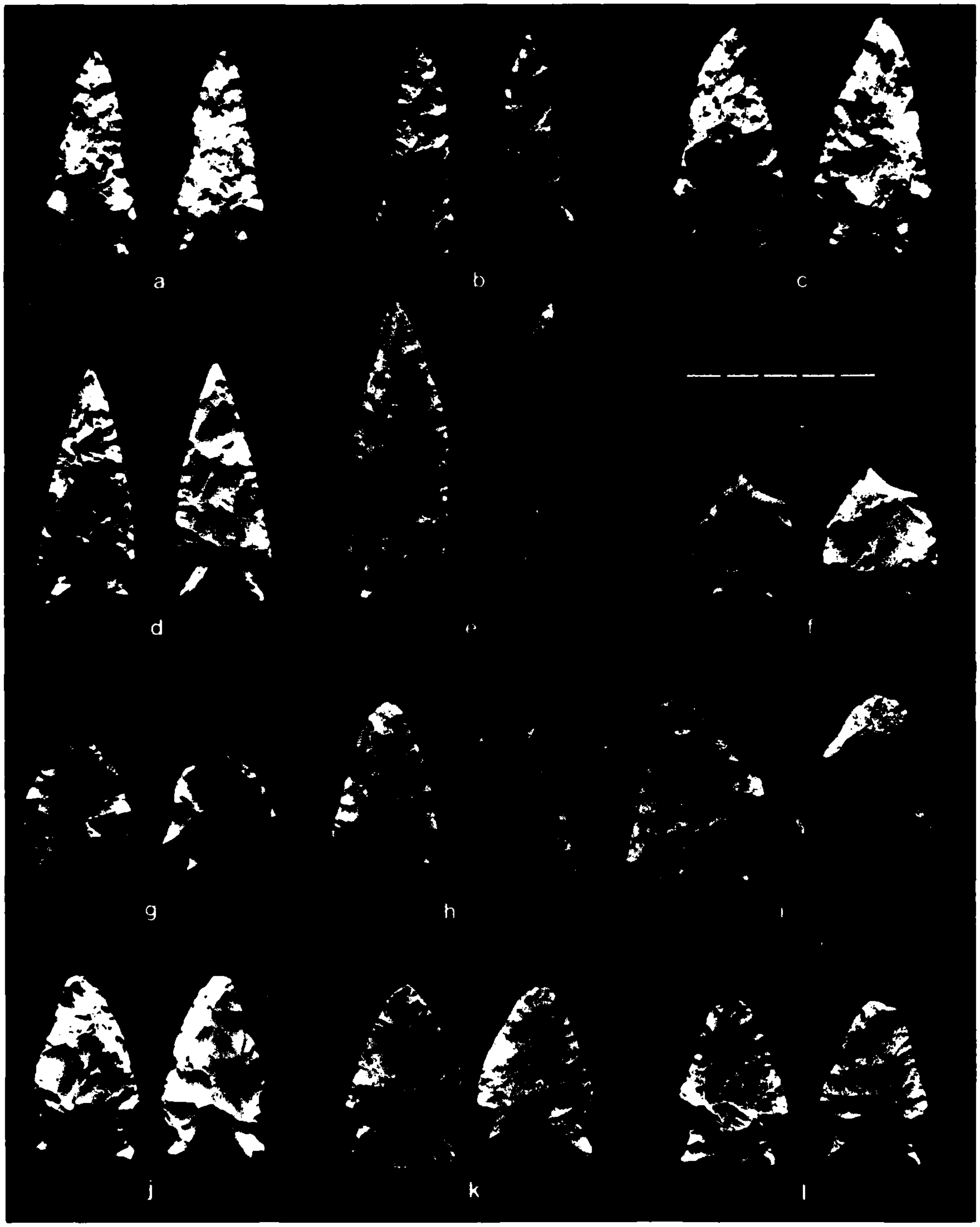

Figure 11.21. Corner notched points: a-b, Category 45; c-e, Category 46; f-l, Category 48. Scale in cm.

HEAT TREATMENT: 4 of the 6 specimens were heated prior to manufacture; the remaining 2 specimens were heated after manufacture and subsequently reused

DIMENSIONS: Length: 65-85 mm
Width: 26-48 mm
Thickness: 5- 8 mm

AGE OR HORIZON: Woodland

The six specimens show almost near total uniformity. The specimens have a superficial resemblance to Afton points (Category 11) and the specimens illustrated in Figure 11.21 should be compared with them.

Category 48

FUNCTION: Multipurpose

FORM: corner notched point
Blade edges: variable including straight, incurvate and excurvate
Shoulders: angular and sometimes barbed
Notches: vary from broad U-shaped to narrow V-shaped
Base: straight or slightly convex with an expanding stem

FLAKING: Blade: flaking is highly variable. Ten specimens are thinned by well controlled percussion flaking of mainly the ventral flake preform ventral surface with from 4 to 8 flakes removed in a serial fashion from the blade edges; removal of the bulb of percussion being the primary objective. The dorsal surfaces of these specimens have a few amorphous percussion flake scars extending across less than half the blade width, major flake preform surfaces remain. Blade edges were pressure flaked into final form. Other specimens have either alternating lateral percussion flaking or bilateral percussion flaking with flake scars meeting at the midline in a subdued ridge and with secondary pressure chipping of the blade edges. Others were finely pressure flaked.
Notches: bifacially or unifacially notched; unifacial notching occasionally alternates from one lateral edge to the other
Base: mainly bifacially thinned by well controlled pressure work

HEAT TREATMENT: 29 of the 42 specimens were heated prior to manufacture; 3 others were heated after manufacture and were then reworked.

DIMENSIONS: Length: 49-55 mm
Width: 28-36 mm
Thickness: 6-11 mm

AGE OR HORIZON: Late Archaic and Woodland

Crosstabulations (Table 11.23) reject the null hypothesis for the relationship among heat treatment and material (P = 0.0129) and mainly show that specimens that are heated after manufacture (including those which were subsequently reworked) are primarily oolitic or banded Jefferson City cherts in contrast to specimens heated prior to manufacture which also include cross-banded Jefferson City chert, Burlington and Chouteau cherts. Although the relationship would be accepted as being due to chance, blade fracture compared to cross section (P = 0.1004; Table 11.24) describes a potentially systematic relationship in which transverse, oblique, irregular and thermal fractures occur more frequently with specific cross sections such as biplano or plano-convex while impact fractures are common to all blade cross sectional shapes. The null hypothesis is accepted for differences in flaking by material type or for basal grinding by blade cross section. In sum, this category expresses some variation in material selection, the manufacturing technology and use of individual specimens even though their shapes are roughly similar. Representative examples are illustrated in Figure 11.21f-1.

Category 50: Etley

FUNCTION: hafted cutting tool

FORM: corner notched point
Blade edges: roughly parallel and generally incurvate-excurvate; occasionally tapering to a tip or serrated
Shoulders: angular and squared with a diminutive barb
Notches: open U-shaped
Base: straight to slightly convex with a square stem

FLAKING: highly variable and includes almost the entire range of possible pressure and percussion flaking. Basal thinning is usually characterized by parallel percussion flake removals oriented perpendicular to the base.

HEAT TREATMENT: 21 of the 42 specimens were heated prior to manufacture

DIMENSIONS: Length: 50-98 mm
Width: 34-50 mm
Thickness: 7-12 mm

AGE OR HORIZON: Late Archaic

REFERENCES: Scully 1951:2; Bell 1960:36-37; C. Chapman 1975:246

TABLE 11.23

Crosstabulation of Heat Treatment by Material for Point Group 48

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * *
   V19        HEAT TREATMENT                                      BY  V18        MATERIAL
CONTROLLING FOR..
   V10        PT GROUP                                            VALUE..   48
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                     V18
              COUNT I
            ROW PCT IOOLITIC  BANDED    X-BANDED BURLNGTN CHOTEAU    ROW
            COL PCT ICHERT    CHERT     CHERT    CHERT    CHERT      TOTAL
            TOT PCT I     2  I     3  I     4  I     5  I     8  I
V19         --------I--------I--------I--------I--------I--------I
                  2 I     6  I    10  I     1  I    11  I     1  I    29
  PRIOR             I  20.7  I  34.5  I   3.4  I  37.9  I   3.4  I  69.0
                    I  75.0  I  55.6  I  50.0  I  84.6  I 100.0  I
                    I  14.3  I  23.8  I   2.4  I  26.2  I   2.4  I
                   -I--------I--------I--------I--------I--------I
                  3 I     1  I     6  I     0  I     2  I     0  I     9
  AFTER             I  11.1  I  66.7  I   0.0  I  22.2  I   0.0  I  21.4
                    I  12.5  I  33.3  I   0.0  I  15.4  I   0.0  I
                    I   2.4  I  14.3  I   0.0  I   4.8  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                  4 I     0  I     0  I     1  I     0  I     0  I     1
  UNKNOWN           I   0.0  I   0.0  I 100.0  I   0.0  I   0.0  I   2.4
                    I   0.0  I   0.0  I  50.0  I   0.0  I   0.0  I
                    I   0.0  I   0.0  I   2.4  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                  5 I     1  I     2  I     0  I     0  I     0  I     3
  HEATED &REWORKED  I  33.3  I  66.7  I   0.0  I   0.0  I   0.0  I   7.1
                    I  12.5  I  11.1  I   0.0  I   0.0  I   0.0  I
                    I   2.4  I   4.8  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I
             COLUMN       8       18        2       13        1       42
              TOTAL    19.0     42.9      4.8     31.0      2.4    100.0

RAW CHI SQUARE =    25.42934 WITH    12 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0129
```

TABLE 11.24

Crosstabulation of Blade Cross Section by Fracture for Point Group 48

```
              COUNT I
            ROW PCT IIMPACT   TRANS-    OBLIQUE  IRREG-   THERMAL    ROW
            COL PCT I         VERSE              ULAR                TOTAL
            TOT PCT I     1  I     2  I     3  I     4  I     5  I
V11         --------I--------I--------I--------I--------I--------I
                  1 I     2  I     1  I     0  I     1  I     0  I     4
  BIPLANO           I  50.0  I  25.0  I   0.0  I  25.0  I   0.0  I  22.2
                    I  22.2  I  50.0  I   0.0  I  33.3  I   0.0  I
                    I  11.1  I   5.6  I   0.0  I   5.6  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                  4 I     1  I     1  I     0  I     0  I     0  I     2
  BICONVEX          I  50.0  I  50.0  I   0.0  I   0.0  I   0.0  I  11.1
                    I  11.1  I  50.0  I   0.0  I   0.0  I   0.0  I
                    I   5.6  I   5.6  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                  6 I     3  I     0  I     2  I     2  I     0  I     7
  PLANO-CONVEX      I  42.9  I   0.0  I  28.6  I  28.6  I   0.0  I  38.9
                    I  33.3  I   0.0  I 100.0  I  66.7  I   0.0  I
                    I  16.7  I   0.0  I  11.1  I  11.1  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                  7 I     1  I     0  I     0  I     0  I     0  I     1
  CONCAVO-CONVEX    I 100.0  I   0.0  I   0.0  I   0.0  I   0.0  I   5.6
                    I  11.1  I   0.0  I   0.0  I   0.0  I   0.0  I
                    I   5.6  I   0.0  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                 10 I     2  I     0  I     0  I     0  I     0  I     2
  BIBEVELED         I 100.0  I   0.0  I   0.0  I   0.0  I   0.0  I  11.1
                    I  22.2  I   0.0  I   0.0  I   0.0  I   0.0  I
                    I  11.1  I   0.0  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I
                 11 I     0  I     0  I     0  I     0  I     2  I     2
  IRREGULAR         I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I  11.1
                    I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I
                    I   0.0  I   0.0  I   0.0  I   0.0  I  11.1  I
                   -I--------I--------I--------I--------I--------I
             COLUMN       9        2        2        3        2       18
              TOTAL    50.0     11.1     11.1     16.7     11.1    100.0

RAW CHI SQUARE =    28.39284 WITH    20 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.1004
```

Chi squares and associated probabilities are insignificant and the null hypothesis is accepted. But even though the relationship between material and heat treatment (Table 11.25) might reasonably be expected by chance (P = 0.0884), it does potentially illustrate a systematic relationship between heat treatment prior to manufacture affecting only the Jefferson City cherts, whereas river gravel, Burlington and Chouteau chert specimens were not heated, were heated after manufacture but not reused or heating could not be determined. Blade fractures occur on less than half of the specimens and no pattern is evident for fracture respective to either material or blade cross section. What seems true of Etley points is that while variable use is indicated by blade fracture types and evidence for blade wear and resharpening, the blade element remains stylistically distinctive: it is a sinuous blade which attains its maximum width usually at roughly two-thirds of its length. The Rodgers Shelter sample includes several that have pronounced distal tapering, in some cases approaching a needle-like tip. The base is proportionately short with a squarish stem at nearly a right angle to the shoulders. Representative examples are illustrated in Figure 11.22.

Category 52

FUNCTION: Projectile point

FORM: corner notched point with a triangular blade
Blade edges: excurvate-incurvate and asymmetric
Shoulders: angular, occasionally barbed
Notches: rounded to broadly V-shaped
Base: varies from straight to concave to convex

FLAKING: blade is primarily thinned by bilateral bifacial percussion flaking, with flake scars intersecting at the blade midline. Blade edges are occasionally pressure flaked. Notching is bifacial and the base is crudely thinned by bifacial flaking.

HEAT TREATMENT: 17 of 28 specimens were heated prior to manufacture; an additional specimen was heated after manufacture and reworked

DIMENSIONS: Length: 43-68 mm
Width: 20-35 mm
Thickness: 6-10 mm

AGE OR HORIZON: Late Archaic or Woodland

Crosstabulations all confirm the null hypothesis that differences in material, point manufacture or use are no more than would be expected by chance. In sum, the Rodgers Shelter sample is reasonably uniform. These medium sized, asymmetrical corner notched points were fashioned from either Jefferson City or Burlington cherts. Twenty-five of the twenty-eight specimens have an assortment of blade fractures; most common are impact and transverse fractures. Blade serration or basal

TABLE 11.25

Crosstabulation of Heat Treatment by Material for Point Group 50

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * *
    V19       HEAT TREATMENT                                    BY  V13        MATERIAL
CONTROLLING FOR..
    V10       PT GROUP                                          VALUE..    50   ETLEY
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                      V18
             COUNT   I
             ROW PCT IOOLITIC  BANDED   X-BANDEC BURLNGTN RIVER    CHOTEAU    ROW
             COL PCT ICHERT    CHERT     CHERT    CHERT   GRAVEL   CHERT      TOTAL
             TOT PCT I      2 I      3 I      4 I      5 I      6 I      8 I
V19          --------I--------I--------I--------I--------I--------I--------I
                   1 I      3 I      1 I      0 I      0 I      1 I      1 I      6
  UNHEATED           I   50.0 I   16.7 I    0.0 I    0.0 I   16.7 I   16.7 I   14.3
                     I   15.8 I    8.3 I    0.0 I    0.0 I  100.0 I   33.3 I
                     I    7.1 I    2.4 I    0.0 I    0.0 I    2.4 I    2.4 I
                    -I--------I--------I--------I--------I--------I--------I
                   2 I     12 I      6 I      3 I      0 I      0 I      0 I     21
  PRIOR              I   57.1 I   28.6 I   14.3 I    0.0 I    0.0 I    0.0 I   50.0
                     I   63.2 I   50.0 I   75.0 I    0.0 I    0.0 I    0.0 I
                     I   28.6 I   14.3 I    7.1 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I
                   3 I      1 I      1 I      1 I      2 I      0 I      1 I      6
  AFTER              I   16.7 I   16.7 I   16.7 I   33.3 I    0.0 I   16.7 I   14.3
                     I    5.3 I    8.3 I   25.0 I   66.7 I    0.0 I   33.3 I
                     I    2.4 I    2.4 I    2.4 I    4.8 I    0.0 I    2.4 I
                    -I--------I--------I--------I--------I--------I--------I
                   4 I      3 I      4 I      0 I      1 I      0 I      1 I      9
  UNKNOWN            I   33.3 I   44.4 I    0.0 I   11.1 I    0.0 I   11.1 I   21.4
                     I   15.8 I   33.3 I    0.0 I   33.3 I    0.0 I   33.3 I
                     I    7.1 I    9.5 I    0.0 I    2.4 I    0.0 I    2.4 I
                    -I--------I--------I--------I--------I--------I--------I
              COLUMN       19       12        4        3        1        3       42
               TOTAL     45.2     28.6      9.5      7.1      2.4      7.1    100.0

RAW CHI SQUARE =    22.80257 WITH    15 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0884
```

TABLE 11.26

Crosstabulation of Flaking by Material for Point Group 26

```
                      V19
             COUNT   I
             ROW PCT IOOLITIC  BANDED   X-BANDED BURLNGTN OTHER    CHOTEAU    ROW
             COL PCT ICHERT    CHERT     CHERT    CHERT   CHERT    CHERT      TOTAL
             TOT PCT I      2 I      3 I      4 I      5 I      7 I      9 I
V17          --------I--------I--------I--------I--------I--------I--------I
                   3 I      0 I      6 I      0 I      0 I      0 I      1 I      7
  TYPE 3  PRESSURE   I    0.0 I   35.7 I    0.0 I    0.0 I    0.0 I   14.3 I   35.0
                     I    0.0 I   50.0 I    0.0 I    0.0 I    0.0 I   50.0 I
                     I    0.0 I   30.0 I    0.0 I    0.0 I    0.0 I    5.0 I
                    -I--------I--------I--------I--------I--------I--------I
                   4 I      1 I      1 I      0 I      0 I      0 I      1 I      3
  TYPE 4  PRESSURE   I   33.3 I   33.3 I    0.0 I    0.0 I    0.0 I   33.3 I   15.0
                     I   20.0 I   10.0 I    0.0 I    0.0 I    0.0 I   50.0 I
                     I    5.0 I    5.0 I    0.0 I    0.0 I    0.0 I    5.0 I
                    -I--------I--------I--------I--------I--------I--------I
                   7 I      1 I      0 I      0 I      0 I      0 I      0 I      1
  TYPE 5  PERCUSN    I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    5.0
                     I   20.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    5.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I
                   9 I      1 I      0 I      0 I      0 I      0 I      0 I      1
  TYPE 6  PERCUSN    I  100.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    5.0
                     I   20.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                     I    5.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I
                  10 I      2 I      3 I      0 I      1 I      1 I      0 I      7
  COMBINED           I   28.6 I   42.9 I    0.0 I   14.3 I   14.3 I    0.0 I   35.0
                     I   40.0 I   30.0 I    0.0 I  100.0 I  100.0 I    0.0 I
                     I   10.0 I   15.0 I    0.0 I    5.0 I    5.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I
                  11 I      0 I      0 I      1 I      0 I      0 I      0 I      1
  FLUTING            I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I    5.0
                     I    0.0 I    0.0 I  100.0 I    0.0 I    0.0 I    0.0 I
                     I    0.0 I    0.0 I    5.0 I    0.0 I    0.0 I    0.0 I
                    -I--------I--------I--------I--------I--------I--------I
              COLUMN        5       10        1        1        1        2       20
               TOTAL     25.0     50.0      5.0      5.0      5.0     10.0    100.0

RAW CHI SQUARE =    35.61999 WITH    25 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0776
```

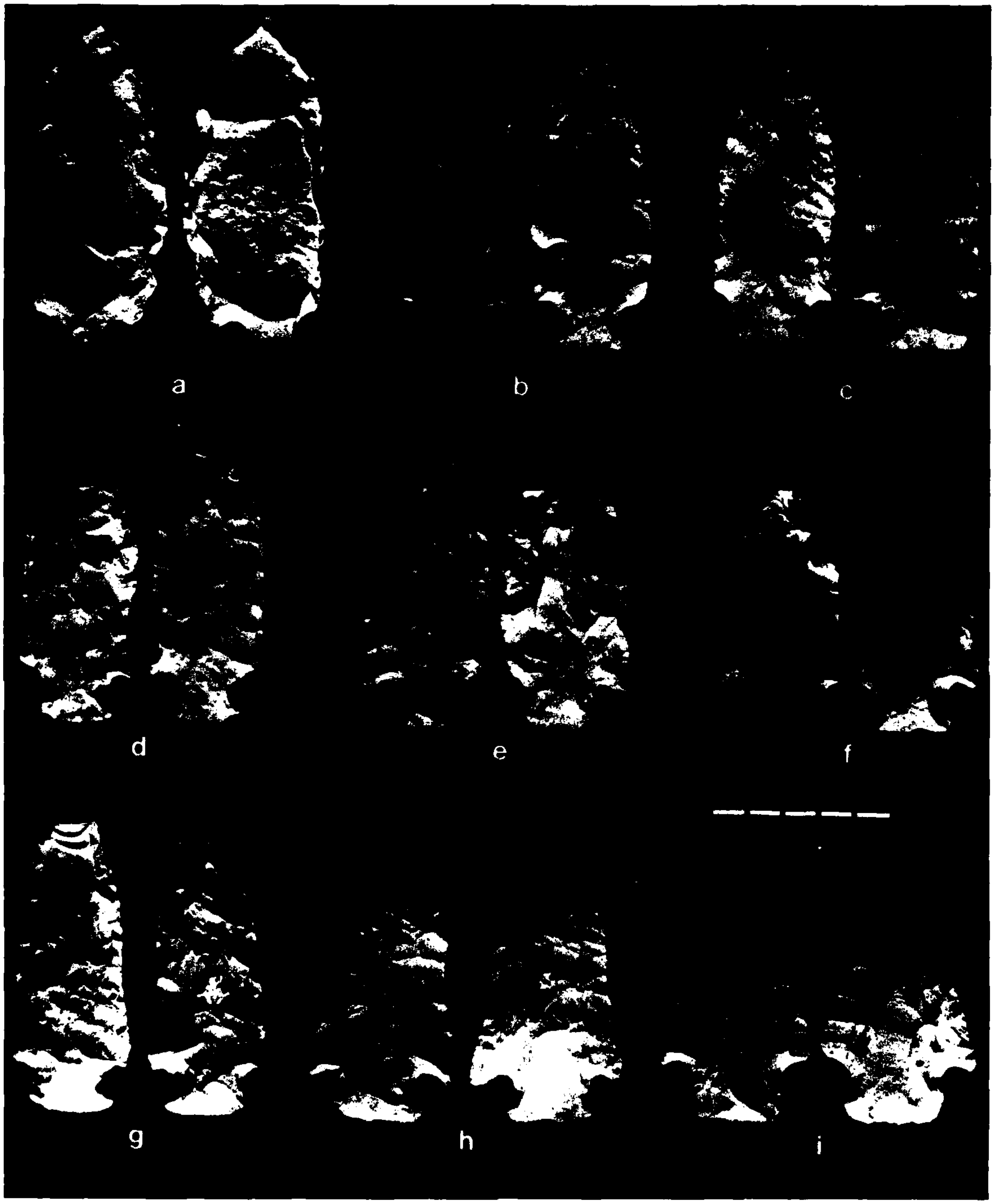

Figure 11.22. Category 50 (Etley). Note specimen a. is a preform. Scale in cm.

grinding rarely occur. Their overall form is ambiguous and no one element appears to be more indicative of style. Representative examples are illustrated in Figure 11.23.

FLARED BASE

Category 26: Johnson

FUNCTION:	Projectile point	
FORM:	expanding stem point with concave, highly flaring base	
	Blade edges:	asymmetric and generally excurvate, sometimes serrated
	Shoulders:	angular to sub-rounded; maximum width of blade
	Notches:	shallow, elongate and rounded
	Stem:	straight but markedly flaring at the base
	Base:	concave with angular stem juncture. Often the haft element is asymmetric.
	Grinding:	basal grinding is common.
FLAKING:	Blade:	consistently high quality bifacial percussion thinning produced thin, well controlled flake scars that extend across one-half to two-thirds of the blade width. Often these flake scars are completely removed by subsequent bifacial pressure flaking which resulted in mainly transverse flake scars. Little, if any, of the flake preform surfaces remain. Edge shaping or resharpening was accomplished primarily by continuous bifacial pressure flaking, resulting in a characteristically steep or beveled appearance. This is also true of the basal edges and presumably represents a final pressure flake edge preparation for the blade and haft elements. A single specimen is unifacially resharpened by alternating, right lateral pressure flaking.
	Base:	Thinned by percussion flaking with flake scars extending across the haft element. One specimen is bifacially fluted. For most specimens, however, the deep basal concavity was produced by relatively steep, bifacial pressure flaking, resulting in a beveled basal edge.
HEAT TREATMENT:		23 of the 24 specimens were heated prior to manufacture
DIMENSIONS:	Length:	51-68 mm
	Width:	20-36 mm
	Thickness:	6-10 mm

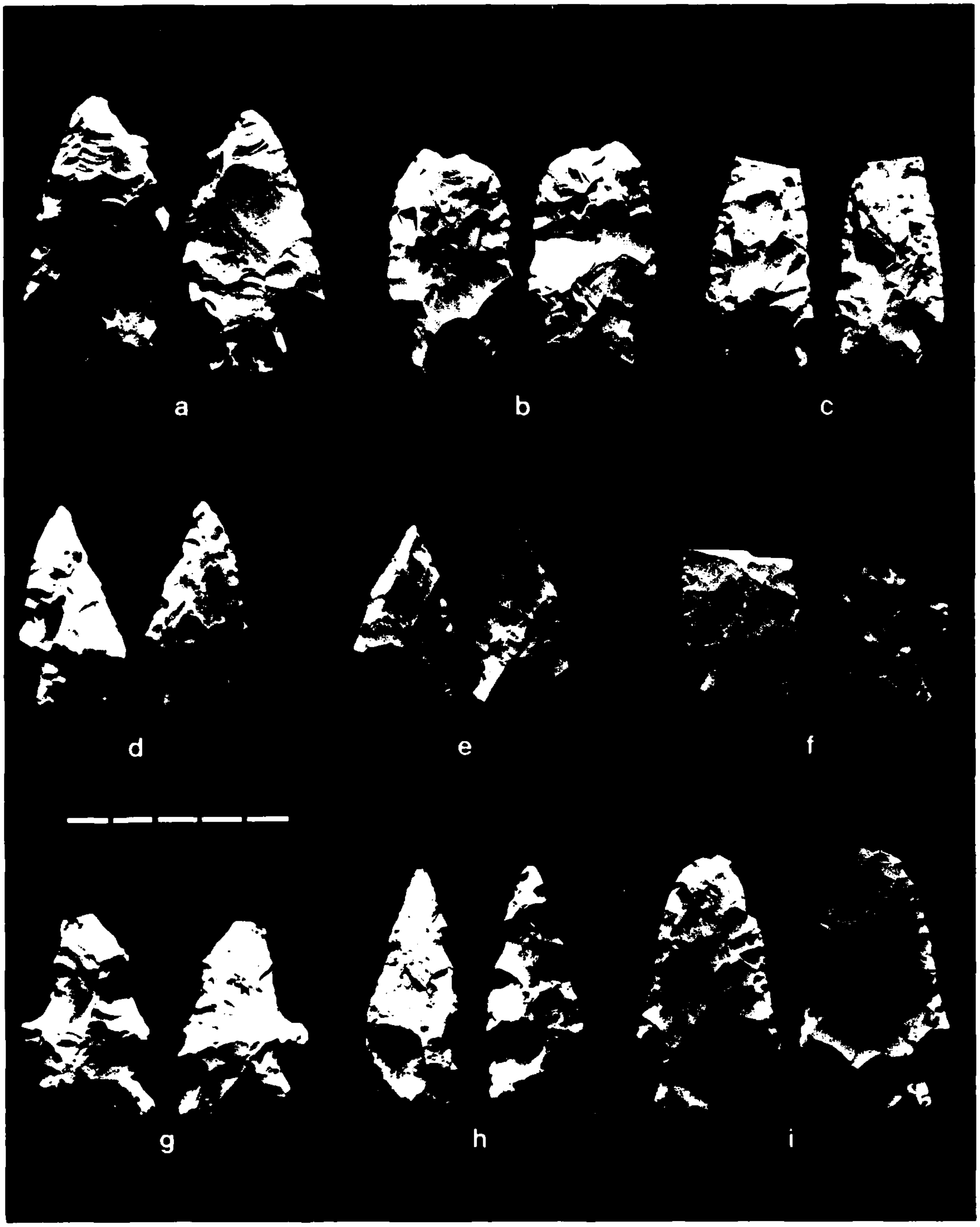

Figure 11.23. Category 25, corner notched points. Scale in cm.

AGE OR HORIZON: Early and Middle Archaic

REFERENCES: Bartlett 1962:28-29; Ahler 1971:13; C. Chapman 1975:250-251

Chi squares and associated probabilities are insignificant and confirm the null hypothesis. Nonetheless, the crosstabulations of flaking by material (Table 11.26) is suggestive of a systematic relationship (P = 0.0776) among various types of pressure and percussion flaking and specific materials. In both flaking and outline, these specimens are very distinctive (Figure 11.24) and are similar to Benton Stemmed (Kneberg 1956:25-26) from Tennessee.

Category 34: Lecroy

FUNCTION: Hafted cutting tool

FORM: straight stemmed point with a bifurcated base and triangular blade
- Blade edges: excurvate and serrated: symmetrical
- Shoulders: angular but unbarbed; maximum point width
- Base: highly concave with a straight stem

FLAKING: for the two specimens for which observations could be made, flaking is either random bifacial pressure flaking or a combination of well controlled percussion and pressure flaking, with continuous secondary pressure flaking of blade edges.

HEAT TREATMENT: 2 of the 3 specimens were heated prior to manufacture; the third was heated after manufacture and reworked.

DIMENSIONS:
- Length: 47 mm (one specimen only)
- Width: 25-34 mm
- Thickness: 6- 7 mm

AGE OR HORIZON: Middle Archaic

REFERENCES: Lewis and Kneberg 1955:79-81; Kneberg 1956:27-28; Bell 1960:64-65; Broyles 1966:26-27, 1971:69; J. Chapman 1975:106-108.

The Lecroy specimens small sizes combined with highly bifurcated bases and serrated triangular blades, produce a highly distinctive form. It would seem likely that blade elements of the Rodgers Shelter Lecroy points are all reworked, perhaps repeatedly, although blade fracture has partially obscured this on two of the three specimens. Representative examples are illustrated in Figure 11.25a-b.

Category 35: Jackie Stemmed

FUNCTION: Hafted cutting tool

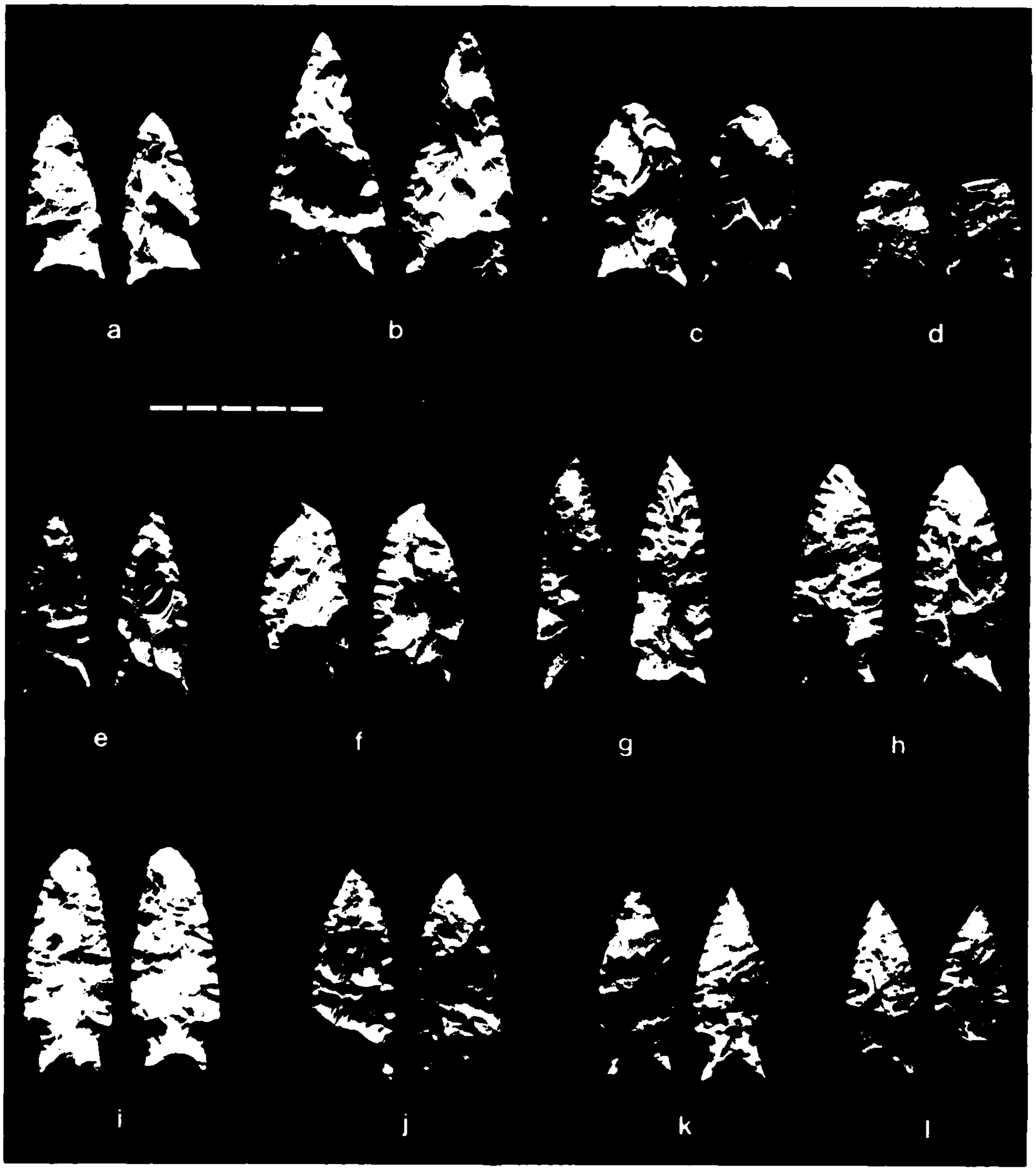

Figure 11.24. Category 26 (Johnson). Scale in cm.

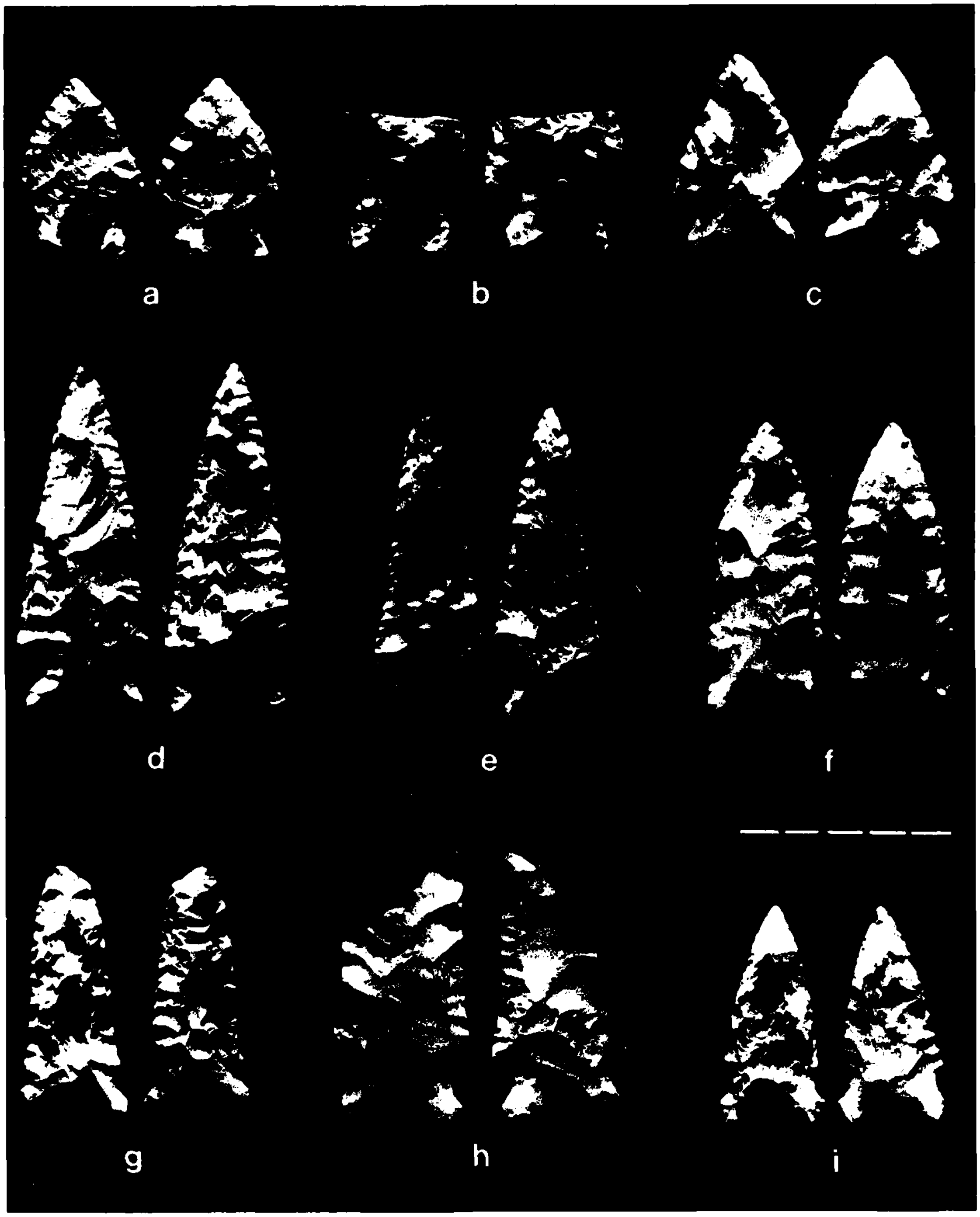

Figure 11.25. Flared base points: a,b, Category 34 (Lecroy); c-e, Category 35 (Jackie Stemmed); f-i, Category 36 (Graham Cave). Scale in cm.

FORM:	symmetrical, expanding stem point with highly concave base	
	Blade edges:	straight, sometimes serrated
	Shoulders:	angular but unbarbed; maximum point width
	Notches:	open U-shaped
	Base:	highly concave with an expanding stem
	Grinding:	1 of the 3 specimens is basally ground
FLAKING:	Blade:	initial blade shaping was bifacial percussion flaking that resulted in an amorphous pattern of well controlled flake scars extending across the blade width. Edge resharpening or final shaping involved well controlled percussion flaking, resulting in generally continuous parallel flake scars. One specimen is unifacially resharpened and has an alternating right lateral bevel.
	Notches:	bifacially worked
	Base:	thinned by well controlled parallel pressure flaking
HEAT TREATMENT:		2 of the 3 specimens were heated prior to manufacture
DIMENSIONS:	Length;	77-83 mm
	Width:	26-31 mm
	Thickness:	5- 9 mm
AGE OR HORIZON:		Early Archaic
REFERENCES:		Marshall 1960:46-47, cited by C. Chapman 1975:251

The few Jackie Stemmed points from Rodgers Shelter are highly similar in general shape to the Graham Cave points, which are discussed next, but tend to be longer and narrower in overall proportions as well as having a rounded stem-base juncture. Representative examples are illustrated in Figure 11.25c-e.

Category 36: Graham Cave

FUNCTION:	Multipurpose	
FORM:	side notched point with a concave base and triangular blade	
	Blade edges:	symmetrical and straight to incurvate-excurvate, occasionally serrated or highly beveled
	Shoulders:	angular but unbarbed; maximum width of point
	Notches:	diagonally side notched with open U-shaped notches
	Base:	highly concave with an expanding stem. A diagnostic feature is the stem edges are almost square below the notches
	Grinding:	basal grinding is common

FLAKING: Blade: initial blade preparation was by well controlled bifacial percussion flaking, with resulting flake scars parallel and extending across the blade width. There are no remnant flake preform surfaces. All specimens have pronounced blade edge resharpening that often obscures the initial preparation scars and results in an accentuated bevel or serrations. Resharpening was by well controlled bifacial pressure flaking, and flake scars are generally continuous and parallel.
Notches: bifacially flaked
Base: all specimens are thinned by parallel pressure flaking; a single specimen is fluted on one side of the base

HEAT TREATMENT: 7 of the 11 specimens were heated prior to manufacture

DIMENSIONS: Length: 54-75 mm
Width: 25-36 mm
Thickness: 7-10 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Scully 1951:8; Logan 1952:31, 32; Perino 1968:28-29; Ahler 1971:13; C. Chapman 1975: 248-249

Crosstabulations of the nominal data confirm the null hypothesis, and it can be assumed that variation in material selection, manufacture and tool use are no more than would be expected by chance. In addition to being resharpened, three specimens have distal impact fractures and it would seem likely that most Graham Cave points served as both cutting tools and projectiles. Serrated blades are most common on specimens with recurvate edges, probably the product of successive attempts to resharpen the blade. It would seem that blade serration for Graham Cave points is more a functional prerequisite than a stylistic feature. Representative examples are illustrated in Figure 11.25.

Category 40

FUNCTION: Projectile point

FORM: expanding stem point with convex base
Blade edges: excurvate, occasionally serrated
Shoulders: angular with diminutive barb, maximum point width
Notches: circular or open U-shaped
Base: convex with small expanding stem
Grinding: basal grinding infrequent

FLAKING: Blade: initial blade preparation was by bifacial percussion flaking that produced an amorphous

but controlled set of thin flake scars variably extending across from one-half to the entire blade width. Subsequent bifacial pressure flaking is bilateral with transverse flake scars extending roughly about the blade midline, forming a subdued ridge
Notches: bifacially flaked
Base: thinned by either unifacial or bifacial pressure flaking

HEAT TREATMENT: 7 of the 8 specimens available for study were heated prior to manufacture

DIMENSIONS: Length: 51-75 mm
Width: 26-33 mm
Thickness: 7- 8 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Ahler 1971:10

Intuitively, there appears to be little difference among any of the specimens, although two have distal impact fractures. Their closest similarity is to the coeval Johnson points (Category 26) but Category 40 points generally do not exhibit pronounced basal flaring; bases being mainly straight or convex. This category could have been included as easily with the corner notched series, but it was felt that their overall form, if not basal configuration, resembled more closely the flared base series. Representative examples are illustrated in Figure 11.26.

OVATE

Category 5

FUNCTION: Indeterminate

FORM: Ovate
Blade edges: excurvate
Base: rounded and without a clear blade-base juncture

FLAKING: either random percussion or pressure flaking; flake preform ridges remain on the midlines of the two specimens

HEAT TREATMENT: 1 of the 2 specimens was heated prior to manufacture

DIMENSIONS: Length: 46 mm (one specimen only)
Width: 19 mm
Thickness: 4- 5 mm

AGE OR HORIZON: Late Archaic or Woodland

One specimen is illustrated in Figure 11.27.

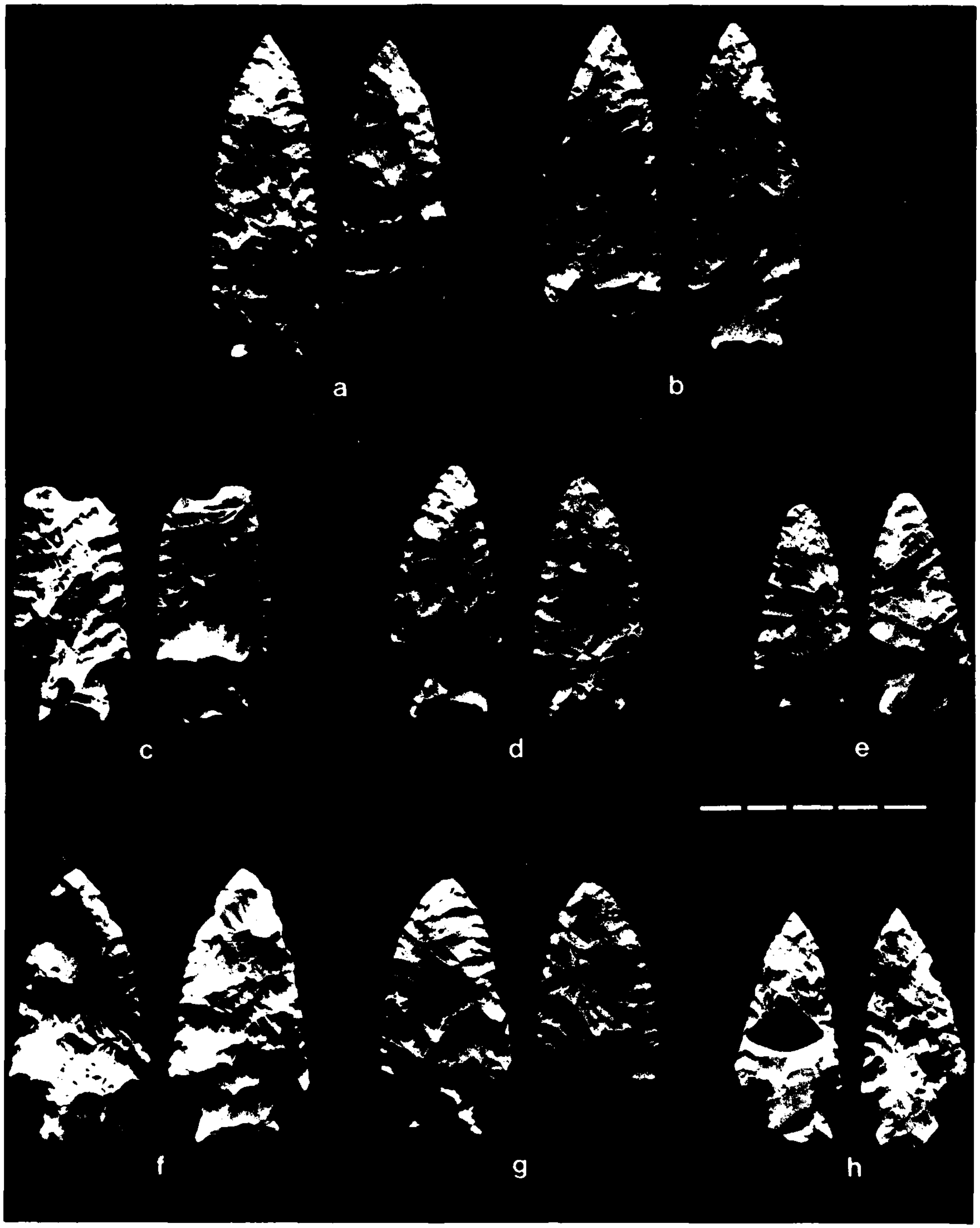

Figure 11.26. Category 40 points. Scale in cm.

Figure 11.27. Ovate points: a, Category 5; b-j, Category 20. Scale in cm.

Category 20

FUNCTION:	Projectile point	
FORM:	ovate or leaf-shaped lanceolate	
	Blade edges:	excurvate and symmetrical, occasionally serrated
	Base:	rounded but with a perceptible blade juncture; the maximum width is approximately at this juncture
	Grinding:	basal grinding infrequent
FLAKING:		consistent fine transverse bifacial percussion and pressure flaking with flake scars generally extending across more than half of the blade width. Flake preform remnants are restricted to cortex at the base of 2 specimens. Basal thinning appears to be not a separate, or later, phase of the manufacturing sequence.
HEAT TREATMENT:		13 of the 14 specimens were heated prior to manufacture
DIMENSIONS:	Length:	55-84 mm
	Width:	26-38 mm
	Thickness:	7- 9 mm
AGE OR HORIZON:		Middle Archaic

Chi squares and associated probabilities are insignificant and confirm the null hypothesis that differences in material selection, point manufacture or use are no more than would be expected by chance. Rodgers Shelter specimens are roughly of two distinct forms: a smaller one with a relatively broad base and a larger, more elongate shape. The smaller ones are generally impact fractured; transverse or oblique fractures also occur. The larger elongate specimens generally are not fractured and some appear to have been resharpened. Practically all of these ovate forms are heat treated and have well executed flaking which produced a consistently thin biface. Representative examples are illustrated in Figure 11.27b-j.

LANCEOLATE

Category 17: Sedalia

FUNCTION:	Multipurpose	
FORM:	concave base lanceolate with excurvate blade	
	Blade edges:	excurvate; maximum width of point at either blade base juncture or on the blade at approximately one-half the total length
	Base:	concave with angular stem juncture. The stem is slightly incurvate
	Grinding:	basal grinding is common

FLAKING: Blade: The narrower specimens have bifacial colateral parallel percussion flaking with flake scars terminating in a subdued medial ridge. The broader specimens have bifacial percussion flaking with flake scars extending about one-third across the blade width; leaving a more-or-less extensive remnant flake preform surface. Blade edges are pressure flaked.

Base: bifacially thinned by pressure flaking; stem edges are marginally pressure flaked into incurvate form.

HEAT TREATMENT: 1 of 10 specimens was heated prior to manufacture

DIMENSIONS: Length: 80-105 mm
Width: 29- 38 mm
Thickness: 9- 13 mm

AGE OR HORIZON: Late Archaic

REFERENCES: Seelen 1961:307, cited by Perino 1968:86-87; C. Chapman 1975:255-256

Crosstabulations of the nominal data confirm the null hypothesis that variation in material selection, manufacture and use of Rodgers Shelter Sedalia lanceolates is no more than would be expected by chance. Although statistically insignificant, the relationship between blade fracture and cross section (P = 0.0671; Table 11.27) is potentially indicative of functional and manufacturing differences associated with one blade shape or another. Impact fractures occur only on biconvex blades, as do transverse fractures which also occur on plano-convex blades or blades with an irregular cross section. Relative to the other Rodgers Shelter lanceolates, the Sedalia forms exhibit a cruder appearance and many appear to be unfinished specimens broken in manufacture. Representative examples are illustrated in Figure 11.28.

Category 18: Rice Lanceolate

FUNCTION: Multipurpose

FORM: concave base lanceolate
Blade edges: straight to excurvate, often serrated
Base: concave with an angular stem juncture; stem is occasionally constricted but generally follows the contours of the blade element
Grinding: grinding is common, especially on the basally constricted stem

FLAKING: varies but generally consists of high quality, controlled percussion and pressure flaking. Flake scars generally meet at the midline and on most specimens obscure remnant pre-

TABLE 11.27

Crosstabulation of Fracture by Material for Point Group 17

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * *
   V14        FRACTURE                                                  BY  V18       MATERIAL
CONTROLLING FOR..
   V10        PT GROUP                                                  VALUE..     17  SEDALIA
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
            COUNT  I
          ROW PCT  IOOLITIC  BANDED   X-BANDED BURLNGTN CHOTEAU     ROW
          COL PCT  ICHERT    CHERT     CHERT    CHERT    CHERT     TOTAL
          TOT PCT  I     2  I     3  I     4  I     5  I     8  I
V14       ---------I--------I--------I--------I--------I--------I
                1  I     1  I     1  I     0  I     0  I     0  I     2
  IMPACT           I  50.0  I  50.0  I   0.C  I   0.0  I   0.0  I  22.2
                   I  33.3  I  50.0  I   0.0  I   0.0  I   0.0  I
                   I  11.1  I  11.1  I   0.0  I   0.0  I   0.0  I
                  -I--------I--------I--------I--------I--------I
                2  I     1  I     0  I     1  I     2  I     0  I     4
  TRANS-  VERSE    I  25.0  I   0.0  I  25.C  I  50.C  I   0.0  I  44.4
                   I  33.3  I   0.0  I 1C0.0  I 100.0  I   0.0  I
                   I  11.1  I   0.0  I  11.1  I  22.2  I   0.0  I
                  -I--------I--------I--------I--------I--------I
                4  I     1  I     0  I     0  I     0  I     1  I     2
  IRREG-  ULAR     I  50.0  I   0.0  I   0.0  I   0.0  I  50.0  I  22.2
                   I  33.3  I   0.0  I   0.0  I   0.0  I 100.0  I
                   I  11.1  I   0.0  I   0.C  I   0.0  I  11.1  I
                  -I--------I--------I--------I--------I--------I
                5  I     0  I     1  I     C  I     0  I     0  I     1
  THERMAL          I   0.0  I 100.0  I   0.0  I   0.0  I   0.0  I  11.1
                   I   0.0  I  50.0  I   0.0  I   0.0  I   0.0  I
                   I   0.0  I  11.1  I   0.C  I   0.0  I   0.0  I
                  -I--------I--------I--------I--------I--------I
           CCLUMN        3        2        1        2        1        9
            TOTAL     33.3     22.2     11.1     22.2     11.1    100.0

RAW CHI SQUARE =    12.74999 WITH    12 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.3875
```

TABLE 11.28

Crosstabulation of Fracture by Material for Point Group 18

```
* * * * * * * * * * * * * * * * * * *   C R C S S T A B U L A T I O N   O F   * * * * *
   V14        FRACTURE                                                  BY  V13       MATERIAL
CONTROLLING FOR..
   V10        PT GROUP                                                  VALUE..     18  RICE LANCE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V18
            CCUNT  I
          ROW PCT  IOOLITIC  BANDED   X-BANCED BURLNGTN CHOTEAU     ROW
          COL PCT  ICHERT    CHERT     CHERT    CHERT    CHERT     TOTAL
          TCT PCT  I     2  I     3  I     4  I     5  I     8  I
V14       ---------I--------I--------I--------I--------I--------I
                1  I     5  I     9  I     C  I     1  I     0  I    15
  IMPACT           I  33.3  I  60.0  I   0.0  I   6.7  I   0.0  I  27.8
                   I  38.5  I  40.9  I   0.0  I   7.1  I   0.0  I
                   I   9.3  I  16.7  I   0.0  I   1.9  I   0.0  I
                  -I--------I--------I--------I--------I--------I
                2  I     5  I     9  I     1  I    10  I     0  I    25
  TRANS-  VERSE    I  20.0  I  36.0  I   4.0  I  40.0  I   0.0  I  46.3
                   I  38.5  I  40.9  I  33.3  I  71.4  I   0.0  I
                   I   9.3  I  16.7  I   1.9  I  18.5  I   0.0  I
                  -I--------I--------I--------I--------I--------I
                3  I     2  I     2  I     1  I     1  I     0  I     6
  OBLIQUE          I  33.3  I  33.3  I  16.7  I  16.7  I   0.0  I  11.1
                   I  15.4  I   9.1  I  33.3  I   7.1  I   0.0  I
                   I   3.7  I   3.7  I   1.9  I   1.9  I   0.0  I
                  -I--------I--------I--------I--------I--------I
                5  I     1  I     2  I     1  I     2  I     2  I     8
  THERMAL          I  12.5  I  25.0  I  12.5  I  25.0  I  25.0  I  14.8
                   I   7.7  I   9.1  I  33.3  I  14.3  I 100.0  I
                   I   1.9  I   3.7  I   1.9  I   3.7  I   3.7  I
                  -I--------I--------I--------I--------I--------I
           CCLUMN       13       22        3       14        2       54
            TOTAL     24.1     40.7      5.6     25.9      3.7    100.0

RAW CHI SQUARE =    22.16341 WITH    12 DEGREES CF FREEDOM.  SIGNIFICANCE =  0.0357
```

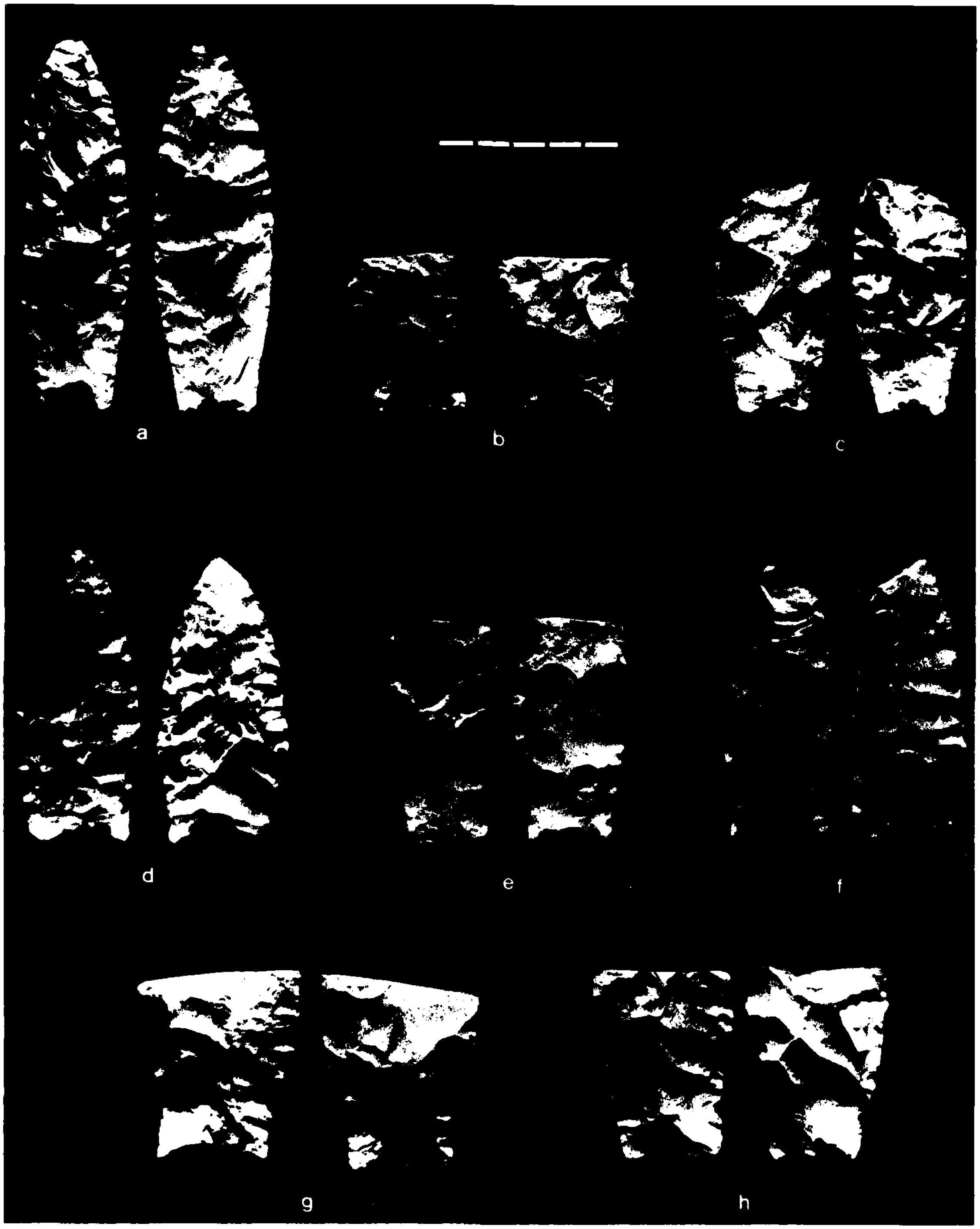

Figure 11.28. Sedalia lanceolates, Category 17. Scale in cm.

form surfaces. Bases are thinned bifacially and at least one specimen has been basally reworked.

HEAT TREATMENT: 52 of the 65 specimens available for study were heated prior to manufacture; 2 others were heated after manufacture and then reworked.

DIMENSIONS: Length: 44-95 mm
Width: 20-34 mm
Thickness: 7-10 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Bray 1956:80-81; Perino 1968:84-85; Ahler 1971:17-18; C. Chapman 1975:253-254.

Crosstabulations confirm the null hypothesis as it pertains to material selection and subsequent flaking or heat treatment, which is to say that differences in manufacture are negligible for the Rodgers Shelter Rice Lanceolate sample. Significant variation is recorded, however, in the relationship between material and blade fracture (P = 0.0357; Table 11.28), and blade cross section and serration-grinding (P = 0.0324; Table 11.29); some importance might well be placed on the relationship between blade cross section and fracture (P = 0.0717; Table 11.30). In sum, significant or near significant variation is recorded for what appears to be use related attributes applied either to a specific material (i.e., oolitic and banded Jefferson City or Burlington chert for impact fractured specimens) or cross sectional shape. With respect to the crosstabulation of blade cross section and serration-grinding probably some importance should be placed in comparing specimens having serrated blades and ground bases with those that have only ground haft elements. For the most part, the two point forms have similar blade cross sections and the variable occurrence of serrations might well relate to progressive blade wear on unserrated specimens. Impact fractures occur on fifteen specimens and thirty-one others have either transverse or oblique fractures. Eight others are thermally (heat) fractured. Of the complete or near complete specimens, blade edges appear to be frequently resharpened, resulting in progressive changes in the blade configuration that ranges from nearly parallel sided blades to tear-drop shaped blades. A second name in common usage for the Rice Lanceolates is Searcy (Perino 1968:84-85); representative examples are illustrated in Figures 11.29 and 11.30.

Category 19: Rodgers

FUNCTION: Projectile point

FORM: straight based symmetrical lanceolate
Blade edges: straight to excurvate
Base: straight to slightly convex and with a square basal stem juncture. Stem constricts perceptibly from the blade.

TABLE 11.29

Crosstabulation of Serration-grinding by Blade Cross Section by Fracture for Point Group 18

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * *
   V24       SERATION-GRINDING                                  BY  V11       BLADE XSECTION
CONTROLLING FOR..
   V10       PT GROUP                                           VALUE..    18   RICE LANCE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    V11
             COUNT  I
           ROW PCT  IBIPLANO  TRIANGUL BICONVEX LENTICUL PLANO-CO ALTERNAT IRREGULA   ROW
           COL PCT  I         AR                AR       NVEX     E BEVEL  R          TOTAL
           TOT PCT  I     1  I     2  I     4  I     5  I     6  I     9  I    11  I
V24         --------I--------I--------I--------I--------I--------I--------I--------I
                  1 I     4  I     0  I     1  I     1  I     0  I     0  I     0  I      6
  SERATED&GROUND    I  66.7  I   0.0  I  16.7  I  16.7  I   0.0  I   0.0  I   0.0  I   10.0
                    I  33.3  I   0.0  I   4.2  I  20.0  I   0.0  I   0.0  I   0.0  I
                    I   6.7  I   0.0  I   1.7  I   1.7  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  2 I     0  I     0  I     3  I     0  I     0  I     0  I     0  I      3
  SERATED STGROUND  I   0.0  I   0.0  I 100.0  I   0.0  I   0.0  I   0.0  I   0.0  I    5.0
                    I   0.0  I   0.0  I  12.5  I   0.0  I   0.0  I   0.0  I   0.0  I
                    I   0.0  I   0.0  I   5.0  I   0.0  I   0.0  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  4 I     0  I     0  I     0  I     0  I     1  I     0  I     0  I      1
  SERATED BLADE     I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I   0.0  I   0.0  I    1.7
                    I   0.0  I   0.0  I   0.0  I   0.0  I  12.5  I   0.0  I   0.0  I
                    I   0.0  I   0.0  I   0.0  I   0.0  I   1.7  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  5 I     7  I     3  I     7  I     2  I     2  I     1  I     1  I     23
  GROUND HAFT       I  30.4  I  13.0  I  30.4  I   8.7  I   8.7  I   4.3  I   4.3  I   38.3
                    I  58.3  I  75.0  I  29.2  I  40.0  I  25.0  I  33.3  I  25.0  I
                    I  11.7  I   5.0  I  11.7  I   3.3  I   3.3  I   1.7  I   1.7  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  6 I     0  I     1  I     5  I     1  I     4  I     0  I     0  I     11
  STEM      GROUND  I   0.0  I   9.1  I  45.5  I   9.1  I  36.4  I   0.0  I   0.0  I   18.3
                    I   0.0  I  25.0  I  20.8  I  20.0  I  50.0  I   0.0  I   0.0  I
                    I   0.0  I   1.7  I   8.3  I   1.7  I   6.7  I   0.0  I   0.0  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  7 I     0  I     0  I     0  I     0  I     0  I     0  I     1  I      1
  BASE      GROUND  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I 100.0  I    1.7
                    I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I  25.0  I
                    I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   0.0  I   1.7  I
                   -I--------I--------I--------I--------I--------I--------I--------I
                  8 I     1  I     0  I     8  I     1  I     1  I     2  I     2  I     15
  NEITHER OBSERVED  I   6.7  I   0.0  I  53.3  I   6.7  I   6.7  I  13.3  I  13.3  I   25.0
                    I   8.3  I   0.0  I  33.3  I  20.0  I  12.5  I  66.7  I  50.0  I
                    I   1.7  I   0.0  I  13.3  I   1.7  I   1.7  I   3.3  I   3.3  I
                   -I--------I--------I--------I--------I--------I--------I--------I
            COLUMN        12        4       24        5        8        3        4      60
             TOTAL      20.0      6.7     40.0      8.3     13.3      5.0      6.7   100.0

RAW CHI SQUARE       53.13947 WITH    36 DEGREES OF FREEDOM.  SIGNIFICANCE = 0.0324
```

TABLE 11.30

Crosstabulation of Blade Cross Section by Fracture for Point Group 18

```
* * * * * * * * * * * * * * * * * * *  C R O S S T A B U L A T I O N   O F  * * * * *
   V11      BLADE XSECTION                                        BY  V14       FRACTURE
CONTROLLING FOR..
   V10      PT GROUP                                              VALUE..   18   RICE LANCE
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      V14
             COUNT   I
             ROW PCT IIMPACT    TRANS-    OBLIQUE  THERMAL      ROW
             COL PCT I          VERSE                           TOTAL
             TOT PCT I       1 I       2 I       3 I       5 I
V11          --------I--------I--------I--------I--------I
                   1 I       3 I       2 I       4 I       1 I      10
  BIPLANO            I    30.0 I    20.0 I    40.0 I    10.0 I    20.0
                     I    21.4 I     8.7 I    80.0 I    12.5 I
                     I     6.0 I     4.0 I     8.0 I     2.0 I
                    -I--------I--------I--------I--------I
                   2 I       0 I       3 I       0 I       0 I       3
  TRIANGULAR         I     0.0 I   100.0 I     0.0 I     0.0 I     6.0
                     I     0.0 I    13.0 I     0.0 I     0.0 I
                     I     0.0 I     6.0 I     0.0 I     0.0 I
                    -I--------I--------I--------I--------I
                   4 I       6 I      11 I       1 I       3 I      21
  BICONVEX           I    28.6 I    52.4 I     4.8 I    14.3 I    42.0
                     I    42.9 I    47.8 I    20.0 I    37.5 I
                     I    12.0 I    22.0 I     2.0 I     6.0 I
                    -I--------I--------I--------I--------I
                   5 I       1 I       2 I       0 I       1 I       4
  LENTICULAR         I    25.0 I    50.0 I     0.0 I    25.0 I     8.0
                     I     7.1 I     8.7 I     0.0 I    12.5 I
                     I     2.0 I     4.0 I     0.0 I     2.0 I
                    -I--------I--------I--------I--------I
                   6 I       4 I       4 I       0 I       1 I       9
  PLANO-CONVEX       I    44.4 I    44.4 I     0.0 I    11.1 I    18.0
                     I    28.6 I    17.4 I     0.0 I    12.5 I
                     I     9.0 I     8.0 I     0.0 I     2.0 I
                    -I--------I--------I--------I--------I
                  11 I       0 I       1 I       0 I       2 I       3
  IRREGULAR          I     0.0 I    33.3 I     0.0 I    66.7 I     6.0
                     I     0.0 I     4.3 I     0.0 I    25.0 I
                     I     0.0 I     2.0 I     0.0 I     4.0 I
                    -I--------I--------I--------I--------I
              COLUMN        14        23         5         8       50
               TOTAL      28.0      46.0      10.0      16.0    100.0

RAW CHI SQUARE =    23.62924 WITH    15 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0717
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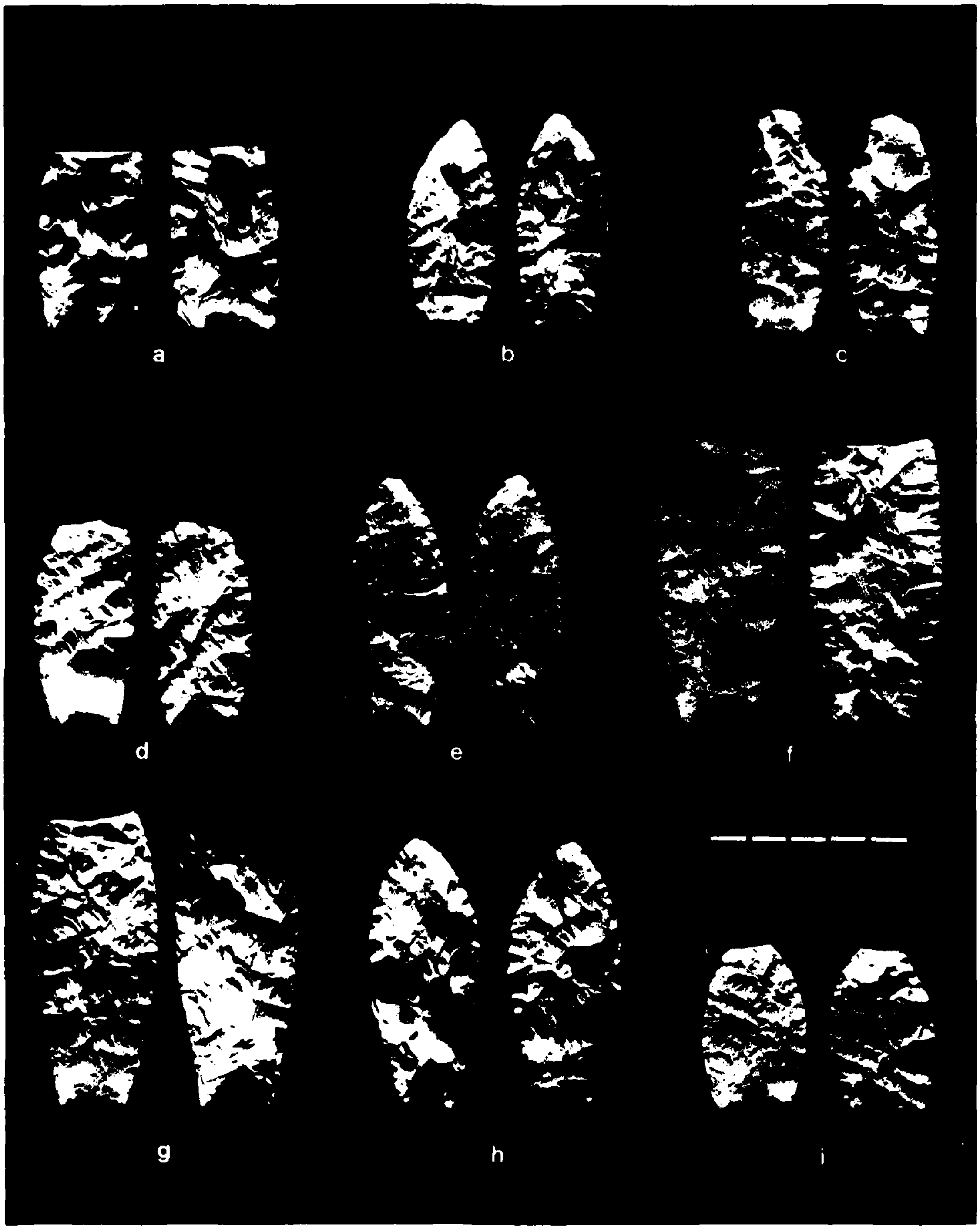

Figure 11.29. Rice lanceolates (Category 18). Scale in cm.

Figure 11.30. Rice lanceolates (Category 18). Scale in cm.

Grinding: basal grinding is common.

FLAKING: flaking is almost uniformly high quality percussion and pressure work, with flake scars often extending across the blade. Remnant preform surfaces rarely occur. Blade edges generally have secondary pressure flaking and flake scars are continuous and parallel. Basal thinning is bifacial pressure flaking.

HEAT TREATMENT: 18 of the 21 specimens were heated prior to manufacture

DIMENSIONS: Length: 62-84 mm
Width: 15-28 mm
Thickness: 6- 8 mm

AGE OR HORIZON: Early to Middle Archaic

REFERENCES: Wormington 1957:141-142; Perino 1968:2-3; Ahler 1971:17-18; C. Chapman 1975:241-242.

Crosstabulations of the nominal data confirm the null hypothesis for the Rodgers points; indeed the sample does appear to be highly uniform in terms of consistent quality of flaking, almost universal heat treatment of blanks and basal grinding. There are several contrasts with the site's Rice lanceolates, although these also reflect a similar quality in craftsmanship. The overall proportions of the two lanceolates are different. The Rodgers points are long and slender while the Rice lanceolates are broader. The total length of the Rice lanceolates however, is usually greater. The Rodgers specimens are all unserrated and their bases have a distinctive square shape. Moreover, they exhibit little of the systemic variation of the Rice lanceolates, with the possible exception of the relationship between flaking and material (P = 0.0824; Table 11.31). This relationship reflects potentially important differences in the manufacturing technology, rather than the functional differences of the Rice lanceolates.

Specimens are illustrated in Figure 11.31. "Agate Basin" has been used in describing these points. It may be noted also that use of the term "Agate Basin" is inappropriate as these specimens do not closely follow Wormington's (1957:141) description of horizontal flaking, fine marginal retouch and an absence of basal thinning though they are "long and slender with parallel or slightly convex sides." Frison (pers. comm, 1977) regards only type-site specimens as Agate Basin points, these represent consumate manufacturing skills rarely duplicated by other plains lanceolates, and Frison notes a time frame of ca. 10,000 B.P. for the type site.

Category 10

FUNCTION: Projectile point

FORM: basally fluted, parallel sided lanceolate
Blade edges: straight, one specimen is serrated

TABLE 11.31

Crosstabulation of Flaking by Material for Point Group 19

```
* * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * *
   V17       FLAKING                                                BY  V18      MATERIAL
CONTROLLING FOR..
   V10       PT GROUP                                               VALUE..    19
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                   V18
            COUNT  I
          ROW PCT  IOOLITIC   BANDED    X-BANDED BURLNGTN   ROW
          COL PCT  ICHERT     CHERT      CHERT    CHERT     TOTAL
          TOT PCT  I     2  I      3  I      4  I     5  I
V17       ---------I--------I---------I---------I--------I
                3  I     1  I      1  I      0  I     1  I      3
  TYPE 3  PRESSURE I  33.3  I   33.3  I    0.0  I  33.3  I   33.3
                   I  33.3  I   25.0  I    0.0  I 100.0  I
                   I  11.1  I   11.1  I    0.0  I  11.1  I
                  -I--------I---------I---------I--------I
                7  I     0  I      0  I      1  I     0  I      1
  TYPE 5  PERCUSN  I   0.0  I    0.0  I  100.0  I   0.0  I   11.1
                   I   0.0  I    0.0  I  100.0  I   0.0  I
                   I   0.0  I    0.0  I   11.1  I   0.0  I
                  -I--------I---------I---------I--------I
               10  I     2  I      3  I      0  I     0  I      5
  COMBINED         I  40.0  I   60.0  I    0.0  I   0.0  I   55.6
                   I  66.7  I   75.0  I    0.0  I   0.0  I
                   I  22.2  I   33.3  I    0.0  I   0.0  I
                  -I--------I---------I---------I--------I
           COLUMN        3        4         1        1          9
            TOTAL     33.3     44.4      11.1     11.1      100.0

RAW CHI SQUARE =    11.20000 WITH     6 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0924
```

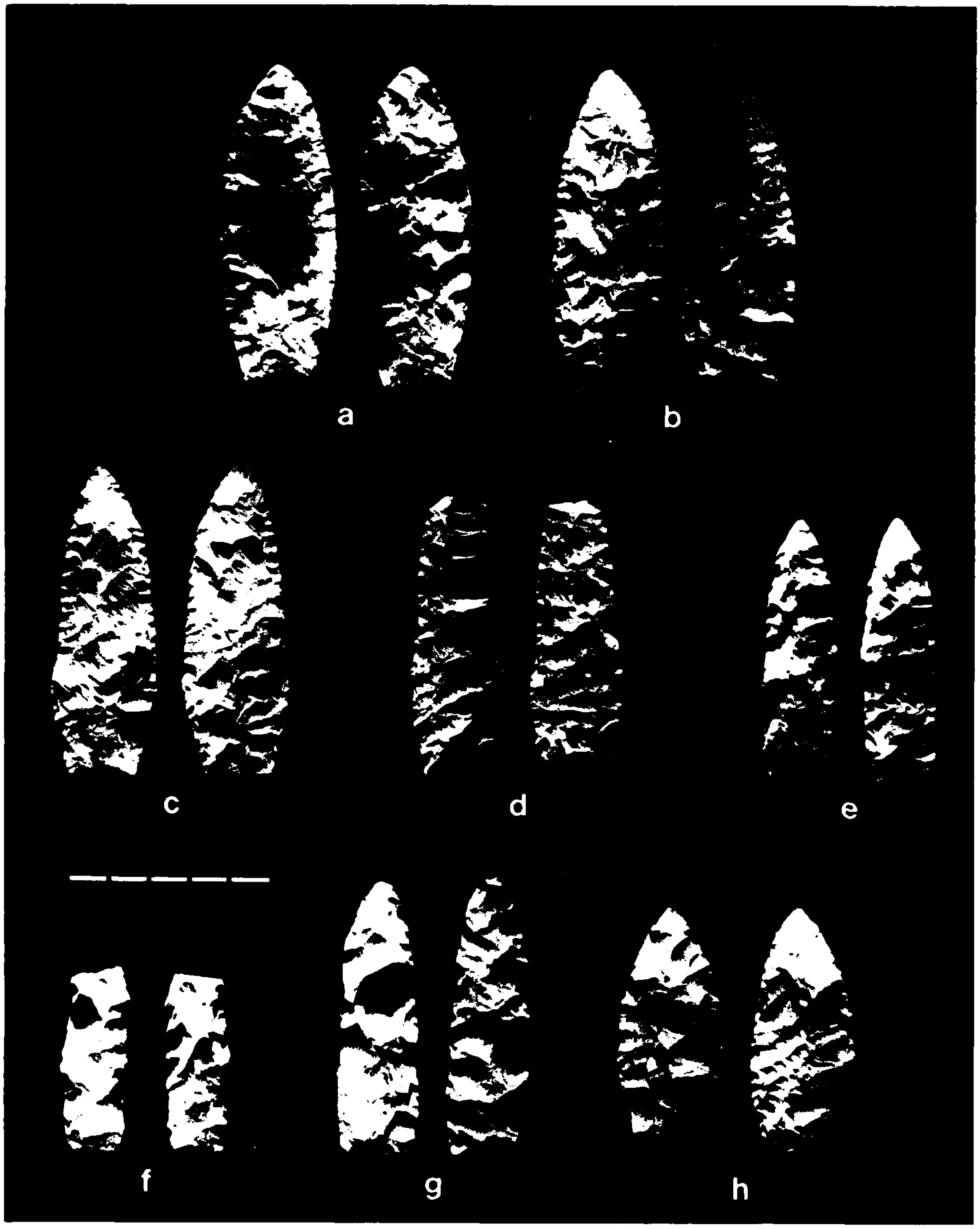

Figure 11.31. Rodgers lanceolates, Category 19. Scale in cm.

Base: concave and generally bifacially fluted and with a square stem
Grinding: basal grinding common

FLAKING: meticulous percussion or pressure flaking of the blade elements of the 3 specimens has resulted in parallel flake scars on the blade. Basal stem is ground and fluting extends from one-half to two-thirds the haft length.

HEAT TREATMENT: 1 of the 3 specimens was heated prior to manufacture; 1 specimen was heated after manufacture and has a distal thermal fracture partially reworked into a graving spur.

DIMENSIONS: Length: 54-78 mm
Width: 21-26 mm
Thickness: 5- 6 mm

AGE OR HORIZON: Dalton Horizon and also the Middle Archaic (one specimen)

REFERENCES: Ahler and McMillan 1976:169

The three specimens have not been labeled as anything beyond fluted lanceolates although, as can be seen in Figure 11.32, they are distinctively reminiscent of Paleo-Indian Llano forms (Willey 1966:36-40), and undisputably are coeval with Dalton points from the site. The one specimen (Figure 11.32j) from a Middle or Early Archaic context is from a shelter area near the contact with the Dalton unit, and it may have been displaced. There are several Dalton-like specimens, however, which also occur in Middle Archaic sediments, described next.

Category 21: Dalton-like

FUNCTION: Hafted cutting tool

FORM: Fluted concave base lanceolate with a steeple-like blade
Blade edges: straight, occasionally serrated and beveled
Base: fluted and highly concave with a ground, square stem

FLAKING: basal fluting is mainly bifacial and extends distally to about the blade juncture. Flaking on the blade element is well controlled percussion and pressure flaking executed before the specimens were fluted. Blade element flake scars are either parallel or transverse, and the blade edges often have continuous secondary parallel pressure flaking.

HEAT TREATMENT: 4 of the 5 specimens were heated prior to manufacture

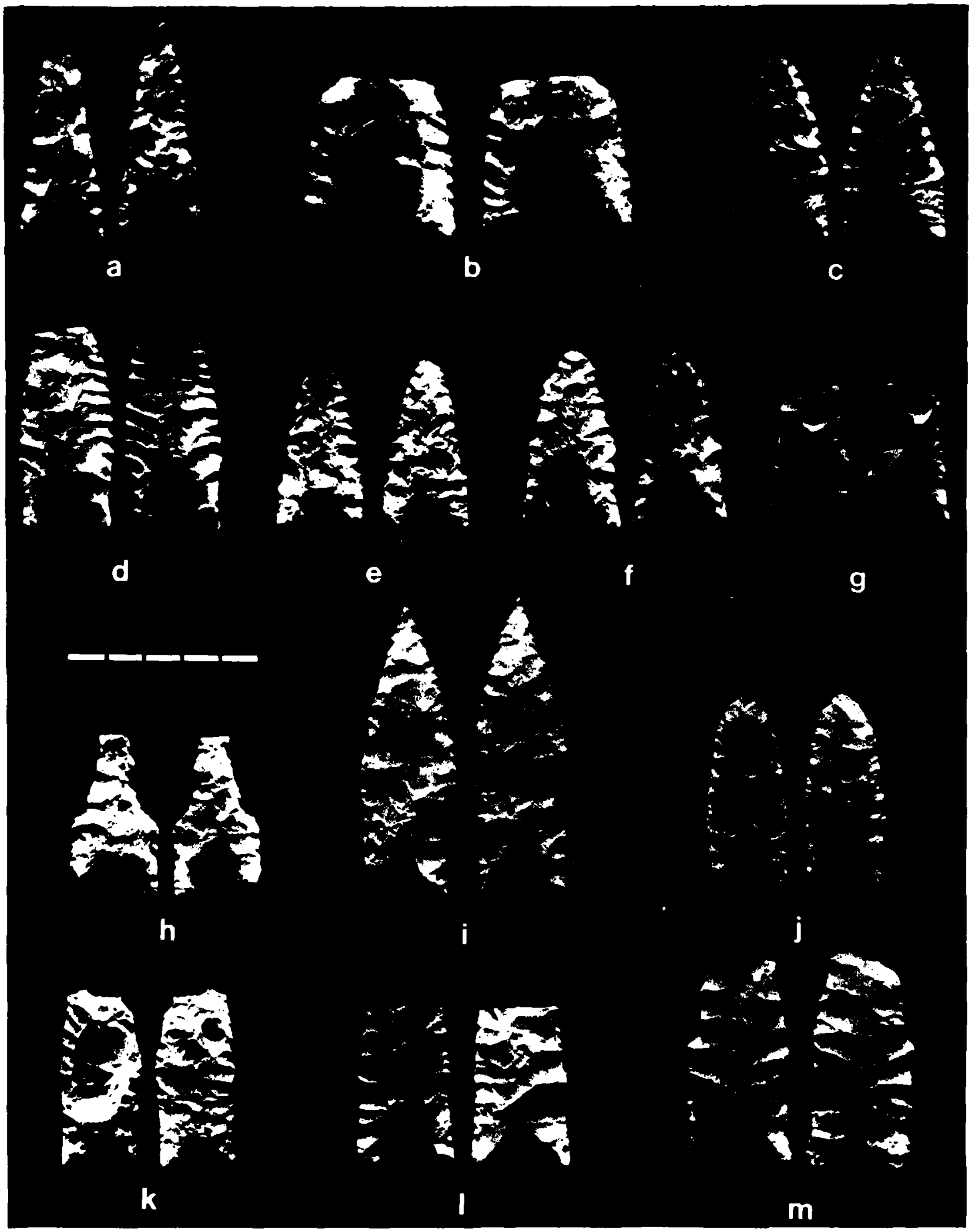

Figure 11.32. Dalton Group points: a-c, Category 21; d-h, Category 22 (Dalton); i-k, Category 10; l-m, Category 23 (Plainview). Scale in cm.

DIMENSIONS: Length: 53-62 mm
Width: 24-41 mm
Thickness: 6- 9 mm

AGE OR HORIZON: Middle Archaic

REFERENCES: Ahler 1971:18

The few Dalton-like specimens are illustrated in Figure 11.32. Ahler (1971:18) suggests that these could be characterized as Meserve points (Bell 1958:52-53), which are found over an extensive midwest area from the Mississippi Valley to the Rocky Mountains. C. Chapman (1975) illustrates numerous similar specimens from Missouri which he describes as Dalton points. We would agree that on a strictly visual basis, it would be nearly impossible to separate these specimens from Dalton or Meserve points, and the main reason for not lumping them with the Dalton specimens is their Middle Archaic stratigraphic context.

Category 22: Dalton

FUNCTION: Hafted cutting tool

FORM: fluted concave base lanceolate
Blade edges: excurvate to highly incurvate, and often serrated
Base: fluted and highly concave with a ground, slightly expanding stem

FLAKING: blade element illustrates meticulous percussion or pressure flaking, resulting in parallel or transverse flake scars and a serrated edge. Subsequent resharpening is evident for several specimens, and repeated attempts apparently led to a highly beveled blade. Initial blade shaping preceded basal fluting.

HEAT TREATMENT: 2 of the 7 specimens were heated prior to manufacture

DIMENSIONS: Length: 48-62 mm (upper range estimated)
Width: 23-26 mm
Thickness: 5- 6 mm

AGE OR HORIZON: Dalton Horizon

REFERENCES: C. Chapman 1948:138, 1975:245-246; Bell 1958: 18-19

Rodgers Shelter Dalton points are illustrated in Figure 11.32d-h. The few specimens are all remarkably similar, especially in basal configuration. Blade edges show progressive use and probably reflect the range of variation seen in other well documented Dalton assemblages (Morse 1973:35; Goodyear 1974:19-39). Goodyear's (1974:29) experimental study of differential edge wear is particularly instructive in this regard; and, as applied to the Rodgers Shelter series, it does suggest that the changes in blade shape from serrated excurvate forms to alternately beveled incurvate forms correlates highly with successive use and blade sharpening. The Dalton points from Rodgers Shelter are all of locally available cherts and one of the specimens may be from chert river gravel.

Category 23: Plainview

FUNCTION:	Projectile point	
FORM:	concave base, parallel sided lanceolate	
	Blade edges:	straight
	Base:	concave with a ground, straight sided stem
FLAKING:		flaking of the blade element is consistently high quality percussion or pressure flaking producing parallel or transverse flake scars. Basal thinning is bifacial and one specimen if fluted.
HEAT TREATMENT:		1 of the 3 specimens was heated prior to manufacture
DIMENSIONS:	Length:	70 mm (estimated)
	Width:	24-28 mm
	Thickness:	6- 7 mm
AGE OR HORIZON:		Dalton Horizon
REFERENCES:		Wormington 1957:107-110, 264-265; Bell 1958: 74-75.

The few Plainview specimens are illustrated in Figure 11.32. The specimens are all of locally obtainable chert; one was damaged in excavation and the other two are either impact or obliquely fractured. The basal shape is most similar to the Category 10 fluted lanceolates but also corresponds closely to the other Dalton Group categories. Their being primarily unfluted and having parallel blade edges are the major features that separate Plainview specimens from the other Dalton categories.

NEARLY UNIQUE FORMS

Category 6: Rice Side Notched

FUNCTION:	Multipurpose	
FORM:	shallow side notched point with a triangular blade	
	Blade edges:	straight to slightly excurvate
	Shoulders:	rounded to subangular, usually not highly pronounced; the point maximum width is often shared by the shoulders and base
	Notches:	shallow and broadly incurvate. In some cases, notching is but a slight, almost

straight indentation from the shoulders to the base.
Base: straight to slightly concave.
Grinding: basal grinding is infrequent

FLAKING: Blade: varies with most specimens exhibiting reasonably well controlled percussion flake shaping of the blade with pressure retouching along the edges. Percussion flake scars are thin and stop generally at the midline leaving a subdued medial ridge and often remnant flake preform surfaces. Other specimens have more refined pressure flaking. Rough, battered protruberances from the original flake preforms also occur on several specimens.
Base: basal preparation is equally variable

HEAT TREATMENT: 52 of the 73 specimens were heated prior to manufacture; 2 others were heated after manufacture and reworked

DIMENSIONS: Length: 43-89 mm
Width: 21-35 mm
Thickness: 6-20 mm

AGE OR HORIZON: Woodland

REFERENCES: Bray 1956:127

Chi squares and associated probabilities are insignificant and confirm the null hypothesis that variations in the Rodgers Shelter Rice Side Notched sample reflect minor differences in material selection, manufacture or use. The sample is mainly heat treated, includes the complete range of locally available cherts and flaking, with the exception of fluting. Several specimens are impact, transversely or obliquely fractured. The sample is highly utilitarian in design and consists of triangular or subtriangular notched forms. Notches vary from being almost imperceptible to broadly incurvate; blade edges are often asymmetric either through initial choice of an asymmetric blank or differential resharpening of blade edges. There well may be contrasts with Rice Side Notched points from mortuary contexts (Wood 1961, 1967). Representative examples are illustrated in Figures 11.33 and 11.34.

Category 32: San Patrice, St. Johns Variant

FUNCTION: Projectile point

FORM: fluted corner notched point with symmetrical triangular blade
Blade edges: excurvate
Shoulders: angular but unbarbed; maximum point width
Base: concave with bifacial basal fluting extending

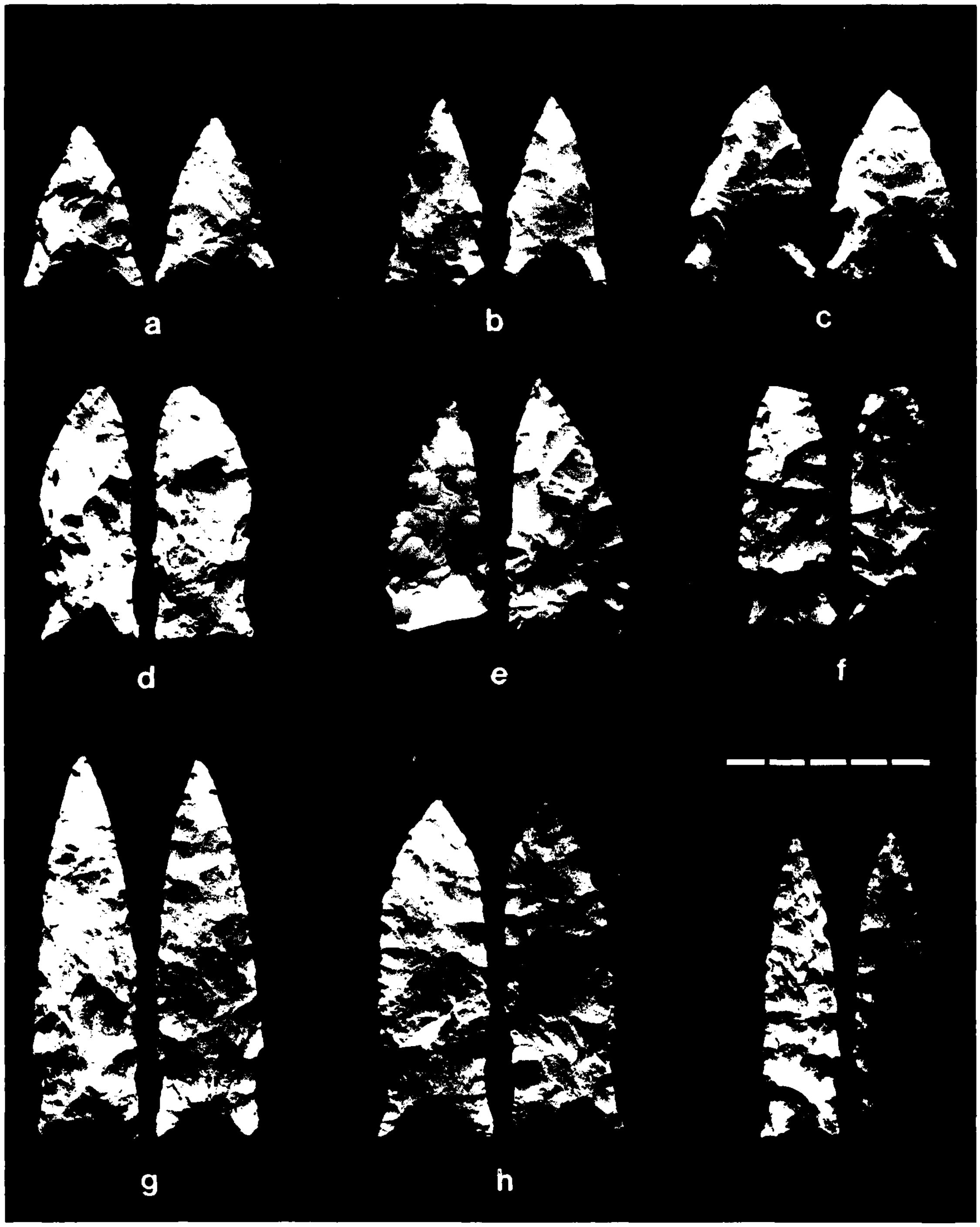

Figure 11.33. Rice Side Notched points (category 6). Scale in cm.

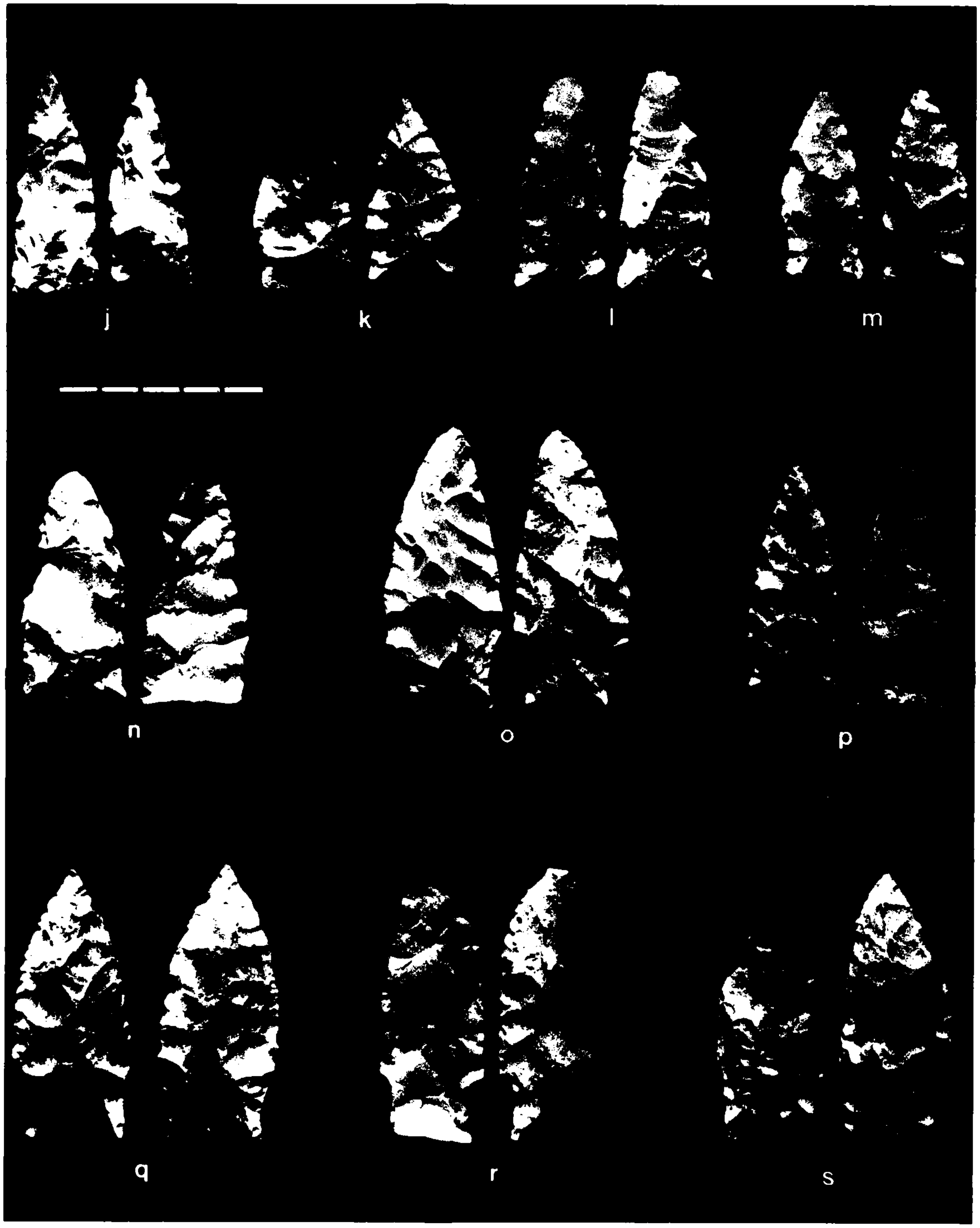

Figure 11.34. Rice Side Notched points (category 6). Scale in cm.

distally at least one-half the blade length. Expanding stem is ground.

FLAKING: blade is collaterally pressure flaked; notching is bifacial and basal fluting was subsequent to blade preparation.

HEAT TREATMENT: neither specimen shows definite evidence of heat treatment.

DIMENSIONS:
Length: 38 mm (shorter specimen only)
Width: 24-25 mm
Thickness: 5 mm (both specimens)

AGE OR HORIZON: Middle Archaic

REFERENCES: Ahler 1971:10-11; Duffield 1963

One specimen is transversely fractured and both are illustrated in Figure 11.35a-b.

Category 38

FUNCTION: Projectile point

FORM: side notched point
Blade edges: parallel or triangular
Shoulders: angular but unbarbed; co-equal with base in width
Notches: vary from narrow to broad U-shaped
Base: straight with square stem; one specimen is fluted
Grinding: basal grinding on 3 of the 5 specimens

FLAKING: varies, but generally consists of controlled pressure flaking, particularly of the notches

HEAT TREATMENT: 2 of the 5 specimens were heated prior to manufacture

DIMENSIONS (For the 4 measured specimens, dimensions are listed individually for 2, and 2 others are combined.):

Length:	80 mm	43 mm	50-57 mm
Width:	22 mm	22 mm	20 mm
Thickness:	8 mm	7 mm	5- 6 mm

AGE OR HORIZON: Middle Archaic

Only two of the specimens show any close similarity to one another (Figure 11.35d,f) and the others were included in this category because they are also side notched Middle Archaic forms. The two similar specimens are virtual carbon copies of one another and probably were made by a single flint knapper.

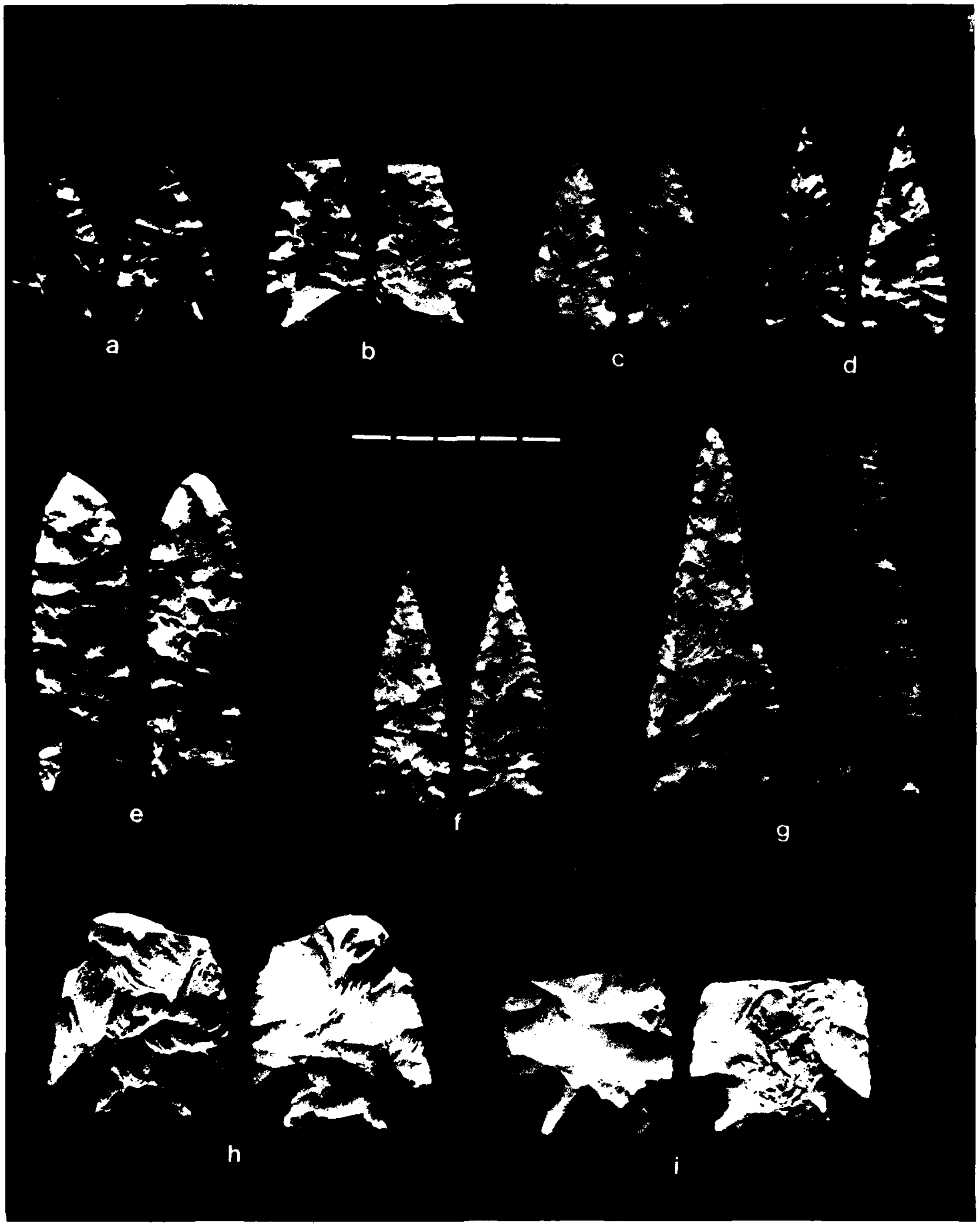

Figure 11.35. Nearly unique point categories: a-b, Category 32; c-f, Category 38; g, Category 41 (Cupp); h,i, Category 47. Scale in cm.

Category 41: Cupp

FUNCTION: Projectile point

FORM: large, symmetrical side notched point with a triangular blade
Blade edges: straight to slightly incurvate
Shoulders: angular but unbarbed; maximum point width
Notches: broad U-shaped
Base: convex

FLAKING: the blade was first thinned by well controlled bifacial percussion flaking, followed by secondary pressure work along the blade edges executed unifacially and alternating from the right side, producing a lenticular cross section. Notches are bifacially flaked and the base is haphazardly thinned.

HEAT TREATMENT: the one specimen was heated prior to manufacture

DIMENSIONS:Length: 95 mm
Width: 34 mm
Thickness: 8 mm

AGE OR HORIZON: Late Archaic or Woodland

REFERENCES: Baerreis and Freeman 1959:52-54

The single specimen is illustrated in Figure 11.35g.

Category 43

FUNCTION: Projectile point

FORM: ovate point with a square stem
Blade edges: highly excurvate and symmetrical
Shoulders: rounded with gradual transition into the stem
Base: slightly convex with straight stem

FLAKING: initial preparation was well controlled bifacial percussion thinning with flake scars extending to the blade midline. Blade edges are secondarily pressure flaked; flaking varies from continuous to local removal of edge protruberances. Basal thinning is incomplete and stem is either alternate lateral or unifacially pressure flaked.

HEAT TREATMENT: 2 of the 3 specimens were heated prior to manufacture

DIMENSIONS:Length: 51-55 mm

Width: 25-31 mm
Thickness: 6- 8 mm

AGE OR HORIZON: Woodland

In overall form, these points loosely resemble Table Rock stemmed points (category 12) but there are significant differences in flaking, basal thinning and grinding; none is illustrated.

Category 47

FUNCTION: Hafted cutting tool

FORM: corner notched point with a triangular blade
Blade edges: straight
Shoulders: angular and barbed; maximum point width
Notches: open and broadly *U-shaped*
Base: straight with an expanding stem

FLAKING: varies from random percussion flaking to well controlled bifacial pressure flaking. Notches are bifacially flaked and the base is bifacially thinned

HEAT TREATMENT: 1 of the 3 specimens was heated prior to manufacture

DIMENSIONS: Length: (undeterminable)
Width: 40-48 mm
Thickness: 8-10 mm

AGE OR HORIZON: Late Archaic, possibly Woodland

Two specimens are *illustrated* in Figure 11.35h-i. The specimens are all transversely fractured and roughly resemble Etley points (Category 50) from the site.

Category 55

FUNCTION: Indeterminate

FORM: convex base side notched point
Blade edges: excurvate
Shoulders: angular but unbarbed; maximum width of point
Notches: subcircular
Base: convex with an expanding stem
Grinding: basal grinding infrequent

FLAKING: initial blade preparation was bifacial percussion flaking, resulting in an amorphous set of thin flake scars which extend to near the blade midline. Subsequent edge shaping and resharpening was bifacial pressure flaking. Remnants of the flake preform surfaces are present on most specimens and the overall appearance suggests a quickly, if not haphazardly, fashioned implement.

HEAT TREATMENT:	4 of the 6 specimens were heated prior to manufacture
DIMENSIONS: Length:	38-65 mm
Width:	19-34 mm
Thickness:	7-11 mm
AGE OR HORIZON:	Middle Archaic or Woodland

Stratigraphically, the category is ill-defined and suggests that there is considerable persistence of this basic form, illustrated in Figure 11.36.

HAFTED SCRAPERS AND OTHER REWORKED POINTS

Thirty-seven specimens have rounded, unifacially beveled distal ends, plano-convex cross sections and can be classified as hafted scrapers. Four specimens are *distally reworked Late Archaic or Woodland* Stratum 4 forms (Rice Side Notched, Langtry, Smith, and an unidentified corner notched dart); the remainder are from Stratum 2 or upper Stratum 1 and generally can be identified as one of several distally reworked Middle or Early Archaic point categories. Two each are distally reworked Johnson (Category 26), Kirk-like straight stem (Category 28), Rodgers (Category 19), or Hidden Valley (Category 25); four are Williams (Category 29); twelve are Marcos or Cypress Creek I (Category 30); and eight could not be classified. Of the latter, five have unmodified bases formed on an old break with bifacially flaked stems. In contrast, three of the Marcos hafted scrapers are proximally reworked basal or blade fragments; two of these were heated after manufacture and reworked; the third is a blade element fragment that was notched and imperfectly thinned, revealing portions of the original proximal fracture. Representative examples are illustrated in Figure 11.37.

Reworked or partially reworked points are more common in the lower strata. Late Archaic examples from Stratum 4 include a Table Rock dart (Figure 11.9b) with a distal fracture ground as preparation for further working; three Stone points with one having a reworked base; a Castroville point which broke in use, was reheated and then reworked; and a Category 52 corner notched point with a reworked impact fractured blade. From Stratum 2, or the upper portion of Stratum 1, are several other examples. Proximal renotching of a broken blade is evident for a Williams point. *Rice Lanceolates probably were repeatedly reworked*, either into a similar lanceolate form (Figure 11.30) or into a flared base point (Figure 11.34j). Basal and blade element reworking of use-broken specimens is also evident on a Kirk-like point and is remarkably common on Hidden Valley points. Progressive blade resharpening is manifest for Williams or Marcos (Cypress Creek I) points, both of which record a high incidence of heated and reworked specimens, as well as for Dalton Group lanceolates.

General impressions about the "style" of the various points--in particular those from the Early or Middle Archaic units--follow:

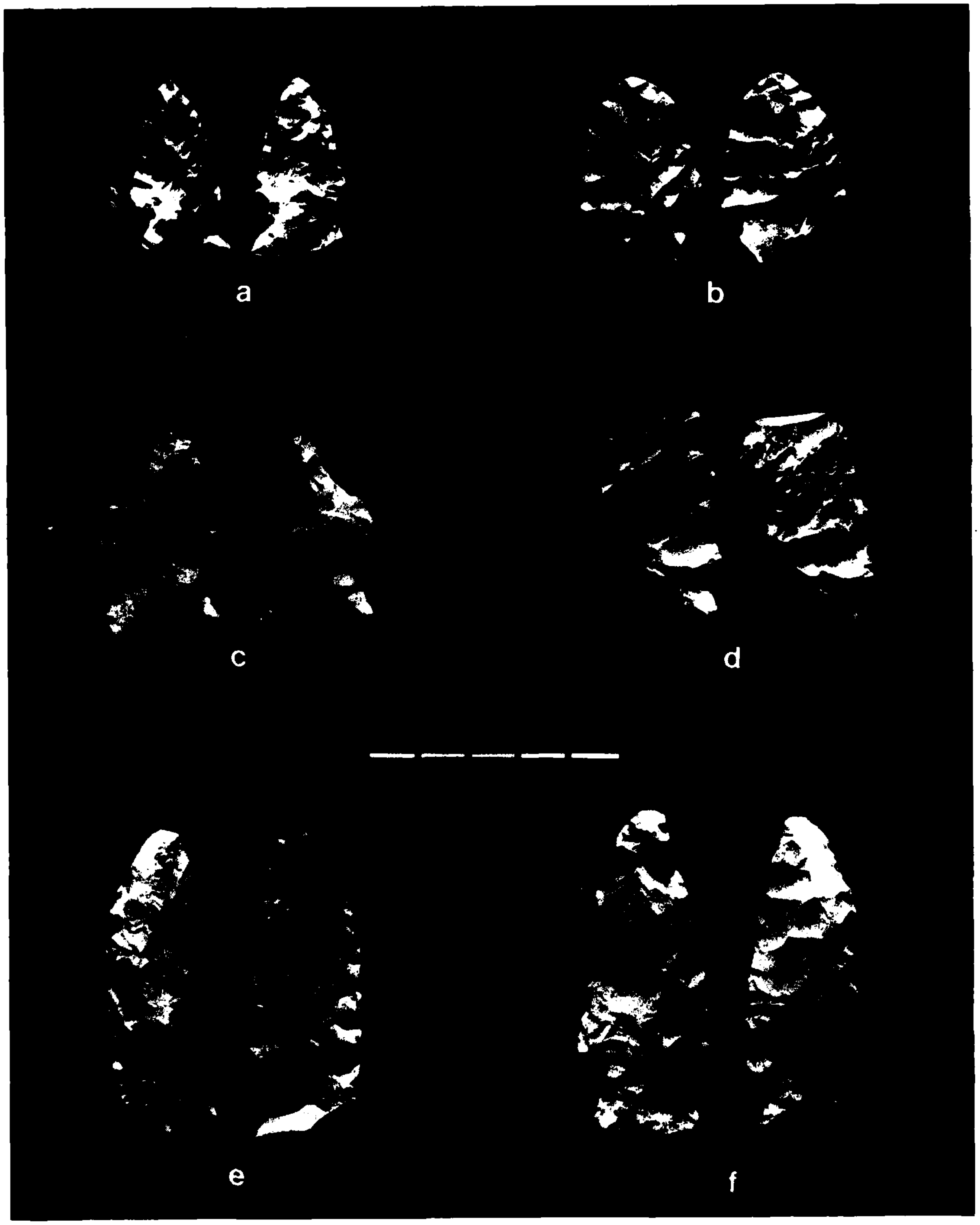

Figure 11.36. Category 55 points. Scale in cm.

Figure 11.37. Hafted scrapers. Scale in cm.

1. First, most of the point types were derived from a limited number of final preform (product groups) shapes. Late Archaic notched or stemmed points appear to have been fashioned from mainly rectangular preforms; Sedalia lanceolates from distally expanding preforms. Early or Middle Archaic corner notched points probably are from triangular preforms; broad bladed points such as Hidden Valley or Rice Lobed from the concave based expanding blade preforms; the lanceolates and flared base (often side notched) points from lanceolate preforms, or from reworked lanceolates.

2. Second, the haft element, so prominent in conventional point classification, often changes during the life span of a point though to a lesser degree than does the blade. In speaking of the Early and Middle Archaic lanceolates and the flared base points, it might be best to think of a general lanceolate form which may or may not be notched. Most attempts to redo the base, however, seem to result in a similar haft form. In contrast, the blade element is dynamic and repeatedly changes its size or form with use.

3. The overall period of use for many of the Dalton, Early or Middle Archaic points appears to have been both long and varied; that is, as blade elements were dulled or broken, the points were repeatedly resharpened and used for similar and/or different tasks.

4. Heat treatment appears to be a recurring technological process associated with initial manufacture and subsequent resharpening of dulled or damaged points.

IV. DISCRIMINANT ANALYSES OF POINT SERIES

The purposes of this section are to efficiently characterize point groups in an objective, replicable manner and, concurrently, to evaluate the conventional typological categories just presented. As briefly summarized in Part II, discriminant function analysis is suitable for both objectives since it attempts to minimize within group variation (i.e., differences in shape for a point category) while maximizing the Euclidean distances among groups (i.e., point categories of a formal series). For more than two groups, these differences can be graphically portrayed, thus illustrating the degree and the direction of group separation. A final objective of discriminant function analysis can be thought of as a two-step process; that is, an initial test of intra- and intergroup separation and a subsequent classification phase of group members or of unknown specimens for one of several groups. The latter possibility is not attempted here but could be used to compare specimens with the Rodgers Shelter point sample.

Specifically, the fifteen polar co-ordinates depicted in Figure 11.1 are used as independent variables in separate discriminant function analyses for the darts (Categories 13, 14, 16, 37), contracting stem points (Categories 7, 8, 25), straight stem or basal notched points (Categories 9, 24, 27, 28, 51), amorphous medium size points (Categories 6, 48, 52, 55), corner notched points (Categories 29, 30, 50), flared base points (Categories 26, 35, 36, 40) and lanceolates (Categories 10, 17, 18, 19; and 10, 18, 21, 22). Represented are all categories having a minimum of three points which could be measured for the fifteen coordinates. Although the selection does not include all of the point types, it is sufficient to repeatedly test the basic structure of the conventional point descriptions as well as objectify some of their more important characteristics.

SPSS subprogram DISCRIMINANT (Klecka 1975) was chosen over several other possibilities (Veldman 1967:268-280; Dixon 1971:214a-t) as being the most versatile discriminant function program, and the reader is encouraged to refer to one or all of these sources for detailed information. The SPSS version allows for the selection of variables for inclusion in the analysis by either direct or stepwise methods. The direct approach uses all variables without regard to their individual discriminating power; in the stepwise procedure, variables are "selected for entry into the analysis on the basis of their discriminating power (Klecka 1975:477)." Klecka (1975:447) notes that "in many instances the full set of independent variables contains excess information about the group differences, or perhaps some of the variables may not be very useful in discriminating among the groups. By sequentially selecting the 'next best' discriminator at each step, a reduced set of variables will be found which is almost as good as, and sometimes better than, the full set." The stepwise method has been shown to be sufficient for many chipped stone point classificatory needs (Gunn and Prewitt 1975), but we found stepwise results to be inferior to, but not greatly disparate from, the direct solution. Results of the two methods are summarized; whenever the stepwise solution is discussed, the Mahalanobis distance criterion (Klecka 1975:447) was used.

DARTS

The subsample of darts consists of twenty-four specimens: eight from Category 13, five from Category 14, four from Category 16, and seven from Category 37. These four groups are all grossly similar in size and are notched, expanding stem darts. Category 37 specimens are from Stratum 2 or the upper part of Stratum 1 and the others are from Stratum 4.

For either direct or stepwise solution, three discriminant functions were delineated for the four dart categories, as any discriminant function analysis will produce functions equal to one less the number of groups or independent variables, depending on which is less. A function is an independent dimension that describes the position of a group relative to others and its evaluation is crucial. The direct solution is inconclusive in that there is statistically insignificant variation in the sample prior to derivation of the first function, or dimension. However, the three dimensions account for 100 percent of the variation and the subsequent classification phase assigned 83.33 percent of the specimens to their respective groups (Table 11.32). Plotting of discriminant scores and group centroids (group multivariate mean position for a dimension) for the first two dimensions (Figure 11.38) also illustrates that the four categories are reasonably discrete, although there is considerable overlap between Category 37 specimens and the others.

TABLE 11.32

Discriminant Analysis of Darts
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4
Group 1 (Category 13)	8.0	8.0	0.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%	0.0%
Group 2 (Category 14)	5.0	0.0	4.0	0.0	1.0
Subfile		0.0%	80.0%	0.0	20.0%
Group 3 (Category 16)	4.0	0.0	0.0	4.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 37)	7.0	1.0	1.0	1.0	4.0
Subfile		14.3%	14.3%	14.3%	57.1%

Percent of "Grouped" cases correctly classified: 83.33%

For the stepwise solution, the reduction in variables to five (coordinates 2, 14, 15, 18, 19) and definition of two statistically significant dimensions (data not presented) would conclusively reject the null hypothesis that no statistically significant differences occur in the shapes of the four dart groups. The stepwise classification results are nonetheless inferior to the direct solution (79.17% classified correctly), although the plot (data not presented) of the group centroids and discriminant scores for the two dimensions have the same configuration.

In practical terms, it would be difficult, if not impossible, to correctly differentiate the Middle from Late Archaic darts from Rodgers Shelter by these methods alone. But it is clear that these methods provide adequate discrimination among the three Late Archaic dart categories.

CONTRACTING STEM POINTS

The subsample of contracting stem points consists of thirty specimens: five from Category 7, fourteen from Category 8, and eleven from Category 25. These are representative of recognized point types: respectively, Gary, Langtry and Hidden Valley forms. Hidden Valley points occur only in Stratum 2 and the upper part of Stratum 1, while Gary and Langtry points occur in the upper part of Stratum 4. The three categories are temporally dichotomous, but overlap in overall proportions and there are subtle differences in shape, particularly among Langtry and Hidden Valley specimens.

Discriminant results are essentially identical for the direct and stepwise solutions and only the direct method is summarized. The analysis defined two statistically significant dimensions, respectively

DISCRIMINANT ANALYSES OF ROGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF SMALL DARTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.

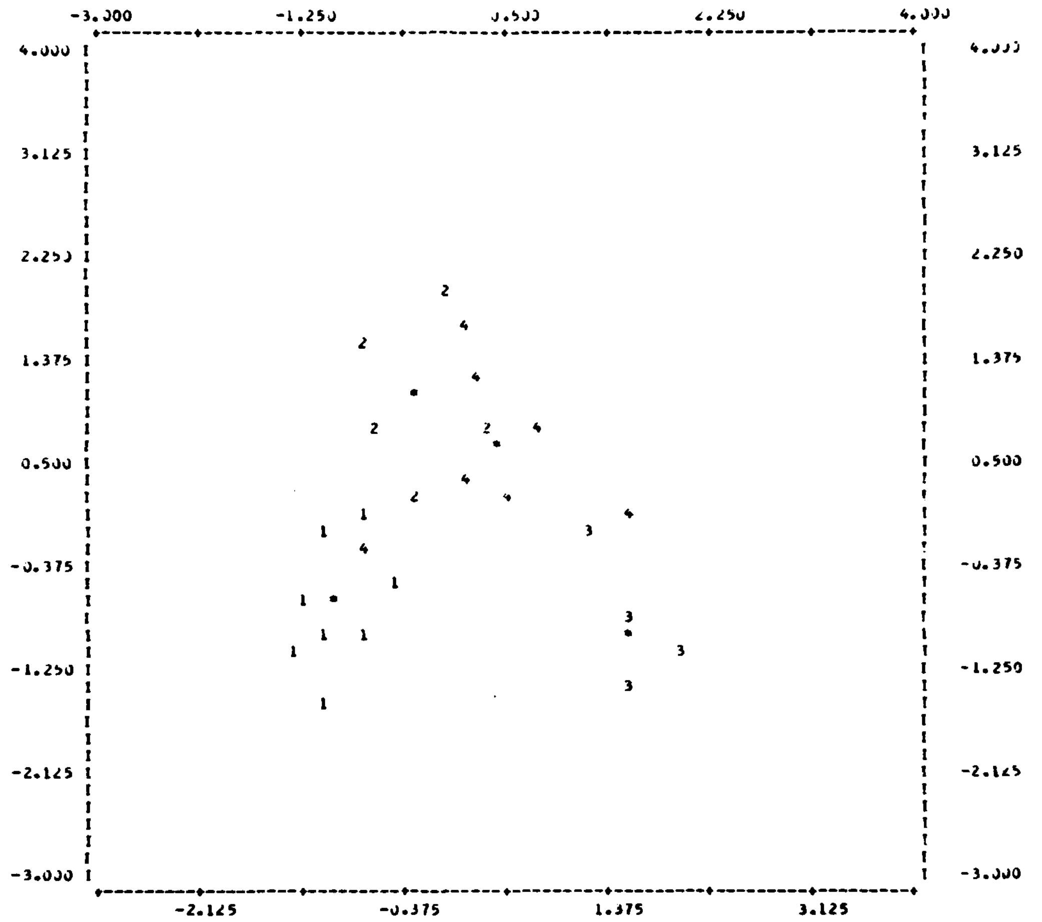

Figure 11.38. Discriminant analysis of darts. 1, Category 13; 2, Category 14; 3, Category 16; 4, Category 37.

accounting for 65.75 percent and 34.25 percent of the total variation (Table 11.33), conclusively rejecting the null hypothesis. Inspection of the standardized discriminant function coefficients (Table 11.34), which identify the contribution of variations to discriminant functions much as factor loadings do in an R-mode factor analysis, indicates that the first dimension defines the haft and shoulder areas, the second dimension the blade element length. The plot of group centroids and discriminant scores (Figure 11.39) for the two dimensions shows almost total separation among the three groups, illustrating that this is indeed a highly appropriate method for analysis of group differences. Subsequent classification results (Table 11.35) indicate as well that the two groups are highly separate in discriminant space; the single misclassfied specimen is a distally reworked Hidden Valley point.

TABLE 11.33

Discriminant Analysis of Contracting Stem Points

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	6.76921	65.75	0.933
2	3.52618	34.25	0.883

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0284	71.201	30	0.000
1	0.2209	30.198	14	0.007

TABLE 11.34

Standardized Discriminant Function Coefficients

	Function 1	Function 2
V01	0.11366	0.30305
V02	-0.62876	0.52012
V03	-0.10578	0.18987
V04	0.01561	-0.60079
V05	-0.05646	0.44624
V06	-0.11544	0.52299
V07	0.05887	-0.97890
V08	0.08215	-0.63835
V13	-0.41626	-0.21987
V14	-0.28872	0.46529
V15	-0.19513	0.12220
V16	0.68422	0.14618
V17	0.75049	-0.01320
V18	-0.90214	-0.54985
V19	-0.28319	-0.09174

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DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF CONTRACTING STEM POINTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL).  * INDICATES A GROUP CENTROID.
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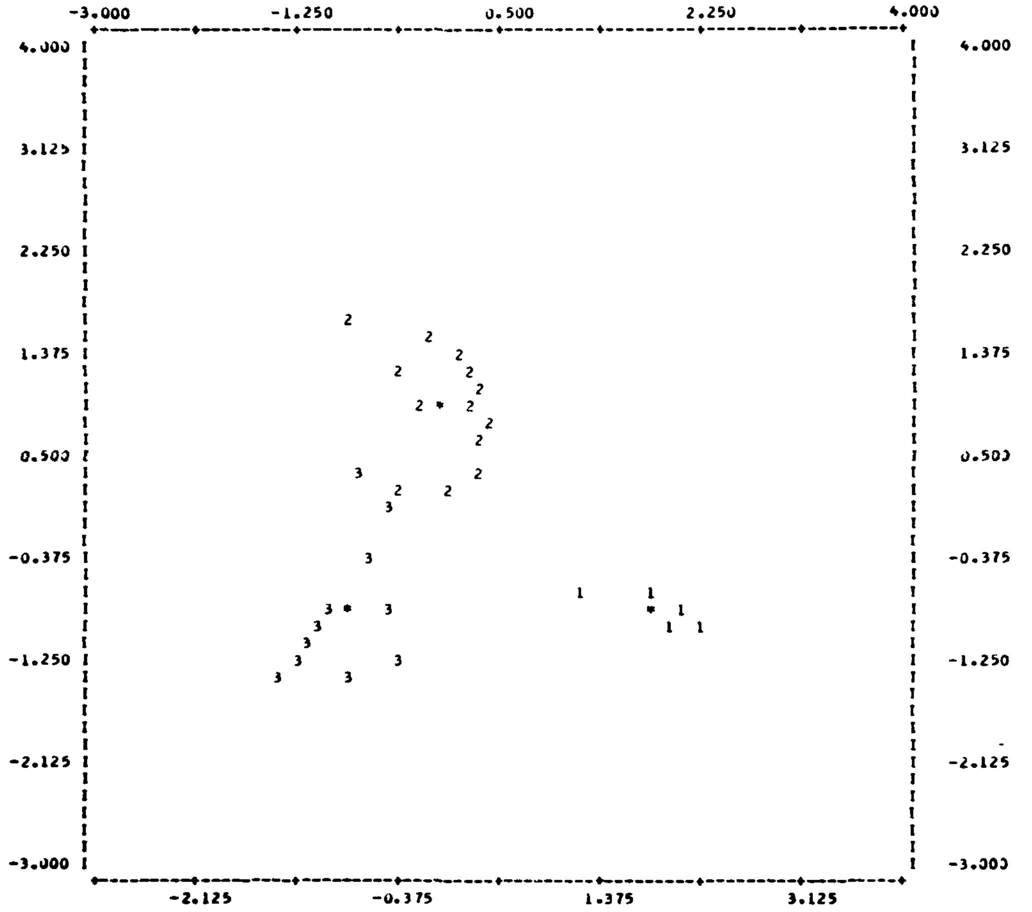

Figure 11.39. Discriminant Analysis of Contracting Stem Points. 1, Category 7; 2, Category 8; 3, Category 25.

TABLE 11.35

Discriminant Analysis of Contracting Stem Points
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3
Group 1 (Category 7)	5.0	5.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%
Group 2 (Category 8)	14.0	0.0	14.0	0.0
Subfile		0.0%	100.0%	0.0%
Group 3 (Category 25)	11.0	0.0	1.0	10.0
Subfile		0.0%	9.1%	90.9%

Percent of "Grouped" cases correctly classified: 96.67%

STRAIGHT STEM OR BASAL NOTCHED POINTS

The subsample of straight stem or basally notched points consists of thirty-seven specimens: nine from Category 9, three from Category 51, six from Category 27, ten from Category 28, and nine from Category 24. The subsample is intuitively the most heterogeneous, although all specimens are nominally straight stemmed. The Smith (Category 9) and Castroville (Category 51) points are from Stratum 4 and provide a useful dichotomy with the other three upper Stratum 1 and Stratum 2 point categories.

Analysis of the five groups by the direct method is by far the less ambiguous and the stepwise results are not discussed. Of the four discriminant functions generated, only the first, which explains 84.23 percent of the total variance, is statistically significant (Table 11.36); the plot of the first two discriminant functions' group centroids and discriminant scores (Fig. 11.40) indicates that the first function defines diachronic variation. The subsequent classification phase assigned (Table 11.37) almost 92 percent of the specimens to their correct group, with complete discrimination between the Late Archaic and Middle or Early Archaic points. The null hypothesis is rejected, even though in practice it would be difficult to separate the Category 27 specimens from coeval Category 28 (Kirk-like) points.

AMORPHOUS MEDIUM SIZE POINTS

The subsample of amorphous medium size points consists of sixty-four specimens: forty-one from Category 6 (Rice Side Notched), eight from Category 48, ten from Category 52, and five from Category 55. These are mainly from Stratum 4. All are notched points with more or less asymmetric blades and varying haft shapes. Point shapes among the categories intergrade and discriminant function analysis should provide a useful test of each category's integrity.

TABLE 11.36

Discriminant Analysis of Straight Stem or Basal Notched Points

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	13.77380	84.23	0.966
2	1.77364	10.85	0.800
3	0.65713	4.02	0.630
4	0.14897	0.91	0.360

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0128	113.281	60	0.000
1	0.1894	43.267	42	0.417
2	0.5252	16.743	26	0.917
3	0.8703	3.610	12	0.989

TABLE 11.37

Discriminant Analysis of Square Stem or Basal Notched Points
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4	Group 5
Group 1 (Category 9)	9.0	9.0	0.0	0.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%	0.0%	0.0%
Group 2 (Category 51)	3.0	0.0	3.0	0.0	0.0	0.0
Subfile		0.0%	100.0%	0.0%	0.0%	0.0%
Group 3 (Category 27)	6.0	0.0	0.0	4.0	2.0	0.0
Subfile		0.0%	0.0%	66.7%	33.3%	0.0%
Group 4 (Category 28)	10.0	0.0	0.0	0.0	10.0	0.0
Subfile		0.0%	0.0%	0.0%	100.0%	0.0%
Group 5 (Category 24)	9.0	0.0	0.0	0.0	1.0	8.0
Subfile		0.0%	0.0%	0.0%	11.1%	88.9%

Percent of "Grouped" cases correctly classified: 91.89%

Results of the two methods are nearly identical and only the direct method solution is summarized. The analysis defined three discriminant functions (Table 11.38), of which the first two are statistically significant. Respectively, these account for 81.22 percent and 12.95 percent of the total variance and examination of their standardized

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DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF MEDIUM TO LARGE SIZE SQUARE STEM POINTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL).  * INDICATES A GROUP CENTROID.
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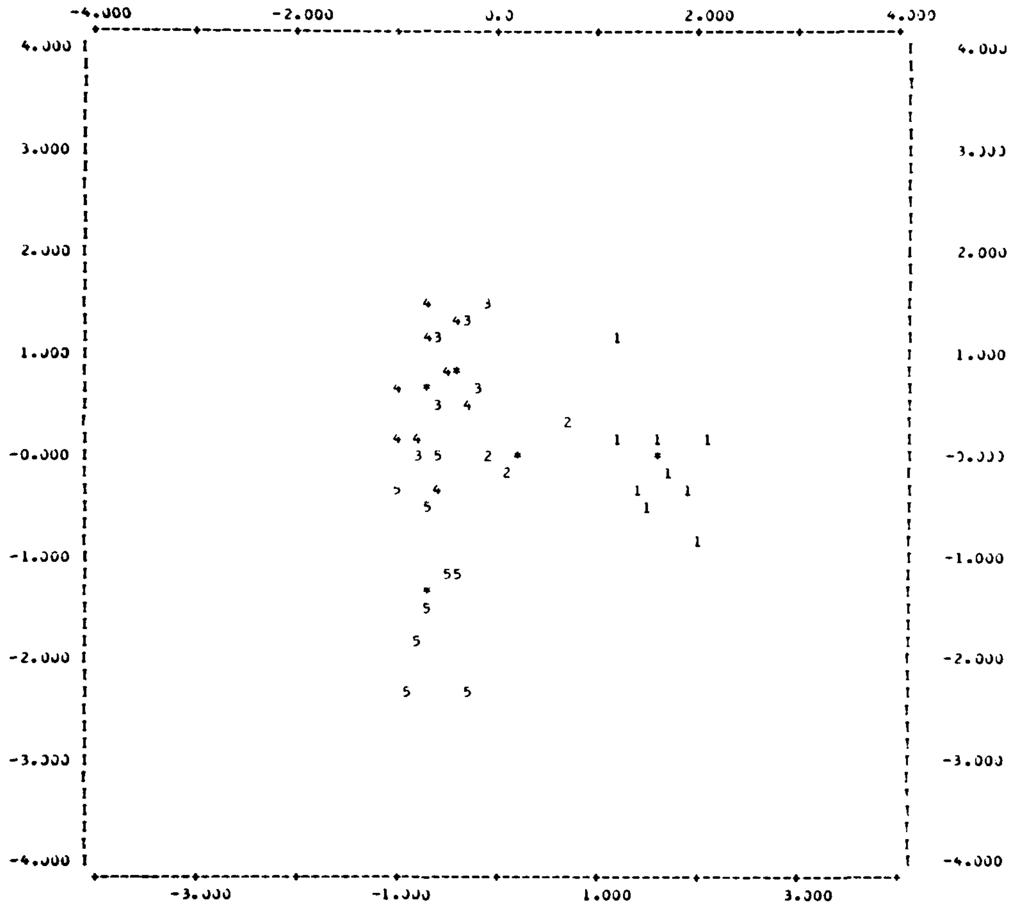

Figure 11.40. Discriminant analysis of medium to large size square stem points. 1, Category 4; 2, Category 51; 3, Category 27; 4, Category 28; 5, Category 24.

TABLE 11.38

Discriminant Analysis of Amorphous Medium Size Points

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	4.10355	81.22	0.897
2	0.65409	12.95	0.629
3	0.29496	5.84	0.477

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0915	127.954	45	0.000
1	0.4669	40.753	28	0.057
2	0.7722	13.829	13	0.386

coefficients (Table 11.39) reveals that both functions reflect mainly haft element variation. The plot of group centroids and discriminant scores for the two dimensions (Fig. 11.41) illustrates that the categories are indeed reasonably discrete. Classification results (Table 11.40) further confirm the integrity of the four groups (93.75% correctly classified) and the null hypothesis is rejected.

TABLE 11.39

Standardized Discriminant Function Coefficients

	Function 1	Function 2	Function 3
V01	0.49069	-0.30524	-0.33730
V02	0.46717	0.31732	0.25821
V03	0.06842	-0.44499	-0.40027
V04	0.07395	-0.41618	0.09742
V05	-0.33964	0.22682	-0.21751
V06	0.04353	0.82591	0.22671
V07	-0.15436	0.04373	-0.08146
V08	0.09175	-0.45440	-0.18131
V13	0.31670	0.36257	0.26074
V14	-0.11151	-0.19761	-0.93040
V15	-0.69538	-0.36912	1.05909
V16	0.08735	0.72109	-0.35966
V17	0.02745	-0.03144	-0.65261
V18	0.00728	0.54067	0.45811
V19	-0.26789	0.13736	0.30038

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DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF AMORPHOUS MEDIUM SIZE POINTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL).  * INDICATES A GROUP CENTROID.
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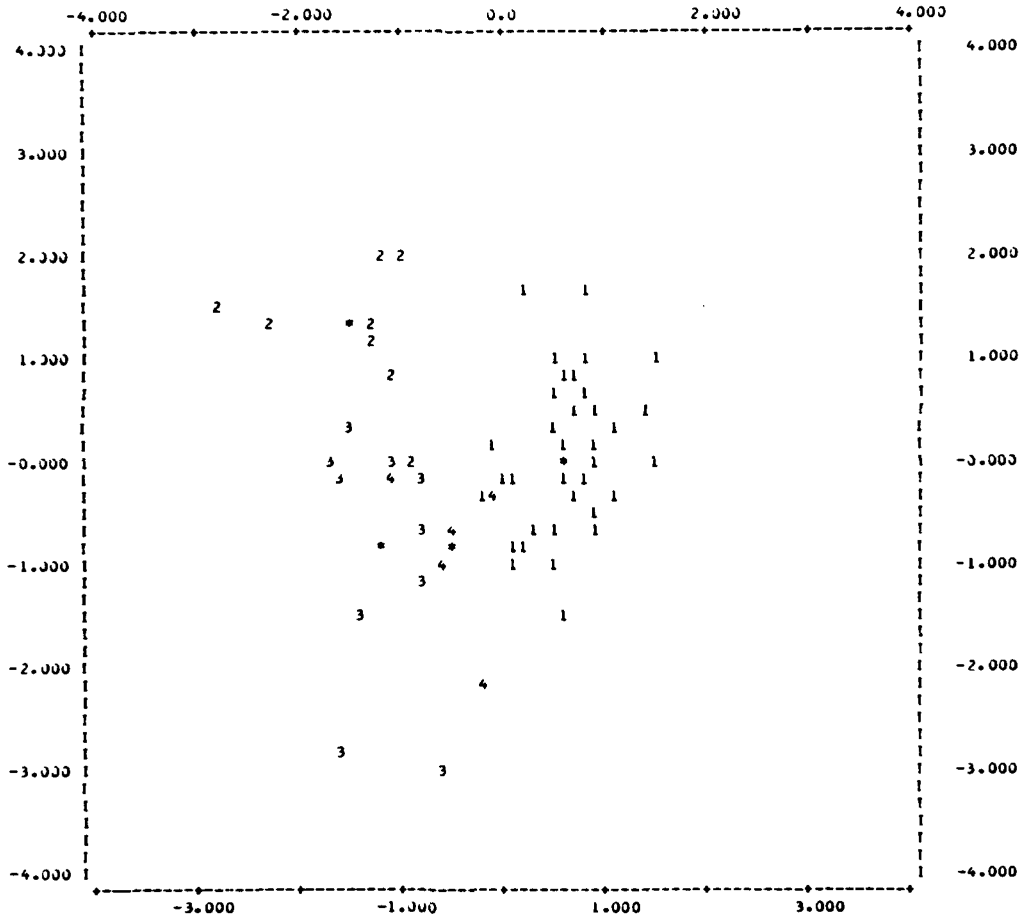

Figure 11.41. Discriminant analysis of amorphous medium sized points. 1, Category 6; 2, Category 48; 3, Category 52; 4, Category 55.

TABLE 11.40

Discriminant Analysis of Amorphous Medium Size Points
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4
Group 1 (Category 6)	41.0	38.0	0.0	0.0	3.0
Subfile		92.7%	0.0%	0.0%	7.3%
Group 2 (Category 48)	8.0	0.0	7.0	0.0	1.0
Subfile		0.0%	87.5%	0.0%	12.5%
Group 3 (Category 52)	10.0	0.0	0.0	10.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 55)	5.0	0.0	0.0	0.0	5.0
Subfile		0.0%	0.0%	0.0%	100.0%

Percent of "Grouped" cases correctly classified: 93.75%

CORNER NOTCHED POINTS

The subsample of corner notched points consists of fifty-one specimens: twenty-seven from Category 50 (Etley), twelve each from Categories 29 (Williams) and 30 (Marcos or Cypress Creek I). The Etley points occur in the lower part of Stratum 4 and are dichotomous with the Early or Middle Archaic points. Within the subsample there is some gradation in size and shape among all three categories.

Discriminant classification results are less ambiguous for the direct method dolution and only it is summarized. Of the two defined discriminant functions (Table 11.41) only the first is statistically

TABLE 11.41

Discriminant Analysis of Corner Notched Points

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	1.85868	79.53	0.806
2	0.47855	20.48	0.569

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.2366	59.098	30	0.011
1	0.6763	16.033	14	0.311

significant and it accounts for 79.53 percent of the total variance. The plot of group centroids and discriminant scores (Fig. 11.42) shows complete separation between Williams and Marcos (Cypress Creek I) points but the Late Archaic Etley points overlap with both. Classification results (Table 11.42) confirm the overall integrity of the three categories (90.2% correctly classified). The null hypothesis is conclusively rejected for Williams and Marcos (Cypress Creek I) points; of the Etley points, five are indistinguishable from Williams or Marcos (Cypress Creek I) points and the null hypothesis is not as categorically denied.

TABLE 11.42

Discriminant Analysis of Medium Sized Corner Notched Points
Prediction Results

Actual Group		No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3
Group 1		27.0	22.0	2.0	3.0
Subfile	Etley		81.5%	7.4%	11.1%
Group 2		12.0	0.0	12.0	0.0
Subfile			0.0%	100.0%	0.0%
Group 3		12.0	0.0	0.0	12.0
Subfile			0.0%	0.0%	100.0%

Percent of "Grouped" cases correctly classified: 90.20%

As a practical matter, the discriminant results suggest a continuation of the Williams and Marcos point types into the Late Archaic where they are largely supplanted by Etley forms.

FLARED BASE POINTS

The subsample of flared base points consists of thirty-four specimens: eight from Category 40, thirteen from Category 26 (Johnson), three from Category 35 (Jackie Stemmed), and ten from Category 36 (Graham Cave Notched). All are Stratum 2 or upper Stratum 1 points and as a series are one of the more distinctive.

Discriminant results for the two methods are very similar; the direct method provides slightly better classification results and is summarized. Of the three defined discriminant functions (Table 11.43), the first two are statistically significant and, respectively, account for 59.69 percent and 23.8 percent of the total variance. Their discriminant function coefficients (Table 11.44) suggest that the two represent one or the other side of the bilaterally symmetrical points. The plot of group centroids and discriminant scores (Fig. 11.43) for the categories show that the Johnson, Graham Cave Notched, and Jackie Stemmed points are most similar. Classification results of over 97%

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DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF MEDIUM SIZE CORNER NOTCHED POINTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL).  * INDICATES A GROUP CENTROID.
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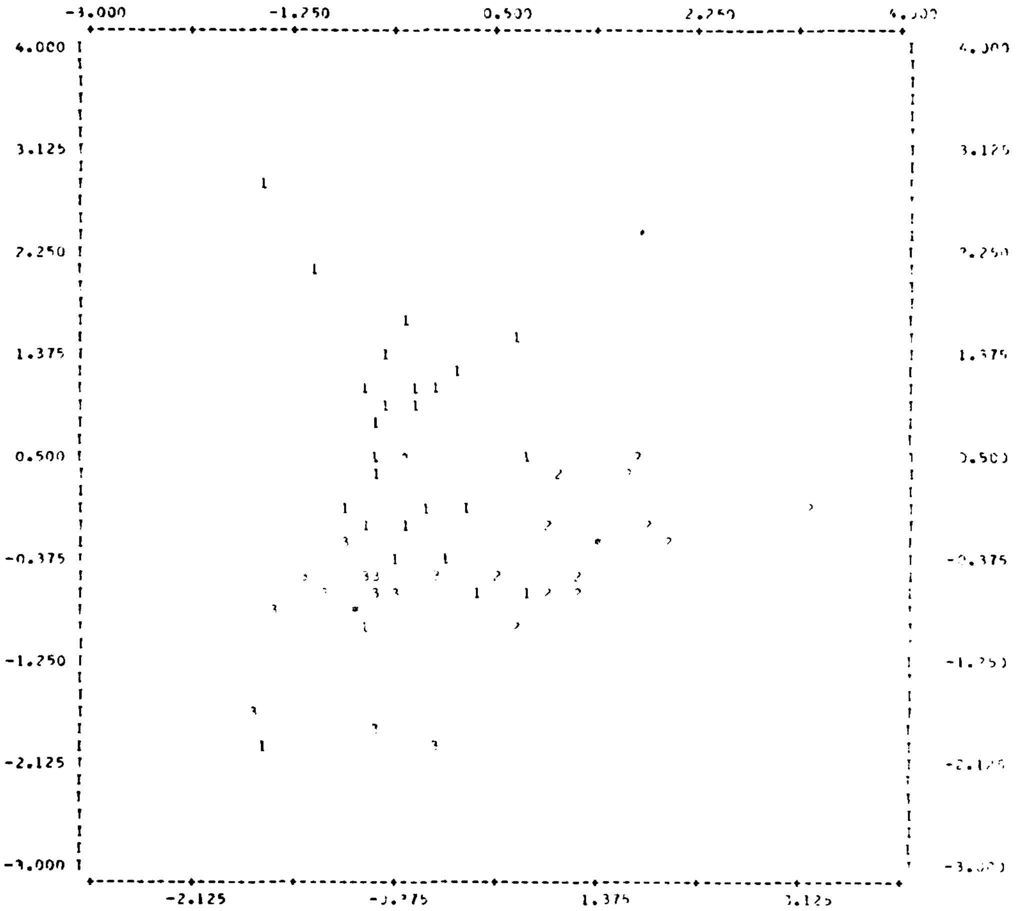

Figure 11.42. Discriminant analysis of medium sized corner notched points. 1, Category 50; 2, Category 29; 3, Category 30.

TABLE 11.43

Discriminant Analysis of Flared Base Points

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	4.27359	59.69	0.900
2	1.67430	23.38	0.791
3	1.21203	16.93	0.740

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0321	80.847	45	0.001
1	0.1690	41.774	28	0.046
2	0.4521	18.657	13	0.134

TABLE 11.44

Standardized Discriminant Function Coefficients

	Function 1	Function 2	Function 3
V01	0.28110	0.02594	-0.65711
V02	0.40723	-0.80287	1.04684
V03	-0.37457	0.76214	0.25954
V04	-0.17289	-0.38194	-0.02237
V05	-0.00435	-0.26322	-0.04717
V06	0.37578	-0.49715	-0.51847
V07	0.64489	-0.15951	-0.10145
V08	-0.44362	0.65701	0.15195
V13	-0.01969	-0.09077	0.69393
V14	-0.24581	0.55682	0.29585
V15	-0.12078	0.17106	-1.17591
V16	0.42737	-0.41960	0.66067
V17	0.10947	-0.05356	-0.65736
V18	-1.00301	0.02975	-0.54004
V19	-0.31109	-0.00397	0.04762

correctly assigned (Table 11.45) further illustrate the high resolution of the analysis with but a single Johnson point misclassified. The null hypothesis is emphatically rejected.

The practical application of these results is that this method provides more than adequate discrimination among a series of very similar points as well as fully confirming their traditional definition as types.

DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF MIDDLE ARCHAIC FLARED BASE POINTS

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.

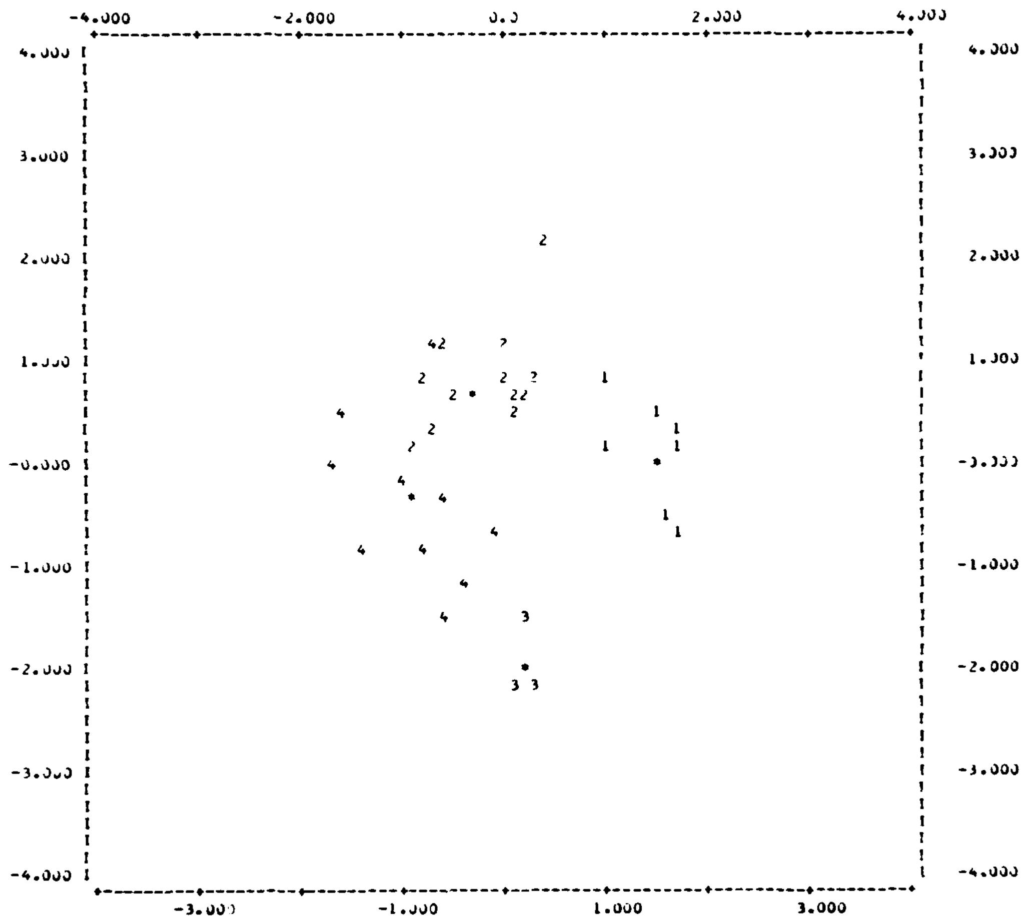

Figure 11.43. Discriminant analysis of Middle Archaic Flared Base Points. 1, Category 40; 2, Category 26; 3, Category 35; 4, Category 36.

TABLE 11.45

Discriminant Analysis of Middle Archaic Flared Base Points
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4
Group 1 (Category 40)	8.0	8.0	0.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%	0.0%
Group 2 (Category 26)	13.0	0.0	12.0	0.0	1.0
Subfile		0.0%	92.3%	0.0%	7.7%
Group 3 (Category 35)	3.0	0.0	0.0	3.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 36)	10.0	0.0	0.0	0.0	10.0
Subfile		0.0%	0.0%	0.0%	100.0%

Percent of "Grouped" cases correctly classified: 97.06%

LANCEOLATES

The first subsample of lanceolates consists of thirty-five specimens, five from Category 17 (Sedalia), twenty from Category 18 (Rice Lanceolates), seven from Category 19 (Rodgers), and three from Category 10 (fluted lanceolate). The four groups represent a nearly complete range in lanceolate shape, with the exception of Category 20 ovate forms, and are temporally trichotomous. Even so, their respective sizes and shapes overlap and they provide an instructive test of both the polar co-ordinate technique and the conventionally defined types.

Results of the two methods are virtually identical and only the direct method solution is discussed. The discriminant analysis defined three dimensions (Table 11.46), the first two of which are statistically significant and, respectively, account for 72.94 percent and 23.72 percent of the total variance. The two dimensions' standardized coefficients (Table 11.47) are roughly identical with high coefficients for the same variables but of different sign. And, inspection of the plot of group centroids and discriminant scores for the two (Fig. 11.44) illustrates that the first dimension separates the Rodgers specimens from the other three lanceolate groups; the second dimension separates the other three groups from one another. The null hypothesis is conclusively rejected. Subsequent classification results (Table 11.48) are 100% of the subsample correctly assigned.

A second set of analyses was also conducted to see if discrimination was possible among the Early and Middle Archaic Rice Lanceolates and the Dalton Group, given the proximity of the Rice Lanceolates and the Category 10 fluted lanceolates in the just discussed analysis. The question asked was: if known heterogeneity (i.e., the Rodgers and Sedalia lanceolates) is removed from the subsample, would meaning-

TABLE 11.46

Discriminant Analysis of Lanceolates, First Subsample

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	11.25619	72.94	0.958
2	3.66008	23.72	0.886
3	0.51498	3.34	0.583

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0116	109.281	45	0.000
1	0.1416	47.884	28	0.011
2	0.6601	10.177	13	0.679

ful discrimination be possible among the remaining, potentially homogeneous lanceolate subsample? Since for more than two groups discriminant function analysis will define a minimum of two dimensions useful for graphically portraying group differences and because the Dalton Group consists of four very similar point types, it was desired as well to increase the number of Dalton Group categories represented in the analysis.

TABLE 11.47

Standardized Discriminant Function Coefficients

	Function 1	Function 2	Function 3
V01	-0.13815	0.05510	-0.37443
V02	0.79461	-1.26486	0.79851
V03	-0.50875	0.65967	-0.20092
V04	-0.82600	0.55674	0.05766
V05	0.59835	-0.80599	-0.95579
V06	0.00154	-0.06493	-0.13284
V07	0.12129	0.52174	-0.31204
V08	-0.30104	-0.10188	0.16534
V13	0.63926	-1.45864	0.24686
V14	-0.36656	1.34152	0.15853
V15	0.06191	-0.21075	0.02411
V16	-0.16141	-0.02534	-0.64362
V17	0.25582	-0.14872	-0.09629
V18	0.19342	0.37873	0.59094
V19	0.62563	0.69545	-0.01893

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DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF LANCEOLATE CATEGORIES 10, 17, 18, 19

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL).  * INDICATES A GROUP CENTROID.
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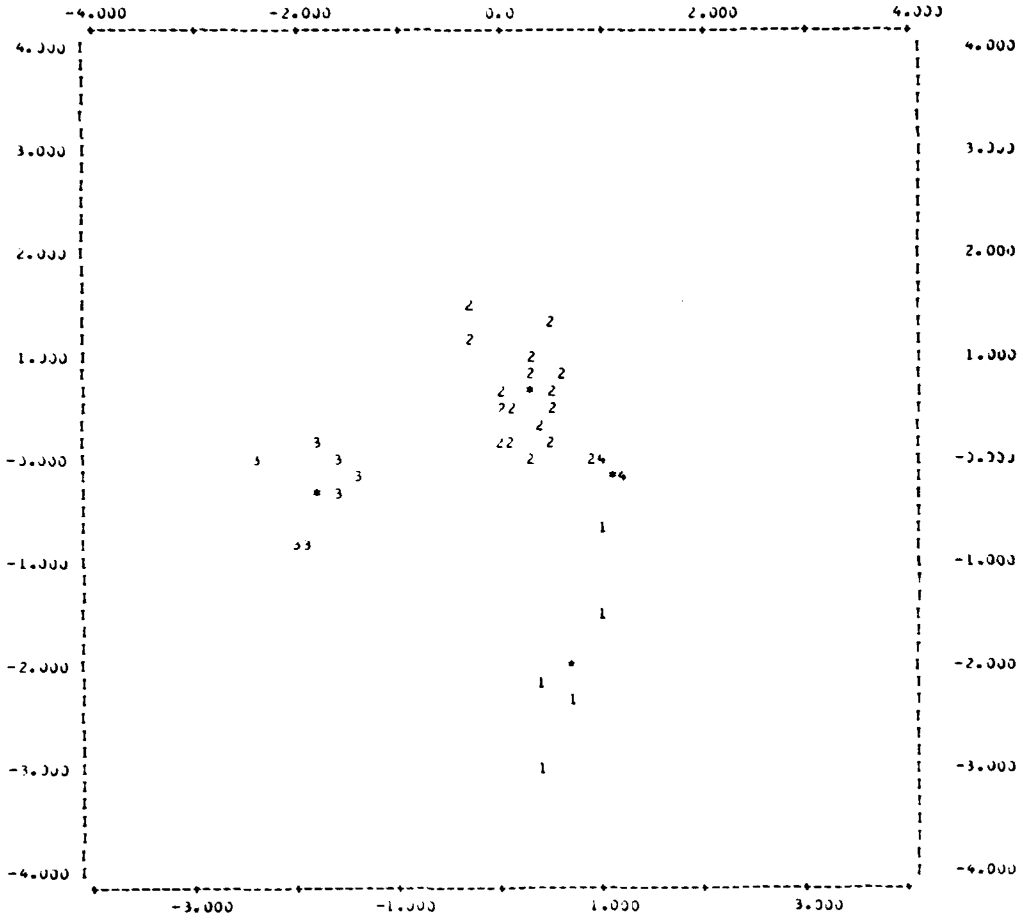

Figure 11.44. Discriminant analysis of lanceolate categories 10, 17, 18, 19. 1, Category 17; 2, Category 18; 3, Category 19; 4, Category 10.

TABLE 11.48

Discriminant Analysis of Lanceolate Categories 10, 17, 18, 19
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4
Group 1 (Category 17)	5.0	5.0	0.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%	0.0%
Group 2 (Category 18)	20.0	0.0	20.0	0.0	0.0
Subfile		0.0%	100.0%	0.0%	0.0%
Group 3 (Category 19)	7.0	0.0	0.0	7.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 10)	3.0	0.0	0.0	0.0	3.0
Subfile		0.0%	0.0%	0.0%	100.0%

Percent of "grouped" cases correctly classified: 100.0%

A second subsample of lanceolates was drawn that consists of twenty-nine specimens; the twenty previously used Rice Lanceolates and three category 10 fluted lanceolates plus three each from categories 21 (Dalton-like) and 22 (Dalton).

Results of the direct and stepwise methods vary in important aspects and the two are summarized. Major differences between the two include: (1) The direct method produced but a single statistically significant dimension while the first two of the three stepwise dimensions were statistically significant (Table 11.49); and (2) the classification phases of the two solutions varied (Table 11.50) in as much as all specimens were correctly assignéd by the direct method while two Rice Lanceolates were reassigned by the stepwise procedure to either Category 10 or 22. For either case, the null hypothesis is emphatically rejected, as is clearly illustrated by the plot of group centroids and discriminate scores for the direct method (Fig. 11.45). In sum the reduction in heterogeneity did not adversely affect the outcome of the analysis.

DISCUSSION

Although not every category was used in the discriminant analyses, it is clear that the Rodgers Shelter conventional point categories are defensible. As a practical matter, we would suspect that most traditional point types are realistic, even though certain subtle nuances of basal shape or hafting may be too specific for type definition (Wood 1967:112-113). A problem with conventional point types, as Ahler (1971:35) suggested, may not be so much with the classification itself but with its underlying meaning in functional or stylistic terms. The discriminant analyses at least provide systematic measures of group differences in shape that vary with time, reflecting stylistic variation

TABLE 11.49

Discriminant Analysis of Lanceolate Categories 10, 18, 21, 22

DIRECT SOLUTION

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	6.65285	74.68	0.932
2	1.65180	18.54	0.789
3	0.60414	6.78	0.614

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.0307	64.434	45	0.030
1	0.2351	26.785	28	0.530
2	0.6234	8.743	13	0.792

STEPWISE SOLUTION

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	2.37601	68.89	0.839
2	0.79206	22.97	0.665
3	0.28069	8.14	0.468

Functions Derived	Wilks' Lambda	Chi-square	DF	Significance
0	0.1291	47.091	18	0.000
1	0.4357	19.108	10	0.039
2	0.7808	5.690	4	0.224

for functionally similar tools. It should be practical now to apply these analytical techniques and data to other western Ozark Highland chipped stone point assemblages.

V. HIERARCHICAL CLUSTER ANALYSIS: A MULTIVARIATE TAXONOMY OF POINT SERIES

The preceding parts describe conventional point types for Rodgers Shelter and through use of discriminant function analysis demonstrate that these types are largely reproducible. For many purposes these results would be assurance enough that meaningful comparisons could be made with a chronologically controlled sample of chipped stone points.

TABLE 11.50

Discriminant Analysis of Lanceolate Categories 10, 18, 21, 22
Prediction Results

Actual Group	No. of Cases	Predicted Group Membership Group 1	Group 2	Group 3	Group 4
DIRECT SOLUTION					
Group 1 (Category 18)	20.0	20.0	0.0	0.0	0.0
Subfile		100.0%	0.0%	0.0%	0.0%
Group 2 (Category 10)	3.0	0.0	3.0	0.0	0.0
Subfile		0.0%	100.0%	0.0%	0.0%
Group 3 (Category 21)	3.0	0.0	0.0	3.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 22)	3.0	0.0	0.0	0.0	3.0
Subfile		0.0%	0.0%	0.0%	100.0%
Percent of "grouped" cases correctly classified: 100.0%					
STEPWISE SOLUTION					
Group 1 (Category 18)	20.0	18.0	1.0	0.0	1.0
Subfile		90.0%	5.0%	0.0%	5.0%
Group 2 (Category 10)	3.0	0.0	3.0	0.0	0.0
Subfile		0.0%	100.0%	0.0%	0.0%
Group 3 (Category 21)	3.0	0.0	0.0	3.0	0.0
Subfile		0.0%	0.0%	100.0%	0.0%
Group 4 (Category 22)	3.0	0.0	0.0	0.0	3.0
Subfile		0.0%	0.0%	0.0%	100.0%
Percent of "grouped" cases correctly classified: 93.10%					

Part V illustrates a slightly different approach to the same problem, hierarchical clustering, a multivariate technique that partitions a collection into groups "ranging from each entity until itself to one grand cluster encompassing the entire data set (Anderberg 1973:177)." In favor of this approach are the economy in verifiable measurement (i.e., only fifteen polar coordinates) and as an adjunct procedure for discriminant analysis of more or less homogeneous groups, the objective of the latter being to delineate functions which best discriminate group differences. We feel that this latter objective particularly has practical application for complex sites such as Rodgers Shelter, where it is often not possible to correlate stratigraphic subdivisions over large distances or for separate excavations, or for defining spatial relationships among contemporary sites (Kay 1975). Two difficulties with the procedure are the initial determination of sample homogeneity prior to clustering and then the decision of how many clusters are

DISCRIMINANT ANALYSES OF RODGERS SHELTER POINTS
DISCRIMINANT ANALYSIS OF LANCEOLATE CATEGORIES 10, 18, 21, 22

PLOT OF DISCRIMINANT SCORE 1 (HORIZONTAL) VS. DISCRIMINANT SCORE 2 (VERTICAL). * INDICATES A GROUP CENTROID.

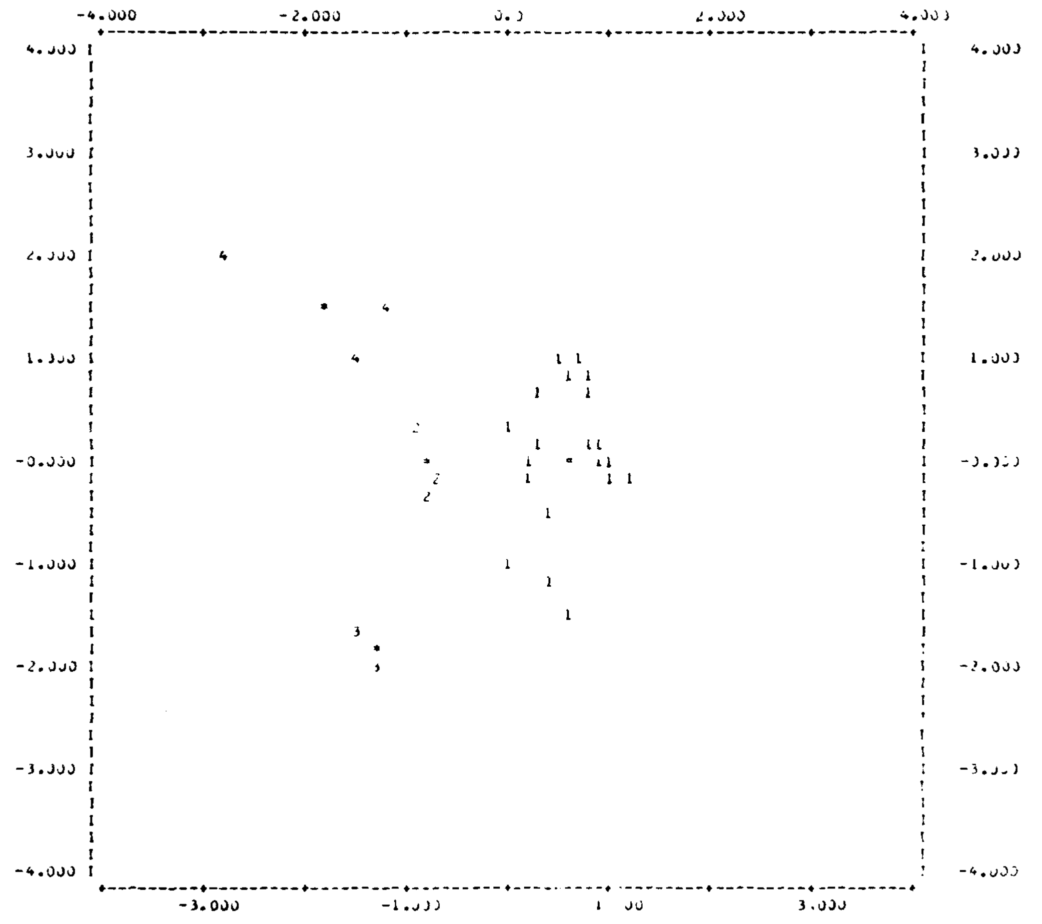

Figure 11.45. Discriminant analysis of lanceolate categories 10, 18, 21, 22. 1, Category 18; 2, Category 10; 3, Category 21; 4, Category 22.

sufficient. For the Rodgers Shelter sample the point series enumerated in Part III were assumed to be roughly homogeneous for initial clustering, and the number of point categories within a series was used as a minimum number of meaningful clusters. Anderberg (1973:176-178) describes other statistical techniques for interpreting hierarchical clustering.

This part discusses several cluster analyses, using Program BMD-P2M (Engleman and Fu 1975:323-338). This program clusters cases (i.e., specimens) according to an amalgamated distance algorithm in which the two cases having the shortest distance between them are treated as one cluster, which is then compared to the next case, and so on, until all cases are amalgamated into one cluster. Distance criterion among cases was chi square and standardized input data consisted of eight image factor scores (Kim 1975:478, 482; data not presented). The cluster analyses are visually presented in seven dendrograms for, respectively, the darts, contracting stem, straight stem, or basal notched points, amorphous medium size points, corner notched, or flared base points, and lanceolates (including the ovate Category 20). To facilitate direct comparison with the conventional categories, the category numbers of specimens clustered are at the ends (i.e., the top) of the branches of the dendrograms. For each graph, the presentation of specimens from left to right illustrates the order of greatest similarity among the specimens clustered; that is, specimens on either end of a dendrogram represent the two least similar.

Clustering results do not completely agree with the conventional point types of any series. Nonetheless, discriminant analyses of the larger clusters for each series, where discriminant groups consisted of points from different horizons, confirm the overall stratigraphic placement of points for each series, regardless of point type. As a practical matter, the clusters insure sample homogeneity that, had there been large enough sample ($N \leq 20$ for each horizon), would allow for satisfactory classification of chronologically unknown specimens, a possibility which, it is hoped, can be pursued in the near future. As statements of subtle nuances in point shape, the cluster analyses can be taken to approximate differences in conventional typing of similar collections that lack chronological controls.

The dendrogram of twenty-nine darts (Fig. 11.46), representing six categories suggests that there are minor differences among the specimens, with seven being unique unto themselves. The remainder have an irregular order as far as the conventional categories go, although the square stem darts (Categories 15 and 33) are to one side.

Greater similarity with the conventional classification is evident (Fig. 11.47) for the contracting stem sample of thirty points, representing three categories. Only two specimens are unique unto themselves, the remainder group into four major clusters. From left to right, these are: a cluster of two Gary points (Category 7) followed by a cluster of three Hidden Valley points (Category 25); the two unique specimens (Categories 8 and 7); a cluster of ten Langtry (Category 8) and one Hidden Valley point; and lastly a mixed group of seven Hidden Valley, two Gary and three Langtry points.

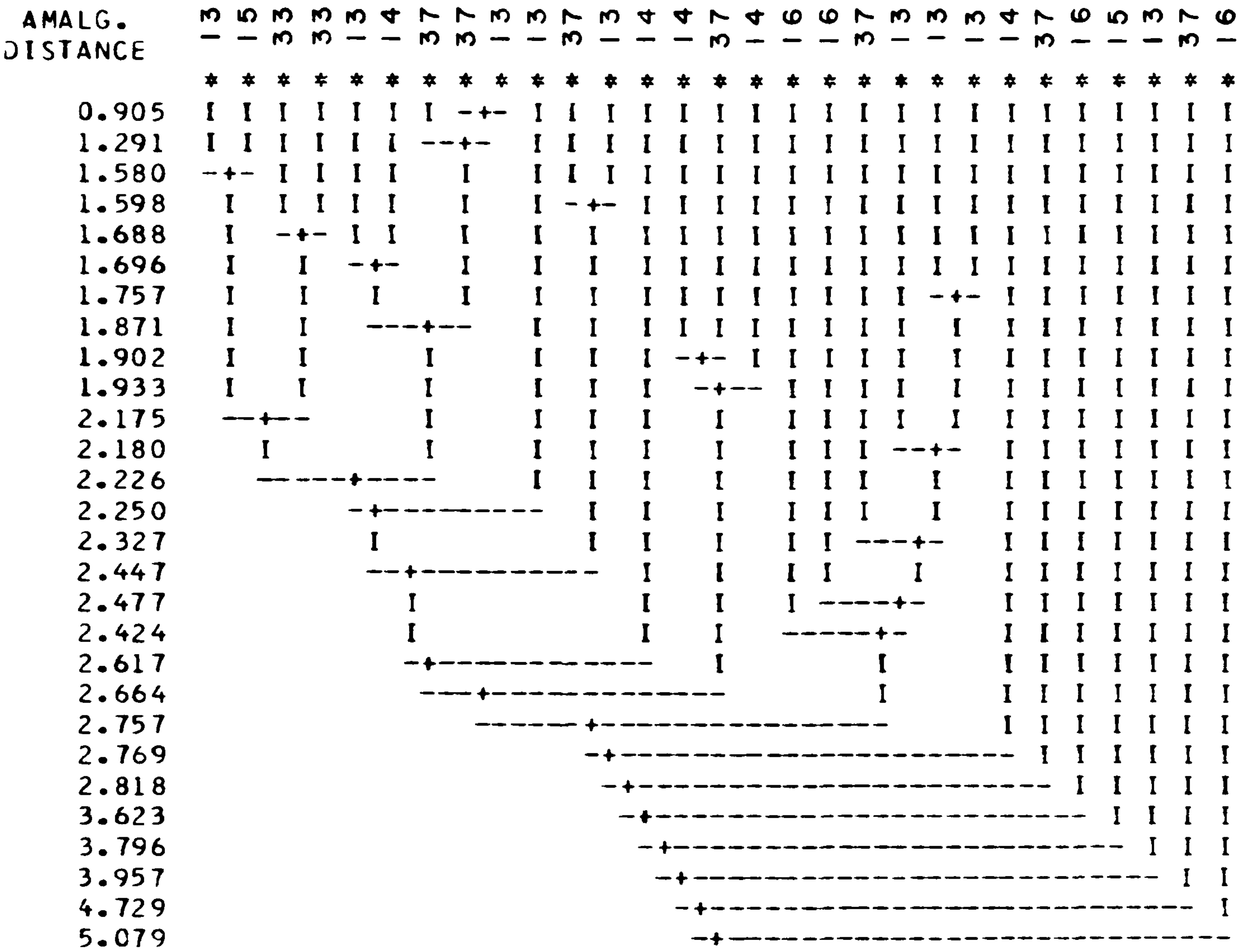

Figure 11.46. Cluster of Small Dart Points.

CLUSTER OF CONTRACTING STEM POINTS

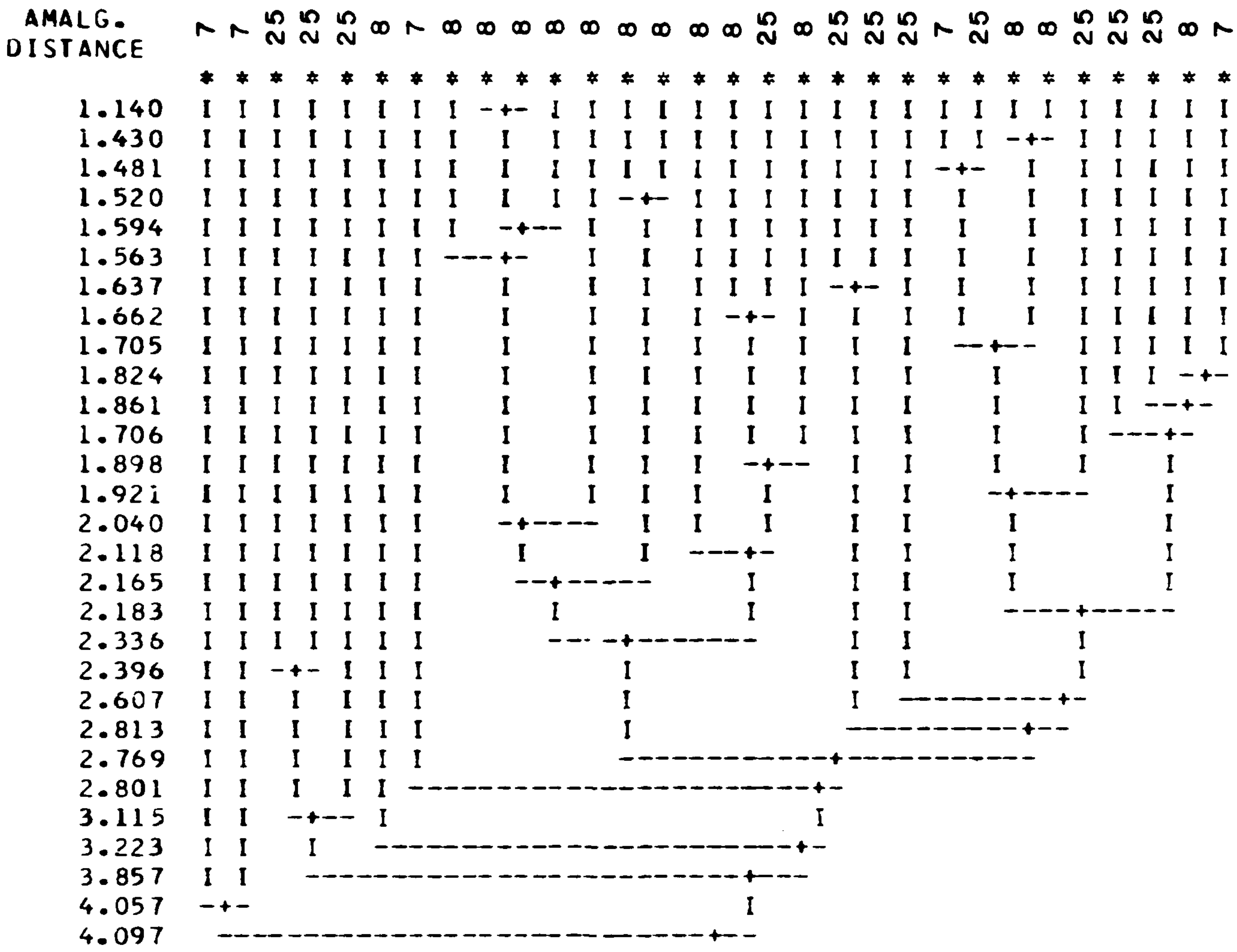

Figure 11.47. Cluster of Contracting Stem Points.

The fifty-two combined straight stem or basal notched points (i.e., square stemmed), representing ten categories, are reduced (Fig. 11.48) to six major clusters and seven unique points. From left to right, these are: a cluster of six Smith points (Category 9), a unique Category 44 point, a major mixed cluster of three Rice Lobed (Category 24), eight Kirk-like (Category 28), five Category 27 points, four Category 49 points, two Category 51 points, and one each from Categories 9 (Smith), 4, and 54; a unique Category 49 point followed by a cluster of three others from the same category; and four unique specimens (Categories 9, 54, 9, 27). For certain purposes, the major cluster might be further subdivided into three groups: an Early or Middle Archaic unit of Rice Lobed and Category 27 points on the left, in the center and on the right two mixed Middle and Late Archaic clusters.

The sixty-four amorphous medium size points, representing four categories, illustrate at least two clustering possibilities (Fig. 11.49). The first would be to accept a basic division at an amalgamated distance of 3.043, resulting in a major cluster of fifty-six points followed by a smaller group of four specimens, a unique specimen, a group of two points and a final unique specimen. This would group most of the forty-one Rice Side Notched points (Category 6) as well as an assortment of Categories 48, 52 and 55 points into a single large cluster with much smaller groupings of Categories 48, 52 and 6 (Rice Side Notched). The other alternative would be to accept the clusters that have amalgamated distances greater than 3.043 and then subdivide the larger cluster at a distance of 2.395, or possibly at 2.287. In the latter case, groupings of the four categories would still be mixed. And, even without any prior knowledge of variation in shape of the Rice Side Notched points, a reasonable conclusion would be that there is considerable intra-category variation, which indeed is true.

Similar problems are evident (Fig. 11.50) for the fifty-one corner notched specimens, representing three categories. Accepting clusters at an amalgamated distance of 3.118 and reading from left to right would produce a cluster of four Williams (Category 29) and Marcos or Cypress Creek I (Category 30) points followed by a major grouping of thirty-nine Williams, Marcos (Cypress Creek I) or Etley (Category 50) points, two smaller clusters of Williams and Etley points and three unique Etley points. Inspection of the major cluster of thirty-nine points further suggests that reasonable subdivisions among the three categories are possible but there would still be some overlap, also born out by the discriminant analysis of the three categories.

Clustering thirty-five flared base points, representing six categories (included is one point from the miscellaneous Category 32), reduces the series to three groups followed by five unique specimens (clusters defined at an amalgamated distance of 2.647, Fig. 11.51). The major twenty-six point cluster could be further subdivided but without adding any correspondence to the primary flared base category distinctions. Although this approach would not be consistent with conventional methods, grouping the flared base points into essentially a single cluster is supported by their overall stratigraphic placement at Rodgers Shelter.

The final dendrogram (Fig. 11.52) of fifty-one lanceolates from

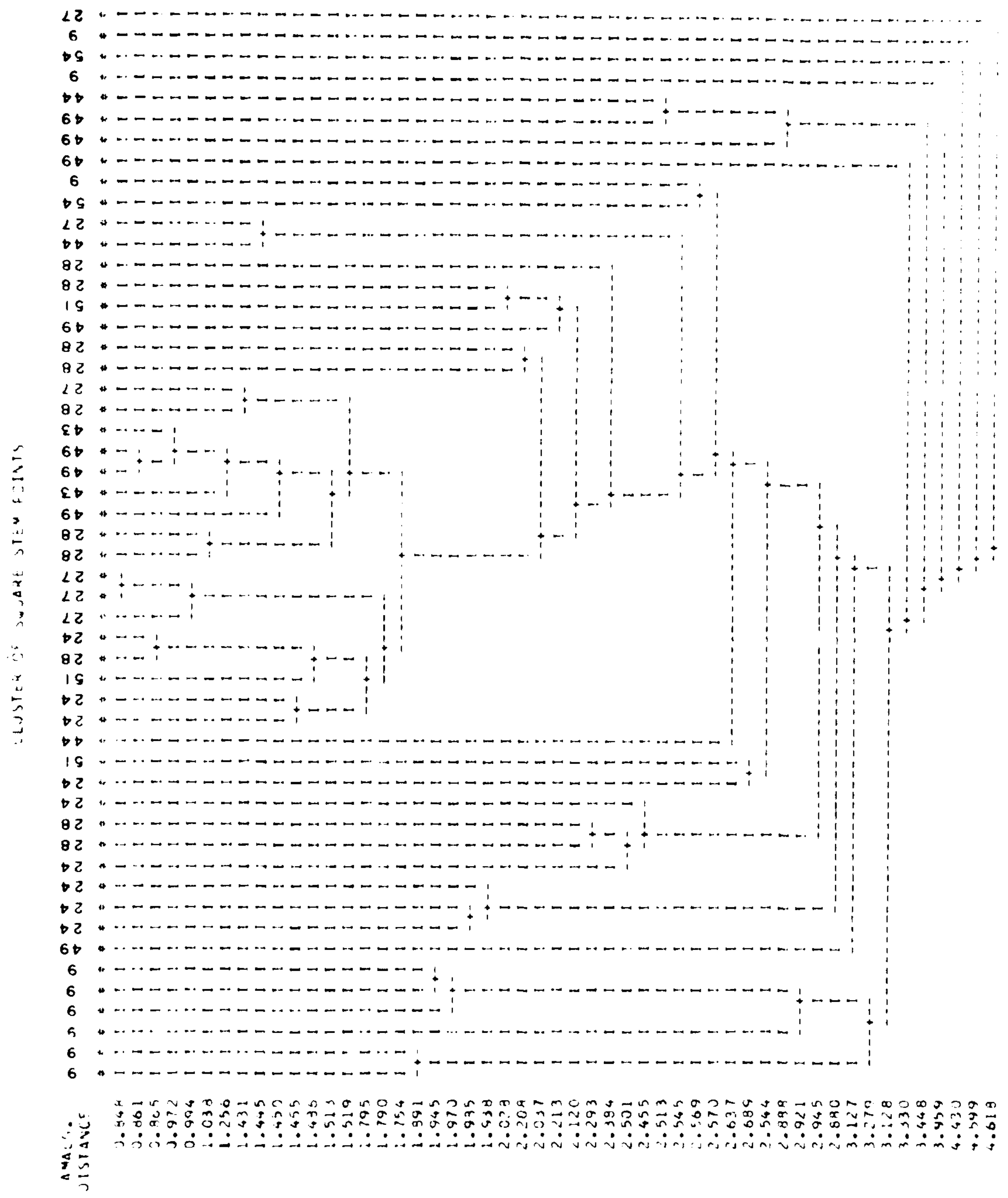

Figure 11.48. Cluster of Square Stem Points.

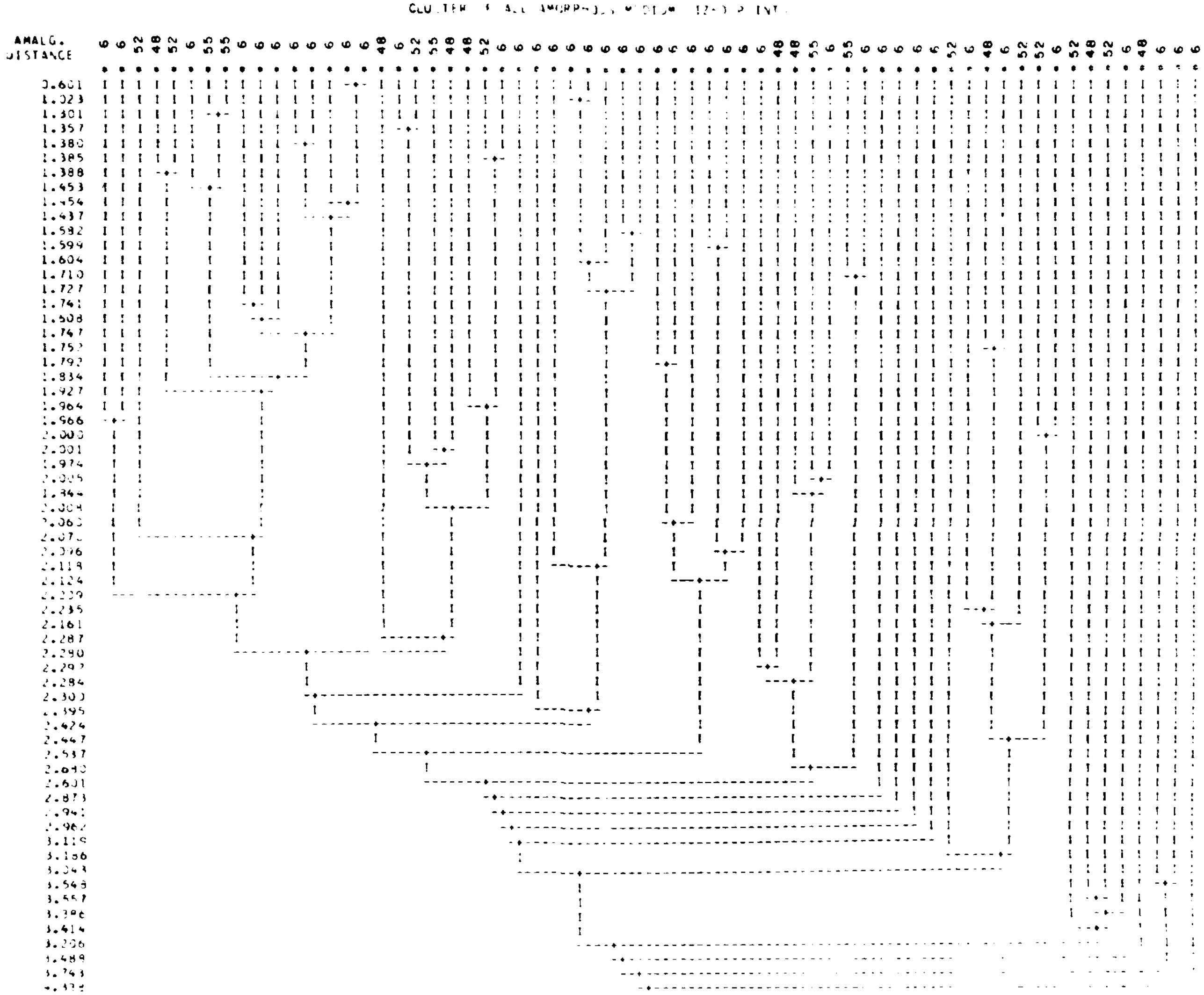

Figure 11.49. Cluster of All Amorphous Medium Sized Points.

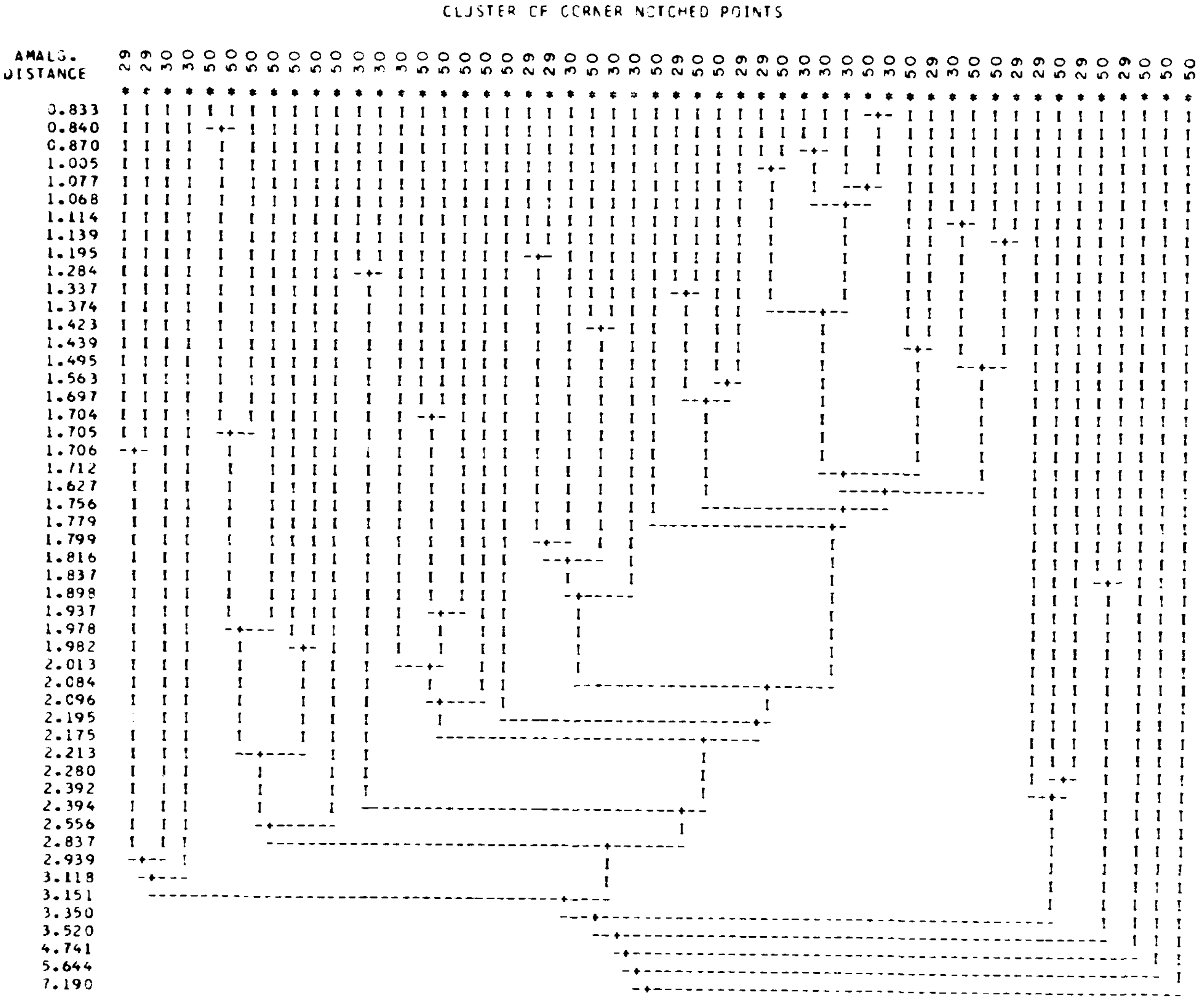

Figure 11.50. Cluster of Corner Notched Poin^s.

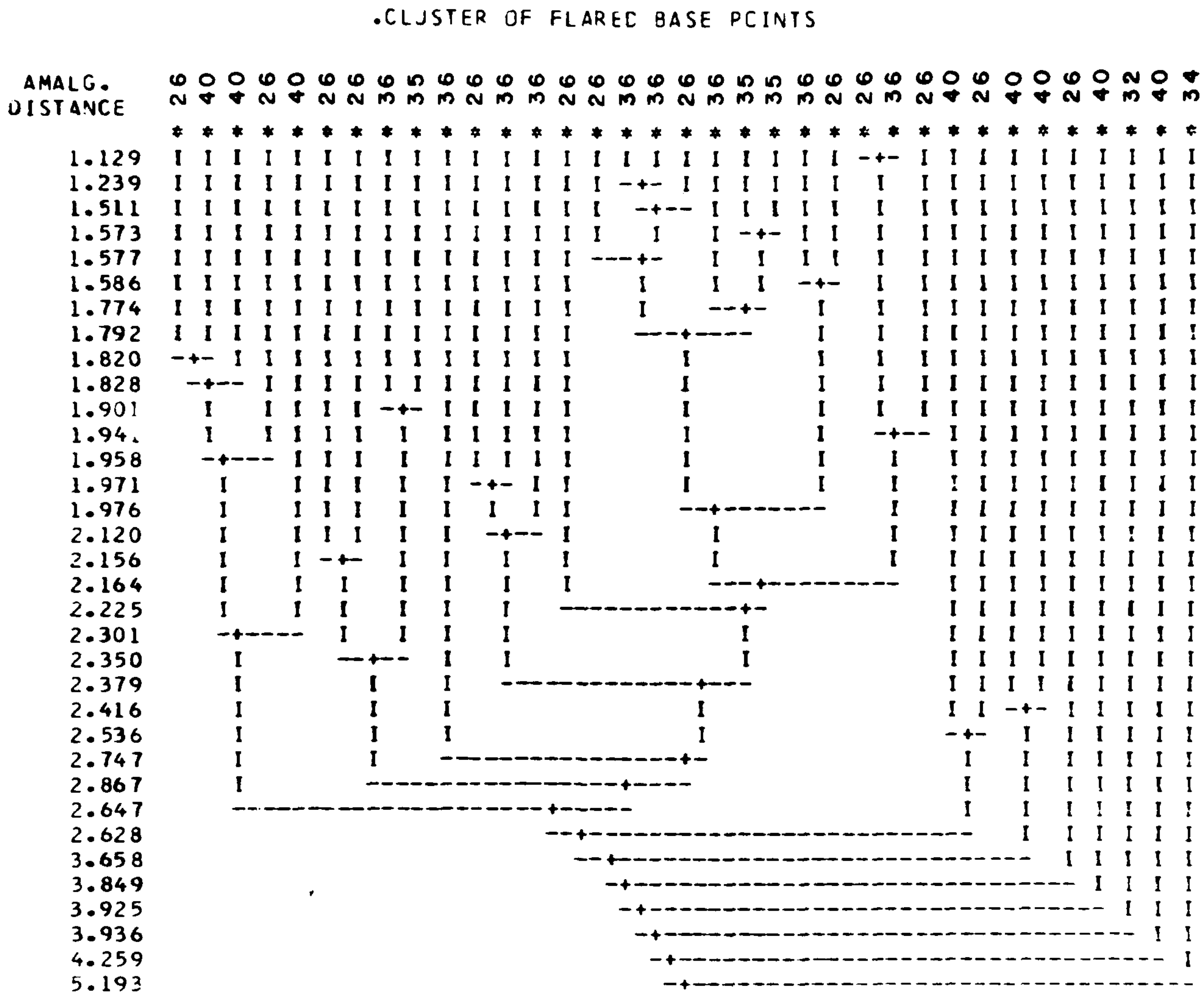

Figure 11.51. Cluster of Flared Base Points.

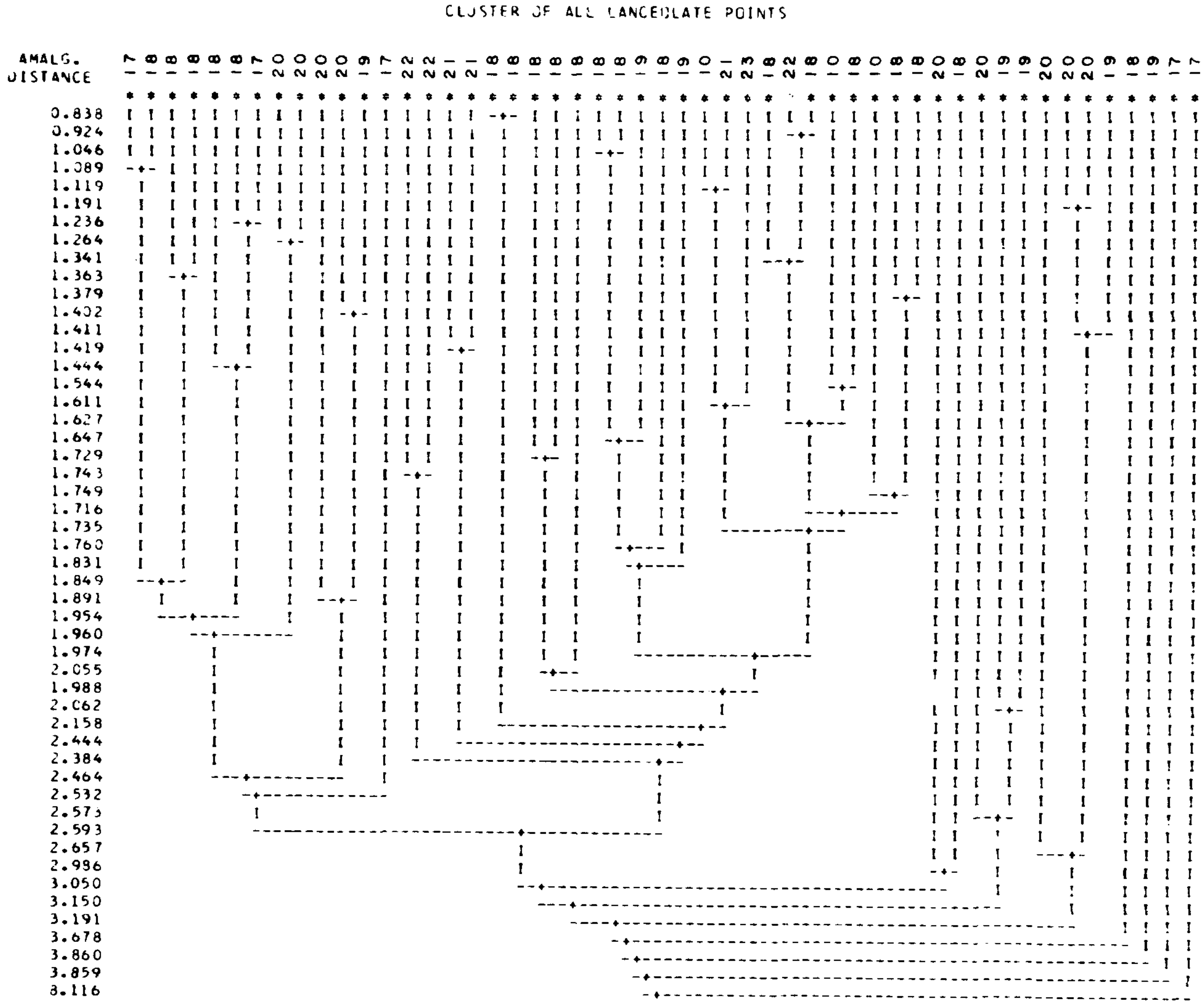

Figure 11.52. Cluster of All Lanceolate Points.

eight categories illustrates a reasonably interpretable set of five clusters that coincide with the discriminant analyses. Accepting clusters at an amalgamated distance of 2.573 and reading from left to right, the clusters are: a group of five Rice Lanceolates (Category 18), three Sedalia (Category 17), one Rodgers (Category 19) and four ovate (Category 20); a major group of thirteen Rice Lanceolates, two Rodgers and all ten of the Dalton Group specimens; a group of one ovate and one Rice Lanceolate followed by a cluster of one ovate and two Rodgers; a similar cluster of three ovate and one Rodgers; and lastly four unique specimens (Categories 18, 19, 17, 17).

DISCUSSION

These results are an independent analysis of point types based upon only the polar coordinate measurements and a preliminary sorting into roughly similar point shapes. That the clusters are not identical to the conventional types is not surprising, though the contracting stem points and lanceolates show considerable agreement. Hierarchical clustering of the other series has the added advantage of reducing ambiguity repeatedly experienced in the initial classification and, when compared to the discriminant analyses, shows similar positioning of point groups in multidimensional space. All of this lends support to the idea that observations of point shape, regardless of the method, are producing highly comparable and often compatible results. The advantage of one approach over another in terms of time expended or reproducibility of results should be weighed against the rigidity of the defined point types. Perhaps in this respect alone the hierarchical clustering is the superior approach primarily because it allows for a directed search of similarities among hierarchically arranged groups. It is also pleasing to note that the small number of objective, interval scale measures upon which this analysis rests is sufficient for many classificatory purposes.

In practice, hierarchical clustering again illustrates a varying faculty to approximate chronologically distinctive point forms. This is particularly so for the darts, the corner notched points and to a lesser degree for the straight stem or basal notched points. Were they not from the same strata, it would also be true of the amorphous medium size points or the flared base series. With good reason we expect that point classifications of other typologists would show similar disparities when dealing with chronologically undefined specimens of these series. Fortunately, discriminant results confirm that temporally correlated types are meaningful and can be closely approximated.

For the lanceolates and contracting stem points hierarchical cluster analysis is especially suitable as it closely approximates conventional description and also indicates where logical subgroupings (macrotypes?) are appropriate. The Rice Lanceolate and Dalton Group cluster, for example, is one that shows gross morphological similarities, though at Rodgers Shelter the Dalton forms are largely separate from the Rice Lanceolates and may well represent an earlier analogue.

VI. CHRONOLOGICAL FRAMEWORK FOR RODGERS SHELTER CHIPPED STONE POINTS

The Rodgers Shelter point sequence represents several clearly divided units, or complexes. In a larger sense, these probably relate to overall adaptive modes, or traditions, in the Ozark Highland. But here our reference will be to point complexes, or the aggregate of tools occurring in the same or closely related depositional units. As illustrated (Fig. 11.53), there are highly significant differences among nine point macrogroups (i.e., an amalgamation of similar points regardless of category; Table 11.51) that define four sequentially related preceramic complexes correlating strongly with the physical stratigraphy of the site. A final, ceramic complex is defined by the arrows, Rice Side Notched and probably some of the contracting stem points. The five point complexes are labeled sequentially Dalton, Early, Middle or Late Archaic and Woodland/Mississippian. To a high degree, these express an evolution of narrow bladed lanceolate or lanceolate derived forms to broad bladed notched and/or stemmed points, which in Figure 11.53 are divided with all the narrow bladed forms to the right of the straight stem points. The diagram also reflects an increasing complexity or proliferation of point styles that may or may not correlate with a single community's tool kit. For most it will be impossible to judge what is the case. But this does not alter the utility of either the diagram or the complexes that are summarized here.

POINT COMPLEXES

Dalton: 10,500 - 9000 B.P.

The assemblage including Dalton, Plainview and fluted lanceolates (Category 10) is the most discrete of the five complexes, due to the rapid alluvial deposition ca. 10,000 B.P. that provided a thick protective mantle of clayey silts not disturbed until the 1960's excavations. The three point types are all truncated lanceolates with ground, concave bases. The Dalton points are often serrated and/or beveled and all but the Plainview points are fluted. The three types probably represent components of a single tool kit that also included the Dalton adze (Morse and Goodyear 1973), symmetrical scrapers and graving spurs on flakes or bifacial implements.

The Rodgers Shelter materials are the oldest dated Dalton assemblage for eastern North America, are coeval with other, mainly fluted Paleo Indian point complexes from the Great Plains (Wilmsen 1974:12; Frison 1974:108, 1976:157), and are associated with a modern forest-edge fauna. The association of Plains Plano, or possibly Llano, points with Dalton is clear and confirms the early development of an Archaic tradition in the eastern Woodlands.

Early Archaic: 9000 - 8100 B.P.

The aggregate of points from the middle and lower part of Stratum 1, approximately 2 meters from the Dalton components, is defined as the Early Archaic complex. Cultural debris in this area is spotty or discontinuous and the point types are not necessarily from a single assem-

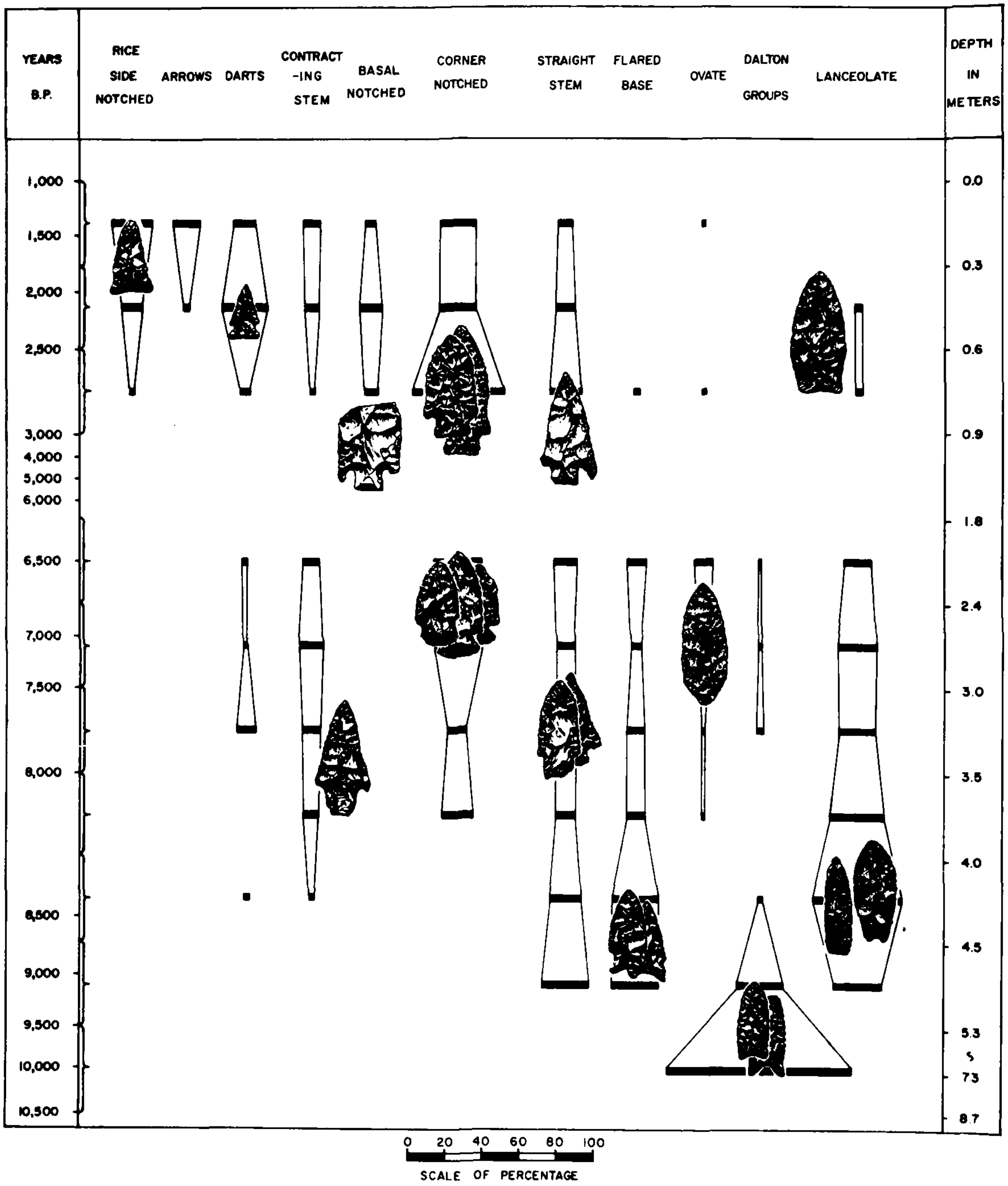

Figure 11.53. Stylistic Changes in Chipped Stone Points, Rodgers Shelter.

TABLE 11.51

Crosstabulation of Macrogroup by Horizon

```
* * * * * * * * * * * * * * * * * * *   C R O S S T A B U L A T I O N   O F   * * * * * * * * * * * * * * * * * * *
   V30      MACROGROUP                                                    BY  V8        HORIZON
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE  1 OF

                   V8
         COUNT    I
         ROW PCT  IONE      TWO      THREE    FIVE     SIX      SEVEN    EIGHT    NINE     TEN           ROW
         COL PCT  I                                                                                    TOTAL
         TOT PCT  I      1 I      2 I      3 I      5 I      6 I      7 I      8 I      9 I     10 I
V30      ---------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                1 I     22 I      5 I      0 I      0 I      1 I      0 I      0 I      0 I      0 I      28
  ARROWS          I   78.6 I   17.9 I    0.0 I    0.0 I    3.6 I    0.0 I    0.0 I    0.0 I    0.0 I     4.3
                  I   15.4 I    3.6 I    0.0 I    0.0 I    1.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                  I    3.3 I    0.8 I    0.0 I    0.0 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                2 I     18 I     35 I      4 I      4 I      2 I      7 I      1 I      0 I      0 I      71
  DARTS           I   25.4 I   49.3 I    5.6 I    5.6 I    2.8 I    9.9 I    1.4 I    0.0 I    0.0 I    10.8
                  I   12.6 I   25.0 I    6.6 I    3.8 I    2.5 I    8.2 I    3.4 I    0.0 I    0.0 I
                  I    2.7 I    5.3 I    0.6 I    0.6 I    0.3 I    1.1 I    0.2 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                3 I     32 I     17 I      1 I      0 I      0 I      0 I      0 I      0 I      0 I      50
  RICE SIDE NOTCH I   64.0 I   34.0 I    2.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I     7.6
                  I   22.4 I   12.1 I    1.6 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  I    4.9 I    2.6 I    0.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                4 I     14 I     12 I      1 I     11 I     12 I     10 I      1 I      0 I      0 I      61
  CONTRACTING STEM I  23.0 I   19.7 I    1.6 I   18.0 I   19.7 I   16.4 I    1.6 I    0.0 I    0.0 I     9.3
                  I    9.8 I    8.6 I    1.6 I   10.6 I   14.8 I   11.8 I    3.4 I    0.0 I    0.0 I
                  I    2.1 I    1.8 I    0.2 I    1.7 I    1.8 I    1.5 I    0.2 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                5 I     12 I     16 I     11 I     16 I      9 I     12 I      5 I      1 I      0 I      82
  STRAIGHT STEM   I   14.6 I   19.5 I   13.4 I   19.5 I   11.0 I   14.6 I    6.1 I    1.2 I    0.0 I    12.5
                  I    8.4 I   11.4 I   18.0 I   15.4 I   11.1 I   14.1 I   17.2 I   25.0 I    0.0 I
                  I    1.8 I    2.4 I    1.7 I    2.4 I    1.4 I    1.8 I    0.8 I    0.2 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                6 I     10 I     18 I      5 I      0 I      0 I      0 I      0 I      0 I      0 I      33
  BASAL NOTCH     I   30.3 I   54.5 I   15.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I     5.0
                  I    7.0 I   12.9 I    8.2 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                  I    1.5 I    2.7 I    0.8 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                7 I     30 I     29 I     32 I     33 I     25 I     14 I      0 I      0 I      0 I     163
  CORNER NOTCH    I   18.4 I   17.8 I   19.6 I   20.2 I   15.3 I    8.6 I    0.0 I    0.0 I    0.0 I    24.8
                  I   21.0 I   20.7 I   52.5 I   31.7 I   30.9 I   16.5 I    0.0 I    0.0 I    0.0 I
                  I    4.6 I    4.4 I    4.9 I    5.0 I    3.8 I    2.1 I    0.0 I    0.0 I    0.0 I
         ---------I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                8 I      0 I      0 I      1 I     13 I      5 I     10 I      7 I      1 I      0 I      37
  FLARED BASE     I    0.0 I    0.0 I    2.7 I   35.1 I   13.5 I   27.0 I   18.9 I    2.7 I    0.0 I     5.6
                  I    0.0 I    0.0 I    1.6 I   12.5 I    6.2 I   11.8 I   24.1 I   25.0 I    0.0 I
                  I    0.0 I    0.0 I    0.2 I    2.0 I    0.8 I    1.5 I    1.1 I    0.2 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
                9 I      1 I      0 I      1 I      4 I      5 I      4 I      0 I      0 I      0 I      15
  OVATE           I    6.7 I    0.0 I    6.7 I   26.7 I   33.3 I   26.7 I    0.0 I    0.0 I    0.0 I     2.3
                  I    0.7 I    0.0 I    1.6 I    3.8 I    6.2 I    4.7 I    0.0 I    0.0 I    0.0 I
                  I    0.2 I    0.0 I    0.2 I    0.6 I    0.8 I    0.6 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               10 I      0 I      6 I      2 I     18 I     19 I     24 I     14 I      1 I      0 I      84
  LANCEOLATE      I    0.0 I    7.1 I    2.4 I   21.4 I   22.6 I   28.6 I   16.7 I    1.2 I    0.0 I    12.8
                  I    0.0 I    4.3 I    3.3 I   17.3 I   23.5 I   28.2 I   48.3 I   25.0 I    0.0 I
                  I    0.0 I    0.9 I    0.3 I    2.7 I    2.9 I    3.7 I    2.1 I    0.2 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               11 I      0 I      0 I      0 I      1 I      1 I      3 I      1 I      1 I     10 I      17
  DALTON GROUP    I    0.0 I    0.0 I    0.0 I    5.9 I    5.9 I   17.6 I    5.9 I    5.9 I   58.8 I     2.6
                  I    0.0 I    0.0 I    0.0 I    1.0 I    1.2 I    3.5 I    3.4 I   25.0 I  100.0 I
                  I    0.0 I    0.0 I    0.0 I    0.2 I    0.2 I    0.5 I    0.2 I    0.2 I    1.5 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
               12 I      4 I      2 I      3 I      4 I      2 I      1 I      0 I      0 I      0 I      16
  MISC.           I   25.0 I   12.5 I   18.8 I   25.0 I   12.5 I    6.3 I    0.0 I    0.0 I    0.0 I     2.4
                  I    2.8 I    1.4 I    4.9 I    3.8 I    2.5 I    1.2 I    0.0 I    0.0 I    0.0 I
                  I    0.6 I    0.3 I    0.5 I    0.6 I    0.3 I    0.2 I    0.0 I    0.0 I    0.0 I
                 -I--------I--------I--------I--------I--------I--------I--------I--------I--------I
           COLUMN      143      140       61      104       81       85       29        4       10       657
            TOTAL     21.8     21.3      9.3     15.8     12.3     12.9      4.4      0.6      1.5     100.0

RAW CHI SQUARE =   799.90283 WITH    88 DEGREES OF FREEDOM.  SIGNIFICANCE =  0.0000

NUMBER OF MISSING OBSERVATIONS =   262
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blage, though the complex is relatively of short duration from a maximum of 9000 to 8100 B.P. Occurrence of Dalton points declines to almost nothing and is supplanted by a peak in Rodgers or Rice lanceolates as well as Graham Cave Notched or Rice Lobed. All of these point types continue into the Middle Archaic complex but in lesser proportions. Basal grinding is common to all of these points; blade serrations and/or beveling are hallmarks of the Graham Cave or Rice Lobed points. As a whole, the points suggest a continuing emphasis of specialized cutting tasks exemplified by use of serrated blades.

Middle Archaic: 8100 - 5200 B.P.

The Middle Archaic complex includes all of Stratum 2 and upper Stratum 1 (horizons 7-5) and represents a radical departure from the preceding complex. Changes in point types within this stratum are insignificant (Table 11.2) even though the unit is separable on stratigraphic grounds into three reasonably discrete horizons. Some mixing has occurred, however, but not of a magnitude sufficient to produce the uniformity of types. With this complex the proliferation of point styles achieves its apex and other diagnostic ground stone implements, especially the full-grooved axes, occur. The Early Archaic lanceolates still predominate. But, in addition, ovate lanceolates, flared base Johnson points, and a broad bladed cluster of Kirk-like stemmed and notched (both Williams and Marcos or Cypress Creek I) points, Hidden Valley contracting stem and concave, ground base side notched darts occur in roughly similar frequencies. Basal grinding remains an important feature, but blade serration and beveling are not as diagnostic as previously. Fluting occurs also on Dalton-like points (Category 21) as well as on a number of notched points including a distinctive corner notched dart with a bifurcated base, St. Johns Variant of San Patrice points commonly found in Louisiana and east Texas (Duffield 1963). Bifurcated base LeCroy points also occur in small numbers. Kirk-like corner notched forms reach their highest frequencies near the top of the stratum and may represent a minor carry-over into the Late Archaic complex.

Late Archaic: 3600 - 2300 B.P.

This complex is separated from the Middle Archaic by the nearly sterile alluvial fan gravels of Stratum 3 and is composed of mainly basal Stratum 4 points, which again witness an almost complete transition from the Middle Archaic styles. Prominent among the late Archaic point complex are the Sedalia lanceolates, the basal notched points--particularly Smith or Castroville, the corner notched Etleys and Afton points with their distinctive pentagonal outline, and lastly, the Table Rock dart, a straight stemmed point with ground base. Preliminary data from Phillips Spring indicate this complex began by 4000 B.P.

Woodland/Mississippian: 2000 - 1000 B.P.

This final complex is but a thin veneer in the upper foot or so of

AD-A147 653 HARRY S TRUMAN DAM AND RESERVOIR MISSOURI HOLOCENE ADAPTATIONS WITHIN THE..(U) ILLINOIS STATE MUSEUM SOCIETY SPRINGFIELD M KAY JUN 82 DACW41-76-C-0011 4/4

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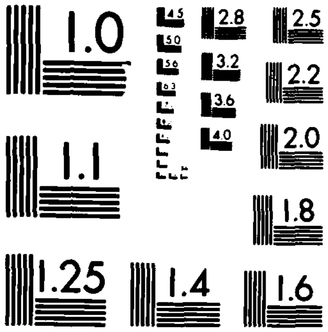

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Stratum 4 and consists predominately of Rice Side Notched points and Late Woodland or Mississippian arrows (Scallorn or its derivatives; Cahokia Notched). The contracting stem Langtry and Gary points may also be a part of this overall complex as probably are some of the corner notched darts. A distinctive point, the Cupp point that resembles an oversized Scallorn point, may also be part of this complex but is represented by only a single specimen. Because of the limited nature of this complex respective to the Archaic sequence, further consideration will not be given.

GEOGRAPHIC DISTRIBUTIONS OF THE ARCHAIC SEQUENCE

The Archaic sequence depicted in Figure 11.53 is a chronological framework for the Pomme de Terre and mid-Osage basins that illustrates: (1) a "pure" Dalton complex of truncated, fluted lanceolates; (2) an overall predominance of lanceolate forms through the Middle Archaic; (3) an increasing proliferation of point styles having considerable continuity and with its maximum expression in the Middle Archaic; and, lastly, (4) an abrupt transition to largely dissimilar Late Archaic point styles with a predominance of basal or corner notched forms. Typical of this sequence as well are insignificant differences in materials or heat treatment of Archaic points, reflecting the local availability of suitable chert usually "improved" by heating, a technological rather than stylistic contrast with other midwest sequences (Klippel and Maddox 1977). There are, however, significant stylistic similarities and contrasts with other Archaic sequences. Exploring these relationships will allow for a geographic statement, albeit minimal, of correlated assemblages of related culture areas.

Putting aside for the moment the Dalton complex, there are several southeastern (Lewis and Lewis 1961; Coe 1964; Broyles 1966; 1971; Griffin 1974; J. Chapman 1975) or Middle Mississippi Valley (Fowler 1957, 1959) Early and Middle Archaic sequences that highly correlate with Rodgers Shelter. Tuck (1974) characterizes these as being comprised of a Big Sandy (side notched) followed by a Kirk (straight stemmed or corner notched) horizon; the latter is also recognized in the Red River Basin of southeast Oklahoma (Wyckoff 1970:88-91). At Modoc Rock Shelter (Fowler 1959:36-37) in southern Illinois an important type is the Hidden Valley point, which also occurs at Rodgers Shelter and other Ozark Highland sites (Baerreis 1951; Wyckoff 1964) in Oklahoma. The major difference between the southeastern or Middle Mississippi Valley sequences and that of Rodgers Shelter is the predominance of Rodgers or Rice lanceolates at the latter site. This seems to be a crucial element, approximated only at the Doerschuk site in the Carolina Piedmont (Coe 1964:34-35, 40-41, 43-44) by the Guilford lanceolate dating roughly to 6000 years ago.

The predominance of similar lanceolates is found in few other stratfied sequences outside of the Ozark Highland. A notable exception is the Starved Rock lanceolates (Mayer-Oakes 1951) from north Illinois. Inspection of several specimens indicates a close identity with the Rodgers Shelter Rice lanceolates, particularly the smaller reworked specimens. They are not only of the same proportions, have similar flaking and basal grinding, but also several are of heated oolitic and banded chert which looks like it is from the Jefferson City formation that outcrops at Rodgers Shelter. Other similar expressions include the non-Cody complex of the Big Horn Basin of north central Wyoming and south Montana, particularly sequences from Medicine Lodge Creek (Frison 1976:157-163) and several related sites in the Yellow Tail Reservoir (Husted 1969). Wormington (1957) and others (Willey 1966; Benedict and Olson 1973) summarize the development of similar lanceolates for the Great Plains and Rocky Mountains, and it is probably a reasonable assumption that the Early and Middle Archaic lanceolates from Rodgers Shelter probably derived from the nearby Central or High Plains.

Although there are associated lanceolate forms, the Prairie Archaic (Anderson and Shuttler 1974:161-168) of western Iowa and eastern Nebraska, and possibly north central South Dakota (Ahler *et al.* 1974) show few similarities with the overall complex of Early and Middle Archaic point styles from Rodgers Shelter. This is also true of another deeply stratified prairie site, Koster (Houart 1971; Cook 1975) from west central Illinois.

Perhaps not surprisingly, the greatest similarity with the Rodgers Shelter sequence is shared with other Ozark Highland or southern border Prairie Peninsula sites. Prominent among these are the earlier levels at Graham Cave (Logan 1952; Klippel 1971) and Research Cave (Shippee 1966) in Missouri, both having Dalton points associated with Graham Cave, or Big Sandy side notched types. To the east of Rodgers Shelter, the Tick Creek complex (Roberts 1b65; McMillan 1965:54-55) of the Gasconade and Meramec basins parallels the Early to Middle Archaic sequence though stratigraphic controls are not as well defined. To the south in the now inundated White River area near the Arkansas border Rice Shelter (Bray 1956) manifests a similar sequence, as do the Arkansas sites Tom's Brook (Bartlett 1962) and Breckenridge (Wood 1962) shelters. In northeastern Oklahoma the Packard site (Wyckoff 1964) in the Grand River drainage again illustrates a nearly identical stratigraphic sequence with a basal date of approximately 9400 years B.P.

Dalton points are found at most of these Ozark sites, usually in uncertain or disputed contexts. Dalton forms at Rodgers Shelter apparently persisted until approximately 6300 B.P. and it could be that the other examples represent similar hold-overs, or that earlier forms such as the Big Sand points at Modoc Rock Shelter (Fowler 1959:23) are in evidence. An alternate interpretation is that the Dalton forms in upper Stratum 1 and Stratum 2 are mixed stratigraphically. At any rate, the Dalton complex at Rodgers Shelter is stratigraphically separate from these later instances and confirms Tuck's (1974) placement of Dalton as the initial Archaic horizon in the eastern United States. Probably Dalton originated in the western Ozark Highland and then rapidly spread eastward to the Atlantic seaboard in a belt from southern Illinois (Fowler 1959), Kentucky (Rolingson and Schwartz 1966), north Alabama (DeJarnette *et al.* 1962), West Virginia (Broyles 1971) and North Carolina (Coe 1964). It probably comes as no great shock that within this belt point styles quickly diversified into more or less regional Archaic complexes whose terminal expressions are the most discrete.

This is probably true of the Rodgers Shelter Late Archaic complex. Other Pomme de Terre sites where this complex is roughly defined include Blackwell Cave (Wood 1961:52-62; Falk 1969) and Phillips Spring (Chomko 1976), which has a series of radiocarbon dates beginning about 4000 B.P. Specific point types such as Afton are further defined to the western Ozark Highland (Wood 1960), or are more common in the adjacent prairie areas to the north and east (Seelen 1961; Klippel 1969). Similarities are also noted with the Grove focus of northeast Oklahoma (Baerreis 1951) and there is high continuity with the Sedalia complex (C. Chapman 1975:200-203), of which the lower Pomme de Terre sites are a more southerly extension.

APPLICATION OF RESULTS: AN ASSESSMENT

The geological setting of Rodgers Shelter is not complacent but rather is representative of massive Holocene alluviation, a depositional pattern now well defined in the lower Pomme de Terre (Haynes 1976) and noted in other Ozark Highland drainages (Knox 1966). The Rodgers Shelter chipped stone point complexes are defensible because they are not only easily partitioned by conventional or numerical taxonomic procedures but also occur in an understood stratigraphic context. It is to be expected that other manifestations of this sequence will be defined primarily from other buried components though surface finds (C. Chapman 1975:200-203) correlating with at least the Late Archaic complex occur. In this respect, Haynes' (1976) research represents an opportunity within a restricted portion of the lower Pomme de Terre to systematically define buried components within terrace insets of the Rodgers alluvium. A similar program based upon terrace geomorphological research throughout the middle Osage basin and using power earthmoving equipment to quickly locate sites (Wood 1961:76-87; J. Chapman 1975:18, 1977) would be feasible now that these lands are in Federal ownership.

It will only be through this additional research in the Ozark Highland, perhaps best initiated in the middle Osage basin, that finer resolution will be possible of the Middle Archaic complex in particular. This complex is clearly identified at several sites but each has a host of problems involving its interpretation. Two possibilities are most likely. The first is that the proliferation of points styles represents no more than chronic mixing of deposits and that each point style is representative of a different small group. This argument has been effectively illustrated by Coe (1964) and Broyles (1966, 1971) and J. Chapman (1977) for alluvial sites with well separated, buried single point type components. An alternative idea is that the complex is evidence of a larger kin-based group with a diversification of tool functions synonomous with various point types. Ahler (1971) forcefully documents this possibility for the Rodgers Shelter Middle Archaic and the research reported here on preforms and basal reworking of points is also supportive, as are indications from Phillips Spring. We need a comprehensive sample of buried Middle Archaic sites.

The point sequence for Rodgers Shelter is a first approximation rather than the ultimate chronological statement of point styles in the Ozark Highland. What makes it particularly attractive is the clarity among the various complexes, which allows for gross chronological placement of other Ozark components. Research at other sites will be required for more detailed point seriation and, more importantly, to evaluate the technological, extractive and environmental subsystems that these complexes represent.

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