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Clovis biface technology at the Topper site, South Carolina: evidence for variation and technological flexibility

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A R T I C L E I N F O

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A B S T R A C T

The Topper site in the South Atlantic Coastal Plain of South Carolina provides a rare glimpse of the entire range of Clovis tool manufacture. Topper is a quarry-related site along the Savannah River with an outcrop of Coastal Plain chert and a buried Clovis component. This paper focuses on the 174 bifaces and diagnostic debitage from recent excavations to understand biface production at Topper. I present the process of manufacture then measure the variation in production characteristics at the site in terms of our current knowledge of Clovis biface technology. I conclude that Topper flintknappers used reduction strategies typical of Clovis-period tool production but created a biface assemblage with greater flexibility in design than documented at most other Clovis sites. This variation in biface production suggests greater variability in Clovis behavior across America—Clovis groups adapted to local resource conditions and adjusted the organization of their technology accordingly.

1. Introduction

Clovis technology is recognized for its characteristic bifacial fluted projectile point, a tool form first defined over 60 years ago at sites in the Plains and Southwest (Stanford, 1991; Tankersley, 2004; Willig, 1991; Wormington, 1957). For many decades, much of what we knew of Clovis biface technology was based on caches and kill-sites in western North America (Bradley, 1991; Stanford and Jodry, 1988). Only recently has the American Southeast started to play a larger role in understanding the process of Early Paleoindian tool production (Broster and Norton, 1993; Morrow, 1995; Sanders, 1990). In this region, primary manufacturing localities contain the empirical evidence critical to reconstructing how Clovis people organized technology, allowing us to refine our understanding of the nature of Clovis lithic procurement and tool production.

The Topper site in South Carolina provides one of these rare glimpses of the entire range of Clovis tool manufacture. Topper is a quarry-related site along the Savannah River with an outcrop of Coastal Plain chert and a buried Clovis component (Fig. 1). This paper focuses on the 174 bifaces and diagnostic debitage from recent excavations to understand biface production at Topper. I first present the process of biface manufacture and then compare production characteristics at the site with other Clovis sites, especially quarry-related sites. I conclude that Topper flintknappers used reduction strategies typical of Clovis-period tool production but created a biface assemblage with greater flexibility in design than previously documented. Clovis behavior across America was diverse, and the patterns seen in the Topper assemblage suggest that Clovis groups adapted their technology for the use of local resources.

1.1. Clovis biface technology

The earliest descriptions of the Clovis archaeological complex were based on excavations of mammoth kill-sites like Dent and Blackwater Draw in western North America (Howard, 1933; Meltzer, 2009). At these localities, large fluted points were found in association with skeletal remains of Pleistocene megafauna, and this early evidence became a standard for characterizing Clovis subsistence. Also in the American West, studies of caches (e.g., Anzick, Simon) established standard morphological characteristics of Clovis tool forms, especially bifaces, and for many decades these formed the basis for understanding tool manufacture (Butler, 1963; Lahren and Bonnichsen, 1974; Mehringer, 1988). Today, Clovis artifacts are known from sites all across mid-latitude North America and have been repeatedly dated to approximately 13,000 cal B.P. (Haynes, 2002; Waters and Stafford, 2007). While tool assemblages vary, they share the hallmark of the culture, the Clovis fluted-point, a bifacially-flaked tool form that is lanceolate-shaped, lenticular in cross-section, and has flutes that originate from the base and usually extend half the length of the point face (Stanford, 1991; Tankersley, 2004; Willig, 1991; Wormington, 1957).

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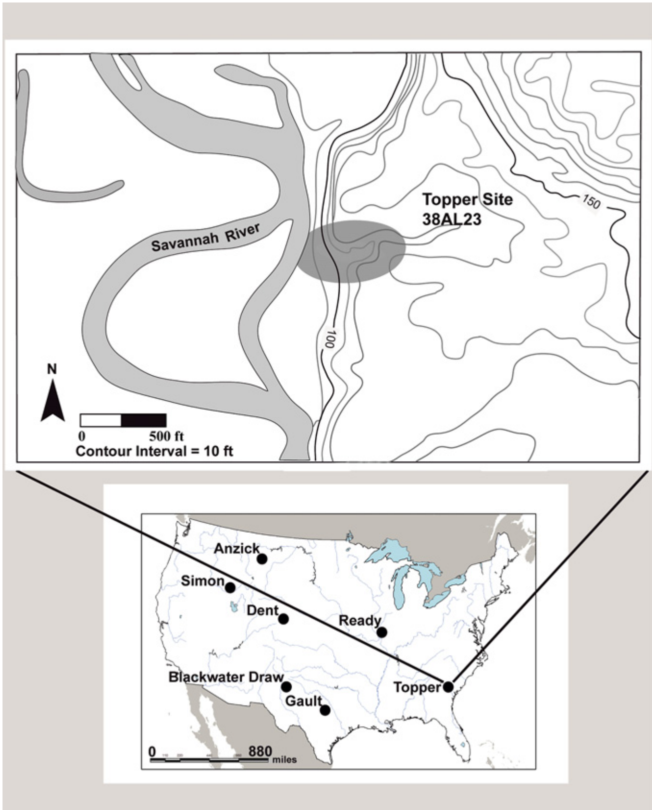


Fig. 1. Map of the Topper site along the Savannah River, South Carolina with United States map showing locations of Clovis sites mentioned in text. Contour elevations taken from U.S.G.S. Quad 33N/81W.

Clovis points have been found at kill and cache sites, camp and quarry locations, and as isolated finds, and their predominance demonstrates the important role this tool type played in Clovis subsistence behavior. Clovis points and preforms functioned as a part of a mobile hunting tool kit (Frison and Bradley, 1999).

The "high-technology forager" (HTF) settlement model was the first to emphasize the role of bifacial tools in Paleoindian mobility strategies, and since then this interpretation has been generally accepted as a standard for understanding Clovis technology (Kelly, 1996; Kelly and Todd, 1988:239; but see Bamforth, 2003; Prasciunas, 2007). Based on evidence from the Plains, Kelly and others have argued Early Paleoindians forewent dependency on local environments to exploit large herbivores, shifting ranges frequently and maintaining consistent behavioral adaptations. Their portable technology consisted of long-lasting and multi-purpose tools fashioned from high-quality stone (Goodyear, 1989; Kelly and Todd, 1988). Bifaces, with sharp but durable edges and high width-to-thickness ratios, facilitated the removal of large flakes for expedient use (Kelly and Todd, 1988). These bifacial cores functioned "like Swiss Army knives"—many tools could be produced from a single bifacial core, including points. Further, the low weight-to-edge ratio ensured mobile groups were less burdened by large amounts of stone but still able to produce needed tools (Kelly, 1996:236). The Clovis point, with a design for bilateral symmetry and strength, was a lethal weapon for highly mobile, big-game hunting foragers (Elston and Brantingham, 2002; Frison and Bradley, 1999). Thus the HTF model emphasized the importance of two Clovis bifacial tool forms, the bifacial core and fluted point.

With newly excavated Early Paleoindian campsites and quarries, however, the research focus has shifted from the relationship of bifaces and mobility, in general, to developing a more comprehensive understanding of technology by reconstructing the process of manufacture and identifying specific production goals (Broster and Norton, 1992, 1993; Broster et al., 1994; Collins, 2002, 2007; Goodyear and Steffy, 2003; Gramly and Yahnig, 1991; McAvoy, 1992). Studies focusing on tool-production processes reveal that Clovis flintknappers used a diagnostic series of techniques, especially in the production of highly stylized bifacial-point preforms (Collins et al., 2007; Morrow, 1995; Waters et al., submitted for publication). With their analysis of the assemblage at Gault, a quarry-campsite in central Texas, Collins and Hemmings (2005) describes the following standards for Clovis biface reduction. Points were crafted on cores or very large flakes. Knappers applied a distinct set of thinning and shaping strategies to create the point outline. Overshot flaking produced broad flake removals that extend across the face of the tool; this was an intentional technique used to thin and narrow the preforms. Large bifaces and preforms generally have three or four of these broad removals that cover most of the tool face, and finished points sometimes retain evidence of two or more of these thinning scars (Collins et al., 2007:103). End thinning, or the removal of flute-like flakes struck from alternating beveled basal edges, longitudinally thinned the tool. Some preforms show signs of early end-thinning removals, while others were only fluted in the final steps of point production (Collins et al., 2007).

These knapping strategies produced what are considered to be "classic" Clovis point preforms (Bever and Meltzer, 2007; Collins and Hemmings, 2005). They have identifiable flake scars distinctive to Clovis reduction and are straight-sided lanceolates with bi-convex cross-sections and squared to convex bases beveled for percussion fluting. Preforms are almost always more than 100 mm in length and can be as long as 230 mm (Collins and Hemmings, 2005:11). Their standard shape was maintained during use and resharpening events, through which a point typically could be reduced to a length of less than 50 mm (Collins, 1999, 2007).

While hints of technological variability in the Clovis record are emerging (Morrow, 1995), standard descriptions of Clovis technology remain based on sites on the Plains and in the West (Bradley et al., 2010; Collins, 2007). Data from a variety of sites in different areas of the continent are needed to fully understand the "fabric" of Clovis technology and behavior. Thus far, the Southeast has contributed little to our knowledge of technological organization and is a poorly understood region.

1.2. *Exploring biface technology at Topper*

The Topper site, in the South Atlantic Coastal Plain of South Carolina, provides an excellent test case for measuring variation in Clovis biface technology. How does biface technology at Topper compare to "classic" Clovis biface production? Did Clovis people at the Topper quarry employ the same reduction strategies as elsewhere, and did they produce bifaces in the standard sizes and shapes observed at other quarry locations?

To answer these questions, I present an analysis of the excavated Topper biface assemblage. First, I reconstruct the process of Clovis biface manufacture to determine if flintknappers crafted bifaces similar to those from other Clovis localities. Second, I present evidence of variation in biface design at Topper.

2. Materials

2.1. *The Topper site*

The Topper site is a multi-component quarry-related site situated at a natural outcrop of Allendale Coastal Plain chert of the Flint River formation (Goodyear and Charles, 1984). Goodyear initiated excavations in 1986, identifying an Archaic component, and in 1998, he unearthed a Clovis component buried in the upper meter of sands (Goodyear, 2005). Excavations have continued, and as of 2009 the Clovis component covered a total excavated area of 590 m^2.

Topper is one of only two excavated Clovis sites in the South Atlantic Coastal Plain (Goodyear, 2005). During the late Pleistocene, Topper existed at the intersection of two major ecosystems, the southern-most limit of a cool, mesic deciduous forest and northern-most limit of a warmer, temperate southeastern evergreen forest (Delcourt and Delcourt, 1985, 1987; Delcourt et al., 1983; Goodyear et al., 1990). Also, the chert source at Topper represents the northern-most outcrop of Coastal Plain chert (Goodyear and Charles, 1984). North and east, raw material was much more scarce and limited to quartz sources at the fall–line transition to the Piedmont (Daniel, 2001).

Buried, intact Clovis deposits have been excavated from two distinct areas at Topper: the terrace (an area adjacent to a chute channel of the Savannah River) and the hillside (a gradually sloping portion of Coastal Plain uplands above the chert outcrop) (Fig. 2). Clovis artifacts have been found in both areas, as well as at the bottom of the river channel, which was also a prehistoric chert source.

The contextual integrity of the buried Clovis component has been demonstrated by spatial analysis and refit studies (Miller, 2007; Smallwood and Miller, 2009). Large block excavations have produced bifaces, fluted-point preforms, and fluted points, an extensive unifacial tool collection with macroblades, denticulates, and scrapers, and large quantities of debitage (Goodyear et al., 2007). No diagnostic bifacial points of post-Clovis periods have been recovered from the Clovis component.

On the terrace Clovis artifacts are buried in the bottom of a colluvial-slopewash set of deposits originating from the hillside. In this area, Clovis is found in buried C-horizon sands that according to optically-stimulated luminescence date to 13,200 ± 1300 cal B.P. (UIC-763) (Waters et al., 2009). On the hillside, where Clovis artifacts occur in a pedogenically altered weak Bw horizon deposited as colluvium (Waters et al., 2009), there have been four separate block excavations. A spatial analysis of the largest contiguous block, an area of 64 m^2, found a vertically discrete zone of diagnostic Clovis artifacts about 70 cm below surface; all artifacts diagnostic of post-Clovis complexes were found above this zone with minimal evidence of vertical displacement (Miller, 2007). The Clovis component in most areas of the upland portion of the site is deeply buried within a reddish-brown Bw horizon, 70–90 cm below surface. Across most of this area, Clovis and middle-Archaic components are vertically distinct and separated by 15 cm of sands. In the western portion (≈ 12 m^2) of the upland excavation, however, erosion has removed the upper 20 cm of sands, but the Clovis component is intact and still separated from an Early-Archaic component by ≈ 5 cm of sands.

2.2. The Clovis biface assemblage

A total of 174 bifaces and biface fragments have been recovered from the buried Clovis components on the terrace ($n = 20$) and hillside ($n = 154$) (Fig. 2). Of these, six are refitted bifaces, five from the hillside and one from the terrace. Fifty-three are complete bifaces and the remaining 121 fragments were broken and discarded during manufacture. All but two bifaces are made on Allendale Coastal Plain (ACP) chert.

Four finished fluted Clovis points have been found in the 590 m^2 of excavation (Fig. 3). Two are bases recovered from the terrace and crafted from local ACP chert, while the other two represent the only artifacts made on non-local materials in the biface assemblage. One is a used broken base made on quartz-plagioclase-porphyritic rhyolite (from the hillside excavation) (Fig. 3b) and the other is a tip fragment made on black rhyolite (from the terrace). Both rhyolites are likely from sources in the Uwharrie Mountains, North Carolina (Daniel and Butler, 1996).

3. Methods

3.1. Variables recorded

The principal goal of this study was to reconstruct the process of biface manufacture at the Topper quarry, and to consider variation

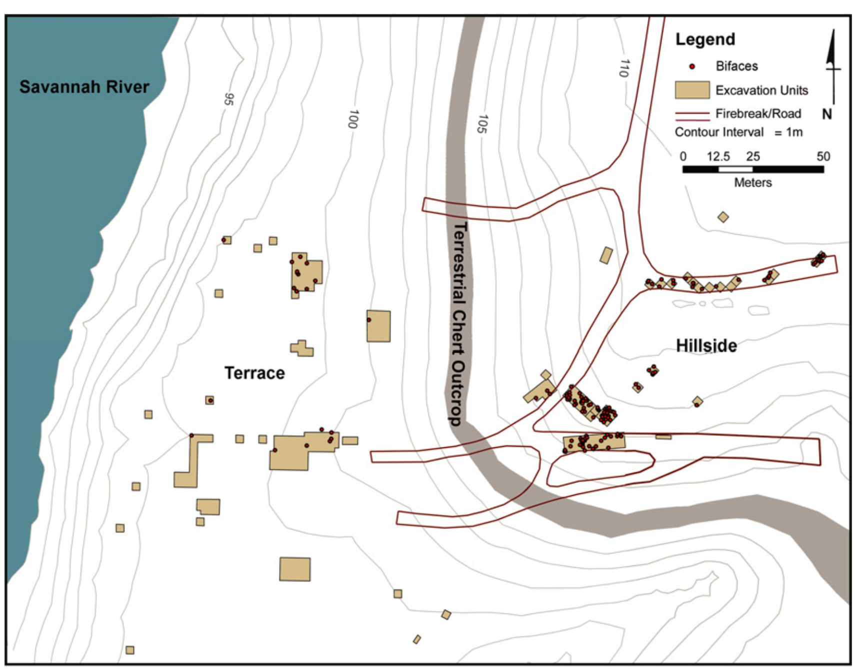


Fig. 2. Map of Topper site excavation blocks, showing excavated bifaces as red dots. Elevations based on site datum arbitrarily set at 100 m (Smallwood and Miller, 2009). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

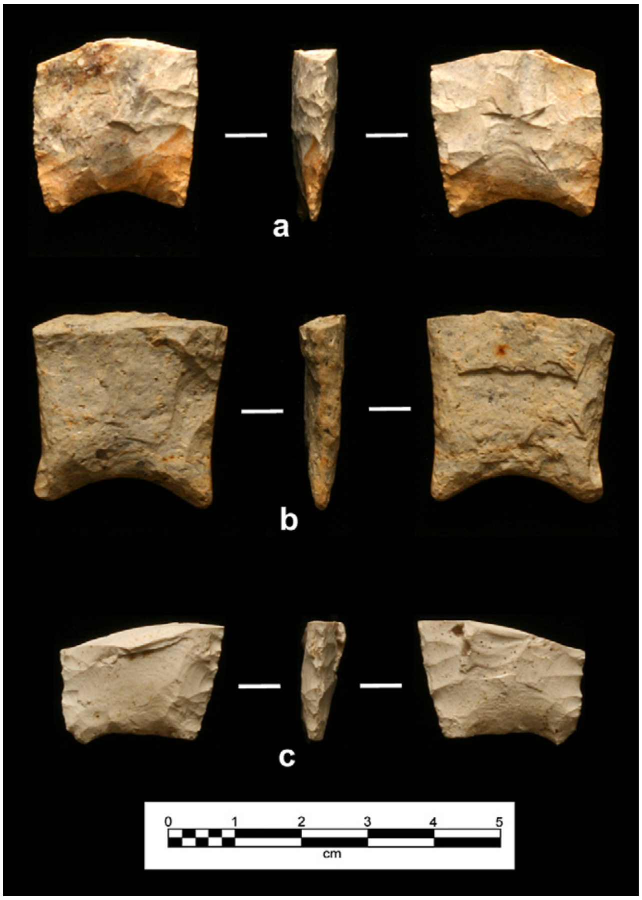


Fig. 3. Clovis point fragments found in the buried Clovis component.

in these production characteristics in terms of our current understanding of Clovis technology and technological organization in the American Southeast. To address these issues, each of the 174 Topper bifaces and diagnostic flakes was analyzed using metric and technological variables.

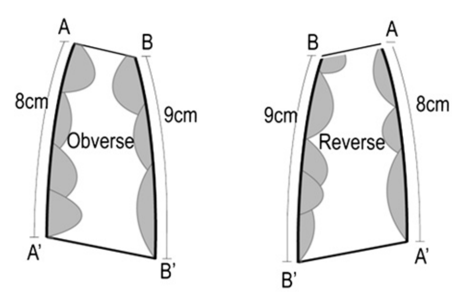
Technological variables measured included condition, original blank form, presence of cortex, planview, edge shape, presence of edge grinding, base shape, transverse cross-section, and platform preparation on thinning flakes (Table 1). These variables helped to document the nature and extent of reduction, general biface shape, and in some cases the type of bifacial tool manufactured. To understand reduction techniques, I recorded the incidence and directionality of overshot flaking (thinning flakes that extended past the center line to the opposite lateral margin, removing the opposite lateral margin), overface flaking (thinning flakes that extended across the center axis of the biface toward the opposite edge but either did not over-shoot or were obscured by subsequent flaking), and end thinning (flakes removed from the end of a biface, parallel to its long-axis) (Bradley, 1991, 1993; Collins et al., 2003, 2007; Waters et al., submitted for publication). These diagnostic Clovis removals helped to document thinning strategies.

Metric variables include maximum weight, length, width and thickness measurements. I also calculated a flaking index to quantify extent of reduction (Miller, 2007; Miller and Smallwood, in press). For this measurement, a continuous quantification of Callahan's "nature of flake scar interval" variable (Callahan, 1979), I counted flake scars greater than 2 mm that intersected each bifacial edge on both faces, and I then measured the corresponding edge length. The flaking index (FI) is the ratio of the total number of flake scars from both faces to the corresponding bifacial edge length (Fig. 4). A biface at an early stage of reduction is expected to have larger, more widely spaced flake scars, while a finished biface is expected to have smaller, more closely spaced flake scars along the bifacial edge. I analyzed all complete bifaces and biface fragments in this way (Miller and Smallwood, in press). Since biface reduction occurs along a continuum, to test the suitability of FI to estimate degree of reduction, I considered it in relation to biface thickness (Fig. 5). The result is a clear inverse relationship: as a biface becomes thinner with reduction, the FI increases.

I also assigned bifaces to three successive reduction stages (early, middle and late) based on presence or absence of cortex, extent of flaking, edge sinuosity, and flake-removal technique (Waters et al., submitted for publication). Statistically, the three stages of reduction approximate values obtained through the flaking index (Fig. 6). At Topper, bifaces identified to be early in the reduction process have a low mean FI of approximately 0.14, those in the middle have a mean FI of approximately 0.27, and those with more extensive late-stage reduction have a mean FI of 0.38. In this way, I used both FI values and technological variables to study reduction. These stages simply serve as classifications for comparing the degree of reduction and do not assume that all bifaces were reduced for a single end product—a finished fluted point.

Table 1
Technological variables recorded in biface analysis.

Technological variable	Value
Condition	Whole, proximal, distal, medial, lateral, corner(s) missing, medial distal, medial proximal, unknown
Stage	Early stage, middle stage, late stage
Blank form	Spall, nodule/biface, blade, undetermined
Cortex	Present on one face, present on both faces, none
Planview	Lanceolate, ovoid/square, circular, triangular
Edge shape	Straight, concave, convex, re-curvate
Edge grinding	Present/absent
Base shape	Concave, convex, square, rounded
Transverse cross-section	Plano-convex, bi-convex, bi-plano, undetermined



$$FI = \frac{\Sigma S}{\Sigma L}$$ Where S is a flake scar intersecting with a bifacial edge and L is the length of the bifacial edge.

A - A'
Flake Scars (S)
Obverse = 4
Reverse = 3
Total (S_A) = 7
Length (L_A) = 8cm

B - B'
Flake Scars (S)
Obverse = 3
Reverse = 5
Total (S_B) = 8
Length (L_B) = 9cm

$$\text{Overall FI} = \frac{\Sigma S_A + \Sigma S_B}{L_A + L_B} = \frac{7+8}{8+9} = \frac{15}{17} = 0.88$$

Fig. 4. Graphic illustrating the calculation of flaking index (Miller and Smallwood, in press).

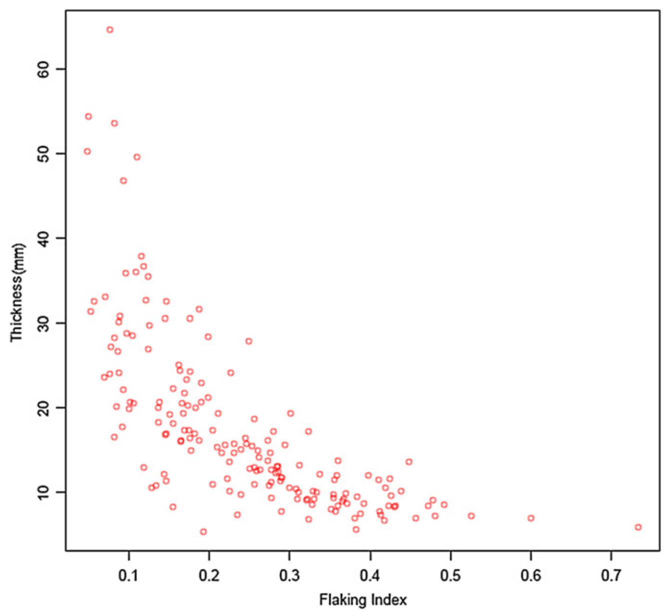


Fig. 5. Bifaces plotted by flaking index and thickness. Graph shows an inverse relationship demonstrating that these variables estimate stage of reduction at Topper.

4. Results

4.1. Biface technology at Topper: reconstructing the Clovis production process

According to the technological variables and flaking index, the Topper assemblage has 68 bifaces in early stages of reduction, 68 in middle stages of reduction, and 38 in late stages.

Bifaces were crafted from spalls, or possibly with suitable nodules, of ACP chert from the hillside and Savannah River. Natural nodules have maximum diameters ranging from 300 to 500 mm, but often have voids and flaws of cortical-like material that never fully silicified (Goodyear, pers. commun., 2010), limiting potential biface size. Based on early-stage biface sizes, Clovis knappers selected blanks that varied in size from approximately 11 to 65 mm in thickness (other dimensions are discussed below). Initial production involved bifacial reduction of nodule/biface blanks (35%), spall blanks (32%), or blade-like flake blanks (2%).

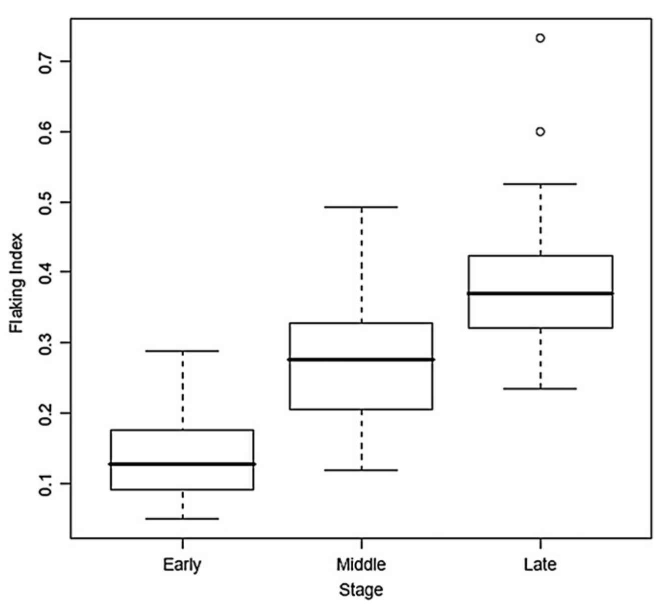


Fig. 6. Bifaces distributed by flaking index and stage. Black line represents the median flaking index. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers—two finished discarded fluted points.

After initial reduction, Clovis flintknappers thinned and shaped the biface. Lateral thinning produced wide bifacial-thinning flakes with flat cross-sections and isolated and abraded platforms. None of the Topper bifaces, excluding the finished fluted points, show signs of edge abrasion; however, platforms of thinning flakes are often heavily abraded, demonstrating Topper knappers regularly used this strategy.

Biface thinning was often achieved by overshot flaking (Fig. 7). A total of 280 overface-flake and 46 overshot-flake scars were recorded on the 174 Topper bifaces, an average of 1.61 overface-flake and 0.26 overshot-flake removals per biface (Table 2). Further, among early-stage bifaces, 66% have overface removals and 24% have overshots; among middle-stage bifaces, 84% have overface removals and 16% have overshots; and among late-stage bifaces, 76% have overface flaking and 26% show signs of overshot flaking (Tables 3 and 4). Based on flaking indexes calculated for proximal ends of 20 actual overshot flakes in the assemblage, 10 were removed during early-stage reduction, 7 were removed during middle-stage reduction, and 3 were removed during late-stage reduction. Thus, overface/overshot techniques were used throughout the reduction process, with no significant relationship with stage.

End thinning also occurred with regularity throughout the reduction process. Of 68 early-stage bifaces, 34% have evidence of end thinning; this ratio is not statistically different from end thinning in middle-stage bifaces (46%) and in late-stage bifaces (53%) (Table 5). Final end thinning or fluting also is present on all three-point bases. Thus, this thinning strategy was used throughout the reduction process.

4.2. Preform production at Topper

Shaping of Topper bifaces was typically governed by two factors: intended size and function of the bifacial tool. Clovis knappers were crafting preforms for fluted points. Eighty-four bifaces are lanceolate forms reduced on a projectile-point trajectory. They have overshot and marginal edge-trimming and multi-stage end-thinning removals. Thirty-two are late-stage preforms with lateral and basal edges not yet ground for hafting and no evidence of use.

A unique aspect of the Topper assemblage is significant variation in manufactured preform size (Fig. 8). Width-to-thickness ratios demonstrate this variability, with preform ranges from 20:5 to 80:14 in size, indicating that at Topper there was no standard blank size (Fig. 9). Nevertheless, Clovis knappers did use the same strategies when crafting the wide-range of preforms—all sizes possess “Clovis-type” attributes; they only vary in the scale of reduction.

Of the 10 complete/refitted specimens, two groups cluster by length and width, with a size threshold of approximately 85 mm in length and 45 mm in width distinguishing the size groups (Fig. 10). Large preforms have lengths and widths that range from 115.0 to 144.80 mm and from 55.1 to 56.2 mm, respectively. Small preforms are more variable; their lengths range from 38.2 to 84.5 mm and widths vary between 22.3 and 41.9 mm.

The smaller preforms are unique examples of variation in production. They have dimensions comparable to finished fluted points. Knappers did not halt reduction because of size; instead, they continued to shape these as point preforms and eventually discarded them due to manufacturing errors. Further, five of the eight complete smaller preforms have remnants of original blank surfaces indicating they were made on small flakes and likely

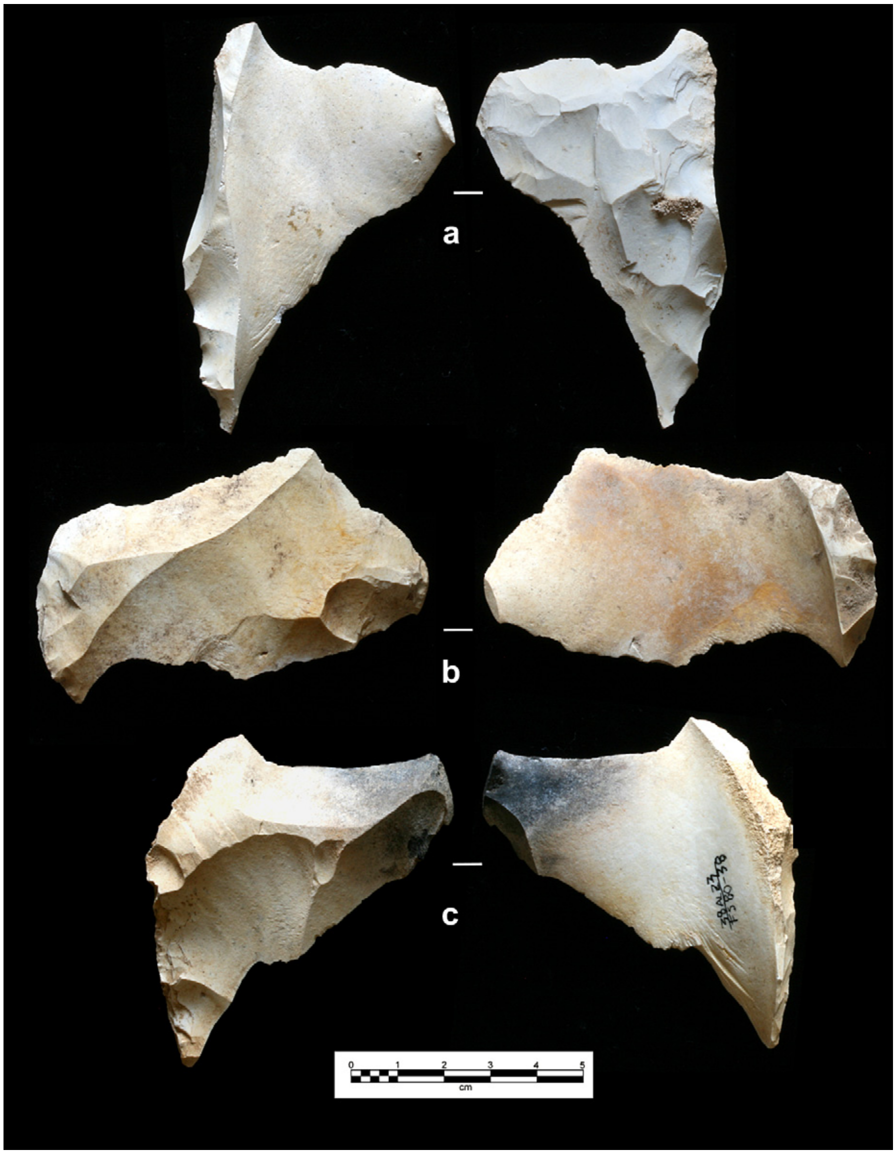


Fig. 7. Overshot flakes from the excavated Topper assemblage.

required less flaking. If size variation was not a limiting factor, perhaps accepting smaller preforms for point production was also a quick-reduction alternative.

When size of preform fragments is considered, another representation of the accepted variation in production is apparent. There is a void of complete discarded preforms falling within the middle-size range, 36–42 mm wide by 9–12 mm thick (Fig. 9). If quarry debris is considered a good indication of what was being manufactured at the site, and the absence of complete discarded preforms is an indicator of what left the quarry, then knappers were also manufacturing preforms of this middle-size range.

4.3. Production of other bifacial tools

Thirty-four bifaces are morphologically distinct from preforms. Based on flaking index these bifacial tools fall into the middle stage of reduction. Most of these tools are similar to preforms with refined marginal flaking and are generally small in size, but they are not lanceolate-shaped and lack squared, beveled bases for fluting. They represent a divergence in production strategies and fall into four other morphological categories.

Nine of the bifaces are interpreted as cores (Fig. 11). Five are small-expended flake cores ovoid in shape with maximum linear

Table 2
Frequency of thinning removals by stage of reduction by count of actual flake scars on bifaces.

	Early-stage bifaces ($n = 68$)	Middle-stage bifaces ($n = 68$)	Late-stage bifaces ($n = 38$)	Total bifaces ($n = 174$)
Frequency of overshot-flake scars on bifaces (ratio of overshots to bifaces)	24 (0.35)	11 (0.16)	11 (0.29)	46 (0.26)
Frequency of overface-flake scars on bifaces (ratio of overfaces to bifaces)	83 (1.22)	117 (1.72)	80 (2.11)	280 (1.61)
Frequency of end-thinning flake scars on bifaces (ratio of end-thins to bifaces)	42 (0.61764)	46 (0.67647)	45 (1.18)	133 (0.76)
Total	149	174	136	459

Table 3
Incidence of bifaces with overshot flaking by stage of reduction. This technique was used throughout reduction.

Number of overshot removals						
Biface stage	0	1	2	3	4	Total number of bifaces with overshots (% bifaces in stage)
Early ($n = 68$)	52 (76.47%)	12 (17.64%)	1 (1.47%)	2 (2.94%)	1 (1.47%)	16 (23.53%)
Middle ($n = 68$)	57 (83.82%)	11 (16.18%)	0 (0%)	0 (0%)	0 (0%)	11 (16.18%)
Late ($n = 38$)	28 (73.68%)	9 (23.68%)	1 (2.63%)	0 (0%)	0 (0%)	10 (26.31%)

$X^2 = 1.8389$, df $= 2$, $p = 0.3987$.

dimensions from 54.6 mm to 83.5 mm. Four are similar to what Collins and Hemmings (2005:15) describe as discoidal cores. These are round thin cores that produced wide flat flakes. One is a complete discoidal core, 121.2 mm long, 94.6 mm wide and 24.5 mm thick.

Other bifaces were crafted into tools (Fig. 12). Like many of the preforms, these bifaces were made on spalls and thinned with broad removals, but final shaping varied. Eighteen have characteristics of heavy bifacial chopping tools, as described by Collins and Hemmings (2005). Twelve of these are ovoid bifaces with bi-convex cross-sections. They have one obtuse (≥90 degrees) lateral edge, and in many cases this edge is naturally backed with remnants of cortex. The opposite lateral edge is notably more acute (50–60 degrees) with radial flaking, crushing, and stepping at the margin. The remaining six has shapes comparable to Dalton adzes (Morse and Goodyear, 1973). These ovoid bifaces have plano-convex cross-sections with marginal flaking and stepping concentrated mainly at distal ends of convex faces (c.f., Collins, 2002). Angles at this potential working edge vary between 50 and 70 degrees.

Four of the Topper bifaces are morphologically similar to small knives (c.f., Collins, 2007:73). Each was made on a flake blank and retained evidence of the original spall. Generally, these tools are asymmetrical in shape; one lateral edge is straight while the other is excurvate. The excurvate lateral margin has an acute angle of 40 degrees and marginal flaking concentrated on the edge.

Three bifacial tools made on spalls are morphologically similar to wedges (c.f., Bamforth, 2007; Keeley, 1980). Each's proximal end is blunt, rounded, and appears to have been battered, while the distal end tapers to approximately a 60-degree angle; it has been marginally flaked to create a squared termination. On both faces of this edge, there are flake removals with pronounced concentric ripples, stepping and crushing. Based on their context and morphology, these bifaces likely served as tools, not bipolar cores (cf., Goodyear, 1993).

At Topper, not all bifacially-reduced pieces were intended to become preforms for fluted points. These other bifacial tools represent variation from the standard preform reduction trajectory, and with this, they offer a broader view of the production process and potential functions of bifaces at a Clovis quarry site.

5. Discussion

The Topper Clovis assemblage is unmixed and separated stratigraphically from later Archaic occupations and has been OSL dated to 13,200 ± 1300 cal B.P. (UIC-763) (Waters et al., 2009). Large block excavations have produced bifaces, fluted-point preforms, fluted points, an extensive unifacial tool assemblage of macro-blades, denticulates, and scrapers and large quantities of debitage (Goodyear et al., 2007). Thus, the size and contextual integrity of the biface assemblage makes Topper a good case for studying Clovis biface production and technological organization in the American Southeast. The discussion that follows addresses the four main questions raised above.

5.1. *Did flintknappers at Topper use standard Clovis production strategies?*

Flintknappers at Topper employed distinctive techniques of Clovis biface production, similar to those at other Clovis sites (Bradley et al., 2010; Collins and Hemmings, 2005; Collins et al., 2007; Dickens, 2005; Morrow, 1995; Waters et al., submitted for publication). Bifaces were produced on nodules and spalls of ACP chert, and about 32% of bifaces retained evidence of the original spall surface. Overface and overshot flaking, as a controlled lateral-thinning strategy, was used throughout the production process, as frequently as at other Clovis quarry sites, like Gault Area 8. In terms of early-stage biface reduction, overshot flakes occurred on 24% of the Topper bifaces and 21% of the Gault bifaces (Waters et al., submitted for publication). Gault secondary bifaces have a slightly higher frequency of overshots (21%) compared to Topper middle-stage bifaces (≈16%), and at Topper the incidence of overshots increases again in late-stage reduction (26%). Similar to Gault preforms, 67% of which have overshot scars, 78% of Topper preforms have overface removals and 31% have overshot-flake scars (Table 6). Topper Clovis point fragments, however, do not have remnants of overface or overshot thinning. These flake scars were obliterated by subsequent flaking.

End thinning and fluting to longitudinally thin bifaces was regularly applied throughout the reduction process at Topper, not just for the final removal of a flute. End thinning is not as predominant among early-stage bifaces at Topper (≈34%) as at Gault Area 8 (≈50%), but as the reduction process continues the incidence of end thinning increases at the Topper quarry while levels fluctuate at Gault Area 8 (46% and 22% for middle stage and 47% and 100% for preforms, respectively) (Table 5 and 6). This variability in thinning strategies may be a product of original blank form. Many Topper bifaces were crafted on spalls, while the

Table 4
Incidence of bifaces with overface flaking by stage of reduction. This technique was used throughout reduction.

Number of overface removals							
Biface stage	0	1	2	3	4	5	Total number of bifaces with overfaces (% bifaces in stage)
Early ($n = 68$)	23 (33.82%)	22 (32.35%)	13 (19.12%)	6 (8.82%)	3 (4.41%)	1 (1.47%)	45 (66.18%)
Middle ($n = 68$)	11 (16.18%)	16 (23.53%)	25 (36.76%)	13 (19.12%)	3 (37.50%)	0 (0%)	57 (83.82%)
Late ($n = 38$)	9 (23.68%)	6 (15.79%)	6 (15.79%)	7 (18.42%)	9 (23.68%)	1 (2.63%)	29 (76.32%)

$X^2 = 5.7186$, df $= 2$, p-value $= 0.05731$.

Table 5
Incidence of bifaces with end thinning by stage of reduction. This technique was used throughout reduction.

Number of end-thinning removals							
Biface stage	0	1	2	3	4	5	Total number of bifaces with end thinning (% bifaces in stage)
Early ($n = 68$)	45 (66.18%)	11 (16.18%)	7 (10.29%)	4 (5.88%)	0 (0%)	1 (1.47%)	23 (33.82%)
Middle ($n = 68$)	37 (%)	18 (%)	11 (%)	2 (%)	0 (%)	0 (0%)	31 (45.59%)
Late ($n = 38$)	18 (47.37%)	6 (15.79%)	6 (15.79%)	5 (13.16%)	3 (7.89%)	0 (0%)	20(52.63%)

$X^2 = 3.9556$, df $= 2$, $p = 0.1384$.

majority of Gault bifaces (≈77%) were made by fully reducing tabular chert nodules (Waters et al., submitted for publication). Dickens (2005:47) suggests that in tabular reduction, biface ends were likely thinned more rapidly early in reduction than flaking from unmodified lateral edges of the tab, potentially explaining the difference between Topper and Gault Area 8.

5.2. Did Topper knappers produce bifaces in the standard sizes and shapes observed at other quarry locations?

The thinning strategies discussed above facilitated production of "classic" Clovis preforms with characteristics and dimensions common on specimens throughout North America—at other Clovis

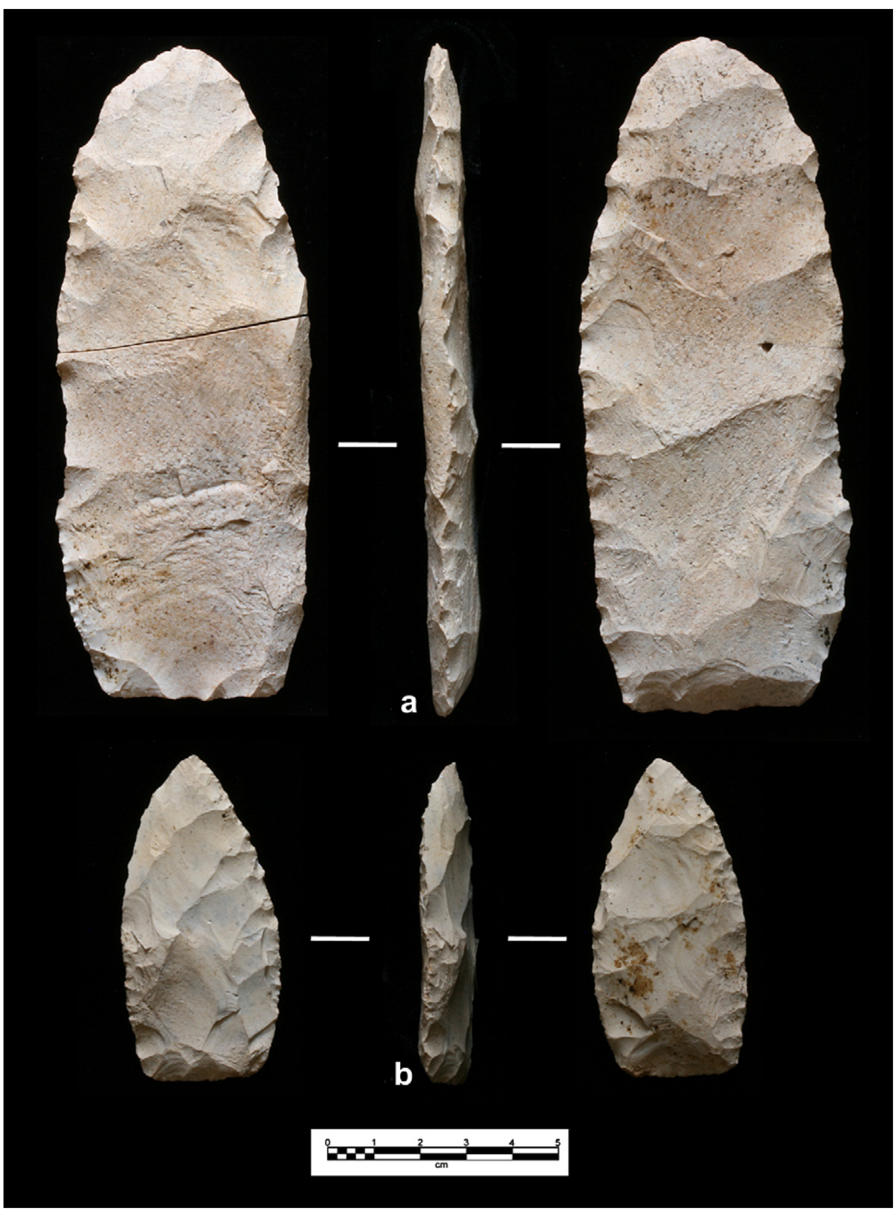


Fig. 8. Examples of preform size variation at Topper: (a) preform with length (144.83 mm) similar to standard descriptions of Clovis preforms and (b) preform with length (69.7 mm) similar to used, finished Clovis points.

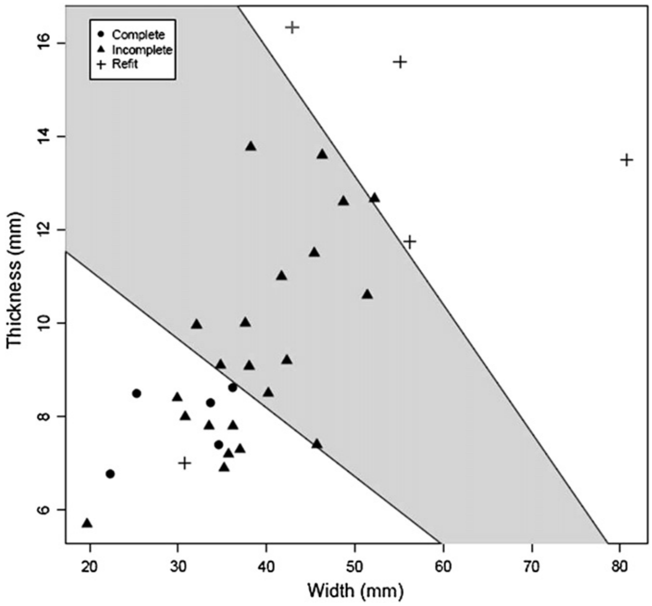


Fig. 9. All preforms evaluated by width and thickness. The highlighted portion represents preform fragments that fall within the middle-size range, with no complete discarded preforms of this size found at the Topper quarry. Preforms from other Clovis sites generally fall within this middle-size range.

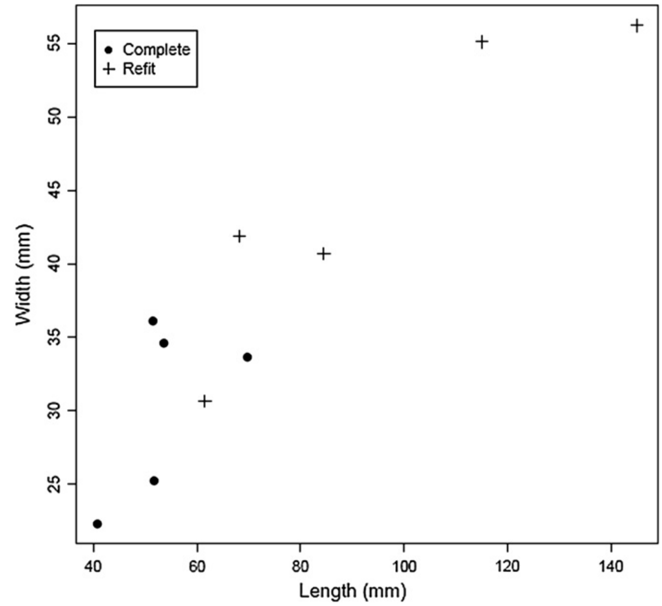


Fig. 10. Complete preforms evaluated by length and width. Preforms cluster by size groups, demonstrating that Topper flintknappers were crafting preforms that varied in size.

sites, preforms are consistently more than 100 mm long and 40 mm wide (Bradley, 1993; Collins, 2007; Huckell, 2007; Waters et al., submitted for publication). These "standard" point preforms are present in the Topper assemblage, but others not so typical of Clovis are present, too. Perhaps this aspect of preform size is the most surprising incidence of variation between Topper and other similarly analyzed Clovis assemblages. Topper knappers produced a broad range of preform sizes for points; complete/refitted preform lengths and widths vary between ≈40 to 145 mm

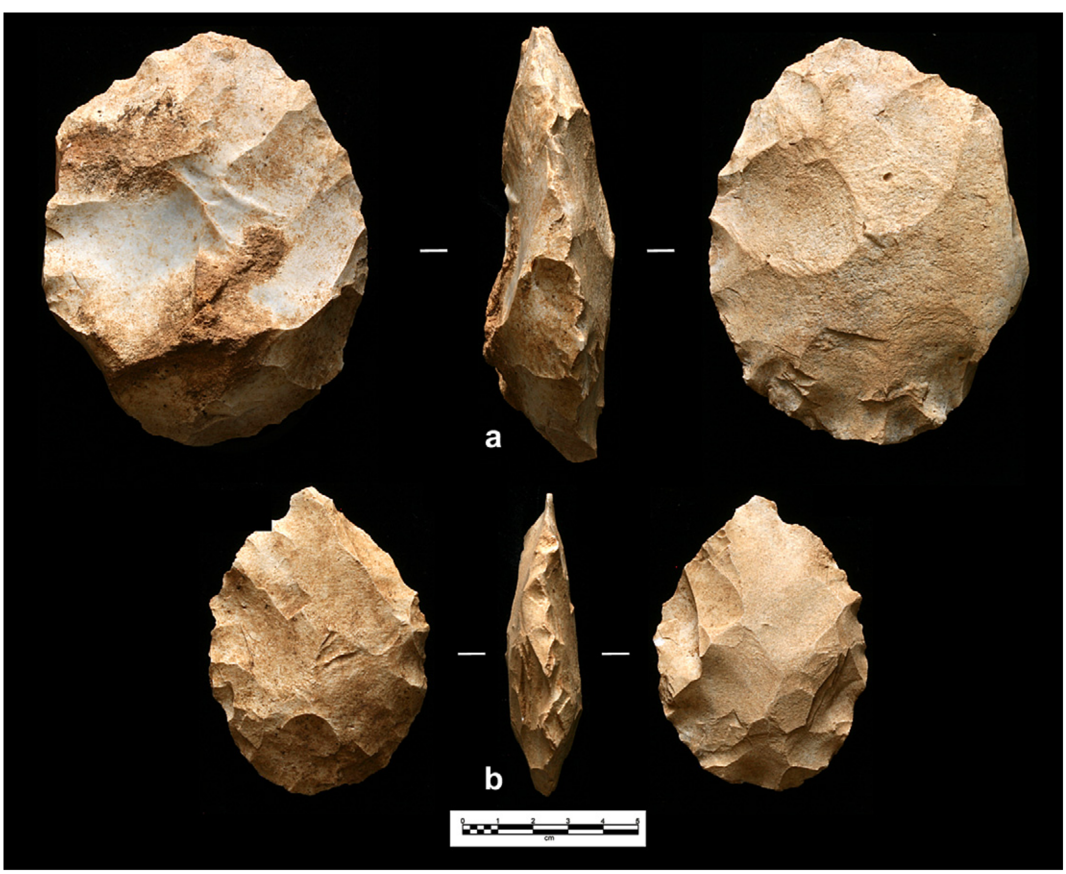


Fig. 11. Examples of cores from the Topper excavations: (a) discoidal core and (b) small flake core.

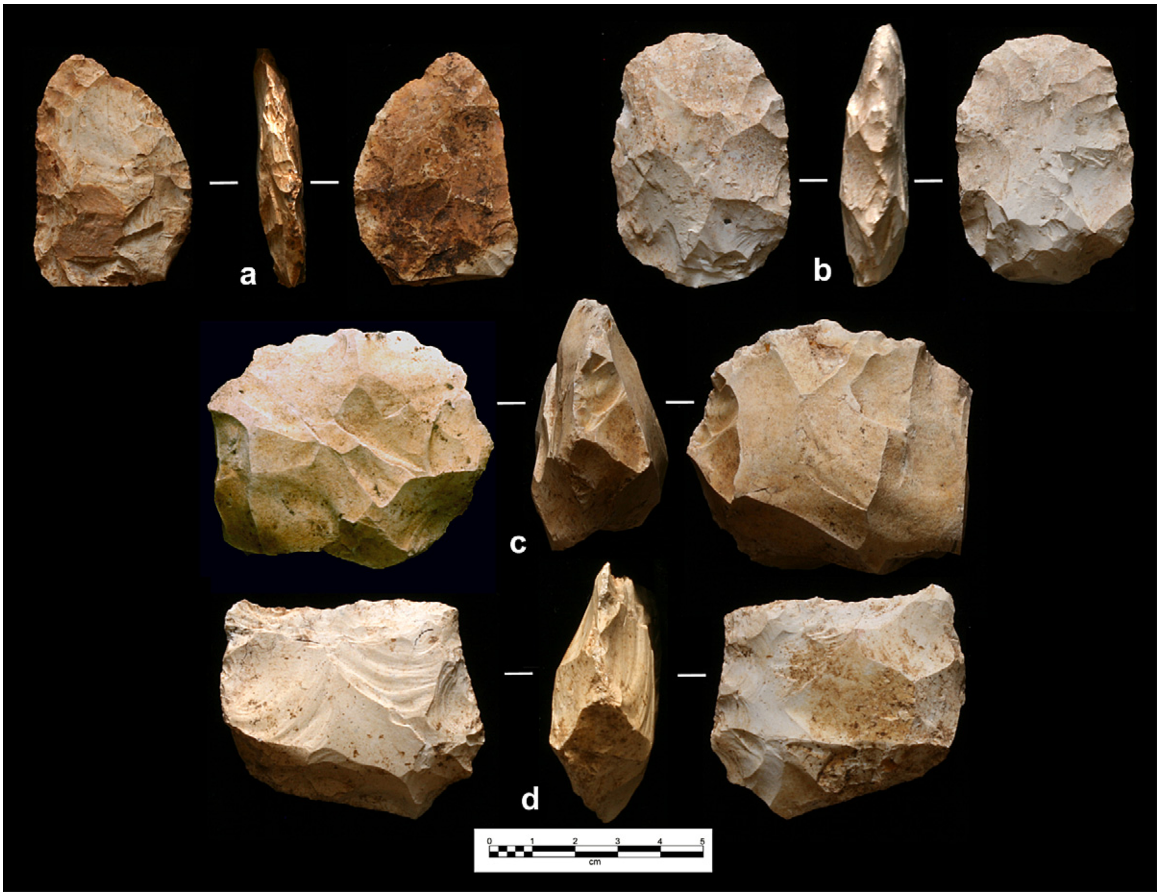


Fig. 12. Examples of bifacial tools: (a) knife, (b) adze, (c) chopper, and (d) wedge.

and ≈20 to 80 mm, respectively. Large preforms allowed for use cycles involving episodes of reworking and reshaping, but the flexibility to do the same with smaller preforms is much more limited. The small preforms at Topper are unique, actually falling within the size range of extensively used and reworked Clovis points from other Clovis sites, like Area 8 at Gault, but unlike at Gault, the small Topper preforms display no evidence of utilization (Dickens, 2005; Waters et al., submitted for publication). A few possible explanations for producing smaller-sized preforms and points have been previously suggested. First, the production of smaller point forms has been associated with the Pleistocene/Holocene transition when the extinction of megafauna may have led to Paleoindian hunters targeting smaller animals, thus the technological difference may mark a temporal and functional shift in the Paleoindian record (Anderson, 2004; Cox, 1986). However, based on ethnographically-documented technologies, point size does not correlate with prey size (Ellis, 1997), and the size variation in points recovered at the Naco Clovis mammoth kill site demonstrate that small points were still viable weapons for hunting megafauna (Haury et al., 1953). Second, smaller point production may relate to a functional difference between points crafted for spearing versus throwing (Ellis et al., 1998), but experimental studies demonstrate there is no correlation with projectile point form and mechanism of launching, because point mass can be balanced by adjustments in the spear or foreshaft (Cattelain, 1997; Ellis, 2004; Greaves, 1997; Yu, 2006). A third possibility is that small preforms are the products of novice knappers (Bamforth and Hicks, 2008; Bradley et al., 2010). In the Topper case, however, the quantity of small preforms, coupled with the regular use of expert thinning techniques, suggests that the Topper preforms were made by experienced knappers, not novices. The use of small Clovis points has also been linked to raw-material restrictions (e.g., limits of material size at the source or flakes transported away) (Haury et al., 1959; Huckell, pers. commun., 2009).

At Topper, the size variation seems best explained by the differences in spalls obtained from size-variable ACP chert nodules. Among early-stage bifaces with low flaking indexes, lengths vary between 26.7 and 176.8 mm, and thicknesses vary between 10.57 and 64.54 mm. Clovis knappers were thus willing and able to create bifaces from spalls varying across a 150-mm length range. Examination of Topper preform fragments is instructive. Fragments range from 20 to 55 mm wide and 4 to 14 mm thick. With average width

Table 6
Incidence of overface, overshot, and end-thin flaking on point preforms.

Number of thinning removals per preform						
Preforms	0	1	2	3	4	Total preforms with thinning scars (%)
Overface-flake scars ($n = 32$)	7 (21.88%)	3 (9.38%)	5 (15.63%)	7 (21.88%)	10 (31.25%)	25 (78.12%)
Overshot-flake scars ($n = 32$)	22 (68.75%)	9 (28.13%)	1 (3.13%)	0 (0%)	0 (0%)	10 (31.25%)
End-thinning flake scars ($n = 32$)	17 (53.13%)	5 (15.63%)	5 (15.63%)	3 (9.38%)	2 (6.25%)	15 (46.87%)

of 38.2 mm and thickness of 9.9 mm, many of these do fall within a middle-size range similar to preform dimensions from other Clovis sites. Morrow (1995:9) reports for the Ready site that preforms average about 95 mm in length, 38 mm in width, and 8.9 mm in thickness. Therefore, the average complete preform from Ready falls within the middle-size range of preform fragments at Topper. This pattern also applies to the refitted preform recovered from the Gault Area 8, measuring 138.2 mm long, 41.7 mm wide, and 9.8 mm thick (Waters et al., submitted for publication:70). At Topper, the presence of similarly sized fragments but absence of complete discarded preforms implies that preforms produced to this standard size were consistently taken away from the quarry. But were the small preforms produced not to be transported from Topper?

Examination of the Paleoindian Database of the Americas (PIDBA) for South Carolina sheds light on this question (Anderson et al., 2005) (Fig. 13). In PIDBA, there are 38 complete, unresharpened, Clovis points crafted from ACP chert. Their mean length is 60.4 mm, mean width is 26.6 mm, and mean thickness is 6.9 mm. Mean length is not significantly different from complete/refitted small preforms at Topper, averaging 60.2 mm in length ($p = 0.354$), but mean width and thickness are significantly smaller than small Topper preforms (averaging 33.2 mm wide and 9.6 mm thick) ($p < 0.01$). In other words, in terms of length, the small preforms from Topper could have been shaped into points and used away from the quarry. The preforms are wider and thicker than the average isolated point, and perhaps these dimensions were most affected in the final stages of shaping, edge retouching, and haft grinding.

Clovis knappers at Topper also made other tools on bifaces, including forms here called small flake and discoidal cores, choppers, adzes, small knives and wedges. Similar types of bifacial tools have been recovered from Gault (Collins and Hemmings, 2005). Bradley et al. (2010) refer to adzes, specifically recovered from the Gault site, as a component of the Clovis techno-complex, and the examples from the buried, intact component at Topper may represent the first recovery of this Clovis tool type in the East. While these bifaces are not particularly diagnostic to Clovis, their presence shows the variety of activities that took place at Topper (e.g., woodworking or cutting tasks) and is evidence that the Topper Clovis occupation represents a multifunctional campsite, like Gault (c.f., Collins, 2007).

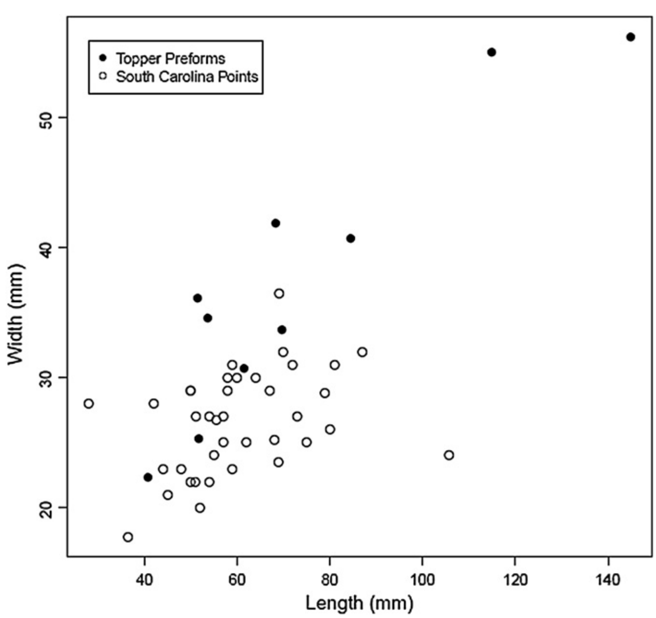


Fig. 13. Comparison of complete South Carolina isolated points and complete/refitted small Topper preforms plotted by length and width. In terms of length, small Topper preforms could be taken away from the quarry and crafted into points.

5.3. What does the Topper biface assemblage tells us about Clovis technological organization and mobility in the American Southeast?

Although Clovis knappers at Topper used production strategies typical of Clovis-period manufacture, there is more variation in production here than previously reported at other sites. Variability in ACP chert spalls clearly guided biface production, and knappers adjusted technology to produce bifaces in a variety of sizes and forms.

Rather than just manufacturing large maintainable biface cores and finished points, the early Topper occupants also produced bifacial tools like adzes, choppers and knives. These forms reveal a greater functional diversity in the Clovis bifacial tool kit and indicate that more than quarrying occurred, suggesting Topper was a multifunctional workshop/campsite where quarrying and other subsistence activities were conducted. Further, Topper knappers produced late-stage preforms with evidence of diagnostic thinning strategies but dimensions that fall in a broader size-range. This variation implies that Clovis groups adjusted the bifacial components of their mobile tool kit with variation in raw material, and the possible range of preform sizes adds an element of variability to tool kit design.

Variation in tool kit design and technological organization has implications for Clovis mobility in the region. One model of Clovis settlement predicts Clovis people rapidly moved across North America with a consistent behavioral adaptation and without settling into areas or focusing on particular resources, as presented in the HTF settlement model (Kelly and Todd, 1988). The expected archaeological correlates for this mobility pattern include the discard of exotic expended bifacial cores, flake tools and debitage from tool resharpening. In addition, quarrying should have focused on the production of bifaces designed for prolonged maintenance and long, variable use-cycles (Kelly and Todd, 1988). An alternative model predicts Clovis populations varied the frequency and/or magnitude of mobility, altering technology and settlement to suit ecological needs, and adapting their mobility system to incorporate the habitual use of productive locations and accordingly altering organization of technology (Anderson, 1991, 1996; Collins, 2007; Meltzer, 2004). Lowered Clovis mobility would have produced archaeological correlates including continuous, undifferentiated scatters of debris from long-term or redundant site use, evidence of a greater dependence on locally acquired material, and diverse tool assemblages (Anderson, 1996; Collins, 2007).

To adequately test these models, the complete Topper assemblage, including all tool forms, must be fully characterized and placed into a broader regional context and compared to other sites of similar size (e.g., Carson Conn Short and Williamson), as well as other site types, like kills and camps. Preliminarily, though, the Topper biface assemblage provides little evidence for long-distance transport of expended biface cores and tools, aside from two rhyolite point fragments from the Uwharrie Mountains, North Carolina. Further, the long use-life expectation of the HTF model is not supported. Raw material size and quality restrictions at Topper appear to have limited the size and potential utility of biface cores, and preforms are in many cases no larger than exhausted Clovis points. Despite this, Clovis groups clearly relied on the Topper outcrop for biface production, amassing a large quantity of bifaces and associated debitage. These patterns are suggestive of lower Clovis mobility.

While this assessment of mobility is currently only tentative, the evidence from the Topper biface assemblage presented here does suggest that Clovis populations in this region adjusted their biface technology to suit local resource conditions, and in the case of Topper, for an outcrop that produced spalls of variable quality and sizes. This adjustment in production strategies means Clovis people in the American Southeast were technologically flexible—they adapted to local resource conditions and adjusted the organization of their technology accordingly. They possibly adjusted settlement organization as well, but further analysis of the Topper assemblage and other Clovis assemblages from the region are needed to fully investigate this issue.

6. Conclusions

The Topper site offers a rare glimpse of the entire range of Clovis biface production from a poorly understood region—the American Southeast. The analyses presented here help confirm the regular use of technological strategies we commonly associate with the Clovis culture; however, variation in the assemblage has provided new insights into the diversity of Early Paleoindian technological organization across the continent. Due to variation in raw-material packages, knappers at Topper did not consistently produce standard-sized preforms. Preforms were variable in size, with many being smaller than some known finished, used Clovis points. This variation, coupled with production of other bifacial tool forms likely used on-site, suggests that Clovis populations at Topper adjusted production strategies to suit resource conditions and local needs.

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