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## Beyond Style and Function: A View from the Middle Paleolithic

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*Chipped stone artifacts are a significant, and often the only available, record of prehistoric hunter-gatherers. The assemblages from four Middle Paleolithic sites in the Iberian peninsula form the basis of a study that addresses the behavioral significance of the variability in these objects. Artifact edges form the primary focus of this analysis, and permit morphology to be quantitatively characterized. Variability is generally continuous for the morphological features examined. Additionally, both edge and tool morphology seem primarily a function of the intensity of edge use and rejuvenation, and whether edge use was linearly extensive or concentrated in small areas. This suggests that retouched artifacts are more the result of the extent and nature of the use of their various edges than preconceived tools. The implications of these results for the study of the Middle Paleolithic and for the interpretation of lithic variability in general are discussed.*

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**B**ECAUSE OF THEIR DURABILITY AND ECONOMIC IMPORTANCE, chipped stone artifacts are perhaps the most significant record of prehistoric hunter-gatherers. However, in spite of considerable study—including experimentation, ethnoarcheological investigations, the development of many classification systems, and innumerable descriptive reports—many questions about the behavioral significance of lithic variability have yet to be adequately answered. This is especially true for the early Upper Pleistocene assemblages of the Middle Paleolithic, where lithics are often the only certain, surviving record of human behavior. 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. Past interpretations have centered around a “culturalist” position, in which most significant variability is seen as a result of cultural tradition or style, and a “functionalist” position in which the same variability is considered to be a result of the uses for which artifacts were intended. These different views of the interpretation of lithic variability have come to be called the “Mousterian debate.”<sup>1</sup>

These positions have been repeatedly addressed in the literature (Binford 1973; Binford and Binford 1966, 1969; Bordes 1973, 1981; Bordes and de Sonneville-Bordes 1970; Butzer 1981; Freeman 1964; Mellars 1965, 1969, 1986; Laville, Rigaud, and Sackett 1980:208–215), and it is not the intent here to present yet another detailed methodological and theoretical critique. It is of value, however, to point out that both positions share several working assumptions (implicit and explicit) that are integral to their interpretations of the lithic data. The first of these is that the relevant unit of analysis for studying lithic variability is the whole piece. That is, lithics are treated as complete tools, much like modern screwdrivers or hammers, with differing characteristics such as one or two retouched edges. Variability in Middle Paleolithic assemblages is usually measured by noting the presence or absence of such tools in the context of classification systems such as the widely used typology developed by François Bordes and Maurice Bourgon (Bordes 1961).

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Another important assumption is that retouched pieces represent purposefully created tools with preconceived forms and, as such, are considered the most informative of chipped stone artifacts. The morphology of such tools was determined by the tasks for which they were intended and/or the maker's traditionally inspired concepts of "proper" tool form. From this viewpoint, variability is deviation from the desired form, due to the differences in knapping skill, constraints of the raw material, and available or utilized technology. Unretouched pieces, on the other hand, are considered to be waste by-products of tool manufacture or "blanks" with an unrealized potential for being transformed into tools.

Finally, implicit in these interpretations is the assumption that the morphology of finished tools remained relatively static throughout their use lives and that the tools found in sites, to a large degree, reflect the maker's intended form. Given this assumption, it should be possible to identify discrete tools or tool classes associated more or less exclusively with specific activities or activity sets. Morphological differences between tool classes are then attributable to either association with different activities or, if associated with the same activities, to derivation from different, culturally influenced, concepts of tool form.

### Methodology

In order to address problems in the interpretation of the behavioral significance of variability in chipped stone artifacts, and to reassess the assumptions that form the basis of these interpretations, a study was undertaken of Middle Paleolithic assemblages from four sites in the Iberian peninsula. A fundamental objective of this study was the quantitative analysis of variability in retouched tools, initiated at a more fundamental level of analysis than previously reported studies—that of artifact edges. These data are used to delineate patterns of morphological variability in edges. Explanations for these patterns are suggested through (1) identifying links between morphology and the processes of lithic production, use, and maintenance, and (2) examining relationships between any observed patterns and nonlithic factors such as spatial and temporal variability in the physical and biotic environment.

The primary data base for this study comprises 1,093 retouched tools from assemblages at four sites in the Iberian Peninsula (Figure 1). Cova del Salt and Cova del Pastor (Barton 1988:37–40; Villaverde 1984:280, 294) are located in the mountains of central eastern Spain, midway between Valencia and Alicante; Gorham's Cave (Waechter 1951, 1964) and Devil's Tower rock-shelter (Garrod et al. 1928) are in Gibraltar, at the southern tip of the peninsula. Additionally, data from the four primary sites of the study were compared with analogous published information from five other sites in eastern and southern Spain. These additional sites are Cova Negra, Cova Petxina, and Cueva del Cochino in central-eastern Spain, Cueva de la Zájara I on the southeastern coast, and Cueva de Carigüela in Sierra Harana of southern Spain (de Lumley 1969; Mueller-Wille 1983; Vega 1980; Villaverde 1984).

Data for this study consist primarily of a series of quantitative measurements of morphological attributes. The most important are those providing information about edge morphology. As edges most often represent the utilized portion of lithic artifacts, variability in edge attributes should reflect any specific associations between edge morphology and function. These attributes also provide a measure of the degree to which edges were used and modified. Finally, because the number, location, and nature of the retouched edges on lithic artifacts form the primary criteria differentiating tool classes in typologies such as that of Bordes, the edge attributes measured permit a quantitative examination of the bases of such systems.

Attributes recorded for both retouched and unretouched edges include the linear extent and position of edges along the piece margin; edge angle; and whether the edge terminated in a break. Additional measurements made only on retouched edges include the

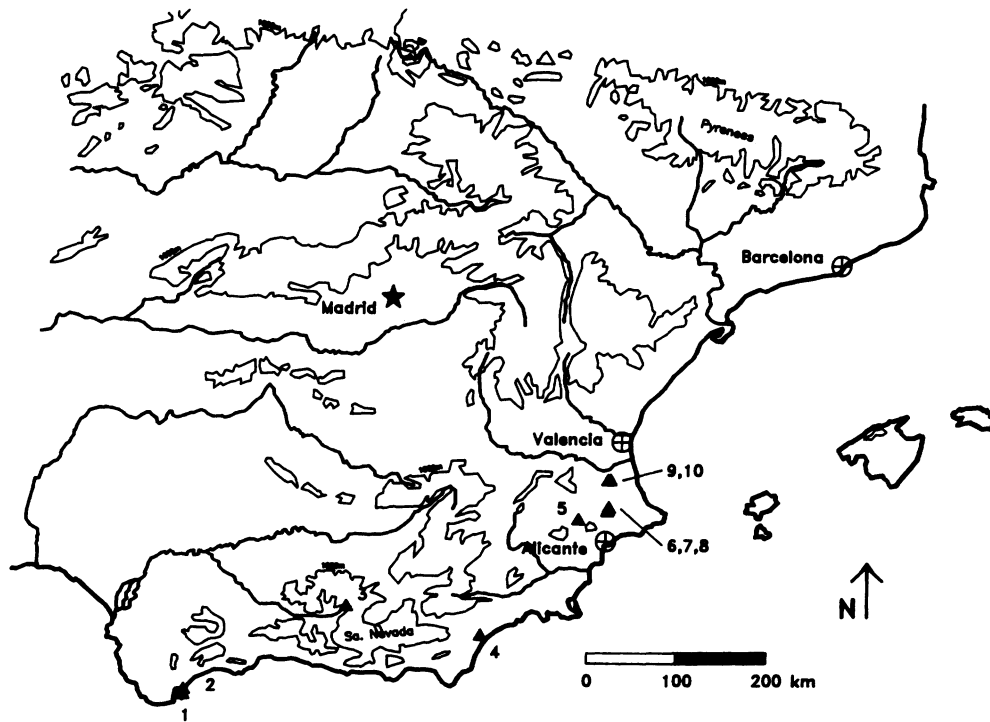


Figure 1

Locations of Iberian peninsula sites discussed in the text: (1) Gorham's Cave; (2) Devil's Tower; (3) Cueva de Carigüela; (4) Cueva de la Zájara I; (5) Cueva del Cochino; (6) Cova del Salt; (7) Cova del Pastor; (8) Cova Beneito; (9) Cova Negra; (10) Cova Petxina. (1,000-m contour outlined.)

invasiveness of modification, the shape of the edge outline (in radius of curvature), and the linear extent of step-flaking, if present. The number, location, and type of any sub-edges (e.g., a notch on a scraper edge) were also noted, as was the category of retouch (parallel, scalar, etc.). A total of 3,028 edges were measured.

In order to assess variability associated with manufacture rather than use, attributes related primarily to processes of flake production were also recorded. These include dimensional measurements, raw material, platform morphology, and exterior surface features. (See Barton 1987:105–110; 1988:112–118 for a detailed description of measurement techniques.) Both individual edges and whole pieces (or “tools”) also were classified using Bordes's typology to provide a basis for integrating the results of the attribute analysis with data from sites where this type of analysis has not been done.

## Results

### *Variability in Artifacts<sup>2</sup>*

*Individual attributes.* One of the most notable features of artifact morphology is that variability is predominantly continuous, unimodal, and tends toward normality in distribution. With one exception, there are no distinct multiple modes, or peaks, in the distributions that would indicate the existence of distinct tool classes. Since more than a single type of task was performed during the Middle Paleolithic, this suggests that most retouched edges are multifunctional rather than designed for specific tasks or task sets.

Edge shape (Figure 2) is the only attribute that shows exception to this pattern of unimodality. Edge shape was measured as radius of curvature and converted to an index (Shape Index, or SI) such that straight edges have a value of zero on the horizontal axis, increasingly convex edges are indicated by higher positive values, and concave edges by negative values.<sup>3</sup> Variability in shape is continuous for the great majority of retouched edges. While these edges range in shape from convex to concave, most are slightly convex (mode = 1.119 for SI, equivalent to a radius of curvature of 38 mm)—the shape of the edges of most unretouched flakes. However, there is also a minor, secondary peak to the concave side of the distribution of shape, composed primarily of notches. This suggests that notches may represent an edge morphology distinct from other concave edges. The bivariate distributions of attributes discussed below seem to support this distinctiveness. Additionally, the shape of very rarely occurring burins and piercers could not be accurately represented as radii of curvature. These may also represent other distinct edge shapes.

Not only do the attribute data fail to provide evidence for more than two distinct "types" of retouched edges, they also suggest that retouched edges may not be qualitatively different from unretouched edges. Figure 3 displays the distribution of edge angles for unretouched edges, marginally retouched edges (those with retouch extending less than 2 mm into the piece), and scraper edges (representing edges with more intensive retouch), as well as the combined distribution of all retouched and unretouched edges. 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. Combined as a single group, however, they display a continuous, normal distribution (mean = median = mode = 55°,  $\sigma = 14^\circ$ ). This suggests that the distinctions of unretouched, marginally retouched, and invasively retouched are simply arbitrary divisions of a single continuous distribution of edge morphology rather than qualitatively different edge classes.

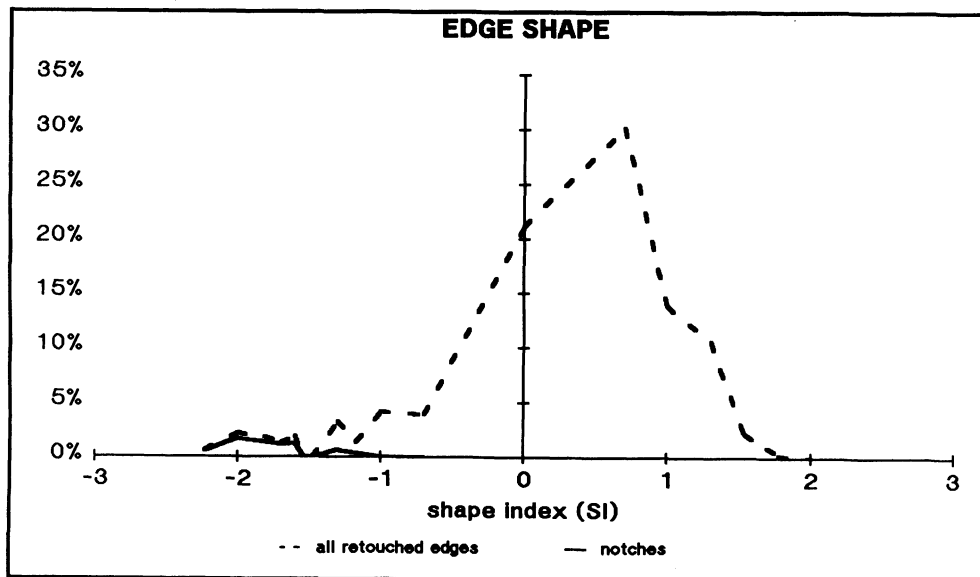
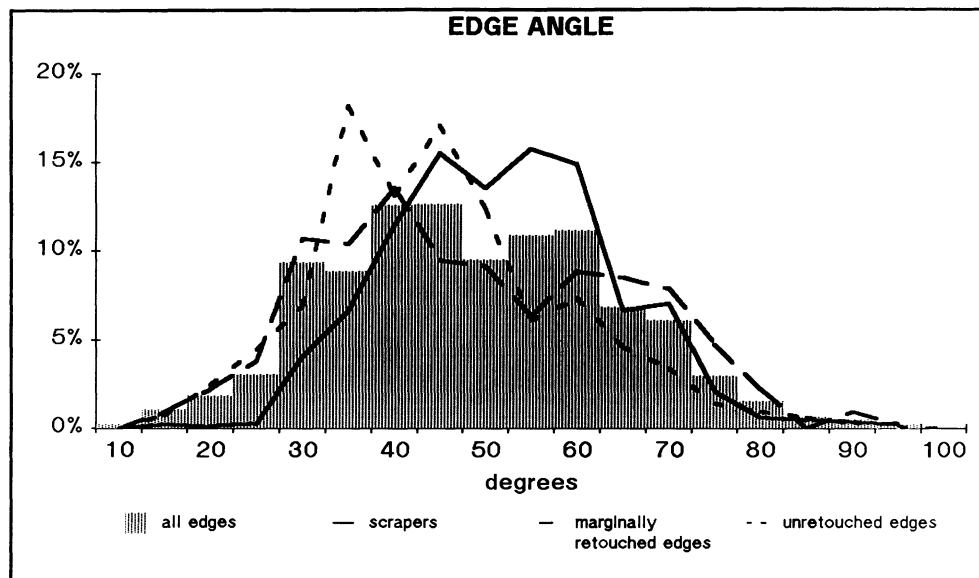


Figure 2

Frequency distribution of edge shape (Shape Index) for all retouched edges and notched edges. Convex edges have positive values for SI, concave edges have negative values, and straight edges have a value of zero.



**Figure 3**

**Frequency distribution of variability in edge angles for sidescraper edges, marginally retouched edges, unretouched edges, and combined group of all retouched and unretouched edges.**

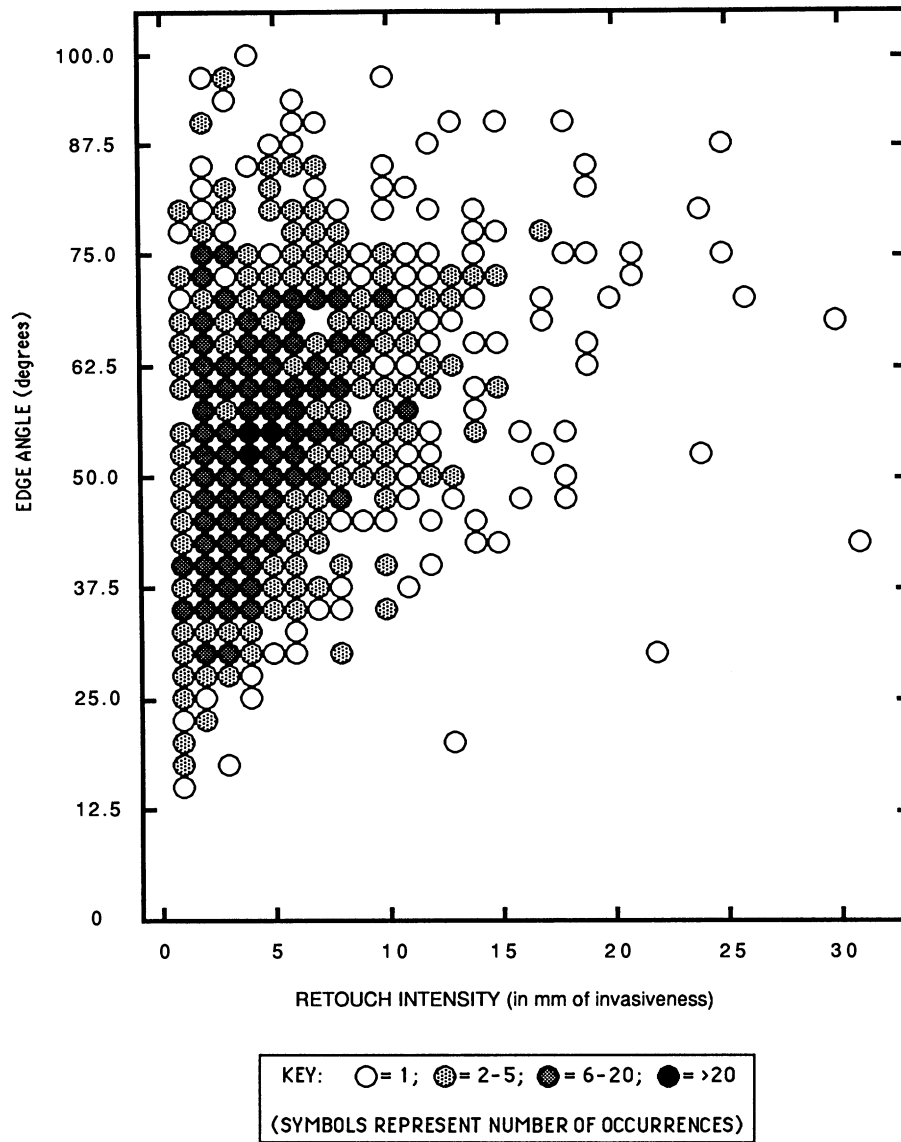
*Relationships between attributes.* Although distinctive edge configurations that might indicate numerous specific tool types are generally lacking for the Middle Paleolithic assemblages studied, there is considerable variability in edge morphology. An examination of bivariate relationships between edge attributes suggests models to explain this variability.

On the whole, relationships between edge attributes are nonlinear. However, the range of variability in some attributes seems to covary with the value of other attributes. For example, Figure 4 is a scatterplot of edge angle versus retouch intensity (represented by invasiveness) for all retouched edges. Among edges with minimal retouch (low values of invasiveness), edge angles can vary greatly. However, edges with intensive retouch tend to have only relatively steep edge angles.

A similar pattern is seen in Figure 5 for relative width and retouch intensity. Edges with minimal retouch occur on pieces with a wide range of relative widths, while intensively retouched edges occur only on relatively narrower, thicker pieces.

These patterns appear to represent, in part, 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. If this model is correct, there should be a generally negative relationship between relative width and edge angle. That is, steep edges should tend to occur on relatively narrow, thick pieces and acute edges on wider, thinner pieces. This is the case, as can be seen in Figure 6 ( $R = -.35$ ).

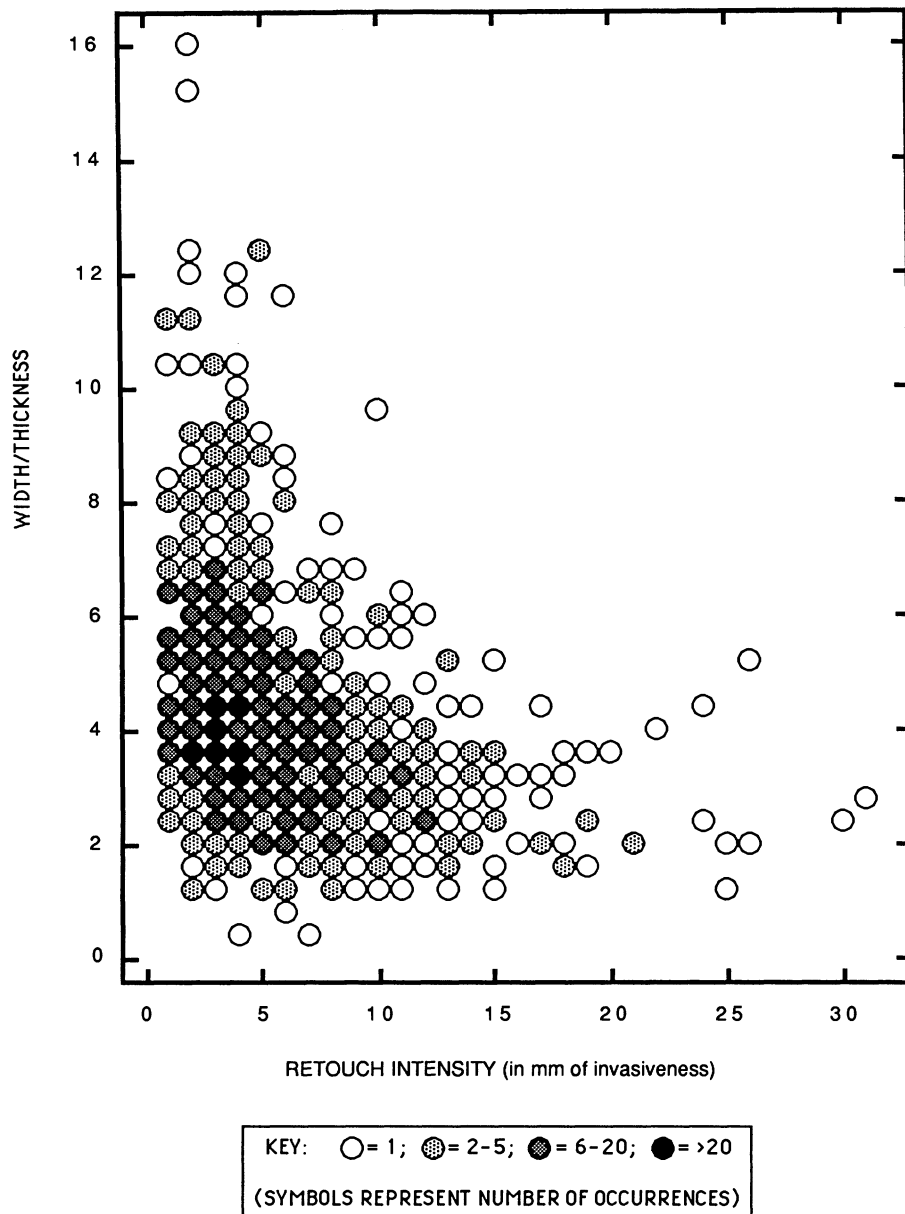
It is also apparent in Figures 4 and 5 that minimally retouched edges have wide ranges of values for both edge angle and relative width. Furthermore, the maximum angle of retouched edges in Figure 4 ( $88^{\circ}$ – $95^{\circ}$ ) and the minimum relative width for retouched pieces in Figure 5 (width/thickness = 1) are constant, regardless of retouch intensity. These patterns are likely a function of discard behavior. The maximum edge angle in



**Figure 4**  
**Scatterplot of edge angle versus retouch intensity (measured by invasiveness) for all retouched edges (1,324 cases plotted).**

Figure 4 probably represents the point at which edges become too steep to remain useful for most activities, no matter how much they are retouched. Likewise, minimum relative width in Figure 5 probably indicates the point at which pieces become so narrow and thick that they are discarded.

In other words, 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 steep edge angles, this point will be reached with only minimal reshaping, while pieces with initially acute edges can undergo considerable



**Figure 5**  
**Scatterplot of piece relative piece width (width/thickness) versus retouch intensity (measured by invasiveness) for all retouched edges (1,226 cases plotted).**

edge maintenance before reaching this point. However, these pieces with a potential for considerable resharpener also may be discarded before their edge angles reach such a discard-controlled limit. The more these edges are resharpener, 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 relatively constant regardless of the amount of retouch edges experience.

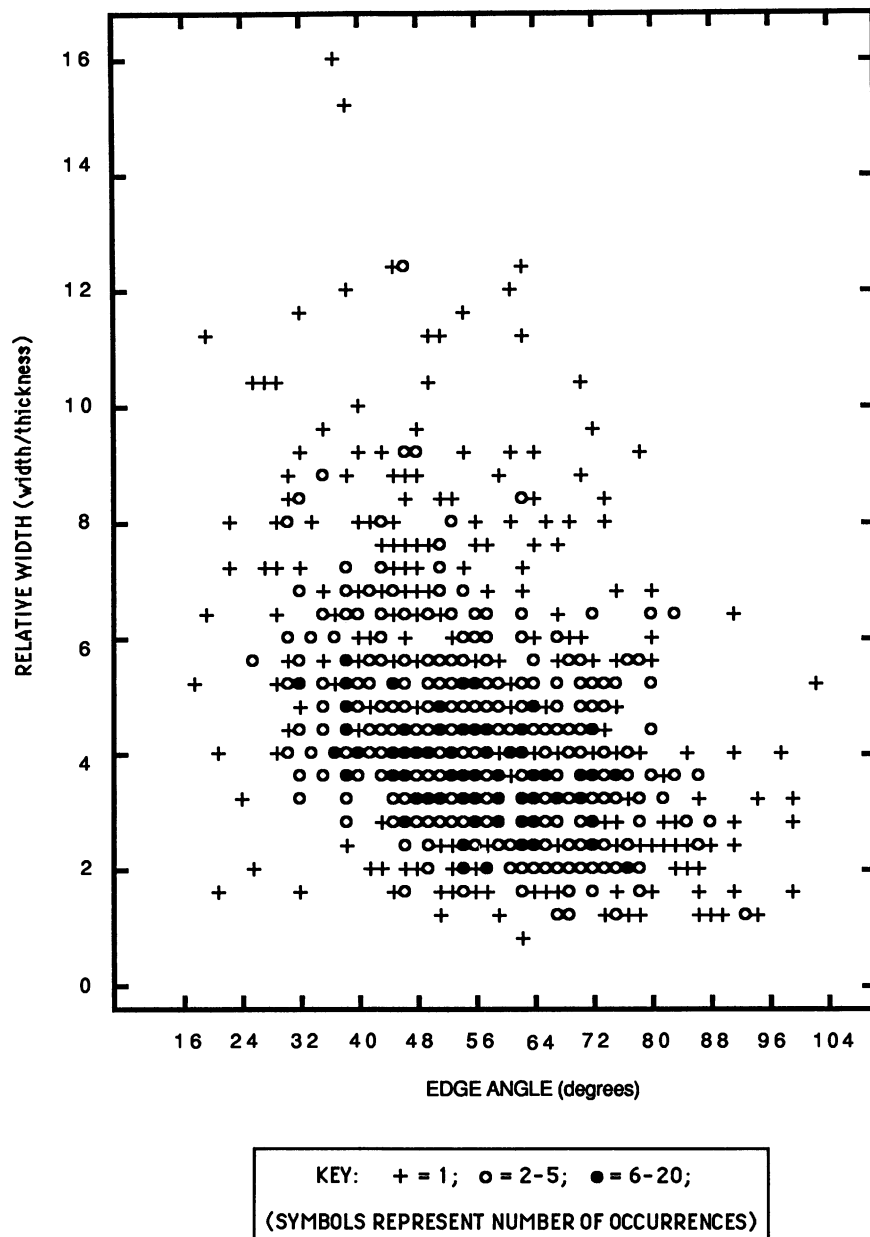


Figure 6

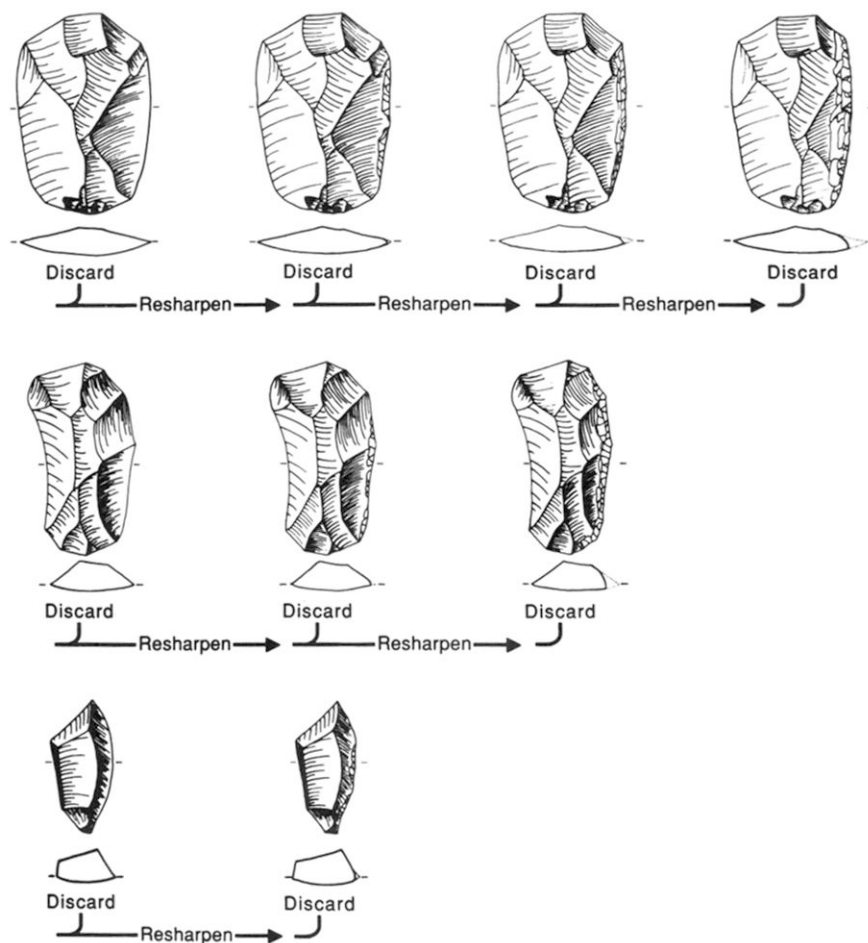
Scatterplot of relative piece width (width/thickness) versus edge angle for all retouched edges (1,264 cases plotted).

Likewise, pieces initially close to the minimum usable relative width will be only minimally resharpened at most. 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 for minimally retouched edges, more restricted variability for heavily retouched edges, and a constant minimum value of width/thickness. In this re-



spect, flake dimensions are both affected by and partly determine the intensity of edge use and subsequent rejuvenation. Other studies (e.g., Dibble 1987) have also suggested that flake width is an important determinant of the extent to which edges may be resharpened prior to discard.

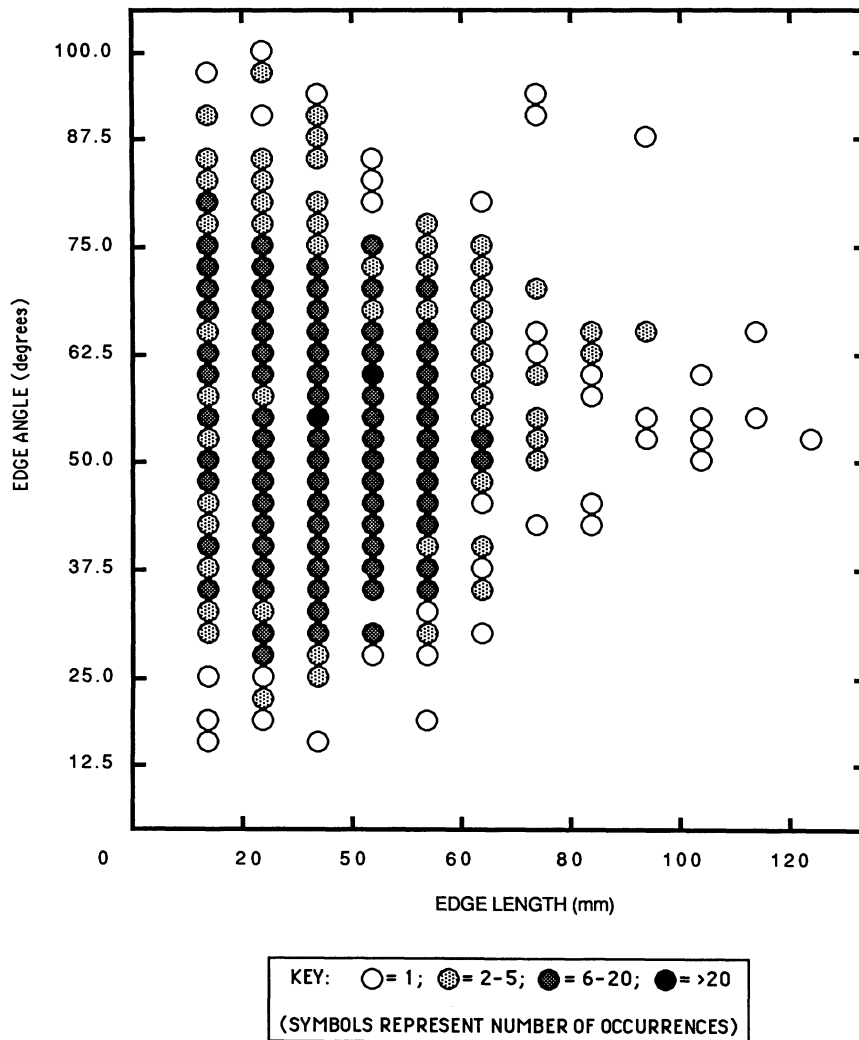
This model is schematically summarized in Figure 7. The top row represents wide flakes with acute edges, and the lower rows represent increasingly narrower pieces with steep edges. Note that all pieces are discarded when they reach an equivalent maximum edge angle. However, there is a greater potential for variability in the edge angle and relative width of discarded pieces that are initially wider and thinner than for thick, narrow flakes.



**Figure 7**

**Schematic representation of rejuvenation/discard model for idealized flake artifacts. 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.**

Another process affecting variability in edge morphology is indicated by the relationship between angle and the linear extent of retouch along piece margins (Figure 8). It is apparent from the scatterplot in Figure 8 that increasing length of retouch is associated with steeper minimum edge angles as well as a more restricted range of edge angles. Maximum edge angle also varies, however, declining from about 95° for the shortest retouched edges to about 65° for those with the longest extent of retouch. If the maximum edge angle reflects the point at which pieces are discarded because their edges are considered too steep to be desirable, these data suggest that edges on which use and rejuvenation are linearly extensive reach such a limit much sooner than edges on which retouch is concentrated in short segments. In this case, the longest edges are discarded when their edge angles reach about 65°, while the shortest edges may have edge angles up to 95° before they are discarded.



**Figure 8**  
Scatterplot of edge angle versus edge length for all complete retouched edges (1,133 cases plotted).

This appears to represent two different patterns of edge use. With one pattern, edge use and associated resharpening take place along some significant segment of a piece perimeter, the entire lateral margin of a flake for example. The more the edge is used and rejuvenated, the longer the zone of retouch becomes. As indicated above, rejuvenation is also accompanied by an increase in edge angle and a decrease in relative width. Eventually a point is reached where the piece is discarded. On those edges where considerable resharpening is possible, retouch can be relatively extensive. Pieces classified as side-scrapers are the most common examples of pieces that have experienced an extensive pattern of use and resharpening. Edges exhibiting this pattern of use are found on the majority of pieces in the assemblages studied. Considering the continuous, unimodal distribution of morphological variability in such pieces, discussed above, they are quite likely nonspecialized and, hence, multifunctional.

In addition to extensive edge use, Figure 8 also suggests an alternative pattern of concentrated edge use. It was noted that maximum edge angle increases with a decrease in the length of retouch. That is, steeper edge angles are permitted on increasingly shorter lengths of retouch. This suggests a pattern in which use and rejuvenation are concentrated in increasingly restricted areas of piece perimeters. Notches exemplify such edge use. With continued use, a notch will deepen and narrow, and any associated modification (including edge damage from intensive use as well as intentional resharpening) is thus concentrated in an increasingly restricted area of the margin. Apparently, the upper limit of edge angles considered usable is considerably higher for edges exhibiting a concentrated use pattern compared with those exhibiting an extensive pattern. Among the assemblages studied, edges with concentrated use are much rarer than those with extensive use and may be associated with a more limited suite of activities.

An analogous dichotomy in edge morphology has been noted by Rolland (1981), Dibble (1988), and Jelinek (1988), who see Mousterian lithics as primarily divisible into a scraper group and a denticulate/notch group. Extensive and concentrated edge use patterns are not limited to scrapers and notches, however. While many denticulates may represent the recurrent concentrated use of a single edge (Dibble 1988; Jelinek 1988), others may simply be heavily and coarsely resharpened, extensively used edges. Pieces classified as Mousterian points, limaces, and backed knives would also generally fall into the extensively retouched group. Those typed as endscrapers, piercers or borers, truncations, and marginally retouched pieces could be grouped into either category depending on the extent of retouch.

Furthermore, these two patterns of edge use are not mutually exclusive. As noted above, there is continuous variability in all relevant attributes (e.g., length of retouch, edge angle, invasiveness) and, as is apparent in Figure 8, these two patterns are not discontinuous. Significantly, a few edges showed evidence of both concentrated and extensive patterns of edge use. For example, 79 extensively retouched edges also included sections that would be classed as notches.

In summary, retouched "tools" seem more likely the end result of the extent and nature of the use of their various edges than planned tools for which the maker had some form of "mental template." In turn, the primary factors that contribute to variability in edges seem to be the dimensions of the original flake used, whether edge use was extensive or concentrated, and the intensity of edge use and subsequent rejuvenation.

#### *Assemblage and Regional Variability*

In addition to providing a model to account for aspects of morphological variability in Middle Paleolithic chipped stone artifacts, information derived from this study can also be applied to interpretation of variability among assemblages of these artifacts. An example of such an application is provided by an investigation of Middle Paleolithic settlement strategies in the southeastern Iberian peninsula.

Assemblages from the four primary sites of this study are associated with geographically and environmentally distinct settings. These assemblages also are distributed across

time in stratigraphically delimited sequences. While they probably represent accumulations of artifacts discarded over unknown time spans rather than residues of single occupations by coherent social groups, they still provide information about variation in artifacts and associated human behavior within the context of space, time, and environment (Barton 1988:17–55).

The integration of data from the primary sites with those from the five additional Spanish sites (Cueva Cochino, Cova Negra, Cova Petxina, Cueva de la Zájara I, and Cueva de Carigüela) permits the development of settlement strategy models for the Middle Paleolithic in this region. Although published data about the lithic assemblages from these latter sites are primarily in the form of relative frequencies of tool classes in Bordes's typology, they also include information more comparable with that of the edge study described above, including the frequencies of marginally, invasively, and steeply retouched edges. Also, variability in certain tool class frequencies reflects variability in edge morphology. For example, the frequency of sidescrapers among retouched pieces (indicated by scraper index, or IR, in most typological studies) closely mirrors the frequency of extensively retouched edges, while the frequency of notches, along with piercers and burins, reflects the frequency of edges with concentrated retouch and distinctive shapes (Barton 1988:84–88). In addition to typological data, the fraction of an assemblage exhibiting retouch also provides a measure of the overall intensity of use of lithic raw material (see Rolland 1977, 1981). Finally, the density of lithic artifacts per cubic meter of deposit, after differences in sedimentation rates are taken into consideration, provides information about the nature of lithic use and site occupation.

Environmentally, these nine Iberian sites fall into an upland group, at locations more than 600 m above sea level, and a lowland group, at locations less than 150 m above sea level. The upland sites include Cova del Salt, Cova del Pastor, Cueva Cochino, and Cueva de Carigüela. Gorham's Cave, Devil's Tower rock-shelter, Cova Negra, Cova Petxina, and Cueva de la Zájara I compose the lowland group.

In general, upland assemblages are more uniform, while those from lowland sites are more variable in character. Still, there are notable differences between the two groups of sites. Upland sites tend to have higher frequencies of scrapers among retouched pieces (mean IR = 70.9,  $n = 14$  assemblages), compared with assemblages from lowland sites (mean IR = 62.9,  $n = 21$ ). However, there are fewer retouched pieces relative to unretouched pieces ( $\bar{X} = 13.2\%$ ,  $n = 32$  for upland sites versus  $\bar{X} = 44.3\%$ ,  $n = 18$  for lowland sites), and retouch is less intensive on those pieces where it does occur.<sup>4</sup> Finally, overall lithic densities are high at upland sites ( $\bar{X} = 320.9$  pieces/ $m^3$ ,  $n = 7$ ) in comparison with those in the lowland group ( $\bar{X} = 24.2$  pieces/ $m^3$ ,  $n = 19$ ). At all sites, lithic raw materials are not reported to outcrop (with the exception of quartzite beach cobbles at Gorham's Cave) but still seem readily available.

These patterns may be indicative of Middle Paleolithic settlement strategies. In one possible model, upland sites represent short-term settlements within the context of considerable mobility. This would permit regular replenishment of lithic raw material, while limited occupations of the sites would not necessitate intensive use of this resource. Hence, there would be a tendency toward the production of new flakes rather than resharpening of used ones. This, 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. Lithic resources would be replenished less often, encouraging conservation through edge maintenance or resharpening. There would be a greater tendency to rework a used edge rather than strike a new flake. This would produce lower lithic densities in site deposits, but more evidence for intensive use of the pieces that are present. Additionally, the need to

use sub-optimum pieces (e.g., broken flakes and shatter) in order to conserve lithic resources could result in a wider diversity of edge configurations. In contrast with the upland localities, 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 also may be indicative of the wider variety of activities and more specialized activities that took place.

These upland and lowland sites may only represent different, possibly seasonal, aspects of a single type of settlement pattern rather than two different strategies. Interestingly, however, the assemblages at these lowland sites become more similar to those at the upland sites through time. This is reflected in trends toward lower amounts of retouch in assemblages, higher lithic densities, less diversity in edge morphology, and more extensively retouched edges. This may indicate the way in which Middle Paleolithic hominids adapted to environmental change. With the approach of the full glacial, lowland areas experienced changes in temperature and precipitation, and a concomitant decline in life zones, becoming environmentally more like upland regions of the early glacial (Barton 1988:48–52). The inhabitants of these areas may have altered their settlement strategies toward an upland pattern as a means of coping with these changes.

### Discussion

The results of this study complement those of Rolland’s (1977, 1981) study of large-scale distributional patterns for Middle Paleolithic assemblages and Dibble’s (1984, 1987, 1988) studies of traditional Mousterian tool classes. Although derived from different avenues of research, taken together, these investigations represent a growing consensus about the nature and significance of Middle Paleolithic assemblages (see also Jelinek 1988). This view differs considerably from the assumptions that are common to both sides of the “Mousterian debate” with respect to the significance of variability among Middle Paleolithic chipped stone artifacts.

First, variability in Middle Paleolithic retouched artifacts is primarily continuous. In most cases, traditional tool types, such as those defined by Bordes, represent arbitrary divisions of this continuous variability rather than morphologically distinct artifact groups that might be associated with specific tasks or styles. Similarly, retouched “tools” and “debitage” simply represent opposite ends of a continuum, associated with the intensity of edge use and subsequent rejuvenation.

For the assemblages studied here, as well as Middle Paleolithic assemblages elsewhere in Western Europe (Rolland 1981; Dibble 1988), it appears that most artifacts can be divided into two broad “tool” classes, those exhibiting an extensive use pattern and those with concentrated use. Differing amounts of edge use and rejuvenation within these classes account for most observed variability in these assemblages.

Additionally, lithic morphology is potentially very dynamic and, in many cases, is more the result of a combination of a variety of factors during the use life of artifacts than the product of a preconceived mental template. These factors can include flake dimensions, extensiveness of margin use, intensity of edge use and associated edge maintenance, availability of raw material, and intensity of site occupation. Obviously, such factors can be closely interrelated. Furthermore, lithic artifacts often may be multifunctional over the course of their use life, and morphology will only clearly reflect the last use made of the piece. Jelinek (1976) has termed this the “Frison effect.” For these reasons, there is often a lack of simple form/function or form/culture relationships for chipped stone artifacts.

This is not to imply a complete lack of planning for lithic artifacts on the part of Middle Paleolithic hominids. However, it would appear that this planning took place primarily at the level of the production or selection (Fish 1979:133–135; Rolland 1981) of unretouched flakes rather than in the subsequent modification of these flakes through retouch. Such behavior with respect to the production and use of chipped stone is not limited to

Neandertals, and may apply to lithic technology in general (see Gould, Koster, and Sontz 1971).

Finally, virtually all lithics found at sites entered the archeological context because they were no longer of value to the makers and users. Some pieces were discarded after minimal or no use, while others experienced considerable reworking prior to discard. Recognition and interpretation of such variability in discard behavior is a vital part of using lithic assemblages to provide information on past human activities and organization.

These characteristics of chipped stone artifacts mean that retouched tools in particular will tend to have complex life histories from which specific functions or stylistic elements may be difficult to extract. This has important implications for lithic studies in general.

In much previous work, especially studies with a primarily typological focus, those lithic artifacts with the most confused life histories (i.e., retouched pieces) have formed the basis of virtually all interpretations of past activities and social organization. Conversely, until recently, the great bulk of chipped stone assemblages, including those with the simplest—and, hence, the potentially most readily interpreted—life histories (i.e., debitage) have been largely ignored.

With respect to the interpretive value of lithics, questions of style and function may be moot for most retouched tools. Chipped stone in general, and especially retouched tools in particular, may be more useful in providing information about settlement systems and related behavioral patterns such as intensity of site occupation, degree of mobility, and intensity of raw material use than information about specific activities or social organization (see also Hayden 1987; Rolland 1977, 1981; Jelinek 1988). The specific activities that took place at sites, for example, may be better inferred through refitting (i.e., core reconstruction) and microwear studies of utilized, but unretouched “debitage” than from morphological studies of retouched “tools” (for example, see Cahen, Keeley, and Van Noten 1979).

These results may have wider applicability, beyond the Middle Paleolithic, to any prehistoric society for which chipped stone artifacts constitute a primary archeological data base. They also underscore the importance of incorporating information about the processes of production, use, and discard that shape final lithic morphology into interpretations of these ubiquitous indicators of the human past. By so doing, it is hoped that paleolithic archeology can progress beyond arguments of the stylistic or functional significance of arbitrary morphological types and begin to realize the goals to which studies of these artifacts are ultimately directed—the reconstruction and explanation of past human behavior.

### Notes

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<sup>1</sup>Often, a third position is also associated with this debate, one that ascribes variability to change through time (e.g., Mellars 1965, 1969, 1986). However, this constitutes more an observation about the temporal distribution of variability than an explanation for this distribution.

<sup>2</sup>All statistical analyses were performed with micro- (SPSS/PC) and mainframe (SPSSx) versions of the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL).

<sup>3</sup>The radii of curvature of edge outlines (positive for convex edges and negative for concave edges) were converted to Shape Index using the formula  $SI = \log_{10}(500/r)$  for  $r > 0$  and  $SI = -\log_{10}(500/r)$  for  $r < 0$ , where  $r = \pm$  radius of curvature. A numerator of 500 was used because  $r = \pm 500$  mm could not be distinguished from a straight edge. Also, because the area under a

curve varies geometrically with the radius of curvature (i.e.,  $r^2$ ), a log function of shape is more easily displayed and interpreted.

<sup>4</sup>This does not include Gorham's Cave, in which retouched pieces make up a mean of 1.0% over 12 assemblages. However, this low frequency appears to be a function of raw material availability (Barton 1988:102–103).

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