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# Unifacial Bifaces: More Than One Way to Thin a Biface

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**T**HE sequencing of biface reduction is viewed by nearly all archaeologists involved in lithic studies as a standardized procedure. This concept, developed primarily by Guy Muto (1971) and Errett Callahan (1979), assumes that as a biface proceeds along the reduction trajectory from blank to preform to end product, flakes are removed systematically from both faces. Recent studies at the Casa Diablo obsidian quarry in east-central California, however, have revealed a substantially different approach to biface reduction (Skinner 1990). This paper describes an alternative biface reduction strategy, the unifacial biface, and its implications for prehistoric stone tool studies and replicative experiments.

The study sample described in this paper is from the data-recovery of four sites (CA-MNO-574, CA-MNO-577, CA-MNO-578, and CA-MNO-833) located in the vicinity of Mammoth Lakes, California, in the western portion of the Long Valley Caldera (Fig. 1). The four sites in the study are related primarily to the procurement and reduction of obsidian from the Casa Diablo obsidian source during the Middle and Late Archaic periods. Casa Diablo obsidian has the most extensive consumer area of any lithic material in California, occurring on sites as far away as the central Mojave Desert to the south, and the central California coast to the west (Ericson 1977).

The Casa Diablo obsidian source is not a single outcrop, but is composed of a series of flows and inclusions within the western portion of the Long Valley Caldera. The obsidian oc-

curs over a large area and consists of a number of discrete localities, with obsidian available in a wide variety of shapes, sizes, visual characteristics, and quality. Two of the sites, MNO-577 and MNO-578, are located at the base of one of the many outcrops of Casa Diablo obsidian, Sawmill Ridge (Fig. 2).

Topography within the project area is quite variable, ranging from broad pumice flats to moderately steep ridges and volcanic domes. The local topography at sites MNO-577 and MNO-578 consists of steep north- to south-trending ridges, separated by forested valleys and open flats. Low, broad, open pumice fields characterize the terrain at the northern sites, MNO-574 and MNO-833.

Sites MNO-574 and MNO-833 represent secondary reduction sites, or sites where biface production not directly related to quarrying occurred. Site MNO-578 appears to be a combined camp site, secondary reduction site, and obsidian quarry. Site MNO-577 is, for the most part, a buried obsidian workshop directly associated with a redeposited obsidian cobble formation.

The total artifact assemblage recovered from 26 1 x 1-m. excavation units consists of 39 projectile points, 193 bifaces, 47 edge-modified flakes, 5 other tools, 77 cores, 5 hammerstones, and approximately a quarter million pieces of debitage (Goldberg et al. 1990). Of particular interest here is the biface reduction technology represented at these four sites, which we have called unifacial biface production. The remainder of this paper deals with a description of the unifacial biface technology at these sites.



Fig. 1. Project location map.

Cursory examination of material collected during a previous investigation conducted at these sites by CalTrans (Adams 1986; Mone 1986), and results of other studies in the area (cf. Basgall 1983, 1984; Jackson et al. 1983; Jackson 1985, 1986; Bouscaren and Wilke 1987), suggested that biface production was the dominant reduction trajectory represented, although other technologies (such as cobble testing, flake production from cores, and cobble sectioning for large flake production) were also represented.

Based on this prior knowledge, the lithic analysis—particularly the debitage analysis—was designed using traditional attributes. For example, bifaces were classified by stages using width-thickness ratios combined with the amount of flake scar coverage, and flakes were classified by reduction stages as determined from attributes such as platform faceting combined with dorsal scar count, complexity, and flake curvature. As debitage analysis progressed, and after re-examining the bifaces, it became clear that neither the bifaces nor many of the flakes could be placed

easily into traditional categories. Many flakes had single-faceted platforms and high dorsal scar counts and complexity, or multifaceted platforms and low dorsal scar counts and complexity. Many of the bifaces had little flaking on their ventral faces, yet appeared to be Stage 4 (after Callahan 1979) bifaces on the dorsal face. Closer attention was then paid to certain other attributes of the debitage, such as the crushing at the platform/dorsal interface, the direction of the platform preparation (always on the face from which the flake was detached), the presence of interior collapsed platforms and the resulting flakes, flake curvature, and a number of other attributes. It became clear that although the bifaces and flakes at the sites represented a biface reduction trajectory, the approach and techniques used appeared to differ from those described by Callahan (1979) and Muto (1971), and the debitage could not be classified according to attribute lists defined from these works.

Based on the observation of the bifaces and flakes from the archaeological sites, as well as a series of biface reduction experiments, a possible reduction strategy represented at the sites was proposed. This proposed strategy uses a staging model that follows closely that of Callahan (1979), but with a variation on the sequencing. Five stages of biface production are proposed for the percussion portion of the reduction, with stages 3 and 4 each using a unifacial approach. The proposed reduction strategy, that of unifacial biface production, is illustrated in Figure 3 and described below.

#### STAGE 1: OBTAINING THE BLANK

The production of flake blanks (Fig. 4) at these sites appears to have been accomplished by at least two methods: (1) sectioning cobbles to produce large flakes (plates); and (2) production of biconvex flakes from cores. The production of plates can be accomplished by sectioning a cobble with a large, heavy hammerstone, and

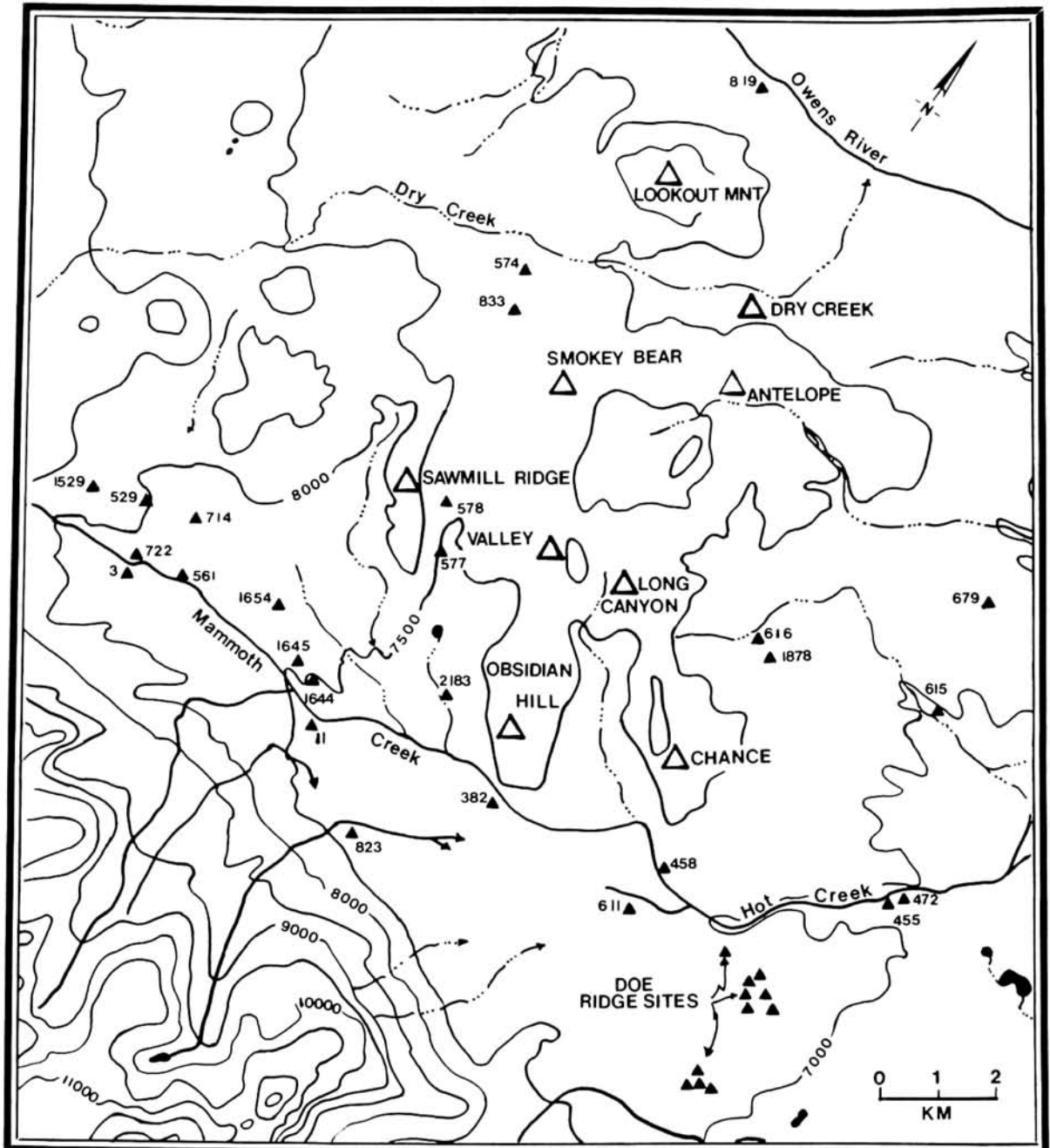


Fig. 2. Excavated sites in western Long Valley (solid triangles) and major quarries of the Casa Diablo obsidian source (open triangles). (After Goldberg et al. 1990, Fig. 3.2.)

often appears to have made use of cortical platforms. This method of producing plates results in a number of large plates (many with cortical platforms and cortical distal ends), relatively small amounts of debitage, small core remnants,

very large errillures, and many flakes that do not fit into standard classifications.

The production of biconvex flakes is proposed to entail preshaping the core or cobble prior to flake removal. This may be done by

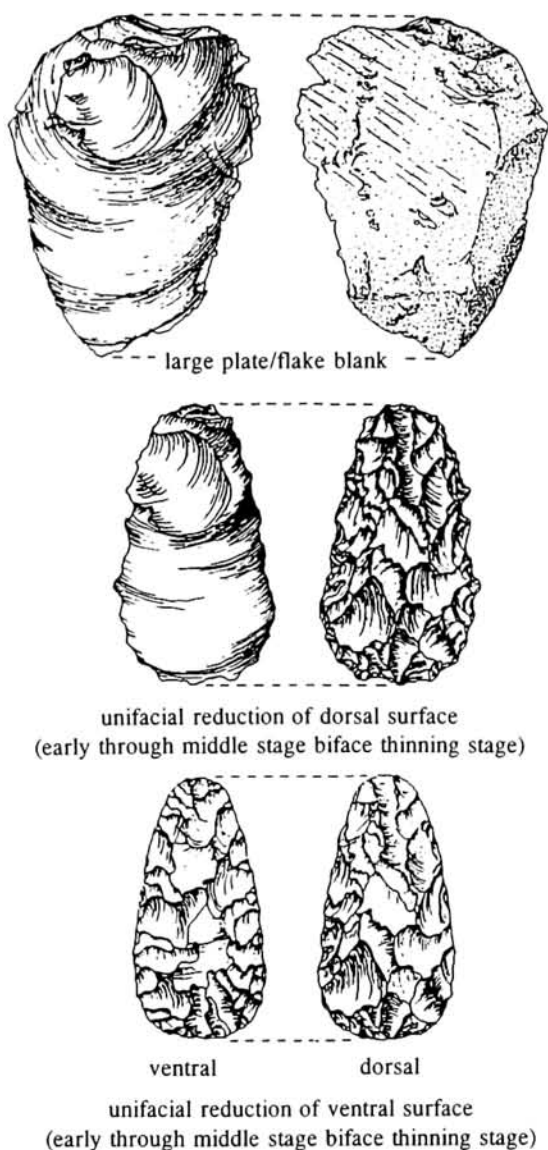


Fig. 3. Proposed reduction sequence for unifacial bifaces (after Skinner 1990, Fig. A.7).

first removing a large plate, or by using a natural flat surface. The flat surface is then shaped to produce a slightly convex face with rounded corners by moving the platform back from the face with the removal of relatively short flakes. The biconvex flake is removed by striking in the center of the face using an arcing blow. This generally produces a "side-struck" flake that has both a convex ventral surface and a convex dorsal surface. This technique pro-

duces more debitage than does sectioning a cobble as described above. Debitage from the production of biconvex flakes would include many flakes with  $90^\circ$  platform angles, flakes with cortical platforms, small "side-struck" flakes, linear flakes, and smaller errillures than would be produced by the first technique. Cores would be more identifiable with this technique than with cobble sectioning.

Differences between the two methods of obtaining the blank include the following: (1) sectioning cobbles generally produces large flakes but is less efficient in producing flakes of a particular size; (2) less debitage is produced by sectioning a cobble for plates than by shaping a core for the production of biconvex flakes; (3) although more effort is expended in shaping a core to produce a particular flake shape, the amount of effort expended later in the reduction of the flakes is minimized because less shaping/thinning is required in later stages; and (4) the production of biconvex flakes is more material-efficient than is production of plates from cobble sectioning. The technique(s) used prehistorically to obtain the blank is hypothetical at this point and awaits testing.

## STAGE 2: INITIAL EDGING

This stage is where the plate or biconvex flake is given an edge. When working with a plate, the edging process may be similar to that described by Callahan (1979). When reducing a biconvex flake, however, either Stage 2 edging is not necessary or relatively few flakes are removed to produce an edge (Fig. 5). Based on the archaeological debitage, it is suggested that the blank is rarely truly edged, and reduction generally begins with Stage 3. Plates generally require more edging, producing numerous alternate flakes; reducing biconvex flakes either does not produce alternate flakes or alternate flakes occur in very low frequency. When alternate flakes *do* occur with the latter reduction, they are generally cortex covered.

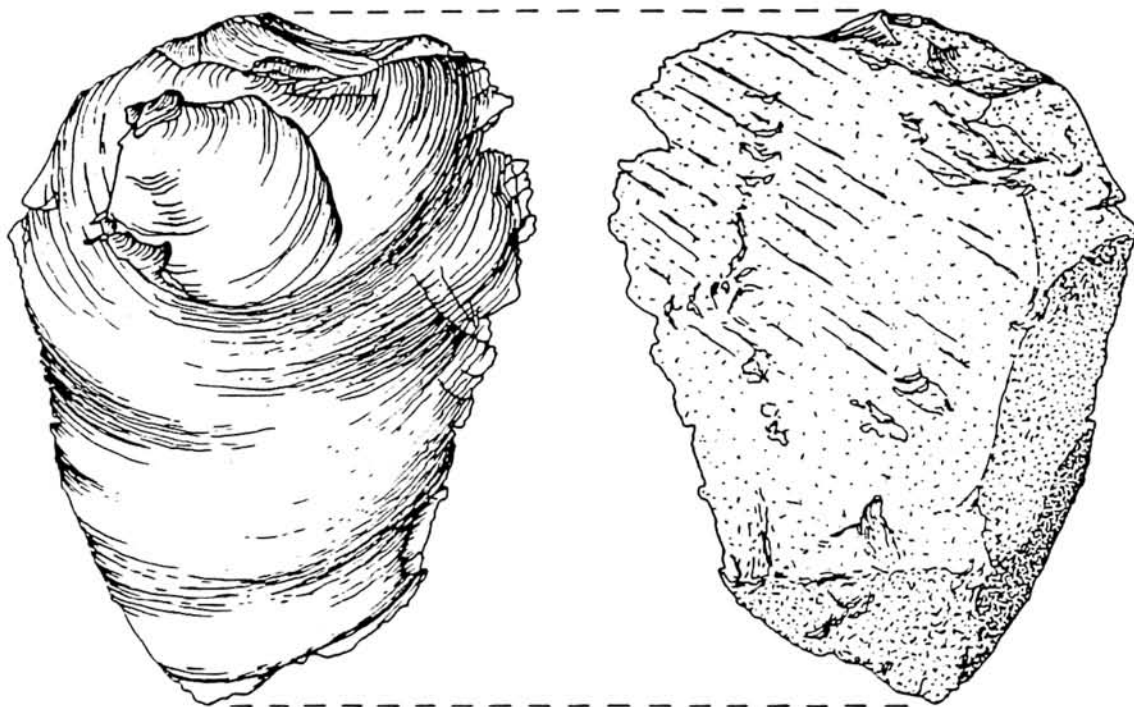


Fig. 4. Large plate/flake blank (after Skinner 1990, Fig. A.7).

### STAGE 3: PRIMARY AND SECONDARY THINNING, DORSAL FACE

This stage involves thinning the dorsal surface. Flakes are removed almost entirely from the dorsal face only, and the dorsal face is thinned, possibly well into what would be considered early or middle Stage 4 as defined by Callahan (1979) (Fig. 6). Flakes are detached by striking a platform on the ventral surface and removing flakes from the dorsal surface. Based on archaeological debitage attributes, little or no platform preparation is done during this stage of reduction (particularly for the initial flakes removed), but when platform preparation is done it is to the same face from which the flake is detached, but platforms are not isolated.

Debitage characteristic of this reduction stage (late) includes flakes with single faceted platforms and high dorsal scar count (Fig. 7), crushed platform-dorsal juncture (Fig. 8), interior collapsed platforms (Fig. 9), and extreme

curvature (Fig. 10) particularly close to the platform (early). The flakes are irregular in outline, but more linear flakes will be produced than usual as a result of removing more mass and following ridges up and over the mass. Recognizable biface thinning flakes may have cortex near the termination and single-faceted platforms. Use of the technique of working only one face at this stage allows the use of what would normally be considered a hammerstone too hard for obsidian. Use of hard hammerstones is indicated on the archaeological bifaces and flakes primarily by exaggerated compression rings and interior collapsed platforms. All of the hammerstone fragments seen at the various quarries are of hard materials such as granite.

### STAGE 4: PRIMARY AND SECONDARY THINNING, VENTRAL FACE

Once the dorsal surface of the biface is reduced to traditional Stage 4, the ventral sur-



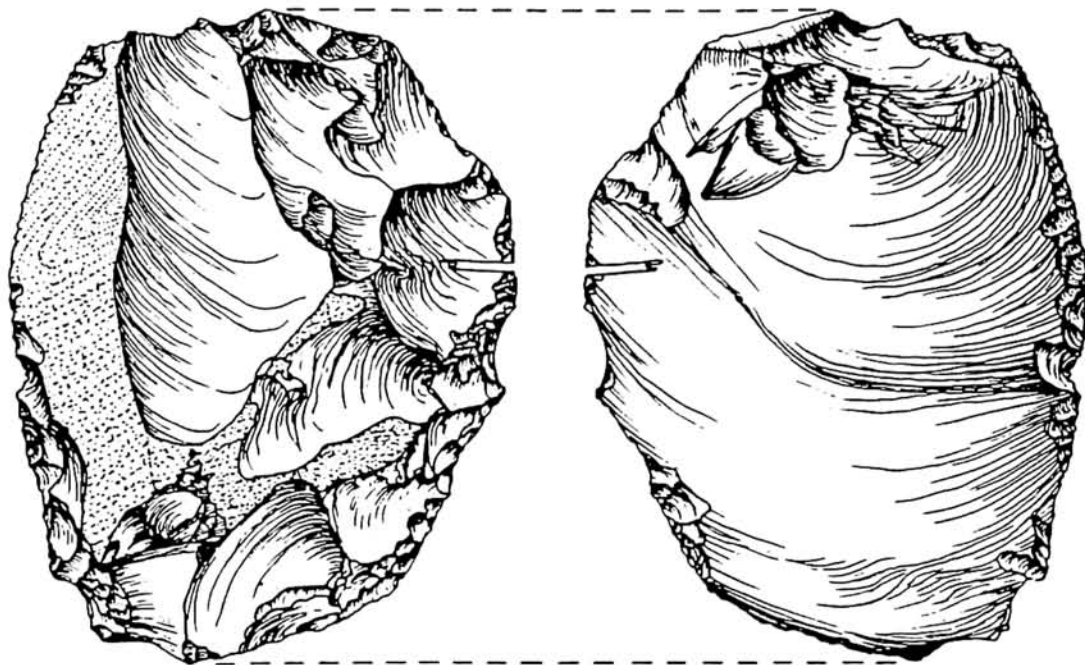


Fig. 5. Edging a plate/flake blank (after Skinner 1990, Fig. A.2).

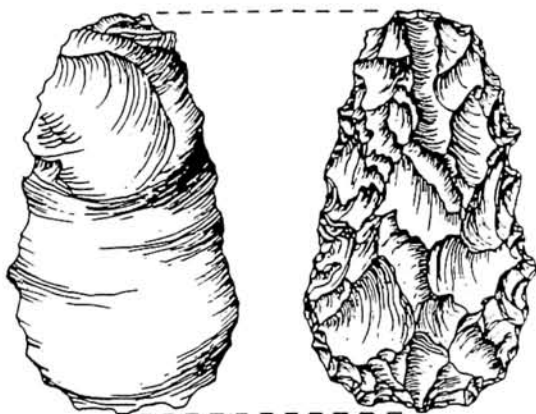


Fig. 6. Unifacial reduction of dorsal surface (after Skinner 1990, Fig. A.7).

face is worked (Fig. 11). This may entail only the removal of several flakes, if any at all, depending on the surface topography of the

ventral face. A flake properly removed from the core may not require any further ventral reduction because it is already convex. When flakes *are* removed, platform preparation is to the opposite face to increase the convexity, but platforms are not isolated. Characteristic debitage produced during this reduction stage includes flakes with multifaceted platforms and simple dorsal scar morphology (Fig. 12), flakes with ventral remnants on their dorsal surface, and flakes with more regular, expanding outlines.

#### STAGE 5: TERTIARY THINNING OF BOTH FACES

This stage encompasses the final percussion thinning of the biface; a change to soft hammer percussion may be made at this point. Both faces may be worked to remove any irregularities to produce a middle Stage 5 biface. During early Stage 5 reduction, most of the thinning is done from the base of the biface with subsequent

## DISCUSSION

This reduction technique has never been described, as such, from prehistoric assemblages, although it may have been observed but not recognized for what it represented. Muto described "transportation" blanks from the Spring Creek Cache whose:

earliest stages show a tendency toward unifaciality in the securing of the section and cross section with the bulk of flaking on the dorsal surface . . . All specimens at this stage show ventral flaking concentrated at the bulbar end, with the flakes directed in such a manner that the mass of the bulb has been reduced [Muto 1971:89].

This reduction technique of producing unifacial bifaces may also be represented at the Sugarloaf obsidian quarry, which is part of the Coso Volcanic Field. Material at this quarry was studied by Elston and Zeier (1984), who described a specialized production technique to produce a "Coso blank" with a "Coso flake" as a by-product. They also described a variation of the Coso technique for thinning the biface whereby thinning is initially confined to the dorsal face. Ventral thinning may occur, but the ventral face may never be entirely reduced.

Although the recognition of yet another biface reduction technique may seem to be a minor point, it has important implications for analytic techniques, for questions about trans-Sierran exchange, and for interpretation of assemblages and technological organization. For analytic techniques, the identification of the unifacial biface reduction strategy changes many of the basic assumptions about biface production, as described by Sharrock (1966), Muto (1971), Crabtree (1973), and Callahan (1979). Many investigators have subsequently applied these concepts to analyze bifaces and debitage in terms of stages, sequencing, and expected flake morphology at certain stages. Problems are often encountered attempting to fit debitage and bifaces into the categories derived from these concepts.

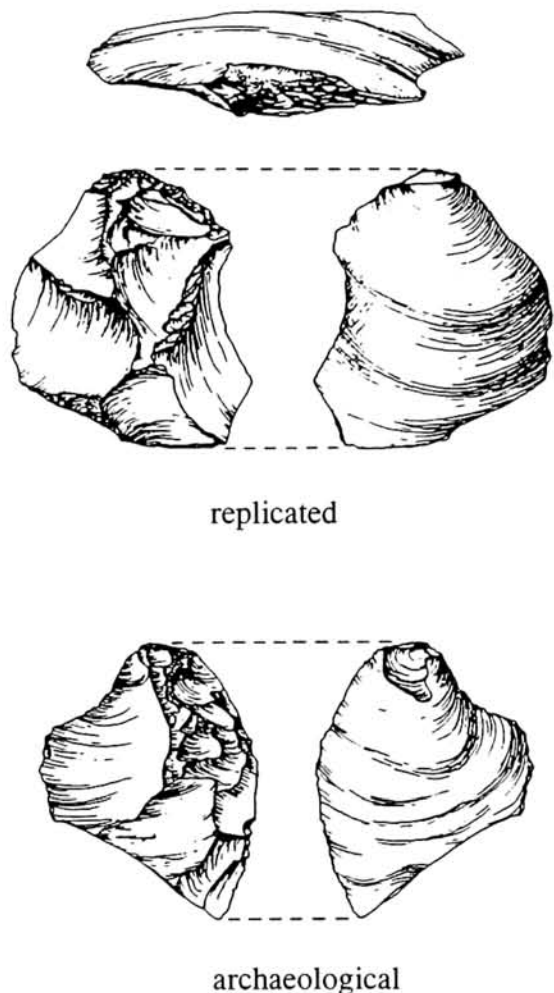


Fig. 7. Dorsal thinning flake with single-faceted platform, complex dorsal scar morphology, and platform preparation to the same face (after Skinner 1990, Fig. A.8).

thinning occurring from the lateral margins, which partially obscures the basal thinning flake scars. Some pressure retouch may be included near the end of this stage to either set up platforms or to regularize the biface. Platform preparation is to the opposite face, and some of the platforms are isolated. Debitage from this stage will be more characteristic of late-stage biface thinning than most of the debitage from any of the previous stages. The remaining stages are similar to those defined for more traditional biface thinning techniques.



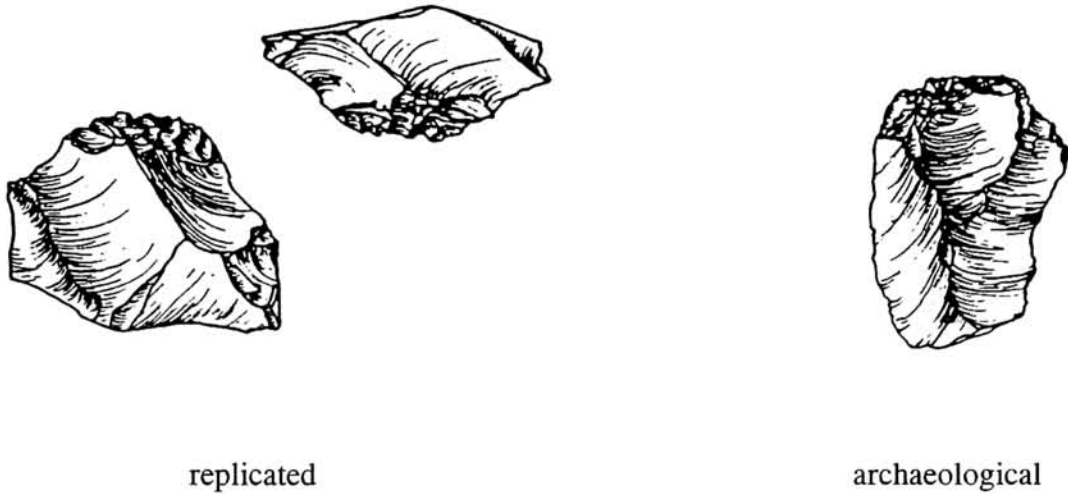


Fig. 8. Crushed platform area on flake (after Skinner 1990, Fig. A.9).

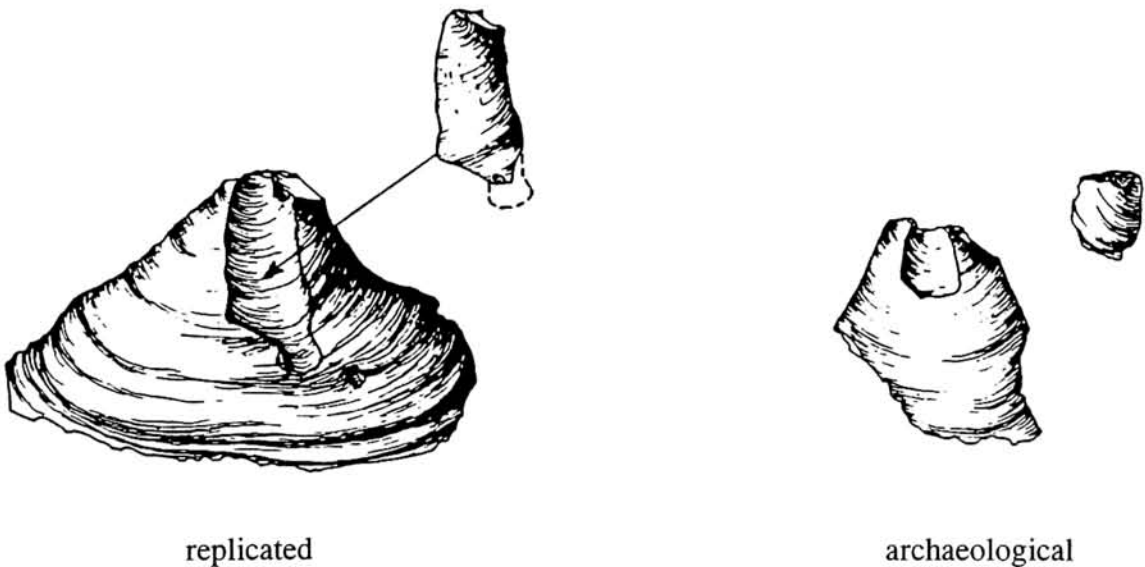


Fig. 9. Interior collapsed platform and resulting flake (after Skinner 1990, Fig. A.10).

The posited core shaping to produce a specialized biconvex flake implies a certain amount of standardization, which results in different ratios of debitage types than the traditional biface reduction model. The predominantly unifacial shaping using a hard hammer-

stone produces a suite of flakes different from those assumed to result from classic biface thinning. Most types of attribute analyses currently being used would classify the reduction at the Mono sites as a combination of late-stage biface and flake production from cores, when, in fact,

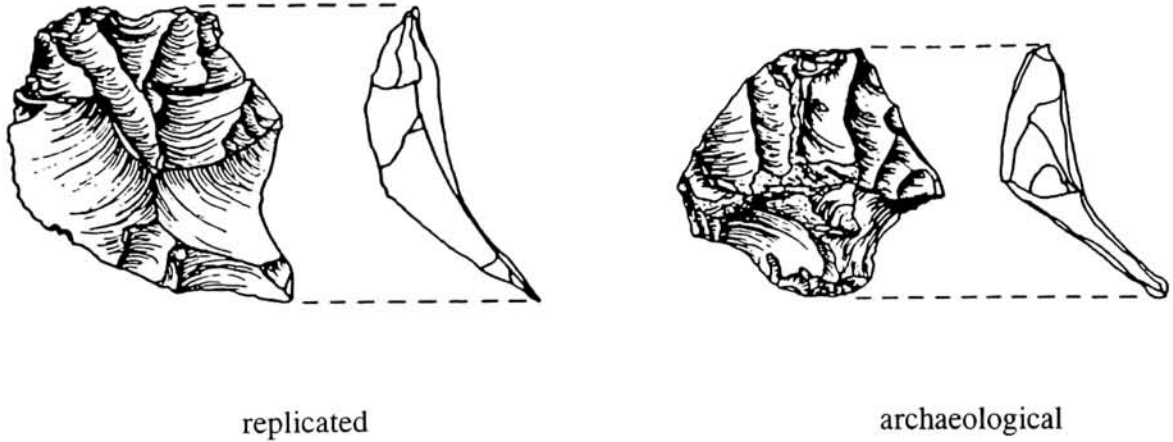


Fig. 10. Proximal curvature on dorsal thinning flake (after Skinner 1990, Fig. A.11).

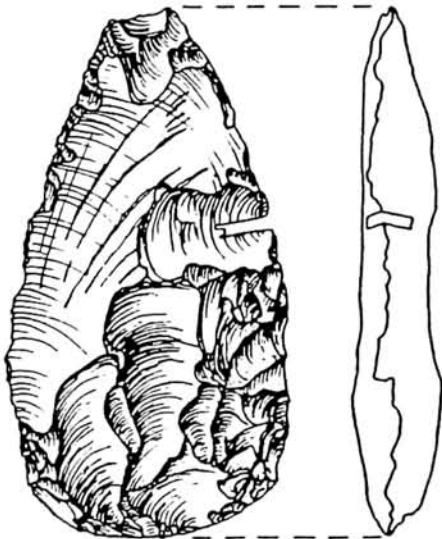


Fig. 11. Unifacial reduction of ventral surface (after Skinner 1990, Fig. A.5).

biface production through all stages occurred.

The recognition of the unifacial biface reduction strategy emphasized that: (1) models of biface production need to be examined in light

of the possibility of a number of strategies and technological organizations present prehistorically; (2) flake attributes used for biface reduction need to be tested against various models by experimentation; and (3) analysts must no longer be constrained in their analyses by traditional concepts of biface reduction, but must approach each analysis with an open mind to allow recognition of other strategies.

Employing the unifacial biface production strategy may have had advantages prehistorically in terms of technological organization. The posited core shaping to produce a biconvex flake blank may have taken a little extra time for shaping, but it resulted in ease of production of the flake blank with less time investment and maximum efficiency; a large number of bifaces ready for transport could be produced quickly and failures would be detected early in the reduction and discarded before a great deal of time was invested. A larger number of biface blanks could be produced with a given cobble than by producing flake blanks from splitting a cobble into plates or by manufacturing a biface directly from a cobble. The replication experiment (and practicing for it) demonstrated that

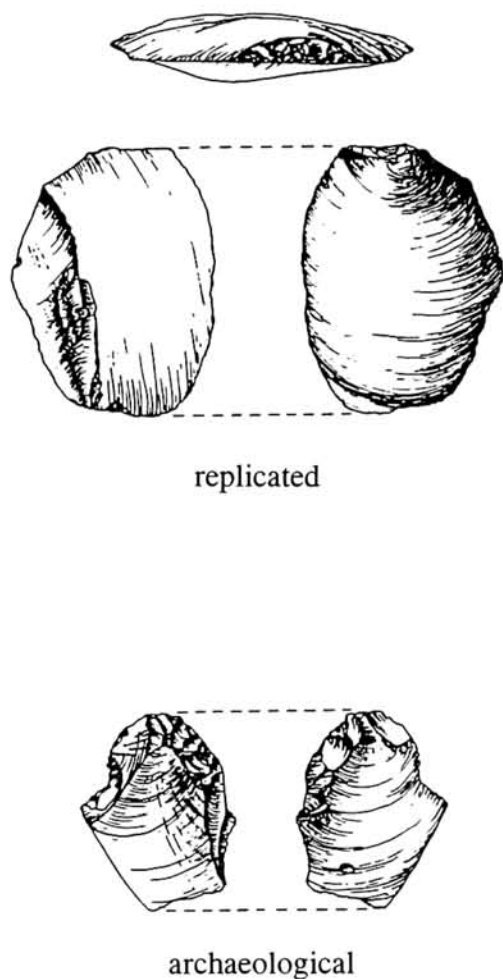


Fig. 12. Ventral thinning flake with multi-faceted platform, low dorsal scar count, presence of ventral scar on dorsal surface, and platform preparation to the opposite face (after Skinner 1990, Fig. A.13).

few bifaces broke by perverse fractures, even with the use of a hard hammerstone. The explanation for this appears to be that unlike traditional biface reduction (cf. Callahan 1979), where the plane of percussor contact (margin) is in the center of the mass, on a unifacial biface the margin is set to the face opposite that from which the flake is detached, leaving most of the mass below the plane of percussor contact to absorb the blow. The cone of initiation of a

perverse fracture on a biface whose margin is set to the center can easily exceed the thickness of the biface mass. On a unifacial biface of the same thickness, the cone of initiation of a perverse fracture would need to be twice as large. This allows using a much harder blow when detaching a flake than when the margin is set to the center of the biface, thus reducing the risk of breakage. In other words, this reduction strategy "makes the biface think it is thicker than it actually is." If hard hammerstones were all that were available, they could be used for biface production with a lower failure rate. Very few bifaces in the prehistoric assemblages from the Mono sites were broken from perverse fractures; instead the common breakage type was bending, and may have been caused most often by end shock later in the reduction process. Another advantage to this strategy is that because faces are not worked alternately throughout the reduction, and platform preparation is only to one face, the biface does not lose width as quickly as with traditional reduction strategies.

The quarries and workshops of Casa Diablo obsidian along the western edge of the Long Valley Caldera are assumed to be involved in the trans-Sierran exchange network. The recognition of the unifacial biface industry has implications for questions about this network. A pile of seven unifacial bifaces were recovered from MNO-574 that appear to represent either bifaces rejected because of recognition early in the reduction process of failure to achieve proper width-thickness ratios, or bifaces left behind as "second-best" when selecting those to transport. The hydration measurements on these bifaces range from 3.1 to 3.8 microns. These readings fall within the range suggested by Ericson (1982) and Hall (1984) for the peak production period for Casa Diablo obsidian. A cursory examination of quarry/workshops around Lookout Mountain revealed the presence of a large number of discarded unifacial bifaces, plus a

number of fragments of hard hammerstones. Recently, a cache of unifacial bifaces was reported from near Mariposa, a low elevation town on the west slope of the Sierra (R. Jackson, personal communication 1990). Although to date these specimens have not been cut for hydration measurements, they appear to be very similar to those seen at the Mono sites.

The production of unifacial bifaces has a number of advantages for trans-Sierran exchange. First, bifaces ready to transport can be produced quite quickly, with failures identified early in the reduction process before much investment of time. Second, at a transportable stage enough mass remains on the biface to allow a number of reduction options for the consumer. Third, the biface can be pressure flaked into final form if desired with little additional reduction.

Indications of these forms arriving on the west slope of the Sierra may have been observed by the authors, but not recognized. For example, much of the debitage from sites at an elevation of approximately 1,061 km. near Oakhurst were interpreted as resulting from the reduction of bifacially worked plates whose ventral surfaces were unmodified or only minimally modified (Skinner 1986, 1989); these may have been unifacial bifaces. Transverse parallel pressure flakes that resulted from flaking on unworked ventral surfaces were identified at CA-FRE-1671 at the edge of the Central Valley (Skinner 1988); again, these may have been unifacial bifaces. It may be possible to use the identification of the unifacial biface reduction strategy to identify the producers of items of Casa Diablo obsidian being used on the west side of the Sierra Nevada and in the Central Valley of California.

In summary, an alternative biface production strategy, first recognized on four sites at and near the Casa Diablo obsidian quarry, has been discussed. This reduction strategy may be represented at other eastern Sierra Nevada obsidian sources such as Coso, Bodie Hills, and Mt.

Hicks. It is crucial that analysts begin to consider alternative reduction strategies when conducting lithic analyses. These considerations are important in interpretations of site activities, and particularly important for understanding larger issues such as trans-Sierran exchange networks and the identity of the producers.

#### ACKNOWLEDGMENTS

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