Perspectives on the Past

Theoretical Biases in Mediterranean Hunter-Gatherer Research

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Chapter 6

Retouched Tools, Fact or Fiction? Paradigms for Interpreting Paleolithic Chipped Stone

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Introduction

Chipped stone artifacts form the most ubiquitous material record for hunter-gatherers, not only in the circum-Mediterranean region but throughout the world. While few would argue with the idea that they represent only a portion of prehistoric technological systems, lithics were, in all probability, of considerable economic importance. This importance plus their durability over extremely long time periods makes them the primary database for reconstructing and explaining paleolithic lifeways. For this reason considerable study has been devoted to these artifacts. These range from studies of prehistoric lithic assemblages that include innumerable descriptive reports (see Dennell 1983, Gamble 1986), the development of classification systems (Bordes 1961, Brézillon 1968), and statistical analyses of the distribution of types (Binford and Binford 1966, 1969; Freeman 1964) and morphological attributes (Barton 1987, 1988; Baumler 1987; Dibble 1981, 1983; Fish 1979, 1980; Jelinek 1982) to replicative and controlled experiments (Dibble 1981, Newcomer 1971, 1972) to ethnoarchaeological studies of modern stone artifact users (Gould, Koster and Sontz 1971, White and Thomas 1972, Gallager 1977).

In spite of this concentration of effort, however, many questions remain about the behavioral significance of lithic variability. This is especially true for the early Upper Pleistocene assemblages assigned to the Middle Paleolithic, where uncertainty about the extent of biocultural differences between these hominids and modern humans leaves analogies with recent hunter-gatherers open to question. Chipped stone artifacts are often the only reliable, surviving record of behavior for the

Middle Paleolithic. For this reason, the Middle Paleolithic of the western Old World has become an arena for continuing investigation and debate on the relationships between lithic variability and human behavior.

Much of this debate has centered around whether such variability is primarily stylistic or functional in origin. Those maintaining a "culturalist" position (e.g., Bordes 1973, 1981a; Bordes and de Sonneville-Bordes 1970, Butzer 1981, Collins 1970, Laville et al 1980:208–215) interpret variability in relative frequencies of artifact types in assemblages as primarily stylistic, resulting from differences in cultural tradition of the makers. Those taking a more "functionalist" position (e.g., Binford 1973; Binford and Binford 1966, 1969; Freeman 1964), on the other hand, see the same variability as deriving from the different uses for which artifacts were intended. These different views of the interpretation of lithic variability, which have come to be called the "Mousterian debate," have yet to be adequately resolved.

While there are certainly a number of historical/theoretical reasons for these different interpretations (see Binford and Sabloff 1982, Gamble 1986:1–27), it is not the intent here to present yet another detailed methodological and theoretical critique of these positions. Rather, it is argued that the difficulties in convincingly relating lithic variability to past behavior may be due, in considerable part, to an underlying paradigm that structures not only the way in which both sides of this debate view lithics, but pervades most interpretations of chipped stone artifact assemblages. This paradigm is derived from implicit analogies with the industrial technology of our own society in which most tools essential for modifying the environment are made of metal. In the sections which follow, an attempt will be made to outline this paradigm and illustrate the ways in which it has been applied to the interpretation of lithic assemblages. Subsequently, an alternative paradigm for interpreting chipped stone is presented that is derived, in part, from recent studies of Middle Paleolithic assemblages.

The Industrial Paradigm

Production

Although metal technology is complex, it can be broadly divided into several categories of production activities. The initial activity is the obtaining of raw material, metal ore. While this may have once been a more opportunistic process of collecting ore-bearing rocks from the surface, today it involves systematically locating ore deposits and mining them as a distinct and specialized set of activities. Ore is then processed to obtain metal through another set of distinct and specialized activities that may or may not be spatially associated with mining operations or each other. Such intermediate processes include milling and smelting, which generally produce large amounts of waste material (e.g., tailings and slag) relative to desired end products such as metal ingots, bars, or sheets. The transformation of metal into usable implements requires the creation of molds into which molten metal is poured. These molds, in turn, require that the finished form of the object be planned in advance. Finally, most metal objects used today require at least a minimal amount of processing in the form of finishing (e.g., polishing or removal of burrs) and some assembly (addition of a handle, for example).

Several features of this process are especially notable in their application, by analogy, to lithic technology. With respect to production technology in general, the production of metal implements involves a series of distinct activity sets that are often performed in separate spatial contexts. Additionally, the location of use of such artifacts is usually spatially distinct, and often distant, from the location(s) of production. Finally, this process involves the transformation of raw material into morphologically (and chemically) very different products through a series of distinct, intermediate stages, many of which are characterized by the production of a large amount of waste material relative to the desired end product.

In the transformation of metal into usable implements, the nature of the casting process as well as the amount of effort required for the production of metal implements encourages planning the form of the end product (i.e., "mental templates"). It also encourages a close, and often very specific, relationship between form and function. Within the limits proscribed by function, it also permits the incorporation of stylistic design elements that reflect "cultural traditions" or "ethnic identity." Because they only have to be executed once for each mold, these design elements can be quite complex with a relatively small amount of effort expended per piece over the life of the mold. Finally, casting both permits and encourages the mass production of populations of implements that exhibit minimal within-group variability and considerable between-group variability. The amount of between-group variability is primarily related to either the intended function(s) of the implements or the stylistic features.

Use

In addition to the production of metal implements, aspects of use are also worth considering in their application to lithic technology. In modern western, industrial societies, most metal implements undergo little if any morphology-altering maintenance during their use life. Significantly, the use life of metal objects is often quite long and may even exceed the lifespan of the original user. This lengthy use of life also affects production by encouraging detailed planning of artifact morphology to ensure its long-term functionality. Similarly, it encourages the incorporation into the artifact of more meaningful (and often more labor-intensive) stylistic elements (Bamforth 1986).

When these pieces eventually are worn or broken they are often discarded and replaced by new ones. One reason for this is that the form of the implement is so closely associated with its function that any alteration of its morphology would render it useless for its intended original purpose. Another factor relates to the economics of replacement. In modern society, much to the disdain of the "shade tree mechanic," replacement is often more economical than repair even for complex mechanical objects. Obviously there are exceptions to this tendency, one example being the general class of cutting tools, many of which are regularly resharpened. Implements may also be reused for purposes other than their originally intended function—reusing a broken automobile leaf spring for a chisel, for example. Most often, however, reuse of metal implements involves melting down scrap metal for recasting into new objects.

Behavioral Residues from Industrial Sites

Based on these general observations about industrial, metal technology, a set of relationships can be postulated between these processes and their potential material correlates. As exemplified below, these relationships are applicable to interpretations of variability among sites and of variability within and among assemblages of artifacts.

Sites

1. Sites having both a source of raw material (ore) and large amounts of initial production debris (such as tailings) often represent specialized resource extraction loci—mines.
2. Sites having no source of raw material but with production debris (tailings, slag, clinkers, shavings, etc.) represent specialized manufacturing loci such as mills, smelters, and foundries.
3. Sites with finished implements usually represent use sites (or discard areas associated with use sites). Production of such finished implements, even those discarded at mining and manufacturing sites, usually took place at localities other than the site of use and discard.

4. Sites with mixed characteristics indicate localities at which more than one of the above-described activity sets took place. Hence, a site with ore, tailings, and finished metal implements would be identified as a combined mine and use site. In reality, most sites will be of a "mixed" character, of course. However, the specialization associated with industrial metal technology ensures that it is usually possible to classify a site according to the primary activity that took place there.

Assemblages and Artifacts

1. In an assemblage of objects that include metal ore, tailings, smelted ingots, and finished metal artifacts, the pieces with the greatest degree of modification, from the raw ore, are usually the desired end products.
2. Waste from production is much greater in both mass and volume than finished end products.
3. Discrete artifact classes or types were produced, the members of which were intended to be identical or very similar by the makers because they were designed for the same tasks and/or to represent the same style.
4. Within-group variability is much less than between group variability.
5. Between-group variability is primarily a function of intended use (function) and/or culturally favored design (style). Thus, there is generally a close relationship between at least some aspects of form and function, and some aspects of form and style. Correct classification of such artifacts will provide information about the activities for which they were used and/or the ethnicity of the makers.
6. When broken or worn to the point of uselessness most metal artifacts are discarded or melted down to be recast into a different form. Hence, morphology tends to be relatively stable throughout the use life of such artifacts. At the end of its use life, the morphology of a discarded artifact tends to be either quite similar to its original form or lost altogether in recasting.

The Industrial Paradigm Applied to Lithic Assemblages

As a source for middle range theory that describes a variety of relationships between process and product, or behavior and material culture, the "industrial paradigm" can aid archaeologists in the interpretation of residues derived from metal technology. However, archaeologists often implicitly assume that very similar relationships also obtain between prehistoric behavior and archaeological residues consisting of chipped stone, rather than metal, artifacts.

Sites

For example, sites having both a source of lithic raw material and large amounts of production debris in the form of cores, flakes, and shatter are usually interpreted as specialized quarry and primary manufacturing sites (e.g., Binford and Binford 1966, Bordes and de Sonneville-Bordes 1970, Burton 1980, Gamble 1986:276–284, Howell et al. 1962, Isaac 1977:109, Marks and Freidel 1977). This is especially true if retouched tools are rare or absent at such sites. In these cases, partly finished artifacts are thought to have been taken elsewhere for finishing, and finished artifacts are taken elsewhere for use. The lack of retouched tools at such sites is felt to support the interpretation that they were specialized raw material extraction/manufacturing sites.

On the other hand, sites having no immediate source of raw material but with considerable amounts of debitage are interpreted as lithic manufacturing sites (Burton 1980, Fish 1979:85–135, Jelinek 1976). It is assumed that raw material extraction took place elsewhere. Again, if retouched pieces are rare or absent, it is further assumed that artifact finishing and use also took place elsewhere.

Finally, sites with retouched artifacts are interpreted as use sites (Binford and Binford 1966, Fish 1979:85–135, Jelinek 1976, Marks and Freidel 1977). If fine screening was employed during artifact recovery and small flakes were recovered, interpretations of site function may also include such activities as tool finishing and maintenance.

Sites with combinations of these characteristics are interpreted as sites where more than one of these activity groups took place (Bordes and de Sonneville-Bordes 1970, M. Collins 1975). For example, sites with debitage and retouched tools, but no apparent immediate source of lithic raw material, are interpreted as mixed manufacturing and use sites.

Assemblages and Artifacts

It is my contention that inferences about the significance of variability within and among lithic assemblages often seem drawn from the industrial paradigm. In most interpretations of chipped stone, those artifacts which exhibit the greatest degree of modification and tend to be numerically few in assemblages, the retouched pieces, are considered to be the most desired end products. Conversely those pieces which are more numerous and least modified, unretouched flakes for example, are often considered to be either production waste or blanks (analogous to metal ingots) with an unrealized potential to be transformed into useable tools (Binford and Binford 1966, D. Collins 1970, M. Collins 1975, Kleindienst 1962).

Particularly in typological studies of lithics, a fundamental assumption is that assemblages can be divided into distinct classes whose members show considerably less within-group variability than between group variability (e.g., Brézillon 1968, Bordes 1961, D. Collins 1970, Laville et al. 1980:32–41). These classes represent stages in the sequence of tool manufacture, tools designed for specific tasks or task sets, or functionally equivalent artifacts that exhibit different, culturally determined styles.

It is also widely implied in most interpretations of lithic variability that chipped stone tools are preconceived and are the end product of goal oriented production (or, more accurately for lithics, reduction) sequences that transform them from naturally occurring rocks to finished implements (e.g., Bradley 1975, M. Collins 1975, Isaac 1977:174, Kleindienst 1962). Hence, retouched pieces are considered the most informative of chipped stone artifacts because they exhibit intentional modification. Such modification is taken to indicate a maker's intent to create a tool whose form was shaped by the task for which it was intended and/or the maker's traditionally inspired concepts of how this particular tool should be made (see Jelinek 1976). The further implication is that variability is deviation from the desired form due to the differences in knapping skill, constraints of the raw material, and available or utilized technology.

Finally, built into most interpretations is the implicit assumption that the morphology of finished tools remained relatively static throughout their use lives. Hence, the discarded tools found at archaeological sites should reflect to a large degree the maker's intended form. This means that it should be possible to identify morphologically distinct tools or tool classes associated more or less exclusively with specific activities or activity sets. Morphological differences between such tool classes are then attributable either to their being associated with different activities or, if associated with the same activities, to being derived from different, culturally influenced concepts of the "proper" form for that tool.

This "industrial" view of lithic manufacture and use leads to several implications about the kinds of information that can be derived from lithic artifacts. Variability in unretouched debitage (including flakes, cores, and debris) primarily provides information about stages in the process of tool manufacture that took place at sites or about the different types of manufacturing processes utilized for tool manufacture. Variability in retouched tools, on the other hand, provides information about the nature and range of (primarily economic) activities that took place at sites or about social structure, ethnicity, or time (through diachronic stylistic changes in morphology).

An Alternative Paradigm

There may well be aspects of the industrial paradigm that are useful for interpreting lithic assemblages, especially when chipped stone artifacts are produced in the context of a specialized industry in a complex society (see Spence 1981, for example). However, a variety of evidence suggests that the wholesale application of this model to the production and use of chipped stone is both inappropriate and misleading. This is apparent in a number of recent studies of Middle Paleolithic assemblages which are based on an alternative paradigm that may be more useful for the interpretation of lithic variability. Several of these studies are briefly summarized below to exemplify this interpretive structure at different levels of analysis, including morphological variability in artifacts and edges, traditionally defined artifact classes or types, and the broader level of assemblages and industries.

Morphological Variability in Artifacts and Edges

In the first study, the retouched pieces from the sites of Cova del Salt and Cova del Pastor in eastern Spain, and Gorham's Cave and Devil's Tower in Gibraltar, were examined in detail from the point of view of their edges (Barton 1987, 1988, 1989). Features such as edge angle, edge length, edge shape, and invasiveness of retouch were measured in order to characterize quantitatively the edge morphology of these "tools."

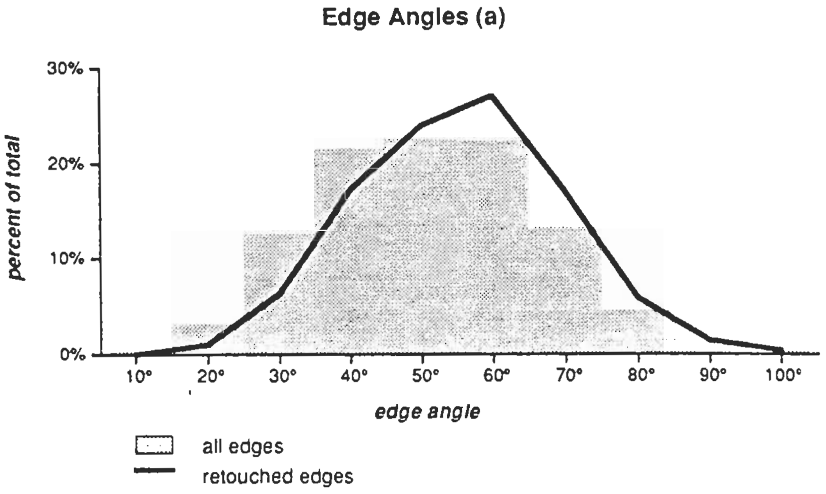
For almost all attributes studied, variability is continuous and often normally distributed. With one exception, the distribution of attribute variability is unimodal and, thus, does not support the existence of distinct artifact classes. As more than a single type of task was performed during the Middle Paleolithic, this indicates a lack of function-specific edge morphologies and suggests that many retouched edges were multi-functional rather than designed for specific tasks or task sets. Edge shape is the only attribute that shows an exception to this pattern, with a minor, secondary mode for those comparatively rare edges with distinctively concave shapes—primarily notches.

Not only do these attribute data fail to provide evidence for a variety of distinct "types" of retouched edges, they also suggest that retouched

edges may not be qualitatively different from unretouched edges. Edge angles, measured for both retouched and unretouched edges, are especially interesting in this respect (Figure 6.1). Figure 6.1a displays angles for all retouched edges and the combined group of retouched plus unretouched sharp edges. In Figure 6.1b, these edges are further broken down into unretouched sharp edges, marginally retouched edges (those with retouch extending less than 2 mm into the piece), and scraper edges (representing edges with more intensive retouch). While marginally retouched edges tend to have steeper edge angles than unretouched edges, and scraper edges have the steepest edge angles, there is considerable overlap in the distributions of these three edge groups (Figure 6.1b). Combined as a single group, however, (Figure 6.1a), they display a continuous normal distribution (mean = median = mode = 55°, σ = 14°). This situation suggests that the distinctions of unretouched, marginally retouched, and invasively retouched edges are simply arbitrary divisions of a single continuous distribution of edge morphology. It also implies that differences between debitage and retouched tools also may be more quantitative than qualitative—that is, retouched pieces do not represent a group of artifacts distinct from unretouched pieces.

If edge attribute data do not indicate the existence of a suite of morphologically distinct tools, then what accounts for variability in the amount and configuration of retouch on Middle Paleolithic chipped stone artifacts? A model to explain this variability is suggested by the pattern of relationships between edge attributes. Among edges with minimal retouch, edge angles can vary greatly. However, increasing amounts of retouch are associated with steeper minimum edge angles and a decreasing range of variability in angles. Edges with the most intensive retouch always have edge angles that are equivalent to the steepest angles on minimally retouched edges. Similarly, edges with minimal retouch occur on pieces with a wide range of relative widths (width/thickness), while intensively retouched edges occur only on relatively narrower, thicker pieces (Barton, 1988:66–71). In part, these patterns appear to represent mechanical relationships between attributes, based on the degree to which use, resharpening, and consequent edge reduction has taken place. As an edge is resharpened, the minimum edge angle that can be maintained becomes steeper and the flake it is on becomes relatively thicker and narrower (Figure 6.2).

However, these patterns also seem to be affected by discard behavior. With respect to edge angles, edge rejuvenation will only be taken to the point that the angle becomes too steep to be considered usable, at which time the edge will be abandoned. Subsequently, another edge may be used or the piece may be discarded. For pieces with initially



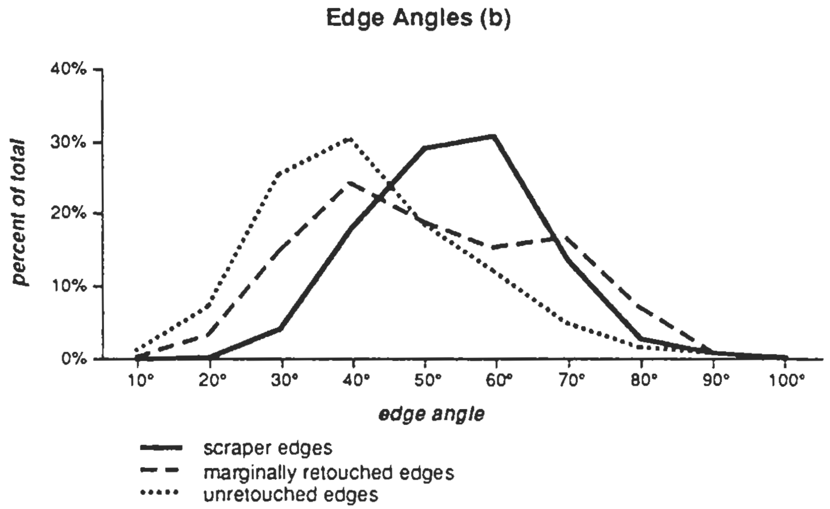


FIGURE 6.1. Edge angles of Middle Paleolithic artifacts from Cova del Salt, Cova del Pastor, Gorham's Cave, and Devil's Tower rockshelter. (a) Frequency distribution for all retouched edges, and combined group of retouched and unretouched sharp edges. (b) Frequency distribution for sidescraper edges, marginally retouched edges, and unretouched edges.

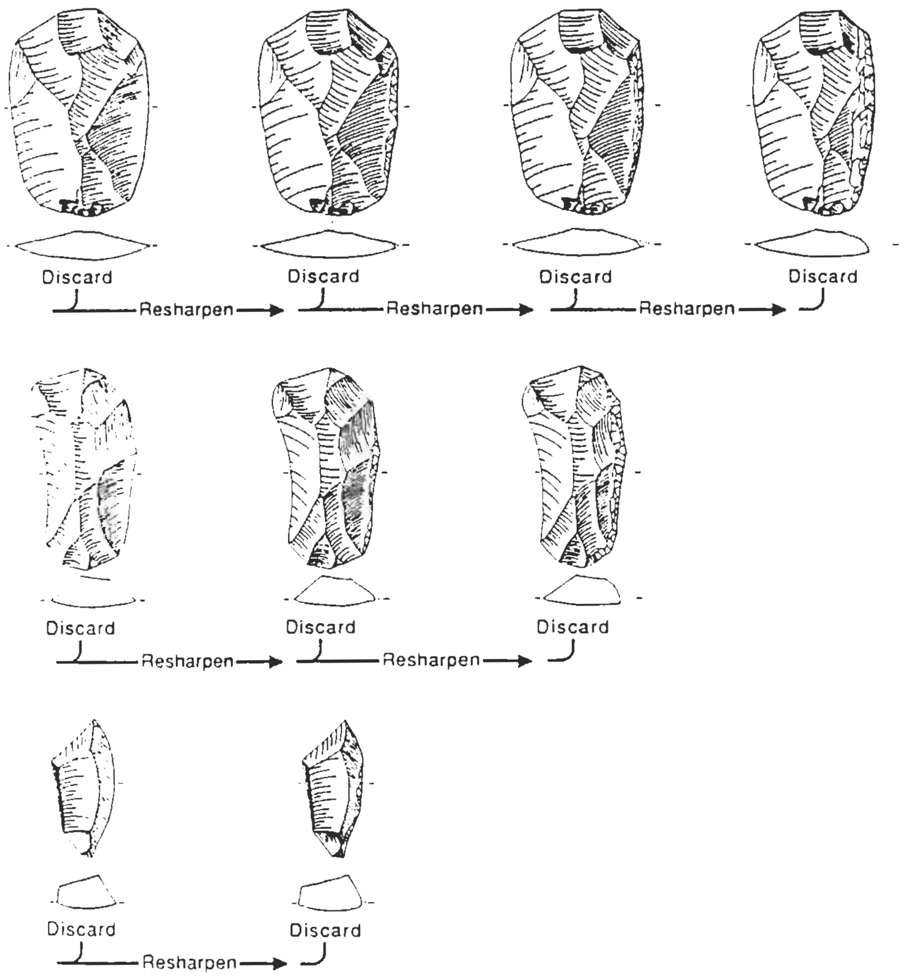


FIGURE 6.2. Schematic representation of relationships between artifact morphology, intensity of utilization, and edge resharpening. The top row represents relatively wide flakes with acute edges. These can undergo considerable edge rejuvenation, but may also be discarded prior to experiencing the maximum resharpening possible. The bottom row represents narrow, thick flakes with steep edges. With only minimal edge rejuvenation, such pieces become too narrow and their edges too steep to be used further. The center row represents flakes intermediate in width and edge angle. The maximum edge angle permitted is equivalent on all pieces.

steep edge angles, this point will be reached with only minimal resharpening, while pieces with initially acute edges can undergo considerable edge maintenance before reaching this point. However, these pieces with a potential for considerable resharpening also may be discarded before their edge angles reach such a discard-controlled limit. The more these edges are resharpened, of course, the closer they approach the maximum edge angle considered usable. This results in a wide range of variability for the angles of minimally retouched edges, an increasingly restricted range for more intensively retouched edges, and a maximum value for edge angles that remains constant regardless of the amount of retouch edges experience (Figure 6.2).

Likewise, pieces initially close to the minimum width or maximum thickness usable will be only, at most, minimally resharpened. While wider and thinner flakes have the potential for undergoing considerable edge rejuvenation, they too may be discarded prior to experiencing the maximum resharpening acceptable. The result, again, is a wide range of variability in relative width and thickness for minimally retouched edges, more restricted variability for heavily retouched edges, and a constant minimum value of width/thickness.

Finally, relationships between edge length and other attributes suggest a dichotomy in the way that edges were used. With one pattern of edge use, the more intensively an edge was used, the greater the linear extent of an edge that shows evidence of modification or resharpening. Edges characteristic of the class of artifacts termed scrapers would exemplify this pattern of edge use. Alternatively, on other edges, greater intensity of use is associated with an increasingly restricted area of retouch. Notches would typify this pattern of edge use. This dichotomy also appears to be reflected in the distribution of edge shape discussed above, in which notches formed a secondary mode of shape (Barton 1988:71).

In sum, then, attribute data indicate that variability among retouched edges is predominantly continuous; the data do not support the existence of a suite of distinct tools whose forms might be attributable to specific intended functions or styles. Edges can be divided into only two broad groups, one consisting of edges in which use and subsequent modification was linearly extensive and shape is generally convex, and the second consisting of edges in which the linear extent of use and modification was restricted and shape is often concave. Furthermore, retouched artifacts seem to form a continuum with unretouched artifacts. This suggests that the functional distinctions between unretouched "debitage" and retouched "tools" may be considerably less significant than is usually implied. Finally, the intensity with which edges were used and rejuvenated may be a more important determinant of variability in retouched edges than the tasks to which edges were put or culturally determined edge forms.

Typological Variability

Besides characterizing morphological variability in Middle Paleolithic retouched artifacts, the processes described above can be used to explain the differences among traditionally defined artifact types. The class of artifacts termed side scrapers make up a third of Bordes's 63 Middle Paleolithic tool types and comprise 20–80% of the retouched artifacts in most Middle Paleolithic assemblages. The 21 side scraper types can be grouped into those with only one retouched edge (simple scrapers and transverse), those with two non-adjacent retouched edges (double scrapers), and those with two retouched edges that converge to a point (convergent and déjeté scrapers).

From studies of assemblages from the sites of Tabūn (Israel), Bisitun and Warwasi (Iran), and La Quina (southwestern France), Dibble (1987a, b, 1988) has argued convincingly that morphological differences among simple, double, transverse, and convergent scrapers are attributable to the degree to which edge resharpening took place. The degree to which edge rejuvenation took place is controlled, in turn, by the original dimensions (especially width) of the flake used.

He found that double scrapers show evidence of more intensive retouch than simple scrapers, and that convergent and transverse scrapers display the most intensive retouch. Using platform width to estimate the original widths of unretouched flakes, Dibble compared widths of scrapers with the original widths of the flakes on which they are made. While the mean widths of simple, double, transverse, and convergent scrapers in each assemblage differed little, the original widths of the flakes on which they were made varied considerably. Convergent and transverse scrapers were made on the widest flakes, simple scrapers on the most narrow flakes, and double scrapers on flakes of intermediate width.

To explain these data, Dibble postulates two pathways for scrapers to follow during their use life. Both begin with a simple scraper on which retouch occurs along one edge. If the piece is wide enough, it can continue to be used with edge rejuvenation. Following one pathway, the single edge is continually resharpened and consequently reduced. For pieces with sufficient initial width, the resharpening will cause the edge to retreat to a point that the scraper becomes typologically a transverse scraper by the time it is discarded. Alternatively, instead of continuously resharpening only one edge, the opposite edge also may be used producing a double scraper. If the piece is wide enough to permit continued resharpening of both edges, they may eventually meet, forming a convergent scraper at the time of discard.

In other words, differences among these significant Mousterian tool types are attributable to the degree to which flakes were resharpened rather than to differences in tool design based on considerations of function or style. Moreover, variability in the frequency of scraper types and scrapers as a whole are responsible to a large extent for differences between the industrial variants of the Mousterian initially defined by Bordes (i.e., Quina and Ferrassie variants of the Charentian, Typical, Acheulean Tradition A and B, and Denticulate) (Dibble 1988, Rolland 1977, 1981). The "meaning" of these industries has been a primary focus of the previously mentioned "Mousterian debate." Dibble's work and the edge analysis discussed above permit new questions about Middle Paleolithic assemblages to be asked and may render the "Mousterian debate" considerably less relevant. To ask why "Quina Mousterians" were resharpening their flakes so much more than "Typical Mousterians" will hopefully prove more fruitful, as exemplified below, than to ask whether "Quina Mousterians" were doing different things than "Typical Mousterians" or were different groups of people.

Assemblage Variability

In a pioneering study, Rolland (1977, 1981) re-examined the nature of typologically defined Middle Paleolithic industries. In so doing, he looked at the distribution of broad artifact classes within assemblages (all scraper types combined, all notches, all denticulates, and debitage, for example) in relation to a variety of contextual information, especially paleoenvironmental. He identified two general types of assemblages: (1) those that have both a high percentage of scrapers among retouched pieces and a high percentage of retouched pieces in the entire assemblages and (2) those with a high relative frequency of denticulates and/or notches among retouched pieces but in which retouched artifacts make up a much lower fraction of the entire assemblage.

Rolland also found that scraper rich assemblages, and assemblages of many retouched pieces, tend to occur, both temporally and geographically, in association with more rigorous environments characterized by open vegetation and seasonal temperature extremes. Scraper-poor assemblages, on the other hand, tend to be associated with more mesic, wooded environments having less extreme seasonal temperature fluctuations. Rolland postulates that industries with high scraper frequencies were a result of the resharpening of flakes due to a need to

economize on lithic raw material. He further suggests that denticulates and notches may have been associated primarily with woodworking, while scrapers were simply reused flakes that served a variety of functions. He also argues that the association of industries with relative high frequencies of scrapers among retouched pieces, and retouched artifacts among all lithics with rigorous environments, reflects seasonal sedentism necessitated by climatic extremes. This would have had the effect of limiting movement and access to raw material sources. Such conditions would lead to a need to economize on raw material already available at a site by reusing pieces as often as possible. If notches and denticulates are associated with woodworking, they might be rarer in these environments with their open floral communities, lacking in trees. However, even if these latter artifacts were made in consistent quantities, the high absolute numbers of "scrapers" produced by the regular reuse of flakes would result in a low relative frequency of notches and denticulates among all "tools."

Conversely, Rolland suggests that the association of scraper-poor and notch/denticulate-rich assemblages with mesic environments results from more mobile settlement patterns that permit regular replenishment of raw materials. Given such conditions, there is less need to economize on raw material through reuse of flakes. Hence, "scraper" relative frequencies would be lower and notch/denticulate frequencies concomitantly higher among retouched artifacts. Furthermore, there would be fewer retouched pieces in assemblages. Finally, if notches and denticulates are associated with woodworking, the forested communities of these environments would permit more opportunity for manipulation of this medium and, hence, higher frequencies of these artifacts.

An Iberian Case Study Compared

An analogous study of Iberian peninsula sites reveals a slightly different pattern (Barton 1988, 1990). Here, assemblages from upland sites tend to have higher frequencies of scrapers among retouched pieces, but lower frequencies of retouched pieces relative to unretouched pieces compared with assemblages from lowland sites. Also, the density of artifacts per cubic meter of sediment is much higher in upland site deposits, even when differences in sedimentation rates are taken into consideration. While assemblages from lower elevation sites are considerably more variable than those of upland sites, there is still a general trend toward lower scraper frequencies and higher frequencies of pieces with restricted edge use and distinctive edge shapes (e.g., notches, burins, and piercers) among retouched pieces, higher frequencies of retouched pieces overall, more intensive retouch on those pieces that are modified, and lower artifact densities in site deposits.

As with Rolland's study, these data seem to represent differences in Middle Paleolithic settlement strategies. In a settlement model that accounts for observed variability in the lithic assemblages, upland sites represent short term occupations by relatively mobile groups. Lithic raw material could be regularly replenished, reducing the need to economize on this resource. This tendency toward the production of new flakes rather than resharpening of used ones, along with repeated visits to the sites, would encourage the deposition of denser quantities of lithic debris, relatively little of it modified. Finally, mobility associated with short, relatively unspecialized occupations, typical of a "forager" strategy (Binford 1980), might encourage the use of fewer multipurpose edges (e.g., "scrapers" and marginally retouched flakes) rather than a larger number of more specialized edges.

Lowland sites, on the other hand, represent less frequent but longer occupations in this model. Lithic raw material would be replenished less often, encouraging conservation through edge maintenance or resharpening, and would produce lower overall lithic densities in site deposits but more evidence for intensive use of the pieces that are present. The need to use sub-optimum pieces (e.g., broken flakes and shatter) in order to conserve lithic resources might also be expected to produce a wider diversity of edge configurations. Finally, these sites may represent more of a "collector" strategy (Binford 1980). If so, the greater variability in edge morphology, apparent in assemblages from these sites, may be indicative of the more specialized and more widely varied activities that took place.

The upland and lowland sites may only represent different, possibly seasonal, aspects of a single type of settlement pattern rather than two different strategies. It is interesting to note, however, that the assemblages at the lowland sites become more similar to those at the upland sites through time, exhibiting trends toward lower amounts of retouch in assemblages, higher lithic densities, and less morphological variation with a focus on extensively retouched edges. These temporal trends in lowland site assemblages occur during the transition from an interglacial to a glacial regime, associated with changes in temperature and precipitation and a concomitant altitudinal descent in life zones. During this transition, the environments of lowland sites became more like the interglacial environments of upland sites. The changes in lithic assemblages may be an indication of the way in which human groups adapted their settlement strategies to cope with the environmental changes that accompanied the approach of the full glacial.

Both studies focus on the interpretation of assemblage level variability in terms of such factors as mobility, intensity of occupation at sites, pressure on lithic resources, and overall settlement strategies. This exemplifies an alternative approach to that of the "industrial paradigm" which tends to emphasize the classification of sites on the basis of specific activities performed there or the ethnic affiliation of the inhabitants. This is not to say that information about settlement strategy is inherently more interesting than prehistoric activities and social organization. However, the database of chipped stone artifacts seems a better support for the preceding interpretations than those of the "Mousterian debate."

Discussion

Although the studies summarized above differ in their approaches to Middle Paleolithic chipped stone assemblages, they paint a consistent picture that is quite different from that derived from the previously described "industrial" paradigm. These studies bring out several characteristics of chipped stone artifacts of considerable significance to interpretations of lithic variability. Notable is the lack of more than a very few distinct artifact classes that can be associated with different functions or styles. Rather, morphological variability is generally continuous and reflects the amount of work performed by artifacts more than it reflects the type of work performed.

The use life of lithic artifacts is very short, compared with metal tools. This tends to discourage any significant investment of labor to execute or maintain a predetermined, standardized form. Also, many retouched pieces are multifunctional over the course of their use life, and both use and maintenance tend to alter their morphologies markedly (Bamforth 1986). The result is that lithic morphology is initially quite variable and subsequently dynamic during use. Hence, the form of a chipped stone artifact will often reflect only the last of a variety of uses. Jelinek (1976) has termed this latter characteristic the "Frison effect" after Frison's (1968) study of lithics from a North American Paleoindian kill site.

This means that, in many cases, the forms of chipped stone artifacts in archaeological assemblages are the cumulative result of a combination of many factors that affected their morphology during use life rather than intentional shaping to match a mental template. Such factors can include flake dimensions, extensiveness of margin use, intensity of edge use and associated edge maintenance, availability and character of raw material, and intensity of site occupation as well as the tasks for which artifacts were used and any culturally influenced choices affecting their production, use, and modification. Obviously, these factors are often closely interrelated. For these reasons, retouched lithic artifacts will tend to have complex life histories from which specific functions or stylistic elements may be difficult to extract. Differences in frequencies of retouched pieces may relate more to the intensity with which a site was occupied or re-occupied than to specific activities carried out there or the ethnicity of the inhabitants.

In Middle Paleolithic flake industries, the regular, extensive reuse of edges for a variety of tasks appears to lead eventually to pieces that are usually classed as scrapers. Alternatively, use may repeatedly focus on the same section of edges, often resulting in artifacts classified as notches. If denticulates are considered to be multiple notches (see Dibble 1988), these processes produce the majority of the retouched "tools" on Bordes's type list (types 4, 6–29, 42–43, 51–52, and 54) and the majority of retouched artifacts in Middle Paleolithic assemblages. In other words, flakes that are repeatedly used will tend to produce typical Middle Paleolithic tools.

These same processes operating on different "blank" forms (such as blades and bifaces) also might be expected to produce characteristic "tool types," but not necessarily side scrapers and notches. This would mean that "blank" production technology alone could be responsible for an important part of what appear to be significant morphological differences between the artifact types of different industries. In this respect, it would be interesting to examine the extent to which differences in core reduction technology affects the apparent differences between Middle and Upper Paleolithic assemblages. The primary direction in which long, narrow pieces like blades can be resharpened (thereby producing "retouched tools") is longitudinal, from the distal or proximal end. Such reduction would produce end scrapers, piercers, truncations, and burins. While the lateral margins of blades might be used, the narrowness of these pieces would preclude significant edge rejuvenation. Hence, laterally retouched pieces (except for pieces with edge backing for hafting), or side scrapers, should be relatively infrequent.

It may well be, then, that many chipped stone "tools" simply represent varying degrees of use of the initially produced "blanks," not the preconceived implements implied by the industrial paradigm. This is not to say that there was no planning or forethought involved in the manufacture of lithic artifacts. However, in many (perhaps most) cases, the "tools" that were planned and desired by prehistoric knappers may not have been the retouched pieces that archaeologists have generally considered the most important, but the unretouched debitage that is usually minimally analyzed at best, and has often been discarded.

If this is so, the great majority of lithic artifacts at sites are likely to be

desired end products, rather than production waste or unfinished tool blanks. Also, instead of being desired end products, many of those pieces with the greatest degree of modification may simply be the most worn-out pieces. This means that debitage, largely ignored in much previous work (especially studies with a primarily typological focus), is not only more numerous but may also be potentially more interpretable than the retouched tools, with their more confused life histories, on which reconstructions of activities and social organization usually have been based (see, e.g., Clark et al. 1986, Straus and Clark 1986c). This stands in contrast to the implications about the significance of debitage derived from the industrial paradigm. Furthermore, it calls into question site classifications based on this paradigm—in particular, distinctions between quarry sites, manufacturing sites, and use sites. Thus, while an abundance of raw material and "debitage" with rarity or lack of "tools" might signify a lithic procurement and primary manufacturing site, it might equally indicate simply that a local abundance of raw material permitted the continuous creation of fresh flakes to replace those dulled by use rather than encouraging the rejuvenation of edges through retouching (e.g., Barton 1988:102–103).

Finally, virtually all lithics found at archaeological sites are discards. Some pieces were discarded after minimal use, while others experienced considerable reworking prior to discard. The recognition of factors influencing the point at which used lithic artifacts are discarded should be an integral part of interpreting variability in lithic assemblages.

Although these processes have been discussed primarily in the context of Middle Paleolithic assemblages, they may have wider applicability to other prehistoric societies in which chipped stone artifacts constitute a significant part of the technological system (see, e.g., Clark et al. 1986, Straus and Clark 1986a–c, Clark 1989c, Hayden 1987). This application may not simply be limited to flake industries like those of the Middle Paleolithic. For example, the various bifacial implements from Upper Paleolithic and later industries, in both the Old and New Worlds, appear to represent exceptions to the processes described above. They seem to be objects with planned, carefully executed morphologies, primarily determined by functional and/or stylistic constraints. However, several studies indicate that variability among even these artifacts may be more strongly affected by factors such as intensity of use and maintenance than would initially seem to be the case (Goodyear 1982, Hoffman 1985, Flenniken and Raymond 1986, Flenniken and Wilke 1989). This is not to say that the Middle Paleolithic should serve as a model for the interpretation of all lithic assemblages. Still, the paradigm presented above seems a more useful starting place for understanding the meaning of lithic variability in prehistoric societies than a paradigm based on western industrial technology.

Conclusions

An attempt has been made here to outline a usually implicit paradigm commonly applied to the interpretation of lithic residues of prehistoric behavior. Subsequently, an alternative paradigm was presented based on several recent studies of Middle Paleolithic assemblages. It is felt that this alternative more realistically models behaviors associated with the manufacture, use, and discard of chipped stone artifacts than the interpretive approach here termed the "industrial paradigm." The title of this paper reflects the fundamental differences between these approaches to chipped stone artifacts.

While retouched lithic artifacts most certainly exist, these models lead to very different views of their significance. Based on the "industrial paradigm," these artifacts would be viewed as distinct tools, analogous to those in a modern toolbox, whose forms were planned to correspond with their intended uses and with stylistic considerations determined by cultural tradition.

Within the alternative paradigm presented above, however, these artifacts would represent a group of multipurpose implements, generally homogeneous both functionally and stylistically, whose morphological variability reflects to a large degree the intensity with which they were used. If they have analogies in modern society, it is perhaps more with an assemblage of Marshalltown trowels in the equipment closet of a long-running archaeological field school than those artifacts we normally consider tools. Recent purchases would have large blades with dull, convex edges. Among those that have been used, variability in blade morphology might include size (ranging from original size to very short or narrow), edge sharpness, and the shape of lateral edges (which could be convex, straight, or even concave) and tips (which might vary from round to pointed). Trowels are used for a wide variety of activities by archaeologists. Also, students attending the field school over the years might come from a variety of cultural backgrounds. However, most observed variability in these artifacts is better attributed to such factors as the texture of the deposits in which they were used, the frequency with which rocks were encountered, the diligence with which the blades were resharpened, and the frequency with which the field school could afford to replace worn trowels with new ones than to the specific uses to which they were put or the ethnic affiliations of the students.

Not even the archaeologist's trowel is a truly accurate analogy for

chipped stone artifacts, however. In fact, it is difficult to identify any implements in modern western, industrial society that would serve as useful analogies for these most common items of material culture for prehistoric hunter-gatherers. Yet this does not mean that lithics must defy interpretation. In fact, although many forms of behaviors and social organization common to Pleistocene populations may have no modern analogs, even among remnant hunter-gatherer populations, one of the challenges of paleolithic archaeology is the reconstruction and explanation of such lifeways. The interpretive model presented here is an attempt to account for a set of such behaviors, once an integral part of daily life and now virtually extinct. Because lithics are the common artifactual evidence for the activities of Pleistocene hominids, developing better paradigms for interpreting these implements is essential to understanding this enormous part of the human past. It is hoped that the work presented here is a step in this direction.

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