Lithic Analysis in Paleoanthropology

Quantitative study of stone artifacts can lead to inferences about aspects of extinct hunting cultures.

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Archaeologists as anthropologists are concerned with the problem of discovering fundamental, underlying properties of cultural processes common to extinct as well as to living cultural systems. This interest weds archaeology to other segments of anthropology in which cultural explanation is sought. Archaeologists must assume that, other things being equal, these processes which structure the ethnographic record have also structured the archaeological record. When ecological conditions, sociocultural integration, or primary subsistence patterns similar to those known ethnographically can be demonstrated or inferred archaeologically, the archaeologist must orient his investigation toward the elucidation of processual factors which may underlie both cases, and he must seek structural explanations for the similarities and differences that are recognized.

Recently, a number of archaeologists have come to realize that, in order to achieve their anthropological goals, new procedures for the collection, description, and interpretation of archaeological data must be formulated within a general theoretical framework in which explanatory inferences may be tested against the whole range of anthropological data.

Archaeological energies have often focused on the recognition of superficial resemblances in form among individually selected specimens. These specimens were labeled "diagnostic traits," and the presence of one or more of these traits in each of several site collections was taken to indicate some sort of relation between the collections. Interpretations were limited to speculations on the significance of the spatial and temporal distributions of these traits. This orientation has served the limited aims of archaeological historiography, but it is inadequate for the formulation of explanatory inferences. Flannery has contrasted the goals and strategies of those archaeologists who hope to construct culture histories with those who seek explanations in terms of cultural processes (*1*).

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A Processual Approach

Willey and Phillips note the failure of American archaeology to develop in any satisfactory way its theoretical structure at an explanatory level (*2*); Binford has suggested that an interpretive framework focused upon selected variations in ideational norms—diagnostic traits—may partially account for this failure. He presents an excellent case for a holistic approach to archaeological systematics and argues for the establishment of multivariate taxonomies as a means for isolating causative factors in the operation of cultural systems and as a basis for identifying regular and predictable relationships among these factors. Binford's discussion is founded on the general cultural theory, formulated by White, in which culture is viewed as a system of adaptive mechanisms with which the member units of human society integrate with their environments (*3*).

Within a cultural system, certain structural poses (*4*) may be isolated which relate a society's economic, political, and ideological activities to ecological conditions of resource availability and competitor activity. These units function to maintain a sociocultural system within an ecological framework by combining social groups with implements, ideas, habits, and the like. Archaeology can supplement ethnographic attempts to elucidate processes of cultural-ecological articulation by expanding the range of cultural knowledge both in time and in variety. The ethnographic record is limited, and almost daily its scope is diminished by modern industrial expansion. It is, therefore, desirable to establish means for identifying and interpreting structural variation in extinct cultural systems.

Neither Binford nor White was primarily concerned with developing detailed procedures for constructing a systematic descriptive and classificatory methodology aimed at the establishment of formal taxonomies and the identification of articulations between variables within a cultural system. But Spaulding has noted that in order to establish "archaeo-sociological" correlations as alternatives to arbitrarily defined taxonomies it is essential that the problem of the classification of archaeological data be satisfactorily treated beforehand (*5*).

In the past, attribute-identification procedures have been formulated to meet the particular requirements of a specific data set and have been characterized by *ad hoc* adjustments in the decision-making process when specimen inclusion within a given category was in doubt. Such procedures are subjective and, therefore, cannot be verified by independent investigators. The position taken here is that all conclusions about the meaning of archaeological data, whether inherently correct or not, based upon intuition-bound notions of culture and loose formulations of interpretive procedure, are indefensible because they cannot be independently verified and because they can generate no evaluative mechanisms by means of which preference for one conclusion over another may be demonstrated. This is not to deny a productive role to intuition. The point is that intuitive formulations cannot of themselves lead to internally satisfying results. Intuition provides a creative element to theory formulation and model building, but that creativity must be evaluable. These considerations provide strong motivation for a systematization of archaeological methodology.

In this paper some steps in the formulation of procedures applicable to one category of lithic material are presented. Specifically, the expansion of the scope of lithic analysis through the presentation of certain descriptive and classificatory devices is attempted. These methods are applied to lithic assemblages from a number of late Pleistocene and early Recent North American sites. The results obtained suggest that a more complete understanding of early American hunting life may be gained by application, to the whole range of data pertaining to it, of more rigorous procedures than those used in the past.

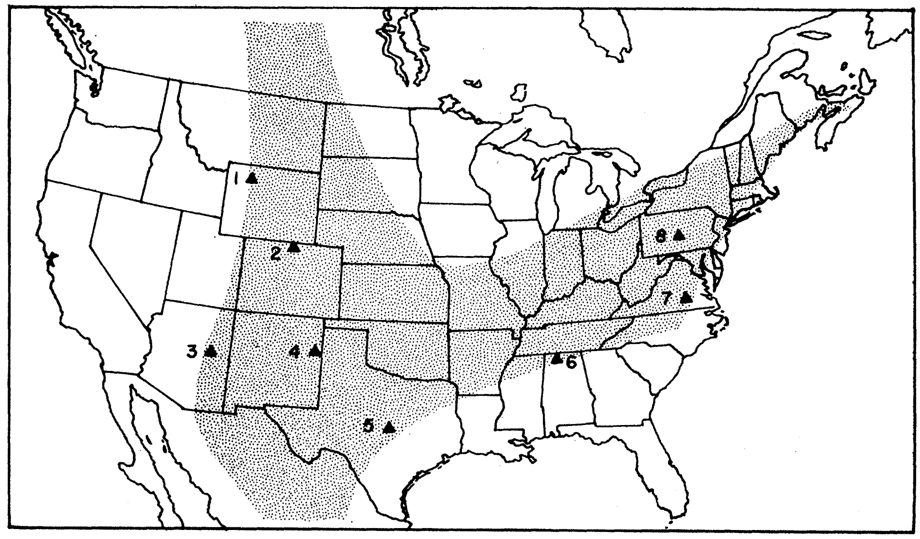

Fig. 1. Locations of sites discussed in text. *1*, Horner; *2*, Lindenmeier; *3*, Vernon; *4*, Blackwater; *5*, Levi; *6*, Quad; *7*, Williamson; *8*, Shoop. Shaded area delimits the extent of the known Paleo-Indian range; beyond these limits, only isolated surface finds are presently known.

Site and Sample Selection

The data for this study were derived from eight sites: Blackwater, Horner, Levi, Lindenmeier, Quad, Shoop, Vernon, and Williamson. A total of 2139 artifacts was selected from the collections for intensive examination.

A number of considerations guided the selection of sites. Primary among these was a desire to incorporate into the analysis as representative a geographical range as practicable. A determined effort was made, therefore, to use collections from sites in all parts of the known Paleo-Indian range (Fig. 1). A second important consideration was that the sites chosen should represent a wide range within the known Paleo-Indian time span. Three sites have been dated by the radiocarbon method: Blackwater—11,170 ± 360 years; Lindenmeier — 10,780 ± 375 years; Horner—6876 ± 250 years. Levi has yielded internally inconsistent ages ranging from 9300 ± 160 years to 6750 ± 150 years. Vernon, Shoop, Williamson, and Quad are not datable by independent methods but on typological grounds they are usually placed between Lindenmeier and Levi in time. The third consideration guiding site selection was collection size. Only large collections and those comprehensive in their representation of the artifact variation in the sites from which they are drawn are useful to a study of the kind presented here (Table 1). Most site assemblages were not collected in ways that are consistent with the requirements of probability sampling.

Table 1. Collection and sample sizes.

Site	Collection	Sample
Lindenmeier	7000 ±	747
Blackwater	175	118
Horner	210	120
Levi	442	139
Shoop	800 ±	181
Williamson	1500 ±	191
Quad	1000 ±	444
Vernon	2334	199

The first step in working with each collection was the selection of a representative sample from the body of available artifacts. In each of four collections (Blackwater, Horner, Shoop, Levi), the total assemblage size was small enough that the entire collection could be used. Apparent discrepancies between assemblage and sample sizes in Table 1 reflect the presence of unchipped and bifacially chipped specimens in the inventories. The four remaining collections were so large, however, that a representative sample was drawn from each.

Although individual site conditions dictated minor modifications, sample-selection procedures for each of these four collections were structured in a generally similar way. The specimens in each collection were divided into sets according to the following criteria: (i) raw material type, (ii) degree of retouch modification, (iii) implement type, (iv) gross size differences, (v) completeness of the specimen. A total sample size was decided upon for each collection, and a proportional number of specimens was drawn from each artifact set resulting from the above steps. Unmodified, unused flakes without striking platforms and chips less than 15 mm in gross length were, in general, not selected.

Variables

The geometry of specimens is described in formal terms and presented as grouped data (Table 2). The variables are described below and graphically illustrated in Fig. 2. Data were recorded on punch cards and processed in the Numerical Analysis Laboratory, University of Arizona (*6*).

The flake angle (β) is the angle formed between the plane of the striking platform and the plane of the ventral surface of a flake (Fig. 3). This angle was measured with a polar co-

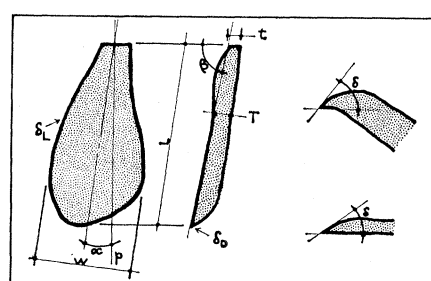

Fig. 2. Geometry of specimens. *a*, dorsal view; *b*, lateral view; *c*, edge-angle measurement on different edge configurations; *L*, length; *W*, width; *T*, thickness; β, flake angle; α, medial angle; δ_L, lateral edge angle; δ_D, distal edge angle; *p*, axis of percussion. No scale.

ordinate grid and lens stand. In a few cases, a jeweler's comparator was used. The Lindenmeier, Blackwater, Horner, and Levi samples are statistically alike, and each is significantly different ($P = .05$) from the Shoop, Williamson, Quad, and Vernon samples which do not differ among themselves.

The medial axis (α) is measured by the angle formed between the axis of percussion (a line drawn perpendicularly to the striking platform at the point of percussion) and the centroidal axis of the flake (Fig. 4). A radial grid was used for this measurement. Readings are to the nearest 2°. The Quad sample displays significantly larger values for this variable ($P = .05$) than do the others.

Length (L) is measured along the medial axis; width (W) is the greatest dimension perpendicular to length; thickness (T) is measured at the base of the bulb of percussion (Fig. 2). There is a great deal of variation, at $P = .05$, among sample dimensions. Levi, Quad, and Vernon tools are larger than are other tools. Williamson tools, although not especially long, are very thick. Shoop specimens tend to be thick in proportion to other dimensions. Blackwater and Horner specimens are comparatively thin.

Platform thickness (t), the dorsoventral distance at the point of percussion (Fig. 2), tends to be small in the Horner, Lindenmeier, and Vernon samples but very thick at Levi. This variable was not measured in the Blackwater and Shoop samples.

Edge angles were measured on distal edges (δ_D) and lateral edges (δ_L) when these displayed either retouch or use scarring (Fig. 5). Measurements are to the nearest 5°. Distal edges as a group are consistently much steeper than are lateral edges. Both edges on Levi, Shoop, and Williamson specimens, those on Vernon tools but not on unused flakes, and Quad distal edges are significantly steeper ($P = .05$) than are their counterparts in other samples. All Horner edges tend to be more acute than others.

Product-moment correlations were run between pairs of variables. There are strong positive correlations ($P = .001$) between platform thickness, flake angle, and specimen thickness. There is a somewhat less pronounced relation (significance levels remain the same but are not reached in all samples) between flake angle and specimen width and between specimen thickness and lateral edge steepness. Edge angles appear to be independent of other variables except each other and, to a very minor extent, flake width. The medial axis varies independently of all variables except specimen length.

Table 2. Characteristics of stone inventories from included sites. Symbols for the geometrical variables are defined in the text; debi, ratio of stone waste to tools; M, raw material source (+, local; —, imported; 0, both); N, number of cases; $\overline{X}$, sample mean; d, standard deviation; t, platform thickness. The data presented are for the total samples drawn from each site except that values for length (L), width (W), and thickness (T) for Quad and Vernon are for finished tools only. β, Flake angle; α, medial axis; δ_D, distal edge; δ_L, lateral edge.

	Dimensions (mm)				Angles (°)				Debi	M
	t	L	W	T	β	α	δ_L	δ_D		
					Blackwater					
$N =$		118	118	118	64	62	39	10		
$\overline{X} =$		44.6	29.2	5.9	67	6.5	48		1 : 1	—
$d =$		19.4	12.4	3.9	12	4.4	12			
					Horner					
$N =$	66	91	91	91	66	66	82	46		
$\overline{X} =$	3.5	33.8	26.4	6.8	67	5.8	45	55	3 : 1	—
$d =$	2.3	14.1	8.4	2.6	10	2.5	12	13		
					Levi					
$N =$	108	70	70	70	108	108	68	31		
$\overline{X} =$	6.9	55.1	42.6	12.8	69	6.9	55	67	25 : 1	+
$d =$	3.0	17.3	13.3	6.3	10	4.5	14	12		
					Lindenmeier					
$N =$	597	578	578	578	597	592	267	122		
$\overline{X} =$	3.1	43.6	31.5	8.0	69	6.6	48	65	6 : 1	0
$d =$	2.1	16.4	11.1	3.4	10	3.9	13	11		
					Quad					
$N =$	336	210	210	210	336	335	244	57		
$\overline{X} =$	4.3	52.5	31.1	9.2	73	8.4	47	66	2 : 1	?
$d =$	2.4	13.5	9.2	3.3	12	6.7	11	10		
					Shoop					
$N =$		132	132	132	160	95	139	132		
$\overline{X} =$		28.4	21.5	6.8	73	6.3	54	65	2 : 1	—
$d =$		9.0	6.1	2.5	10	4.1	27	10		
					Vernon					
$N =$	157	12	12	12	157	156	81	36		
$\overline{X} =$	3.5	50.8	36.9	15.0	73	6.5	51	60	20 : 1	+
$d =$	2.3	18.8	15.0	9.0	11	4.2	12	13		
					Williamson					
$N =$	153	181	181	181	153	153	58	38		
$\overline{X} =$	4.5	41.2	30.2	10.2	72	7.2	58	68	19 : 1	+
$d =$	2.5	15.3	11.0	4.4	11	4.3	10	8		

Technological Variation

Technological processes in stone tool manufacture are activated in the conversion of raw stone materials into culturally useful forms. It is apparent from the data that in a social group occupying any site from which samples were drawn, a knapper exercised controls over flaking techniques that were widely shared by other knappers in the group. Whether these controls are inherent in the processes employed, or whether adjustments must be made when these processes are applied to different stone types, can only be determined by experiment and by testing complete stone inventories from a number of sites where specific activities are known to have taken place. Crabtree suggests that some rocks must be heat treated before being flaked (*7*). Other technical adjustments may be necessary as well.

It seems evident, however, that flaking techniques were directed toward the production of blanks that could be converted into tools with a minimum of further modification. In almost every sample, the mean values of flake angles, medial axes, and length-width-thickness dimensions are essentially the same for tools as for that sample as a whole. Unmodified, unused flakes tend to vary more widely from sample means. Obviously, specific flake forms were being produced and selected for use as tools. It seems reasonable to suggest that technological processes of stone flaking were directed toward the preparation of these preferred flake forms and that these forms were prescribed by functional criteria. This interpretation is supported by the fact that postdetachment modification is minimal on most tools in this series. In many cases, modification appears to have been accomplished by the simple expedient of dragging a flaking baton along one lateral edge of a flake. And in only rare cases were tools (other than points and bifaces) modified beyond the immediate area of use. Significantly, a relatively large proportion of flakes was used without postdetachment modification. Control of flaking processes was such that functionally desirable flake forms could be predetermined on and struck directly from cores.

The data suggest that striking platform architecture is of fundamental importance in predetermining at least some flake-form characteristics. Platform thickness is apparently a strong determinate of specimen thickness and width and, to a lesser extent, length. Platform width, because not measured in several samples, was not tested against other variables, but this dimension displays a tendency to vary within those samples for which data are available in a manner similar to that displayed by platform thickness. The flake angle (β) appears to be another factor upon which specimen morphology depends. Although the pattern is not consistent among all samples, the large samples and the pooled data indicate that increases in specimen thickness are strongly related to increases in the steepness of the flake angle. Specimen width is less strongly related to this angle, and length appears to be only weakly correlated if at all. These correlations suggest that a decision to produce thicker, heavier flakes or thinner, sharper flakes could be implemented by controlling the striking direction and the point of striking force application.

We may conclude, therefore, that flake morphology depends upon a number of factors. Among the more important technical factors that can be measured, platform size and striking direction appear to be critical. The amount of force applied in detachment is probably also important, but I know of no way to measure this factor after the flake has been removed. While it is probably not true that a Paleo-Indian knapper could direct every single flake to a specific size and shape, it appears certain that he could regulate any series of flakes to meet intended dimensional and formal tolerances. He apparently did this by varying the distance from the edge of a core at which he applied detaching force as well as the direction and strength of that force.

There is some internal evidence to suggest that other characteristics of platform preparation visible on flakes are indicative of more specific core-flake relations. Transverse preparation and platform abrasion co-occur in greatest frequency in the same samples. These samples—from Lindenmeier, Blackwater, Horner—also contain high proportions of thin flakes with small platforms and relatively acute flake angles. This combination of characteristics should be indicative of a high proportion of thinning, trimming, and resharpening flakes at these sites. Transverse preparation and abrasion would be applied to relatively narrow striking areas in order to provide purchase for a detaching force to "peel" off a thin flake. The core, in this case, might be a flake undergoing modification into a tool. In many cases, abrasion may have been the product of tool use. Such an inference fits well with the previous suggestion that specimen thickness is

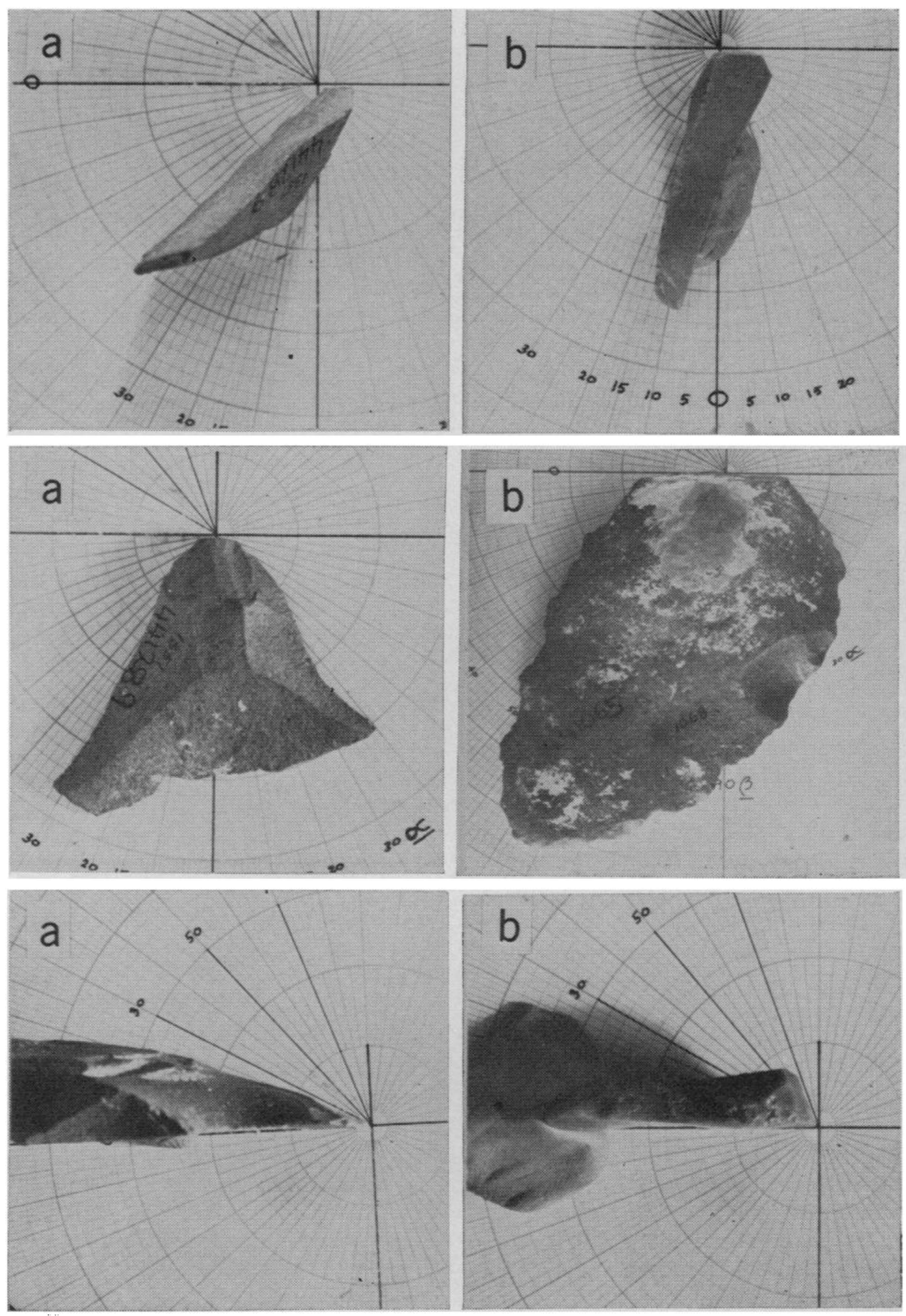

Fig. 3 (top). Measurement of flake angle. (a) $\beta = 48°$; (b) $\beta = 74°$. Fig. 4 (middle). Measurement of medial axis. (a) $\alpha = 3°$; (b) $\alpha = 15°$. Fig. 5 (bottom). Measurement of edge angles. (a) $\delta_L = 30°$; (b) $\delta_D = 70°$.

directly related to platform thickness. A "peeling" force would necessarily be applied near the core platform edge and would, therefore, carry with it only a small remnant from the platform at the same time that it was producing a thin flake. Such a force is also likely to produce relatively high proportions of acute values of β.

Functional Variation

The distribution of edge angle values found in the samples in this series displays a distribution with peaks in the 26° to 35°, the 46° to 55°, and the 66° to 75° range. We may reasonably suspect that differential functional capacities are reflected in this distribution. It would certainly be an oversimplification to equate each mode with some specific functional operation; however, general categories of functional effectiveness may be suggested for each mode. We may infer that cutting operations are associated with the most acute mode (26° to 35°). Essentially all angles of this value occur on lateral edges. Semenov suggests that the optimum angle for whittling knives is 35° to 40° (*8*). Knives for cutting meat and skin may be expected to have even more acute working edges. Edge angles in this size range are often not the result of retouch but are simply the natural edges of flakes which have been used in an unaltered state.

The most frequent incidence of edge-angle values falls within the interval 46° to 55°. The prevalence of angles of this size suggests that this was a broadly useful attribute appropriate to a number of functional applications. Angles of this size occur both on lateral and on distal edges. Inferred uses for this range of edge angle values are (i) skinning and hide-scraping; (ii) shredding of sinew and plant fiber; (iii) heavy cutting—of wood, bone, or horn; (iv) tool-back blunting. Large, unhafted tools retouched on the distal edge and on one or both lateral edges as well as socketed endscrapers are suggested implements for the first set of tasks. The same unhafted tools and tools retouched on both lateral edges would be appropriate to the second group. Tools with natural edge angles of about 50° might have been preferred for bone cutting but edges carefully retouched to this size could also be used for this purpose. Edge blunting is common in all of the Paleo-Indian collections studied. Retouch of about 50° or more was used to create dulled edges on the backs of many cutting or scraping tools so that greater pressure could be applied to the working edges of the tools. These tools are the analogs of European Upper Paleolithic backed blades. They obviously were not hafted. Burin-like blows were also employed to blunt tool backs.

Edge angles of 66° to 75° are found on about 12 percent of all laterally retouched tools and about 48 percent of all distally retouched tools. Suggested functions for tools with edges in this steepness range are (i) woodworking; (ii) bone working; and (iii) heavy fiber shredding. It is significant that 65 percent of all accessory tool tips and notches are associated with tools having edge angles of this steepness. Socketed endscrapers and heavy, unhafted side tools are included in this group. A large proportion of those tools with edge angles of 56° to 65° (present in significant quantity only in the Levi and Williamson samples) are probably functionally allied with these more steeply edged tools (*9*).

Site Characteristics

With this outline of the data in mind, the artifact contents of the various sites may be briefly summarized (*10*). The Blackwater and Horner inventories are characterized by predominantly thin tools with low values for edge angles, relatively few artifacts (but, among these, relatively many projectile points), relatively low proportions of *débitage*, and a great deal of bone waste. Single-edged cutting tools are in the majority in both samples. The associated fauna is mammoth (*Mammuthus columbi*) at Blackwater and an unidentified bison species at Horner. This assemblage is consistent with kill and butchering operations. In the Williamson and Levi inventories, steep edges predominate. These sites have yielded high proportions of *débitage* and much evidence of stone working. A single raw material type accounts for 95 percent of each assemblage. The sources of raw material are located in the immediate vicinities of these two sites. Heavy, double-edged scraping and cutting tools are common at both; steep-bitted distal end scrapers are abundant at Williamson. These are primarily quarry sites but wood working appears to have been a strong secondary activity. Hunting was apparently only a maintenance activity. Small, extant species predominate at Levi; there are no faunal associations at Williamson. Shellfish remains and hackberry seeds are important components at Levi.

The Lindenmeier inventory is heterogeneous in all respects other than technology. There is a wide range of raw material types, steep and acute edge angles, thick and thin flakes, and a great variety of tool types. Associated fauna include extinct bison as well as deer, antelope, jackrabbit, rodents, and carnivores of species not yet fully identified. Tools, debitage, and bone scraps are mutually localized in a number of discrete clusters within the site. It is possible that several band units simultaneously occupied the site and that this was a relatively long-term camp.

The Quad, Shoop, and Vernon sites may be considered to be band segment camp locations which were occupied briefly during the seasonal round. These sites are characterized by small occupation units. They tend to have rather heavy, steep-edged tools along with relatively large numbers of projectile points and moderate proportions of cutting tools. Activities at these sites appear to have been oriented toward the exploitation of small animals and plant products. There are no associated organic materials of any kind.

Subsistence and Task Performance

Processes involving subsistence activities and specific task performance sequences are intimately related to technological and functional variables. Primary among these processes are those which are directly related to the choice of a particular site. A second set of processes is centered around tool manufacture and maintenance required to perform the primary tasks as well as other activities ancillary to those tasks. A third group of processes includes those employed in sustaining the group regardless of its specific location. These include food preparation and consumption, procurement of water, manufacture and repair of clothing, and a host of everyday tasks.

Paleo-Indian bands probably behaved not unlike later hunter-gatherer groups in adjusting their behavior to their environments (*11*). Band movements were likely within a more or less well-defined territory. Even during the initial spread of peoples over the continent, groups probably moved in relation to other groups and new territory was entered only as it became familiar and as population size could accommodate new ground. Bands appear to have broken up periodically either under the stress of seasonal fluctuations in resources or to take more efficient advantage of ecological opportunities. Surface quarrying and plant collecting do not require large numbers of workers to be carried out effectively. It may be that one segment of a band exploited one set of resources while other segments directed their attention to different parts of the environment. Band segments regathered periodically and, in fact, bands themselves may have joined with other bands (as at Lindenmeier) in order to exploit the larger environment and to maintain socio-economic integration. Hunting parties as well as raw material and plant collection parties may have voluntarily moved out from these larger units and returned to distribute the products of their activities to the group as a whole. It may be that hunts for mammoth and bison were carried out principally and perhaps only by groups such as these at times when large band units were assembled.

Multiband units also functioned to maintain technocultural processes among groups and to disseminate change which arose in these processes. When individual groups moved into new environments they began to exploit the new opportunities offered by these environments and adapted their technologies to new exploitative tasks. It is probable that these adaptations involved no more than a realignment of emphasis in a preexisting technocultural system. Those elements in a familiar technology which were most useful in the new environment were emphasized. Prolonged emphasis in one direction gradually produced a technology which was distinctive from the parent, other-directed, technology. The dynamics of this process may be seen in the eastern sites included in this survey. Technologically, Shoop, Williamson, and Quad tend to be alike. To a lesser extent, they share technological features with Levi but they deviate sharply from Lindenmeier, Blackwater, and Horner. Functionally, Shoop, Williamson, Quad, and Levi are alike. These sites exemplify the tendency of a basic stoneworking tradition to be modified to meet new conditions. The implication is that woodland or scrub forest conditions were being increasingly met. This need not imply any real climatic change. It is more likely that these environmental areas were entered for the first time. Structurally related changes in other sectors of the cultural system no doubt took place along with these technological changes but these changes are not discernible in the existing data. MacNeish and Flannery suggest that postglacial adaptations were complex and not necessarily centered about the extinction of megafauna (*12*). It is probable that hunting activities at Shoop and Williamson, as at Levi, were directed toward small mammals and deer. These hunting patterns, once established, were maintained well into historic times.

Stability in basic patterns of technological and functional variation is also exemplified in the Blackwater and Horner sites. Blackwater is the oldest and Horner among the youngest sites in our sample; some 4000 years separate them in time. At both, large mammals were killed and butchered and this functional regularity is reflected in both artifact assemblages. Stylistic variation is present in projectile points and as yet unrecognized structural changes may differentiate the two sites. But those technological and functional processes associated with hunting appear to have remained essentially stable.

Summary

It is clear that technological, functional, social, and ecological processes were structurally interrelated in the Paleo-Indian cultural system. Technological procedures were directed toward an economy of tool production in which functionally useful artifacts were produced with a minimum of effort. Changes in resource patterns elicited changes in functional responses, and patterns of sociocultural interaction were adapted to ecological opportunities and task performance requirements.

Although Paleo-Indian sites are usually thought of as locations where large animals were killed and butchered, only two of the eight sites examined in this survey may be exclusively characterized as such. The relative chronological status of the Paleo-Indian stage has been fixed (*13*), and we now have an opportunity to enquire more deeply into the nature of this Paleolithic way of life. It is because of its early date that this stage takes on special significance for Americanist studies. For Paleo-Indians were the first widely successful, if not the initial, human inhabitants of the North American continent; we may assume that a significant portion of later American cultural development stemmed from this early culture.

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14. I thank E. W. Haury, W. A. Longacre, and R. H. Thompson for suggestions. Supported by an NSF graduate fellowship and by a Smithsonian Institution predoctoral research internship. Reprint requests should be addressed to E.N.W., Office of Anthropology, Smithsonian Institution, U.S. National Museum, Washington, D.C. 20560.