THE INTERPRETATION OF MIDDLE PALEOLITHIC SCRAPER MORPHOLOGY

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In Bordes's typology for the Lower and Middle Paleolithic, he defines four major classes of side scrapers: single, double, convergent, and transverse forms. Data from three Middle Paleolithic assemblages, one from Iran and two from France, suggest that these scraper classes may be interpreted as representing stages in reduction of flake blanks through continued reuse and remodification.

In his typology for the Lower and Middle Paleolithic, Bordes (1961a) recognized 63 discrete types of flake tools that commonly appear in assemblages throughout the Old World. Among these are several different types of *racloirs,* or side scrapers, each of which is defined according to the placement of retouch along the perimeter of the flake blank. In an earlier study of a collection of Middle Paleolithic material from Iran (Dibble 1984a), the question was raised whether these types represent discrete functional or stylistic types, as is commonly assumed, or whether they instead reflect stages along a continuum of edge reduction. This article presents new data from collections of Middle Paleolithic material from France that support the reduction model in principle yet suggest patterns that differ from those found for the Zagros region of the Near East. If correct, then the implications for the interpretation of typological variability among whole assemblages of the Middle Paleolithic and, indeed, any lithic assemblage, would be significant.

Three Middle Paleolithic sites are represented in this study. The first, Bisitun, is located in the Zagros region in northwestern Iran and was excavated by Coon in 1949 (Coon 1951, 1957; see also Dibble 1984b; Skinner 1965). All of the recognizable scrapers from the Mousterian levels (E+ through G) are included here. The second site is La Quina, located in the Charente region of France (Martin 1923; see also Bordes 1953, 1961b), which is the type-site of the Quina Mousterian variant. The present study is based on a portion of a collection housed at the Musée de l'Homme in Paris that was excavated in the earlier part of this century by Dr. Henri Martin. All of the complete (i.e., non-broken) scrapers from this collection were analyzed. The third site, Combe Grenal, is also located in France, but in the Department of the Dordogne (Bordes 1955, 1972). The data presented here represent all of the recognizable scrapers from thirteen of the Mousterian levels (levels 11–16, 20, 22, 27–28, 38, 41, and 50).

SCRAPER MORPHOLOGY RELATED TO REDUCTION

In Bordes's typology, four major classes of side scrapers can be recognized that differ in terms of the number of retouched edges and the location of those edges relative to the major axis of the flake blank: (1) simple single-edged scrapers that have one lateral retouched edge; (2) double scrapers, with two non-joining retouched edges; (3) convergent scrapers, which exhibit two edges that come together to form a point, usually at the distal end of the flake; and (4) transverse scrapers—those with a single retouched edge opposite the striking platform (see Bordes [1961a] for illustrations of these types). Within these major classes Bordes has defined separate types primarily on the basis of the shape of the retouched edge. Thus, there are three types of simple single-edged scrapers for

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straight, convex, and concave retouched edges (respectively assigned type numbers 9 through 11 in the typology), six types (numbered 12 through 17) of double scrapers to account for the six different possible combinations of edge shapes, four convergent types (18–21), and three transverse (22–24).

In the study of the Bisitun material (Dibble 1984a), it was suggested that the simple single-edged scrapers could be seen to reflect initial modifications of a flake blank to provide one working edge. As the tool is used, and as the need for edge rejuvenation arose, it sometimes becomes expedient to modify a second edge, thus yielding a double scraper. As both edges continue to be resharpened the lateral retouched margins of the tool could eventually meet, thereby resulting in a form classified as a convergent scraper. Many morphological features of the Bisitun scrapers, including aspects of their retouch and overall dimensions, were found to be consistent with this reduction model. Overall, it appeared that individual flake blanks were repeatedly retouched until a certain minimum width was obtained (presumably relating to either hafting or grasping requirements), at which point the piece was discarded.

All of the details of the analysis of the Bisitun material can be found in Dibble (1984a) and so will not be repeated here. At this point it is of considerable interest to determine whether similar reduction patterns are evidenced in the French Mousterian industries.

ANALYSIS OF THE FRENCH DATA

To address this question, I first present data on intensity of retouch among the various classes of scrapers from the three sites. As in the earlier analysis of Bisitun, retouch intensity is judged according to four ordered categories: (1) light and/or discontinuous retouch that exhibits no more than one row of retouch and where the retouch scars extend no more than 2–3 mm from the edge; (2) medium or "normal" retouch, either parallel or subparallel, with moderately invasive retouch scars; (3) heavy retouch, which is very steep and/or invasive; and (4) stepped retouch, which is heavy retouch with the presence of stepped fractures, similar to Quina retouch. Assuming that intensity of retouch reflects the amount of material removed through repeated retouching, either in the course of one knapping episode or over a series of cycles of use and resharpening, then this scale provides some indication of the degree to which reduction has taken place.

The graphs in Figure 1 present the cumulative percentages of the four intensity categories for each scraper class. At all three sites, simple single-edged scrapers exhibit the highest frequency of light retouch, double scrapers have more heavily retouched pieces, and convergent scrapers have the highest proportion of heavy and stepped retouch. Using Kruskal-Wallis tests, these relations are found to be significant at each site (Bisitun: $\chi^2 = 37.39$, $df = 2$, $p < .0001$; La Quina: $\chi^2 = 37.30$, $df = 3$, $p < .0001$; Combe Grenal: $\chi^2 = 163.93$, $df = 3$, $p < .0001$). Thus, the kind of relation between retouch intensity and these three classes of scrapers that was observed in the Bisitun material is also present in the data from La Quina and Combe Grenal.

However, there are typological differences between the Bisitun Mousterian on the one hand and the French industries presented here (see Dibble 1984b). At Bisitun single, double, and convergent scrapers are quite common, while transverse forms are virtually absent, whereas among Mousterian assemblages from France that are rich in scrapers, transverse types as well as convergent types often occur in relatively high frequencies. It is interesting that in Figure 1, the transverse scrapers from the French industries, which have only one retouched edge, exhibit retouch that is nearly as heavy as the convergent forms. In this respect they are unlike the other single-edged types (types 9–11). This suggests that transverse scrapers fall toward the end of a sequence of reduction. If true, then the reduction process that leads to these transverse scrapers is distinct from one that leads to the convergent types.

In fact, it appears that there are two reduction sequences that operate more or less simultaneously in the French material and that contribute to the typological differences apparent between them and the industry at Bisitun. The first of these reduction sequences, and the one similar to that identified in the Bisitun material, entails the retouching of additional edges. The typological result of this is the production of double scrapers that, if the resharpening and reduction process continues, eventually are transformed to convergent forms. The second process, not evident at Bisitun, involves the repeated retouching of a single edge. Although initially the retouch is usually located on the

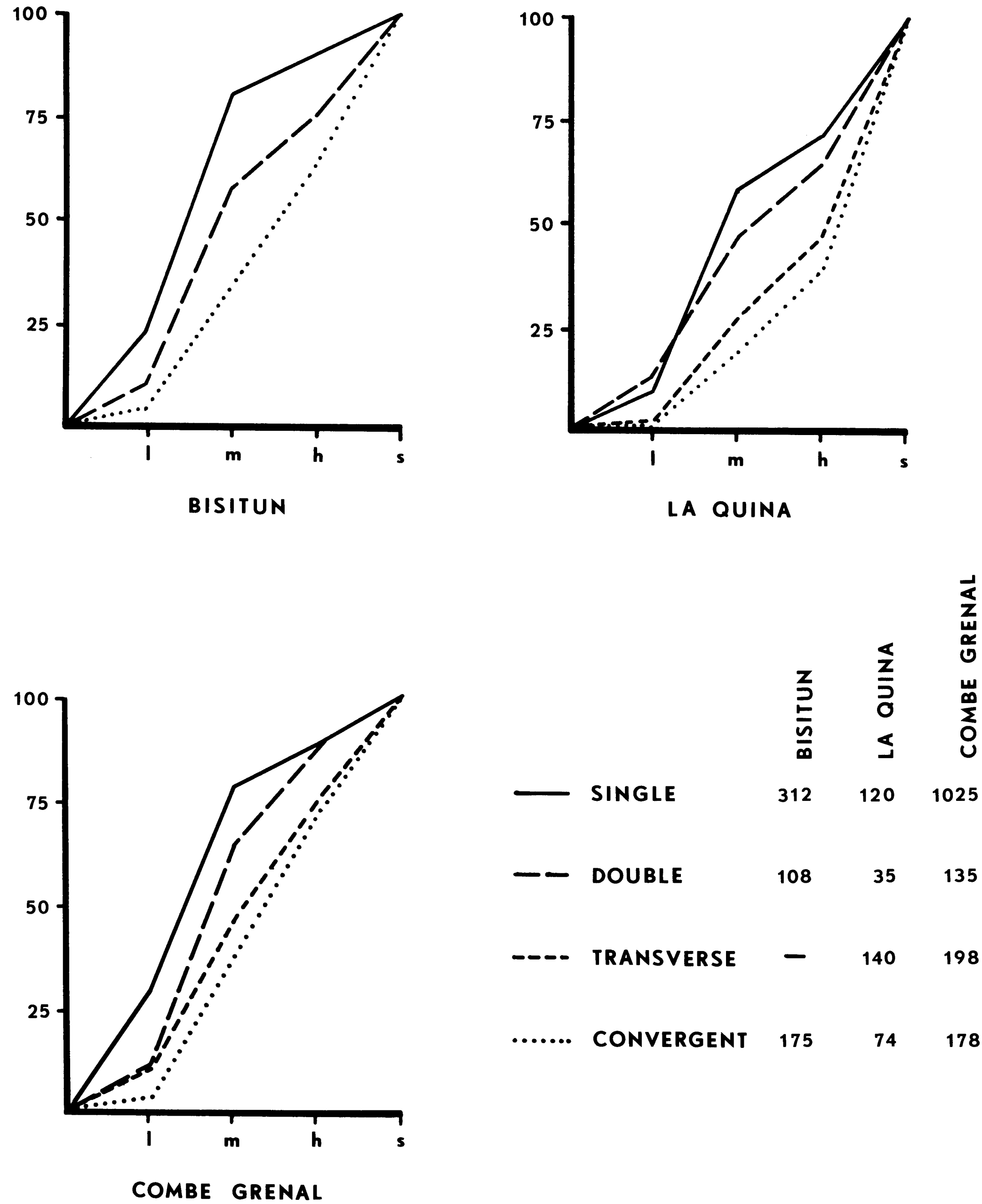

Figure 1. Cumulative graphs of retouch type (l = light, m = medium, h = heavy, s = stepped) for the three sites by scraper class, and frequency of each class represented by site.

lateral edge of the flake blank, as the edge retreats through repeated retouching the axis of the working edge eventually crosses the axis of flaking and yields a transverse scraper (see Figure 2). On occasion, these two alternatives for edge rejuvenation, that is, the repeated retouching of one edge or the retouching of additional edges, are combined on the same piece. Thus, it appears that the reduction sequences seen in France show an additional option to what is seen at Bisitun.

The processes of reduction described above and illustrated in Figure 2 predict the presence of

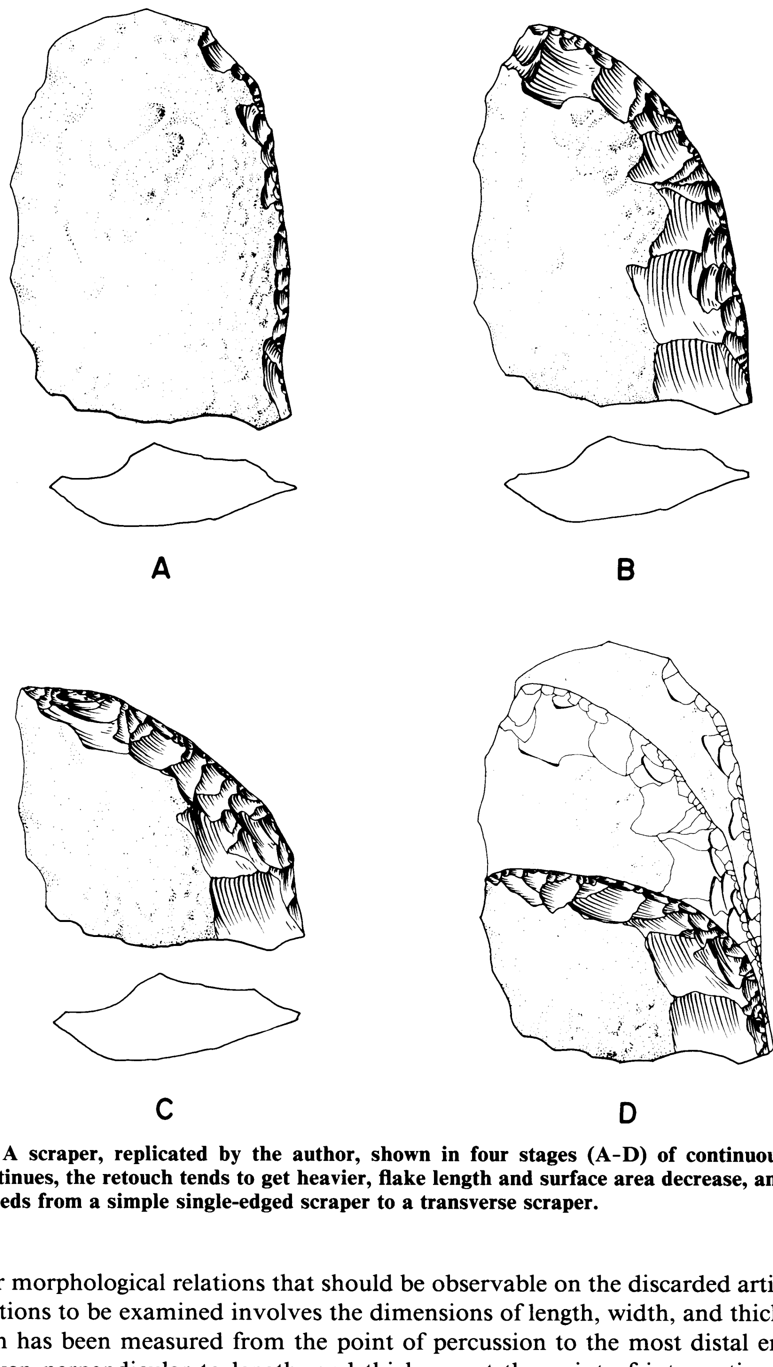

Figure 2. A scraper, replicated by the author, shown in four stages (A-D) of continuous reduction. As reduction continues, the retouch tends to get heavier, flake length and surface area decrease, and, typologically, the tool proceeds from a simple single-edged scraper to a transverse scraper.

certain other morphological relations that should be observable on the discarded artifacts. The first of these relations to be examined involves the dimensions of length, width, and thickness. For this study, length has been measured from the point of percussion to the most distal end of the tool. Width is taken perpendicular to length, and thickness at the point of intersection of length and width. All measurements were taken in millimeters. Only the collection from La Quina is represented in the following analyses.

In terms of their length (see Table 1), the tools from La Quina are consistent with a reduction model. Thus, simple single-edged scrapers and double scrapers, types that do not lose length during reduction, have virtually the same mean length ($t = .1871$, $df = 153$, $p = .8519$). Convergent forms

Table 1. Means and (Standard Deviations) of Basic Tool Dimensions by Scraper Class.

Scraper Class	N	Length	Width	Thickness	Surface Area	Platform Thickness	Platform Area	Flake Area/ Platform Area
Single	117	60.86	35.85	10.17	2,229.56	9.13	246.41	19.48
		(13.48)	(8.75)	(4.28)	(925.1)	(4.01)	(200.14)	(24.35)
Double	35	61.51	34.99	9.88	2,228.09	7.48	173.49	19.73
		(13.58)	(9.62)	(4.69)	(1,181.3)	(3.55)	(152.15)	(9.74)
Transverse	137	47.31	38.08	13.27	1,816.08	12.99	570.80	7.30
		(12.58)	(11.28)	(5.12)	(780.4)	(5.12)	(380.29)	(13.28)
Convergent	71	52.81	35.99	13.07	1,923.80	10.97	328.89	9.69
		(10.93)	(8.59)	(4.38)	(724.8)	(5.58)	(276.44)	(8.73)

are somewhat shorter, and transverse forms, as would be expected, are the shortest of all ($F = 29.92$, $df = 3/365$, $p < .001$). This reduction in length is paralleled by a reduction in average surface area (the product of length and width) of the tools ($F = 6.05$, $df = 3/364$, $p < .001$). However, no significant differences are found among the scraper classes in terms of width ($F = 1.67$, $df = 3/364$, $p = .1711$). Similar results were also obtained with the Bisitun scrapers. The lack of difference in width among the different types suggests that, for both industries, the attainment of a particular width determines the stage in the reduction sequence at which a tool is discarded.

While absolute dimensions are consistent with the reduction process, they do not directly test whether the transverse and convergent scrapers are the result of more retouching, or alternatively, that these types were originally made on smaller or differently shaped blanks. Already it has been shown that the transverse and convergent forms tend to have heavier retouch, which suggests that more material was removed in their manufacture. This would not necessarily be the case if, for example, convergent scrapers were always made on flakes that were originally triangular. However, to judge how much *reduction* has taken place it would be more satisfactory to consider the final size of the artifacts *relative* to the original size of the blanks.

It has been shown on the basis of controlled experiments (Dibble 1981, 1985a; Dibble and Whittaker 1981; Speth 1972, 1974, 1975, 1981), that original flake size is, to a large extent, a function of certain characteristics of striking platform, including platform width and thickness. As Figure 2 illustrates, the reduction of a tool affects the flake surface area to a much greater extent than it does platform area. Therefore, the most appropriate statistic to investigate reduction of the tool from its original blank size is the ratio of remaining surface area to platform area. On the average, blanks that are more reduced will have smaller ratios of flake area to platform area than will blanks that are less reduced from their original size.

Table 1 presents the mean ratios of flake surface area to platform surface area for each of the four major scraper classes. These ratios show a gradation in amount of size reduction from simple side scrapers that are reduced the least (i.e., their ratio of flake area to platform area is the highest) through double scrapers to convergent and transverse forms. Over the four scraper classes these differences are significant ($F = 14.46$, $df = 3/356$, $p < .001$). This relationship parallels the data on retouch intensity shown earlier.

Another reduction process to be investigated is the one illustrated in Figure 2, from a single, lateral-edge scraper to a transverse scraper. In Figure 2, it can be seen that as reduction continues, the angle of the retouched edge, or "axis of the tool" (Bordes 1961a:6–7), changes relative to the axis of flaking. This angle was measured on the La Quina material in intervals of ten degrees (see Figure 3). An angle of zero degrees indicates that the working edge or edges are parallel to the axis of the flake, while an angle of 90 degrees indicates a working edge that is perpendicular to the flake axis. In the course of analysis it was also noted whether the working edge was angled toward the right or left of the piece, as viewed from the interior side of the flake, proximal (platform) end toward the observer.

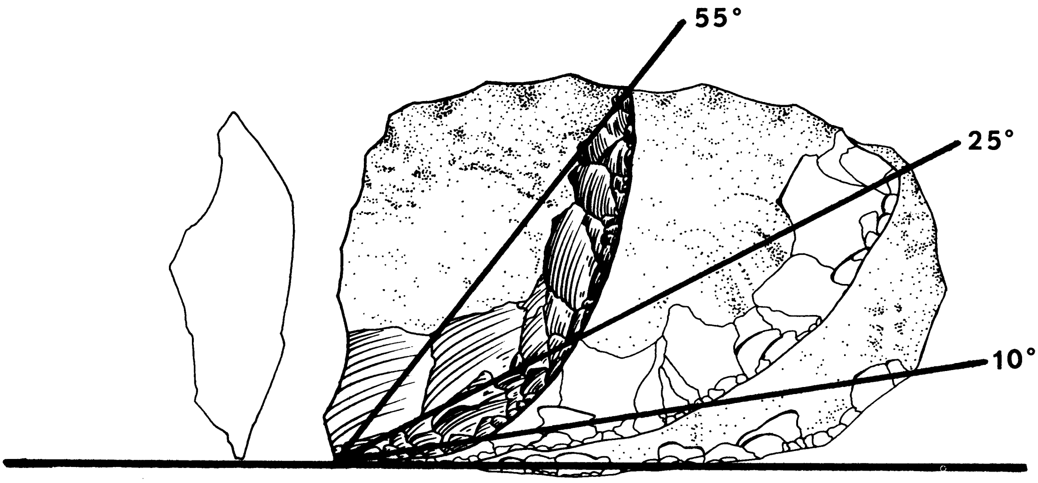

Figure 3. Measurement of angle of skew of the working edge, shown here against the replicated scraper presented in Figure 2. The axis of the working edge is defined as the chord that connects the limits of retouch.

If the reduction model is correct, then there should be a continuous relation between this angle of skew and the other variables that reflect reduction. Table 2 shows that such is the case. As this angle of skew increases, retouch becomes more intense (with Kruskal-Wallis, $\chi^2 = 32.38$, $df = 9$, $p = .0002$), and there is a continuous decrease in length ($F = 13.55$, $df = 9/359$, $p < .001$) and relative surface area ($F = 4.91$, $df = 9/350$, $p < .001$). Again, there are no significant differences in

Table 2. Means and (Standard Deviations) of Basic Tool Dimensions by Intervals of Skew of Working Edge.

Skew (Degrees)	N	Length	Width	Thickness	Surface Area	Platform Area	Flake Area/ Platform Area	Retouch Intensity
0	39	60.68 (16.15)	35.78 (8.07)	10.01 (4.16)	2,232.18 (1,019.73)	202.50 (164.97)	24.31 (26.18)	2.48 (1.04)
10	47	63.33 (11.94)	36.27 (9.45)	9.96 (4.16)	2,355.22 (1,000.34)	210.58 (205.56)	29.01 (45.70)	2.68 (1.04)
20	46	61.74 (13.80)	35.11 (7.80)	9.94 (4.52)	2,196.71 (836.27)	271.24 (256.93)	15.78 (18.18)	2.69 (1.02)
30	26	53.11 (9.50)	34.05 (7.37)	11.51 (3.74)	1,818.74 (537.36)	319.59 (340.92)	10.81 (10.94)	2.88 (.951)
40	35	56.34 (11.32)	37.67 (11.57)	13.19 (5.09)	2,203.06 (1,176.75)	370.14 (186.70)	8.65 (9.58)	3.14 (1.00)
50	43	51.15 (11.66)	36.31 (8.60)	12.73 (5.36)	1,893.65 (747.00)	391.69 (319.36)	11.72 (17.42)	3.06 (.961)
60	35	50.79 (8.80)	36.95 (9.99)	13.18 (4.00)	1,920.96 (804.74)	512.59 (329.86)	7.90 (12.05)	3.22 (.942)
70	32	46.72 (10.42)	37.11 (9.79)	13.97 (6.18)	1,729.38 (570.86)	522.75 (387.43)	6.12 (6.75)	3.31 (.895)
80	34	46.33 (14.37)	38.47 (11.94)	12.76 (4.85)	1,748.72 (672.34)	551.91 (435.59)	10.34 (18.76)	3.29 (.833)
90	23	40.03 (11.87)	40.11 (14.78)	13.70 (4.48)	1,634.08 (884.67)	636.53 (384.68)	4.81 (6.02)	3.43 (.843)

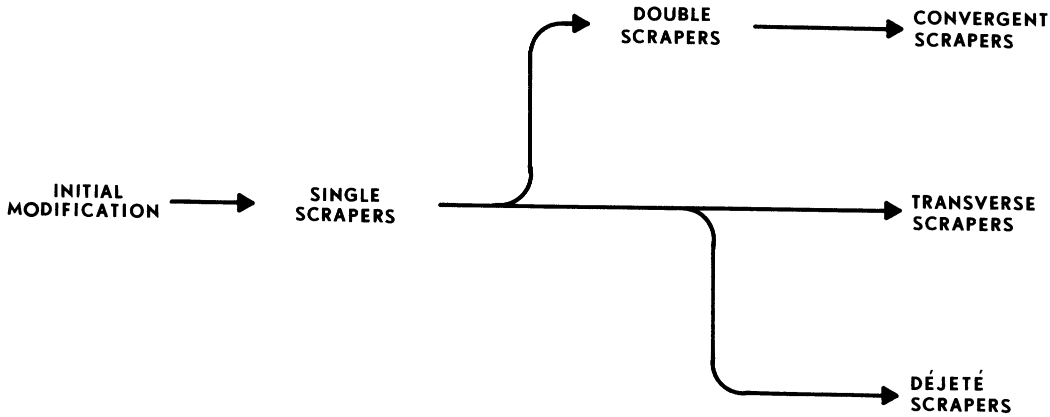

Figure 4. Flowchart suggesting typological consequences of reduction. Movement from left to right reflects increased reduction of the edge(s), while branching reflects retouching of additional edges.

width ($F = 0.93$, $df = 9/358$, $p > .49$). Moreover, there does not appear to be any bias toward a left versus a right-hand angle (ratio of left to right = .874, $Z = 1.15$, $N = 298$, $p > .25$) and the frequency distribution of the angles is not significantly different from a random, even distribution ($\chi^2 = 15.83$, $df = 9$, $p > .05$), both of which argue against the presence of predefined modes in this angle.

Thus, in many morphological aspects, the La Quina material shows a continuous gradation from lightly reduced to heavily reduced implements. This raises the question of why not all tools are representative of the final stage of reduction, i.e., why were some discarded at an earlier stage in reduction than others. As discussed earlier, it appears that the reduction process continued until a particular *minimum* width was attained. Thus, it would be expected that blanks that were originally larger would go through more reduction than blanks that were originally smaller. Examination of both flake thickness and platform area, two features that are not significantly affected by retouching, shows that the most heavily reduced pieces are found on blanks that are thicker and have larger platforms than those tools that are not so heavily reduced (see Tables 1 and 2). This shows that, on the average, it was the largest blanks that were retouched the most.

Thus, virtually every morphological aspect that was observed on the scrapers from each of these sites corresponds to what would be expected if the reduction sequence were operating. In addition, independent microwear analysis of Middle Paleolithic material from six sites in France has shown that there is no association between particular types of scrapers and particular functions (Beyries 1984:135–136). Although consistent with the reduction model, this conclusion is based on only the final use of those artifacts. More definite confirmation or rejection of this model can be obtained only be conjoining the small retouch flakes to the discarded scrapers in order to reconstruct the sequence of reduction for particular pieces. In addition, microwear analysis should be performed on the retouch flakes of each stage to determine whether the use of the tool changes during the sequence of reduction.

RELATION BETWEEN REDUCTION AND TYPOLOGY

Based on the above analysis, it is possible that several of the scraper types recognized in Bordes's typology reflect, to at least some degree, different stages of reduction. In order to clarify this, one can construct a flowchart that relates the reduction of a piece to the production of specific type classes. Figure 4 represents the use-life of a blank, from its initial modification on the left to its eventual discard toward the right. All scrapers begin with one modified edge. At any time other edges can be modified as well. Depending on the stage of reduction that a second edge is retouched, and depending on how much reduction takes place (itself a function of width), different types will be produced.

Initial retouch along one margin produces a simple single-edge side scraper, either a type 9, 10, or 11 depending on whether the edge is straight, convex, or concave, respectively. If this single edge continues to be retouched, the angle it forms with respect to the axis of flaking also continues to change. Eventually the angle of the working edge will be such that the tool typologically becomes a transverse scraper, again with three types (22–24) reflecting the shape of the edge.

From this simple process of continuous reduction, the model will branch with the modification of a second edge. If an additional edge is retouched early in the reduction process, it results in one of the six types of double scraper. If both of these edges continue to be reduced, the result is one of the three convergent types, types 18–20, or if convergences exist on both the proximal and distal end, then it is a *limace,* type 8. If an additional edge is retouched after the angle of the first working edge is greater than 45 degrees relative to the axis of flaking, the typological result is a *déjeté* scraper (type 21, or a skewed convergent scraper).

DISCUSSION

There are many important implications of this work for the analysis of prehistoric lithic remains. Since its development, Bordes's typology has provided an important means for describing and comparing Lower and Middle Paleolithic assemblages. However, the *interpretation* of typological variability among these industries has been a major focus for Old World prehistorians. In general, it could be stated that the interpretation of lithic variability is central to much of prehistoric research throughout the world. It is obvious that accurate interpretations of industrial typological variability depend on accurate interpretations of individual types.

If correct, the reduction models described above would help to clarify the meaning of the scraper types defined by Bordes in terms of specific aspects of prehistoric behavior, i.e., the resharpening and continued utilization of lithic artifacts during their life-cycles. This would not invalidate Bordes's typology. On the contrary, it would strengthen the use of the typology as an analytical tool in interpreting Paleolithic assemblages. Accordingly, typological variability among the scrapers could be seen as reflecting variability in intensity of reduction. This is a clear example of what Jelinek (1976) calls the "Fison effect," i.e., the process by which lithic artifacts can go through several phases of reuse and remodification of their form.

However, this does not deny any role of functional or stylistic factors in producing other aspects of scraper variability, such as the shape and perhaps angle of the working edge. Nor does it mean that every scraper follows exactly the same course of reduction. It has been shown that at least two distinct reduction sequences are demonstrable in this material, possibly reflecting differences in shapes of the original flake blanks. Also, there may be exceptions for particular kinds of scrapers, such as classic Quina scrapers.

But, if subsequent work does confirm the general validity of this reduction model, then several avenues of research will be opened. For one, it is clear that the isolation of different aspects of lithic variability related to technology, function, style, and even raw material (see Dibble 1985b) will continue to be basic to our understanding of assemblage variation. In particular, the degree to which reduction processes are reflected in various typological systems must be explored further. Also, the identification of specific reduction processes may help to clarify relations and distinctions among different assemblages. For example, this analysis has already demonstrated that differences are apparent in the reduction sequences from La Quina and Combe Grenal on the one hand and Bisitun on the other. Whether these differences are due to cultural or other factors such as differences in raw material, or technology that leads to the production of differently shaped flake blanks, is a question that should be addressed. Other reduction strategies may also be found in other areas or among various kinds of assemblages within the same region. By clarifying the meaning of certain aspects of typological variation, this model may help to isolate specific factors underlying the typological variability that is apparent among Middle Paleolithic industries of the Old World (Bordes 1961b; Rolland 1977, 1981) and thus contribute to our interpretation of assemblage differences.

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