AN ARCHAEOLOGICAL COMPARISON AND EVALUATION OF TWO QUANTITATIVE GROUPING TECHNIQUES

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ABSTRACT

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Archaeologists have traditionally defined types by subjective means, thereby rendering their classifications neither repeatable nor testable. The use of quantitative typological methods has been advocated to counter these problems. Such methods have been, in fact, successfully applied to archaological materials.

It is evident, however, that if quantitative techniques are to be maximally beneficial, a rigorous analytical methodology must be constructed about their use. Such a methodology would include a systematized attribute list and a cross-comparison and evaluation of various numerical techniques. The former is prerequisite to rendering quantitative groupings repeatable, the latter to determination of those techniques showing maximum utility and comparability of results.

An analytical methodology based upon an expansion of L. R. Binford's 1963 projectile point attribute list and a comparison and evaluation of two of the more commonly employed quantitative grouping techniques (average-link cluster and principal-component analyses) is set forth here. Data utilized in the study were 155 projectile points, 35 bifaces, and 80 end scrapers from the Lowton site in south-central Manitoba. Additionally, final objective typologies were compared to published subjective groupings of the same sorts of material.

It was found that the results of the factor analysis were not comparable with those of the cluster analysis. Furthermore, it was determined that the factoring technique is not suitable for the type of analysis attempted here.

Comparison of final clusters with classifications found in the literature revealed that projectile point and end scraper cluster types are comparable to subjective groupings of the same sorts of material, although numerical classifications tend to be more generalized in composition. The final biface cluster type is not comparable to subjectively-defined groupings, nor may it be said to be an adequately-defined numerical grouping. This is a function of sample size, and the number and nature of the attributes of analysis.

Weaknesses inherent in this study and areas for future research are outlined.

ACKNOWLEDGEMENTS

For the material on which this study has been carried out I am much indebted to Mr. Chris Vickers and the Laboratory of Anthropology, the University of Manitoba.

Advice and criticism of the problems dealt with in this thesis were provided by the members of my Thesis Committee: Mr. C. W. Amsden, Mr. R. T. Carter, and Dr. W. W. Koolage. I am particularly indebted to Mr. Amsden for first making me aware of the value of applying statistics to archaeology.

Finally, I wish to thank Miss Mary Ann Tisdale, who has provided the excellent illustrations of the projectile points, bifaces, and end scrapers used in this study.

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CHAPTER I
INTRODUCTION

BACKGROUND AND USEFULNESS OF NUMERICAL TAXONOMIES

Within the last thirty years there has been an ever increasing application of rigorous methodologies to archaeological data in an attempt to enhance both analytical efficiency and utility, especially as the latter bears upon the formulation and testing of hypotheses (Brothwell and Higgs 1969). However, this scientific orientation of the discipline may by no means be considered comprehensive, since many areas of research continue to generate results lacking the technological and terminological standardizations prerequisite to unification of thought and repeatability of action. Regrettably, this deficiency occurs in what is here regarded a crucial area of consideration, the realm of typology (Wormington 1957:3; Wheat, Gifford and Wasley 1958:34; Tugby 1958:24; Clarke 1968:31).

Anthropologists have long acknowledged a relationship between cultural organization and patterning in archaological residues, particularly artifactual remains. It is evident, therefore, that some consensus of what constitutes a given type — "real"or otherwise — is necessary if, as it has been postulated, the major aim of archaeology is to reconstruct past cultural systems (Steward and Setzler 1938; Binford 1962, 1963, 1968:2; Keesing 1965:4; Steward 1967; Brothwell and Higgs 1969:23). Plainly, a more rigorous typological methodology is needed in the archaeological context.

Such a methodology, involving the use of quantitative techniques, has already been developed for use elsewhere, but as yet its archaeological applications are few and entirely experimental in nature. Quantitative strategies operate on the basic premise that any object is a potential source of knowledge capable of representation in numeric form (Heizer and Cook 1956:229). Various recent studies have demonstrated the value of quantitative expression to the archaeological typological problem, consistently generating statistically significant artifactual groupings of an objective, and therefore potentially repeatable nature.

Although they are by no means exhaustive of suitable quantitative techniques available to the archaeologist, average-link cluster, proximity, and factor analyses have enjoyed the widest application to date. Whallon (1972) has recently advocated the use of what may be considered yet another method of arriving at meaningful patterns of relationship among sets of variables through the application of the statistic chi-square. The proposed technique remains to be tested against or compared with others in an experimental situation. Indeed, with the notable exception of studies conducted by Hodson, Sneath, and Doran (1966) and Cowgill (1967), it has been common practice to favour one technique over another ignoring the basic fact that all such methods are bound by peculiar inherent limitations which tend both to restrict applicability and to influence results obtained (Sokal and Sneath 1963:166-168; Cowgill 1968:367; Clarke 1968:594). Furthermore, the failure to clearly delineate attributes has rendered most existing quantitative studies non-repeatable.

THE PROBLEM

If archaeological typology is to become maximally efficient and useful, a rigorous analytical methodology must obviously be implemented. The objective of this study is the formulation of such a methodology, the salient aspects of which are outlined below:

i) Systematization of attribute list(s).
Each attribute list, including terminology, form conceptualizations, and measurement practices is precisely stated that the results might be repeatable.

ii) Use of quantitative typological methodology. Quantitatively-produced typologies promise to best meet archaeological classificatory needs. Here, two numerical taxonomic techniques, average-link cluster and principal component analysis (with rotation to a simple structure), were applied to three artifact categories, namely 155 projectile points, 35 bifaces, and 80 end scrapers. The various steps involved in this analysis have been set forth.

iii) Cross-comparison and evaluation of multivariate techniques.
Experimental testings and cross-comparisons of all suitable multivariate techniques on the same set or sets of data utilizing identical variables for each analysis are required to determine comparability of resultant typologies (Sackett 1966:360). The two techniques employed in this analysis and the various typologies generated are compared and evaluated.

iv) Comparison of subjective vs objective typologies.
The lack of precision involved in the generation of types through individualized intuitive analysis must be demonstrated to discourage use of this unsatisfactory typological method.

The artifacts chosen for analytical purposes are from the Lowton site, a confined area of late prehistoric habitation located near Pelican Lake in south-central Manitoba. Calculations were made on the University of Manitoba's IBM - 360/65 computer, using Rubin and Friedman's *A Cluster Analysis and Taxonomic System for Grouping and Classifying Data* and Nie, Bent, and Hull's *Statistical Package for the Social Sciences*, Version 3.00.

CHAPTER II
THE ARTIFACT SAMPLE

HISTORY OF THE LOWTON SITE

The Lowton Village site, or DiLv-3 as it is classified under the Borden system of site designation (Borden 1952), is located principally on farm property previously owned by Harry C. Lowton, a resident of the Belmont-Ninette district, south-central Manitoba (Vickers 1945a:19). Situated approximately three miles west of Belmont (Figure 1) on the south half of Section 26, Range 16, Township 5, Rural Municipality of Strathcona, the site covers the south-west corner of the former Lowton tract, extending over a level area of roughly twenty acres to a maximum depth of thirty inches (Vickers 1945a:19-20; Wettlaufer 1952:177). The nearest supply of surficial water in quantity is apparently Pelican Lake, although slough water has been noted in the immediate vicinity of the former habitation area (Wettlaufer 1952:177).

Originally discovered by the late Frank Brown of Glenora, Manitoba, the site was surface collected by local residents for many years. It was extensively gathered and partially excavated between May, 1945, and September, 1947, by Chris Vickers, then of

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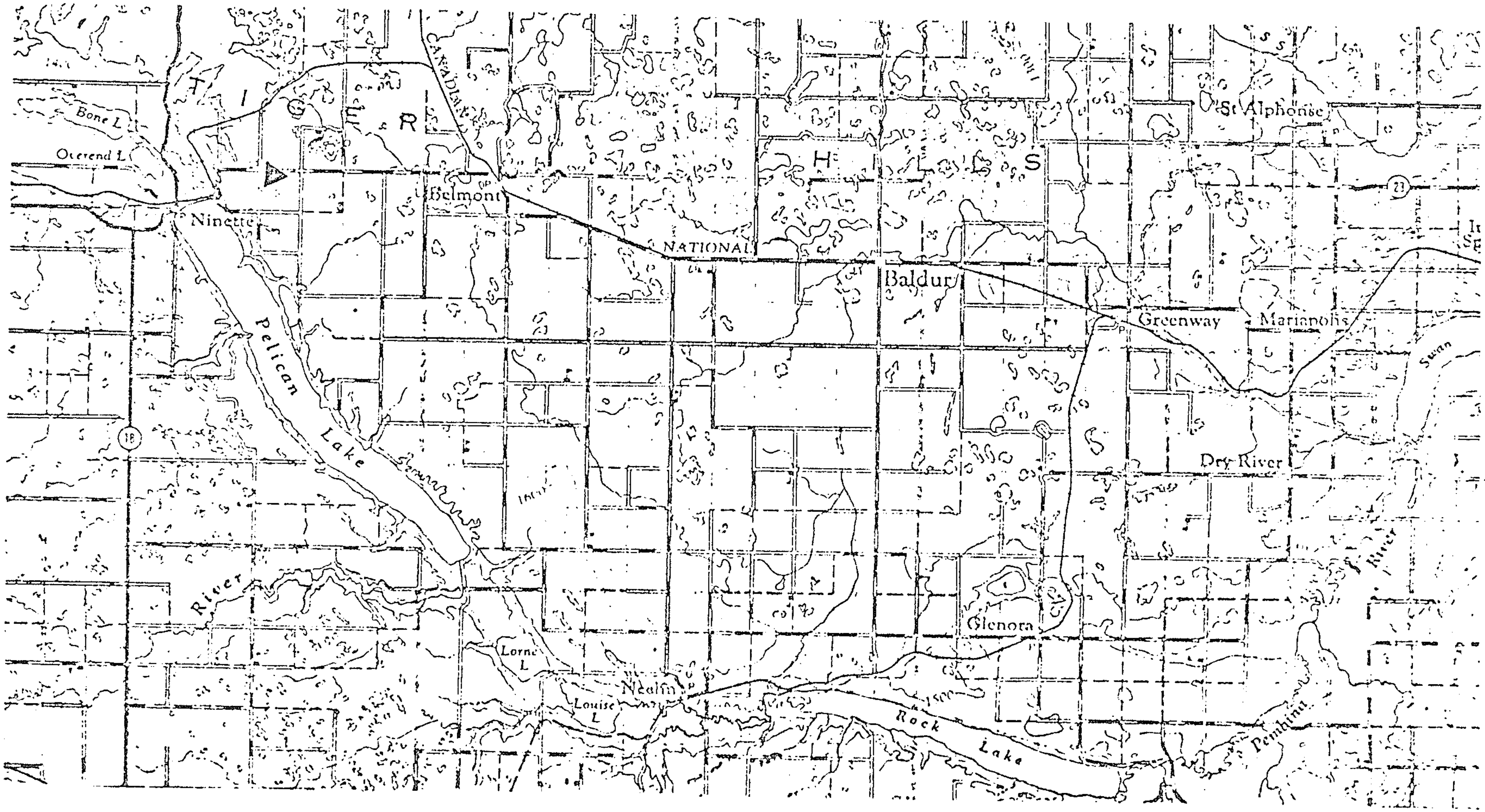

Figure 1 — Lowton site (triangle) and environs.

Base map from Canada Department of Mines and Technical Surveys, Brandon 62G, Edition 2. 1:250,000.

Baldur and currently of Winnipeg, Manitoba (Vickers 1945a, 1945b, 1946, 1947). In September of 1947, roadbuilding activities between Belmont and Ninette totally destroyed the habitation area, although approximately thirty years of cultivation by means of a one-way disc harrow prior to this date had already effectively done so (Vickers 1945 a, 1945b, 1946, 1947; Wettlaufer 1952:177).

The site has never been satisfactorily dated. Arguing on the basis of decorative motifs on certain of the site's ceramics, Vickers (1945a:24, 1945b) estimates that it was inhabited *circa* A.D. 1300 by an unknown group, possibly of Mandan-Hidatsa affiliation. Wettlaufer remarks, on the other hand, that the artifactual remains are similar to those of the Pelican Lake-Manitoba foci, which could date the site as early as A.D. 1100 or as late as A.D. 1600 (MacNeish 1948:64). Mayer-Oakes (1969:365) has placed the village occupation in the A.D. 1600-1650 time period, noting a correlation of archaeological materials to the historically documented Assiniboine.

Material from this and other sites was donated to the Department of Anthropology at the University of Manitoba in 1962 by Mr. Vickers. Included among the Lowton collection were several artifacts gathered from that site by Mr. Brown and subsequently purchased by Mr. Vickers.

THE ARTIFACT CLASSES ANALYZED

Selected for analysis from the Lowton collection were: 155 projectile points of the side-notched and triangular varieties common to the site (Wettlaufer 1952:177); 35 bifaces ranging from ovate, rectangular, and triangular, to teardrop-shaped in outline; and 80 end scrapers, many of which exhibit bifacial working (Vickers 1945b). It is believed that this sample constitutes the total number of whole artifacts for each of the three categories in the collection. Other artifact groupings were not used owing either to small sample size or the degree of breakage to which they had been subjected.

ADDITIONAL SITE MATERIALS

In addition to those artifacts actually utilized in the study, there are in the Vickers' Lowton collection: 2,839 pot sherds; 905 lithic artifacts, utilized, and waste flakes; 111 pieces of bone; and 69 pieces of shell. These may be categorized as follows:

a) ceramics — 1,287 rim sherds and 1,552 body sherds.
   Decorative motifs indicate southern affiliations (Vickers 1945b).

b) lithics — 179 broken projectile points, 14 broken end scrapers, 7 grooved hammers, 3 anvils, 1 adze, 4 gravers, 7 hoes, 17 hammerstones, 2 drills, 3 pipe fragments, 342 retouched and utilized flakes, and chipping detritus. The smaller artifacts, including those used in the study, are formed primarily of silicious materials: chert, chalcedony, Knife River flint, and quartzite. Larger tools such as hammers, anvils, and hammerstones tend to be of granitic composition. Three fragments of obsidian were recovered from the site and are currently being dated.

c) bone — 5 projectile points and a small quantity of fragmentary faunal remains were taken from the site. Wettlaufer (1952: 177) reports that ninety per cent of the osteological remains from Lowton are representative of Bison bison.

d) shell — some of the shell is that of freshwater clam, possibly Lampsiles ventricosa (Vickers 1950:164), which was locally obtainable, while the remainder is marine and could only have been secured through trade.

LIMITATIONS OF THE DATA

The Lowton collection imposes inferential limitations owing to the fact that it can by no means be considered a statistically random sample. Prior to collection most of the site's surface had been thoroughly ploughed, imposing sampling difficulties generated by mixing, the effects of which are not properly understood (Vescelius 1960:460). Furthermore, artifact retrieval proceeded in an imprecise manner: Vickers' field notes indicate both a selective and a canvassing bias in the recovery of cultural remains, complicated by the activities of other collectors on the site. Finally, not all of the collection was catalogued prior to donation, consequently the exact provenience of some of the objects is unknown.

The utilization of such materials in the kind of study proposed is justified on the basis of sample size and variability. The number of artifacts is large enough to permit other than chance correlations to be demonstrated by the various quantitative techniques employed in the analysis; moreover, the variability of the sample poses interesting problems in classification. The difficulties imposed by the use of such a sample are largely overcome by considering the sample as a population for the purposes of this analysis.

CHAPTER III
THE ATTRIBUTES OF ANALYSIS

ANALYTICAL FRAMEWORK

A rigorous typological methodology presupposes a systematized attribute list. Consequently, all attributes (including terminology, form conceptualizations, and measurement practices) adopted for each of the three artifact categories classified in this study are specified and described.

Variables employed in the following analysis are based upon a descriptive framework devised by L. R. Binford (1963:193-221) for use with projectile point data. Binford's attribute list has been applied to the Lowton projectile points with minimal revision, subsequently being extended to include bifaces and end scrapers. This particular scheme, in contrast to others available, is considered suitable for the kind of study undertaken in that it is, for the most part, explicit, complete, easily adaptable, and workable. The majority of terminology presented is precisely defined, thereby rendering the list satisfactory for comparative work. The variables, reflecting both geometrical form and technical processes, have been so incorporated as to permit wide application and great flexibility. With minimal change the framework may be extended to other functional classes, a great advantage when problematical artifacts bridging two or more categories must be typed. Finally, the attribute list has been devised in such a manner that it may be easily codified for inclusion on key punch cards. Binford's descriptive and analytical framework for projectile points has been repeated below in order that the accompanying discussion of end scraper and biface categories might be more fully understood.

Prior to a presentation and discussion of these attributes, it is considered advisable to elaborate upon two concepts which prove fundamental to this study, those of "attribute" and "type". The ability to discriminate between, or to even make distinctions within, various artifact categories presupposes recognition of those characteristics which serve to set one class apart from another. These characteristics — properties or qualities pertaining to a particular artifact class or category — may be termed "attributes" (Spaulding 1960a:61). As such, attributes may be highly varied in nature, encompassing physical and chemical properties, temporal and spatial aspects, and culturally patterned behaviour (Spaulding 1960a:61). This latter is of primary concern in the reconstruction of past cultural systems. Following from this, an homogenous aggregate of artifacts which share a consistently recurrent range of attributes may be considered a "type". In this particular study, types are held to be polythetic, that is "each (constituent) individual possesses a large but unspecified number of the attributes of the aggregate, each attribute is possessed by large numbers of these individuals, and no single attribute is both sufficient and necessary to the aggregate membership"(Clarke 1968: 42, after Sokal and Sneath 1963:14).

MORPHOLOGY AND ATTRIBUTES OF POINTS, BIFACES, AND END SCRAPERS

Generalized terms relating to the three artifact categories under consideration demand clarification prior to a detailed examination of attributes. These terms, the last two of which have been derived directly from Binford's 1963 study, are:

a) projectile point — a marginally retouched, regularly-shaped artifact exhibiting beveled or double beveled lateral working edges converging at one point along its longitudinal axis (White 1963:10,32).

b) biface — a bifacially worked artifact with longitudinal working edge(s) and marginal retouching (White 1963:40).

c) end scraper — a marginally retouched artifact exhibiting a beveled transverse working edge in relation to its longitudinal axis (White 1963:41).

d) longitudinal axis — the median line drawn from the point of percussion of a flake tool, or the medial point of the base of a bifacial tool (White 1963:10).

e) element — a morphologically differentiated edge or area.

f) subelement — a morphologically differentiated edge definable in terms of major directional change.

g) primary chipping — the initial alteration of a "blank" to obtain the desired rough shape. All chip scars not obscured or partly obscured by others made in a distinctly different manner will be described as primary chip scars.

h) secondary chipping — the supplementary alteration of a "blank" which serves to further shape, in other than specifically marginally-confined areas, products of primary chipping. Secondary chipping scars tend to originate marginally and to obscure the points of origin of the primary scars.

i) primary retouch — the marginally-confined secondary removal of small flakes from an artifact for the purpose of sharpening or resharpening the edge (Wormington 1957:279).

j) secondary retouch — the marginally-confined deliberate tertiary removal of small flakes from an artifact. These tend to obscure the points of origin of the primary retouching scars.

k) reworking — the reshaping of an artifact, either as a function of breakage or remodification into another style of implement.

l) points of juncture — the loci where one element of an artifact connects with other elements. These loci are referenced on the basis of their relationships to the longitudinal axis and its point of intersection with the proximal end of the artifact. They are named by using the terms of the two elements which can be said to unite at a given locus; for example, the lateral-basal point of juncture would be the point at which the lateral edges of the artifact intersect with the basal edge.

Detailed attribute definitions for points, bifaces, and end scrapers are considered below. Following Binford's proposed attribute list, each class of artifact is analyzed from a morphological, geometrical, and technical viewpoint. Morphological attributes may be best understood as those dealing with areal or edge form. Geometrical attributes serve to further describe morphological constituents, both as they occur individually and in combination with others, while technical attributes are those considered to be indicative of manufacturing techniques and/or motor habits. Many of these attributes are restated in metric terms, a necessity to adequate description. Parentheses indicate to which artifact category or categories the definitions apply if they have not been utilized for all three classes.

a) Points of juncture [*Figure 2*]

i) proximal — the point of any element that is nearest the locus where the longitudinal axix of the artifact interesects the basal edge.

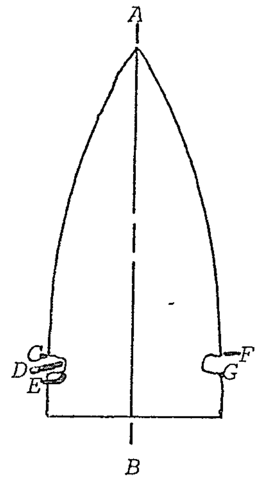

Figure 2 — Points of juncture

A	tip	E	proximal medial point
B	longitudinal axis	F	distal point
C	shoulder	G	proximal point
D	distal medial point		

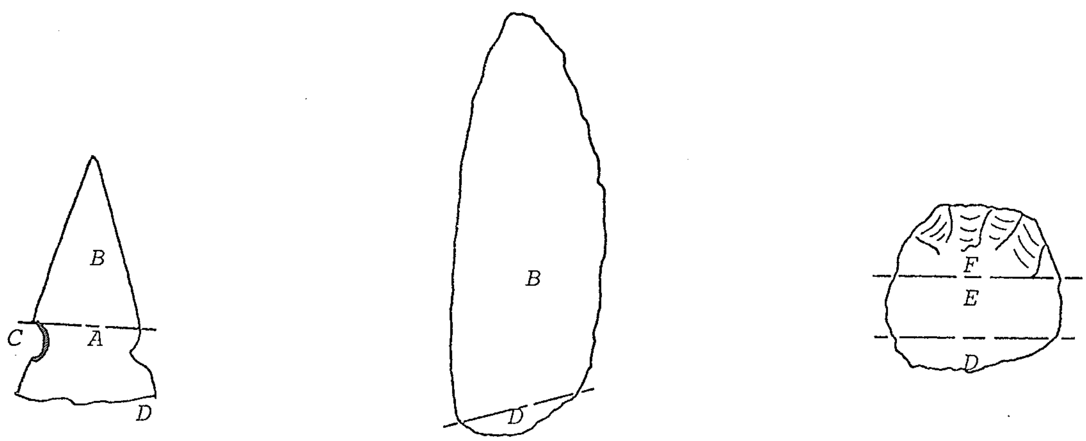

Figure 3 — Elements

A	tang	D	base
B	blade	E	body
C	haft element (heavy line)	F	front

ii) distal — the point of any element that is most distant from the locus of intersection between the longitudinal axis and the basal edge.

iii) medial — the loci where any major directional change occurs along the edge of a defined element (applies to points and scrapers).

iv) tip — the only permanently defined point of juncture on the projectile point. It is concurrent with the most distal locus of the projectile, and is defined as the point of juncture between the two lateral edges of the distal segment (applies to points).

b) Elements [*Figure 3*]

i) haft — the edges between any two points of interruption in the projected symmetry of the proximal segment of the artifact (applies to points).

ii) base — the edge between the two loci that serve to mark the transition between the proximal transverse edge and the lateral longitudinal edges of the projectile point (applies to points).

That area of the artifact defined by a line drawn through the two most proximal points of the lateral edges, and taking in all the area proximal to this (applies to bifaces and scrapers).

iii) blade — the area delimited by the most distal point or points of the artifact and the lateral-basal points of juncture of the longitudinal edges. In its applicability to projectile point data, the distal points of juncture of the haft element may additionally serve to delimit the distal margin of the blade element (applies to points and bifaces).

iv) tang — the area of the projectile point defined by a line drawn through the two most distal points of the haft element, regardless of whether they are points or juncture or medial points, and taking in all the area below this line to the proximal limits of the projectile point. If the haft element is absent, the projectile may be said to lack a tang[1] (applies to points).

v) front — that area of the scraper defined by a line drawn through the two most distal points of the lateral edges, and taking in all the area distal to this (applies to scrapers).

vi) body — that area between the two most proximal and the two most distal points of transition of the lateral longitudinal

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1. In his discussion of projectile point elements, Binford has presented both modified and unmodified tang subelement categories for consideration. These have been omitted from the present study in an attempt to limit the number of variables requiring simultaneous testing. Such limits are necessary if statistically reliable measures of significance are to be obtained (Sackett 1966:369). For this reason, there is no pretense of a complete attribute listing for each artifact category. It is believed that the subelement omissions did not greatly affect results in view of the fact that the tang as an element is analyzed elsewhere.

edges of the scraper (applies to scrapers).

c) Morphological and geometrical attributes [*Figures 4 to 17, inclusive*] — *described in terms of the most geometrically consistent edge, where applicable.*

i) blade outline

(a) triangular [*Figure 4A*] — the lateral edges describe a straight line between the proximal defining points of the blade and tip. The widest part of the blade is between the proximal defining points (applies to points).

(b) excurvate [*Figure 4B*] — the lateral edges describe convex lines between the proximal defining points of the blade and tip. The widest part of the blade is not between the proximal defining points (applies to points).

(c) ovate [*Figure 4C*] — the lateral edges describe convex lines between the proximal and distal defining points of the blade. The widest part of the blade is between the proximal defining points (applies to points and bifaces).

(d) rectangular [*Figure 4E*] — the lateral edges are roughly parallel to one another and describe more or less straight lines between the distal and proximal defining points of the blade (applies to bifaces).

(e) rectangular [*Figure 4E*] — the lateral edges are roughly parallel to one another and describe more or less straight

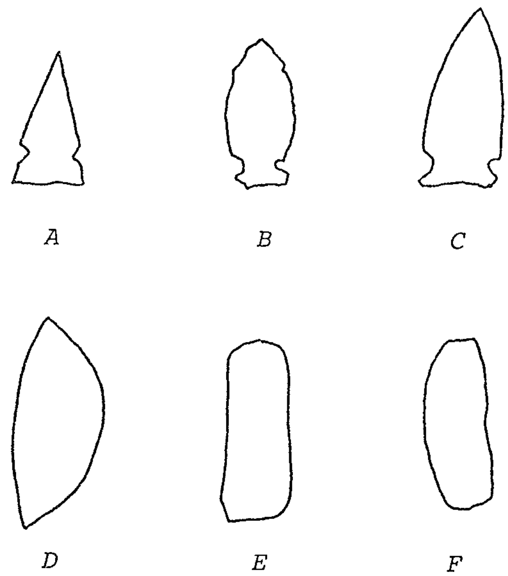

Figure 4 — Blade outlines

A	triangular	D	lunate
B	excurvate	E	rectangular
C	ovate	F	crescentic

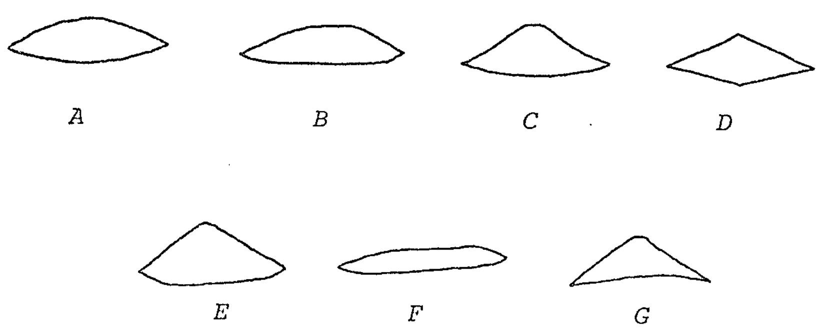

Figure 5 — Transverse sections

A	biconvex	E	plano-triangular
B	plano-convex	F	biplano
C	convexo-triangular	G	concavo-triangular
D	bitriangular		

lines between the distal and proximal defining points of the blade (applies to bifaces).

(f) crescentic [*Figure 4F*] — one lateral edge describes a concave, the other a convex line between the proximal and distal defining points of the blade (applies to bifaces).

ii) transverse section [*Figures 5A to 5G*] — observed at midpoint of blade or body.

(a) biconvex [*Figure 5A*]

(b) plano-convex [*Figure 5B*]

(c) convexo-triangular [*Figure 5C*]

(d) bitriangular [*Figure 5D*]

(e) plano-triangular [*Figure 5E*]

(f) biplano [*Figure 5F*]

(g) concavo-triangular [*Figure 5G*]

iii) longitudinal section [*Figure 6A to 6G*] -- observed on longitudinal axis with artifact oriented vertically.

(a) plano-convex [*Figure 6A*]

(b) biconvex [*Figure 6B*]

(c) biplano [*Figure 6C*]

(d) concavo-convex [*Figure 6D*]

(e) plano-triangular [*Figure 6E*]

(f) convexo-triangular [*Figure 6F*]

(g) concavo-triangular[*Figure 6G*]

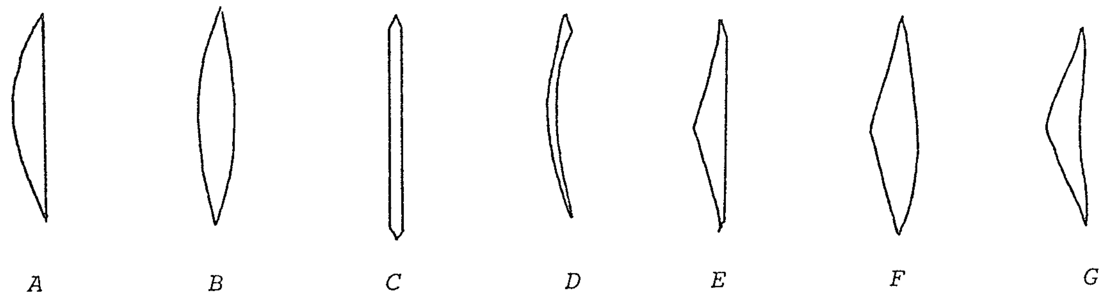

Figure 6 — Longitudinal sections

A	*plano-convex*	*E*	*plano-triangular*
B	*biconvex*	*F*	*convexo-triangular*
C	*biplano*	*G*	*concavo-triangular*
D	*concavo-convex*		

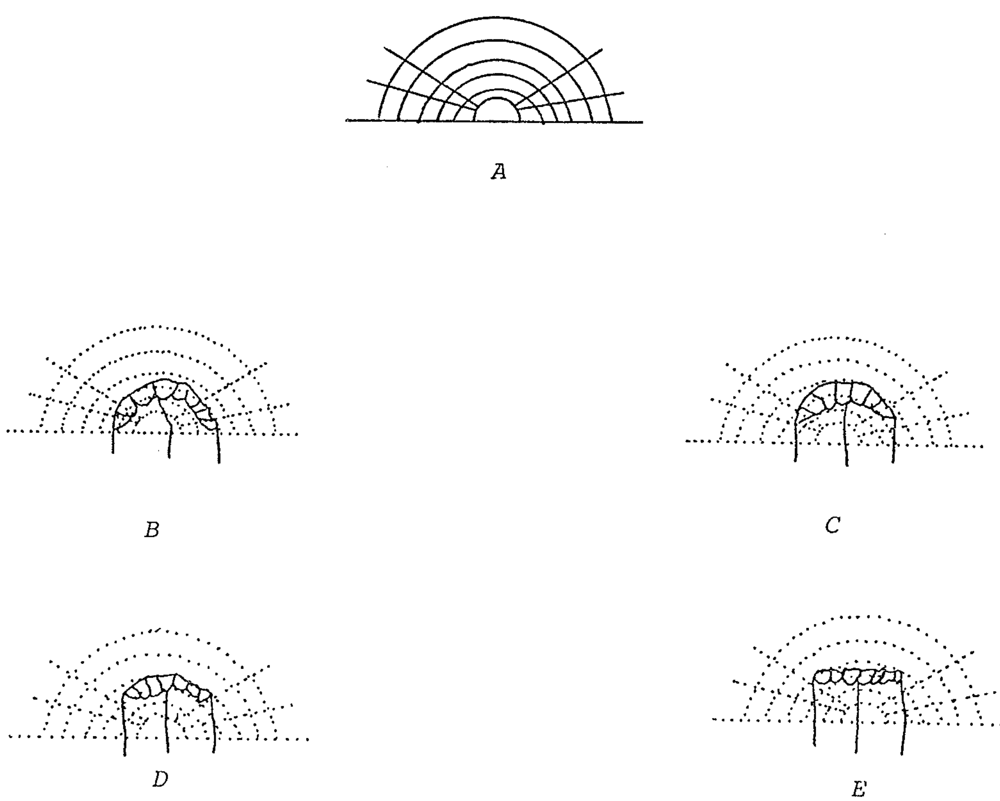

Figure 7 — Front contours

A	*front contour gauge*	*C*	*medium*	*E*	*straight*
B	*round*	*D*	*shallow*		

iv) Front contour[1] (applies to scrapers).

(a) round [*Figure 7B*] — has an edge describing an arc of more than 140 degrees between the distal points of juncture of the longitudinal lateral edges.

(b) medium [*Figure 7C*] — has an edge describing an arc of 110 to 140 degrees between the distal points of juncture of the longitudinal lateral edges.

(c) shallow [*Figure 7D*] — has an edge describing an arc of less than 110 degrees between the distal points of juncture of the longitudinal lateral edges.

(d) straight [*Figure 7E*] — has an edge lacking curvature between the distal points of juncture of the longitudinal lateral edges.

v) Base outline

(a) straight [*Figure 8A*] — an edge which describes a straight line between the two defining points of the base.

(b) convex [*Figure 8B*] — an edge which describes a convex line between the two defining points of the base.

(c) concave [*Figure 8C*] — an edge which describes a concave line between the two defining points of the base.

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1. Front contour is measured by fitting the artifact to a protractor-like gauge upon which concentric circles have been superimposed. The chords of the gauge serve to demarcate the zones of frontal curvature (Sackett 1966:361).

(d) bivectoral [*Figure 8D*] — an edge which describes two more or less straight lines between the two defining points of the base which converge proximally at the longitudinal axis (applies to scrapers).

(e) trivectoral [*Figure 8E*] — an edge which describes three more or less straight lines between the two defining points of the base, one of which is transverse to the longitudinal axis (applies to scrapers).

(f) tetrameral [*Figure 8F*] — an edge which describes four more or less straight lines between the two defining points of the base (applies to scrapers).

vi) end scraper outline (applies to scrapers).

(a) pyriform [*Figure 9A*] — one whose lateral edges and front element converge to form a rough triangle.

(b) parallel-sided [*Figure 9B*] — one which has a recti-lineal outline in which the lateral edges are roughly parallel.

(c) trapezoidal [*Figure 9C*] — one whose outline is quadrilateral with no two sides parallel.

(d) semi-discoidal [*Figure 9D*] — one whose four margins converge so as to form a roughly circular to semi-circular outline.

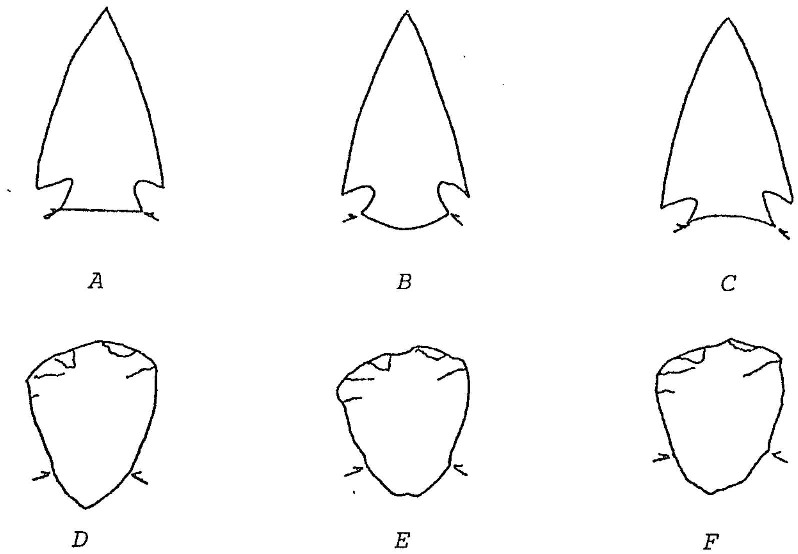

Figure 8 — Base outlines

A	*straight*	*D*	*bivectoral*
B	*convex*	*E*	*trivectoral*
C	*concave*	*F*	*tetrameral*

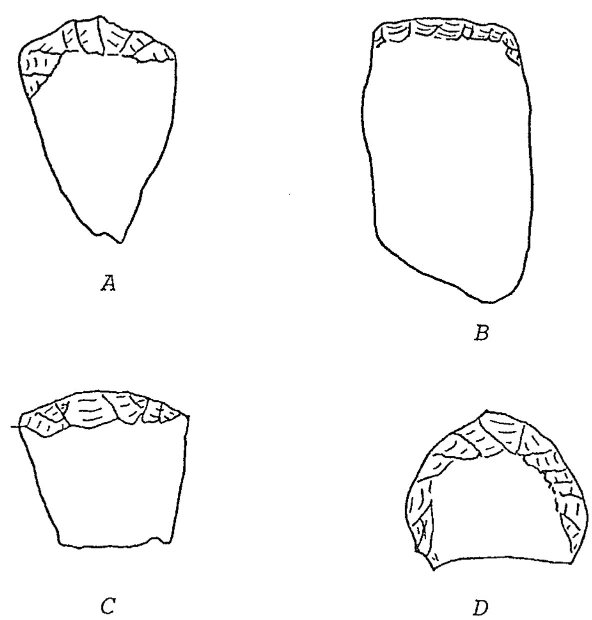

Figure 9 — End Scraper outlines

A	*pyriform*	*C*	*trapezoidal*
B	*parallel-sided*	*D*	*semi-discoidal*

vii) shoulder outline (applies to points)

(a) straight [*Figure 10A*] — the edge between the distal medial point and the distal point of juncture of the haft element describes a straight line.

(b) concave [*Figure 10B*] — the edge between the distal medial point and the distal points of juncture of the haft element describes a concave line.

(c) convex [*Figure 10C*] — the edge between the distal medial point and the distal point of juncture of the haft element describes a convex line.

viii) tang outline[1] (applies to points).

(a) expanding [*Figure 11A*] — the tang edge is uninterrupted and expands proximally away from the longitudinal axis of the specimen.

(b) contracting [*Figure 11B*] — the tang edge is uninterrupted and contracts proximally toward the longitudinal axis of the specimen.

(c) parallel-expanding [*Figure 11C*] — the tang edge is interrupted by a proximal medial point and the edge between the medial points parallels the longitudinal

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1. Those attributes presented by Binford (1963:217-218) relating to the configuration of the points of juncture and the technical aspects of the tang have been omitted. What is here considered "tang outline" corresponds to Binford's "geometrical form of tang" category. His observations on the proximal segment of the tang have been eliminated.

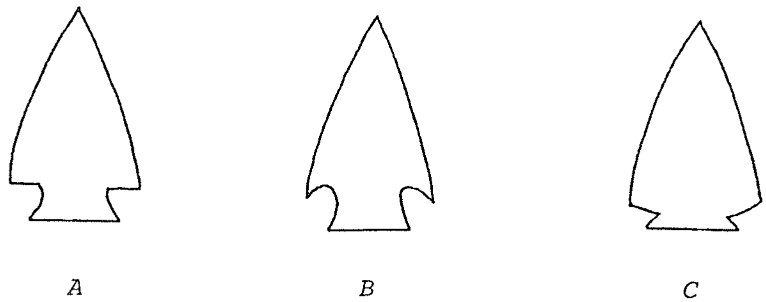


Figure 10 — Shoulder outlines

A	*straight*	*B*	*concave*
C	*convex*		

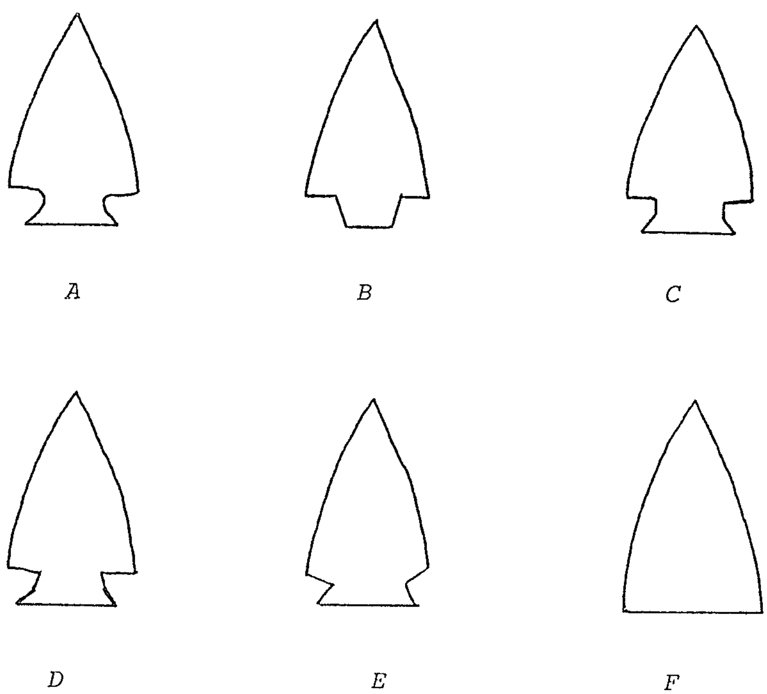


Figure 11 — Tang outlines

A	*expanding*	*D*	*biexpanding*
B	*contracting*	*E*	*contracting-expanding*
C	*parallel-expanding*	*F*	*absent*

axis of the specimen but the edge from the proximal medial point to the proximal lateral point is expanding proximally away from the longitudinal axis of the specimen.

(d) biexpanding [*Figure 11D*] — the tang edge is interrupted by the proximal medial point but both edges of the element expand differentially away from the longitudinal axis of the specimen.

(e) contracting-expanding [*Figure 11E*] — the tang edge is interrupted by the proximal medial point and the edge between the medial points is contracting proximally toward the longitudinal axis but the edge between the proximal medial point and the proximal lateral point is expanding proximally away from the longitudinal axis of the specimen.

(f) absent [*Figure 11F*] — no definable tang subelement present.

ix) shoulder barbing (applies to points)

(a) barbed [*Figure 12A*] — the distal point of juncture of the haft element is more proximal than the distal medial point of the haft element.

(b) nonbarbed [*Figure 12B*] — the distal point of juncture of the haft element is more distal than is the distal medial point of the haft element.

(c) absent [*Figure 12C*] — no definable shoulder sub-element present.

x) haft juncture (applies to points).

(a) lateral-lateral [*Figure 13A*] — both proximal and distal points of juncture of the haft element are codefined by the lateral edges of the projectile point.

(b) lateral-basal [*Figure 13B*] — the distal point is codefined by the lateral edge of the projectile point and the proximal points are codefied by the basal edge.

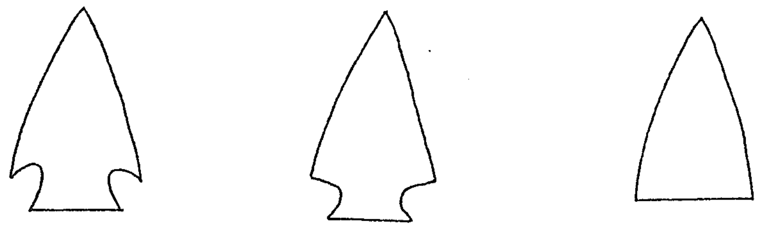
(c) absent [*Figure 13C*] — no definable haft element present.

xi) tang juncture (applies to points).

(a) lateral-basal [*Figure 14A*] — basal extension of specimen below the point of juncture between the lateral and basal edges.

(b) lateral-lateral [*Figure 14B*] — extension of lateral edge of specimen below proximal point of juncture of the haft element.

(c) absent [*Figure 14C*] — absence of any extension of the lateral blade edge below the proximal point of

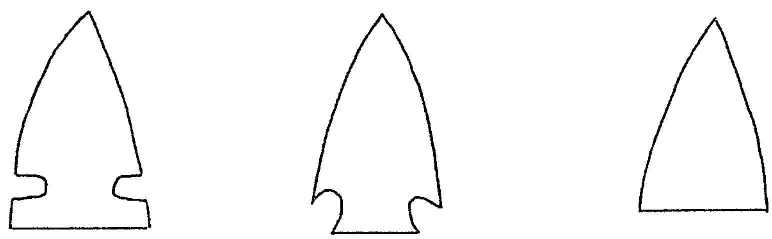


A *B* *C*

Figure 12 — Shoulder barbing

A *barbed* *B* *nonbarbed*

C *absent*

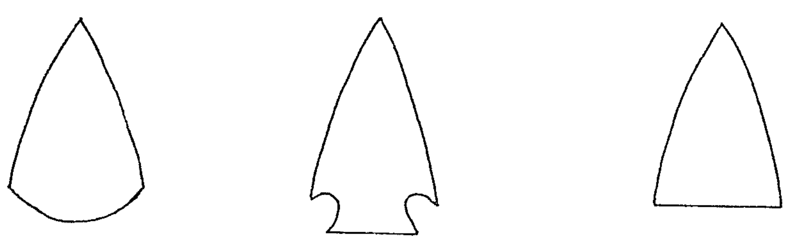


A *B* *C*

Figure 13 — Haft junctures

A *lateral-lateral* *B* *lateral-basal*

C *absent*



A *B* *C*

Figure 14 — Tang junctures

A *lateral-basal* *B* *lateral-lateral*

C *absent*

juncture of the haft element and the point of juncture between the lateral and basal edges of the specimen.

xii) basal articulation[1]

(a) oblique [*Figure 15A*] — the lateral and basal edges produce an inside angle of 80 degrees or less at the defining point of the base (applies to points).

(b) splayed [*Figure 15B*] — the lateral and basal edges produce an inside angle of greater than 80 degrees at the defining point of the base (applies to points).

(c) acute [*Figure 15C*] — the lateral and basal edges produce an inside angle of 110 degrees or less at the defining point of the base (applies to bifaces).

(d) obtuse [*Figure 15D*] — the lateral and basal edges produce an inside angle of greater than 110 degrees at the defining point of the base (applies to bifaces).

xiii) symmetry

(a) symmetrical element — both halves of the element in question are geometrically complementary.

---

1. These measurements are taken from the side showing the greatest angle. Basal articulation angles have been added to Binford's list of base element attributes in lieu of the more complex "proximal point of juncture of the haft element" category (Binford 1963:215) which the new measurement roughly approximates.

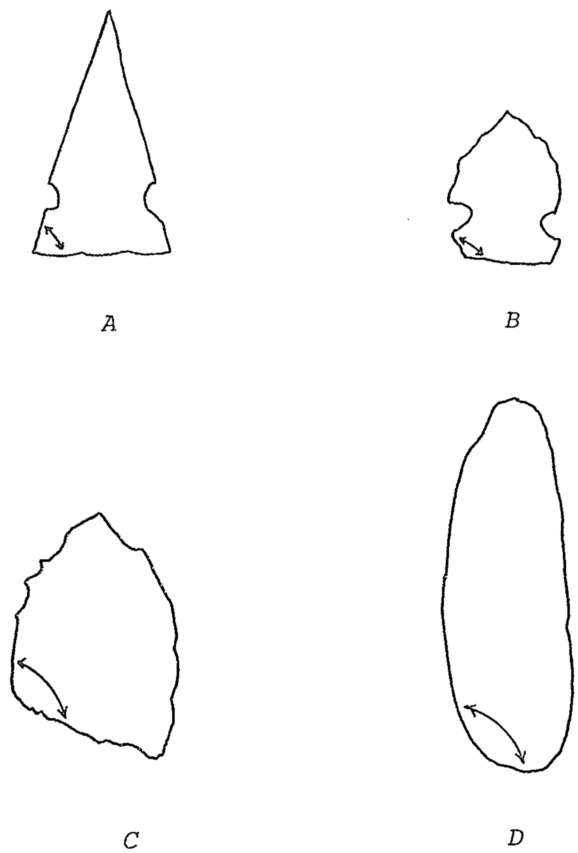


Figure 15 — Basal articulation

A	*oblique*	*C*	*acute*
B	*splayed*	*D*	*obtuse*

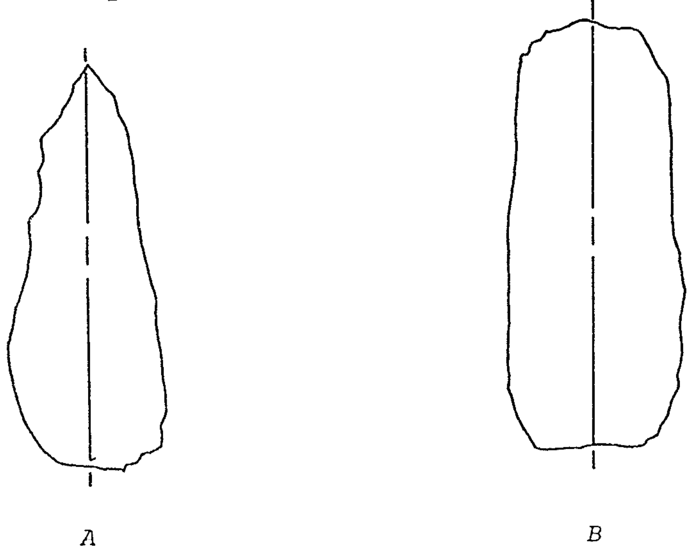


Figure 16 — Lateral edge juncture

A	*present*	*B*	*absent*

(b) asymmetrical element — both halves of the element are not geometrically complementary, eg. one edge ovate, one excurvate.

(c) transverse basal symmetry or frontal orientation [*Figure 17A, 17B*] — a chord constructed between the defining points of the base or front element would cross the longitudinal axis forming roughly a ninety degree angle. (Applies to bifaces and scrapers).

(d) oblique basal symmetry or frontal orientation[1] [*Figure 17C, 17D*] — a chord constructed between the defining points of the base or front element would cross the longitudinal axis forming complementary angles of greater than 100 degrees and less than 80 degrees, respectively (applies to bifaces and scrapers).

xiv) lateral edge juncture (applies to bifaces).

(a) distal juncture present [*Figure 16A*] — the lateral edges converge distally toward the longitudinal axis.

(b) distal juncture absent [*Figure 16B*] — the lateral edges do not converge distally, but rather make a directional change transverse to the longitudinal axis.

---

1. Binford's basal orientation category, which serves to indicate basal position in relation to the artifact "blank", has been omitted. In many cases, this orientation was obscured. Also deleted was the basal symmetry category. All projectile points exhibited a transverse symmetry.

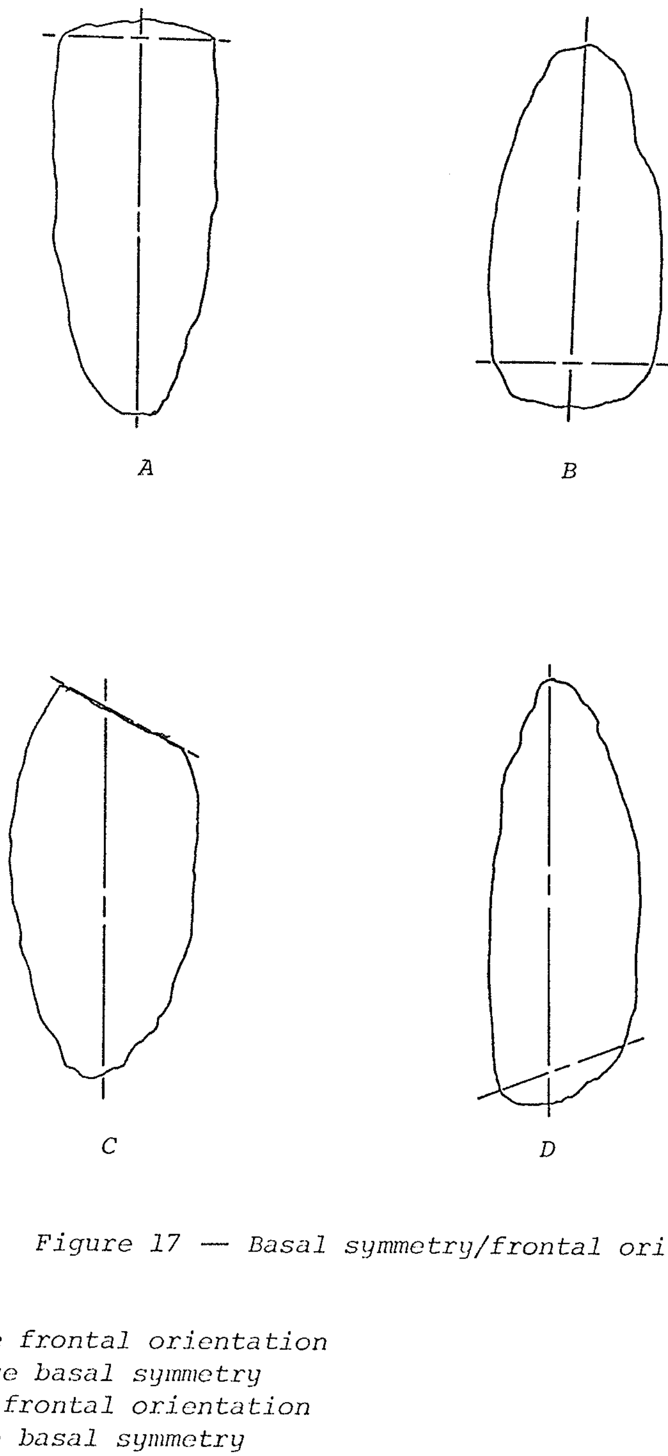


Figure 17 — Basal symmetry/frontal orientation

A transverse frontal orientation
B transverse basal symmetry
C oblique frontal orientation
D oblique basal symmetry

xv) point of maximum thickness in the longitudinal dimension

(a) proximal — the point of maximum thickness occurs at a point located proximally of the distal point of juncture of the basal element.

(b) medial — the point of maximum thickness occurs at a point located opposite the distal point of juncture of the base element or more distally up to one-third the length of the blade (applies to points and bifaces).

(c) distal — the point of maximum thickness occurs within the most distal two-thirds of the blade or body length.

xvi) point of maximum thickness in the lateral dimension

(a) medial — point of maximum thickness occurs along the longitudinal axis of the specimen.

(b) lateral — point of maximum thickness occurs along the most lateral two-thirds of the area between the longitudinal axis and the lateral edge of the specimen.

xvii) length/width ratio

(a) axial length and maximum width measurements taken as described below (pages 46 - 47) and the ratio computed. Following the production of a histogram for each artifact category showing respective frequencies, discrete values were assigned as follows:

projectile points:	(1)	less than 1:1
	(2)	1:1.1 - 1:1.5
	(3)	1:1.6 - 1:2.0
	(4)	1:2.1 - 1:2.5
	(5)	1:2.6 - 1:3.0
	(6)	greater than 1:3.0
bifaces:	(1)	less than 1:1.5
	(2)	1:1.5 - 1:2.5
	(3)	1:2.6 - 1:3.5
	(4)	greater than 1:3.5
end scrapers:	(1)	less than 1:1
	(2)	1:1.1 - 1:1.5
	(3)	1:1.6 - 1:2.0
	(4)	1:2.1 - 1:3.0
	(5)	greater than 3.0

d) Technical attributes

i) primary chipping scar size[1] [*Figure 18*]

(a) massive — generally extend more than half way

---

1. Primary scar types were omitted, thereby limiting the number of variables, after little variation was found within a specific category.

across the artifact, and have a modal width at the widest point (at right angles to the longitudinal axis of the scar) of greater than one-half an inch.

(b) diminutive — those which generally do not extend more than half way across the artifact and have a modal width at the widest point (at right angles to the longitudinal axis of the scar) of less than one-half inch.

(c) obscured — primary chipping scars have been rendered unidentifiable because of obscuring secondary scars.

ii) primary chipping scar depth

(a) deep — exhibit well-defined negative bulbs of percussion together with pronounced ridges separating individual scars.

(b) flat — exhibit ill-defined negative bulbs of percussion together with ill-defined ridges separating individual scars.

iii) placement of primary chipping

(a) bifacial — present on both artifact faces.

(b) unifacial — present on only one artifact face.

iv) secondary chipping scar patterning[1][*Figure 18*] (applies to points and scrapers).

---

1. Secondary chipping and primary retouch scar types were omitted owing to the fact that little variation was noted within a specific artifact category. As with primary chipping scar placement, secondary scar placement and patterning have been restricted to two categories in an effort to limit the number of attributes requiring simultaneous testing. Additionally, patterning of secondary basal retouch has been eliminated.

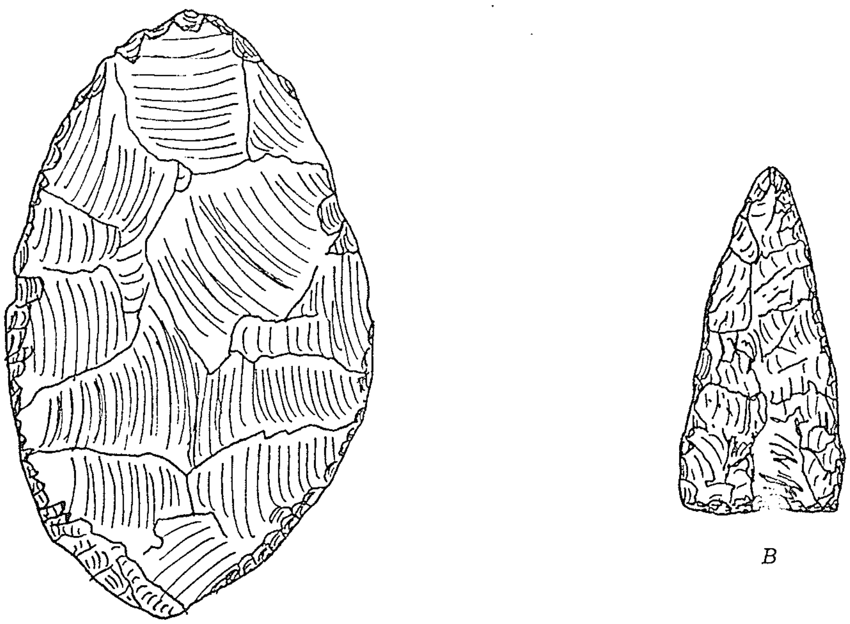
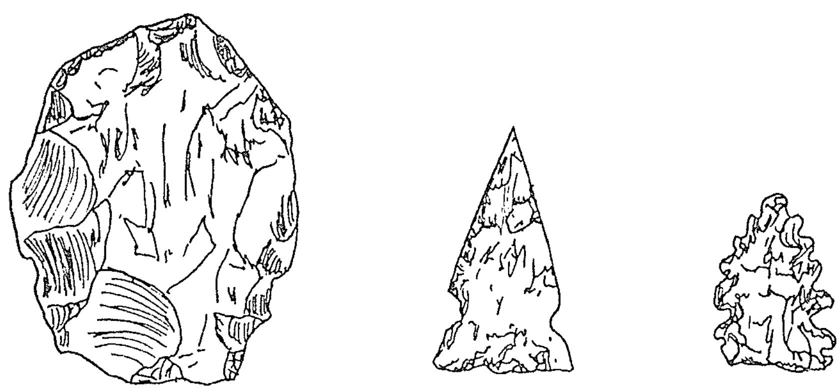


Figure 18 — Scar types and patterns

A

A	*massive primary chipping scars, discontinuous secondary chipping*
B	*diminutive primary chipping scars, continuous secondary chipping*



A B C

Figure 19 — Edge configuration and treatment

A	*irregular edge configuration, plain lateral edges*
B	*even edge configuration, plain lateral edges*
C	*even edge configuration, serrated lateral edges*

(a) continuous — secondary scars occur sequentially along all lateral edges.

(b) discontinuous — secondary scars occur non-sequentially arranged as a function of the thickness irregularities resulting from primary flaking and/or shaping requirements.

v) edge configuration[1] [*Figure 19*]

(a) serrated — chips removed so as to produce regular notches in the lateral edge.

(b) plain — edge unembellished. May be chipped or ground.

vii) basal edge treatment[2] (applies to points).

(a) ground — the basal edge has been abraded during manufacture.

(b) chipped — the basal edge has been formed by chipping and has not been subsequently ground.

viii) blade backing [*Figure 20*] (applies to bifaces).

(a) present — blade has been treated along one lateral edge to produce a blunted surface or cortex has been retained along one lateral edge.

(b) absent — no definable blade backing present.

---

1. This and the following category replace Binford's "form of lateral edge" classification.
2. Binford's "basal preparation" category has been omitted.

Figure 20 — Blade backing

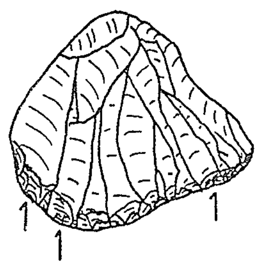
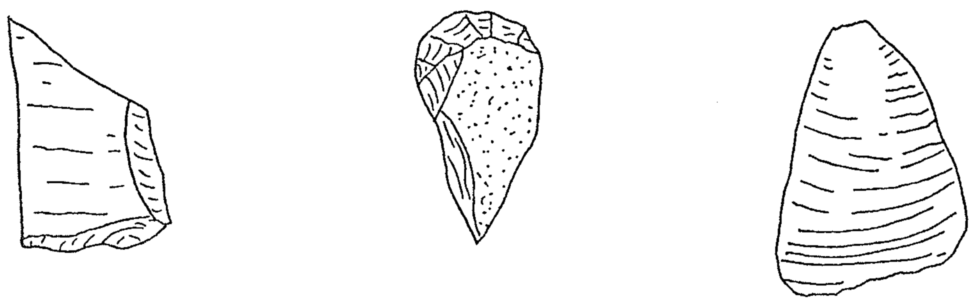


Figure 21 — Use/tertiary chipping



A B C

Figure 22 — Flake type

A tabular B decortication

C expanding

vix) notching

(a) present — the lateral edge has been deliberately modified by the inclusion of one or more regularly chipped nicks in the most proximal one-half (of bifaces) or in the distal portion of the body element (of scrapers).

(b) absent — the lateral edge lacks any interruption of a deliberate nature (applies to bifaces and scrapers).

vx) use/tertiary chipping [*Figure 21*] (applies to scrapers).

(a) present — steep shallow fracture scars lacking distinct definition, diminutive ovate scars, or a smoothing of scar ridges present on edge(s).

(b) absent — above evidences of use are lacking.

vxi) flake type[2] (applies to scrapers).

(a) tabular [*Figure 22A*] — a thick, plate-like flake lacking a dorsal ridge.

(b) decortication [*Figure 22B*] — a primary-flaking reject with cortex adhering to part or all of the outer surface (White 1963:5).

---

1. Presence and absence of blade use wear were eliminated from the projectile point scheme since these artifacts generally may be considered free from such modification. It was eliminated from the biface attribute list for the converse reason.

2. Flake shape is determined by considering the orientation of the lateral edges to the longitudinal axis of the flake. Point of reference is the striking or proximal end (White 1963:8).

(c) expanding [*Figure 22C*] — a flake whose lateral margins expand distally away from the longitudinal axis.

(d) obscured — flake type has been rendered unidentifiable by subsequent working.

e) Metrical attributes[1] [see *Figure 23 - 29,* inclusive]

i) widths [*Figure 23*]

(a) base width — this measurement is taken between the two defining points for the base (applies to points and bifaces).

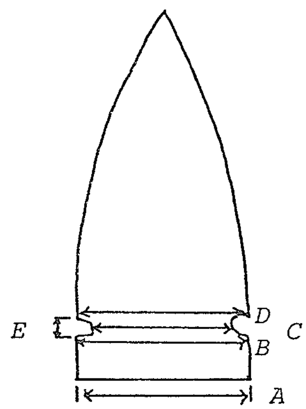
(b) neck width[2] — this measurement is taken between the two symmetrically opposing medial points of the haft element closest to the longitudinal axis of the speciment. In cases where medial points are not present, this measurement is not applicable (applies to points).

(c) tang width* — this measurement is taken at right angles to the longitudinal axis midway down the tang. In cases where specimens are untanged, this measurement

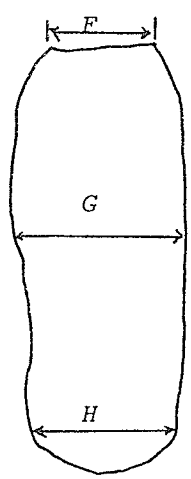
---

1. Unless otherwise stated, all metrical attributes are measured to the nearest millimeter by means of calipers. Those point attributes which deviate from Binford's scheme are marked with an asterisk.

2. Note: this definition is identical to Binford's "tang width" measurement, which is conceived of somewhat differently in this study.



A base width
B tang width
C neck width
D proximal width
E notch width



F distal width
G width at midpoint
H base width

Figure 23 — widths

does not apply (applies to points).

(d) proximal width of blade — this measurement is taken between the two proximal defining points of the blade (applies to point or the "body" of scraper data only). In some instances, this measurement may correspond to basal width (applies to points).

(e) distal width — this measurement is taken between the two distal defining points of the blade (of bifaces) or body (of scrapers).

(f) width at blade midpoint — this measurement is taken at right angles to the longitudinal axis of the specimen at a point midway between the proximal and distal defining points of the blade (applies to bifaces).

(g) maximum width — this measurement may be concurrent with any of the above. If the axis of maximum width (at right angles to the longitudinal axis) is not located at any of the above widths, it will be measured.

(h) notch width* — this measurement is taken between the proximal and distal points of juncture for each side of the haft element. Left is distinguished from right by taking measurements from the face opposite the lettered catalogue number, usually placed on the smoothest side (Benfer 1967:721). In cases where there are not two points of interruption in the projected symmetry of the proximal segment of the projectile point, this measurement does not apply (applies to points).

ii) lengths [*Figure 24*]

(a) notch length* — this measurement is taken from a point midway between the proximal medial and distal medial points of each haft element to the midpoint of a line constructed between the proximal and distal points of juncture of the same element. Left is distinguished from right as per notch width. Not applicable in cases where there are not two points of interruption in the projected symmetry of the proximal segment of the projectile (applies to points).

(b) axial length — this measurement is taken on the longitudinal axis of the specimen between the proximal and distal extremities.

(c) tang length* — this measurement is taken on the longigudinal axis of the specimen. It is made between the point where the longitudinal axis crosses the most proximal transverse edge of the specimen and a constructed line between the two most proximal points of the blade element (applies to points).

(d) blade length* — this measurement is taken on the longitudinal axis of the specimen. It is made between the distal point of juncture of the lateral edges or from a point midway between the distal points of the lateral edges, as the case may be, and the point where the longitudinal axis crosses a line constructed between the two proximal points of juncture of the blade element (applies to points and bifaces).

(e) base length — this measurement is taken on the longitudinal axis of the specimen. It is made between the point where the longitudinal axis crosses the most proximal transverse edge of the specimen and a constructed line between the two most proximal points of the blade element (applies to bifaces).

(f) distance of point of maximum width from working face — measured along the longitudinal axis of the specimen from the most distal point to the axis of maximum width (applies to scrapers).

iii) thicknesses [*Figure 25*]

(a) maximum thickness — taken at point of maximum thickness.

(b) front thickness — taken at the thickest point of working edge, generally where the front and body elements meet. Often concurrent with maximum thickness (applies to scrapers).

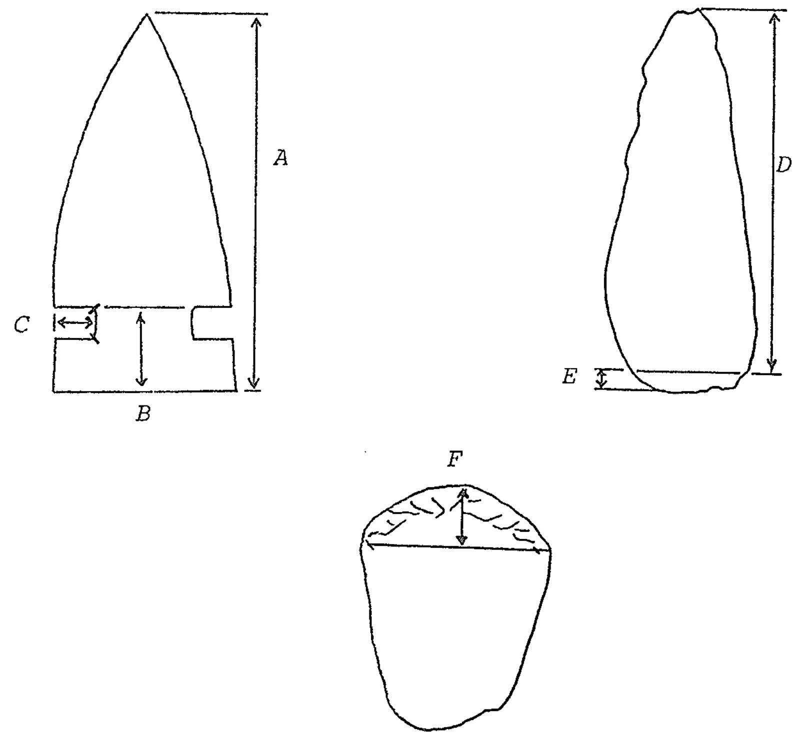


Figure 24 — Lengths

A	axial length
B	tang length
C	notch length
D	blade length
E	base length
F	distance of point of maximum width from front

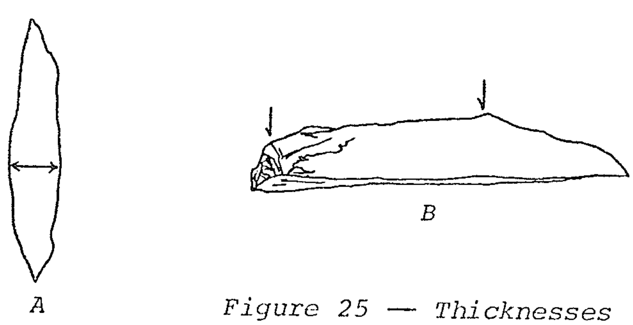


Figure 25 — Thicknesses

A	maximum thickness
B	front thickness and maximum thickness

iv) angles

(a) index of the angle of basal orientation [*Figure 26*] — this is a measurement devised by Binford (1963:219-220) to determine the orientation of the base with respect to the longitudinal axis of a specimen:

$$i = \left(\text{distance} - \frac{\text{basal width}}{2}\right)\left(\frac{4.0}{\text{length}}\right)$$

where

distance = the distance of the distal end of the longitudinal axis of a specimen from a vertical arm when the specimen is aligned parallel and adjacent to the vertical arm so that the base of the specimen abuts a horizontal intersecting the vertical at right angles. The specimen is always aligned to obtain the maximum possible distance from the vertical arm.

basal width = the measurement between the two defining points of the base.

length = the measurement of the longitudinal axis of the specimen between the proximal and distal extremities.

It is necessary to correct by dividing a standard (4.0) by the observed length because of a positive correlation between the length of a specimen and the distance away from the arm of a right angle regardless

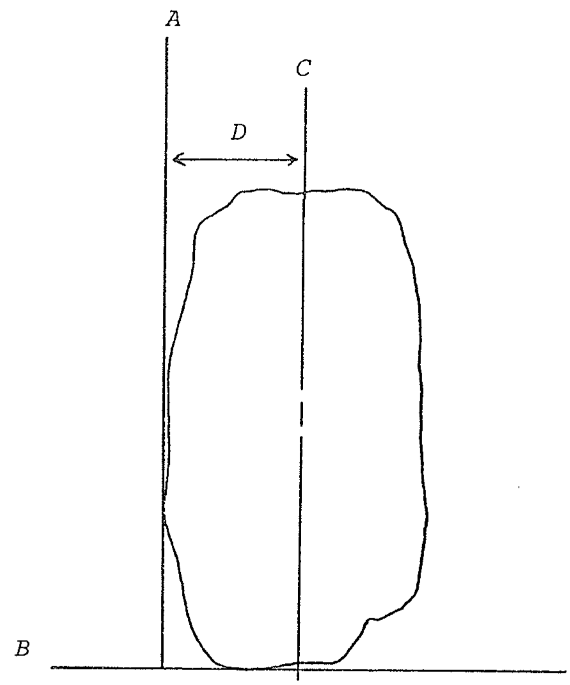


Figure 26 — Angle of basal orientation (initial measurement)

A	*vertical arm*
B	*horizontal arm (meets A at right angles)*
C	*longitudinal axis (parallel to A) of specimen*
D	*distance of longitudinal axis from vertical arm*

of the angle of basal orientation. Once the index has been calculated, the angle of basal orientation may be determined by reference to Table 1 (applies to points and bifaces).

Table 1. — Indexes of the angle of basal orientation

observed index	angle indicated
.000 - .06	91°
.065 - .13	92°
.135 - .18	93°
.185 - .25	94°
.255 - .32	95°
.325 - .39	96°
.395 - .46	97°
.465 - .53	98°
.535 - .61	99°
.615 - .69	100°
.695 - .76	101°
.765 - .84	102°
.845 - .92	103°
.925 - .99	104°
.995 - 1.07	105°
1.075 - 1.15	106°

(b) angle of convergence/divergence of margin* (side, base, or tip) [*Figure 27*] — this measurement may be taken by aligning the specimen against a protractor-like gauge so that one of the (specified) margins is placed along the zero degree line. The corresponding margin is then read from the gauge to determine angle of convergence/divergence. (Is not applicable as a measure of basal convergence against straight-based specimens).

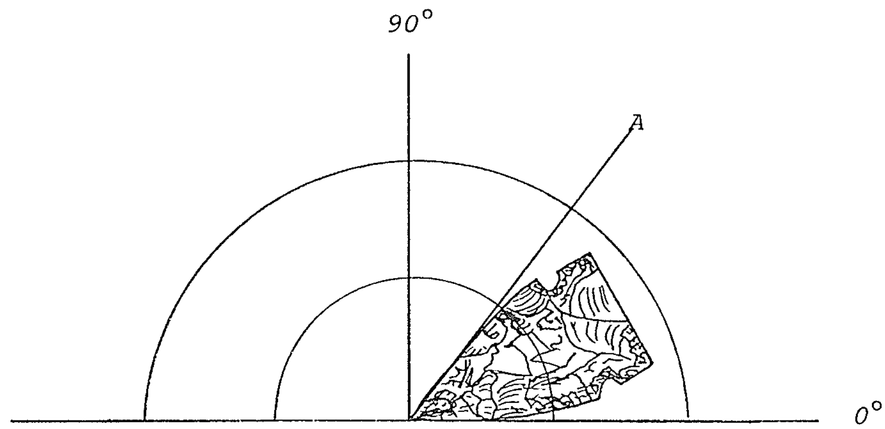


Figure 27 — Measuring angle of convergence at tip

A the angle of convergence

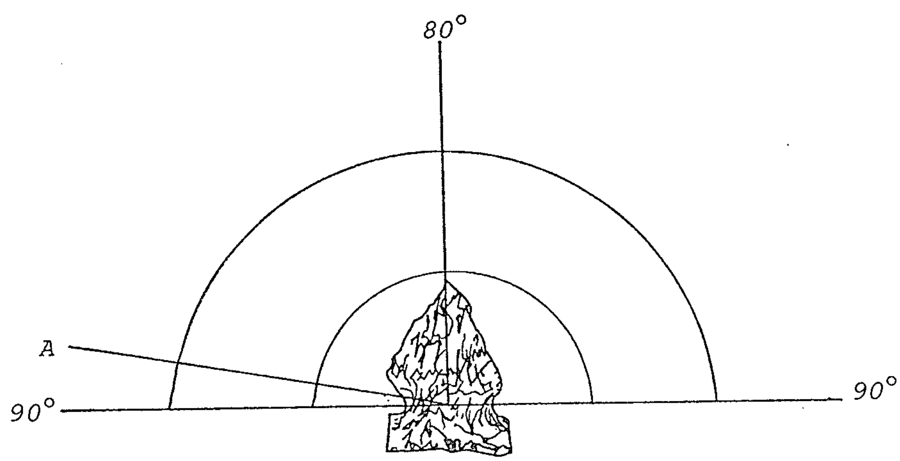


Figure 28 — Measuring angle of notching

A the angle of notching for left side of specimen. In this instance right notch is 90°

(c) angle of notching* [*Figure 28*] — this is the measurement of the orientation of notching with respect to the longitudinal axis of the projectile. It is taken by aligning the longitudinal axis of the specimen over the zero degree line of a protractor-like gauge and then projecting the chord outwards from midway between the proximal medial and distal medial points and the proximal and distal points of juncture of the haft element. By aligning the chord with the best approximation present on the gauge, the angle of one notch may be determined. This measurement is then repeated for the other haft element. The results of these measurements were summed since it was considered preferable to work with a single attribute given the number of variables requiring simultaneous analysis in this study. In cases where only one notch is present, a single such measurement is made (applies to points).

(d) angle of working edge [*Figure 29*] — this is a measure of the steepness of retouch of the front element. It is made by aligning the distal end of the scraper laterally along the zero degree line of a protractor-like gauge so that the most distal transverse element butts against the 90 degree chord. A straightedge is then applied to the front element and the chord

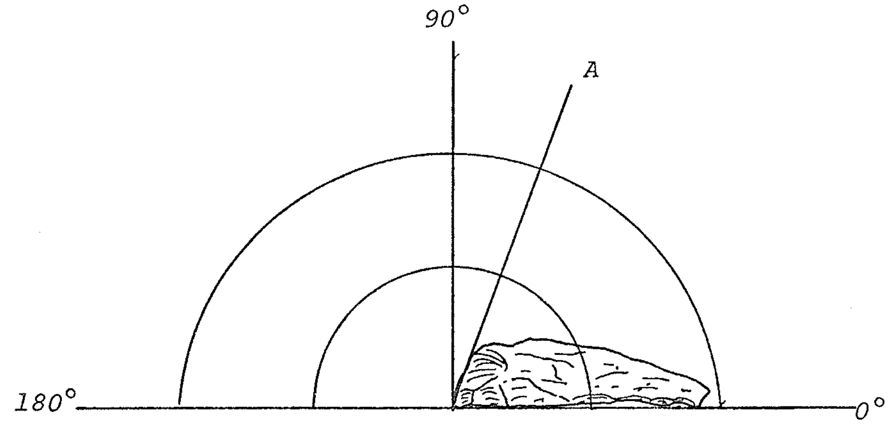


Figure 29 — Measuring angle of working edge

A   *angle of the working edge*

which it best approximates indicates the required angle. Care must be taken to hold the scraper with the axis of width at right angles to the zero degree chord of the gauge while the measurement is being taken (applies to scrapers).

ATTRIBUTE LISTS

The applicational sequence of the above-detailed attributes to each artifact class is outlined below. Actual values and measurements for each artifact in each of the respective categories may be found in Appendices I to III.

a) projectile points

i) blade outline

— triangular

— excurvate

— ovate

ii) blade transverse section

— biconvex

— plano-convex

— convexo-triangular

— biplano

— concavo-triangular

iii) point longitudinal section

— plano-convex

— biconvex

— biplano

— concavo-convex

iv) blade symmetry

— symmetrical

— assymetrical

v) size of primary chipping scars occurring on blade

— massive

— diminutive

— obscured

vi) depth of primary chipping scars occurring on blade

— deep

— flat

vii) placement of primary chipping scars on blade

— bifacial

— unifacial

viii) placement of secondary chipping scars on blade

— bifacial

— unifacial

ix) pattern of occurrence of secondary chipping scars on blade
- — continuous
- — discontinuous

x) configuration of lateral edge of blade
- — even
- — irregular

xi) treatment of lateral edge of blade
- — serrated
- — plain

xii) blade reworking
- — present
- — absent

xiii) base outline
- — straight
- — convex
- — concave

xiv) basal articulation
- — oblique
- — splayed

xv) basal treatment
- — ground
- — chipped

xvi) shape of basal edge

— even

— irregular

xvii) placement of primary retouch on base

— bifacial

— unifacial

xviii) basal secondary retouch

— present

— absent

xix) basal reworking

— present

— absent

xx) haft juncture

— lateral-lateral

— lateral-basal

— absent

xxi) shoulder barbing

— barbed

— nonbarbed

— absent

xxii) shoulder outline

— straight

— concave

— convex

xxiii) tang outline

— expanding

— contracting

— parallel-expanding

— biexpanding

— contracting-expanding

— absent

xxiv) tang juncture

— lateral-basal

— lateral-lateral

— absent

xxv) point of maximum thickness, longitudinal dimension

— proximal

— medial

— distal

xxvi) point of maximum thickness, lateral dimension

— medial

— lateral

xxvii) length/width ratio

xxviii) width of base

xxix) width of neck

xxx) width of tang

xxxi) proximal width

xxxii) point of maximum width

xxxiii) notch width

xxxiv) notch length

xxxv) axial length

xxxvi) tang length

xxxvii) blade length

xxxviii) maximum thickness

xxxix) index of the angle of basal orientation

xl) angle of notching

xli) angle of convergence of sides

xlii) angle of convergence of tip

b) bifaces

i) blade outline

— lunate

— rectangular

— ovate

— crescentic

ii) blade symmetry

— symmetrical

— asymmetrical

iii) distal juncture of lateral edges

— present

— absent

iv) size of primary chipping scars occuring on blade

— massive

— diminutive

— obscured

v) depth of primary chipping scars occurring on blade

— deep

— flat

vi) palcement of secondary chipping scars on blade

— bifacial

— unifacial

vii) pattern of occurrence of secondary chipping scars on blade

— continuous

— discontinuous

viii) configuration of lateral edge of blade

— even

— irregular

ix) blade reworking

— present

— absent

x) blade use or tertiary flaking

— present

— absent

xi) blade backing

— present

— absent

xii) blade notching

— present

— absent

xiii) base outline

— straight

— convex

— concave

xiv) basal symmetry

— transverse

— oblique

xv) basal articulation

— acute

— obtuse

xvi) shape of basal edge

— even

— irregular

xvii) placement of primary retouch on base

— bifacial

— unifacial

xviii) basal secondary retouch

— present

— absent

xix) basal reworking

— present

— absent

xx) point of maximum thickness, longitudinal dimension

— proximal

— medial

— distal

xxi) point of maximum thickness, lateral dimension

— medial

— lateral

xxii) length/width ratio

xxiii) width of base

xxiv) distal width

xxv) width at midpoint of blade

xxvi) point of maximum width

xxvii) axial length

xxviii) blade length

xxix) base length

xxx) maximum thickness

xxxi) index of the angle of basal orientation

xxxii) angle of convergence of sides

xxxiii) angle of convergence of base

c) end scrapers

i) front contour

— round

— medium

— shallow

— straight

ii) frontal orientation

— transverse

— oblique

iii) front symmetry

— symmetrical

— asymmetrical

iv) scraper longitudinal section

— plano-triangular

— biconvex

— convexo-triangular

— concavo-triangular

— concavo-convex

— plano-convex

v) body symmetry

— symmetrical

— asymmetrical

vi) size of primary chipping scars occurring on body

— massive

— diminutive

— obscured

vii) depth of primary chipping scars occurring on body

— deep

— flat

viii) placement of primary chipping scars on body

— bifacial

— unifacial

ix) secondary chipping scars on body

— present

— absent

x) body use or tertiary flaking

— present

— absent

xi) body reworking

— present

— absent

xii) body notching

— present

— absent

xiii) configuration of lateral edge of body

— even

— irregular

xiv) basal outline

— straight

— convex

— concave

— bivectoral

— trivectoral

— tetrameral

xv) basal symmetry

— transverse

— oblique

xvi) configuration of basal edge

— even

— irregular

xvii) basal placement of primary retouch

— bifacial

— unifacial

xviii) basal secondary retouch

— present

— absent

xix) basal reworking

— present

— absent

xx) scraper outline

— pyriform

— parallel sided

— trapezoidal

— semi-discoidal

xxi) point of maximum thickness, longitudinal dimension

— proximal

— distal

xxii) point of maximum thickness, lateral dimension

— medial

— lateral

xxiii) flake type

— tabular

— expanding

— decortication

— obscured

xxiv) length/width ratio

xxv) distal width

xxvi) proximal width

xxviii) maximum width

xxviii) distance of maximum width from working face

xxix) axial length

xxx) maximum thickness

xxxi) front thickness

xxxi) angle of working edge

xxxiii) angle of divergence of sides

CHAPTER IV
NUMERICAL CLASSIFICATION

INTRODUCTION

Although several quantitative techniques are well suited for application to problems of archaologicai classification in that they permit simultaneous examination of several variables, cluster, proximity, and factor analyses have been most commonly utilized in this connection to date. These have been employed either on an individual basis or in various combination pairs involving other than clustering and factoring. The fact that these techniques hold in common a numerical basis, however, does not necessarily imply that comparable classifications will be produced by each method, even when applied to identical data and attribute sets. The aims of this chapter, therefore, are twofold: to compare the resultant typologies of average-link cluster and principal component analyses, utilizing all three categories of artifacts and their respective continuous variables; and to prepare the way for a comparison of the two specific techniques employed following additional average-link cluster analysis involving both discrete variables[1] alone and in combination with continuous attributes.

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1. A continuous variable is one which can assume any value within a certain range, while a discrete variable is one which can only assume isolated values (Moroney 1970:44-46). In this study, continuous variables are equated with metrical attributes, and discrete variables with morphological, geometrical, and technical attributes

These two multivariate quantitative techniques are based upon measures of variable association and significance which have been arranged in matrices of similarity coefficients. The Pearson Product-Moment Correlation Coefficient forms the basis for the testing of all continuous variables. Values for each artifact category may be found in Table I, Appendices IV to VI. Chi-square, with Yate's correction applied to all two by two tables; contingency coefficient; and Cramer's V, with a calculation of phi for all two by two tables, form the necessary substructure for the testing of discrete variables. Chi-square values may be found in Table II, Appendices IV to VI.

DESCRIPTION AND EXPLANATION OF GROUPING TECHNIQUES

Cluster Analysis

Cluster analysis is a general term covering a variety of numerical techniques designed to sort single units into groups on the basis of high similarity coefficients (Sokal and Sneath 1963: 178). The major limitation of these techniques is their tendency to find discrete clusters even when they are not present in the data analyzed: the total standardized variance of a unit — its communality — is assumed to be 1.0 and is always placed in either one cluster or another (Hodson, Sneath and Doran 1966:322; Cowgill 1968:369). Four of these techniques are discussed below.

Elementary Clustering

This is a simple, although somewhat unsatisfactory method of clustering described by Sokal and Sneath (1963:179-180). It involves an arbitrary selection of a cut-off point on the scale of similarity coefficients. All coefficients above this point are linked to yield clusters. Obviously, the selection of a very high coefficient would yield a minimal number of small clusters, while the lowering of this point to any appreciable degree would result in large, overlapping groups.

Single Linkage Clustering

This technique clusters those units most related, successively lowering the level of admission by steps of equal magnitude, and gradually accepting more members into a cluster until the lowest acceptable admission level is reached (Sokal and Sneath 1963:180). Important aspects of single linkage are that a single bond with one member of a cluster is sufficient to affect juncture, and clusters are joined if any pair of units (one in each of two clusters) are related at the level of admission (Sokal and Sneath 1963:180; Cowgill 1968:370).

Complete Linkage Clustering

This method corresponds closely to that of single linkage, except that for admission at a given level a unit must have relations at that criterion level or above with every other member of the cluster (Sokal and Sneath 1963:181).

Average Linkage Clustering

Average-link clustering first groups those units most related, basing subsequent admissions of any individual into a cluster on the average of the similarities of that individual with other cluster members (Sokal and Sneath 1963:182). In the variable-group method, a prospective group member is admitted only if the arithmetic mean of its similarity coefficients with existing cluster units is higher than any remaining coefficient in the matrix (Cowgill 1968:370). Obviously, as the cluster increases in size and more distant units are considered as prospective members, the value of average similarity is reduced. When any one unit lowers the average group similarity by more than a predetermined value (generally set at .03 or .05), it should not be included in that cluster. (Sokal and Sneath 1963:182; Hodson, Sneath and Doran 1966:312-313, 322). In the pair-group method, a single unit (always that with the highest similarity value) joins its cluster at any one time, and a new similarity matrix of all clusters with each other and with single stems is recalculated prior to further grouping (Sokal and Sneath 1963:183).

Of those satisfactory clustering methods available, Hodson, Sneath, and Doran (1966) established that average-link is most in accord with archaeological data. Therefore, average-link clustering was the technique employed in this study. Limitations of computational equipment and programming necessitated the choice of pair-group over variable-group procedure; however, this is of little consequence as it is known that the two alternatives produce closely comparable results (Sokal and Sneath 1963:191).

In application of the pair-group method, variables were left unweighted, that is to say no priorities were intentionally assigned, since weighting is at best a complex and poorly understood matter. Furthermore, the computation of similarity coefficients among clusters on an unweighted basis is apparently the most accurate means of condensing the original coefficients (Sokal and Sneath 1963:191).

The specific programme utilized was devised by J. Rubin and H. P. Friedman (1967) to partition those units detracting from group structure[1] into a "residue set", a tactic designed to

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1. Group structure is expressed by average between-group similarities and object-group similarities (Rubin and Friedman 1967:72).

prevent development of overlapping groups. This in turn permits an estimation of the "best" possible grouping. "Best" is used here in the sense that a chosen preference relation, here a geometric measure of intra-group cohesion relying upon similarity coefficients, indicates that one partition of units has attained a higher value than any other grouping of the same objects (Rubin and Friedman 1967: 54, 75). "Best" is therefore an evaluation of group structure, and does not necessarily imply "optimal", since there is no guarantee of ever reaching this point and it is doubtful that it would be recognized if it were achieved.

Factor Analysis

Like clustering, factor analysis forms groups of data on the basis of high similarity coefficients. Unlike clustering, which can be applied to most types of similarity coefficient matrices, factoring generally requires a matrix of product-moment correlation coefficients (Sokal and Sneath 1963:182; Nie, Bent and Hull 1970:210). Furthermore, factor analysis assumes communalities of less than 1.0, partitioning variance among several factors (Sokal and Sneath 1963:196). A factor may be defined as "the best linear summary of variance left in the data, accounting for the most residual variance as the effect of each component is removed" (Nie, Bent and Hull 1970:211).

In this way, factoring may be considered a method for the exploration of possible data reduction, since it describes complex interrelationships in terms of the smallest number of factors present (Sokal and Sneath 1963:194). Generally speaking, in the process of factoring, a unit is placed in that group corresponding to the factor to which it is most closely related (Benfer 1967:721; Tugby 1965:14). The correlation between this unit and the group into which it is placed is expressed by factor loadings, the square roots of the percentages of variance accounted for by each factor shown on a scale from -1.0 to +1.0 (Sokal and Sneath 1963:194; Binford and Binford 1966:245). The higher the factor loading, the more that factor accounts for variance. These factor patterns may be simplified, and thereby rendered more meaningful, by rotation to a simple structure. The two methods of factor analysis most commonly practiced (as described by Nie, Bent and Hull 1970:209-212) are outlined below.

Principal-Component Analysis

Following the generation of a suitable correlation matrix, data-reduction possibilities are examined by constructing a new set of variables or principal components based on similarity coefficients

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and defined as exact mathematical transformations of the original data.[1] Consequently, no particular assumptions concerning the underlying structure of the variables are required. In this technique, components are extracted in such a way that one is independent from the other, that is, orthogonal. The particular combination of variables accounting for more of the variance in the data as a whole than any other combination of variables may be viewed as the first principal component; the second component as the linear combination of variables accounting for the most residual variance in the data after the effect of the first component is removed, etc. (Nie, Bent and Hull 1970:210).

Since each component is defined as the best linear summary of variance left in the data after the previous components are eliminated, the first components may explain most of the variance present in the data.

Classical-Factor Analysis

After the generation of a suitable correlation matrix in which the main diagonals have been replaced with communality estimates, data-reduction possibilities are examined by constructing a new set of inferred orthogonal variables or "factors", based on similarity coefficients. These factors are inferred in the sense that the investigator

---

1. Ones are placed in the diagonal of the original correlation coefficient matrix.

assumes that each variable is influenced by a series of determinants, some of which are shared by other variables in the set and are therefore termed common, and some of which are idiosyncratic, or unique. Under this assumption, it follows that the unique part of any variable does not contribute to relationships among variables, and observed correlations must be the result of the interconnected variables sharing common determinants (factors). The investigator must therefore have confidence that assumed factors will not only account for all the observed relations in the data, but will also be smaller in number than the number of variables.

Rotation of Factors into Terminal Factors

There are many statistically equivalent ways of defining the underlying properties of a given set of data. For this reason, no single factor structure can be said to be unique, nor can there be a generally accepted "best" solution as far as the configuration of such structure is concerned. Some solutions, however, may prove to be more concise and informative than others. For this reason, it is left to the investigator to chose that method of transforming one factor solution into another which will generate a simplified end product satisfying both theoretical and practical needs. Basically, transformation involves the rotation of coordinate axes from one system to another. Two basic rotational methods may be employed: orthogonal and oblique. In the case of the former, factors are independent from assumes that each variable is influenced by a series of determinants, some of which are shared by other variables in the set and are therefore termed common, and some of which are idiosyncratic, or unique. Under this assumption, it follows that the unique part of any variable does not contribute to relationships among variables, and observed correlations must be the result of the interconnected variables sharing common determinants (factors). The investigator must therefore have confidence that assumed factors will not only account for all the observed relations in the data, but will also be smaller in number than the number of variables.

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Q and R Modes of Factor Analysis

When factor analysis is applied to a correlation matrix of units, it is known as Q-mode analysis, while the more commonly utilized variety based upon correlations between variables is known as R-mode analysis. Q-mode analysis is the technique employed here.

Since principal-component analysis does not require that any assumptions be made regarding the general structure of variables, this factoring technique was considered the most suitable for grouping the data at hand. Simple structure was achieved through varimax orthogonal rotation, the most widely used of all transformational processes, which served to simplify the columns of the factor matrix (Nie, Bent and Hull 1970:224). Nie, Bent and Hull's *Statistical Package for the Social Sciences* (version 3.00) was the programme utilized to compute all statistics of association as well as the various factor groupings.

AVERAGE-LINK CLUSTER AND PRINCIPAL-COMPONENT TYPOLOGIES

Projectile Points

The average-link cluster analysis of projectile point continuous attributes generated three groupings, each of which has been designated as a type, and a small residue set (a generalized convenience grouping of all objects which detract from group structure). Type 1 is composed of relatively large, thick, side-notched points, in contrast to Type 2 which is, for the most part, a grouping of small side-or corner-notched points. Type 3 consists entirely of unnotched projectile points. Table 2 presents a resumé of these types, all of which are illustrated in Appendix XVI, Plates 1 and 2.

A similar analysis of discrete attributes produced a single artifact group composed of notched and tanged unnotched points and a large residue set containing many points lacking both tangs and notches. Type 1 is outlined below in Table 3, and represented in Appendix XVI, Plate 3.

The final cluster analysis of projectile points was run on a combination of continuous and discrete variables. Prior to this analysis, computational limitations necessitated that continuous data be rendered discrete. This was accomplished by means of a tripartate division of each continuous attribute so that one standard deviation either side of the mean constituted one state, and anything above or below it additional states.

TABLE 2

PROJECTILE POINT CLUSTER TYPES, CONTINUOUS ATTRIBUTES

Attribute	Type 1	Type 2	Type 3
Maximum width..........................	2.0-2.6 cm.	1.0-1.9 cm.	1.2-3.8 cm.
Maximum thickness......................	0.3-0.7	0.2-0.5	0.2-0.9
Axial length...........................	2.3-3.7	1.0-4.7	1.5-7.2
Tang length............................	1.1-1.4	0.6-0.9	1.2-2.3 or abs.
Neck width.............................	1.2-1.8	0.7-1.2	1.3 or abs.
Proximal width.........................	1.9-2.5	0.7-1.7	1.2-3.8
Base width.............................	1.9-2.5	0.9-1.8	0.8-3.4
Width at mid tang......................	2.0-2.6	1.0-1.8	2.3-3.5 or abs.
Blade length...........................	1.2-2.3	0.4-3.9	1.0-5.2
Left notch depth.......................	0.2-0.3	0.1-0.3	absent
Left notch width.......................	0.4-0.7	0.2-0.7	absent
Right notch depth......................	0.3-0.4	0.1-0.4	0.1 or abs.
Right notch width......................	0.4-0.6	0.2-0.8	0.4 or abs.
Angle of notching......................	165-190°	155-208°	75° or abs.
Angle convergence of sides............	20-60	10-108	15-40
Angle convergence of tip..............	60-100	20-108	25-85
Total number of artifacts per type....	5	107	36

TABLE 3

PROJECTILE POINT CLUSTER TYPE, DISCRETE ATTRIBUTES[1]

Attribute	Type 1
Point maximum longitudinal thickness	primarily medial
Point maximum lateral thickness	primarily medial
Length/width ratio	primarily less than 1:2
Blade symmetry	primarily symmetrical
Pattern secondary chipping	primarily continuous
Configuraton of basal edge	primarily even
Treatment of basal edge	some ground, most chipped
Blade outline	triangular or ovate
Depth of primary chipping, blade	deep or flat
Presence of shoulder	primarily shouldered
Tang form	biexpanding or parallel-expanding
Articulation of tang	primarily lateral-lateral
Articulation of haft	primarily lateral-basal
Total number of artifacts in type	136

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

Two groupings and a small residue set were generated. The first of these groupings, designated Type 1, is composed of unnotched, untanged projectile points, while the second, or Type 2, contains relatively small side-or corner-notched tanged points. Both types exhibit triangular, ovate, or excurvate blade forms. A brief description of these may be found below in Table 4. They are illustrated in Appendix XVI, Plates 4 and 5.

A principal-component analysis of the points generated four components accounting for slightly over eighty percent of all variance present in the input data. This variance may be considered complex, that is, in every instance, total variance is differentially parcelled among all four components. This complex nature necessitates somewhat arbitrary groupings in that the highest loading of an artifact is the only one considered in the classificatory process. Furthermore, only those artifacts loading highly on a given component are considered diagnostic of that component for purposes of grouping. The criterion level for component types is arbitrary: that each component be represented, it is necessary to establish this point at .18. Artifacts whose loadings fall below this level are placed in a residue set.

The resultant four types are presented in Table 5. These types are illustrated in Appendix XVI, Plates 6 and 7. Type 1 is

TABLE 4

PROJECTILE POINT CLUSTER TYPES, ALL ATTRIBUTES[1]

Attribute	Type 1	Type 2
Maximum width	1.2-3.8 cm.	1.0-1.9 cm.
Maximum thickness	0.2-0.9	0.2-0.6
Axial length	1.5-7.2	1.0-4.7
Tang length	0.0-2.3	0.6-1.4
Neck width	absent	0.5-1.3
Proximal width	1.2-3.8	0.7-1.9
Base width	0.8-3.4	0.7-1.8
width at mid tang	0.0-3.5	0.6-2.0
Blade length	1.0-5.2	0.4-3.9
Left notch depth	absent	0.1-0.5
Left notch width	absent	0.2-0.8
Right notch depth	absent	0.1-0.4
Right notch width	absent	0.2-0.8
Angle of notching	absent	155-208°
Angle of convergence of sides	15-40°	10-108
Angle of convergence of tip	25-85	20-108
Blade outline	ovate, some triangular and excurvate	ovate or triangular, some excurvate
Transverse section	plano-convex, convexo-triangular, plano-triangular, biplano	bitriangular, biconvex, plano-convex, convexo-triangular, plano-triangular, biplano, concavo-triangular
Blade reworking	present	present, some absent
Configuration basal edge	irregular, few even	even, few irregular
Articulation of base	splayed, few oblique	splayed and oblique
Presence of shoulder	absent	present
Tang form	absent or contracting	biexpanding, parallel-expanding, contracting, expanding-contracting
Articulation of tang	primarily absent	lateral-lateral
Articulation of haft	primarily lateral-lateral	lateral-basal
Total number of artifacts per type	35	113

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

TABLE 5

PROJECTILE POINT PRINCIPAL-COMPONENT TYPES

ATTRIBUTE	Type 1	Type 2	Type 3	Type 4
Maximum width....................	2.1-3.8 cm	1.4-2.0 cm.	1.0-2.1 cm.	1.3-2.0 cm.
Maximum thickness................	0.5-0.9	0.2-0.5	0.2-0.5	0.2-0.6
Axial length.....................	2.8-7.2	2.0-2.8	1.7-4.7	1.8-3.9
Tang length......................	0.6-2.3	0.2-0.7	0.7-1.2	0.7-1.0
Neck width.......................	1.5-1.8 or abs.	absent	0.6-1.4 or abs.	0.8-1.3 or abs.
Proximal width...................	2.0-3.8	1.4-2.0	0.6-1.9	1.2-2.0
Base width.......................	2.0-3.4	1.4-2.0	0.6-2.0	1.4-2.0
Mid Tang width...................	2.0-3.5	absent	0.6-2.1	1.1-1.8
Blade length.....................	2.8-5.2	1.7-2.4	0.4-3.9	0.8-2.9
Left notch depth.................	0.1-0.4 or abs.	absent	0.1-0.3 or abs.	0.1-0.3 or abs.
Left notch width.................	0.3-0.6 or abs.	absent	0.3-0.6 or abs.	0.2-0.5 or abs.
Right notch depth................	0.1-0.4 or abs.	absent	0.1-0.3 or abs.	0.1-0.3 or abs.
Right notch width................	0.3-0.6 or abs.	absent	0.2-0.6 or abs.	0.2-0.5 or abs.
Angle of notching................	155-194° or abs.	absent	75-208° or abs.	168-198° or abs.
Angle of convergence of sides	15-60	15-45	10-108	25-40
Angle of convergence of tip	35-85	25-75	20-108	50-80
Total number of artifacts per type	6	8	10	5

a grouping of six unnotched and side-notched points which, for the most part, are representative of the most massive points in the sample in that they exhibit the greatest widths. Type 2 is a cluster of eight unnotched points whose relative thinness apparently has drawn them together. In a similar vein, Type 3 is a grouping of ten points which are relatively short or long in relation to their width, and Type 4 a cluster of five points of relatively great tang length. Both of these latter two types are composed primarily of side-notched specimens, although a few unnotched points are also present.

Projectile point component loadings and cluster elements may be found in Appendixes VII and X, respectively.

Bifaces

An average-link cluster analysis of biface continuous attributes generated three groupings and a small residue set. Type 1 is composed of relatively small, finely-worked, ovate, crescentic, lunate, and rectangular bifaces, in contrast to the other two types, which are groupings of relatively large, coarsely-flaked artifacts. Type 2 is a cluster of ovate and lunate, and Type 3 of crescentic and ovate types. Table 6, below, provides a brief numerical description of the results of this clustering technique on the continuous variables. The types are illustrated in Appendix XVI, Plates 8 and 9.

TABLE 6

BIFACE CLUSTER TYPES, CONTINUOUS ATTRIBUTES[1]

Attribute	Type 1	Type 2	Type 3
Maximum width	1.4-3.2 cm.	1.4-6.7 cm.	4.0-5.7 cm.
Maximum thickness	0.4-1.1	0.4-1.6	0.4-1.2
Axial length	3.3-6.8	3.3-9.9	3.6-8.1
Base width	0.9-2.8	0.9-2.4	2.4-4.5
Blade length	2.7-4.6	2.7-6.2	2.3-3.9
Base length	0.6-2.2	0.6-3.8	1.3-4.2
Angle of convergence of sides	8-45°	10-73°	25-50°
Total number of artifacts per type	27	2	4

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

Discrete attributes failed to cluster adequately, generating one large group and a very small residue set. Table 7 gives the parameters of this type, which is represented in Appendix XVI, Plate 10.

The ultimate cluster analysis of biface data was run on a combination of continuous and discrete attributes, after all of these variables had been rendered discrete in a manner identical to that described for projectile points. One grouping and a large residue set were generated. This grouping, or Type 1, is composed of relatively small, finely-worked ovate, crescentic, lunate, and rectangular artifacts. A brief description of Type 1 may be found below in Table 8. It is illustrated in Appendix XVI, Plate 11.

The principal-component analysis of bifaces produced four components accounting for slightly over eighty-three percent of all variance present in the input data. As with the analogous projectile point analysis, the highest loadings of artifacts loading highly on a given component were considered diagnostic, although the criterion level was set at .20. Artifacts whose loadings fell below this point were placed in a residue set. The resultant four types are presented below in Table 9. These types are illustrated in Appendix XVI, Plates 12 and 13.

TABLE 7

BIFACE CLUSTER TYPE, DISCRETE ATTRIBUTES

Attribute	Type 1
Length/width ratio	primarily 1:1.5-1:2.5
Presence of notching	primarily absent
Placement of primary retouch, base	primarily bifacial
Blade outline	ovate, crescentic, lunate, rectangular
Total number of artifacts in type	33

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

TABLE 8

BIFACE CLUSTER TYPE, ALL ATTRIBUTES[1]

Attribute	Type 1
Maximum width....................................	1.4-3.2 cm.
Maximum thickness................................	0.4-1.1
Axial length.....................................	3.3-8.0
Base width.......................................	0.9-2.8
Blade length.....................................	2.7-5.6
Base length......................................	0.6-2.4
Angle of convergence of sides....................	8-45°
Angle of basal orientation.......................	91-107
Blade outline....................................	ovate, crescentic, lunate, rectuangular
Size of primary chipping scars on blade...........	diminutive
Point of maximum longitudinal thickness...........	proximal, few distal
Length/width ratio...............................	1:1.2-1:1.5
Articulation of base.............................	primarily acute
Total number of artifacts in type.................	28

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

TABLE 9

BIFACE PRINCIPAL-COMPONENT TYPES[1]

Attribute	Type 1	Type 2	Type 3	Type 4
Maximum width...................	3.7-6.7 cm.	3.7 cm.	3.1 cm.	3.9 cm.
Maximum thickness...............	0.4-1.6	1.4	1.1	0.8
Axial length....................	3.0-9.9	9.3	5.5	4.8
Base width......................	3.1-4.3	2.1	2.5	3.9
Blade length....................	3.0-6.2	7.8	4.3	3.4
Base length.....................	0.6-3.8	1.5	1.2	1.4
Angle of convergence of sides...	8-73°	51°	85°	45°
Total number of artifacts per type..........................	6	1	1	1

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

Type 1 is a grouping of six ovate and crescentic bifaces exhibiting the greatest widths in the sample. Type 2 is a single very thick lunate artifact. Similarly, Type 3 is a single biface which is relatively short in relation to its width, and Type 4 a single biface with relatively great basal width. Both of these latter two types are composed of ovate forms.

Biface component loadings and cluster elements are presented in Appendixes VIII and XI, respectively.

End Scrapers

A large residue set and eight groupings, each of which has been designated as a type, were generated by an average-link cluster analysis of end scraper continuous attributes. Type 1 is composed of small trapezoidal artifacts with shallow front contour and symmetrical frontal orientation. Type 2 end scrapers are of medium size, pyriform outline, and shallow to medium front contour. Frontal orientation is symmetrical. Type 3 is similar to Type 2 with the exception that both pyriform and trapezoidal scraper outlines are present in the latter grouping. Type 4 exhibits considerable internal variation: all scrapers are small, but outlines vary from pyriform and trapezoidal to semi-discoidal, and front contour from round and medium to shallow. Here, again, frontal orientation is symmetrical. Those artifacts of medium size, trapezoidal outline, shallow front contour, and symmetrical frontal orientation have been clustered as Type 5. Thpes 6 and 7 are identical in that they are composed of small, pyriform scrapers with shallow front contours. They differ in that members of Type 6 have symmetrical frontal orientations, while those of Type 7 are asymmetrical. The final type is a clustering of large parallel-sided scrapers with shallow or straight front contour and symmetrical frontal orientation. Table 10, below, presents a resumé of these types, all of which are illustrated in Appendix XVI, Plates 14 to 16.

A similar analysis of discrete attributes failed to produce clusters or residue sets, all artifacts being placed into one inclusive cluster, although an average-link cluster analysis of all variables, utilizing a procedure identical to that previously described, generated two groups and a large residue set.

The first of these groups, designated Type 1, is composed of trapezoidal- and pyriform-shaped scrapers ranging in axial length from 1.5 to 3.6 centimeters. Longitudinal section is primarily convexo-triangular, although some other forms do occur. Primary chipping is, for the most part, bifacial. The second group, Type 2, contains trapezoidal or parallel-sided scrapers, unifacially chipped and large, ranging from 2.4 to 5.5 centimeters in length and 1.8 to 2.8 in maximum width. Longitudinal section is primarily biconvex or concavo-convex.

TABLE 10

END SCRAPER CLUSTER TYPES, CONTINUOUS ATTRIBUTES

Attribute	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8
Axial length..............	2.0-3.7 cm.	1.7-3.1 cm.	1.9-3.9 cm.	1.6-3.4 cm.	1.6-2.9 cm.	2.0-2.8 cm.	1.7-2.8 cm.	4.4-5.5 cm.
Maximum width.............	2.1-2.5	1.7-2.0	2.2-2.6	1.4-2.0	2.3-2.8	1.2-1.8	1.4-1.7	2.4-2.8
Maximum thickness.........	0.5-0.9	0.4-0.8	0.5-0.7	0.4-0.8	0.4-0.7	0.4	0.4-0.8	0.8-1.2
Front thickness...........	0.5-0.9	0.4-0.7	0.3-0.7	0.4-0.7	0.4-0.7	0.3-0.4	0.2-0.6	0.7-0.8
Proximal width............	1.3-1.9	0.0-1.8	0.0-1.4	0.6-1.2	1.9-2.4	0.0-0.3	0.4-0.8	0.3-2.0
Distal width..............	2.5-2.9	1.7-2.0	2.2-2.6	1.4-2.0	2.4-2.8	1.2-1.7	1.3-1.7	0.9-2.2
Distance point of maximum width from front..........	0.4-1.0	0.2-0.6	0.3-1.4	0.1-1.2	0.2-0.4	0.2-0.9	0.3-0.9	1.2-2.0
Angle of working edge......	47-87°	35-80°	47-70°	47-75°	50-70°	37-45°	63-70°	30-83°
Angle divergence of sides..	20-35	20-50	15-45	15-55	12-15	25-35	15	0-15
Total number of artifacts per type..................	6	9	22	13	4	2	4	5

A brief description of these types is presented in Table 11. They are illustrated in Appendix XVI, Plate 17.

A principal-component analysis of end scrapers generated four components accounting for slightly over eighty percent of all variance present in the input data. As with previous analogous analyses, the highest loadings of artifacts loading highly on a given component were considered diagnostic, the criterion level being set at .18. The resultant four types are presented in Table 12. These types are illustrated in Appendix XVI, Plates 18 and 19.

Type 1 is a grouping of four scrapers which are relatively short in relation to their width. Those leading positively on the component exhibit some of the shortest lengths present in the sample. Type 2 is a cluster of four artifacts of relatively great width. Likewise, Type 3 is a grouping of three scrapers whose relative thickness has drawn them together, and Type 4 a cluster of seven artifacts similarly based upon front thickness.

End scraper component loadings and cluster elements may be found in Appendixes IX and XII, respectively.

TABLE 11

END SCRAPER CLUSTER TYPES, ALL ATTRIBUTES[1]

Attribute	Type 1	Type 2
Axial length	1.5-3.6 cm.	2.4-5.5 cm.
Maximum width	1.5-2.7	1.8-2.8
Maximum thickness	0.4-1.2	0.5-1.2
Front thickness	0.3-0.7	0.5-0.8
Proximal width	0.0-2.3	0.7-2.0
Distal width	1.5-2.7	1.7-2.2
Distance point of maximum width from front	0.2-0.4	0.2-2.0
Angle of working edge	47-87°	30-83°
Angle of divergence of sides	12-69	0-35
Basal reworking	primarily present	absent
Scraper outline	trapezoidal, pyriform	trapezoidal, parallel-sided
Basal outline	convex, bivectoral, trivectoral, tetrameral	convex
Presence of secondary chipping, body	present or absent	present
Flake type	expanding, some tabular and decortication	tabular, some decortication and expanding
Longitudinal section	primarily convexo-triangular	primarily biconvex or concavo-convex
Point of maximum thickness, lateral dimension	lateral or medial	lateral-some medial
Frontal orientation	transverse or oblique	transverse, some oblique
Configuration of body edge	even, some irregular	irregular, some even
Placement of primary chipping, body	primarily bifacial	primarily unifacial
Length/width ratio	1:3 or less	1:2.5 or less
Total number of artifacts per type	50	13

1. For descriptive purposes, only those attributes indicative of intergroup differences are presented.

TABLE 12

END SCRAPER PRINCIPAL-COMPONENT TYPES

ATTRIBUTE	Type 1	Type 2	Type 3	Type 4
Axial length..................	1.6-3.9 cm.	4.3-5.4 cm.	1.2-3.8 cm.	2.2-3.4 cm.
Maximum width.................	1.2-2.6	2.4-2.7	1.9-2.5	2.0-2.8
Maximum thickness.............	0.4-0.8	0.7-1.2	0.3-0.9	0.3-0.8
Front thickness...............	0.2-0.8	0.4-0.9	-.3-0.9	0.3-0.8
Proximal width................	0.0-1.4	0.0-2.2	0.0-1.6	0.0-2.3
Distal width..................	1.2-2.6	1.7-2.4	1.6-2.4	1.9-2.5
Distance of point of maximum width from front............	0.2-0.7	0.2-2.0	0.1-1.0	0.2-1.6
Angle of working edge..........	35-75°	47-80°	33-75°	35-87°
Angle of divergence of sides...	15-45	0-60	15-45	12-55
Total number of artifacts per type......................	4	4	3	7

CHAPTER V
TYPE COMPARISONS

CLUSTER- AND FACTOR-DERIVED TYPE COMPARISONS

In order to facilitate a comparison of the foregoing cluster- and factor-derived types, contingency tables were constructed for each artifact category, showing cross-tabulated artifact counts for all types. These tables limited the number of methods of analysis which could be compared at any one time to two, therefore six such cross-tabulations were required to completely cover each general category. Individual cell frequencies for each table thus indicate only the number of mutually shared artifacts present among the various types generated by the two specific techniques under comparison. Where possible, a chi-square test of significance was applied to each table to determine overall degree of relationship. By this means, an objective illustration of the various typological methodologies is put forth for each of the three major artifact classes.

PROJECTILE POINTS

TABLE 13

COMPARISON OF PROJECTILE POINT PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTE) DERIVED TYPES

		Principal-component Types				Total
		1	2	3	4	
Cluster Types	1	4	7	4	4	19
	2	0	1	5	0	6
	3	1	6	0	0	7
Total		5	14	9	4	32

χ^2 — 4.87 with 6 degrees of freedom

(not significant at .05 level of probability)

TABLE 14

COMPARISON OF PROJECTILE POINT PRINCIPAL-COMPONENT-
AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTE) DERIVED TYPES

	Principal-component Types				
	1	2	3	4	Total
Cluster Type 1	2	5	10	4	21
Total	2	5	10	4	21

TABLE 15

COMPARISON OF PROJECTILE POINT PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

		Principal-component Types				
		1	2	3	4	Total
Cluster Types	1	1	0	1	0	2
	2	0	0	8	3	11
	3	4	7	1	2	14
Total		5	7	10	5	27

x^2 — .49 with 6 degrees of freedom
(not significant at .05 level of probability)

TABLE 16

COMPARISON OF PROJECTILE POINT AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) DERIVED TYPES

	Cluster (cont.) Types			Total
	1	2	3	
Cluster (dis.) Type 1	5	103	19	127
Total	5	103	19	127

TABLE 17

COMPARISON OF PROJECTILE POINT AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

		Cluster (cont.) Types			Total
		1	2	3	
Cluster (all) Types	1	0*	0*	35	35
	2	1	107	0*	108
Total		1	107	35	143

X^2 — 26.43 with 2 degrees of freedom

(significant at .001 level of probability)

* expected value of less than 5

TABLE 18

COMPARISON OF PROJECTILE POINT AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) DERIVED TYPES

	Cluster (all) Types 1	2	Total
Cluster (dis) Type 1	20	109	129
Total	20	109	129

BIFACES

TABLE 19

COMPARISON OF BIFACE PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) DERIVED TYPES

		Principal-component Types 1	2	3	4	Total
	1	2	0	1	0	3
Cluster Types	2	0	2	0	0	2
	3	4	0	0	0	4
Total		6	2	1	0	9

X^2 — .01 with 6 degress of freedom
(not significant at .05 level of probability)

TABLE 20

COMPARISON OF BIFACE PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER-(DISCRETE ATTRIBUTES) DERIVED TYPES

		Principal-component Types				Total
		1	2	3	4	
Cluster Type	1	5	1	1	1	8
Total		5	1	1	1	8

TABLE 21

COMPARISON OF BIFACE PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

	Principal-component Types 1	2	3	4	Total
Cluster Type 1	2	0	1	0	3
Total	2	0	1	0	3

TABLE 22

COMPARISON OF BIFACE AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) DERIVED TYPES

	Cluster (cont.) Types			Total
	1	2	3	
Cluster (dis.) Type 1	26	2	3	21
Total	26	2	3	21

TABLE 23

COMPARISON OF BIFACE AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES)
AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

	Cluster (cont.) Types			Total
	1	2	3	
Cluster (all) Type 1	27	0*	0*	27
Total	27	0	0	27

* members of cluster continuous variable Types 2 and 3 fell into residue set for cluster Type 1, all variables.

TABLE 24

COMPARISON OF BIFACE AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) DERIVED TYPES

	Cluster (all) Type 1	Total
Cluster (dis.) Type 1	27	27
Total	27	27

END SCRAPERS

TABLE 25

COMPARISON OF END SCRAPER PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTE) DERIVED TYPES

		Principal-component Types				Total
		1	2	3	4	
Cluster Types	1	0	0	1	2	3
	2	0	0	0	2	2
	3	0	0	1	1	2
	4	2	0	0	0	2
	5	0	0	0	3	3
	6	1	0	0	0	1
	7	1	0	0	0	1
	8	0	3	0	0	3
Total		4	3	2	8	17

χ^2 — 10.56 with 21 degrees of freedom
(not significant at .05 level of probability)

TABLE 26

COMPARISON OF END SCRAPER PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTE) DERIVED TYPES

		Principal-component Types 1	2	3	4	Total
Cluster Type	1	4	4	3	7	18
Total		4	4	3	7	18

TABLE 27

COMPARISON OF END SCRAPER PRINCIPAL-COMPONENT- AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

		Principal-component Types 1	2	3	4	Total
	1	2	0	0	3	5
	2	0	3	1	2	6
Total		2	3	1	5	11

X^2 — .09 with 3 degrees of freedom

(not significant at .05 level of probability)

TABLE 28

COMPARISON OF END SCRAPER AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) DERIVED TYPES

	Cluster (cont.) Types 1	2	3	4	5	6	7	8	Total
Cluster (dis.) Type 1	6	9	22	13	4	2	4	5	65
Total	6	9	22	13	4	2	4	5	65

TABLE 29

COMPARISON OF END SCRAPER AVERAGE-LINK CLUSTER- (CONTINUOUS ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) DERIVED TYPES

	Cluster (cont.) Types 1	2	3	4	5	6	7	8	Total
Cluster (all) Types 1	3	5	17	9	3	0*	1	0*	38
2	1	1	0*	0*	1	1	1	5	10
Total	4	6	17	9	4	1	2	5	48

χ^2 — 15.07 with 7 degrees of freedom

(significant at .05 level of probability)

* expected value of less than 5

TABLE 30

COMPARISON OF END SCRAPER AVERAGE-LINK CLUSTER- (ALL ATTRIBUTES) AND AVERAGE-LINK CLUSTER- (DISCRETE ATTRIBUTES) DERIVED TYPES

	Cluster (all) Types		Total
	1	2	
Cluster (dis.) 1 Type	50	13	63
Total	50	13	63

Problematical Objects

Included in the sample under consideration were nine problematical artifacts, difficult to assign to either the projectile point or biface category. Consequently, they were clustered and factored as members of both of these groupings in an attempt to determine where they best fit.

Results were somewhat inconclusive, since the artifacts in question tended to factor indiscriminately into projectile point and biface types, yet cluster differentially in that some exhibited a fairly high degree of ingroup similarity and object stability and others a low degree of ingroup similarity and object stability when clustered with projectile point or biface data (see Table 1, Appendixes XIII and XIV). However, on this basis, it is probable that artifacts number 3000, 3490, 3506, 3514, 3515, and perhaps 3001 are bifaces, and that numbers 3004, 3080, and 3106 are projectile points. They will be considered as such for further comparison.

DISCUSSION

The results of the chi-square tests of association between the various cluster- and factor- derived types indicate that only those clusters of continuous and continuous/discrete projectile point attributes, and continuous and continuous/discrete end scraper attributes appear to have any significant relationship. However, the values obtained in these two instances must be treated with reservation, since several of the expected cell frequencies fall below five (Freund 1967:290). Since the factor and cluster types are interrelated in the sense that in most cases they hold a majority of attributes in common, this apparent insignificance of association becomes rather important: one would normally expect high chi-square values. It may be assumed therefore, that *in toto* the various typologies generated from this analysis are not commensurable. Hence, it becomes necessary to determine not only which multivariate technique best represents the data analyzed, but also which may be considered to have the widest applicability to archaeological problems. Through a process of elimination, those groups produced by means of an average-link clustering of both continuous and discrete attributes may be considered to best meet the criteria in question.

Sackett (1969:1125-30) has raised objections against the application of factor analysis to artifactual materials, arguing that the technique has a propensity for data distortion whenever interdependent variables such as those forming the basis for artifactual patterning are considered. Logically impossible attribute combinations, in Sackett's opinion, could be assigned maximum negative associations.

It is argued here that although use of a Q-mode technique, in which artifacts are considered the unit of analysis, would not negate the distortion, it would serve an ameliorative function, since attributes which have achieved factor or component status through application of this technique would seldom form fallacious combinations among themselves. At very least, similar combinations would distort in analogous fashion so that factoring would be capable of generating relatively consistent types. Furthermore, it is difficult to condemn the application of a particular technique solely on the grounds of distortion, since any multivariate technique must of necessity distort reality (Sokal and Sneath 1963:169, 312). Q-mode factoring, however, may have limited application where low factor loadings are present, since artifacts may be assigned to a group on the basis of a small percentage of their total variance. Additionally, the technique's partitioning of variance among several factors tends to render resultant groups somewhat over-simplified.

The major limitation of factor analysis in archaeological applications may ultimately prove to be the technique's inability to handle non-metric data, for many of the key attributes employed in typologies are of a discrete nature (Binford 1963; Sackett 1969: 1126). Such attributes are required to adequately reflect the many aspects of form, function, and style of which typologies considered maximally useful are composed (Binford 1968: 50; Binford and Binford 1969). In this respect, factor analysis has limited application to archaeological problems. Similarly, there are limitations to any cluster analysis based solely upon metric data.

The analysis of non-metric discrete attributes alone, however, resulted in generalized categories of low average group stability. In every instance, these groupings failed to reflect ranges of variability present in the data which rypes generated utilizing metric or combinations of metric and non-metric data reproduced, albeit to differing intensities. This failure may be largely a function of inaedquate attribute lists. Nevertheless, those typologies based solely on non-metric discrete attributes may be considered less complete for comparative purposes than those based on a combination of metric and non-metric data.

Evidently, a combination of metric and non-metric attributes should be employed in the formulation of archaeological typologies whenever possible, necessitating the use of a clustering, as opposed to a factoring, technique. Types constructed on this basis have proven the most serviceable elsewhere, since factoring tends to generate spurious correlations when confronted by even partially interdependent attributes such as those relating to size and shape (where the latter is convertible to metric expression)(Sokal and Sneath 1963:12; Sackett 1969:1128).

COMPARISON OF OBJECTIVE AND SUBJECTIVE TYPES

Although it is difficult to assess which of the numerical groupings prove most useful in comparison with subjective types, it is suggested that those produced by an average-link clustering of both continuous and discrete attributes are most satisfactory. Therefore, the types generated through the final cluster analysis of each artifact category were those compared to similar subjectively-defined artifactual materials from Manitoba, as discussed by MacNeish (1958) and Joyes (1968), and related artifacts from North and South Dakota analyzed by Wood and Woolworth (1964a, 1964b) and Wood (1967). Side-notched projectile points were additionally compared to Kehoe's (1966) Northern Plains projectile typology. Results of this comparison are set out in Tables 31, 32, and 33, and illustrated in Appendix XVI, Plates 20 to 24.

It is evident from an examination of Tables 31 and 33 that projectile point and end scraper cluster Types 1 and 2 are comparable to subjective groupings of the same sorts of material, although the technique has not split these generalized types into a series of subtypes as have most of the aforementioned analyses.

Biface cluster Type 1 is not generally comparable to published groupings of similar data, since it tends to encompass several subjectively-defined types (see Table 32).

A major difference between the classificatory techniques employed here and those utilized by subjective typologists is that the attributes and methods of grouping are made explicit in the former case, in direct contrast to the implicit nature of the latter. It is clear that if archaeology is to be developed into a rigorous discipline, quantitative grouping methodologies will have to undergo widespread adoption and use.

TABLE 31

COMPARISON BETWEEN PROJECTILE POINT CLUSTER AND PUBLISHED TYPES

Item	MacNeish	Joyes	Wood & Woolworth	Kehoe
Cluster 1	Eastern Triangular	Plains Triangular	Plain Lanceolate, convex base Plain Lanceolate, straight base Plain Triangular, concave base	
Cluster 2	Prairie Side-notched Plain Side-notched	Late side-notched		High River Small Corner-notched Paskapoo Square-ground Base Emigrant Basal-notched Buffalo Gap Single-spur Washita Triangular or Prairie Side-notched Plain Side-notched

TABLE 32

COMPARISON BETWEEN BIFACE CLUSTER AND PUBLISHED TYPES

Item	MacNeish	Joyes	Wood, Wood & Woolworth
Cluster 1	Small Half-moon Triangular Oblong Ovoid	Rectangular Crescent Ovate Oval Lanceolate	Leaf-shaped Knife Asymmetrical Knife Flake Knife or Narrow Knives

TABLE 33

COMPARISON BETWEEN END SCRAPER CLUSTER AND PUBLISHED TYPES

Item	MacNeish	Wood & Woolworth	Wood
Cluster 1	Triangular Disc	Group 1 Group 2	Small Bifacially Flaked Small Plano-convex
Cluster 2	Triangular Oblong Plano-convex	Group 2 Group 3	Large Bifacially Flaked Large Plano-convex

CHAPTER VI
CONCLUSIONS

ANALYTICAL WEAKNESSES AS INDICATED BY TYPE CLASSIFICATIONS

Analytical results indicate that certain weaknesses or deficiencies are present in this study. These inadequacies may be roughly categorized as follows:

a) overemphasis and/or weighting for certain variables

b) inclusion of "insignificant" variables in correlation matrices; and

c) choice of grouping techniques.

The Attribute Lists

Although the set of possible variables may be considered infinite, attempts were made to limit variables utilized, since limits on the number of variables requiring simultaneous testing are necessary if statistically reliable measures of significance are to be obtained (Sackett 1966:369). Providing that variables selected are representative of the various formal, functional, technical, and stylistic aspects of the category under consideration, adequately-defined groupings should occur. The primary difficulty is that not all aspects were so defined.

First, the overemphasis of certain variables — primarily those dealing with specific technical as opposed to functional aspects — resulted in unintentional attribute weighting. Such has been demonstrated as data-distorting (Sokal and Sneath 1963:119).

Second, important variables have apparently been omitted from the attribute lists, expecially those used in the description of bifaces and end scrapers. For example, the functions of these two categories were originally oversimplified with the result that the types and patterning/positioning of use wear were omitted. It also seems probable that the grain size of the material of manufacture may have functional and/or stylistic connections. This lack is a fault of training; that of the archaeologist in general, and of the author in particular. Typological training has traditionally been restricted to a subjective level with consequent expectations of less critical analysis. There will have to be a rethinking of attributes if statistical classificatory techniques are to be successfully employed, especially with regard to form-function-style-technical variable interactions. In fact, studies in this area are urgently required to determine exactly how such interactions work, and what common denominators or subelements, if any, may be extracted from them. Furthermore, a thorough knowledge of lithic artifact technology (which the author lacks) is recommended for anyone undertaking classifications of the sort attempted here.

Third, upper and lower limits on the number of variables which may be simultaneously tested with each grouping technique must be determined. On the basis of biface analysis results, the lower permissible extreme may have been approached, both for factoring and clustering, although the nature of the attribute list employed must also be taken into account.

The Correlation Matrices

Many insignificant correlations, represented by low coefficient values, are present in the matrices employed in this study. Attributes forming statistically insignificant relationships may better be omitted from analysis at this level than included, as they were in this study (Freund 1967:366-369). Such an omission, however, presupposes thorough knowledge of attribute subelements, their many aspects, and complex interactions. Furthermore, it might be argued that low interacting variables are better included since their omission can lead to further distortion.

The Grouping Techniques

Any statistical technique is restrictive in one way or another (Sokal and Sneath 1963:166-8; Cowgill 1968:367; Clarke 1968: 594). Choice of technique must therefore be made with its particular limitations in mind, as appropriate or inappropriate to the analysis to be undertaken. Factoring has already been demonstrated as inappropriate in the production of generalized typologies requiring analysis of both discrete and continuous attributes. It is appropriate to restricted applications in the sense that it not only groups a given unit, but also provides the degree of resemblance of that unit to an average representative of the cluster, thereby preventing unreliable interpretations of differences (Sokal and Sneath 1963:196).

Clustering, on the other hand, is appropriate in that it is capable of producing both specific and generalized typologies but is limited in the sense that units which do not correlate highly with any others tend to have their degree of isolation exaggerated during the course of subsequent interpretation (Sokal and Sneath 1963:196). This latter fact is certainly true of this particular analysis, since some artifacts were omitted from consideration with each interpretation of results produced for the respective artifact categories. Those omitted, incidentally, were not always the same artifacts.

Summary

Unintentional variable weighting and inclusion of insignificant attributes in correlation matrices have combined to strongly influence types generated by the factor and various cluster analyses. Such affects are perhaps no more clearly evident than in the low factor loading values produced for each artifact category. These types are further influenced by the statistical techniques employed. Factoring, with its assumption of a communality of less than one, parcels total unit variation among several factors, with the result that all entities are accounted for by one or more factors (Sokal and Sneath 1963:182; Nie, Bent, and Hull 1970:210). Clustering, on the other hand, assumes a communality of one, parcelling unit variation to one group or another (Hodson, Sneath, and Doran 1966:322; Cowgill 1968:369). Consequently, discrete types are developed, and entities detracting from the structure of such groupings are omitted from them.

THE NATURE OF NUMERICAL TYPES

It should be evident from previous discussion that numerically-defined types are conceived of as hierarchical organizations typified by "most representative" or "average" entities (Sokal and Sneath 1963:171). Such types are generally conceived of as polythetic, that is, each entity possesses a large unspecified number of properties in a given set; each property in the set is possessed by a large number of these individuals; and no one property in a given set is necessarily possessed by every individual in the aggregate (Sokal and Sneath 1963:13-15; Clarke 1968:190). Thus, types are more or less discrete from one another.

The analysis of archaeological materials has pointed to certain difficulties in the above assumptions concerning the nature of types implied by numerical taxonomy. For example, archaological types are not fully polythetic, since every individual in a type aggregate will frequently possess one or more properties present in a given set (Clarke 1968:191). Cultural patterning additionally serves to reduce the number of properties in a given set to a quantity which will probably be rendered specifiable with further study. Finally, type boundaries, while envisioned as concrete, may be in reality reflections of gaps in existing knowledge. Where such gaps are not present, boundaries are vague (Sokal and Sneath 1963:173).

Basing types on problematical assumptions of the sort outlined above results in somewhat abstract, oversimplified taxonomies (Sokal and Sneath 1963:169). Use of such is justified on the basis that numerical classifications are the most explicit, adequately defined, and repeatable possible at the present time. The onus is on the investigator to bear in mind their open-ended, imperfect nature.

NUMERICAL AND SUBJECTIVE TYPOLOGY: AN APPRAISAL

If repeatable archaological typologies are to be achieved, then numerical or objective methods of classification (exemplified by quantification) will have to supercede traditional subjective idiosyncratic techniques. For such to be truly effective, however, further research is urgently required in four basic areas:

a) lithic technology must be fully explored so that the importance of choice of technique might be understood, not only for itself, but also for its relationships with other variables;

b) variable interactions must be analyzed to determine component subelements and how they work, since only then can core attributes or basic attribute lists be determined;

c) upper and lower limits on the number of input variables must be established for each statistical technique so that resultant groupings are neither so overwhelmed by non-essential information nor so generalized as to be rendered useless; and

d) statistical techniques themselves must be compared, and use of such in numerical classifications of archaological materials be restricted to a few of the most comparable and broadly useful.

Additionally, archaologists must be made aware of the necessity for careful sampling techniques and should practice such, where possible. Until these basic criteria are met, numerical classification will have little more to offer than subjective typology. Furthermore, many of the above limitations generate statistical distortion that currently renders premature and effectively prohibits any jump from artifactual patterning to a more useful large scale cultural patterning capable of yielding that knowledge prerequisite to reconstruction of past cultural systems (Ford 1954c).

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APPENDIX I

PROJECTILE POINT
ATTRIBUTE FREQUENCIES AND PARAMETERS

TABLE I.

PROJECTILE POINT
DISCRETE ATTRIBUTE FREQUENCIES

Attribute	State	Absolute Frequency	Relative Frequency
Blade Outline	excurvate	5	3.2
	triangular	108	69.7
	ovate	42	27.1
Transverse section	biconvex	85	54.8
	plano-convex	17	11.0
	convexo-triangular	25	16.1
	bitriangular	4	2.6
	plano-triangular	7	4.5
	biplano	10	6.5
	concavo-triangular	7	4.5
Longitudinal section	plano-convex	7	4.5
	biconvex	104	67.1
	biplano	6	3.9
	concavo-convex	38	24.5
Blade symmetry	assymetrical	16	10.3
	symmetrical	139	89.7
Size primary chip., blade	dimminutive	140	90.3
	massive	15	9.7
	obscured	0	0.0

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Depth primary chip., blade	deep	81	52.3
	flat	74	47.7
Placement prim. chip., blade	bifacial	135	87.1
	unifacial	20	12.9
Placement sec. chip., blade	bifacial	151	97.4
	unifacial	4	2.6
Pattern sec. chip., blade	continuous	127	81.9
	discontinuous	28	18.1
Configuration lat. edge, bld.	even	140	90.3
	irregular	15	9.7
Treatment lat. edge, bld.	plain	154	99.4
	serrated	1	0.6
Blade reworking	present	9	5.8
	absent	146	94.2
Base outline	convex	66	42.6
	concave	31	20.0
	straight	58	37.4
Articulation base	splayed	87	58.1
	oblique	68	41.9
Treatment basal edge	chipped	121	78.1
	ground	34	21.9

TABLE I
Continued

Attribute	State	Absolute Frequency	Relative Frequency
Configuration basal edge	even	144	92.9
	irregular	11	7.1
Placement prim. retouch, base.	bifacial	137	88.4
	unifacial	18	11.6
Presence sec. retouch, base	absent	66	42.6
	present	89	57.4
Basal reworking	present	15	9.7
	absent	140	90.3
Haft juncture	absent	8	5.2
	lateral-lateral	117	75.4
	lateral-basal	30	19.4
Shoulder barbing	absent	35	22.6
	barbed	1	0.6
	nonbarbed	119	76.8
Shoulder outline	absent	35	22.6
	straight	45	29.0
	concave	58	37.4
	convex	17	11.0

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Tang outline	absent	8	5.2
	contracting	27	17.4
	contracting-expanding	13	8.4
	expanding	2	1.3
	biexpanding	39	25.2
	parallel-expanding	66	42.6
Tang juncture	absent	38	24.5
	lateral-basal	116	74.8
	lateral-lateral	1	0.6
Point max. long. thickness	proximal	44	28.4
	medial	74	47.7
	distal	37	23.9
Point max. lat. thickness	lateral	42	27.1
	medial	113	72.9
Length/width ratio	1. <1:1	4	2.6
	2. 1:1-1:1.5	82	52.9
	3. 1:1.6-1:2	54	34.8
	4. 1:1.21-1:25	11	7.1
	5. 1:2.6-1:3	3	1.9
	6. >1:3	1	0.6

TABLE II

DESCRIPTION OF PROJECTILE POINT CONTINUOUS ATTRIBUTES

Attribute	Mean	Mode	Range	Standard Deviation	Variance
Base width....................	1.4 cm.	1.4 cm.	0.6-3.4 cm.	1.18	1.38
Neck width....................	0.9	0.9	0.5-1.8	2.44	5.96
Tang width....................	1.4	1.3	0.6-3.5	1.26	1.58
Proximal width................	1.4	1.4	0.6-3.8	1.40	1.96
Maximum width.................	1.5	1.5	1.0-3.8	1.30	1.69
Left notch width..............	0.4	0.3	0.1-0.8	0.13	0.02
Left notch length.............	0.2	0.2	0.1-0.5	0.09	0.01
Right notch width.............	0.4	0.3	0.2-0.7	0.11	0.01
Right notch length............	0.2	0.2	0.1-0.4	0.08	0.01
Axial length..................	2.4	2.2	1.0-7.2	1.83	3.34
Tang length...................	0.8	0.7	0.3-2.3	1.16	1.36
Blade length..................	1.6	1.4	0.4-5.2	1.60	2.55
Maximum thickness.............	0.4	0.3	0.2-0.9	1.08	1.17
Angle of basal orientation....	91°	91°	91-98°	0.79	0.62
Angle of notching.............	179	185	75-208	2.86	8.18
Angle of convergence of sides.	34	25	10-108	1.68	2.84
Angle of convergence of tip...	63	55	20-140	1.63	2.66

APPENDIX II

BIFACE ATTRIBUTE FREQUENCIES AND PARAMETERS

TABLE I

BIFACE DISCRETE ATTRIBUTE FREQUENCIES

Attribute	State	Absolute Frequency	Relative Frequency
Blade outline	rectangular	2	5.7
	ovate	24	68.6
	lunate	3	8.6
	concavo-convex	6	17.1
Blade symmetry	symmetrical	17	48.6
	asymmetrical	18	51.4
Distal juncture	present	13	37.1
	absent	22	62.9
Size primary chip., blade	massive	13	37.1
	diminutive	22	62.9
Depth primary chip., blade	flat	7	20.0
	deep	28	80.0
Placement sec. chip., blade	unifacial	0	0.0
	bifacial	35	100.0
Pattern sec. chip., blade	continuous	18	51.4
	discontinuous	17	48.6
Configuration lat. edge, bld.	even	18	51.4
	irregular	17	48.6
Blade reworking	present	1	2.9
	absent	34	97.1

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Blade backing	present	6	17.1
	absent	29	82.9
Blade notching	present	5	14.3
	absent	30	85.7
Base outline	concave	1	2.9
	straight	2	5.7
	convex	32	91.4
Base symmetry	transverse	17	48.6
	oblique	18	51.2
Articulation base	acute	18	51.2
	obtuse	17	48.6
Configuration basal edge	irregular	18	51.2
	even	17	48.6
Placement prim. retouch, base	bifacial	32	91.4
	unifacial	3	8.6
presence second. retouch, base	present	26	74.3
	absent	9	25.7
Basal reworking	present	1	2.9
	absent	34	97.1

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Point Max. long. thickness	proximal	20	57.1
	distal	15	42.9
Point max. lat. thickness	medial	16	45.7
	lateral	19	54.3
Length/width ratio	1. <1:1.5	7	20.0
	2. 1:1.51-1:2.5	24	68.6
	3. 1:2.51-1:3.5	3	8.6
	4. >1:3.5	1	2.9

TABLE II

DESCRIPTION OF BIFACE CONTINUOUS ATTRIBUTES

Attribute	Mean	Mode	Range	Standard Deviation	Variance
Base width......................	1.9 cm.	1.6 cm.	0.9-4.5 cm.	2.49	6.20
Distal width....................	2.6	2.3	1.2-6.4	2.31	5.32
Width at mid point of blade.....	2.4	1.8	1.2-6.4	2.38	5.64
Maximum width...................	2.7	2.3	1.4-6.7	2.46	6.07
Axial length....................	5.3	5.8	3.1-9.9	3.18	10.14
Blade length....................	3.7	2.7	1.8-7.9	2.39	5.73
Base length.....................	1.6	1.6	0.6-4.2	1.74	3.02
Maximum thickness...............	0.8	0.6	0.4-1.6	2.86	8.19
Angle of basal orientation......	93°	92°	91-107°	3.46	11.95
Angle of convergence of sides...	29	25	8-85	3.62	13.13
Angle of convergence of base....	83	105	30-155	3.33	11.06

APPENDIX III

END SCRAPER
ATTRIBUTE FREQUENCIES AND PARAMETERS

TABLE I

END SCRAPER DISCRETE ATTRIBUTE FREQUENCIES

Attribute	State	Absolute Frequency	Relative Frequency
Front contour	round	5	2.5
	medium	3	3.7
	straight	7	8.7
	shallow	68	85.0
Frontal orientation	oblique	36	45.0
	transverse	44	55.0
Frontal symmetry	asymmetrical	22	27.5
	symmetrical	58	72.5
Longitudinal section	plano-triangular	11	13.7
	biconvex	15	18.8
	convexo-triangular	33	41.2
	concavo-triangular	8	10.0
	concavo-convex	11	13.7
	plano-convex	2	2.5
Body symmetry	present	51	63.7
	absent	29	36.2
Size primary chip; body.	diminutive	55	68.8
	massive	25	31.3

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Depth primary chip., body	flat	6	7.5
	deep	74	92.5
Placement prim. chip., body	unifacial	30	37.5
	bifacial	50	62.5
Presence sec. chip., body	present	69	86.2
	absent	11	13.7
Use/tertiary chip., body	present	65	81.3
	absent	18	18.8
Body reworking	present	2	2.5
	absent	78	97.5
Notching	present	5	6.3
	absent	75	93.8
Configuration lat. edge, body	even	51	63.7
	irregular	29	36.2
Base outline	straight	2	2.5
	convex	39	48.7
	concave	1	1.2
	bivectoral	23	28.7
	trivectoral	14	17.5
	tetrameral	1	1.2

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Basal symmetry	transverse	70	87.5
	oblique	10	12.5
Configuration basal edge	even	49	61.2
	irregular	31	38.7
Placement prim. retouch, base	bifacial	54	67.5
	unifacial	26	32.5
Presence sec. retouch, base	present	57	71.2
	absent	23	28.7
Basal reworking	present	8	10.0
	absent	72	90.0
Scraper outline	pyriform	39	48.7
	parallel-sided	4	5.0
	trapezoidal	35	43.8
	semi-discoidal	2	2.5
Point max. long. thickness	distal	61	76.2
	proximal	19	23.7
Point max. lat. thickness	lateral	43	53.7
	medial	37	46.2

TABLE I

Continued

Attribute	State	Absolute Frequency	Relative Frequency
Flake type	decortication	17	21.2
	expanding	45	56.3
	tabular	17	21.2
	obscured	1	1.2
Length/width ratio	1. <1:1.1	24	30.0
	2. 1:1.1-1:1.5	42	52.5
	3. 1:1.51-1:2	11	13.7
	4. 1:2.1-1:2.5	2	2.5
	5. 1:2.51-1:3	1	1.2

TABLE II

DESCRIPTION OF END SCRAPER CONTINUOUS ATTRIBUTES

Attribute	Mean	Mode	Range	Standard Deviation	Variance
Distal width....................	2.0 cm.	2.2 cm.	1.2-2.8 cm.	1.65	2.72
Proximal width..................	0.8	0.0	0.0-2.4	2.68	1.67
Maximum width...................	2.1	1.8	1.2-2.8	2.99	8.91
Distance of max. width from front..........................	0.5	0.3	0.1-2.0	1.95	3.80
Axial length....................	2.6	1.6	1.2-5.5	1.81	3.29
Maximum thickness...............	0.6	0.6	0.3-1.2	1.62	2.63
Front thickness.................	0.6	0.6	0.2-0.9	1.46	2.13
Angle of working edge...........	57°	55°	30-87°	2.14	4.58
Angle of divergence of sides.....	29	15	0-60	2.48	6.16

APPENDIX IV

PROJECTILE POINT
STATISTICS OF ASSOCIATION

TABLE I

PROJECTILE POINT PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS

	Base width	Neck width	Tang width	Proximal width	Maximum width	L. notch width	L. notch length	R. notch width	R. notch length	Axial length	Tang length	Blade length	Max. thickness	Angle basal orientation	Angle notching	Angle converg. sides	Angle converg tip
Base width																	
Neck width	.74***																
Tang width	.93***	.79***															
Proximal width	.80***	.78***	.91***														
Maximum width	.89***	.82***	.96***	.97***													
L. notch width	.24**	.24**	.27**	.35***	.32***												
L. notch length	.44***	.09	.47***	.56***	.49***	.29**											
R. notch width	.28**	.30**	.30***	.39***	.37***	.75***	.30***										
R. notch length	.44***	.06	.47***	.53***	.47***	.27**	.83***	.29***									
Axial length	.54***	.47***	.71***	.79***	.76***	.29***	.43***	.34***	.38***								
Tang length	.45***	.45***	.58***	.56***	.60***	.39***	.38***	.44***	.39***	.67***							
Blade length	.53***	.40***	.66***	.78***	.73***	.23**	.39***	.27**	.32***	.96***	.50***						
Max. thickness	.53***	.52***	.66***	.67***	.66***	.39***	.23**	.40***	.25**	.73***	.65***	.66***					
Angle basal orientation	-.05	.12	.01	.04	-.01	.03	.01	.12	-.04	.07	.08	.04	.09				
Angle notching	-.03	-.26**	-.00	-.32***	-.18*	-.09	-.16	-.14	.02	-.26**	.05	-.29***	-.18*	-.08			
Angle converg. sides	-.02	-.07	-.09	-.25**	-.12 [illegible]	.04	-.26**	-.08	.22**	-.41***	-.04	-.48***	-.19	-.03	.34***		
Angle converg. tip	.16	.12	.15	.07	.12	.00	-.07	-.05	-.05	-.19**	.14	-.29***	.00	.01	.12	.42***	

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

TABLE IIa

PROJECTILE POINT CHI-SQUARE VALUES, DISCRETE ATTRIBUTES

	Blade outline	Transverse section	Longitudinal section	Blade symmetry	Size primary chipping, blade	Depth primary chipping, blade	Placement primary chipping, blade	Placement secondary chipping, blade	Configuration lateral edges blade.	Treatment lateral edges blade	Blade reworking	Base outline	Articulation base		
Blade outline															
Transverse section	21.5*														
Longitudinal section	14.2*	63.6***													
Blade symmetry	3.3	11.5	4.5												
Size primary chip., blade	4.2	30.0	6.6	0.7											
Depth primary chip., blade	0.9	5.8	3.2	1.3	0.9										
Placement primary chip., blade	0.8	17.7**	43.6	0.2	0.2	0.9									
Placement secondary chip., blade	8.0**	10.8	1.6	0.2	0.0	0.4	0.0								
Pattern secondary chip., blade	7.0*	2.8	12.6**	0.9	.07	6.0**	1.4	1.1							
Configuration lateral edges, blade	2.4	4.8	0.8	0.9	0.8	3.9*	0.2	0.0	7.2**						
Treatment lateral edges, blade	0.4	0.8	0.5	1.7	1.9	0.0	1.2	0.7	9.0**	1.9					
Blade reworking	0.5	1.6	1.8	0.4	0.2	0.3	0.1	0.3	0.0	0.2	3.6				
Base outline	1.4	7.4	7.6	1.2	0.7	0.8	10.4**	2.0	1.4	0.1	1.4	2.3			
Articulation base	0.7	1.7	1.7	0.2	0.1	0.9	0.3	0.5	0.0	0.1	4.1*	39.3	0.1		
Treatment basal edge	1.5	2.8	2.9	0.0	1.4	0.1	2.8	0.9	0.5	0.6	0.5	0.2	1.9	1.2	
Configuration basal edge	11.7**	9.3*	9.2*	0.1	2.3	0.0	1.0	0.2	0.2	2.3	2.8	0.0	1.2	0.1	→
Basal primary retouch	0.4	32.9	33.8	1.3	0.0	1.1	47.1	0.0	4.5*	0.0	1.5	0.2	4.2	0.8	→
Basal secondary retouch	6.8*	6.7	7.0	0.1	0.4	0.9	0.0	0.0	3.5	1.1	0.0	3.4	7.0*	0.6	→
Basal reworking	0.6	10.1**	10.1**	3.0	0.0	0.1	0.2	0.0	0.0	0.0	1.9	0.2	0.3	0.1	→
Haft juncture	10.1*	4.9	4.8	0.5	0.8	3.3	0.2	0.0	1.3	0.3	0.3	0.1	4.5	0.8	→
Shoulder barbing	1.2	9.5	4.9	0.3	0.0	3.5	1.1	0.6	1.6	0.0	0.5	1.8	3.5	2.3	→
Shoulder outline	9.3	4.5	2.9	0.7	1.2	3.5	0.9	0.0	0.9	0.2	0.3	2.9	3.8	0.1	→
Tang outline	27.2	16.5	5.7	0.4	1.8	5.1	4.9	3.2	1.4	4.3	8.2	4.8	4.2	1.2	→
Tang juncture	30.4***	30.1	14.9	3.9	1.5	7.1	3.0	2.1	1.9	4.8	1.4	4.7	9.1	1.3	→
Point maximum longitudinal thickness	7.2	12.7	8.8	0.8	5.3	2.1	3.1	2.3	2.6	1.9	2.5	6.8*	4.6	3.7	→
Point maximum latitudinal thickness	0.5	6.4	3.6	0.0	2.2	0.0	0.0	0.2	0.0	0.1	0.3	0.0	7.4**	0.1	→
Length/width ratio	25.5**	30.1	4.8	11.4	3.6	24.3***	2.4	0.9	14.9**	4.6	0.9	4.1	12.5	4.0	→

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ this line continued on Table IIb

TABLE IIb

PROJECTILE POINT CHI-SQUARE VALUES, DISCRETE ATTRIBUTES (continued)

↓		Treatment basal edge	Configuration basal edge	Basal primary retouch	Basal second. retouch	Basal reworking	Haft juncture	Shoulder barbing	Shoulder outline	Tang outline	Tang juncture	Point Max. long. thickness	Point max. lat. thickness	Length/width ratio
Configuration basal edge	→	0.4												
Basal primary retouch	→	1.9	1.9											
Basal second. retouch	→	4.2	2.4	1.1										
Basal reworking	→	3.3	0.2	0.1	0.0									
Haft juncture	→	11.4 **	2.9	0.9	1.5	2.2								
Shoulder barbing	→	2.6	2.9	0.4	0.2	0.1	5.7							
Shoulder outline	→	10.1 **	3.6	0.4	2.5	1.2	3.5	0.8						
Tang outline	→	9.8 *	4.4	7.1	2.7	1.6	5.7	0.8	5.5					
Tang juncture	→	18.7 **	5.6	3.7	24.1	3.9	7.2	1.4	4.7	4.5				
Point maximum longitudinal thickness	→	6.9 *	4.2	0.2	0.4	0.4	4.2	2.5	2.7	5.2	6.9			
Point maximum latitudinal thickness	→	2.6	6.1 **	0.1	0.0	0.1	0.8	0.0	0.8	6.6	8.7	3.9		
Length/width ratio	→	5.9	5.5	1.6	7.2	2.2	13.1	2.0	13.0	18.3	45.4	13.9	6.7	

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ continuation from completed horizontal columns
↓ continuation from completed vertical columns

APPENDIX V

BIFACE STATISTICS OF ASSOCIATION

TABLE I

BIFACE PEARSON
PRODUCT-MOMENT CORRELATION COEFFICIENTS

	Base width	Distal width	Width mid point blade	Maximum width	Axial length	Blade length	Base length	Maximum thickness	Angle basal orientation	Angle convergence sides	Angle convergence base
Base width											
Distal width	-.17										
Width mid point blade	.58***	.09									
Maximum width	.67***	.08	.98***								
Axial length	.17	.18	.55***	.51***							
Blade length	.06	.09	.37*	.31	.92***						
Base length	.29	.26	.64***	.65***	.76***	.43**					
Max. thickness	.28	.18	.58***	.56***	.64***	.60***	.47**				
Angle basal orientation	-.12	-.07	.18	.13	.29	.18	.36*	.12			
Angle converg sides	.37*	.11	.67***	.66***	.34*	.21	.42**	.42**	.49**		
Angle converg base	.21	.09	.53***	.52***	.21	.09	.31	.29	.36*	.43**	

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

TABLE IIa

BIFACE CHI-SQUARE VALUES, DISCRETE ATTRIBUTES

	Blade outline	Blade symmetry	Distal juncture	Size primary chip., blade	Depth primary chip., blade	Placement sec. chip., blade	Pattern sec. chip., blade	Configuration lat. edge., blade	Blade reworking	Use/tertiary chip., blade	Backing	Notching	
Blade outline													
Blade symmetry	7.1												
Distal juncture	3.6	0.0											
Size primary chip., blade	1.5	0.0	0.1										
Depth primary chip., blade	2.7	0.0	0.6	0.0									
Placement secondary chip., blade	1.5	0.0	0.0	0.2	0.0								
Pattern secondary chip., blade	2.5	0.3	0.0	0.0	0.0	0.0							
Configuration lateral edge blade	0.3	0.3	0.1	0.8	3.6*	0.2	4.8*						
Blade reworking	0.5	0.0	0.1	0.1	0.6	0.3	0.0	0.2					
Use/tertiary chip., blade	1.9	0.0	0.1	1.1	1.4	0.0	0.0	0.0	0.2				
Backing	4.5	0.1	1.4	0.1	0.6	0.0	0.1	0.1	0.8	1.8			
Notching	4.0	0.0	0.1	0.4	0.4	0.0	0.0	0.6	1.1	0.0	0.2		
Basal outline	8.4	0.9	0.7	2.9	0.8	0.0	2.9	0.1	16.9	2.7	0.7	2.3	→
Basal symmetry	2.3	0.0	0.0	2.3	0.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	→
Articulation base	2.3	0.0	0.0	2.3	0.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	→
Configuration basal edge	3.6	6.5**	0.0	0.0	0.0	0.0	1.4	2.3	0.0	0.0	0.1	0.0	→
Placement primary retouch, base	1.5	1.6	0.6	0.2	0.0	0.0	0.0	0.0	2.3	0.3	0.0	3.4	→
Presence secondary retouch, base	2.1	0.8	0.9	0.5	2.7	0.0	0.0	0.8	0.3	0.1	4.0*	0.1	→
Basal reworking	0.5	0.0	0.1	0.1	0.6	0.0	0.0	0.0	8.3**	0.2	0.8	1.1	→
Point maximum longitudinal thickness	4.6	0.0	1.9	0.0	0.2	0.0	0.2	2.3	0.0	0.0	0.0	0.1	→
Point maximum latitudinal thickness	8.9*	3.4	0.2	1.0	1.2	0.0	0.0	0.0	0.0	0.2	0.1	0.6	→
Length/width ratio	7.6	5.3	0.7	1.9	1.1	0.7	2.8	1.6	0.5	0.9	3.3	1.9	→

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ this line continued on Table IIb

TABLE IIb

BIFACE CHI-SQUARE VALUES, DISCRETE ATTRIBUTES (Continued)

↓		Base outline	Basal symmetry	Articulation base	Configuration basal edge	Placement prim. retouch base	Presence sec. retouch base	Basal reworking	Point max. long. thick.	Point max. lat. thick.	Length/width ratio
Basal symmetry	→	3.1									
Articulation base	→	2.9	0.0								
Configuration basal edge	→	3.5	1.4	0.3							
Placement primary retouch, base	→	0.3	0.0	0.0	0.0						
Presence secondary retouch, base	→	3.6	0.8	0.0	0.0	0.1					
Basal reworking	→	0.1	0.0	0.0	0.0	2.3	0.3				
Point maximum longitudinal thickness	→	4.4	0.3	0.3	0.7	0.1	0.1	0.0			
Point maximum latitudinal thickness	→	1.3	1.4	0.0	0.8	0.0	1.2	0.0	1.3		
Length/width ratio	→	4.9	4.8	5.3	4.8	4.5	1.6	4.1	1.5	1.4	

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ continuation from completed horizontal columns
↓ continuation from completed vertical columns

APPENDIX VI

END SCRAPER
STATISTICS OF ASSOCIATION

TABLE I

END SCRAPER PEARSON
PRODUCT-MOMENT CORRELATION COEFFICIENTS

	Distal width	Proximal width	Maximum width	Distance working face	Axial length	Maximum thickness	Front thickness	Angle working edge	Angle diverg. sides
Distal width									
Proximal width	.38 ***								
Max. width	.94 ***	.42 ***							
Distance working face	.14	.12	.38 ***						
Axial length	.41 ***	-.01	.55 ***	.60 ***					
Max. thickness	.30 **	.13	.42 ***	.40 ***	.51 ***				
Front thickness	.33 **	.16	.37 ***	.10	.18	.82 ***			
Angle working edge	.04	.11	-.00	-.21	-.15	.09	.16		
Angle diverg. sides	-.20	-.43 ***	-.32 **	-.36 **	-.49 ***	-.34 **	-.14	-.03	

* significant at .050 level of probability
** significant at .010 level of probability
*** significant at .001 level of probability

TABLE IIa

END SCRAPER CHI-SQUARE VALUES, DISCRETE ATTRIBUTES

	Front contour	Frontal orientation	Frontal symmetry	Long. section	Body symmetry	Size prim. chip., body.	Depth primary chip., body	Placement prim. chip body	Presence sec. chip., body	Use/tertiary chip., body	Body reworking	Notching	
Front contour													
Frontal orientation	5.5												
Frontal symmetry	2.9	11.0											
Longitudinal section	33.3**	2.0	3.0										
Body symmetry	6.8	6.5**	8.3**	3.9									
Size primary chip., body	6.5	0.0	0.0	10.2	0.5								
Depth primary chip., body	3.6	0.0	0.0	2.6	0.1	2.2							
Placement prim. chip., body	3.9	3.5	0.2	10.9**	0.4	6.5**	0.1						
Presence sec. chip., body	0.9	0.1	0.1	5.9	0.1	0.0	0.7	5.1					
Use/tertiary chip., body	1.9	0.5	0.1	6.3	0.0	0.5	2.2	0.0	4.1*				
Body reworking	12.2**	0.3	0.0	21.2	0.1	0.0	0.9	0.1	0.2	4.3*			
Notching	4.4	0.1	0.0	3.4	0.1	0.0	0.1	0.1	0.1	3.4	1.2		
Configuration lat. edge, body	2.0	1.4	0.1	1.2	0.2	1.5	0.4	0.1	0.2	0.0	0.1	0.1	
Basal outline	45.5	3.9	5.3	57.5	4.1	4.8	18.3**	13.3*	10.3	8.6	20.2**	7.9	→
Basal symmetry	2.0	1.9	0.3	2.3	4.1*	0.1	0.1	0.0	0.0	0.1	0.3	0.0	→
Configuration basal edge	3.0	0.0	0.0	1.7	0.0	0.2	2.5	0.0	0.0	0.0	0.2	0.2	→
Basal primary retouch	4.8	2.4	0.0	17.9	0.0	0.5	0.2	33.6	0.4	0.2	0.1	0.0	→
Basal secondary retouch	1.2	1.1	0.2	3.8	1.2	0.0	2.8	0.0	2.8	0.6	0.0	0.0	→
Basal reworking	2.8	0.0	0.1	6.7	0.1	0.7	0.0	0.2	0.2	0.0	0.5	0.0	→
Scraper outline	64.1	2.5	2.6	37.0**	5.4	6.0	7.1	1.2	1.1	6.9	19.5	7.6	→
Point max. long. thick.	0.9	0.0	0.2	8.3	0.1	4.0*	4.3*	0.1	0.0	0.1	0.0	0.0	→
Point max. lat. thick.	2.1	0.0	0.0	7.5	0.9	0.3	0.4	6.2	0.1	2.2	0.4	1.2	→
Flake type	51.2	3.6	1.6	14.7	8.8	8.1	17.5**	12.2**	0.4	8.8	39.9	16.2**	→
Length/width ratio	33.6	4.4	2.4	30.8	1.8	7.1	0.3	7.4	8.7	2.1	0.6	0.6	→

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ this line continued on Table IIb

TABLE IIb

END SCRAPER CHI-SQUARE VALUES, DISCRETE ATTRIBUTES

↓		Configuration lat. edge, body	Basal outline	Basal symmetry	Configuration basal edge	Placement prim. retouch, base	Presence sec. retouch base	Basal reworking	Scraper outline	Point max. long. thick.	Point max. lat. thick.	Flake type	Length/width ratio
Basal outline	→	9.6											
Basal symmetry	→	0.9	1.3										
Configuration basal edge	→	34.3	3.7	0.9									
Basal primary retouch	→	0.5	11.6 *	0.3	0.5								
Basal secondary retouch	→	0.2	6.4	3.8 *	0.1	1.5							
Basal reworking	→	0.2	9.5	0.3	0.2	0.0	0.0						
Scraper outline	→	5.0	94.1	1.2	3.6	0.8	2.2	4.3					
Point max. long. thick.	→	0.0	0.3	0.0	0.1	0.1	0.1	0.0	0.8				
Point max. lat. thick.	→	0.2	5.4	1.6	0.0	4.7 *	0.2	0.0	0.8	3.0			
Flake type	→	0.9	48.8	3.4	1.8	2.9	9.9 *	3.9	50.9	2.9	5.9		
Length/width ratio	→	5.5	21.4 **	0.9	0.1	3.9	1.5	12.0 **	21.0 *	0.1	5.4	19.7	

* significant at .05 level of probability
** significant at .01 level of probability
*** significant at .001 level of probability

→ continuation from completed horizontal columns
↓ continuation from completed vertical columns

APPENDIX VII

PROJECTILE POINT COMPONENT LOADINGS

TABLE I

PROJECTILE POINT COMPONENT LOADINGS

Point	Factor 1	Factor 2	Factor 3	Factor 4
3000...........	.488*	-.142	.075	.142
3001...........	.545*	-.171	.138	-.176
3002...........	.150	.056	-.163*	-.057
3003...........	.065	.091	-.175	-.060
3004...........	.161	-.185	.209*	.173
3005...........	.046	.081	-.086	.361*
3006...........	.041	-.011	-.116	.742*
3007...........	-.070	.028	-.038	.085*
3008...........	-.008	.054	-.064*	-.050
3009...........	.019	.099	-.223*	-.025
3010...........	-.049	.061	.126	.310*
3011...........	-.0.9	.106*	.026	-.039
3012...........	-.021	-.186	-.094	-.199*
3013...........	-.112*	.029	-.075	.026
3014...........	.020	.104*	-.003	-.047
3015...........	-.085	-.169*	-.021	-.042
3016...........	.064*	.058	-.023	-.050
3017...........	.044	.127*	-.052	-.094
3018...........	-.064*	.024	.017	-.018
3019...........	.097*	.079	-.089	-.044
3020...........	.022	.079*	.075	.036
3021...........	-.099	-.185*	-.099	-.113
3022...........	.009	.080	.001	.062
3023...........	-.037	.045	.064*	-.042
3024...........	.009	-.003	.401*	-.059
3025...........	-.137	-.017	.217*	.013
3026...........	.177*	.165	-.043	.003
3027...........	.059	.103*	.027	-.061
3028...........	-.056	.053	-.073*	-.028
3029...........	.024	.055*	.008	-.037
3030...........	-.007	.139*	-.015	-.055
3031...........	.082*	.062	-.014	-.049
3032...........	-.008	-.193*	-.155	-.029
3033...........	-.062	-.171*	-.022	.080
3034...........	-.009	.074	.080*	-.011
3035...........	-.001	-.162*	-.057	-.039
3036...........	-.011	-.167*	-.001	-.041
3037...........	.049	-.150*	-.136	.014
3038...........	.003	-.179	.099	.250*
3039...........	-.049	.044	-.088*	.004
3040...........	-.071	.030	-.081*	-.056
3041...........	-.119	-.036	.146	-.019
3042...........	-.066	.034	-.047	.093*
3043...........	-.105	.038	-.175*	.045
3044...........	-.099*	.021	-.025	.009
3045...........	-.043	-.012	.146*	.078

TABLE I

Continued

Point	Factor 1	Factor 2	Factor 3	Factor 4
3046...........	-.025	.032	-.041*	-.002
3047...........	-.038	.026	.178*	-.036
3048...........	.069	.184*	-.046	-.053
3049...........	.076	.099	-.118*	-.031
3050...........	-.001	.012	.006	.042*
3051...........	.031	.053*	-.001	-.035
3052...........	.004	.044*	.034	-.015
3053...........	-.012	.046	.049	-.080*
3054...........	-.005	-.185*	-.128	-.162
3055...........	-.036	.024	.011	.051*
3056...........	-.041	-.167*	-.049	-.049
3057...........	-.012	.046*	-.007	-.031
3058...........	-.135*	.040	-.007	-.031
3059...........	.020	.052	.054	-.068*
3060...........	.153	.111	.250*	.077
3061...........	.135	.162*	-.135	-.030
3062...........	.275*	.122	.107	.004
3063...........	-.069*	.032	.007	-.018
3064...........	-.080	-.003	-.114*	.012
3065...........	-.033	-.172*	.049	-.007
3066...........	-.032	.031	.099*	-.028
3067...........	-.047	-.001	.235*	-.023
3068...........	-.068*	.026	-.026	.001
3069...........	.016	-.169*	-.051	.055
3070...........	-.006	.022	-.055*	-.048
3071...........	-.085*	.042	-.033	.074
3072...........	.079	.089	-.132*	-.050
3073...........	.009	-.162*	-.022	-.049
3074...........	-.063	-.183*	-.135	-.115
3075...........	-.013	-.169*	.033	.114
3076...........	-.004	.049	.057*	-.052
3077...........	-.035	.026	.232*	-.050
3078...........	.003	-.008	.058*	-.021
3079...........	.044	-.166*	.030	-.018
3080...........	.195*	-.149	.099	-.026
3081...........	.034	.069*	.035	.068
3082...........	.076	.070	-.084*	.015
3083...........	-.053	.019	-.032	.138*
3084...........	-.069*	-.004	.048	-.035
3085...........	-.018	.049	.148*	-.063
3086...........	-.046	.074	-.104*	-.011
3087...........	.053	.067	.042	.083*
3088...........	-.065*	-.005	-.009	.008
3089...........	-.032	.048*	.039	-.011
3090...........	.016	.099*	-.047	-.026

TABLE I

Continued

Point	Factor 1	Factor 2	Factor 3	Factor 4
3091...........	-.021	-.170*	-.023	.140
3092...........	.028	.066*	-.054	-.060
3093...........	-.048*	.045	-.021	-.034
3094...........	-.019	.044	.009	-.052*
3095...........	-.051	.099*	-.083	-.022
3096...........	-.054	.029	-.087*	-.034
3097...........	-.048	.054	.093*	-.078
3098...........	-.074	.047	.120*	.105
3099...........	-.021	.029	-.014	-.055*
3100...........	-.024	.031	.041	.076*
3101...........	-.032	-.004	.012	-.070*
3102...........	.156*	.143	.134	-.112
3103...........	.025	.056	.065*	-.046
3104...........	.038	-.172*	.013	-.009
3105...........	-.096	-.019	.229*	.001
3106...........	.106	-.144*	-.069	.127
3107...........	-.143*	.005	-.132	.089
3108...........	-.038	.054*	.016	.004
3109...........	.077	.130*	.026	-.047
3110...........	.063	-.171*	.121	-.054
3111...........	-.002	-.172*	.009	-.006
3112...........	-.075*	.004	.003	-.013
3113...........	-.034	-.191*	-.050	-.160
3114...........	-.075	.021	.140*	.009
3115...........	-.056*	.026	-.013	-.018
3116...........	-.064	.016	.140*	-.021
3117...........	.028	.067*	-.020	-.006
3118...........	-.045	-.113*	-.034	-.071
3119...........	.069	.113*	-.041	.087
3120...........	.043	-.167*	.005	.096
3121...........	.063	.087*	.062	-.039
3122...........	-.112	-.045	.194*	.090
3123...........	-.004	-.191*	-.032	-.181
3124...........	-.106*	.027	-.044	-.002
3125...........	.017	.074	.072	-.091*
3126...........	-.139*	-.004	-.053	.082
3127...........	-.016	.079*	-.060	-.072
3128...........	-.099*	-.010	.061	.018
3129...........	-.023	.059	.114*	-.041
3130...........	.004	.044	.139*	-.079
3131...........	.090	.096	-.179*	-.077
3132...........	.085*	.079	-.040	-.042
3133...........	-.005	-.168*	.022	-.050

TABLE I

Continued

Point	Factor 1	Factor 2	Factor 3	Factor 4
3134...........	-.062*	.035	.006	-.030
3135...........	-.084*	-.002	-.021	.004
3136...........	-.101*	.049	.004	.072
3137...........	-.061	.060	-.097*	.096
3138...........	-.106*	-.034	.054	-.037
3139...........	-.069	.064	-.107*	-.020
3140...........	.011	.077*	-.047	.053
3141...........	-.075*	.002	.006	-.008
3142...........	.076*	.056	-.074	-.075
3143...........	-.019	.078*	-.034	-.014
3144...........	-.081	.015	-.268*	.071
3145...........	-.064	-.186*	-.103	-.115
3146...........	-.044	.062	.070*	-.057
3147...........	-.018	-.169*	.015	-.009
3148...........	-.078*	.018	-.073	-.034
3149...........	-.033	-.041*	-.004	-.019
3150...........	-.122	-.175*	-.019	.102
3151...........	.061	-.047	-.065*	-.032
3152...........	.097*	.062	.037	-.032
3388...........	.230*	.148	-.032	.073
3515...........	.404*	-.140	-.106	.120

* projectile point whose highest loading is on that component

APPENDIX VIII

BIFACE COMPONENT LOADINGS

TABLE I

BIFACE COMPONENT LOADINGS

Biface	Factor 1	Factor 2	Factor 3	Factor 4
3480	.242*	-.013	-.030	-.062
3481	.191	-.094	.032	.274*
3482	.361*	.067	.117	.038
3483	.092*	.056	-.058	-.085
3484	.577*	-.211	.093	-.071
3485	-.178*	-.090	.008	-.088
3486	-.039	.033	-.016	.125*
3487	.095*	-.036	-.041	-.008
3488	-.007	.056	-.019	-.107*
3489	-.017	.030	.362*	-.134
3490	-.020	-.121	.014	-.122*
3491	-.059	-.036	.025	.065*
3492	-.126*	.030	-.023	-.104
3493	-.157*	.018	-.024	.012
3494	-.071	.006	-.115*	-.034
3495	-.184*	-.008	-.040	-.015
3496	-.129*	.031	-.072	-.023
3497	-.170*	-.013	-.046	-.036
3498	-.255	.142	.281*	.036
3499	-.187*	-.036	-.055	.034
3500	-.080*	-.022	-.070	.056
3501	-.144*	.121	-.056	.080
3502	.357*	.041	-.041	-.064
3503	.099	.313*	-.097	-.170
3504	-.045	.002	.126*	-.035
3505	-.239*	-.090	-.071	.086
3506	-.039	-.055	-.055	-.109*
3507	-.225*	-.068	-.067	.053
3508	-.095*	-.013	-.002	.059
3509	-.169*	-.112	.007	.141
3510	-.037	-.075*	-.056	-.022
3511	.622*	.241	.038	.216
3512	.102*	.048	-.094	-.002
3513	-.046	.001	-.079*	-.026
3514	-.021	-.140*	.044	-.099

* biface whose highest loading is on that component

APPENDIX IX

END SCRAPER COMPONENT LOADINGS

TABLE I

END SCRAPER COMPONENT LOADINGS

Scraper	Factor 1	Factor 2	Factor 3	Factor 4
3389...........	-.005	-.047	.141	.199
3390...........	-.073*	.012	-.027	.023
3392...........	.099*	-.039	-.043	.093
3393...........	-.072	-.049	.022	-.088*
3394...........	-.035	-.045	-.120*	-.064
3396...........	.096*	.028	.047	.078
3397...........	.100	-.154	.171	.193*
3399...........	.024	.343*	.037	.221
3400...........	.124*	-.002	-.028	-.066
3401...........	.182*	.105	-.180	.030
3403...........	.007	-.052	.121*	.038
3404...........	.194	-.057	.030	.196*
3405...........	.114	.069	.170*	-.106
3406...........	.011	.223*	.120	-.041
3409...........	.090	-.116	.136	.154*
3410...........	.037	.043*	.007	.014
3411...........	.092*	-.078	-.076	-.048
3412...........	.113	-.071	.018	.124*
3413...........	-.108*	-.019	.101	-.047
3414...........	.042	.039	-.058*	-.029
3415...........	.081	-.032*	-.023	.010
3416...........	-.107*	.001	-.032	.046
3417...........	.113	.214*	-.069	-.080
3418...........	.122*	-.047	.102	-.021
3419...........	.055	-.057	.029	-.136*
3420...........	-.079	.136	-.143*	-.128
3421...........	.066*	.004	-.032	-.056
3422...........	-.053	-.022	.048	-.103*
3423...........	-.027	-.084	.092	-.133*
3425...........	.029	-.029	.069*	.005
3426...........	.102*	-.045	-.018	.014
3427...........	.029	-.078	-.136*	-.019
3428...........	-.054	.073	-.080*	-.048
3429...........	-.075*	.006	-.001	-.023
3430...........	.012	.132*	.033	-.026
3431...........	.140*	-.011	-.099	-.028
3432...........	-.022	.300*	.072	-.026
3433...........	.035	.023	.197*	-.044
3434...........	-.016	.024	-.066	.100*
3436...........	-.037	-.083*	-.047	.032
3437...........	-.149*	-.032	.104	.092
3438...........	.039	-.005	-.126	-.191*
3439...........	-.252*	.022	-.142	.001
3440...........	-.064	-.091*	.027	-.010

TABLE I

Continued

Scraper	Factor 1	Factor 2	Factor 3	Factor 4
3441...........	-.030	.092*	.018	.006
3442...........	-.176	.070	-.246*	.153
3443...........	.040	.056	-.158	-.219*
3444...........	.095	-.067	-.115	.174*
3445...........	.022	.355*	.180	-.044
3446...........	-.046	-.037	.070*	.013
3448...........	.117	.057	.019	-.261*
3450...........	-.257*	.045	-.143	.118
3451...........	.042	-.110*	-.050	-.132
3452...........	-.086	-.178*	.099	-.144
3453...........	.071	-.078	.037	-.079*
3454...........	-.033	.022	-.040	.060*
3455...........	-.017	-.150*	.044	-.044
3456...........	.006	.165*	-.107	-.059
3457...........	-.147*	.003	.038	.113
3459...........	.036	-.043	.058*	.056
3460...........	-.049	-.017	.137*	-.084
3461...........	-.203*	-.142	.150	-.022
3462...........	-.065	-.077	-.116*	-.051
3463...........	-.002	-.058	-.047	-.110*
3464...........	-.093*	-.020	.013	-.066
3465...........	.244	-.097	-.156	.254*
3466...........	-.140*	-.028	-.105	.077
3468...........	-.024	-.089*	-.039	-.006
3469...........	.020	.013	.032	.096*
3470...........	-.130*	-.087	-.108	.001
3472...........	.135	-.082	-.139*	-.078
3473...........	.076	-.029	.126*	.007
3474...........	.089	-.026	-.101*	-.013
3475...........	-.034	.011	-.029	.089*
3476...........	.026	-.046*	.003	-.033
3479...........	-.064	.006	.109*	-.030
3516...........	-.120	-.019	.205*	.087
3517...........	-.088*	-.062	.070	-.027
3518...........	.045*	-.012	.014	-.020
3519...........	-.173*	-.006	-.069	.113

* scraper whose highest loading is on that component

APPENDIX X

PROJECTILE POINT CLUSTER ELEMENTS

TABLE I

PROJECTILE POINT CLUSTER ELEMENTS, ALL ATTRIBUTES

Group & av. stability	Point	Type	Av. inside similarity	Max. av. outside similarity
Group 1 .28	3026	stable	.68	.50
	3060	stable	.65	.50
	3062	stable	.58	.50
	3102	stable	.66	.50
	3388	stable	.65	.50
Group 2 .47	3002	stable	.62	.50
	3003	stable	.66	.50
	3005	stable	.66	.50
	3006	stable	.61	.50
	3007	stable	.79	.50
	3008	stable	.81	.50
	3009	stable	.63	.50
	3010	stable	.62	.50
	3011	stable	.67	.50
	3013	stable	.77	.50
	3014	stable	.66	.52
	3016	stable	.77	.50
	3017	stable	.70	.50
	3018	stable	.79	.50
	3019	stable	.69	.50
	3020	stable	.63	.50
	3022	stable	.74	.50
	3023	stable	.79	.50
	3024	stable	.72	.50
	3025	stable	.64	.50
	3027	stable	.63	.50
	3028	stable	.77	.50
	3029	stable	.79	.50
	3030	stable	.65	.50
	3031	stable	.73	.53
	3034	stable	.73	.50
	3039	stable	.81	.50
	3040	stable	.75	.50
	3041	stable	.73	.50
	3042	stable	.81	.50
	3044	stable	.76	.50
	3045	stable	.68	.50
	3046	stable	.79	.50
	3047	stable	.77	.50
	3049	stable	.65	.50
	3050	stable	.74	.50
	3051	stable	.74	.51
	3052	stable	.78	.50

TABLE I

Continued

Group & av. stability	Point	Type	Av. inside similarity	Max. av. outside similarity
	3053	stable	.78	.50
	3055	stable	.81	.50
	3057	stable	.79	.50
	3058	stable	.70	.50
	3059	stable	.76	.50
	3063	stable	.81	.50
	3064	stable	.81	.50
	3066	stable	.78	.50
	3067	stable	.77	.50
	3068	stable	.79	.50
	3070	stable	.81	.50
	3071	stable	.77	.50
	3072	stable	.67	.50
	3076	stable	.71	.50
Group 2	3077	stable	.72	.50
(continued)	3078	stable	.73	.50
	3081	stable	.68	.50
.47	3082	stable	.72	.50
	3083	stable	.75	.50
	3084	stable	.79	.50
	3085	stable	.73	.50
	3086	stable	.75	.50
	3087	stable	.73	.52
	3088	stable	.77	.50
	3089	stable	.79	.50
	3090	stable	.68	.51
	3092	stable	.75	.50
	3093	stable	.78	.50
	3094	stable	.81	.50
	3095	stable	.73	.50
	3096	stable	.81	.50
	3097	stable	.73	.50
	3098	stable	.68	.50
	3099	stable	.81	.50
	3100	stable	.79	.50
	3101	stable	.81	.50
	3103	stable	.75	.50
	3105	stable	.73	.50
	3108	stable	.67	.50
	3112	stable	.66	.50
	3114	stable	.66	.50
	3115	stable	.81	.50
	3116	stable	.77	.50
	3117	stable	.76	.50
	3119	stable	.68	.50

TABLE I

Continued

Group & av. stability	Point	Type	Av. inside similarity	Max. av. outside similarity
	3121	stable	.68	.51
	3122	stable	.73	.50
	3124	stable	.77	.50
	3125	stable	.72	.50
	3126	stable	.62	.50
	3127	stable	.71	.50
	3128	stable	.75	.50
	3129	stable	.73	.50
Group 2	3130	stable	.75	.50
(continued)	3131	stable	.66	.50
	3132	stable	.74	.51
.47	3134	stable	.78	.50
	3135	stable	.77	.50
	3136	stable	.71	.50
	3137	stable	.76	.50
	3138	stable	.74	.50
	3139	stable	.77	.50
	3140	stable	.75	.50
	3141	stable	.79	.50
	3142	stable	.75	.50
	3143	stable	.73	.50
	3144	stable	.64	.50
	3146	stable	.72	.50
	3148	stable	.81	.50
	3000	stable	.50	.50
	3001	stable	.54	.50
	3004	stable	.72	.50
	3012	stable	.68	.50
	3015	stable	.79	.51
	3021	stable	.71	.50
	3032	stable	.66	.50
	3033	stable	.79	.56
Group 3	3035	stable	.79	.51
	3036	stable	.79	.51
.43	3037	stable	.76	.52
	3038	stable	.70	.50
	3054	stable	.74	.50
	3056	stable	.79	.51
	3065	stable	.76	.54
	3069	stable	.79	.51
	3073	stable	.79	.56
	3074	stable	.77	.50
	3075	stable	.80	.54
	3079	stable	.80	.54
	3080	stable	.62	.50

TABLE I

Continued

Group & av. stability	Point	Type	Av. inside similarity	Max. av. outside similarity
	3091	stable	.80	.54
	3104	stable	.76	.50
	3106	stable	.76	.50
	3110	stable	.72	.50
	3111	stable	.71	.52
	3113	stable	.73	.50
	3118	stable	.74	.51
Group 3	3120	stable	.80	.54
(continued)	3123	stable	.73	.50
	3133	stable	.79	.51
.43	3145	stable	.77	.50
	3147	stable	.79	.56
	3150	stable	.74	.50
	3151	stable	.56	.54
	3515	stable	.57	.50

APPENDIX XI

BIFACE CLUSTER ELEMENTS

TABLE I

BIFACE CLUSTER ELEMENTS, ALL ATTRIBUTES

Group & av. stability	Biface	Type	Av. inside similarity	Max. av. outside similarity
	3483	stable	.76	.50
	3485	stable	.76	.50
	3486	stable	.67	.50
	3487	stable	.81	.50
	3488	stable	.81	.50
	3489	stable	.64	.50
	3490	stable	.70	.50
Group 1	3491	stable	.70	.52
	3492	stable	.81	.50
.51	3493	stable	.77	.50
	3494	stable	.76	.50
	3495	stable	.82	.50
	3496	stable	.82	.50
	3497	stable	.82	.50
	3499	stable	.77	.50
	3500	stable	.76	.50
	3501	stable	.76	.50
	3504	stable	.71	.50
	3505	stable	.67	.50
	3506	stable	.81	.50
	3507	stable	.82	.50
	3508	stable	.82	.50
	3509	stable	.72	.50
	3510	stable	.75	.50
	3512	stable	.76	.50
	3513	stable	.81	.50
	3514	stable	.64	.50
Group 2	3505	stable	.50	.50
.00	3511	stable	.50	.50
	3480	stable	.57	.56
Group 3	3482	unstable	.48	.50
	3484	unstable	.48	.50
.04	3502	stable	.62	.50

APPENDIX XII

END SCRAPER CLUSTER ELEMENTS

TABLE I

END SCRAPER CLUSTER ELEMENTS, ALL ATTRIBUTES

Group & av. stability	Scraper	Type	Av. inside similarity	Max. av. outside similarity
Group 1	3389	stable	.71	.50
.36	3397	stable	.71	.50
	3403	stable	.75	.61
	3405	stable	.67	.53
	3418	stable	.75	.50
	3433	stable	.75	.61
Group 2	3413	stable	.73	.57
.24	3423	stable	.66	.61
	3438	stable	.71	.58
	3443	stable	.64	.50
	3446	stable	.65	.53
	3452	stable	.63	.59
	3460	stable	.67	.52
	3463	stable	.74	.51
	3479	stable	.72	.57
Group 3	3392	stable	.61	.50
.23	3396	stable	.62	.58
	3400	stable	.73	.59
	3401	stable	.60	.53
	3411	stable	.72	.54
	3414	stable	.62	.53
	3415	stable	.70	.57
	3419	stable	.67	.59
	3421	stable	.78	.61
	3425	stable	.72	.68
	3426	stable	.71	.61
	3428	stable	.72	.62
	3430	stable	.71	.61
	3431	stable	.67	.62
	3441	stable	.74	.55
	3448	stable	.62	.56
	3459	stable	.78	.61
	3469	stable	.71	.61
	3472	stable	.63	.51
	3474	stable	.78	.61
	3476	stable	.78	.61
	3518	stable	.78	.61

TABLE I

Continued

Group & av. stability	Scraper	Type	Av. inside similarity	Max. av. outside similarity
Group 4	3427	stable	.73	.56
.20	3429	stable	.76	.64
	3434	stable	.62	.55
	3436	stable	.76	.64
	3440	stable	.76	.64
	3451	stable	.68	.60
	3454	stable	.64	.56
	3461	unstable	.67	.68
	3462	stable	.71	.59
	3464	stable	.74	.59
	3466	stable	.58	.50
	3470	stable	.66	.50
	3517	stable	.64	.58
Group 5	3404	stable	.70	.53
.33	3412	stable	.76	.55
	3444	stable	.70	.60
	3465	stable	.70	.50
Group 6	3420	stable	.64	.50
.27	3439	stable	.64	.50
Group 7	3437	stable	.70	.57
.33	3450	stable	.70	.55
	3457	stable	.73	.55
	3519	stable	.73	.53
Group 8	3399	stable	.75	.52
.44	3406	stable	.75	.50
	3409	stable	.66	.50
	3432	stable	.80	.53
	3445	stable	.73	.53

APPENDIX XIII

COMPARISON OF TYPE CLASSIFICATIONS FOR PROJECTILE POINTS

TABLE I

COMPARISON OF TYPE CLASSIFICATIONS FOR PROJECTILE POINTS

Point	Factor Types	Cluster Types		
		Discrete	Continuous	All
3000*	1	residue	1	3
3001*	1	residue	1	3
3002	residue	1	2	2
3003	residue	residue	2	2
3004	3	1	1	3
3005	4	1	2	2
3006	4	1	2	2
3007	residue	1	2	2
3008	residue	1	2	2
3009	3	1	2	2
3010	4	1	2	2
3011	residue	1	2	2
3012	4	residue	1	3
3013	residue	1	2	2
3014	residue	1	2	2
3015	residue	1	1	3
3016	residue	1	2	2
3017	residue	1	2	2
3018	residue	1	2	2
3019	residue	1	2	2
3020	residue	1	2	2
3021	3	1	1	3
3022	residue	1	2	2
3023	residue	1	2	2
3024	3	1	2	2
3025	3	1	2	2
3026	residue	1	1	2
3027	residue	1	2	2
3028	residue	1	2	2
3029	residue	1	2	2
3030	residue	1	2	2
3031	residue	1	2	2
3032	2	residue	1	3
3033	residue	residue	1	3
3034	residue	1	2	2
3035	residue	1	1	3
3036	residue	1	1	3
3037	residue	1	1	3
3038	4	1	1	3
3039	residue	1	2	2
3040	residue	1	2	2
3041	residue	1	2	2
3042	residue	1	2	2
3043	residue	1	residue	residue

TABLE I

Continued

Point	Factor Types	Cluster Types Discrete	Continuous	All
3044	residue	1	2	2
3045	residue	1	2	2
3046	residue	1	2	2
3047	residue	1	2	2
3048	2	1	2	residue
3049	residue	1	2	2
3050	residue	1	2	2
3051	residue	1	2	2
3052	residue	1	2	2
3053	residue	1	2	2
3054	2	1	1	3
3055	residue	1	2	2
3056	residue	1	1	3
3057	residue	1	2	2
3058	residue	1	2	2
3059	residue	1	2	2
3060	3	1	residue	1
3061	residue	1	2	residue
3062	1	1	residue	1
3063	residue	1	2	2
3064	residue	1	2	2
3065	residue	1	1	3
3066	residue	1	2	2
3067	3	1	2	2
3068	residue	1	2	2
3069	residue	1	1	3
3070	residue	1	2	2
3071	residue	1	2	2
3072	residue	1	2	2
3073	residue	1	1	3
3074	2	residue	1	3
3075	residue	residue	1	3
3076	residue	1	2	2
3077	3	1	2	2
3078	residue	1	2	2
3079	residue	1	1	3
3080*	1	residue	1	3
3081	residue	1	2	2
3082	residue	1	2	2
3083	residue	residue	2	2
3084	residue	1	2	2
3085	residue	1	2	2
3086	residue	1	2	2
3087	residue	1	2	2
3088	residue	1	2	2

TABLE I

Continued

Point	Factor Types	Cluster Types		
		Discrete	Continuous	All
3089	residue	1	2	2
3090	residue	1	2	2
3091	residue	1	1	3
3092	residue	1	2	2
3093	residue	1	2	2
3094	residue	1	2	2
3095	residue	1	2	2
3096	residue	1	2	2
3097	residue	1	2	2
3098	residue	1	2	2
3099	residue	1	2	2
3100	residue	1	2	2
3101	residue	1	2	2
3102	residue	1	residue	1
3103	residue	1	2	2
3104	residue	1	1	3
3105	3	1	2	2
3106*	residue	residue	1	3
3107	residue	1	2	residue
3108	residue	1	2	2
3109	residue	1	2	residue
3110	residue	1	1	3
3111	residue	1	1	3
3112	residue	1	2	2
3113	2	1	1	3
3114	residue	1	2	2
3115	residue	1	2	2
3116	residue	1	2	2
3117	residue	1	2	2
3118	residue	residue	1	3
3119	residue	1	2	2
3120	residue	1	1	3
3121	residue	1	2	2
3122	3	1	2	2
3123	2	residue	1	3
3124	residue	1	2	2
3125	residue	1	2	2
3126	residue	1	2	2
3127	residue	1	2	2
3128	residue	1	2	2
3129	residue	1	2	2
3130	residue	1	2	2
3131	residue	1	2	2
3132	residue	1	2	2
3133	residue	residue	1	3

TABLE I

Continued

Point	Factor Types	Cluster Types Discrete	Continuous	All
3134	residue	1	2	2
3135	residue	1	2	2
3136	residue	1	2	2
3137	residue	1	2	2
3138	residue	1	2	2
3139	residue	1	2	2
3140	residue	1	2	2
3141	residue	1	2	2
3142	residue	1	2	2
3143	residue	residue	2	2
3144	3	1	2	2
3145	2	1	1	3
3146	residue	1	2	2
3147	residue	1	1	3
3148	residue	1	2	2
3149	residue	residue	residue	residue
3150	residue	residue	1	3
3151	residue	residue	residue	3
3152	residue	1	residue	2
3388	1	1	1	residue
3515*	residue	residue	3	1
3490*	residue	residue	3	1
3506*	residue	residue	3	1
3515*	1	residue	1	3

* problematical object

APPENDIX XIV

COMPARISON OF TYPE CLASSIFICATIONS FOR BIFACES

TABLE I

COMPARISON OF TYPE CLASSIFICATIONS FOR BIFACES

Biface	Factor Types	Cluster Types		
		Discrete	Continuous	All
3480	1	1	3	residue
3481	4	1	residue	residue
3482	1	1	3	residue
3483	residue	1	1	1
3484	1	residue	3	residue
3485	residue	1	1	1
3486	residue	1	1	1
3487	residue	residue	1	1
3488	residue	1	1	1
3489	3	1	1	1
3490*	residue	1	1	1
3491	residue	1	1	1
3492	residue	1	1	1
3493	residue	1	1	1
3494	residue	1	1	1
3495	residue	1	1	1
3496	residue	1	1	1
3497	residue	1	1	1
3498	residue	1	residue	1
3499	residue	1	1	1
3500	residue	1	1	1
3501	residue	1	1	1
3502	1	1	3	residue
3503	2	1	2	residue
3504	residue	1	1	1
3505	1	1	1	1
3506*	residue	1	1	1
3507	1	1	1	1
3508	residue	1	1	1
3509	residue	1	1	1
3510	residue	1	1	1
3511	residue	1	2	residue
3512	residue	1	1	1
3513	residue	1	1	1
3514*	residue	1	1	1
3000*	residue	1	1	1
3001*	residue	1	1	residue
3004*	residue	residue	1	1
3080*	residue	residue	1	1
3106*	residue	residue	1	1
3515*	residue	1	1	1

* problematical object

APPENDIX XV

COMPARISON OF TYPE CLASSIFICATIONS FOR END SCRAPERS

TABLE I

COMPARISON OF TYPE CLASSIFICATIONS FOR END SCRAPERS

Scraper	Factor Types	Cluster Types		
		Discrete	Continuous	All.
3389	4	1	1	residue
3390	residue	1	residue	1
3392	residue	1	3	1
3393	residue	1	residue	1
3394	residue	1	residue	1
3396	residue	1	3	1
3397	4	1	1	1
3399	2	1	8	2
3400	residue	1	3	1
3401	1	1	3	1
3403	residue	1	1	1
3404	4	1	4	1
3405	residue	1	1	2
3406	2	1	8	2
3409	residue	1	8	2
3410	residue	1	residue	1
3411	residue	1	3	1
3412	residue	1	5	1
3413	residue	1	2	residue
3414	residue	1	3	residue
3415	residue	1	3	1
3416	2	1	residue	1
3417	residue	1	residue	residue
3418	residue	1	1	1
3419	residue	1	3	residue
3420	residue	1	6	2
3421	residue	1	3	1
3422	residue	1	residue	1
3423	residue	1	2	1
3425	residue	1	3	1
3426	residue	1	3	1
3427	residue	1	4	1
3428	residue	1	3	1
3429	residue	1	4	1
3430	residue	1	3	residue
3431	residue	1	3	1
3432	residue	1	8	2
3433	3	1	1	residue
3434	residue	1	4	1
3436	residue	1	4	1
3437	residue	1	7	2
3438	4	1	2	1
3439	1	1	6	1
3440	residue	1	4	1

TABLE I

Continued

Scraper	Factor Types	Cluster Types		
		Discrete	Continuous	All
3441	residue	1	3	1
3442	3	1	residue	residue
3443	3	1	2	residue
3444	residue	1	5	1
3445	2	1	8	2
3446	residue	1	2	residue
3448	4	1	3	residue
3450	1	1	7	residue
3451	residue	1	4	1
3452	residue	1	2	1
3453	residue	1	residue	1
3454	residue	1	4	1
3455	residue	1	residue	1
3456	residue	1	residue	2
3457	residue	1	7	residue
3459	residue	1	3	1
3460	residue	1	2	2
3461	1	1	4	residue
3462	residue	1	4	1
3463	residue	1	2	1
3464	residue	1	4	1
3465	4	1	5	2
3466	residue	1	4	residue
3468	residue	1	residue	1
3469	residue	1	3	1
3470	residue	1	4	1
3472	residue	1	3	1
3473	residue	1	3	2
3474	residue	1	3	1
3475	residue	1	3	1
3476	residue	1	3	1
3479	residue	1	2	1
3516	3	1	3	2
3517	residue	1	4	residue
3518	residue	1	3	1
3519	residue	1	7	1

APPENDIX XVI

PLATES 1 TO 24
INCLUSIVE

PLATE 1

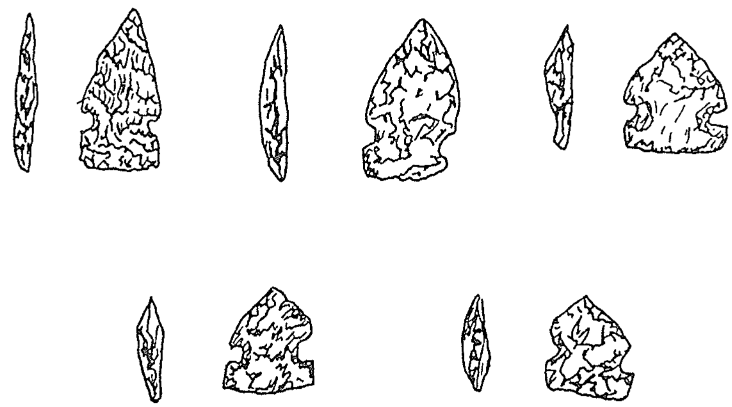
(1/2 natural size)

Fig.

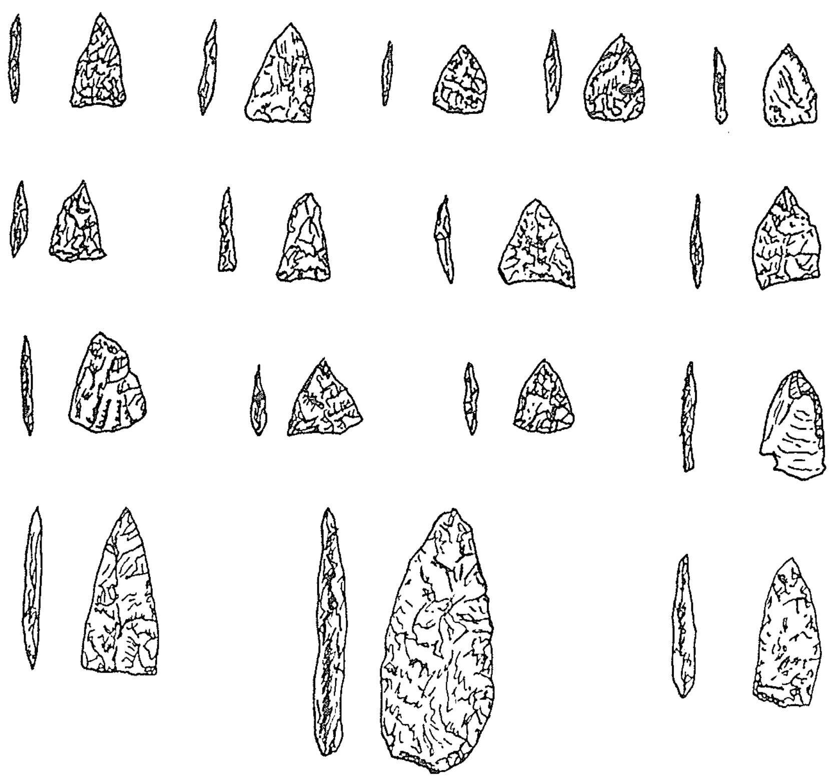
a Type 1, average-link cluster of projectile point continuous attributes

b Type 3, average-link cluster of projectile point continuous attributes

Plate 1



a



b

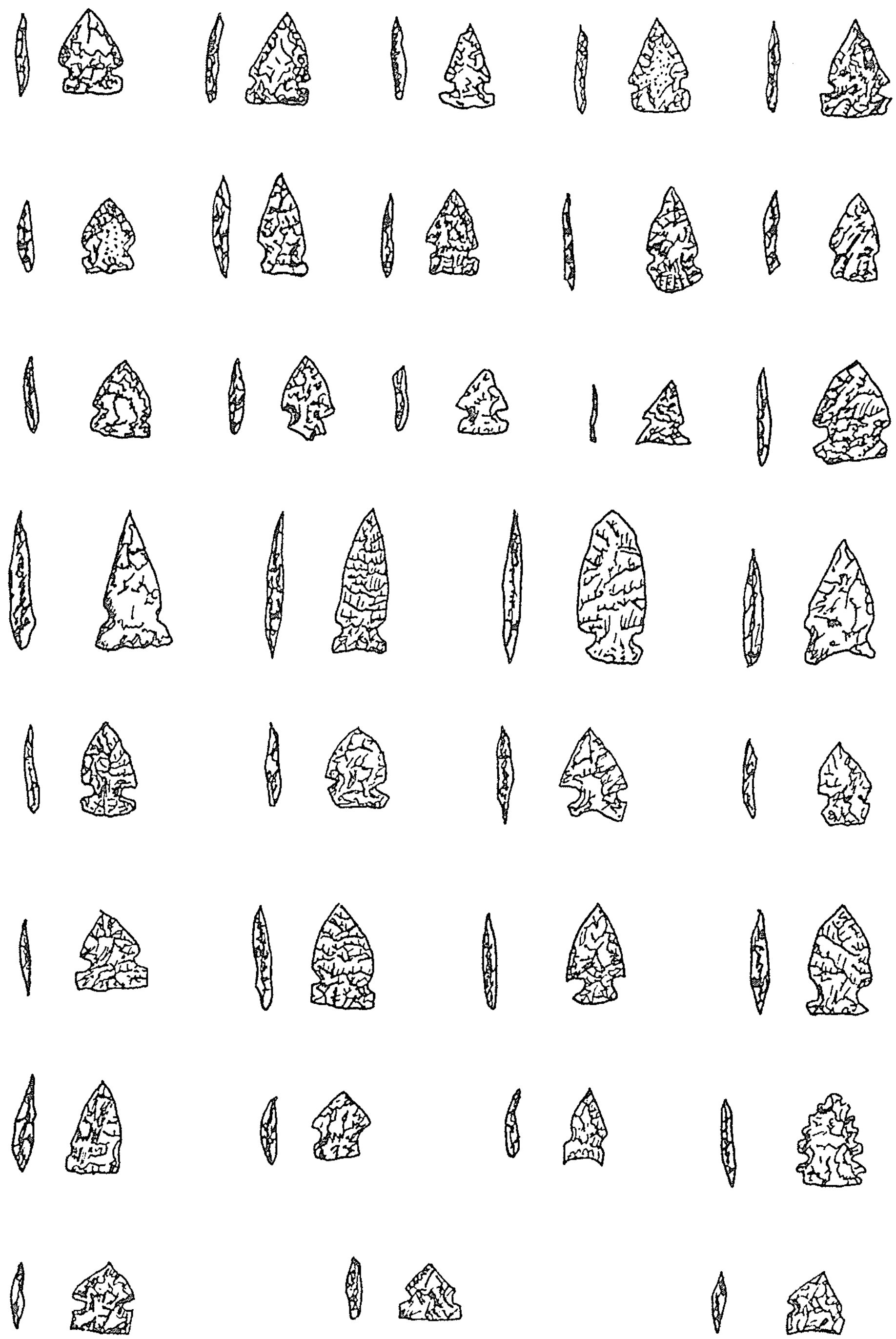
PLATE 2

(1/2 natural size)

Fig.

a Type 2, average-link cluster of projectile point continuous attributes

Plate 2



a

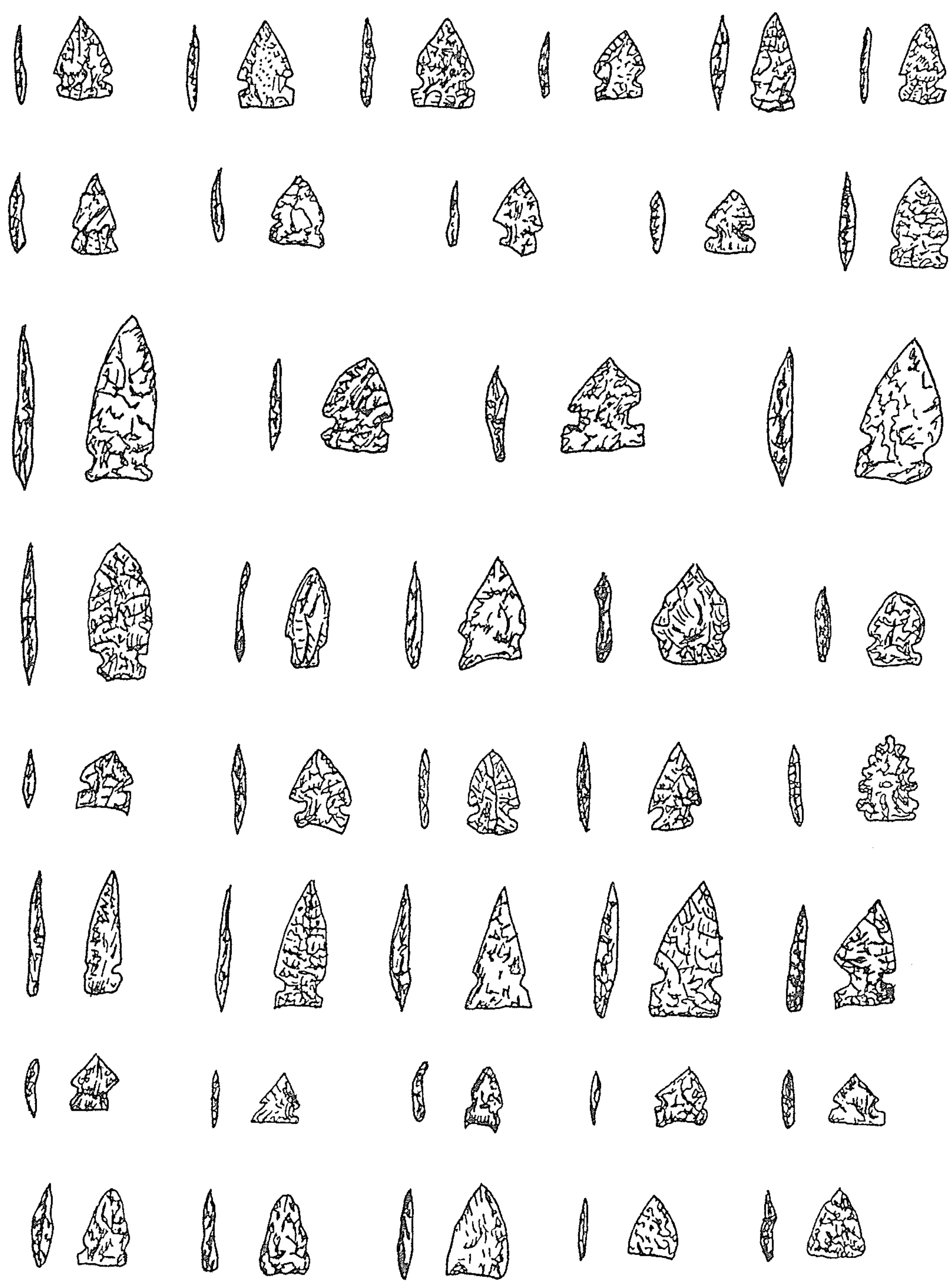
PLATE 3

(1/2 natural size)

Fig.

a Type 1, average-link cluster of projectile point discrete attributes

Plate 3



a

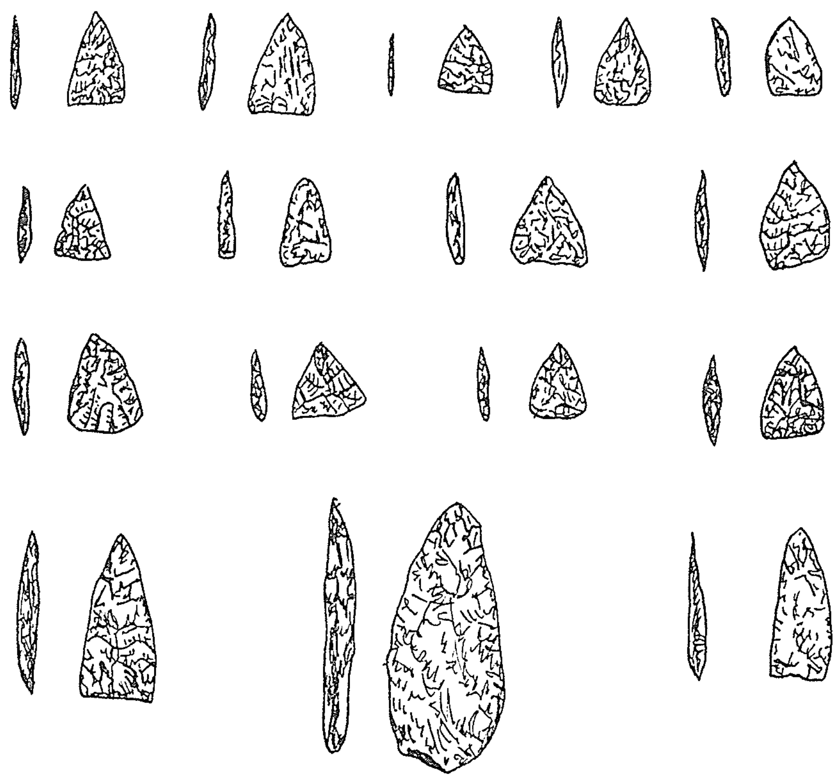
PLATE 4

(1/2 natural size)

Fig.

a Type 1, average-link cluster of all projectile point attributes

Plate 4



a

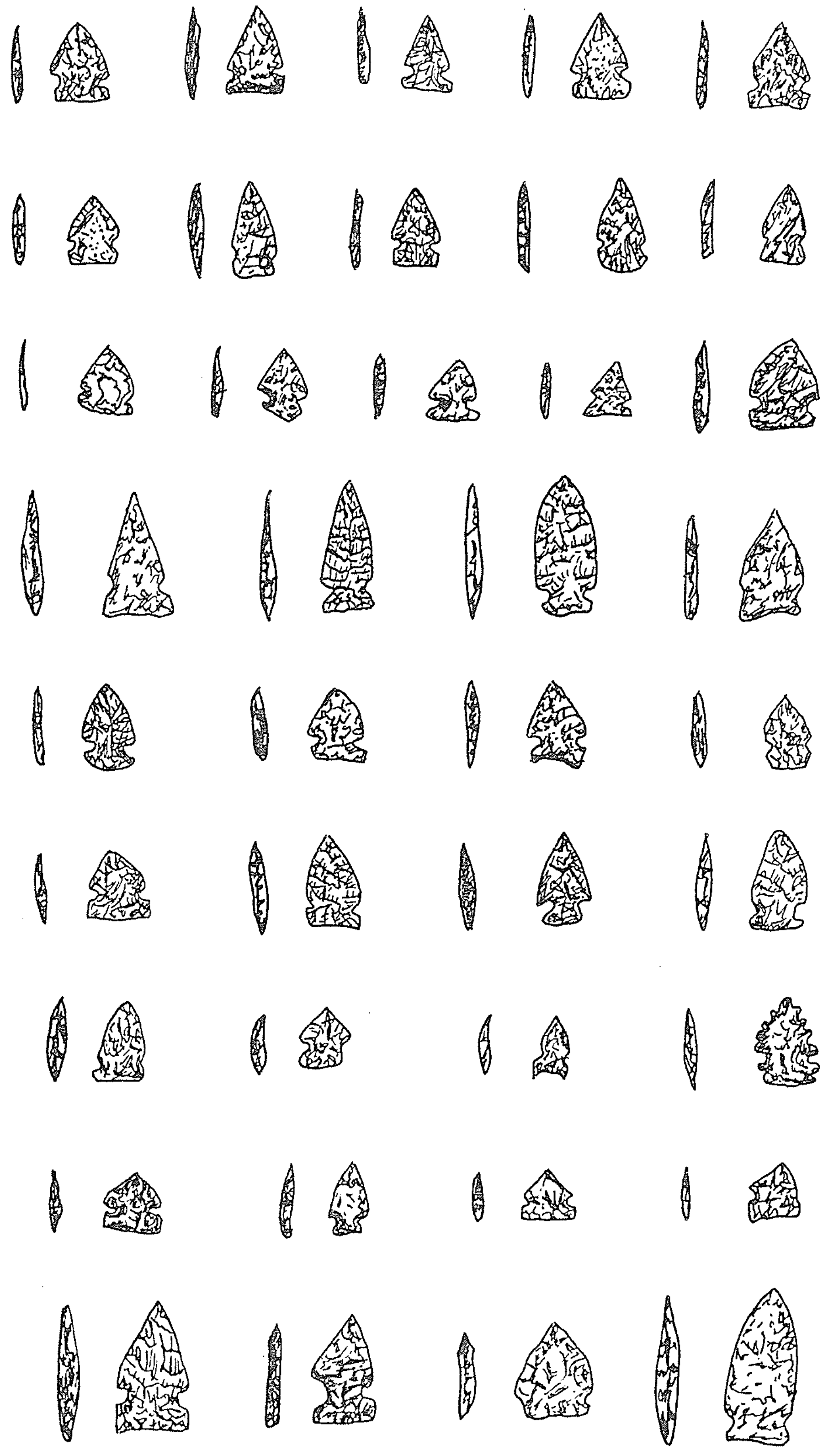
PLATE 5

(1/2 natural size)

Fig.

a Type 2, average-link cluster of all projectile point attributes

Plate 5



a

PLATE 6

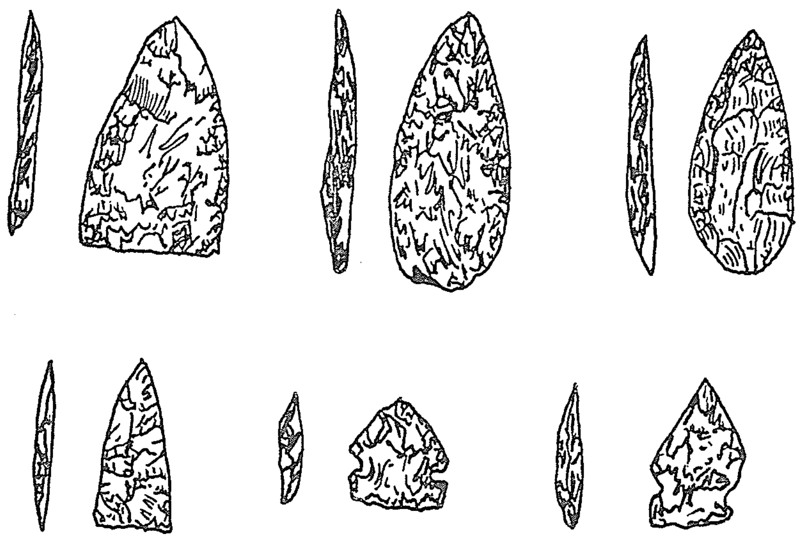
(1/2 natural size)

Fig.

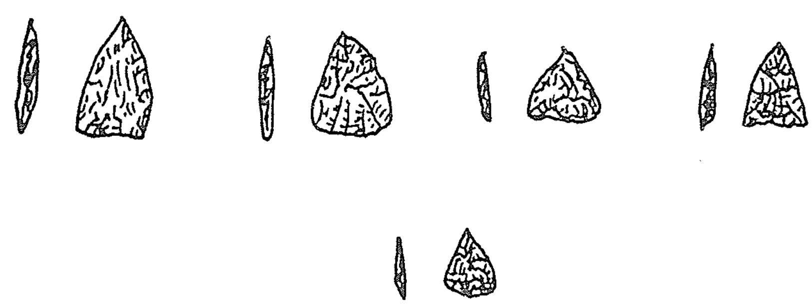
a Type 1, principal component of projectile point attributes

b Type 2, principal-component of projectile point attributes

Plate 6



a



b

PLATE 7

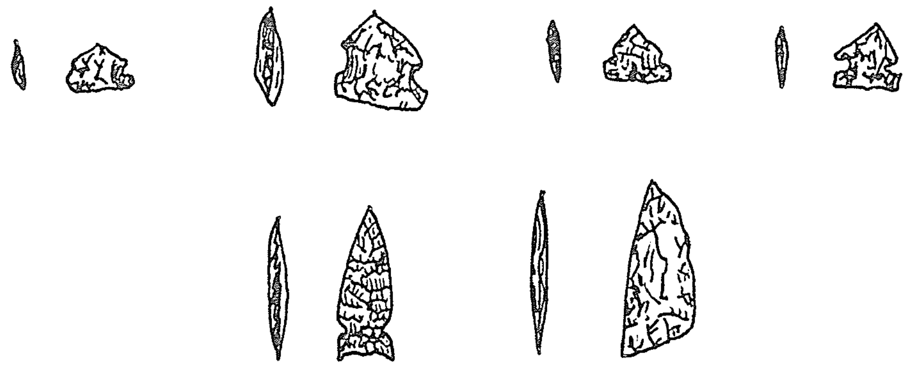
(1/2 natural size)

Fig.

a Type 3, principal-component of projectile point attributes

b Type 4, principal-component of projectile point attributes

Plate 7



a

b

PLATE 8

(1/2 natural size)

Fig.

a Type 1, average-link cluster of biface continuous attributes

Plate 8

a

PLATE 9

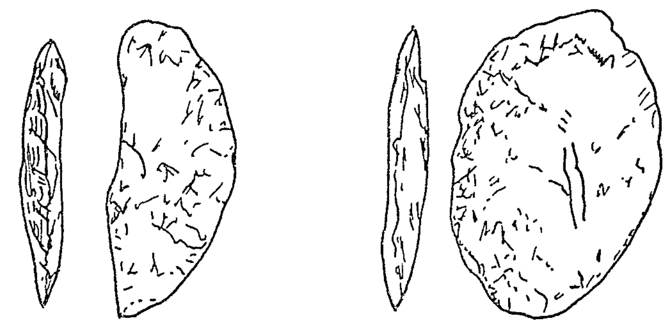
(1/2 natural size)

Fig.

a Type 2, average-link cluster of biface continuous attributes

b Type 3, average-link cluster of biface continuous attributes

Plate 9



a

b

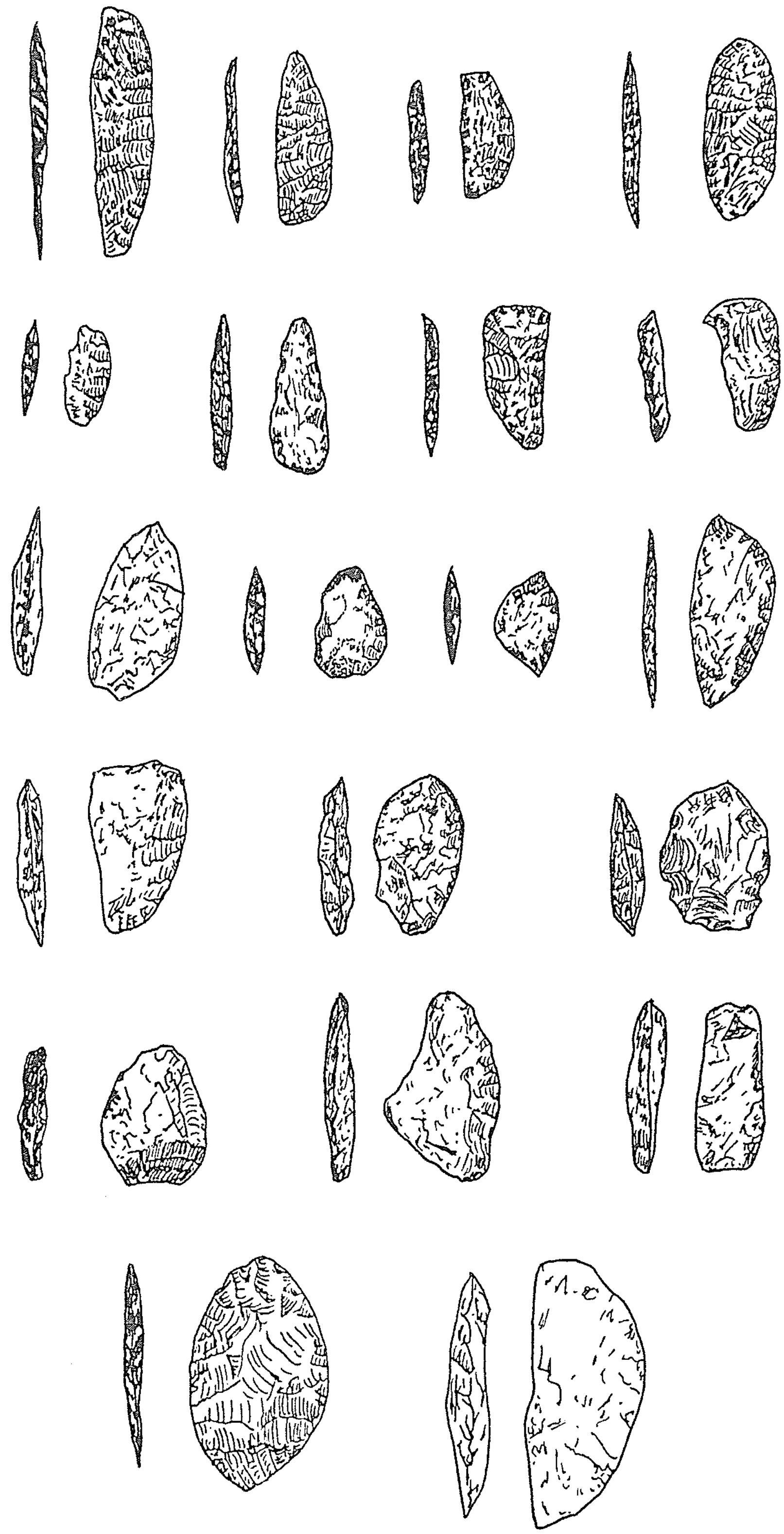
PLATE 10

(1/2 natural size)

Fig.

a Type 1, average-link cluster of biface discrete attributes

Plate 19



a

PLATE 11

(1/2 natural size)

Fig.

a Type 1, average-link cluster of all biface attributes

Plate 11

a

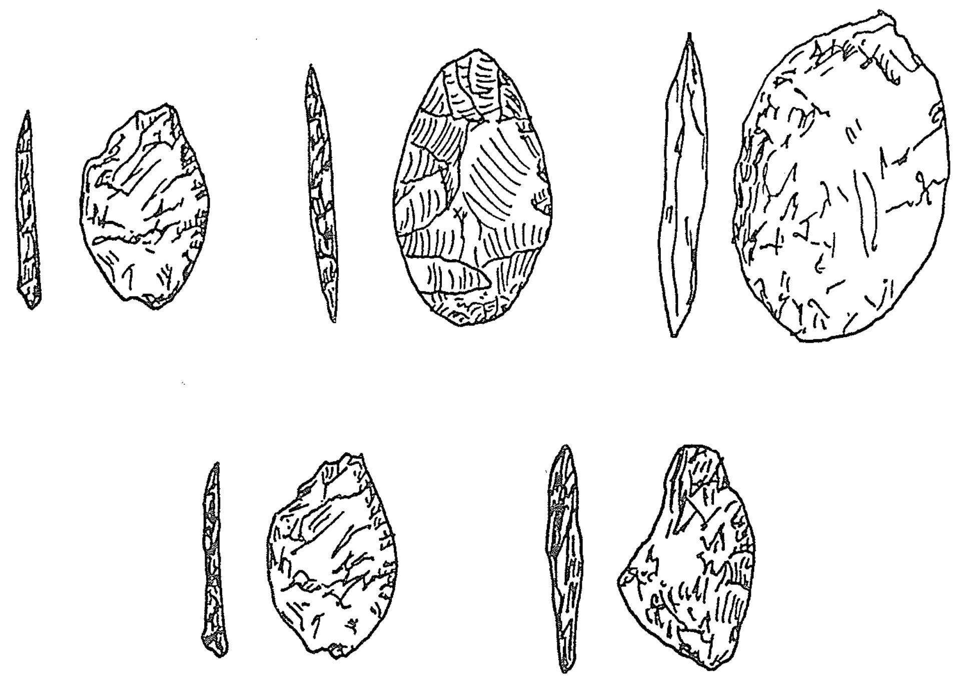
PLATE 12

(1/2 natural size)

Fig.

a Type 1 — principal-component of biface attributes

Plate 12



a

PLATE 13

(1/2 natural size)

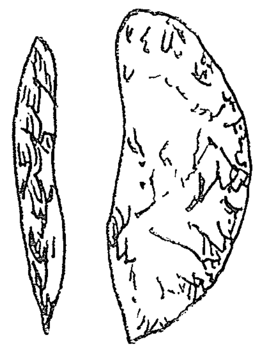
Fig.

a Type 2, principal-component of biface attributes

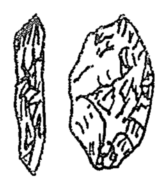
b Type 3, principal-component of biface attributes

c Type 4, principal-component of biface attributes

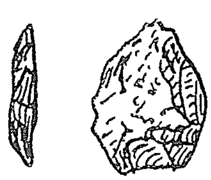
Plate 13



a



b



c

PLATE 14

(1/2 natural size)

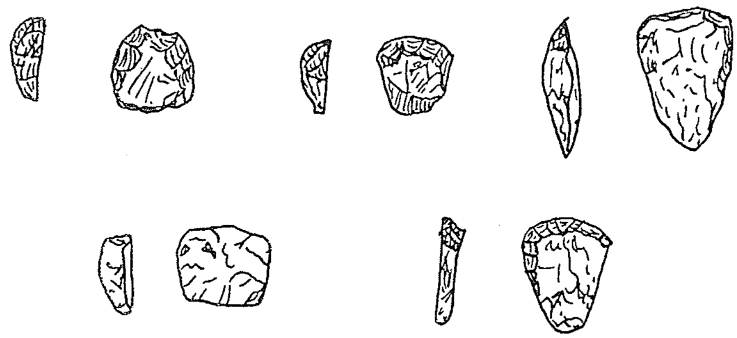
Fig.

a Type 1, average-link cluster of end scraper continuous attributes

b Type 2, average-link cluster of end scraper continuous attributes

c Type 3, average-link cluster of end scraper continuous attributes

Plate 14



a

b

c

PLATE 15

(1/2 natural size)

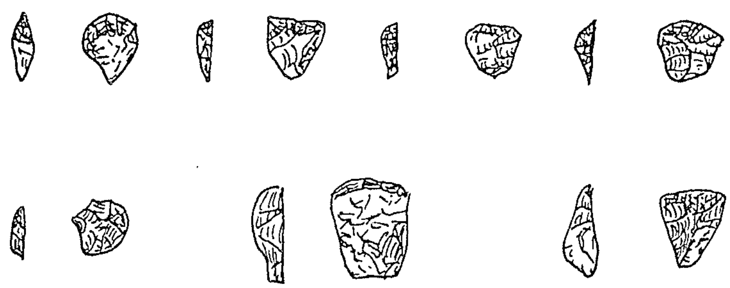
Fig.

a Type 4, average-link cluster of end scraper continuous attributes

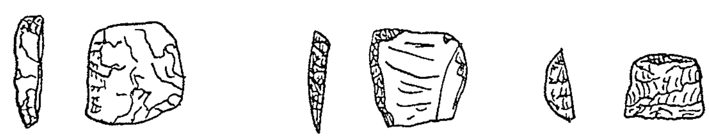
b Type 5, average-link cluster of end scraper continuous attributes

c Type 6, average-link cluster of end scraper continuous attributes

Plate 15



a



b

c

PLATE 16

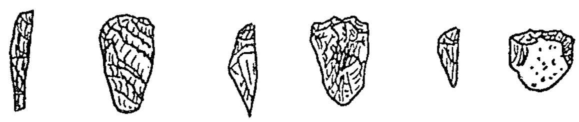
(1/2 natural size)

Fig.

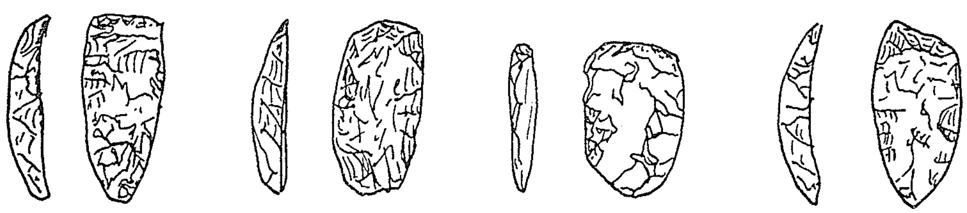
a Type 7, average-link cluster of end scraper continuous attributes

b Type 8, average-link cluster of end scraper continuous attributes

Plate 16



a



b

PLATE 17

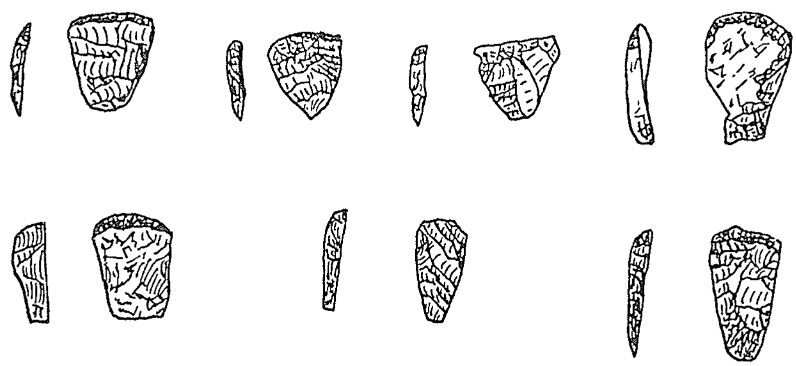
(1/2 natural size)

Fig.

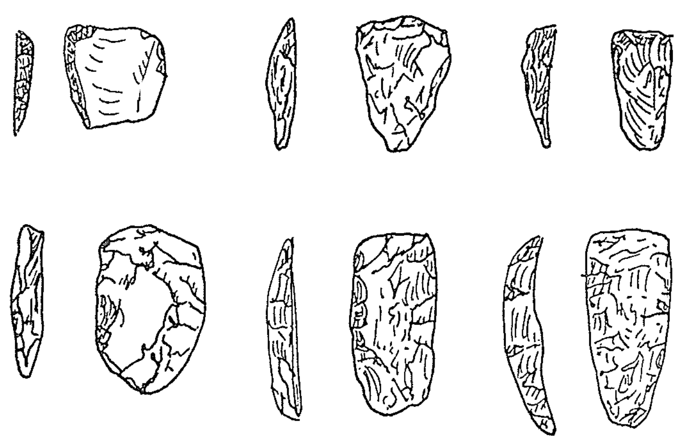
a Type 1, average-link cluster of all end scraper attributes

b Type 2, average-link cluster of all end scraper attributes

Plate 17



a



b

PLATE 18

(1/2 natural size)

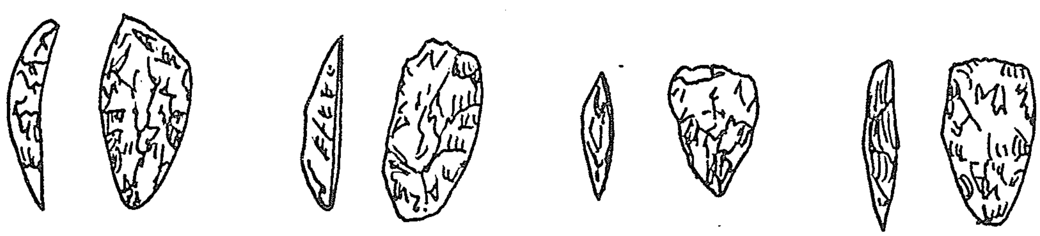
Fig.

a Type 1, principal-component of end scraper attributes

b Type 2, principal-component of end scraper attributes

Plate 18

a



b

PLATE 19

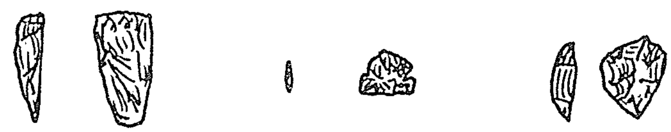
(1/2 natural size)

Fig.

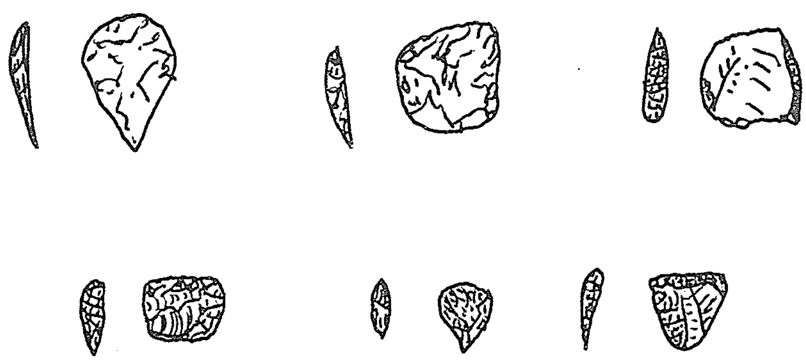
a Type 3, principal-component of end scraper attributes

b Type 4, principal-component of end scraper attributes

Plate 19



a



b

PLATE 20

(1/2 natural size)

Fig.

a Published projectile types

A-E Eastern Triangular (MacNeish)

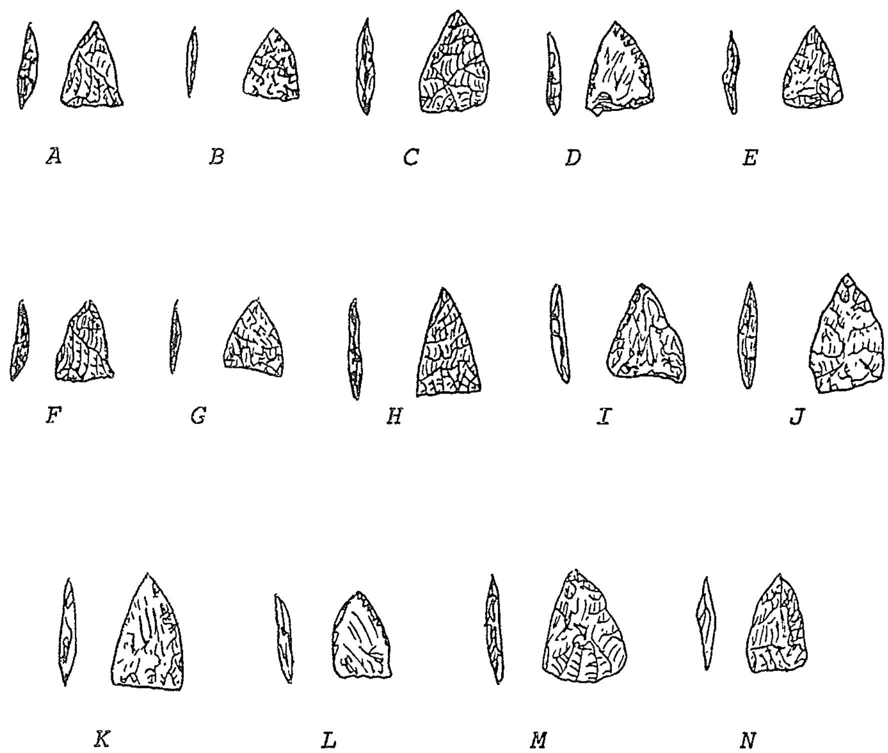
F-J Plains Triangular (Joyes)

K-N Plain Lanceolate, straight base (Wood and Woolworth)

L Plain Triangular, Concave base (Wood and Woolworth)

M Plain Lanceolate, convex base (Wood and Woolworth)

Plate 20



a

PLATE 21

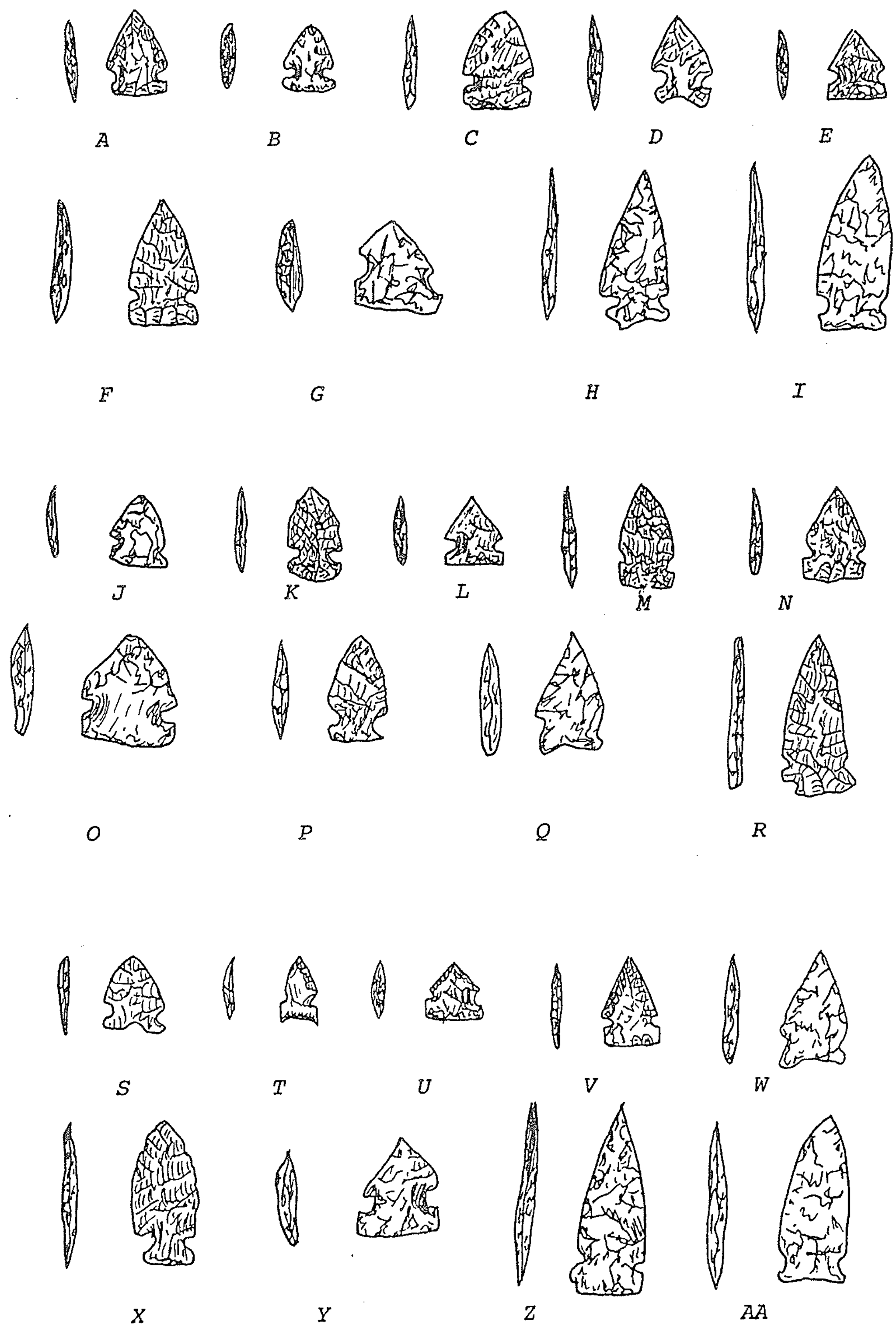
(1/2 natural size)

Fig.

a Published projectile types

A-E	Plain side-notched (MacNeish)
F-I	Prairie Side-Notched (MacNeish)
J-R	Late Side-notched (Joyes)
S-W	Plain Side-notched (Kehoe)
X-AA	Prairie Side-notched (Kehoe)

Plate 21



a

PLATE 22

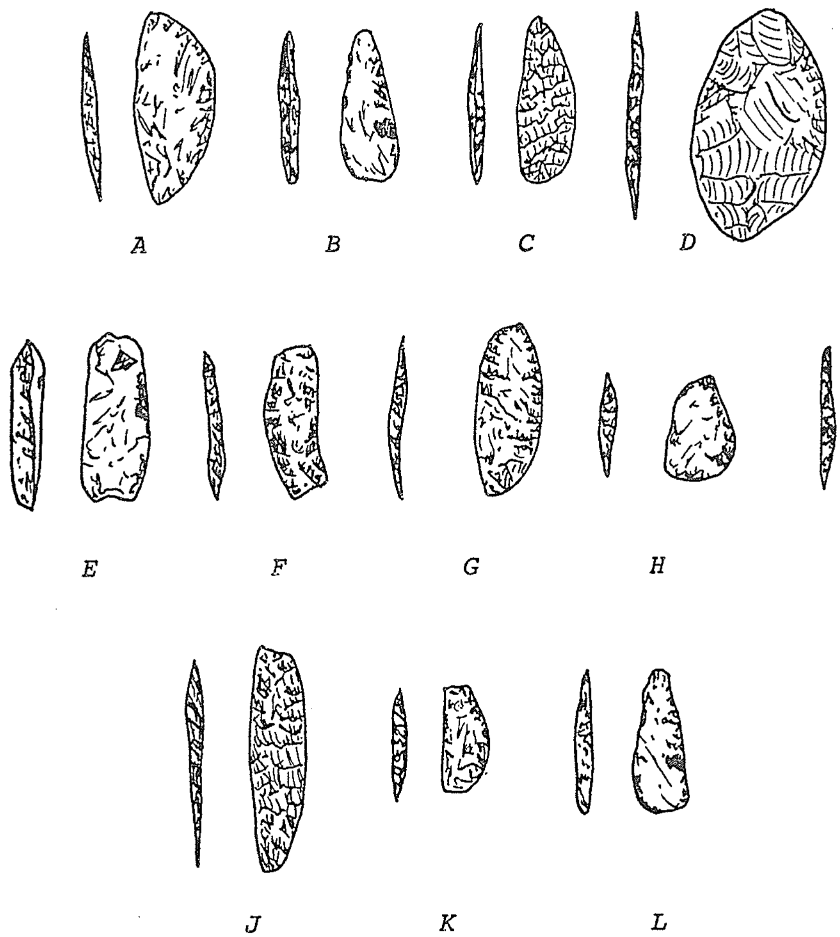
(1/2 natural size)

Fig.

a   Published biface types

A	Small Half-moon (MacNeish)
B	Triangular (MacNeish)
C	Oblong (MacNeish)
D	Ovoid (MacNeish)
E	Rectangular (Joyes)
F	Crescent (Joyes)
G	Ovate (Joyes)
H	Oval (Joyes)
I	Lanceolate (Joyes)
J-L	Narrow knives (Wood; Wood & Woolworth)

Plate 22



a

PLATE 23

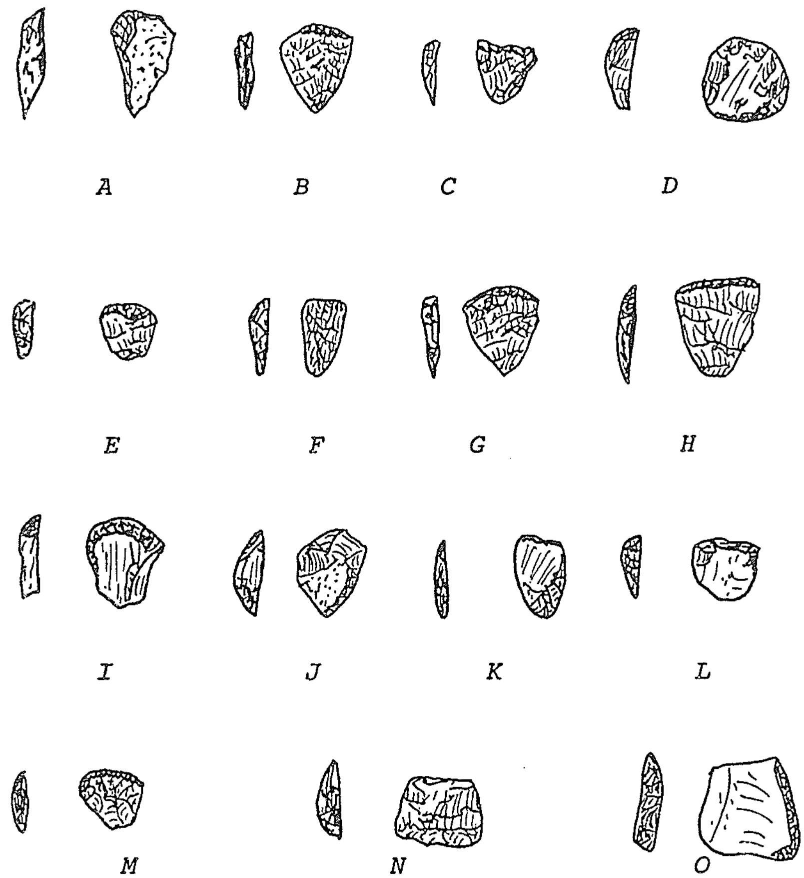
(1/2 natural size)

Fig.

a Published end scraper types

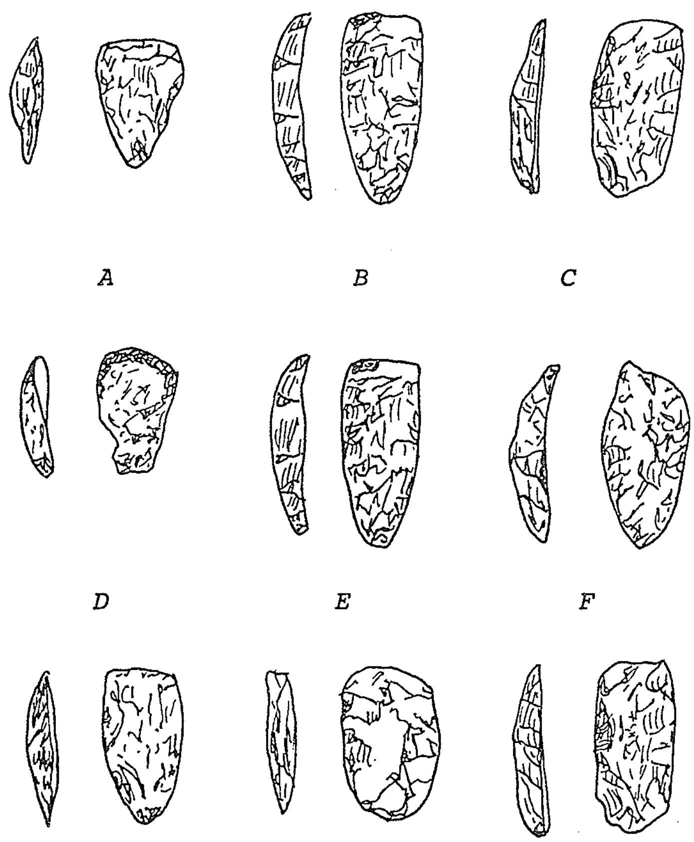
A-C	Triangular (MacNeish)
D	Disc (MacNeish)
E	Group 1 (Wood & Woolworth)
I-L	Group 2 (Wood & Woolworth)
M, N	Small Bifacially Flaked (Wood)
O	Small Plano-convex (Wood)

Plate 23



a

Plate 24



a